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Contents

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No.	Research Title	Page(s)
1.	Evaluation of Biosafety and Biosecurity procedures in Airport Road Polyclinic laboratory, Tripoli-Libya. Somaya Elgodwi	E1 – E7
2.	Prevalence of Hyperuricemia in Type 2 Diabetes Mellitus Patients Attending Khoums Diabetic Center.Mohammed Farhat S.and others	E8 – E14
3.	Performance Evaluation of VGG19 Deep Learning Model for Chest X-ray Image Classification Bader N. Awedat, Alqasr	E15- E33
4.	Phytochemical Screening, Quantitative Evaluation and Biological Activity of Acacia(Nilotica) Leaves in Libya.Adel M Mlitan and other	E34– E51
5	Production of antibiotics from Neochlorise Alga by partially analyzing their molecules to uncover beneficial biological properties. Fatima S. R. ELBARASI1	E52– E68
6	Scented Shadows: The Hidden Dangers of " "Incense Smoke in Libyan Culture Melod M, Unis1	E69– E80
7	study of Relationship Between Heparin and .Platelets in Hemodialysis Patients Mustafa Lawar.and other	E81– E93
8	Study of some epidemiological aspects of chickenpox in EL-Marj city Rajab Saeid Mashathi	E94– E104
9	The impacts of Cigarettes on Serum Creatinine levels.Riad M Aboghalia and others	E105– E111
10	Fast Removal of Methyl Green Dye From Aqueous Solutions by Adsorption on Commercial Poly Urethane Foam Khalifa Algheryani.and others	E112– E123
11	PHYCOREMEDIATION USING MICROALGAE IN PUBLIC MARKET WASTEWATER Aisha A. AmhimmidAlqantosh	E124– E133

12	Analyzing the ground water quality between the southern Libyan regions of Al-Fujeij and Al-Kharig using Total Dissolved Solids and PH data Abdulrahman Abdulsalam Bin Zayd	E134– E144
13	THE FUTURE OF ENGINEERING: INTEGRATING ARCHITECTURAL DESIGN WITH COMPUTER TECHNOLOGIES IN THE CITY OF AJDABYA SALMIN MOHAMED BELGHSEM ELHASI.and others	E145– E166
14	Evaluation of Intelligent Reflecting Surfaces versus Massive MIMO Technology in Near Field Wireless Communications Alia Andi.and others	E167– E175
15	Load Frequency Control Stability utilizing a GA-PID Controller AlnajehabraheemAllafi.and others	E176– E191
16	THE EFFICIENCY OF PHYTOREMEDIATION IN NUTRIENT REDUCTIONS IN CHICKEN SLAUGHTERHOUSE WASTEWATER Alfituri Ibrahim Abdullah Abu ala and others	E192– E199
17	Joint performance in jointed concrete pavements with focus on dowel and aggregate interlock interaction under various traffic loads SHABAN SALEM	E200– E226
18	Full Coverage System Using High Altitude Platforms for Benghazi City Atif I. E. Tajouri	E227– E233
19	Assessment of natural radioactivity and radiological risks in the sandy beaches of Qarabulli city, Libya Nuclear Research Center in Tajoura NRCT. Khadija Aliand others	E234– E246
20	Model Reference Adaptive System for Speed Estimation of Permanent Magnet Synchronous Motors Ezzaddine Ahmed Amhmed and others	E247– E262

21	Adaptive antenna array for improved SNR in MIMO communications x4 adaptive antenna array10 Ashraf Sherif	E263– E271
22	Design and Implementation of Sun Tracking System Using Android Board Salem A. Shufat	E272– E293
23	Design Solar Panel Cleaning Robot to Optimise System Efficiency Ibrahim Imbayah and others	E294– E306
24	CFD Analysis of Finned Tube Heat Exchanger to Impact the Heat Transfer Performance by Geometric Modification Salem Alabd Mohamed	E307– E318
25	COMPRESSION CHARACTERISTICS OF LIME STABILIZED COHESIVE SOILFathi Mohammed. Ashmila	E319– E327
26	Eco-Friendly Biodiesel Production from Waste Cooking Oil Mohammed Ahmed Altouns and other	E328– E342
27	Plasma amino acid levels in children with autism: An Libyan sample ElhedmiAbdulkhaleg and others	E343– E357

Evaluation of Biosafety and Biosecurity procedures in Airport Road Polyclinic laboratory, Tripoli-Libya.

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Abstract

Background :

Biosafety and biosecurity are considered to be the essential practices which should be constantly implemented and enforced in all bioscience research settings and diagnostic medical laboratories around the globe. The World Health Organization (WHO) has long acknowledged that safety, particularly biological safety, is a significant international concern, especially in developing countries where standard operating procedures (SOPs) are typically inadequate.

Objective: To evaluate the current biosafety and biosecurity practices and regulations in the Airport Road Polyclinic laboratory in Libya. Additionally, the goal is to develop a set of recommendations for implementing improved biosafety and biosecurity measures.

Methods: Data were collected through a questionnaire distributed to 80 technicians working in the laboratory of Airport Road Polyclinic from November to December 2023. The questionnaire aimed to assess awareness of biosafety and biosecurity measures and to identify the practices being implemented by laboratory technicians in their routine work.

Results:

The results of this study revealed that 68.5% of laboratory technicians used gloves and lab coats, while only 27.5% of participants had received their recommended vaccinations. Additionally, 53.8% of respondents stored food, drinks, and medicine in the laboratory.

Also this study showed 59% of the technicians not separate broken glass from regular trash. In the present study 68 (85 %) technicians were exposed to needlestick injury and the most common causes associated with needle stick injuries was overcrowding in the work.

This study also revealed that 10% of technicians written a report about any lab accidents and only 2.5% of technicians trained on biosafety programs.

Conclusion: This study concluded that the level of biosafety and biosecurity measures in the Airport Road Polyclinic laboratory was

significantly low. Furthermore, the awareness of proper laboratory practices among laboratory staff and technicians was generally lacking.

Keywords: Biosafety; Biosecurity; Evaluation.

Introduction

Many laboratories present substantial risks, and preventing accidents requires meticulous care and ongoing vigilance. Examples of risk factors include high voltages, extreme pressures and temperatures, corrosive and toxic chemicals, and biohazards such as infectious organisms and their toxins.

Biosafety and biosecurity are considered to be the essential practices which should be constantly implemented and enforced in all bioscience research settings and diagnostic medical laboratories around the globe. The World Health Organization (WHO) has long acknowledged that safety, particularly biological safety ^[1], is a crucial international issue, especially in developing countries where standard operating procedures (SOPs) are often inadequate ^[2].

Biosafety is complementary to biosecurity and both concepts are essential to protect laboratory workers, environment and population. Biosafety practice in any clinical laboratory refers to proper use of equipment, devices and facilities, in the way of assuring the safe storage, handling, and disposal of hazards biological material and living organisms capable of causing diseases. It also refers to reduce or eliminate accidental exposure to potential hazardous ^[3]. On the other hand, biosecurity is a critical part that has been put in place by bioscience laboratories efforts to prevent the spread or introduction of harmful organisms and toxins to human, animal community and plant life in the surrounding areas. Laboratory staffs who deal with blood or any biological samples are usually at a continuous risk of getting occupational infections.

In many countries, laboratory work is governed by health and safety legislation. In some instances, laboratory activities can pose environmental health risks, such as the accidental or intentional release of toxic or infectious materials into the environment [4].

Measures to safeguard against laboratory accidents include safety training, safe waste management, safety reviews of experimental designs, and the use of personal protective equipment.

This study was conducted to assess and evaluate the biosafety and biosecurity practices and regulations in the Airport Road Polyclinic laboratory in Libya, with the aim of developing a set of recommendations for implementing effective biosafety and biosecurity procedures.

Methodology

Evaluation of Biosafety and Biosecurity procedures in Airport Road ——— Polyclinic

Data were collected through a questionnaire distributed to 80 technicians working in the Airport Road Polyclinic laboratory from November to December 2023. The purpose was to assess awareness of biosafety and biosecurity measures and to identify the practices performed by laboratory technicians in their routine work.

The questionnaire included various questions addressing different aspects of biosafety and biosecurity practices, along with basic inquiries regarding personal protective equipment (PPE), such as the wearing of gloves and lab coats, vaccination programs, and routine laboratory practices, including unsafe behaviors like eating or drinking in the lab. Additionally, the survey asked about services provided within the laboratory, such as the presence of international biohazard symbols and signs, accident records, and training in biosafety and biosecurity.

Data were qualitatively checked and analyzed using the statistical software SPSS Version 20, with a p-value of less than 0.05 considered statistically significant.

Results

In terms of personal protective equipment, 68.5% of workers routinely used gloves and lab coats, while 31.5% reported never using these protective tools. Additionally, the survey indicated that 72.5% of technicians were not vaccinated against infectious diseases, compared to 27.5% who had received vaccinations.

The study also evaluated the practices of laboratory technicians during their routine work. It was noted that 59% of laboratory technicians removed their gloves while using computers or phones, whereas 41% either never or occasionally did so. Furthermore, 53.8% of respondents stored food, drinks, medicine, and cosmetics in the laboratory, with only 46.2% indicating that they rarely or never did this.

The findings also revealed that 51.3% of technicians did not cover centrifuge machines during operation, and accidents during specimen centrifugation were reported in 70% with the technicians surveyed.

About 25% of the technicians declared that they do not disinfect worktables, while the remaining technicians sterilize their workbench either occasionally or regularly.

In the present study, 64% of lab staff know the location of emergency equipments.

Also this study showed 59% of the technicians not separate broken glass from regular trash.

In the present study 68 (85 %) technicians were exposed to needlestick injury and the most common causes associated with needle stick injuries was overcrowding in the work.

This study also revealed that 10% of technicians written a report about any lab accidents and only 2.5% of technicians trained on biosafety programs.

Table 1: biosafety and biosecurity practices.

Question	Yes	No	P value
Is protective clothing worn for example, lab coat, and gloves?	68.5%	31.5%	0.531
Have you take any recommended vaccines against infection diseases?	27.5%	72.5%	0.000
Do you remove your gloves while working on a computer or using your phone?	59%	41%	0.001
Are food, drink, medicine and cosmetics stored or consumed in lab?	53.8%	46.2%	0.002
Do you cover centrifuge and samples during centrifugation?	48.7%	51.3%	0.001
Have you encountered any rupture accidents during specimen centrifugation?	70%	30%	0.001
Do you know the location of emergency equipment's?	64%	36%	0.001
Do you keep your laboratory doors closed, when testing is undergoing?	36%	64%	0.000
Do you know how to use fire extinguisher in laboratory ?	23%	77%	0.000
Do you dispose of needles in sharps box?	93.8%	6.2%	0.000
Do you dispose of the broken glass separately from regular trash?	41%	59%	0.002
Do you wash your hands after work?	80%	20%	0.000
Do you disinfect your hands after work?	67.5%	32.5%	0.000
Do you disinfect your workbench ?	75%	25%	0.000
Do you know how to deal with blood spillage?	36.3%	63.7%	0.002
Have you been exposure to needlestick injury	85%	15%	0.000
Have you written a report about any lab accidents?	10%	90%	0.000

Evaluation of Biosafety and Biosecurity procedures in Airport Road — Polyclinic

DO you know international biohazard symbols and signs ?	41%	59%	0.002
Is there any formal biosafety training programs in your lab?	2.5%	97.5%	0.000

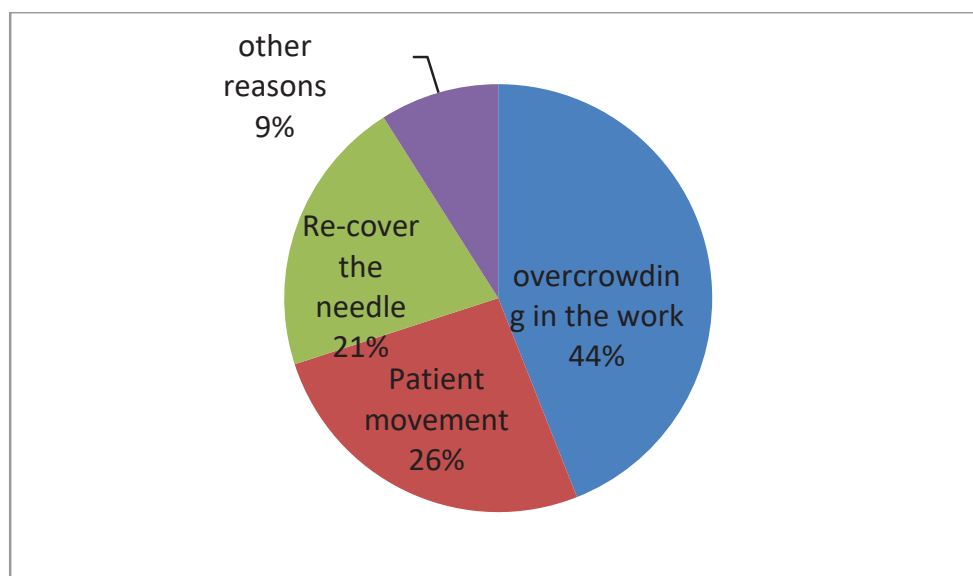


Figure 1 : Causes Of Needle Stick Injuries

Discussion

The current study found that personal protective equipment (PPE), such as gloves and lab coats, was used by 68.5% of technicians. This result contrasts with findings from Pakistan, where only 31.9% of participants reported using gloves and lab coats ^[2].

Additionally, the study indicated a low rate of immunization, with only 27.5% of participants vaccinated against infectious diseases. This could be attributed to a shortage of adequate resources and a lack of attention from relevant authorities. However, this percentage is higher compared to the 21% reported in Libya by Franka (2009) ^[5].

Furthermore, around 51.3% of laboratory workers did not close the centrifuge machines during operation, which differs from a previous study in Pakistan where 25% of technicians left their centrifuge machines open [2]. The present study also revealed that tube breakage in centrifuges was common, occurring in 70% of cases, which can lead to the release of aerosols and increase the risk of acquired infections.

Moreover, about 25% of technicians never disinfected their worktables. This finding aligns with an earlier study in Pakistan, where 23.7% of technicians reported not disinfecting their work areas ^[2].

A lack of restricted access to laboratory was also noted; only 36% of respondents reported closing laboratory doors during work hours, leaving the

majority of doors unlocked. This poses a risk of biological material being transported outside the lab.

Finally, 53.8% of technicians stored or consumed food, drinks, medicine, and cosmetics in the laboratory. This is higher than the rate observed in a Turkish study, where only 38.3% of technicians reported consuming food and drinks in the lab ^[6].

In this study 68 (85 %) of technicians were exposed to needlestick injury .

This result was low compared to those reported in Taiwan (87%) ^[7].

The most common causes associated with needle stick injuries was overcrowding in the work .

This result not similar to another study done by Varma (2000) in Indian which mentioned The most common causes associated with needle stick injuries was re-cover the needle ^[8].

Also in this study revealed that 10% of technicians written a report about any lab accidents and only 2.5% of technicians trained on biosafety programs.

This result not similar to another study done by Shiferaw (2011) in Ethiopia. which mentioned All the staff did not train on the infection control ^[9].

Conclusion and Recommendations

The study reveals that the biosafety and biosecurity measures in the Airport Road Polyclinic laboratory are inadequate. Additionally, the awareness among laboratory personnel regarding the implementation of biosafety and biosecurity principles is also lacking.

Based on the findings of this study, the following recommendations are proposed to enhance biosafety and biosecurity practices in diagnostic laboratories:

It is essential to enhance the awareness of biosafety and biosecurity practices among laboratory workers through mandatory coursework, seminars, and conferences.

The Ministry of Health should establish specialized departments in all hospitals to design and oversee occupational safety initiatives. This includes focusing on staff training to promote awareness and develop their skills effectively.

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**Evaluation of Biosafety and Biosecurity procedures in Airport Road ———
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Prevalence of Hyperuricemia in Type 2 Diabetes Mellitus Patients Attending Khoums Diabetic Center

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ABSTRACT

Background:

Type 2 is the most common form of diabetes mellitus which related to cessation in insulin secretion, decreased in the action of insulin at the target tissue and environmental factors, such as obesity, overeating, physical inactivity and genetic factors are decremented in the etiology Increased uric acid level (Hyperuricemia) in Type 2 DM has been associated with long term complications on various organs such as peripheral neuropathy, retinopathy and nephropathy.

Aim of the work:

The aim of our study was to assess the incidence of plasma uric acid in diabetic patients attending their follow-up diabetic clinic.

Materials and Methods:

The total number was 78 individuals suffering from type 2 diabetes mellitus attending to the outpatient clinic of Khoums Diabetes Center for follow up. The study was done from (April 1 to June 30, 2022). Interviewer-administered questionnaires were used to collect data after obtaining the consent from the participants. The collected blood samples are used for biochemical analysis.

Results:

Our results showed the main age was 45 years in the collected type 2 diabetes cases, 41.02% of cases were males, and 58.98 were females. The cases are divided according to uric acid level into normal (39) and

hyperuricemic (39) cases; the BMI, FBS and glycosylated hemoglobin (HbA1C) levels was elevated in patients with high uric acid levels compared to normal group.

Conclusion:

The results of this study showed an increased serum uric acid levels among type 2 diabetic suffering patients.

Keyword: Hyperuricemia, Diabetes mellitus, Uric acid

Introduction: Diabetes mellitus (DM) is a worldwide growing public health problem [1]. Cessation in insulin secretion or decreased in the action of insulin at the target tissue or both are the main cause of diabetes [2]. A fasting blood glucose level ≥ 126 mg/dL (7.0 mmol/L), post prandial (after 2-hour) plasma glucose ≥ 11.1 mmol/L (200 mg/dL) or glycated hemoglobin (HbA1C) $\geq 6.5\%$ are the criteria for diagnosing DM according to the World Health Organization (WHO) 2006 [3]. 90–95% of cases are from type 2 diabetes mellitus (T2DM) accounting it as the most common form [2], which characterized by hyperglycemia, relative insulin deficiency and insulin resistance [3]. Environmental factors such as obesity, overeating, physical inactivity, stress, aging and genetic factors are all related to impaired insulin secretion and insulin resistance and decremented in the etiology of type 2 DM [4]. The significant long term complications on various organs, such as the heart, kidneys, eyes, nerves and blood vessels are related to the chronic hyperglycemia of diabetes [5].

Early detection of diabetes and proper management and avoid risk factors are the main primary prevention strategies to minimize the incidence of DM and reducing its related complications. Hyperuricemia in T2DM has been demonstrated and correlated with its long term complications [6], also results in a poor prognosis on the diabetic complications such as increased prevalence of diabetic nephropathy, retinopathy and peripheral neuropathy [7].

An increase in serum uric acid (Hyperuricemia) which is the end product of purine catabolism [8], either due to an increase in production or decrease in excretion of uric acid or both are the cause of increase in serum uric acid level (Hyperuricemia) [9]. Uric acid is considered as one of the antioxidants that contribute to the prevention of atherosclerosis in its early stages. However, during later stages of atherosclerosis, elevated uric acid acts as a pro-oxidant rather than an antioxidant [10], and has been implicated in cardiovascular disease through these processes [11]. Moreover lowering uric acid has been

reported to improve insulin resistance in subjects with congestive heart failure [12], and also improving the HbA1c levels in normotensive diabetic subjects [13].

The aim of our study was to assess the incidence of uric acid level among type 2 diabetic patients attending their follow-up diabetic clinic for the early detection of raised serum uric acid and work for prevention of complications among the hyperuricemia diabetic patients, also it will help to form local baseline data for management of patients and provide guidelines for researchers.

Methods: The study was carried from (April 1 to June 30, 2022) on patients diagnosed and attending their follow-up diabetic clinic in khoums Diabetic Center. Interviewer-administered questionnaires were used to collect demographic, clinical and behavior-related factors, as well as anthropometric data. After the consent obtained from the study participants, the collected blood samples are used for biochemical analysis. Data was processed using the software Statistical Package for Social Science (SPSS ve.24.0).

Results: The total number of precipitants was 78 individuals attending the outpatient clinic of khoums Diabetes Center, the mean age was 45 years, 32 cases were males, and 46 were females figure 1.

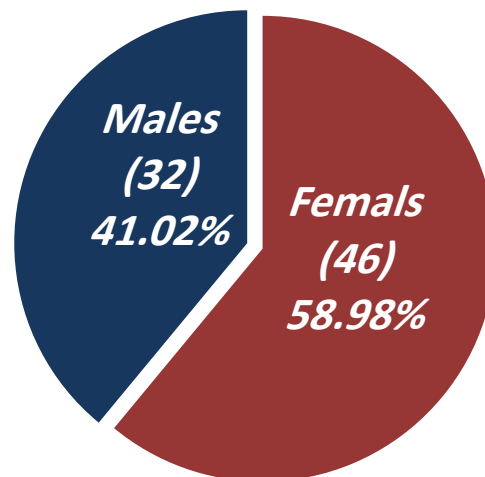


Figure (1): showing the male (32) and the female (46) and their percentage who are participated in this study.

The cases are divided according to the uric acid level into two groups; hyperurivemic group (39) cases and normal uric acid level group (39) cases. Table 1 shows the distribution of females and males in hyperuricemic and the normal uric acid level group (normal group). Table 2 shows that the mean uric acid level (7.8) and the mean HbA1c

level (5.46) are significantly higher in hyperuricemic group in compare to the normal group. Also BMI and FBS were higher in hyperuricemic group but insignificant compared to the normal uric acid level group.

Table (1): shows the distribution of cases in normal and hyperuricemic groups according to gender

	Normal		Hyperuricemic		Total
	No. of cases	%	No. of cases	%	
Females	24	61.54	22	56.41	46 (58.97%)
Males	15	38.46	17	43.59	32 (41.03%)
Total	39		39		

Table (2): shows the main serum uric acid level in (mg/dl), the mean glycosylated hemoglobin (HbA1C) level in %, the main fasting blood sugar in (mg %) and body mass index (BMI)

Parameter	Normal uric acid cases (39) Mean $\pm$ SD	Hyperuricemic cases (39) Mean $\pm$ SD	P. value
Uric Acid (mg/dl)	4.6 $\pm$ 1.42	*7.8 $\pm$ 0.85	0.000
HbA1C (%)	5.07 $\pm$ 0.6	*5.46 $\pm$ 0.6	0.007
FBS (mg %)	92 $\pm$ 16.8	110 $\pm$ 26.2	0.896
BMI	25.9 $\pm$ 4.3	27.7 $\pm$ 4.7	0.090

Values are expressed as mean $\pm$ SD.

The number of cases is given in parentheses.

*: Significance of differences calculated by Student's t-test for paired data at $P \leq 0.05$

Discussion: this study shows that 50% of T2DM patients suffered from hyperuricemia and about 59% of cases are females. A review of the literature reveals several publications with conflicting messages regarding the association between hyperuricemia and T2DM; associated relationship between the uric acid blood glucose level in diabetic patients have been reported by several studies (14-18). Many reports showed that in diabetic patients there is a rise in the plasma uric acid levels [14-16] while other reports showed negative association [17, 18].

There are several biological mechanisms underlying the relationship of serum uric acid and its time course with DM, such as the rise in plasma uric acid levels in diabetic subjects may be due to deterioration of

glucose metabolism which is primarily due to insulin insufficiency or resistance in type 2 diabetic patients [19]. Moreover, in diabetic patients production of uric acid is increased due to elevation of purine synthesis, that is results from subnormal insulin levels or insulin resistance seen in type 2 diabetes mellitus which may decrease the activity of many glycolytic and citric acid cycle enzymes leading to accumulation of glucose-6-phosphate, that may be channeled through hexose monophosphate pathway causing an increase in ribose-5-phosphate which is the starting compound for purine biosynthesis [20]. Thus purine synthesis increases resulting in an elevated formation of uric acid.

Adenosine modulates the action of insulin on various tissues differently, mimics the action of insulin on glucose and lipid metabolism in adipose tissue and myocardium, while it inhibits the insulin effect on total hepatic glucose output and causes local insulin resistance in liver tissue and adenosine tissue concentration is affected by adenosine deaminase [21]. Kurtul N. et al. have shown increased level of serum adenosine deaminase activity in type 2 diabetic subjects with its correlation to HbA1c and suggested that this enzyme is for modulating the bioactivity of insulin [22].

Conclusions: The results of our study demonstrated that there is a high prevalence of hyperuricemia among type 2 diabetic patients. That is why, screening of uric acid level is required in type 2 diabetic patients for proper management and reducing associated morbidity and mortality from diabetic complications.

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Performance Evaluation of VGG19 Deep Learning Model for Chest X-ray Image Classification

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Abstract

This research paper addresses evaluation of a deep learning model based on VGG19 architecture, trained to classify chest X-ray images into two main categories: "Normal" and "Pneumonia." Study utilized a dataset consisting of 5,216 training images and 624 test images. During training process, which spanned 10 epochs, model achieved an accuracy of 95.37% with a final loss of 0.1286. When evaluating performance using test data, results indicated an accuracy of 77.88% with a loss of 0.6009, suggesting variability in model's performance between training and test datasets, thereby supporting hypothesis of overfitting. Performance metrics such as precision, recall, and F1-score were calculated, revealing a precision of 91% and a recall of 82% for "Normal" class, while "Pneumonia" class exhibited a precision of 90% and a recall of 95%. Overall accuracy of model was 90%, reflecting satisfactory performance. Subsequently, fine-tuning of model was conducted, resulting in a notable improvement in accuracy, reaching 96.81% in fourth epoch with a low loss. Model's effectiveness was further validated using external images, where it demonstrated 100% accuracy in classification, albeit with slight variability in confidence levels. Results indicate that trained model has proven effective in classifying chest X-ray images, showcasing good performance on test data and significant improvement after fine-tuning. Despite variability in performance between training and test datasets, positive outcomes derived from external images suggest model's capability for generalization. Furthermore, model's performance could be further enhanced through application of data augmentation techniques and modifications to its architecture.

Keywords: Deep learning, image classification, X-rays, pneumonia, model accuracy, data augmentation.

Introduction

Importance of utilizing deep learning techniques in healthcare has significantly increased, particularly in diagnosis of diseases through analysis of medical images. Respiratory diseases, such as pneumonia

and tuberculosis, present major health challenges that communities face, leading to high mortality rates, especially in areas with limited access to healthcare. Early diagnosis requires advanced techniques that ensure effective detection of cases, which contributes to improving treatment outcomes and increasing survival chances.

In recent years, deep learning techniques, a branch of artificial intelligence, have made remarkable progress in analysis of medical images. Convolutional Neural Networks (CNNs) demonstrate exceptional performance in processing visual data, enabling development of models capable of classifying images with high accuracy.

This research paper aims to investigate effectiveness of a deep learning model based on VGG19 architecture for classifying chest X-ray images into two categories: "Normal" and "Pneumonia." By analyzing a dataset comprising over 5,000 images, we will highlight importance of improving model accuracy and evaluating its performance on independent test data.

This study contributes to enhancing understanding of how deep learning techniques can be applied in diagnosis of respiratory diseases, presenting results that emphasize impact of continuous improvements on model performance. Additionally, it aims to provide a clear perspective on current challenges and future opportunities in this domain, thereby opening new avenues for research and development in applications of artificial intelligence in healthcare. We will apply fine-tuning to VGG19 model and evaluate its performance using a dataset containing chest X-ray images, presenting results and discussions on its effectiveness and impact on model accuracy.

Related work:

1. Study conducted by Bharati et al. in 2020 focuses on application of hybrid deep learning techniques for diagnosing lung diseases through analysis of X-ray images. Several advanced algorithms were utilized to achieve high accuracy in classification. Foundational model for image classification was Convolutional Neural Network (CNN), which served as the basis for approach. Additionally, Visual Geometry Group (VGG) model was integrated with CNN to enhance performance of overall system. For comparative purposes, researchers also employed a Capsule Network (CapsNet), which allowed them to assess effectiveness of different architectures. To improve the processing of

images with various orientations, a Spatial Transformer Network (STN) was applied.

Study utilized NIH Chest X-ray Dataset, which was collected from Kaggle repository. This dataset comprises 112,120 X-ray images representing 30,805 patients, with classifications covering 15 different types of diseases. A new algorithm, termed VDSNet, was introduced and achieved a significant improvement in classification accuracy compared to traditional models. Main results from this study demonstrate effectiveness of different models employed, with VDSNet achieving an accuracy of 73.0 percent, while Vanilla CNN achieved 67.8 percent, VGG reached 69.5 percent, and Modified Capsule Net recorded an accuracy of 63.8 percent.

To achieve these results, several enhancement methods were employed. Data augmentation contributed to improving quality of data and increasing its diversity. Model integration involved combining CNN with VGG and STN, which enhanced overall performance of the classification task. Additionally, careful parameter tuning was conducted to improve the accuracy of the results and the speed of training.

This study provides significant contributions to the use of deep learning techniques in facilitating the diagnosis of lung diseases, aiding doctors in improving diagnostic accuracy and reducing the time required for image analysis [1].

Summary Table of Key Results

Model	Accuracy (%)
VDSNet	73.0
Vanilla CNN	67.8
VGG	69.5
Modified Capsule Net	63.8

2. Study by Sharma, S., and Guleria, K. (2023) highlights that pneumonia is a common disease affecting many individuals, particularly in developing countries. Early detection of this condition necessitates the use of advanced techniques, such as deep learning, to enhance diagnostic accuracy. In this research, the VGG16 model, a well-known architecture in field of convolutional neural networks, was employed to classify chest X-ray images into two categories: "Normal" and "Pneumonia." Researchers utilized VGG16 model along with neural networks to analyze two datasets of X-ray images. Model was

initially trained on one dataset and then evaluated on a second dataset containing diverse images. First dataset comprised an unspecified number of training X-ray images, while the second dataset included 6,436 images, encompassing pneumonia cases, normal cases, and COVID-19 cases.

Results indicated that model achieved outstanding performance in both datasets, attaining high accuracy and robust performance metrics. Findings suggest that VGG16 model combined with neural networks provides superior performance in detecting pneumonia through chest X-ray images. This study underscores importance of employing deep learning techniques in healthcare, contributing to improved diagnostics and increasing chances of successful treatment [2].

Summary Table of Key Results:

Dataset	Accuracy	Recall	Precision	F1-Score
First Dataset	92.15%	0.9308	0.9428	0.937
Second Dataset	95.4%	0.954	0.954	0.954

3. In light of the significant challenges posed by the COVID-19 pandemic, importance of developing effective and rapid diagnostic tools becomes evident. Paper by Sahin, M. E. (2022) discusses methods used to detect the virus through the analysis of X-ray images using deep learning techniques. Study relies on use of three main models based on Convolutional Neural Networks (CNN):

1. Proposed Model (CNN): This model is specifically designed to classify X-ray images into two categories (COVID-19 and Normal). It consists of several convolutional layers, pooling layers, and dense layers, making it an effective tool for analyzing medical data.

2. MobileNetv2: This is a pre-trained model that is characterized by its efficient resource usage and effectiveness in recognizing patterns in images. It is considered an ideal choice for systems with limited computational capacity.

3. ResNet50: Another pre-trained model that uses residual blocks to address common issues such as vanishing gradients. This model is widely used in deep learning applications due to its high performance. Study is based on an open dataset available on Kaggle, containing 13,824 X-ray images. This dataset includes two main categories: positive COVID-19 images and normal (uninfected) images. Data was split into two ratios, with 80% for training and 20% for testing. Results showed that proposed model achieved outstanding performance in

diagnostic accuracy, confirming that it outperforms other well-known models in diagnostic accuracy, making it a promising tool for accelerating and improving the accuracy of COVID-19 diagnosis through X-ray images. This study contributes to enhancing use of deep learning techniques in medical field and providing effective diagnostic tools to tackle contemporary health challenges.

To improve the performance of proposed model, paper employed advanced techniques such as Dropout and Max Pooling, aimed at reducing the risk of overfitting. Additionally, the proposed model was designed with fewer convolutional layers compared to other models, which reduced number of required computational parameters.

Following table illustrates a comparison between the different models:

Model	Test Accuracy (%)	F1-score (%)
Proposed Model	96.71	97
MobileNetv2	95.73	96
ResNet50	91.54	91

Respiratory Diseases:

Respiratory diseases encompass a wide range of conditions affecting the respiratory system, including pneumonia, asthma, chronic obstructive pulmonary disease (COPD), and lung cancer. These diseases pose significant health challenges, particularly in resource-limited communities. Diagnosing these conditions requires the use of advanced imaging techniques to ensure early and accurate detection.

Medical Imaging:

Medical imaging is a vital tool in diagnosing respiratory diseases. The most commonly used imaging techniques include:

- 1. X-rays:** Utilized to visualize the lungs and identify the presence of any infections, tumors, or obstructions.
- 2. Computed Tomography (CT) Scan:** Provides detailed images of the lungs, aiding in the diagnosis of complex conditions such as lung cancer.
- 3. Magnetic Resonance Imaging (MRI):** Used to evaluate soft tissue, though its application in respiratory diseases is less common compared to X-rays and CT scans.

Deep Learning in Medical Imaging:

Deep learning techniques have revolutionized the field of medical image analysis, with advanced models such as Convolutional Neural Networks (CNNs) offering the ability to classify images with high

precision. For instance, studies have demonstrated that deep learning can significantly enhance the accuracy of diagnosing pneumonia and lung cancer, thereby improving the prospects for early and effective treatment.

VGG19 Model Overview

The VGG19 model is a deep convolutional neural network developed by a group of researchers at the University of Oxford, specifically within the framework of the Visual Geometry Group (VGG). The model was introduced at the ImageNet Large Scale Visual Recognition Challenge (ILSVRC) in 2014.

Key Components

- **Depth:** VGG19 consists of 19 trainable layers, which include 16 convolutional layers and 3 fully connected layers.
- **Convolutions:** The VGG19 model employs 3x3 convolutional filters, allowing for an increase in network depth without a significant increase in the number of parameters.
- **Pooling:** VGG19 utilizes 2x2 max pooling operations following each group of convolutional layers, which reduces dimensionality and enhances the model's ability to generalize.
- **Activation:** The model uses the Rectified Linear Unit (ReLU) activation function after each convolutional layer, facilitating faster training processes [4].

VGG19 was trained on the ImageNet dataset, which contains millions of labeled images across 1,000 different classes. The model has demonstrated excellent performance in image recognition tasks, achieving high accuracy in image classification. Pre-trained weights from VGG19 can be utilized as a starting point in machine learning projects, saving time and enhancing performance on new tasks. VGG19 has been applied in a variety of applications, including image recognition, image segmentation, and feature extraction.

The VGG19 model is one of the leading models in the field of deep learning and serves as a cornerstone for many applications in computer vision. Its simple design and effectiveness in image recognition make it a popular choice in numerous research and industrial projects [5].

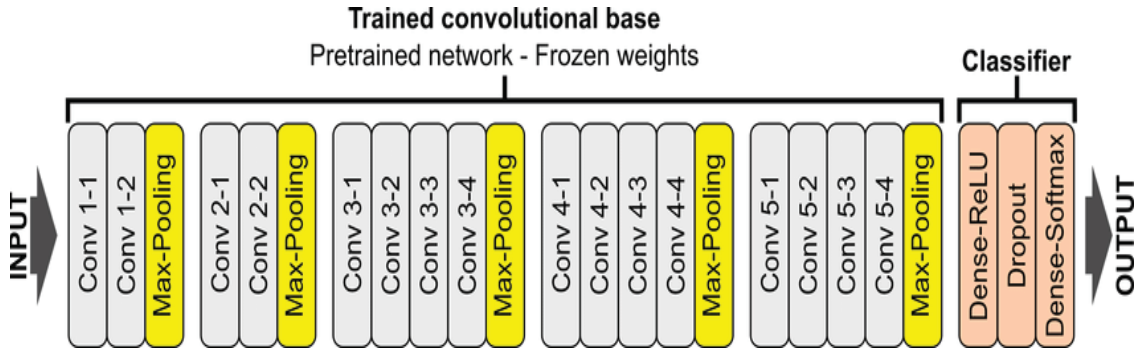


Figure 1. Schematic overview of VGG-19 network architecture with description of layers [6].

Chest X-Ray Dataset

Chest X-Ray dataset contains images representing cases of pneumonia and is designed to support research in medical classification using deep learning techniques. Dataset comprises 5,863 X-ray images in JPEG format, categorized into two classes: Pneumonia and Normal. It is organized into three main folders: training (train), testing (test), and validation (val), with subfolders for each category. In this study, 5,216 images were utilized as training data to train model, 624 images were used for testing, and 16 images were employed for external validation of the model.

Images were collected from pediatric patients aged one to five years at Guangzhou Women and Children's Medical Center in China. All X-ray imaging was performed as part of the patients' routine clinical care.

Initially, all X-ray images were screened to ensure quality, with any low-quality or unreadable images being excluded. Diagnoses were evaluated by two expert physicians, with accuracy verified by a third physician to ensure there were no errors in the assessment. This dataset contributes to enhancing the accuracy of AI-based models in diagnosing pneumonia, which may lead to improved clinical outcomes for children [7].

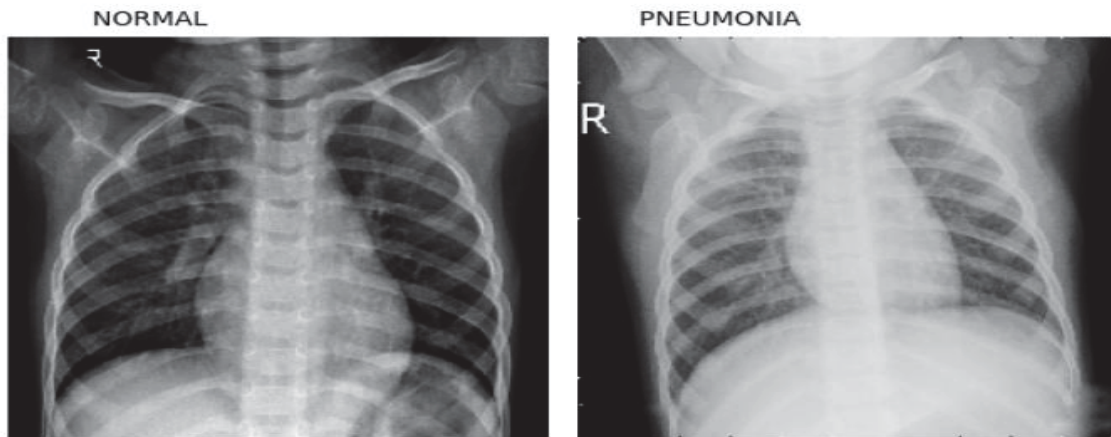


Figure 2. Sample Image from Dataset.

Model Training Steps

In this study, we employed a transfer learning approach using the VGG19 model for training our pneumonia classification model. Training dataset comprised 5,216 images with a shape of (5216, 224, 224, 3), while corresponding labels were structured as (5216,).

1. Model Architecture:

We utilized VGG19 architecture pre-trained on ImageNet dataset, excluding top classification layers. Input shape was defined as (224, 224, 3) to match dimensions of training images. Output from base model was flattened and passed through a dense layer with a sigmoid activation function, yielding a binary classification output.

2. Freezing Base Layers:

To retain the learned features from VGG19 model, all layers of base model were frozen, preventing them from being updated during training.

3. Model Compilation:

Model was compiled using Adam optimizer and binary cross-entropy loss function, with accuracy as evaluation metric.

These steps facilitated efficient training of model for classifying chest X-ray images, optimizing its performance in distinguishing between pneumonia-affected and normal cases.

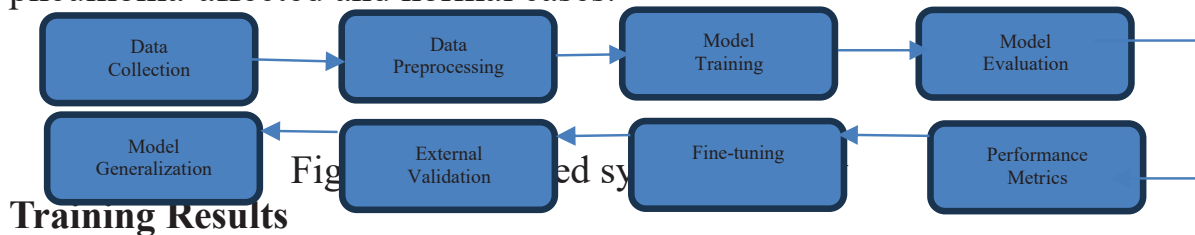


Figure 3. Proposed system

Training Results

Model was trained over 10 epochs, yielding significant improvements in accuracy and loss metrics throughout training process. Following summarizes the key findings:

Epoch Performance:

Epoch 1: Achieved an accuracy of 86.11% with a loss of 0.3282.

Epoch 2: Notable increase in accuracy to 93.01%, with a reduction in loss to 0.1861.

Epoch 3: Accuracy slightly decreased to 92.10%, but loss remained stable at 0.1906.

Epoch 4: Recovery in performance with an accuracy of 93.56% and loss of 0.1630.

Epoch 5: A decline in accuracy to 91.18% and an increase in loss to 0.2301.

Epoch 6: Improvement in accuracy to 94.02%, with a significant decrease in loss to 0.1499.

Epoch 7: Accuracy returned to 92.42% with a loss of 0.2071.

Epoch 8: Achieved an accuracy of 94.38% and a loss of 0.1424.

Epoch 9: Accuracy slightly decreased to 94.32% with a loss of 0.1502.

Epoch 10: Final epoch demonstrated highest accuracy of 95.37% and lowest loss of 0.1286.

```
Epoch 1/10
/usr/local/lib/python3.10/dist-packages/keras/src/trainers/data_adapters/py_data
self._warn_if_super_not_called()
326/326 ————— 123s 336ms/step - accuracy: 0.8611 - loss: 0.3282
Epoch 2/10
326/326 ————— 116s 346ms/step - accuracy: 0.9301 - loss: 0.1861
Epoch 3/10
326/326 ————— 135s 329ms/step - accuracy: 0.9210 - loss: 0.1906
Epoch 4/10
326/326 ————— 143s 334ms/step - accuracy: 0.9356 - loss: 0.1630
Epoch 5/10
326/326 ————— 142s 334ms/step - accuracy: 0.9118 - loss: 0.2301
Epoch 6/10
326/326 ————— 112s 337ms/step - accuracy: 0.9402 - loss: 0.1499
Epoch 7/10
326/326 ————— 140s 330ms/step - accuracy: 0.9242 - loss: 0.2071
Epoch 8/10
326/326 ————— 110s 333ms/step - accuracy: 0.9438 - loss: 0.1424
Epoch 9/10
326/326 ————— 108s 322ms/step - accuracy: 0.9432 - loss: 0.1502
Epoch 10/10
326/326 ————— 146s 334ms/step - accuracy: 0.9537 - loss: 0.1286
```

Figure 4. Training phases

These results indicate that the model effectively learned to distinguish between pneumonia and normal chest X-ray images, achieving a

commendable accuracy of 95.37% by end of training. Fluctuations in accuracy and loss across epochs suggest that model was refining its understanding of data, indicating robust learning dynamics. Such performance underscores the potential of using deep learning models for medical image classification tasks.

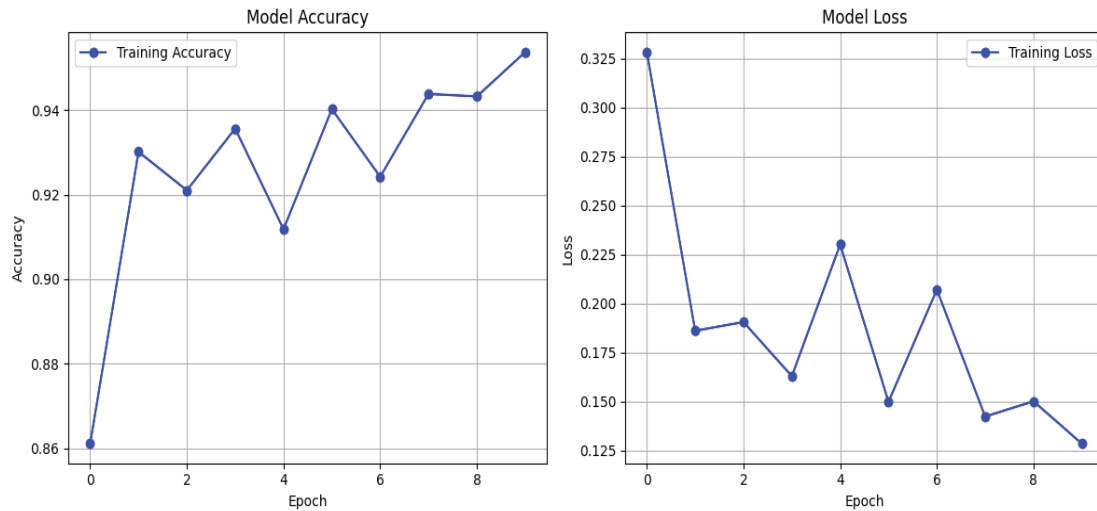


Figure 5. Accuracy vs. Loss for model

Fine-tuning Results Summary

Fine-tuning process involved re-training model over 5 epochs to enhance its performance further on pneumonia classification task. Following summarizes key findings from this phase:

Epoch Performance:

Epoch 1: Model achieved an accuracy of 94.77% with a loss of 0.1195, indicating strong initial performance.

Epoch 2: Accuracy improved to 96.08%, accompanied by a reduction in loss to 0.0995, suggesting effective learning.

Epoch 3: Continued improvement saw accuracy rise to 96.73% with a further decrease in loss to 0.0891, demonstrating the model's capability to refine its predictions.

Epoch 4: Accuracy reached 96.81%, and loss decreased to 0.0857, indicating that model was effectively minimizing error.

Epoch 5: Final epoch recorded an accuracy of 96.75% with a loss of 0.0877, highlighting model's stability in performance.

Overall, fine-tuning process significantly enhanced model's accuracy on training data, achieving a peak accuracy of 96.81% by fourth epoch. Consistent reduction in loss across epochs indicates that model was successfully optimizing its parameters to improve classification

performance. These results underscore efficacy of fine-tuning in enhancing deep learning models for medical image classification tasks.

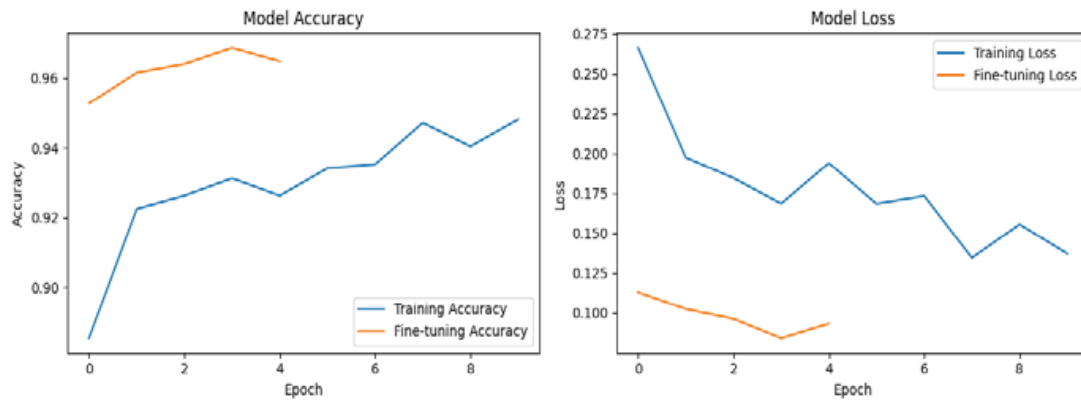


Figure 6. Accuracy vs. Loss for model after Fine-tuning

Results Analysis

Evaluation of model reveals promising performance across several key metrics.

Key Metrics

Precision measures accuracy of positive predictions made by model. For Class 0, precision is 0.91, indicating that 91% of instances predicted as Class 0 were indeed correct. For Class 1, the precision stands at 0.90, meaning that 90% of instances predicted as Class 1 were accurate.

Recall assesses model's ability to identify all relevant instances. Recall for Class 0 is 0.82, suggesting that the model correctly identified 82% of actual Class 0 instances. In contrast, Class 1 shows a recall of 0.95, indicating a strong ability to recognize 95% of true Class 1 instances.

F1-Score serves as a harmonic mean of precision and recall, providing a balanced measure. The F1-Score for Class 0 is 0.86, reflecting a good balance between precision and recall. For Class 1, the F1-Score is higher at 0.93, demonstrating excellent performance in identifying this class.

The overall **accuracy** of the model is 0.90, which signifies that 90% of all predictions made by the model were correct.

When examining the averages, the **macro average** shows precision at 0.91, recall at 0.89, and F1-Score at 0.90, indicating balanced performance across classes. The **weighted average** is slightly lower, with precision, recall, and F1-Score all at 0.90, taking into account the support of each class.

	precision	recall	f1-score	support
0	0.91	0.82	0.86	234
1	0.90	0.95	0.93	390
accuracy			0.90	624
macro avg	0.91	0.89	0.90	624
weighted avg	0.90	0.90	0.90	624

Figure 7. Key Metrics Result

Receiver Operating Characteristic (ROC) Curve

ROC curve illustrates the model's ability to discriminate between classes effectively. Curve approaches top left corner of the graph, indicating strong performance. Area under the curve (AUC) is 0.96, which suggests that model has an excellent capacity to differentiate between positive and negative classes. AUC values close to 1 indicate outstanding model performance.

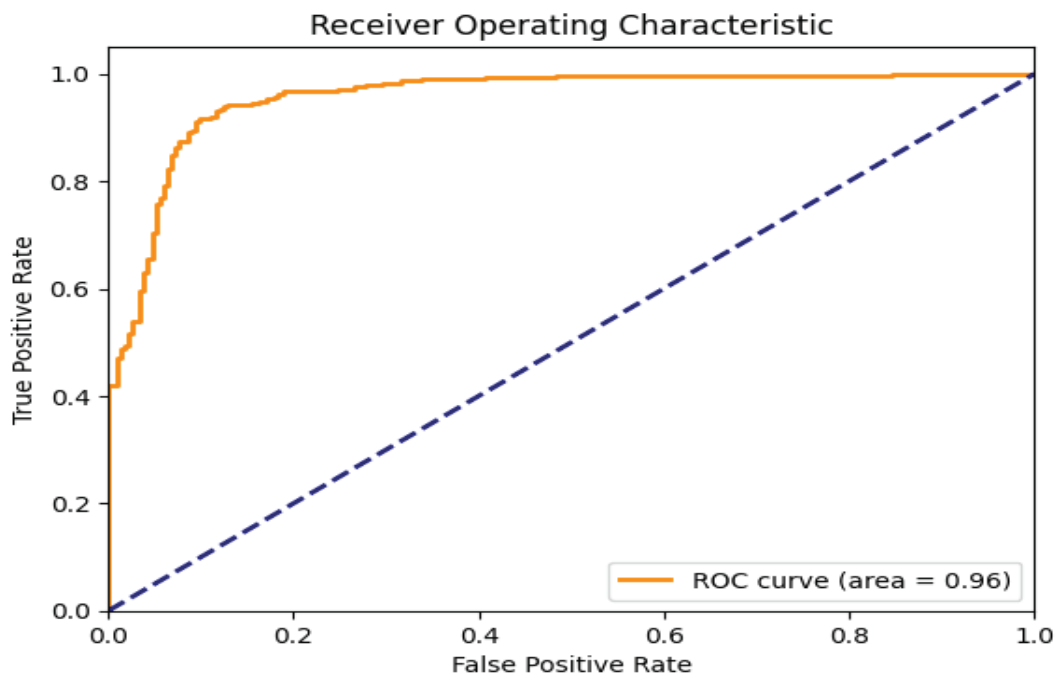


Figure 8. Receiver Operating Characteristic.

Analysis of External Validation Results

External validation results from analysis of 16 chest X-ray images display a mixed performance in identifying pneumonia and normal lung conditions.

1. Classification Results:

- Model successfully identified several images as "NORMAL" with high confidence levels, reaching up to 1.00 in some cases.
- Instances of pneumonia were also detected, with confidence scores ranging from 0.50 to 0.99. Notably, three images were classified as pneumonia with confidence levels above 0.96, indicating strong model reliability for these cases.

2. Confidence Levels:

- Confidence scores reflect the model's certainty in its predictions. High confidence (≥ 0.90) in normal classifications suggests the model's effectiveness in detecting healthy lung conditions.
- Lower confidence score of 0.50 for one pneumonia instance indicates potential uncertainty or difficulty in distinguishing this case from normal conditions, which could warrant further investigation or model refinement.

3. Distribution of Results:

- Out of 16 images, a balanced representation of normal and pneumonia cases was observed. Effective identification of normal cases suggests that model may possess a bias towards recognizing healthier conditions, which is common in medical imaging scenarios.

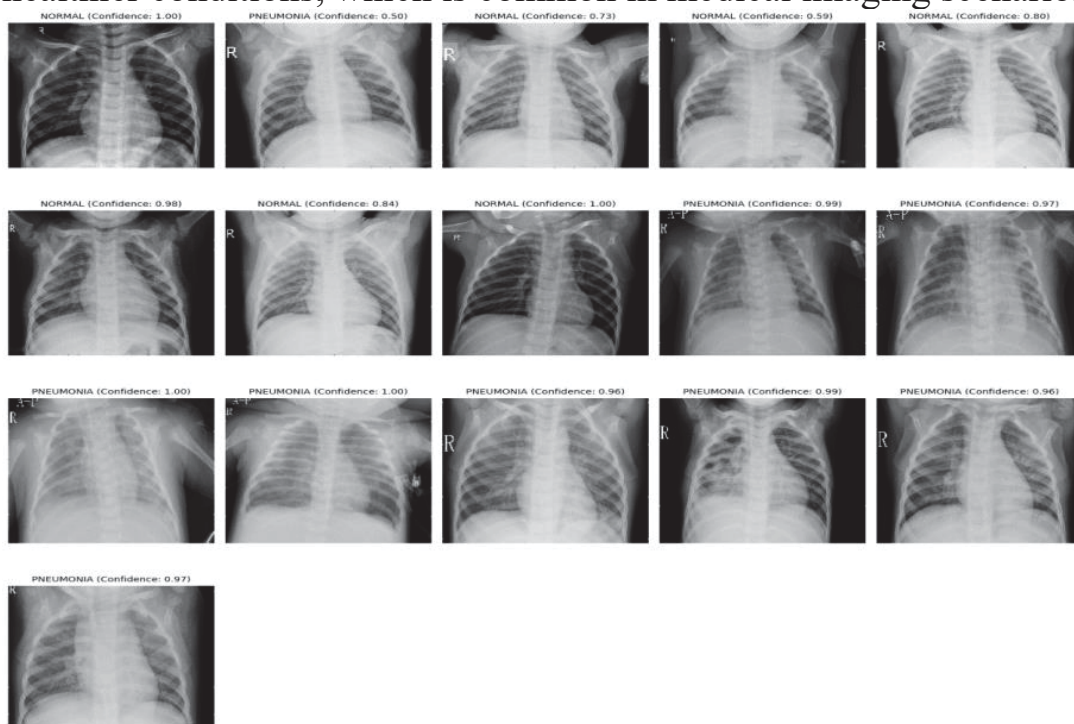


Figure 9. External Validation Results

Conclusion

This study focuses on developing and evaluating a deep learning model for the classification of chest X-ray images, specifically targeting the

identification of pneumonia versus normal conditions. The model was compiled using the Adam optimizer and a binary cross-entropy loss function, with accuracy as the evaluation metric, ensuring efficient training for distinguishing between the two categories. The training process spanned 10 epochs, achieving a peak accuracy of 95.37% by the final epoch, with fluctuations in accuracy and loss indicating robust learning dynamics. These results reflect the model's effective learning capabilities, progressively improving from an initial accuracy of 86.11% to 95.37%.

Subsequently, a fine-tuning phase was conducted, involving re-training the model for an additional five epochs. This phase resulted in further improvements, culminating in a peak accuracy of 96.81%. The consistent reduction in loss across epochs during this phase underscores the model's ability to optimize its parameters effectively. Evaluation revealed strong performance metrics, with precision for Class 0 (normal) at 0.91 and for Class 1 (pneumonia) at 0.90. Recall for Class 0 was 0.82, while Class 1 achieved a recall of 0.95, indicating the model's proficiency in identifying true pneumonia instances. The overall accuracy of the model was 96.75%, with macro averages showing balanced performance across classes.

The Receiver Operating Characteristic (ROC) curve demonstrated the model's ability to effectively discriminate between classes, with an area under the curve (AUC) of 0.96, indicating excellent classification capability. External validation of the model on 16 chest X-ray images showed mixed performance. The model successfully identified several normal cases with high confidence, while instances of pneumonia varied in confidence from 0.50 to 0.99. This variability, particularly a lower score for one pneumonia case, suggests areas for potential refinement.

Overall, this study confirms the efficacy of deep learning models in medical image classification tasks, particularly for pneumonia detection in chest X-rays. While the model exhibits commendable accuracy and reliability, further training and refinement are recommended to enhance its diagnostic performance, especially in ambiguous cases. This research underscores the potential of leveraging advanced machine learning techniques to support healthcare professionals in clinical decision-making.

Discussion

1. This study presents a deep learning model developed for classification of chest X-ray images, particularly focusing on distinguishing pneumonia from normal conditions. Results indicate a peak accuracy of 96.81% following a fine-tuning phase, demonstrating model's proficiency in medical image classification. Use of Adam optimizer and binary cross-entropy loss function facilitated efficient training, reflected in model's effective learning dynamics and robust performance metrics, including precision and recall values of 0.91 and 0.95, respectively.

In contrast, study by Bharati et al. in 2020 explored hybrid deep learning techniques for diagnosing lung diseases using a broader dataset from NIH Chest X-ray Database. Their approach integrated various architectures, including Convolutional Neural Networks (CNN), Visual Geometry Group (VGG) models, and Capsule Networks (CapsNet), achieving a maximum accuracy of 73.0% with their newly proposed VDSNet. This study highlights effectiveness of combining different models and enhancing image processing through data augmentation and spatial transformer networks.

While both studies leverage deep learning techniques for chest X-ray analysis, significant differences in performance outcomes are evident. Higher accuracy achieved in our study suggests a more targeted approach in model architecture and training methodology. Successful integration of fine-tuning further indicates potential of deep learning models to improve diagnostic accuracy in specialized medical contexts. Moreover, variability in confidence scores observed in our study, particularly for pneumonia classifications, emphasizes need for continued refinement and optimization of models. This aligns with Bharati et al.'s findings, which advocate for careful parameter tuning and model integration to enhance classification performance.

In summary, both studies underscore transformative potential of deep learning in medical imaging but also highlight ongoing challenges in achieving high accuracy across diverse datasets and conditions. Future research should continue to explore model enhancements and validation against larger, more varied datasets to ensure robust clinical applicability.

2. This study presents a deep learning model designed for classification of chest X-ray images, specifically focusing on distinguishing pneumonia from normal conditions. Model achieved a peak accuracy of 96.81% after a thorough training and fine-tuning process, reflecting

its effective learning capabilities. Key performance metrics, including precision, recall, and an area under ROC curve of 0.96, indicate model's strong proficiency in medical image classification.

In comparison, study by Sharma and Guleria (2023) emphasizes significance of early pneumonia detection, particularly in developing countries where such conditions are prevalent. Their research utilized VGG16 model, a well-established architecture in convolutional neural networks, to classify chest X-ray images into "Normal" and "Pneumonia" categories. They analyzed two datasets, with second comprising 6,436 images, and reported impressive results, achieving a maximum accuracy of 95.4% on second dataset.

Both studies highlight critical role of deep learning in enhancing diagnostic accuracy for pneumonia detection. While our model demonstrates a slightly higher accuracy, both approaches underline effectiveness of advanced neural network architectures in medical imaging. Results from Sharma and Guleria further support the notion that models like VGG16 can provide robust performance metrics, achieving a recall of 0.954 and precision of 0.954 on their second dataset.

Moreover, findings from both studies reinforce importance of utilizing diverse datasets to improve model generalization and performance in real-world scenarios. Our study's external validation on 16 chest X-ray images revealed variability in confidence scores, particularly for pneumonia cases, indicating areas for potential refinement. Similarly, successful application of VGG16 across different datasets in Sharma and Guleria's research demonstrates model's adaptability to varying image characteristics.

In conclusion, both studies illustrate transformative potential of deep learning models in improving pneumonia detection through chest X-ray analysis. While our model achieves commendable accuracy and reliability, insights from Sharma and Guleria emphasize need for continuous advancements and validation in medical imaging practices. Together, these findings contribute to growing body of evidence supporting the integration of machine learning techniques in healthcare, ultimately aiming to enhance diagnostic capabilities and patient outcomes.

3. This study focuses on developing and evaluating a deep learning model for classification of chest X-ray images, specifically targeting identification of pneumonia versus normal conditions. Model achieved

a peak accuracy of 96.81% following a comprehensive training and fine-tuning process. Key performance metrics, including precision and recall, indicate that model is proficient in distinguishing between two classes, with an area under ROC curve of 0.96, demonstrating excellent classification capability.

In context of current health challenges, such as COVID-19 pandemic, importance of effective diagnostic tools has been underscored. Study by Sahin (2022) explores deep learning techniques for detecting COVID-19 through X-ray image analysis. Sahin's research utilized three main convolutional neural network (CNN) models, including a proposed model that achieved an outstanding test accuracy of 96.71% and an F1-score of 97%. This indicates a high level of performance in diagnosing COVID-19, positioning it as a promising tool for rapid diagnostic applications.

Both studies emphasize significant role of deep learning in enhancing diagnostic accuracy in medical imaging. While our model focuses on pneumonia detection, Sahin's research highlights adaptability of CNN architectures in tackling different respiratory diseases, including COVID-19. Approaches share commonalities in leveraging advanced neural network architectures to classify medical images effectively, demonstrating versatility of deep learning techniques in addressing contemporary health challenges.

Furthermore, both studies utilize open datasets for training and evaluation, which is crucial for ensuring generalizability of models. While our study utilized a specific dataset for pneumonia classification, Sahin's work employed a dataset of 13,824 X-ray images, demonstrating the capacity for deep learning models to be trained on diverse image collections.

Additionally, incorporation of advanced techniques such as Dropout and Max Pooling in Sahin's model to mitigate overfitting parallels need for continuous refinement in our own model, particularly in light of variability in confidence scores observed during external validation.

In conclusion, both studies reinforce transformative potential of deep learning in medical diagnostics, highlighting need for ongoing research and development to improve accuracy and reliability in detecting respiratory conditions. Findings suggest that integrating various deep learning architectures and techniques can enhance diagnostic tools, ultimately leading to better patient outcomes and more effective responses to public health challenges.

Future Work

Building on the findings of this study, several avenues for future research can be pursued to enhance the effectiveness and applicability of deep learning models in medical image classification.

1. Expanding the dataset to include a more diverse range of chest X-ray images would be beneficial. This could involve incorporating images from different demographics, varying stages of pneumonia, and other lung conditions. A larger and more varied dataset would help the model generalize better and improve its performance on previously unseen cases.

2. Implementing advanced data augmentation techniques could further enhance the model's robustness. Techniques such as rotation, scaling, and flipping can artificially increase the dataset size and variability, allowing the model to learn from a wider array of scenarios.

3. Conducting a comprehensive hyperparameter tuning process could optimize model performance. Exploring different architectures, optimizers, and learning rates may lead to improved accuracy and reliability in classifications.

Additionally, integrating ensemble learning methods could enhance predictive performance. Combining multiple models or approaches may help mitigate errors and improve overall classification confidence, particularly in ambiguous cases.

Moreover, further investigation into the interpretability of the model's predictions is essential. Developing methods to visualize and understand the decision-making process of the model could provide valuable insights for healthcare professionals, fostering trust and facilitating clinical adoption.

Lastly, real-world clinical validation of the model is crucial. Collaborating with healthcare institutions to test the model on actual patient data will provide critical feedback and insights, helping refine the model for practical applications in clinical settings.

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Phytochemical Screening, Quantitative Evaluation and Biological Activity of Acacia(Nilotica) Leaves in Libya

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Abstract

This study investigated the medicinal importance of Acacia Nilotica leaf extracts by examining their chemical composition. The extraction process involved soaking the leaves in water, ethanol, and chloroform. The qualitative detection results revealed that the aqueous and ethanolic extracts contained higher quantities of active substances, including alkaloids, flavonoids, glycosides, phenols, soaps, steroids. Additionally, we conducted an estimation of (Ash 7.4%), (Moisture 6.5%), (Proteins 24.19%), and (Fats 14%). The biological efficacy of ethanol extract was tested on four types of bacteria (*E. coli*, *Ps. Aeruginosa*, *K. pneumoniae*, *S. aureus*). The study results showed sensitivity of *S. aureus* to the ethanol extract, with the highest inhibition zone (17.33 mm) at a concentration of 50%. However, extract showed no inhibition on the bacteria (*E. coli*, *Ps. aeruginosa*, *K. pneumoniae*).

Introduction

Medicinal plants have been used for centuries in traditional healthcare systems for treating various diseases. These plants contain different constituents that are related to organic chemistry and natural products. These constituents can be divided into primary constituents, such as acids, Proteins, Chlorophyll, and Sugars, and secondary constituents.

Including Saponins, Tannins, Flavonoids, Alkaloids, Terpenoids, Fatty Acids, Seed Oils, and Phenolic compounds. The presence of these secondary metabolites in plants helps explain their traditional medicinal uses. *Acacia Nilotica*, for example, contains phytochemicals in its fruits, seeds, barks, and leaves, which are important for both human and animal nutrition (Yuan and Piao (2016)). The *Acacia* tree, belonging to the Leguminosae family, is a perennial plant with 1350 species. It can be either shrubs or trees, reaching heights of up to 20 meters depending on the type. These trees bear bright yellow flowers and horn-like fruits that can grow up to 15 cm in length. Inside the fruits, there are several seeds that resemble kidney beans but have a brown color. Additionally, the trunk of the tree produces a gum-like substance known as Arabic gum. *Acacia* trees reproduce through seeds (El-Ayadi *et al.*, 201) *Acacia Nilotica*, also known as the Nile *Acacia*, was first described by Linnaeus in 1773. It belongs to the Plantae kingdom and the Fabaceae family. It's the second-largest genus in the Fabaceae family is distributed in tropical and warm regions worldwide, including Asia, Australia, Africa, and America (Saeedi *et al.*, 2020). The aim of the conceptualizing this present study was to find out phytochemical presence in local *Acacia nilotica* in leaves grown in Libya, comparative study were done in both leaves for presence of protein, carbohydrates, ash, moisture and fats compounds.

Study Objectives

Qualitative chemical identification of active substances such as glycosides, alkaloids, phenols, saponins, flavonoids, resins, terpenes, steroids, coumarins, anthocyanins, carbohydrates, and proteins. Quantitative estimation of certain components including moisture, ash, fats, proteins, as well as the total content of phenols and flavonoids.

Study Area:

Samples of *Acacia Nilotica* plants were collected from the Dafniya region in Misrata, Libya, between February and July 2021. The samples were brought to the laboratory of the Faculty of Science at Misrata University and classified by experts.

Plant extracts preparation:

Dry leaves were used, first purified from impurities. Then they were thoroughly washed with water and air-dried away from sunlight at room temperature for 15 days. Next, the leaves were crushed in an electric grinder and stored in dark, tightly sealed bottles, away from light, moisture, and heat until use. Different polar solvents (water, ethanol, chloroform) were used for plant extraction, each separately. The soaking extraction method (solid-liquid) was employed in this study. A total of 25g of the dry material was soaked in 250ml of either water, ethanol, or chloroform for 72 hours at laboratory temperature, with continuous stirring using an electric stirrer. Then, all the extracts were filtered using filter paper. The extracts were collected and the solvents were evaporated using a rotary evaporator at a temperature of 40°C, until obtaining the crude extract, which was stored at 4°C until use. (Trease and Evans, 2002),(Sofowora,1993) and(Trease and Evans, 1989).

Chemical specific and Phytochemical analysis

•Molisch Reagent Test:

2ml of Molisch solution is added to 2ml of plant extract, followed by the careful addition of 2ml of concentrated H₂SO₄ along the side of the test tube. The appearance of a purple ring in the test tube indicates the presence of carbohydrates.

•Benedict's Reagent Test:

2ml of Benedict's reagent is boiled with 5-2mg of raw plant extract until a reddish-brown color appears, indicating the presence of carbohydrates.

•Fehling's Reagent Test:

Equal amounts of Fehling's solution A and B are boiled with 2ml of plant extract. The formation of a red precipitate indicates the presence of reducing sugars.

Glycoside Detection:

Glycosides are detected using the Keller-Kilani test. A mixture of 2ml of acetic acid and two drops of 2% FeCl₃ solution is added to 5-2mg of raw plant extract, followed by treatment with 1ml of concentrated H₂SO₄. The formation of a brown ring and the appearance of purple

and green colors in the solution layers indicate the presence of cardiac glycosides.

Resin Detection:

2-5mg of raw plant extract is dissolved in 1ml of acetone and treated with 5ml of 4% HCl. The presence of resins is indicated by a noticeable cloudiness in the solution.

Alkaloid Detection:

Alkaloids are detected by dissolving approximately 5mg of raw plant extract in hydrochloric acid (10% g/g) and filtering the solution. The resulting filters are treated with a few drops of one of following reagents:

Mayer's Reagent: It consists of 1.35g of mercuric chloride (HgCl_2) in 60ml of water and 5g of potassium iodide (KI) in 10ml. , then mix both solutions together) The formation of a white or pale yellow precipitate indicates the presence of alkaloids

Wagner Reagent A fraction of each extract was treated with 3 - 5 drops detected for the formation a reddish-brown precipitate which was observed to detect attendance of alkaloids.

Detection of Phenols:

Phenols are detected by taking 0.5 ml of plant extract in 3 ml of 5% FeCl_3 (Iron chloride) solution, and then adding 1 ml of Folin-Ciocalteu reagent. The solution is gently mixed. The appearance of dark blue or black color indicates the attendance of phenols.

Detection of Flavonoids:

Flavonoids are detected by adding 3 ml of the plant extract to 10 ml of distilled water and placing it in a shaker for 10 minutes. Then, 1 ml of 10% sodium hydroxide is added, and the formation of a yellow color indicates the presence of flavonoids

Detection of Proteins and Amino Acids:

Proteins and amino acids are detected using the following tests:

Xanthoproteic Test: Dissolve 2 mg of the crude extract in ethanol and treat it with a few drops of concentrated nitric acid solution. The formation of a yellow color indicates the presence of proteins.

Ninhydrin Test: Dissolve approximately 0.1 mg of the crude extract in ethanol and heat it with 1 ml of 2% ninhydrin solution until boiling. The appearance of a blue-purple color indicates the presence of proteins in the extract.

Detection of Saponins:

Saponins are detected by dissolving 0.5 g of the crude extract in a test tube containing 3 ml of hot distilled water, and vigorously shaking the mixture for one minute. The formation of foam indicates the presence of saponins.

Detection of Terpenes

Terpenes are detected using the Salkowski test, where approximately 2 mg of each extract is mixed with chloroform. Then, sulfuric acid is added.

Detection of Steroids

5drops of concentrated sulfuric acid were added to 1ml of the plant extract in a test tube. The appearance of a red color indicates the presence of steroids

Detection of Coumarins

To detect coumarins, 2ml of 10% sodium hydroxide (NaOH) is added to 2mg of the crude extract in a test tube. The test tube is covered with filter paper soaked in diluted sodium hydroxide and heated in a water bath for a few minutes. The filter paper is then exposed to ultraviolet light. The appearance of a greenish-yellow color indicates the presence of coumarins

Detection of Anthocyanins

Detection of anthocyanins is done by adding 2mg of the crude extract to 2ml of hydrochloric acid (HCl) and 2N ammonia. The appearance of pink-red color waves turning into blue-purple indicates the presence of anthocyanins.

Chemical Quantitative Estimation

The percentage of ash, moisture, fat, and protein in dry leaves was estimated, as well as the total phenols and flavonoids in the ethanol extract. (Baur, and Ensminger, 1977). And (AOA, 2000).

Estimating the percentage of Ash

3g of the plant sample was weighed in a clean, dry porcelain crucible and placed in a combustion furnace at 550°C for 3 hours. The crucible was then cooled in a desiccator for 15 minutes and weighed. The percentage of ash can be calculated using the following equation:

$$\text{Ash percentage} = (\text{weight of ash} / \text{initial weight of sample}) \times 100$$

Estimating the percentage of Moisture

Moisture refers to the amount of water lost by the food material after drying in a drying oven until a constant weight is achieved. The importance of moisture lies in determining the food material's resistance to preservation and storage. The moisture was estimated by drying the sample in an oven at 105°C for 2 hours (AOAC, 2000). The relative moisture was calculated using the equation

$$\text{Relative moisture} = (\text{weight after drying} - \text{weight before drying}) / \text{weight before drying} \times 100$$

Estimating total Fat and Protein:

The fat and protein in the plant samples were estimated using the DA7200 instrument from Peren Instruments, manufactured in Sweden, at the Food and Drug Control Center in Misrata City.

Chemical Study Results:

The active compounds in the extracts of the leaves of the Acacia tree were identified in three different polar solvents: water, ethanol, and chloroform. Quantitative estimation was also conducted for the ethanol extract, including moisture content, ash content, protein content, total phenolic content, and total flavonoid content.

Study of antimicrobial efficacy

The initial screening of the extract's ability to inhibit the growth of some pathogenic bacterial isolates was conducted using the agar well diffusion method (Zhang et al., 2021). The tested bacterial isolates were:

- Escherichia coli(gram-negative bacteria)
- Staphylococcus aureus(gram-positive bacteria)
- Klebsiella pneumoniae(gram-negative bacteria)
- Pseudomonas aeruginosa(gram-negative bacteria)

All the isolates used were pathogenic isolates, multi-drug resistant (MDR), prepared and identified by the Microbiology Department at the Faculty of Science, Misurata University. The bacterial suspensions were adjusted compared to a 0.5 McFarland standard solution, and using cotton swabs, the samples were spread on Muller Hinton agar plates. The plates were then left for bacterial cells to settle on the entire surface, and using a sterile flamed cork borer, wells with a diameter of 6 mm were made in the inoculated agar plates. Solutions with concentrations of 1.5%, 3%, 6.25%, 12.5%, 25%, 50% were prepared using DMSO as a solvent (which does not affect bacterial growth or the extract). 50µl of the different concentrations were injected into the wells, and the plates were then incubated at 37°C for 24 hours. The efficacy of the extract was determined by measuring the diameter of the inhibition zone around the well compared to DMSO used as a negative control. Each dilution efficacy test was performed with each type of bacteria

Specific Chemical Detection Results:

Table 1 presents the results of specific chemical detection, indicating the types of active compounds present in medicinal plants. Some tests can detect more than one type of active compound. Specific detection was performed using three different polar solvents to identify the active substances. The test results indicate the concentration of the active substance with the symbol (+++), moderate changes with the symbol (++), minimal changes with the symbol (+), and no changes with the symbol (-).

Table 1: Qualitative Detection of Active Substances

Active Ingredient	Detector	Result	solvent		
			Solvent		
			Water	Ethanol	Chloroform
Alkaloids	Mayer	Forms creamy white or pale yellow precipitate	+	+	+
	Wagner	Forms brown to yellow precipitate	++	+	-
Anthocyanins	+HCL NH ₃	pink-red color waves turning to blue-purple	-	-	-
Flavonoids	NaOH 10%	yellow color	+++	+++	-
Glycosides	Keller-Kilani	purple and green colors	+++	++	-
Phenols	Folin-Ciocalteu	Dark blue or black color appearance	+++	+++	-
Soaps	Distillation water	Formation of foam	+++	+++	-
Steroids	H ₂ SO ₄	Red color appearance	+++	+	-
Carbohydrates	Molisch	Formation of purple ring	+++	-	-
	Benedic	Reddish-brown color appearance	+++	+	-

Active Ingredient	Detector	Result	solvent		
			Solvent		
			Water	Ethanol	Chloroform
	Fehling	Formation of red precipitate	+	+++	-
Terpenoids	Salkowski	Formation of reddish-brown ring	+++	-	-
Resins	CH ₃ COCH ₃ أستون + حمض الهيدروكلوريك HCL	Clear turbidity in solution	++	-	-
Coumarins	NaOH	Greenish-yellow color appearance	+	+	-
Proteins	Xanthoprotein اكرانثوبروتين	Yellow color appearance	+	+++	+++

The qualitative analysis of the leaves of the *Acacia nilotica* tree revealed the existence of various active compounds, including Alkaloids, Flavonoids, Glycosides, Phenols, Saponins, Steroids, Carbohydrates, Terpenoids, and Resins. However, Anthocyanins were absent in all solvents used. In a study conducted by Khaleel *et al.* (2021) using the same solvents, it was found that the leaves of *Acacia nilotica* do not contain steroids, which contradicts the results of the current study. However, both studies agree on the presence of saponins, alkaloids, phenols, flavonoids, and glycosides. Another study by Algfri *et al.* (2015) on the leaves of this tree showed that the aqueous extract did not contain saponins, alkaloids, or coumarins, which contradicts the results of the current study. Similarly, a study by Sadat *et al.* (2021) on the leaves of *Acacia nilotica* using ethanol extract showed compatibility

with the current study in terms of the presence of alkaloids, glycosides, and steroids. This study is supported by the findings of Solomon-Wisdom & Shittu (2010), which confirmed the presence of saponins, phenols, flavonoids, and alkaloids in the leaves of *Acacia nilotica*, although they differ in the absence of steroids. The study conducted by Aulya (2020) revealed the presence of soaps, alkaloids, flavonoids, and terpenoids, which aligns with the current study, while steroids were not detected, contradicting the current study. The previous table indicates differences in the qualitative detection results regarding the presence and concentration of active compounds. These differences can be attributed to the type of solvent used, the extraction method employed, and the accuracy of the test. Comparing the extracts, the water and ethanol extract showed positive results and higher concentrations for most active compounds. On the other hand, the chloroform extract only showed the presence of two active compounds (proteins, alkaloids) compared to water and ethanol in terms of the presence and concentration of active compounds. The study conducted by Kalaivani *et al.* (2011) demonstrated the presence of phenols and flavonoids in the chloroform extract, which contradicts the current study but aligns in the absence of soaps. Additionally, a study by Raghavendra *et al.* (2006) showed the absence of carbohydrates, glycosides, soaps, and phenols in the chloroform extract, which aligns with the current study. In a study by Okoro *et al.* (2014) on *Axia nilotica* leaves, the ethanol extract revealed the presence of alkaloids and resins, which aligns with the current study in terms of

Chemical Quantitative

Moisture, Ash, Phenolic, Flavonoid, Protein, and Fat were estimatedolic content, total flavonoid content, protein. The results, and fat of the study were estimated. The results are as follows of the study:were as Quant follows: itative estimation of moisture.ash, protein, estimation of and fat moisture, in the studied ash, protein Nile tree leave.and fat in the studied leaves of the results of the quantitative the Nile tamarisk estimation of tree. Moisture. The results ash, protein

of the quantitative, and fat estimation of are shown moisture, ash, protein and fat values of the results are shown in Figure 1.

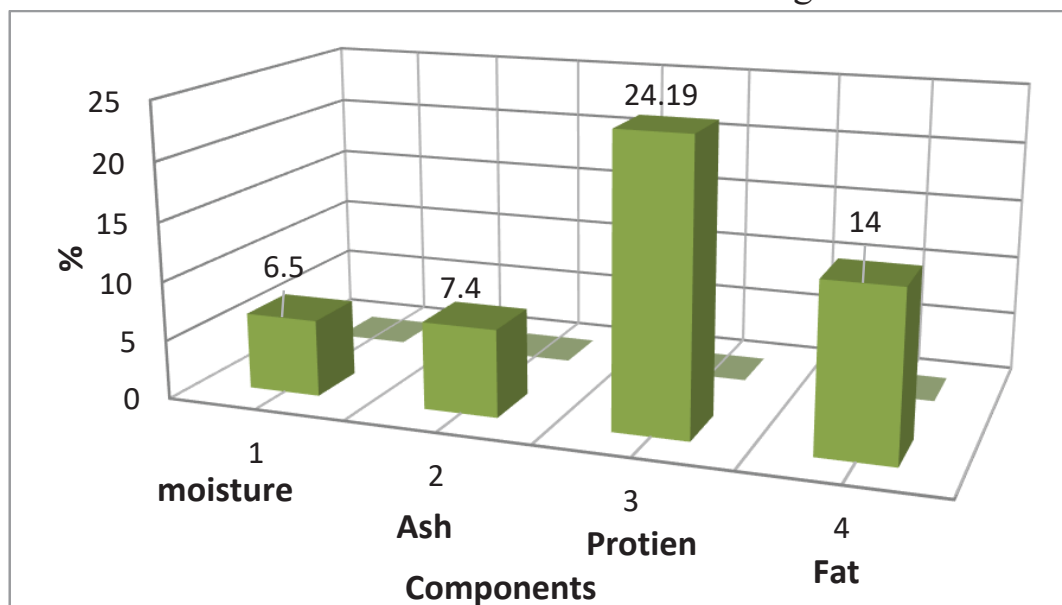


Figure (1): percentage of some components in raw *Acacia Nilotica* tree leaves

The results show that the percentage of moisture in the leaves of the indigo acacia was (6.5%), the amount of ash was (7.4%), while the percentage of protein and fat in these leaves was 24.19 and 14, respectively. The comparison with the results of the study conducted by (Sarkiyayi and Abubakar, 2018) was lower than the results of the current study. As for the results of the study conducted by (Bargali, 2009) in detecting ash, protein and fat, we find that the results of this study have a lower protein and fat content compared to the current study, but as for ash, they were close.

Diagnosis using infrared (IR) spectroscopy.

The results of the analyzes in this study of the infrared spectrum indicated that the peaks reached the range of $1000\text{-}3500\text{ cm}^{-1}$. The distinct groups in the infrared image spectrum are clearly visible in Table (2)

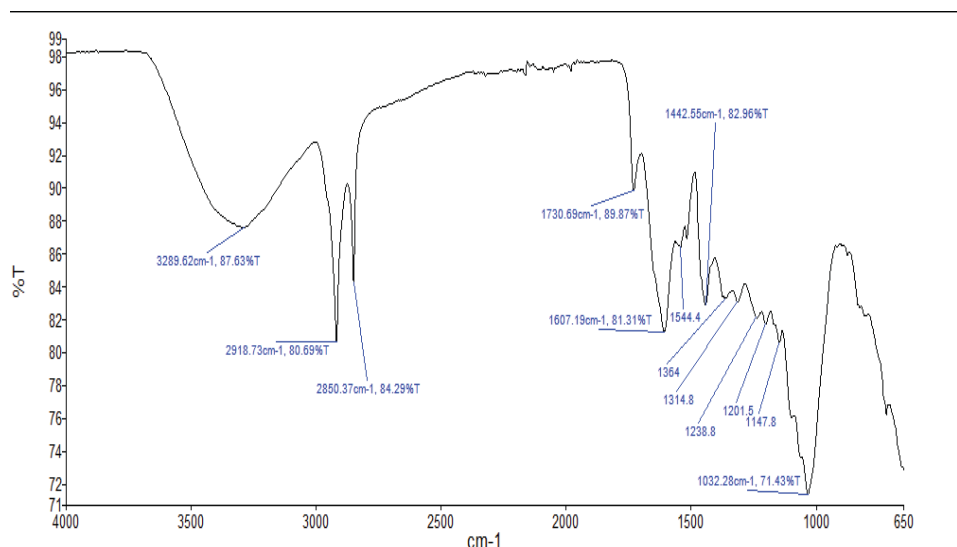


Figure (2): Peaks of the infrared spectrum

Table 2: Peak of infrared spectrum in IR Spectra.

Description	Frequency (cm ⁻¹) of leaves extract
3289.62	O-H stretch
2918.73	C-H
2850.37	C-H
1730.69	C=O stretch
1607.19	N-H bend
1544.4	N-O stretch
1442.55	C-H
1364	C-H
1314.8	C-N
1238.8	C-N
1147.8	C-F stretch
1032.28	C-F, S-O stretch

Through the results of the analysis of the infrared spectrometer for this study, it became clear that most of the functional groups are present in acacia (indigo) leaves. This indicates conformity with the qualitative analysis, as the most important absorptions range were hydroxyl and carbonyl group at frequency 3269.21 and 1649 as shown in the table (2). Some the results are consistent with the results of the study conducted

by (Jangade *et al.*, 2014), (Bimla, 2002) and (Elgubi *et al.*, 2019) This indicates consistency with the qualitative analysis.

Results of the biological study

Estimation of antimicrobial activity

The effect of the ethanol extract at concentrations (1.5%, 3%, 6.25%, 12.5%, 25%, 50%) on some pathogenic bacteria was studied. The results obtained and shown in Table (3) indicate that the ethanol extract showed no effect on bacteria (*E. coli*, *Ps. Aeruginosa*, *K. pneumoniae*) at all concentrations, while there was inhibition on the growth of bacteria (*S-aureus*) at all concentrations.

Table (3): Inhibitory zone (mm) against of some studied microbes types of bacteria

Bacteria concentration %	Escherich ia coli	Staphylococ cus aureus	Klebsiella pneumoni ae	Pseudo monas aeruginosa
1.5	-	12	-	-
3	-	13.33	-	-
6.25	-	15	-	-
12.5	-	16	-	-
25	-	16.33	-	-
50	-	17.33	-	-

*(-) means no inhibition

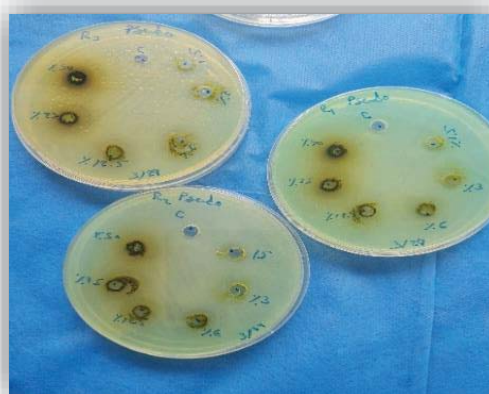
The results obtained in Table (3) and Figure (3) show the inhibitory activity of ethanol extract at all concentrations against a single type of bacteria (*S-aureus*). After 24 hours of incubation at 37 °C, the effect of the extract at different concentrations was observed, manifested by the appearance of a clear zone surrounded by wells containing the extract, known as the inhibition zone. The highest inhibition was observed at a concentration of 50%, with an inhibition diameter of 17.33 mm, while the lowest inhibition diameter was 12 mm at a concentration of 1.5%. This is consistent with a study by Sadat *et al.*, 2021, which showed inhibition of ethanol extract from the same leaves against bacteria (*S-*

aureus) with an inhibition diameter of 16.67 mm using a concentration of 300 µl of the extract. In contrast, a study by Dhabhai et al., 2012, using 100 µl of ethanol extract, showed inhibitory activity against *E. coli* and *Ps. Aeruginosa*, which differs from the current study but aligns with the inhibitory effect against *S. aureus*. Another study by Sharma et al., 2014, recorded inhibitory activity against *E. coli*, *Ps. Aeruginosa*, which does not match the current study but aligns in the inhibition against *S. aureus*. A study by Sadiq et al., 2017, found inhibitory activity of ethanol extract at concentrations of 10% and 5% against *E. coli*, which differs from the current study. A study by ur Rahman et al., 2014, demonstrated inhibitory capacity at various concentrations of ethanol extract from the same leaves against four types of bacteria. And this does not agree with the current study where the study results showed inhibition of only one type *S. aureus*. The current study is consistent with the study (Khaleel et al., 2021) in showing inhibition of the ethanol extract against *S. aureus* and does not agree in the presence of inhibition of *E. coli*, *Ps. Aeruginosa*.



بكتيريا *S. aureus*

بكتيريا *E. coli*



بكتيريا *Ps. aeruginosa*

Form (3): The effect of the extract of the leaves of the Acacia (Nile) tree using ethanol against bacteria under study

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Production of antibiotics from Neochlorise Alga by partially analyzing their molecules to uncover beneficial biological properties.

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Fatima S. R. ELBARASI , **Produce antibiotics from Neochlorise Alga by partially analyzing their molecules to uncover beneficial biological properties.** Ministry of Technical Education Higher Institute of Medical Technology Sabratha , Libya

Abstract: Algae are a large and diverse group, They include giant algae, large brown algae that can grow up to 50 m long, unicellular organisms such as Chlorella and diatoms, with multicellular forms. . The algae were extracted using different solvents, and these extracts were tested as antimicrobials against pathogenic microbes such as bacteria and fungi using the agar diffusion method. The study showed that all extracts, especially those extracted from brown and green algae, had the highest antimicrobial activity. The most effective extracts were selected to study their effect on the cell wall of some types of bacteria. They are mainly used in the production of antibiotics from the culture of Neochloris aquatic Star and their biochemical properties are determined by various methods. The study showed that sodium nitrate is the best inorganic nitrogen source for the production of the antagonist. In the case of using organic nitrogen sources, it was observed that the antagonist is formed in the highest quantity in the case of serine, glutamic acid and threonine. However, the use of lysine, methionine, tryptophan and tyrosine led to a significant reduction in the production of the antagonist by this algae. As for some other sources such as leonine, aspartic acid and praline The production of antibiotics from Neochloris aquatica culture and their application in determining the biological properties.

Keywords: CULTURE OF NEOCHLORIS, internet, education Natural History', e-course Microbiology

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Science Code: 101 .

1. Introduction

Chlorella vulgaris Beijerinck is one of the green microalgae, or Chlorophyceae, that have been on Earth since the dawn of life. According to fossil evidence, algae have been around for 2.5 billion years, or the Precambrian époque. Over time, the algae spread around the world and are now present everywhere: mostly in aquatic habitats like lakes and water tanks, but they can also be found in soil, ice, snow, high mountains, geysers, and wastewater. Different unicellular eukaryotic organisms with distinct photosynthetic assimilatory pigments, such as those in the groups Cyanophyceae (cyanobacteria), Chlorophyceae, Euglenophyceae, Xanthophyceae, Bacillariophyceae, and Rhodophyceae, are referred to as "micro-algae." More than 40,000 species have been identified to yet, and new species are constantly being discovered because of contemporary molecular technology.

One of the initial concepts for using microalgae was to add it as a source of protein to food for humans or animals, as was previously indicated. Microalgae have a very high protein content; it is on par with or even higher than that of higher plants, therefore in theory they could be a useful source of protein. However, initial feeding studies indicated that raw algal biomass had relatively low protein digestibility. This was because the algal cell's solid cellulose cell wall prevented digestive enzymes from penetrating and breaking down the cell's contents. Biotechnologists experimented with and created a variety of techniques to get around this, including boiling, autoclaving, homogenizing, high-pressure homogenizing, and various drying processes. Implementing innovative processing techniques did not always lead to higher protein digestibility or lower production expenses (Komaki et al., 1998; Bock & Wuensche, 1967; Cook et al., 1963; Cook, 1962). It is imperative to bear in mind that applying diverse technological treatments to algal biomass could lead to annihilating some components of the algal cells, hence diminishing the nutritional value of the algae. Power plants produce CO₂, one of the gasses that causes the greenhouse effect. According to Kremer et al. (2004), this gas can be used to grow microalgae efficiently, reducing the energy needed for the process and the amount of CO₂ released into the environment globally. Wastewater treatment also allows the microorganism to be used twice.

1. Study objectives

The study showed that this alga has the ability to use nitrogen sources at a concentration of (2 g/L) to improve its growth and produce a larger amount of the antibiotic. The study showed that sodium nitrate is one of the best inorganic nitrogen sources in producing the antibiotic. As for using organic nitrogen sources, it was observed that the antibiotic is formed in the highest amount in the case of serine, glutamic acid and threonine, while using lysine, methionine, tryptophan and tyrosine led to a significant reduction in the production of the antibiotic by this alga. As for some other sources such as leucine, aspartic acid and proline, they led to a significant increase in the production efficiency of the antibiotic

The importance of research in algae.

Additionally, The Micro-Algae Can Serve As A Vehicle For Other Nutritional Elements That May Benefit People Or Animals, Such As Glycoproteins, Unsaturated Fatty Acids, Or Other Compounds. New Strains Rich In Active Ingredients And Low In Anti-Nutritive Substances Can Be Produced Through Selection And Targeted Cultivation (As In The Case Of "Double Zero" Rapeseed, Which Saw A Decrease In Glucosinolate And Erucic Acid Levels During The Search For New Protein Sources From Higher Plants). Public Interest In "Healthy Food" Development Is High, And This Enthusiasm May Indicate The Direction That Microalgae May Take In The Future For Animal And Human Nutrition.

Light: Microalgae absorb inorganic carbon to transform it into organic matter through a process called photosynthetic respiration, much like all other plants do. This reaction is fueled by light, hence factors like intensity, spectral quality, and photoperiod must be taken into account. The amount of light that is required varies significantly depending on the algal culture's density and culture depth. PH: The pH range for most cultured algal species is between 7 and 9, with the optimum range being 8.2-8.7. Complete culture collapse due to the disruption of many cellular processes can result from a failure to maintain an acceptable pH.

Temperature: Depending on the species and strain being cultivated, as well as the makeup of the culture media, the ideal temperature range for phytoplankton cultures is typically between 20 and 24°C. The most widely cultivated microalgal species can withstand temperatures ranging from 16 to 27°C. While temperatures over 35°C are deadly for

many species, those below 16°C will only slow down growth. Algal cultures can be chilled if needed by running cold water over the culture vessel's surface or by using refrigerator air conditioners to regulate the air's temperature.

2. PREVIOUS STUDIES

The content and results of some of the local and foreign studies that will shed light on our work on the Thesis Subject are summarized below.

As mentioned in the introduction, studies on intensive culture of microalgae date back 120 years. In his study in 1890, Beijerinck prepared a culture that could provide intensive production of the *Chlorella* genus (Richmond, 2004).

In their study in 2006, Horvatic and his colleagues tried to find the nutrients required for the growth of *Chlorella kessleri* green algae using biological methods. They determined the usable nutrients and investigated the effects of nitrogen and phosphorus limitation in Lake Sakadas in miniaturized biological environments.

In their 2006 study, Dayanandaa and his colleagues performed autotrophic culture of *Botryococcus braunii* microalgae for hydrocarbon and exopolysaccharide production in different culture media. As a result of the study, they found that the organism could adapt to different culture media and could produce more than one metabolite in these media.

Hameed and Hasnain 2005, isolated single-cell cyanobacteria from water and soil samples collected from various regions of Pakistan, were grown in BG11, Bold Basal, Chu10 and Gorham media at different pH, light and temperatures and determined the optimum growth conditions. In this process, they added chromium to the media at 100-200 µg/ml and tried to determine chromium-resistant strains. They determined that the optimum temperature at which these strains resistant to chromium heavy metal reduce Cr+6 ions to Cr+3 ions is 30 C in different pH environments. In the study conducted by El-Sheekh et al. in 2005; they investigated the effectiveness of heavy metal uptake in domestic and industrial wastewaters comparing *Nostoc muscorum* is a landrace that includes *Anabaena*. taxa and their effects on growth. They observed that heavy metals like cobalt and copper, lead and manganese could be taken from wastewaters at the rates of 12.5-818,11.8,-33.7,26.4-100 and 32.7-7100%, respectively, by using cyanobacteria cultures

3. Collection of Data

3.1. MATERIALS AND METHODS

In this study, *Tetracystis* from Kaşıklı Pond in the Ergene Basin (Thrace), which was determined as a new record for Turkey during field studies and was sent to the Ege University Microalgae Culture Collection within the Ege University Scientific Technology Application and Research Center (EBILTEM), was given the Ege-MACC63 catalog number. *isobilateralis* R. M. Brown & H. C. Bold taxon was chosen as material.

3.2. *Characteristics of the Microorganism*

The taxon *Tetracystis isobilateralis* was first described in 1964 by R. M. Brown and H. C. Bold. They were detected by C. Ç. Bold in Texas, as a result of floristic studies on leaves in fresh water and moist soil (Guiry and Guiry 2010). Young cells of the microalga *Tetracystis isobilateralis* are ellipsoidal, old vegetative cells are in the form of round or nearly round, diad or quadruple (tetrad) cells with a diameter of 18-19 µm. Chloroplast ; It has a single, sometimes mottled

■ Obtaining the Microorganism

As a result of the literature review in the field of microalgal biotechnology, it was determined that studies such as the culture, biochemistry and heavy absorption capacity of the *Tetracystis isobilateralis* species have not been carried out. The microalgae required to carry out these studies, which are the subject of the thesis, were obtained from the Ege University Microalgae culture collection within the Ege University Scientific - Technology and Research Center (EBILTEM) with the catalog number Ege-MACC63.

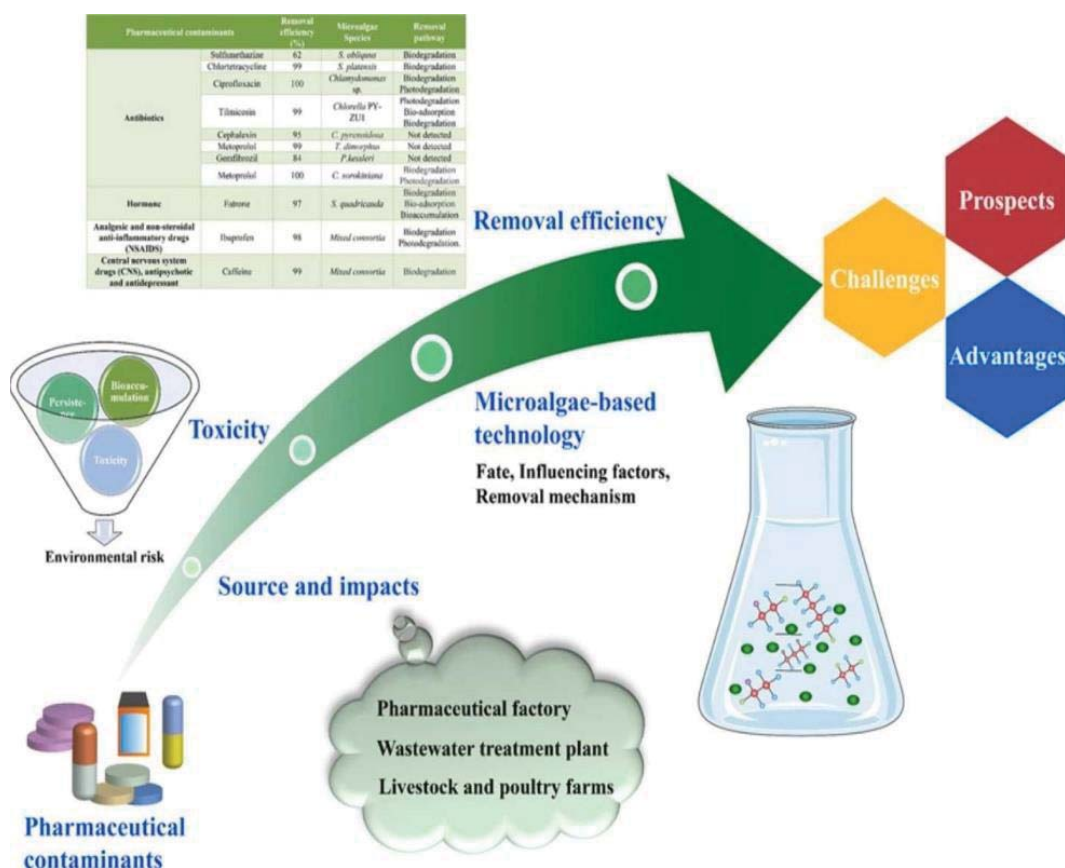


Figure 2 :microalgae-based technology for pharmaceutical contaminants removal.

Culture Experiments (Sale of Optimum Liquid Nutrient Medium)

In order to determine the growth conditions and appropriate culture environment for microalgae culture, culture studies and microalgae culture collections previously conducted by various scientists were used. Blue Green Medium (BGII), Bold's Basal Medium (BBM), Modifield Bold's Basal Medium (B3N) with different pH values, in which Chlorococcales members distributed in freshwaters grow well and at the same time contain almost all nutritional salts for the growth of all microalgae, are four Medium was determined and prepared under sterile conditions.

In addition to these four media prepared for microalgae, a fifth liquid culture called Our (Our) Tetracistis Medium (OTM) was prepared, with varying concentrations of nitrogen and phosphate content based on BBM..

Tablo 3. 1 Nutrient composition of liquid culture media (mg/L)

	BBM Mg/L (Stein 1973)	BGII mg/L (Rippka ve ark., 1979)	B3N mg/L (McGurk, 1975)	OTM Mg/L
Na ₂ CO ₃	-	20	-	-
Na ₂ MoO ₄ .2H ₂ O	0,39	0,39	0,39	0,008
Nasio ₃	-	-		-
Na ₂ EDTA	100	1	100	-
NaNO ₃	250	1500	750	500
Nacl	25	-	25	25
KH ₂ PO ₄	175	-	175	262,5
K ₂ HPO ₄	75	40	75	112,5
KOH	62		62	
MgSO ₄ .7H ₂ O	75	75	76	75
Cacl.2H ₂ o	25	36	25	25
Ca(NO ₃) ₂ . 4H ₂ O	-	-	-	-
Citic Acid	-	6	-	-
H ₃ BO ₃	2,86	2,86	2,86	-
FeSO ₄ .7H ₂ O	4,98	-	4,98	-
FeCl ₃ .6H ₂ O	-	-	-	0,194
ZnSO ₄ .7H ₂ O	0,222	0,222	0,222	-
ZnCL ₂	-	-	-	0,01
Mncl ₂ .4H ₂ O	1,81	1,81	1,81	0,082
CuSO ₄ .5H ₂ O	0,079	0,08	0,079	-
CoCl ₂ .6H ₂ O	-	-	-	0,004
Co(NO ₃) ₂ .6H ₂ O	0,0494	0,05	0,0494	-
Ammonium ferik-	-	6	-	-
(NH ₄) ₆ Mo ₇ O ₂₄ .4H ₂	-	-	-	-
Toprak su ekstratı	-	-	-	20ml
B12	-	-	-	-
Thiamine HCl	-	-	-	-
Biotin	-	-	-	-
H ₂ SO ₄	1ml	-	1ml	-
HCl	-	-	-	-
pH	7,1	7,5-8	6,7	8,7

After five different liquid culture media were prepared, 1 (one) L volume of each was transferred to the Erlenmeyer. For inoculation, 4.5×10^6 cells/ml were added to each medium in a sterile manner using the tube culture taken from the culture collection.

vaccination was done at high density. Care was taken to transfer equal numbers of cells to each culture medium. Inoculated liquid cultures of 1 liter each were cultured in an air-conditioning cabinet at a temperature of $24 \pm 2^\circ\text{C}$, at a light intensity of $200 \mu\text{mol photons m}^{-2} \text{sec}^{-1}$ and under illumination conditions for a period of 12/12 (equal days). Mixing and aeration process, 500ml/min. It was done with aquarium pumps with aeration capacity.

Cell densities of the cultures were monitored from the first day and counted in triplicate using a Thoma counting chamber every two days until the culture entered the death phase.

In addition, when determining the liquid culture medium in which the species develops best, 10 ml samples were taken from each liquid culture medium every three days and filtered with Whatman GF/C filters with 0.45μ pores in order to see how the nutritional state of the culture changes (anion-cation exchange). It was analyzed with the ICP-AES device.

Obtaining Biomass

Vaccination

In the culture studies carried out to obtain *T. isobilateralis* microalgae biomass, the unialgal stock culture in the tube was inoculated into 250 ml conical flasks containing OTM medium to be used as vaccine. The culture was kept in ambient conditions using an air-conditioning cabinet at a temperature of $24 \pm 2^\circ\text{C}$, a light intensity of $200 \mu\text{mol photons m}^{-2} \text{sec}^{-1}$, and illumination for a long day period of 18/6 (Day-Night). Then, in the same medium and environment, they were first transferred to 1-liter conical flasks, then to 5-liter containers, and finally the culture in the 5-liter containers, which had reached the stationary phase, was inoculated into aquariums with a volume of 50 liters.

For large-scale culture of microalgae, 50-liter glass aquariums were used. Sterile OTM mediums in the aquariums were aerated and mixed with aquarium pumps with 500ml/min aeration capacity. The development of the culture, which was brought to the final volume that could be achieved under laboratory conditions, was followed every two days by dry biomass measurement.

Culture Development

Monitoring the development of the culture was achieved by determining the amount of dry biomass. For this, 20 mL microalgae cultures were taken from the OTM culture medium at two-day intervals. It was filtered through Whatman GF/C filter papers with a pore size of 0.45μ , previously kept in an oven at 105°C for 1 hour, cooled in a desiccator and tared, with the help of a vacuum created using a filtering mechanism and a water thrombus. The filtered biomass was washed by pouring pure water with HCl and pH adjusted to 4. The filtered and washed microalgae biomass were dried in petri dishes by keeping them in an oven at 105°C for 2 hours and placed in a desiccator. They were allowed to cool to room temperature and then weighed on a scale with an accuracy of 0.0001 g. The growth chart of microalgae in different culture media was created by calculating the amount of biomass in 1 L by proportioning the weighed dry biomass to the filtered culture volume. (Gökpınar and Büyükkışık, 1994).

Harvest

18, when the culture reaches a stagnant phase. at the end of the day. the culture was terminated and harvested. While harvesting, ventilation was stopped and the coagulated microalgae were waited to settle by settling. The dense part that settled and accumulated at the bottom of the aquarium was siphoned and filtered through plankton cloths with a 55μ pore opening. The harvested biomass was dried in a vacuum oven at 50°C for 3 hours. Dry samples, which do not contain any water, are kept at -20°C to be used in biochemical analyses. A part of the obtained biomass was used and biochemical analysis, fatty acids, protein, carbohydrates, vitamins and ash amounts were determined.

Heavy metal absorption experiments were continued in aquariums that had reached the saturation phase but were not filtered..



Figure 6 .The harvested biomass” was baked under vacuum at 50 °C for 3 hours

Biochemical Analysis

Analysis Of Crude Proteins

The approach created by Kjeldahl was used to calculate total crude protein. (AOAC 2000) in three stages, wet distillation and titration, and in three repetitions.

Age Burning

The 0.5 g of the dried and powdered Teracystis sample was weighed and put into khieldal tubes. Khieldal protein catalyst tablet was added to the tubes containing the samples. 15 ml each of 96% sulfuric acid was added to them and the tubes were placed in the wet combustion unit. The burning process was continued for approximately 2.5-3 hours until the colors of the samples became light yellow - green or colorless. The samples removed from the combustion unit were left to cool. Then, 20 ml of pure water was added to the samples and the distillation process was started.

The last sample, placed in a 250 ml conical flask, was added to 25 ml of the previously prepared boric acid solution (40 g of H_3BO_3 into 1L of water, then 7ml of methyl red bomoxal gren 10 ml) and placed at the outlet of the distillation unit and was subjected to distillation with NaOH. A blank sample was prepared to measure the amount in the environment during distillation..

Titration

At the end of the distillation process, the distillate accumulated in the flask was titrated with 0.1 N HCl until its color turned pink and the consumption was determined.

For the blank, 0.1 ml of HCl was consumed.

The values obtained at the end of three repetitions were calculated with the following equation and the average was taken.

%N= -----

% protein % N x 6.25

A: "Amount of HCl consumed for the sample".

B: "Amount of HCl consumed for blank"

M:" Acid molarity"

g:"sample quantity"

Determination of Crude Fat Content

After weighing 1 g of the sample of the dried material, it was transferred to a tared 250 ml volumetric flask and 20 ml of the methanol: chloroform mixture prepared in a 2:1 ratio was added. The sealed sample was mixed in a magnetic stirrer for 15-20 minutes at room temperature. Then, it was centrifuged for 15 minutes (10000 rpm) to remove the oil phase in the resulting homogeneous mixture. After centrifugation, 4 mL of 0.9% NaCl solution was added to the mixture in the falcon tubes. After shaking by hand for 1-2 minutes, it was centrifuged again at low speed (2000 rpm). The uppermost phase formed after these processes contains gangliosides along with small organic polar molecules. If desired, it can be stored and used for other special analyses. The uppermost ganglioside phase was siphoned off. The methanol:chloroform phase remaining below holds the total amount of oil, for example. This phase was siphoned into previously tared 250 ml volumetric flasks and evaporated in a rotevaporator at 60°C.

The extraction flask was weighed on a precision scale (0.0001gr) after evaporating methanol and chloroform in an oven at 103 °C for three hours (Folch et al. 1956). The biochemical properties of *Neochloris aquatica* star were also determined.

The total amount of oil was calculated with the following formula. The process to determine the amount of crude oil was repeated three times and the results were averaged.

Amount of crude oil (%)=[(ts-t)/m]x 100
m=Sample weight

t_1 =empty weight of the volumetric flask

t_s =Weight of volumetric flask and accumulated oil after the proce

DISCUSSION

- The biochemical composition of algae varies between species and according to culture conditions (Leonardos & Lucas, 2000; Martínez-Fernández et al., 2006). It is influenced by growth phase and culture medium composition as well as environment factors (Brown et al., 1993; Valenzuela-Espinosa et al., 2002). In the present study, proximate composition, vitamin and mineral contents of *Cladophore* sp. i.e., protein, vitamin A and P increased with increased phosphorus levels in culture media, while carbohydrate decreased.
- The previous studies have been shown the environmental conditions influence to algal nutritional values. Khuantrairong and (Traichaiyaporn 2009) suggested that P content of *Cladophore* sp. was positively correlated with phosphorus levels in culture medium. Leonardos and Lucas (2000) reported that phosphorus limitation affected to decrease protein content of a microalga *Chaetoceros muelleri*. Elenkov et al. (1996) reported that high salinity affected increasing lipid content of *Cladophora vagubunda*. In addition, *C. siwaschensis* living in high salt water was considerably increased calcium and phosphorus content (Alfimov and Proshkina-Lavrenko, 1961).
- The study showed that sodium nitrate is the best inorganic nitrogen source for the production of the antagonist. In the case of using organic nitrogen sources, it was observed that the antagonist is formed in the highest quantity in the case of serine, glutamic acid and threonine. However, the use of lysine, methionine, tryptophan and tyrosine led to a significant reduction in the production of the antagonist by this algae. As for some other sources such as leucine, aspartic acid and proline, they led to a significant increase in the efficiency of the production of the antagonist.

- Auer and Canale (1982) found that high dissolved P levels in water increased the tissue P concentration of *Cladophora*. Furthermore, enrichment of P in culture media raised tissue P levels in the green macroalga *C. lignum* (Menendez et al., 2004). According to Zeidan (2007) and Togay et al. (2008), *D. salina*'s nutritional profiles may alter due to study settings, resulting in moderately different results than Borowitzka .
- External irradiance and residence time had a significant impact on biomass nutritional profiles. Multivariable data analysis is a viable way to identify underlying structures in complex biological systems. A PCA analysis identified variable clustering, indicating a significant influence of residence duration. During the nine days of culture, differences in cell density were noticed between treatments; as a result, the specific growth rate was much greater at lower salinities, since *T. weissflogii* is an estuary microalgae (Radchenko and Il'yash, 2006). Vrieling et al. (2007) discovered a comparable growth response in cultures of two marine diatoms (*T. punctigera* and *T. weissflogii*) at low salinities (25 and 33 psu). The biomass peak was observed at greater salinities, probably due to an increase in the mineral fraction.
- Chemical analysis of algal components was conducted. The algae were extracted with various solvents, and the extracts were evaluated for antibacterial activity against harmful microorganisms such as bacteria and fungi using the agar diffusion method. The study found that all extracts, particularly those from brown and green algae, had the strongest antibacterial activity. The most effective extracts were chosen to investigate their effects on the cell walls of certain bacteria. Furthermore, the toxicity of various extracts was investigated utilizing the lethality of *Artemia* larvae.

- According to Mansour and Salama (2004), an increase in the mineral percentage may be a biological response to osmotic pressure alterations. In this investigation, the mineral fraction in *T. weissflogii* increased at salinities larger than 35 psu. For example, unfavorable results have been seen when *T. Weiss flog* cultivated at >35 psu is utilized as feed for shrimp larvae, owing to the decreased organic matter content and inadequate macronutrient profiles.
- Protein concentrations in our experiment at 25 psu were comparable to those reported by Kamentha et al. (2010) for mass cultures of the diatom *T. Weiss flog*, with a maximum of 326 mg g⁻¹ DW. The carbohydrate concentration was considerably impacted by salinity, with maximum concentrations reported in the late exponential and stationary phases at 25 and 30 psu, respectively; these findings are comparable with Raghav an et al. (2008). Regarding the effect of salinity, it was discovered that as salinity increased, lipid levels decreased.

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"Scented Shadows: The Hidden Dangers of Incense Smoke in Libyan Culture"

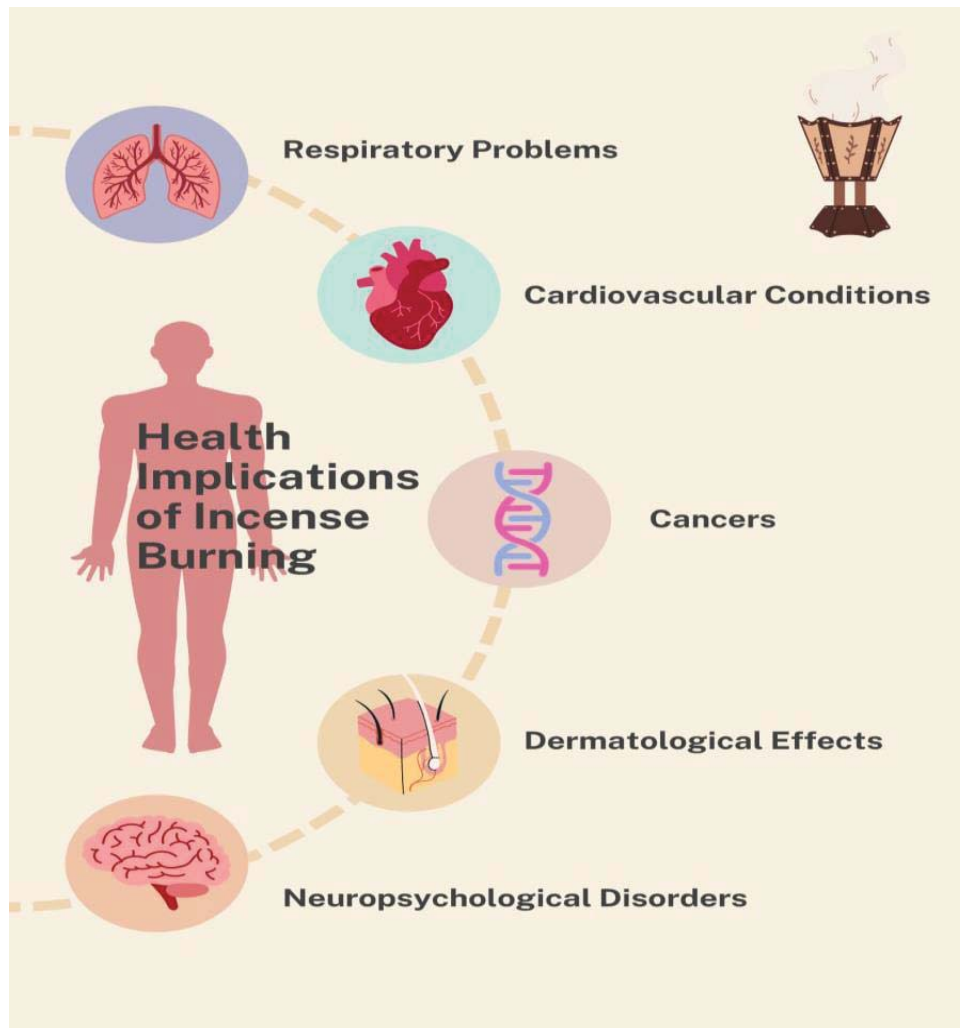
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Abstract:

This research paper aims to raise awareness about the potential health risks associated with the widespread use of incense in Libyan cultural and social traditions. Despite the deep-rooted significance of incense burning in Libya, the study highlights the growing evidence that incense smoke can be a significant source of ambient air pollution and may be linked to increased cardiovascular and lung cancer mortality risks. The paper underscores that incense smoke contains high concentrations of fine and ultrafine airborne particulates, as well as gaseous pollutants such as carbon monoxide, nitric oxide, and volatile organic compounds - all of which have also been detected in tobacco smoke. By shedding light on these potential toxicities, the research seeks to empower the Libyan people to make more informed decisions about the use of incense, prioritizing their health and well-being within their cultural practices.

Keywords: Libyan culture, Incense, Lung cancer, Gaseous pollutants, Volatile organic compounds, Ultrafine particulates.



Introduction:

Incense is a fragrant material that is burned to produce a pleasant aroma. According to the Oxford Dictionary, incense is "a substance that produces a pleasant smell when you burn it." This aromatic material comes in various forms, such as sticks, cones, and powders, and is used for religious, spiritual, and cultural purposes around the world.

In Libya and the broader Arab world, the use of incense is deeply ingrained in cultural and social traditions. Incense is burned not only for its pleasant aroma, but also for its purported ability to repel mosquitoes. In fact, many Libyans strongly associate the scent of incense with cleanliness and the celebration of important events. Incense is commonly used in Libyan homes, at weddings, during Eid festivities, and in numerous other social gatherings. The ubiquitous presence of incense in these contexts underscores its central role in Libyan culture and daily life.

However, what many Libyans may not be aware of is the potential toxicity of incense smoke. Despite its widespread use, it is important to recognize that incense smoke contains high concentrations of pollutants that have been detected in tobacco smoke. The toxicities of incense smoke come mainly from its various chemical constituents. As such, it is crucial that awareness be raised about the potential harmful effects of excessive incense burning, in order to promote safer practices and mitigate any health risks.

Research has shown that the practice of burning incense is a source of ambient air pollution [1] and that this practice may be related to increased risk of cardiovascular and lung cancer mortality [2,3,4,5]. Incense smoke contains high concentrations of fine and ultrafine airborne particulates and gaseous pollutants such as carbon monoxide (CO), nitric oxide (NO) and volatile organic compounds (VOCs). [1,6,7] all of which have also been detected in tobacco smoke [8,9].

By highlighting the potential dangers of incense smoke, this research paper aims to empower the Libyan people to make more informed choices about the use of incense within their cultural traditions, ultimately prioritizing their health and well-being.

Key types of air pollutants found in incense smoke and their toxicological impacts:

Individuals exposed to incense smoke inhale a complex mixture comprising particulate matter, gaseous byproducts, and various organic compounds. This complexity makes it challenging, if not impossible, to isolate the specific health impacts associated with individual components of the smoke.

Nonetheless, understanding the composition of incense smoke—including its pollutants and their toxicological effects—is crucial. Much of the existing research on health effects is derived from studies of general air pollutants rather than incense specifically, yet these findings can still shed light on potential risks.

Research indicates that certain pollutants commonly found in incense smoke, such as volatile organic compounds (VOCs) and particulate matter, are associated with respiratory issues, cardiovascular problems, and other health concerns. By investigating the broader implications of these pollutants, we gain a clearer understanding of the potential health risks tied to long-term exposure to incense smoke. This knowledge can help guide users toward safer practices and inform public health policies.

The harmful emissions from incense can be categorized into three main types: inorganic gaseous products, particulate matter, and organic compounds. Individuals exposed to burning incense are likely to inhale this complex mixture of irritants and toxic substances, which poses significant risks to human health.

1. Inorganic Gaseous Products:

1.1. Carbon Monoxide (CO)

Carbon monoxide is a colorless, odorless, and tasteless gas that is toxic. It typically arises from the incomplete combustion of organic materials, including hydrocarbons, wood, incense, cigarettes, and fossil fuels.

The major mechanism of CO toxicity is attributed to its greatly high affinity for hemoglobin in the blood which is the vital oxygen deliver in the body, resulting in the deprivation of adequate oxygen supply called hypoxia. Thus, tissues with a greater requirement for oxygen such as the brain and heart tissues are much more vulnerable to the hypoxic state.[14]

The signs and symptoms of carbon monoxide poisoning are typically non-specific and can vary between individuals. They may include headache, nausea, vomiting, dizziness, altered consciousness, weakness, confusion, myocardial infarction, respiratory failure, loss of consciousness, and potentially death. The severity of these effects largely depends on the concentration of carbon monoxide and the duration of exposure.

1.2. Nitrogen Dioxide (NO₂)

Nitrogen dioxide (NO₂) poses significant health risks through various toxic mechanisms. NO₂ can cause respiratory irritation by penetrating the airway epithelium and generating reactive oxygen species (ROS), leading to inflammation and oxidative stress. This irritation results in symptoms such as coughing, wheezing, and shortness of breath. Prolonged exposure increases the risk of respiratory infections by weakening the immune response, aggravates asthma, and impairs lung function, raising the likelihood of chronic obstructive pulmonary disease (COPD). Long-term exposure to NO₂ is also associated with various respiratory and cardiovascular diseases.

1.3. Sulfur dioxide (SO₂) .

SO₂ has been not only documented as a respiratory irritant and bronchial constrictor but also associated with cardiovascular

conditions, leading to the increased admissions, morbidity and mortality with respect to cardiopulmonary issues.[15]

2. Particulate Matter:

PM can be described as a complex mixture of physically and chemically diverse particles as solids and/or liquid droplets suspended in the atmosphere. [16] Incense burning generates particulate matter (PM) at a level four times higher than that of cigarettes, producing approximately $45 \text{ mg}\cdot\text{g}^{-1}$ compared to around $10 \text{ mg}\cdot\text{g}^{-1}$ for cigarettes.[29] Particulate matter consists of tiny particles or droplets in the air that can be harmful to both health and the environment, encompassing various sizes, including dust, dirt, soot, and smoke. PM is categorized based on size, with PM10 referring to particles with a diameter of 10 micrometers or smaller, which can be inhaled and may lead to respiratory problems. PM2.5, on the other hand, includes finer particles with a diameter of 2.5 micrometers or smaller, posing an even greater concern as they can penetrate deep into the lungs and potentially enter the bloodstream, resulting in serious health issues.

3. Organic Gaseous Products:

A wide range of toxic organic compounds has been identified in the incense smoke, among which carbonyls, volatile organic compounds (VOCs), and polycyclic aromatic hydrocarbons (PAHs) have been commonly reported. The emissions of carbonyls from the burning of ten different incense types in a large environmental test chamber detected a total of eight carbonyl compounds, predominantly aldehydes. Remarkably, the formaldehyde concentrations of six types were higher than the 8-h average formaldehyde concentration recommended by HKIAQO ($100 \mu\text{g}/\text{m}^3$), and the highest burning level of formaldehyde even surpassed the standard value by twice [26]. Regarding VOCs, their emission from incense burning at different temples in China were measured and analyzed as well. The results found that there were twelve kinds of VOCs identified in the air samples, among which benzene, toluene, and xylene were the abundant species whose concentrations surpassed the recommended levels of $0.05 \text{ mg}/\text{m}^3$ by WHO [27]. Acute symptoms of VOC exposures are: eye irritation/watering, nose irritation, throat irritation, headaches, nausea/vomiting, dizziness, and asthma exacerbation. Chronic symptoms of VOC exposure are: cancer, liver damage, kidney damage, central nervous system damage [28].

Health Implications of Incense Burning:

The smoke produced by burning incense is harmful to both human health and air quality in several ways. The main sources of these dangers include unburnt carbon particles and other complex residues, which can combine with surrounding air and form larger particles. When inhaled, these particles tend to settle and can vary in toxicity. The most significant risks from these pollutants are to respiratory health, as the respiratory system is the first to come into contact with them. Recently, many restrictions have been placed on incense use, as nearly all currently exported brands pose a risk of generating pollutants.[9] Numerous studies have shown an increased risk of asthma, respiratory allergies, breathing difficulties, neurological issues, leukemia, skin irritation, cardiovascular problems, and lung cancer.[10,11,12,13].

Respiratory Problems

Burning incense can have several toxic effects on the respiratory system due to the presence of fine particulate matter and carcinogens amongst other particles which can penetrate deep into the lungs, leading to respiratory issues such as asthma and chronic inflammation, as well as an increased risk of upper respiratory tract and lung cancers from long-term exposure. Additionally, incense smoke can irritate the eyes, nose, throat, and skin, exacerbating conditions like asthma and causing symptoms such as wheezing and shortness of breath. The inhalation of incense also triggers inflammation in the lungs and other body parts, while volatile organic compounds (VOCs) released during burning contribute to respiratory and cardiovascular diseases. To mitigate these risks, it's advisable to limit incense use, ensure good ventilation, and consider healthier, safer alternatives. Historical studies, such as one by Sturton et al. in 1966, indicated a high incidence of nasopharyngeal carcinoma among males in Hong Kong who burned incense, with a significant percentage of cancer cases linked to incense exposure [17]. In order to determine whether indoor environmental factors affected respiratory dysfunction, Yang et al. have surveyed 4,164 elementary school children in several rural areas in Kaohsiung, Taiwan. They found that, among the other chemical factors, incense burning and mosquito repellent burning were significantly associated with cough symptoms [18]. Also in a prospective cohort study among more than 4000 school children in Hong Kong from 2012 to 2014, the adverse effects of incense burning on lung function and lung function development of children were evidenced. Moreover, exposure to domestic incense burning was found to associate with the increased risks of bronchitis

and bronchiolitis in both sexes, and so were pneumonia and wheeze but only in boys. The reasons for such gender sensitivity were unknown. One plausible explanation was that respiratory problems were more prevalent in boys than in girls at the baseline.[19]

Cancers

To explore the causes of leukemia, Lowengart et al. conducted a study involving children aged 10 and under in Los Angeles County. They interviewed the parents of acute leukemia cases and their individually matched controls about specific occupational and home exposures, along with other potential risk factors linked to leukemia. The analysis of data from 123 matched pairs revealed that children whose parents burned incense at home faced a heightened risk of developing leukemia. Notably, this risk increased with the frequency of incense use.[20]

One of the earliest evidences for positive association was a hospital-based case-control study in Singapore in 1970s, where univariate analysis reported a strong relationship between lung cancer and incense use while sleeping with overall relative risk of 4.11 ($p < 0.01$).[21] The lack of adjustment of potential confounders such as age, gender, and smoking status was a major drawback of that study. Following the adjustment for smoking and confounding demographic variables, another hospital-based case-control investigation with 331 lung cancer cases and 331 matched controls in Hong Kong indicated that exposure to incense burning during festivals was associated with a significantly higher risk of lung cancer among women (adjusted Odd ratio (OR) = 2.95; 95% confidence interval (CI): 1.10–7.87) but not daily exposure (adjusted OR = 1.58; 95% CI: 0.77–3.26). Meanwhile, neither daily exposure (adjusted OR = 0.94; 95% CI: 0.56–1.56) nor festival (adjusted OR = 1.03; 95% CI: 0.47–2.26) showed an association with the increased risk of lung cancer among men.[22] The stronger association found among women might be due to their higher tendency of incense use. On the other hand, the null association between incense use and lung cancer has also been documented. A Singapore Chinese population-based prospective cohort study was unable to observe the overall effect of incense use on lung carcinoma development regardless the smoking status.[13] Besides, the impact of incense use on the risk of other respiratory tract cancers other than lung cancer has been commonly investigated as well, and most of existing evidences have been in respect with nasopharyngeal carcinoma (NPC). A case-control study among Hong Kong Chinese with 352 incident cases of NPC and

410 controls observed an increased risk of NPC among women who had burned incense daily at home (adjusted OR = 2.49; 95% CI: 1.33–1.46) but not among men (adjusted OR = 0.96; 95% CI: 0.63–1.45). Remarkably, evident exposure-response relationship was found, where the risk for NPC in women who had practiced daily domestic incense burning for 40 years or more was over four times that in non-users.[23]

Cardiovascular Conditions

The strong relationship between incense use and death due to cardiovascular diseases (CVDs) was reported [2]. A cross-sectional study conducted among 132 Thai-Vietnamese adults aged more than 35 years in Thailand demonstrated the positive association between household incense burning and carotid artery intima-media thickness (CIMT) in multivariable regression analysis after controlling potential confounding factors.[24] Since CIMT generally identifies the levels of atherosclerosis and thus estimates the risk of CVDs,[25] such findings suggest that incense burning at home may be a risk factor for the development of cardiovascular conditions.

Considerations for Public Health Management

Guidelines for Safer Incense Use :

Using incense safely requires following some important guidelines to minimize health risks. Here are a few key considerations:

1. Choose Quality Products

- Opt for natural incense made from high-quality ingredients.
- Avoid products with synthetic fragrances or harmful additives.

2. Ventilation

- Burn incense in a well-ventilated area to reduce smoke accumulation.
- Open windows or use fans to circulate air.

3. Limit Duration and Frequency

- Do not burn incense for extended periods; limit sessions.
- Use incense sparingly to avoid respiratory issues.

4. Monitor Reactions

- Pay attention to how your body reacts. If you experience headaches, dizziness, or respiratory discomfort, discontinue use.
- Consider using alternatives like essential oils or diffusers.

5. Keep Away from Children and Pets

- Ensure that burning incense is out of reach of children and pets.

6. Educate Yourself

- Research the types of incense you use and their potential health effects.
- Look for reputable brands and read reviews before purchasing.

Recommendations

To promote safer use of incense in Libyan culture, it is essential to raise awareness about the potential health risks associated with incense smoke. Education campaigns can inform communities about the links between incense use and respiratory or cardiovascular diseases, helping individuals make more informed decisions regarding their practices.

Encouraging informed choices involves presenting alternatives to traditional incense that may produce fewer harmful emissions. Options such as essential oils or electric diffusers can be highlighted as safer substitutes that still provide a pleasant aroma without the associated health risks.

Proper ventilation is crucial when using incense. It is recommended that individuals use incense in well-ventilated areas to minimize inhalation of smoke and reduce exposure to pollutants. This simple practice can significantly lower health risks while allowing individuals to enjoy their cultural traditions.

Further research into the health effects of incense smoke is necessary. A multi-disciplinary approach can provide valuable insights into the risks associated with incense, drawing parallels with tobacco smoke. This knowledge can inform public health policies aimed at reducing exposure and protecting community health.

Public health strategies can be developed to guide safe incense use, including community health initiatives that offer workshops or informational sessions. These programs can empower individuals with knowledge and strategies for minimizing health risks.

Finally, monitoring and regulation of incense use in public spaces may be necessary. Establishing guidelines for safe usage, including limits on use during certain events or in enclosed areas, can help protect public health while respecting cultural practices.

By implementing these recommendations, it is possible to balance the rich cultural heritage surrounding incense with the imperative of safeguarding public health.

Conclusion

In conclusion, while incense holds a significant place in Libyan culture as a symbol of cleanliness and an integral part of social and religious gatherings, it is crucial to recognize the associated health risks posed by

its smoke. The pleasant aroma and cultural importance of incense must be weighed against the potential pollutants it emits, which can lead to serious health issues, including cardiovascular and lung diseases. Research has linked incense smoke to various health problems, such as airway dysfunction and allergic reactions, highlighting the need for further investigation into its long-term effects. As both incense and tobacco smoke share similar harmful pathways, understanding these relationships can inform public health strategies aimed at promoting safer practices. By raising awareness about the toxic effects of incense smoke and encouraging informed choices, we can honor cultural traditions while prioritizing the health and well-being of individuals and communities. Ensuring proper ventilation and adopting a multi-disciplinary approach to research will help mitigate exposure risks and allow Libyans to enjoy their cherished customs without compromising their health.

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Study of Relationship Between Heparin and Platelets in Hemodialysis Patients

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Abstract

Platelets are considered one of the most important components of blood that contribute to the coagulation process, and they also play an important role in the blood clotting process. Platelets may be exposed to some types of anticoagulant drugs, such as heparin, which increases the risk of thrombocytopenia, especially in dialysis patients who receive heparin periodically in the extracorporeal circuit in the dialysis unit; thrombocytopenia may develop due to receiving heparin in every dialysis session, which has been confirmed for patients in previous research. This research, aims to find the relationship between heparin and platelets among dialysis patients .

Some parameters were carried on for hemodialysis patients of (Al-Jamil - Raqdalien - Zuwara) hemodialysis centers to support the study of the relationship between them, (CBC, PT, PTT, CT, and BT), also a questionnaire has been collected from the patients for further information.

The results showed that there is an inverse relationship between the dose of heparin and platelets at α (0.5), meaning that the higher the dose of heparin, the greater the thrombocytopenia. We also found that there is an inverse relationship between the duration of dialysis and platelets, meaning that the longer the duration of dialysis, the lower the platelet count. The results showed also the presence of clots in the dialysis machine in varying proportions .

We can conclude that there are no effects on the types of treatment doses on the platelets. Also, heparin dose and Platelets count have an inverse significant relationship. We can conclude also that there are no significant differences between the average platelets due to the types of heparins at the level of significance.

Keywords: Heparin; Platelets Hemodialysis.

1. Introduction:

1. Introduction:

In general, heparin is used in hemodialysis units as an anticoagulant both in the extracorporeal circuit and in long-term hemodialysis catheters. Both unfractionated heparin and low atomic weight heparin can be used^[1]. Heparin is the first choice when a rapid anticoagulant is needed because its effectiveness is immediate when not controlled by intravenous infusion. Heparin is controlled in low doses when used for primary prevention and in high doses when used therapeutically to prevent stroke recurrence^[2]. Unfractionated heparin (UFH) and low molecular weight heparin (LMWH) are the two most widely used types of heparins^[3]. UFH and LMWH don't have characteristic anticoagulant movement but potentiate the action of antithrombin III restraining actuated coagulation factors. These specialists comprise roundabout anticoagulants as their action is intervened by plasma cofactors^[4]. We advise obtaining CBC, PT, APTT, and total body weight before beginning heparin medication. Regardless of the method, heparin effectiveness is dependent on dosage. When predicting effectiveness, the first dosage matters more than the APTT. A baseline platelet count is advised as a starting point from which to evaluate the potential development of Heparin Induced Thrombocytopenia (HIT)^[5]. Thrombocytopenia is indicated by a blood platelet count of less than $150 \times 10^9/L$ ($150,000/mm^3$); however, spontaneous capillary bleeding typically does not occur until the count is less than 30×10^9 ($30,000/mm^3$)^[6], there are two types of heparin-induced thrombocytopenia (HIT) in hemodialysis patients: type I (HIT I), a mild, self-limiting condition that manifests 1-4 days after administration and accounts for 10%-20% of cases; The second type, known as HIT II, is severe; it begins between 5 and 15 days after the initial exposure to heparin and results in a decrease in the number of platelets that is greater than 30 to 50 percent lower than the baseline value^[7]. HIT happens when antibodies against multi-molecular buildings shaped by adversely charged heparin and the emphatically charged (platelets protein) platelet factor 4 (PF4) initiate platelets by means of the platelet FcγIIa receptor, prompting platelet micro-particle age and thrombin age^[8]. expanded clump development in extracorporeal circuit during hemodialysis with UFH is some of the time experienced by not just patients with HIT type II yet additionally those with HIT type I, this sort of HIT is credited to a direct ability of

heparin to animate platelet aggregation, which prompts expanded platelet sequestration and resulting decline in platelet count^[9]; in the concentrated consideration unite setting, continued coagulation of the extracorporeal circuit is the commonest appearance of HIT antibodies^[10]. Antibodies against PF4/heparin are not an uncommon tracking down inpatients on persistent renal substitution treatment; HIT ought to be through when thrombocytopenia and additionally clump development happen during the initial 2-3 weeks after beginning of hemodialysis and during the initial fourteen days when patients on persistent dialysis ^[11]. The study performed a retrospective review of patients with ESRD (creatinine clearance < 15 mL/min or on renal replacement therapy [RRT]) who underwent PF4 heparin ELISA testing from October 2015 to September 2019. True-positive PF4s required an intermediate to high 4T score (≥ 4), a positive SRA, and receipt of treatment for a HIT diagnosis. False-positive PF4s were defined as a positive PF4 with a negative SRA, low 4T score (< 4) or lack of treatment for HIT ^[12]. Another retrospective study analyzed patients who were tested for evidence of positive anti-heparin antibody in the period from 2015 to 2020 in Zvezdara University Medical Centre. The diagnosis was confirmed by the 4T clinical scoring system, a positive antiheparin-PF4 ELISA test and a positive platelet aggregation test with heparin. the researchers stressed; HIT should be considered in patients at risk. It is necessary to abolish heparin treatment and use alternative method (PD) or alternative anticoagulation ^[13]. To determine the impact of CRRT on platelet count and development of thrombocytopenia, the researchers conducted a study: Retrospective analyses evaluated the intra-patient change in platelet count following CRRT initiation. Critically ill adult patients who received CRRT for at least 48 hours were included. ^[14]. Hence, HIT is a challenging diagnosis in ESRD patients, a population that has frequent exposure to anticoagulants. The diagnosis and treatment of HIT can be difficult in ESRD patients and requires careful consideration in order to provide appropriate care for this patient population. Alternative treatments are available, and clinical trials are ongoing to potentially prevent this condition from occurring in the first place. Therefore, a clinical approach should always be taken to address this issue ^[15].

2. Materials and Method

2.1. Patient sample

This study was conducted in the period from the beginning of May to the end of August 2023. It targeted three dialysis centers in the far northwest of Libya (Al-Jameel, Zuwara, and Raqdalín). 90 dialysis patients on regular hemodialysis participated in this study, and their distribution was 45 participants from the Al-Jameel dialysis center, 31 participants from Zuwara dialysis Center and 14 participants from Raqdalín dialysis Center.

Those ninety patients were (59 males and 31 females), targeted for this study through a letter from the dean of the college and obtaining the approval of the doctors supervising these centers, as well as the approval of the patients. In addition to the questionnaire, patients were informed that they would undergo tests to measure bleeding and clotting times, and blood samples would be drawn from them to measure prothrombin time.

2.2. Coagulation tests

2.2.1. Bleeding Time and Clotting Time:

Bleeding time and clotting time tests were performed directly on patients in dialysis units. The following tools were used: a glass slide, a stopwatch, cotton, filter paper, a scalpel, and 70% alcohol.

2.2.2. Prothrombin Time (PT):

The clotting time is measured at 37°C in the presence of tissular thromboplastin and calcium. It reflects the activity of Factor II (prothrombin), V (proaccelerin), VII (proconvertin), X (Stuart Factor) and fibrinogen. The measured time is converted into PT (%) or INR. Specimens of the test were: Blood/anticoagulant ratio: 4.5 mL of blood for 0.5 mL of sodium citrate 2 H₂O 0.109. The coagulation analyzer used is Thermostat.

2.3. Statistical analysis:

All data collected from the questionnaire, from patient records, through examinations conducted directly on patients, or through collecting samples and conducting laboratory tests, was collected, transcribed, and statistically analyzed using Statistical Package for Social Sciences (SPSS) V24.

3. Results

3.1. Distribution of patients according to sex:

Distribution of patients included in the study according to sex, 90 people were observed with chronic renal failure whereas, the proportion of male patients who were investigated was 65.6% and the

female was 34.4%. These percentages as presented in Figure (1) below indicate that the percent of male is higher than female.

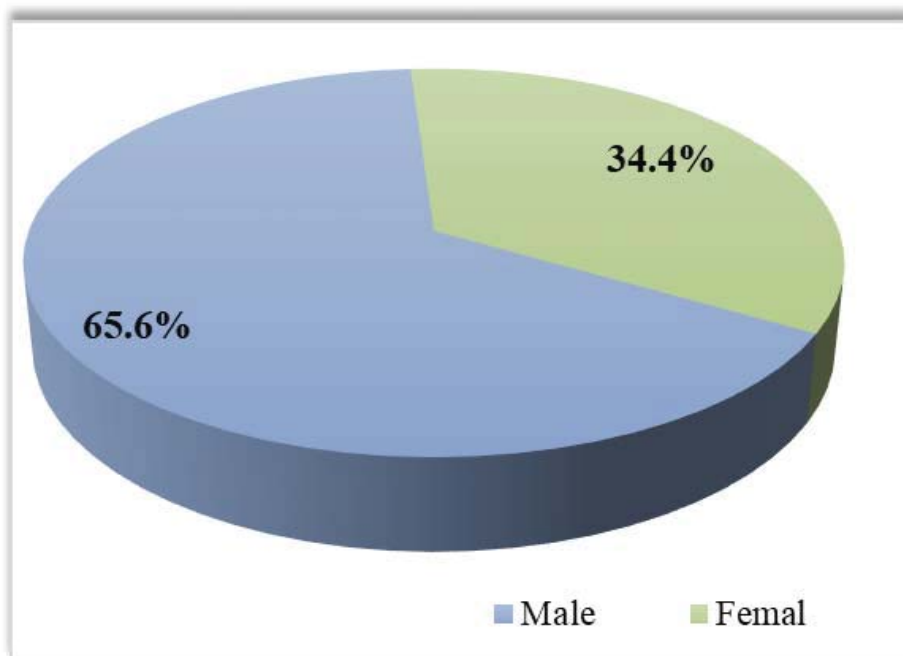


Figure 1: Gender of patients

3.1. Distribution of patients according to age:

Distribution of patients included in the study according to age, the CRF increased with increase of age where it raised from the percentage of the first age group 20-39 year was 16.7%, the percentage of 40-59 years was the highest group with frequently 61.1%, and the age group of 60-79 year was 22.2%.

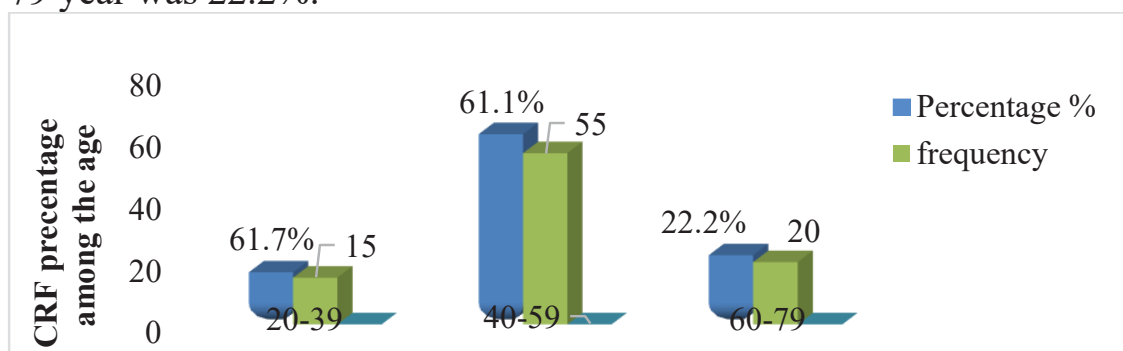


Figure 2: Distribution of patients according to age

3.3. Type of Heparin :

Distribution of patients according the type of heparin, these is data clarify that the percentage of patients taking UFH are more than those taking LMWH, the percentage is 74.4% and 25.6% respectively.

Table 1: Displays the frequency and Percent for Heparin type

Heparin type	frequency	Percentage %
UFH	67	74.4
LMWH	23	25.6
Total	90	100.0

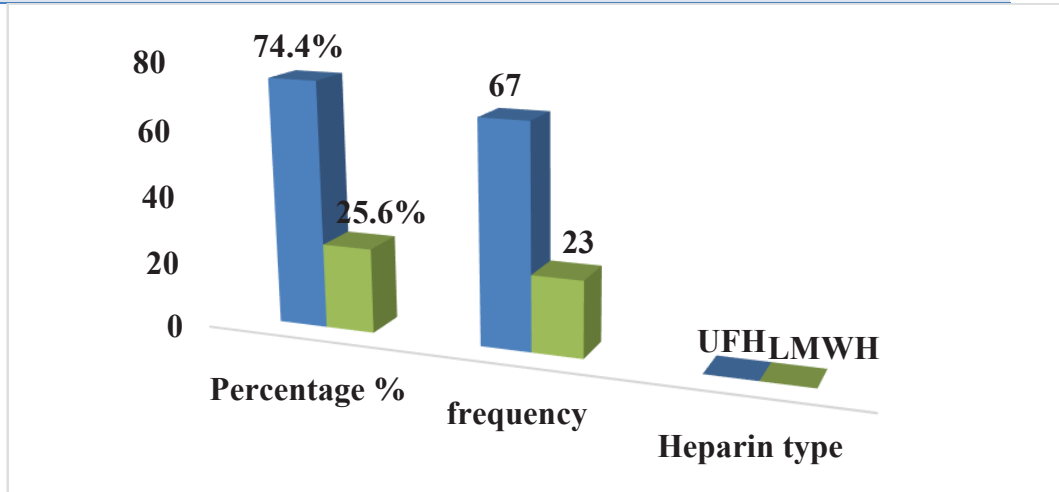


Figure 3: The heparin type

3.1. The incidence of clot site in machine dialysis:

This result indicates that percentage of patients who do not develop clots in the dialysis machine has reached 30%, while the percentage of patients in whom clots do not occur in all parts of the machine has reached 30%. The incidence of clotting in the “Line” stage was 5.6%. We note that the highest percentage of those who had clots during the (Filter, Line and Chamber) stage was 13.3%. The lowest percentage was in the “Catheter” stage, where it reached 1.1%, as shown in the (table 2).

No	27	30.0
Line	5	5.6
Filter	2	2.2
Chamber	3	3.3
Catheter	1	1.1
Filter and Line	10	11.1

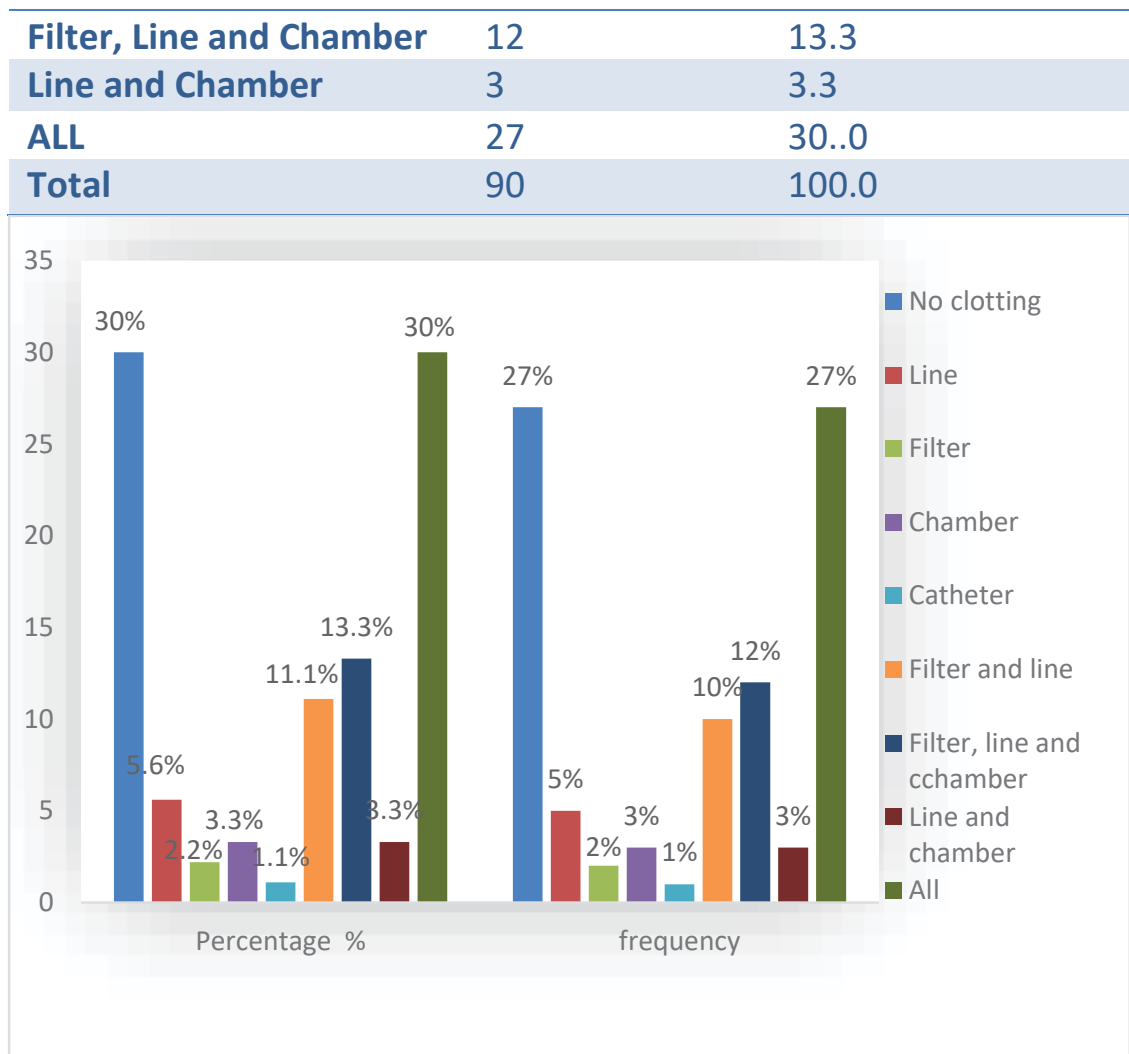


Figure 4: the frequency and Percent for Clotting site in machine

3.5. Incidence of bleeding after and before dialysis:

It is clear from (Table 4) followed that the percentage of patients in whom clotting occurred before or after the dialysis process reached 35.6%, while we find that the percentage of patients in whom clotting did not occur reached 64.4%. (Table 3).

Bleeding after and before dialysis	Frequency	Percentage %
No	58	64.4
Yes	32	35.6
Total	90	100.0

3.6. Statically Analysis:

3.6.1. Relationship between heparin dose and platelet count :

SPSS programming was used to study the relationship between heparin dose and platelet count, as shown in Table (4) below the P-value was 0.021 which is less than α (0.05), from that can be conclude that there is an inverse significant relationship between heparin dose and Platelets counts at.(0.05)

Table 4: Correlation Coefficient heparin dose and Platelets.

Variables	Correlation Coefficient (<i>R</i>)	Determine Coefficient (<i>R</i> ²)	p-value	Significant
heparin dose and Platelets	-0.46	0.212	0.021*	A significant relationship

3.6.2. Descriptive statistics:

A descriptive statistic will be presented as averages and standard deviations for the variables. (Table 8) shows that the average age of the members of this study was (50.6) years with standard deviation (10.8), while the average duration of dialysis for those patients was (4.6) with standard deviation (4.2), and the average of platelet count was (206.6) with standard deviation (75.4), moreover, for the BT and CT the average was (1.7), (6.5) minutes with standard deviation (1.3), (1.1) respectively .

Table 5: Descriptive Statistics for the Variables

Mean $\pm$ St.d	Variables
50.6 $\pm$ 10.8	Age (Years)
4.6 $\pm$ 4.2	Duration of dialysis
206.6 $\pm$ 75.4	Platelet
1.7 $\pm$ 1.3	BT
$\pm$ 1.1	CT

4. Discussion

This research indicates that the ages most at risk of developing chronic kidney failure are 40-59, which explains the development of chronic kidney disease at these ages or that the patient suffers from several diseases that lead to their exacerbation and entry into the dialysis stage. It is noted that the prevalence of dialysis is more common in men than

women, as its rate in men is about 65.6%, while its rate in women is about 34.4%. It was also confirmed in this research that there is no relationship between the different types of heparins used and the occurrence of thrombocytopenia in dialysis patients, which indicates that these two types differ in terms of bioavailability and half-life. We also found that there is no relationship between the occurrence of bleeding in the patient and its association with the occurrence of thrombocytopenia before and after dialysis because the dose of heparin does not cause bleeding due to the length of the dialysis session, which reduces the dose of heparin during the session. There is also no relationship between the occurrence of clots in the dialysis machine and the incidence of thrombocytopenia, and the largest percentage of clotting occurred in the parts of the machine, which are the filter, line, and chamber; when clotting occurs in these parts, the risk of clotting increases in the rest of the entire dialysis machine procedure. It has been confirmed that there is an inverse relationship between the dose of heparin and the number of platelets, meaning that the higher the dose, the lower the thrombocytopenia. Due to differences in the doses used the thrombocytopenia increases among patients. In this case there was also an inverse relationship between the duration of dialysis and platelets, that is, the longer the duration the fewer platelets, which accounts for the prevalence of thrombocytopenia in the long term in patients. The duration of dialysis increases the risk of thrombocytopenia in patients, which requires transferring the patient to alternative anticoagulants are less dangerous such as direct thrombin medications such as argatroban. In this research, we found that heparin flushes into the extracorporeal circuit causes clotting in the circuit, which increases the incidence of thrombocytopenia, which was discovered through a study conducted in Japan [16], this was confirmed in this study using a completely different analyzes such as ELISA assay, which was not used in our research despite the similarity of the results between the two studies, immediate ELISA is used after clinical suspicion of HIT, when HD-HIT patients show an elevated coagulation index or worsening of coagulation. In another study conducted at University Konya Turkey [17], says that patients are undergoing hemodialysis (HD) treatment have increased risk of developing HIT due to prolonged exposure to unfractionated heparin or low-molecular weight heparin. This study differed from ours in that this study observed sever sepsis and thrombosis complicated by bleeding in the digestive system, which we

did not notice in our research and did not address it. Confirming a study conducted in the USA [18], the use of heparin as CRRT is not necessarily associated with the presence of HIT; this study differed from ours in that it showed a serial decrease in platelet count across multiple days after the start of CRRT, regardless of the dose of heparin given during dialysis. Previous research also differed from our research in that it relied on diagnosing thrombocytopenia using clinical T4 scores and PF4 antibodies, ELISA assay as evidence of the presence of HIT, as thrombocytopenia was diagnosed using these analyses by previous studies confirming the existence of a relationship between heparin and platelet; these studies were: ([12], [13], [15]). However, in our research, these analyses were not used as diagnostic tests, but rather tests were used to diagnose or monitor the dose of heparin that causes thrombocytopenia. Our research has been compared to similar research so that its results are identical or substantially similar to those mentioned above .

5. Conclusion

We can conclude from this study that there is an inverse significant relationship between heparin dose and Platelets count at (0.05). And we can conclude that there is an inverse significant relationship between the duration of dialysis and the Platelets count at (0.05). We also conclude that there are no significant differences between the average platelets due to the types of heparins at the level of significance (0.05). Thus, we can say that there are no effects on the types of treatment doses on the platelets. Also, we conclude that there are no significant differences between the average platelets due to the bleeding during dialysis at the level of significance (0.05). Thus, we can say that there is no effect of the bleeding during dialysis on the platelets .

6. Recommendation:

- 1- The necessary dose of heparin must be taken into account to avoid the occurrence of clots in the extracorporeal circuit.
- 2- Follow up and monitor the extracorporeal circuit and address the problem of clotting that may occur during the session, especially in the filter, line and chamber.

- 3- Taking into account the duration of dialysis for patients and monitoring the platelet rate periodically.
- 4- Monitoring of the platelet count regularly for those with long time of hemodialysis.
- 5- Further researches about heparin type and dose concentration and the platelet count among the patients of hemodialysis.
- 6- The type of dialysis machine must be taken into account and checked periodically to avoid the occurrence of any clots during dialysis and the use of modern and advanced dialysis machines .

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Study of some epidemiological aspects of chickenpox in EL-Marj city

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Abstract

Chickenpox is an acute communicable disease caused by the virus belong the human herpes virus known as varicella-zoster virus (VZV). It is transmitted through droplet infection from a sneeze or cough, or by direct contact. It is characterized by a very itchy vesicular exanthema and is one of childhood's most common infectious diseases

This study aimed to determine and describe the occurrence of chickenpox in EL-Marj city in terms of (age and gender distribution, and seasonal variation appearance of rash (its period and its location on the body)) and perform some comparisons and relationships among some variables.

Materials and methods: A cross-sectional study was carried out from the first of January to mid-August of 2023. 61 participants were obtained from the population of EL-Marj city to respond to questions in the questionnaire. The data were collected using a data collection form distributed to all participants to get information.

Results: The highest percentage of cases (54.1%) occurred in the age group < 4 years. regarding the period during which the rash takes about on the body of a patient, in most cases (41%) the rash lasts for 6 days, in terms of seasonal variation the study findings indicated that the peak number of cases remained the greatest during the June and July months (34.4%) (21.3%) respectively

The present study concluded a rising trend in registering clinical chickenpox cases, as most cases occur in the age group of less than 15 years. Females are a little bit higher than males. Also, the highest frequencies were reported in June and July. Most of the cases were registered in EL-Marj city

Keywords: Chickenpox, infectious disease, varicella zoster, childhood disease, EL-Marj City

1. Introduction

Chickenpox is an acute communicable disease caused by the virus belong the human herpes virus known as varicella-zoster virus (VZV) also called "human (alpha) herpes virus 3 (Kennedym et al., 2018). It is transmitted from person to person by droplet infection through a sneeze or cough, or by direct contact with the infected person's fomites or discharges of blisters. it characterizes a very itchy vesicular exanthema and is one of childhood's most common infectious diseases. (Heininger, et al., 2006).

Primary infection with varicella zoster virus (VZV) in susceptible individuals causes chickenpox, which generally is innocuous in wholesome children. hence VZV becomes dormant in ganglionic neurons. The reactivation of the virus leads to its replica, and the transmission of it to the skin innervated by these neurons causes herpes zoster (shingles), of the causes that lead to the appearance of shingles, is an increase in age and compromised immunity performance (Hambleton, et al., 2015)

Varicella-zoster virus exists universally and, where there is no varicella immunization strategy, most of the population be infected before adulthood, varicella gives rise to a comparatively lower cosmopolitan burden of disease-specific death rates than other major infectious diseases such as whooping cough, measles, polio, rotavirus, diphtheria or invader *Streptococcus pneumoniae* disease. Even though chickenpox disease has relatively low morbidity and death rates in most conditions, it still places a great load on the health system and the community at large. chickenpox might cause perilous complications, for instance, a bacterial infection of the skin and soft tissue, coagulopathy, and inflammation of the lung, brain, and cerebellum (Khalifa, et al., 2024).

In Libya, chicken pox is a disease that should be reported within a week according to recommendations and advice of the World Health Organization (WHO) applied in several nations, this measure is achieved by the National Center For Disease Control (NCDC) in Libya, where this enterprise that is responsible for disease control and surveillance through several activities including collecting data about communicable diseases, establishing a net to report certain diseases that forming threats to public health, and fighting epidemics and pandemic through strategies of Early Warning Alert and Response Network (EWARN) & Diseases Surveillance Departments and distribution in all the provinces. there are two lists of notifiable infectious diseases, one

of them should be notified promptly and another ought to be reported within a week from diagnosis, chickenpox is considered one of the diseases that should be notifiable within a week. surveillance reports about communicable diseases collected in periodic form by branches of NCDC in each province then referring to the central administration of NCDC to prepare a final report about the epidemiological situation. Through this study, we try to point light on one of the infectious diseases that have had a rising trend in occurrence in the last period in EL-Marj City, which is chicken pox.

This study aimed to determine and describe the occurrence of chickenpox in EL-Marj city in terms of some variables (age and gender distribution, and seasonal variation appearance of rash - its period and location - on the body) and perform some comparisons and relationships among some variables in the sample of the study such as rash period and its site on the body and relates it to gender and age.

Methodology

Materials and methods

Type of Study

Cross-sectional study.

Study site

The study was carried out in the El-Marj region. El-Marj region is located in northeastern Libya. It has an estimated population of approximately 250000.

Study period

The study period was from the first of January to mid-August of 2023.

Collection of data

The data were collected using a data collection form (questionnaire) which was distributed to all participants to get information.

The group of the study

61 participants (case of chickenpox) were obtained from the population of EL-Marj city to respond to questions in the questionnaire. All participants gave informed consent before entering the study, verbal consent.

Statistical analysis

Data were analyzed using Statistical Package for Social Science (SPSS) version 21.

Descriptive statistics such as mean, median, and mode were used. Inferential statistics were used when needed. Data were presented as tables and figures, done by (SPSS) and Microsoft Excel.

Results

The results obtained from the data collection form that was distributed to the participants in the study and filled out by the researchers themselves gave the findings as follows:

The distribution of the sample of the study according to gender is illustrated in Table (1) where the percentage of females (54.1%) is more than male

Table (1) Distribution of participants in the study according to the gender

	Frequency	Percent
female	33	54.1
male	28	45.9
Total	61	100.0

The age distribution of the cases showed that the mean age was 4.4 years, the age more frequent (Mode) was 0.515 years (approximately 6 months) the standard deviation was 4.39. The most frequent of the cases occurred in those of the age group < 4 years (54.1 %), and only 1.6 % occurred in those >20 years with statistical significance p-value= 0.000 (see tables 2&3).

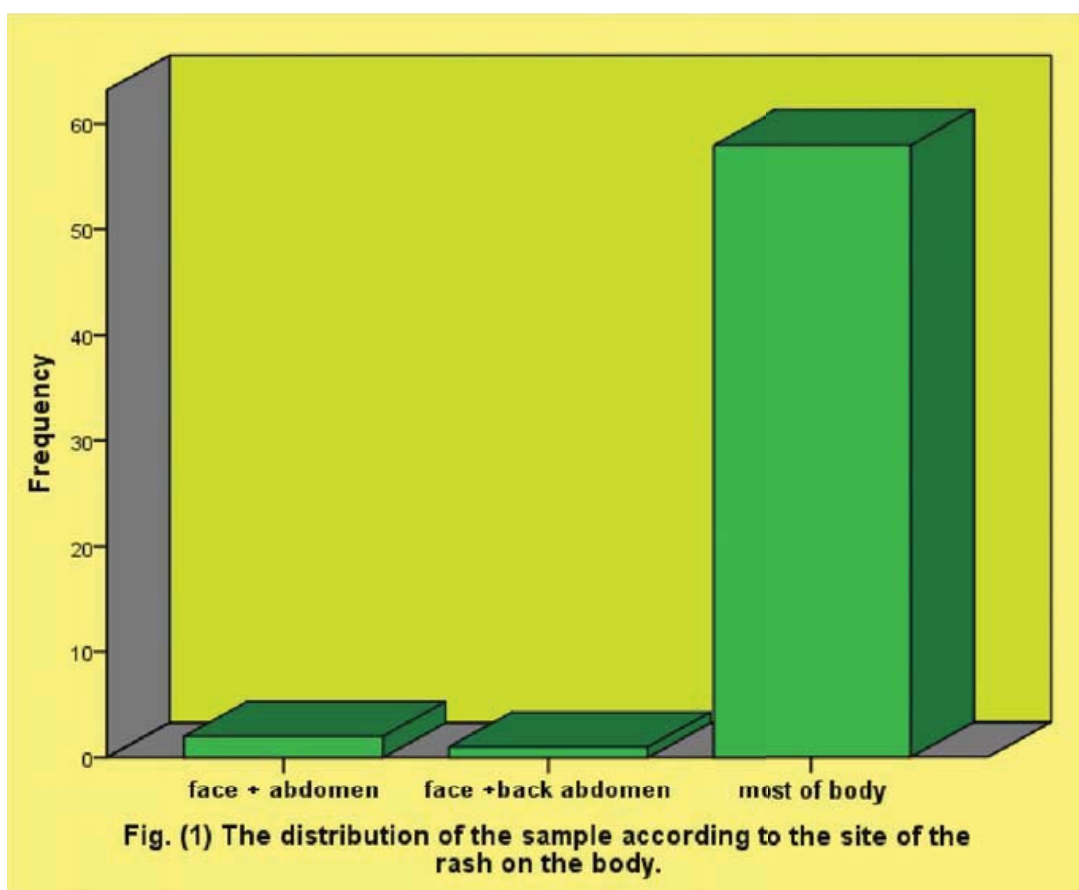
Table (2) Distribution of participants in the study according to age in years

	Frequency	Percent	Cumulative Percent
0-3.99	33	54.1	54.1
4-7.99	18	29.5	83.6
8-11.99	7	11.5	95.1
12-15.99	2	3.3	98.4
20-24	1	1.6	100.0
Total	61	100.0	

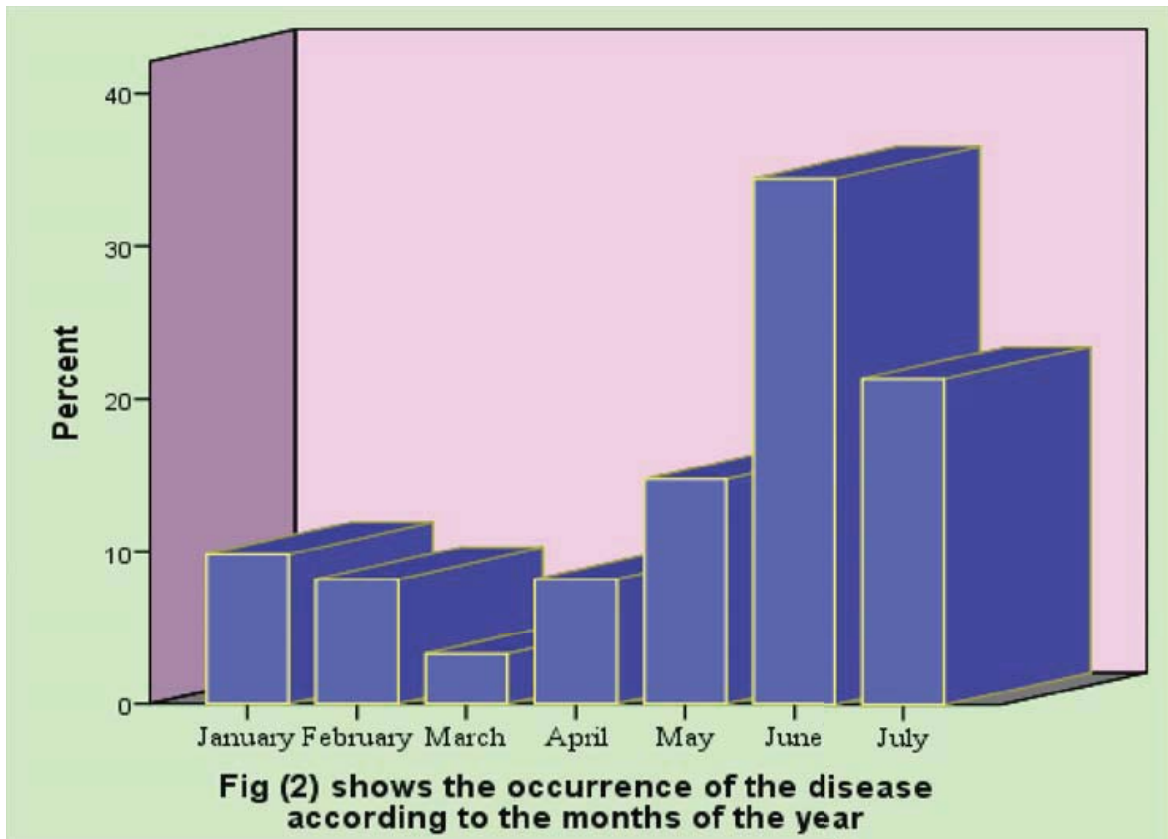
Regarding the site of residence, most cases were from EL-Marj city with percent 73.9 %, As shown in Table 3.

Table (3) Distribution of participants in the study according to the residence

	Frequency	Percent
El Abiar	1	1.62
Al militanyah	1	1.62
El Uweilia	1	1.62
Al-Shalioni	1	1.62
Battah	3	4.9
EL-Marj	45	73.9
Jarddass	6	9.9
Farzougha	1	1.62
Suluq	1	1.6
Taucheira	1	1.6
Total	61	100.0



It can be observed that the appearance of rash on the full body in most cases in Figure (1), while Figure (2) shows the distribution of occurring cases according to the months of the year where it was revealed that June has the most cases.



It can be seen in Table (4) the period during which the rash takes about on the body of a patient, in most cases (41%) the rash lasts for 6 days

Table (4) Distribution of participants in the study according to the rash period.

The days of rash	Frequency	Percent	Cumulative Percent
0-6	25	41.0	41.0
7-12	17	27.9	68.9
13-18	4	6.6	75.4
19-24	5	8.2	83.6
25-30	6	9.8	93.4
31-36	2	3.3	96.7
43-48	1	1.6	98.4
55-60	1	1.6	100.0
Total	61	100.0	

The following figures present the comparison between the two genders according to some variables

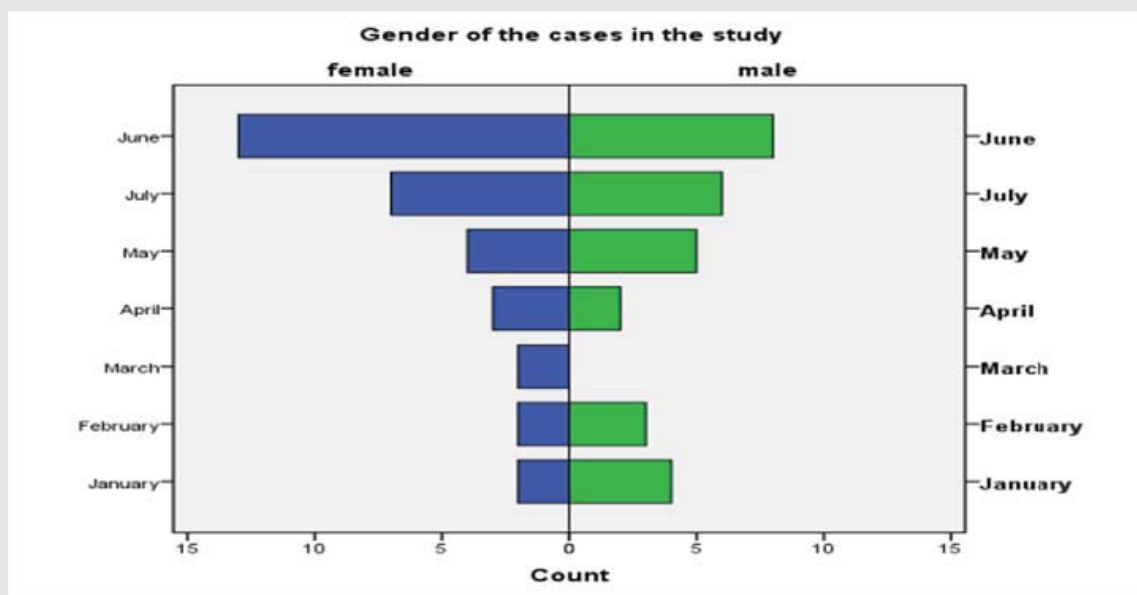


Fig (3) shows the occurrence of chickenpox cases according to the month the appearance of the rash and its association with gender

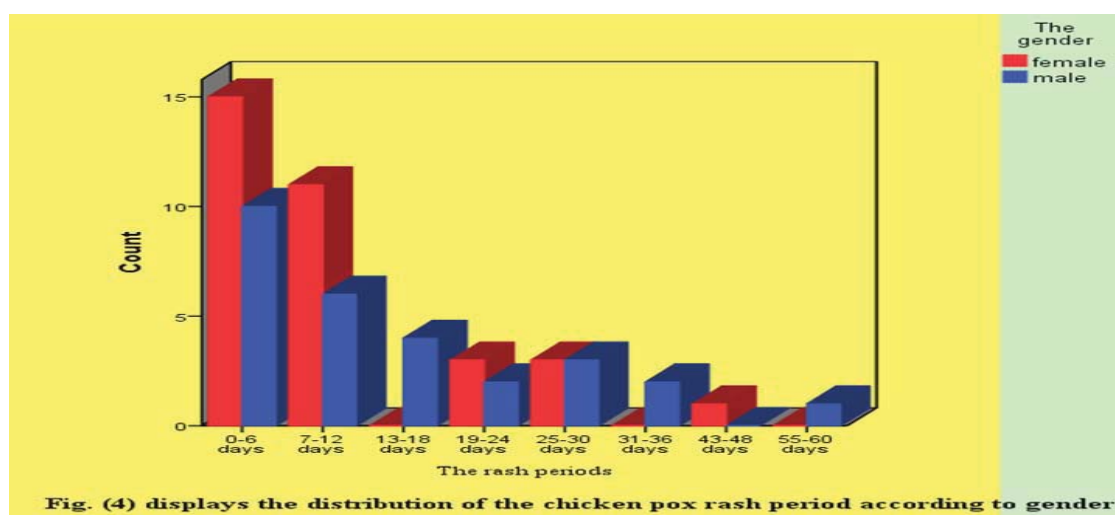


Fig. (4) displays the distribution of the chicken pox rash period according to gender

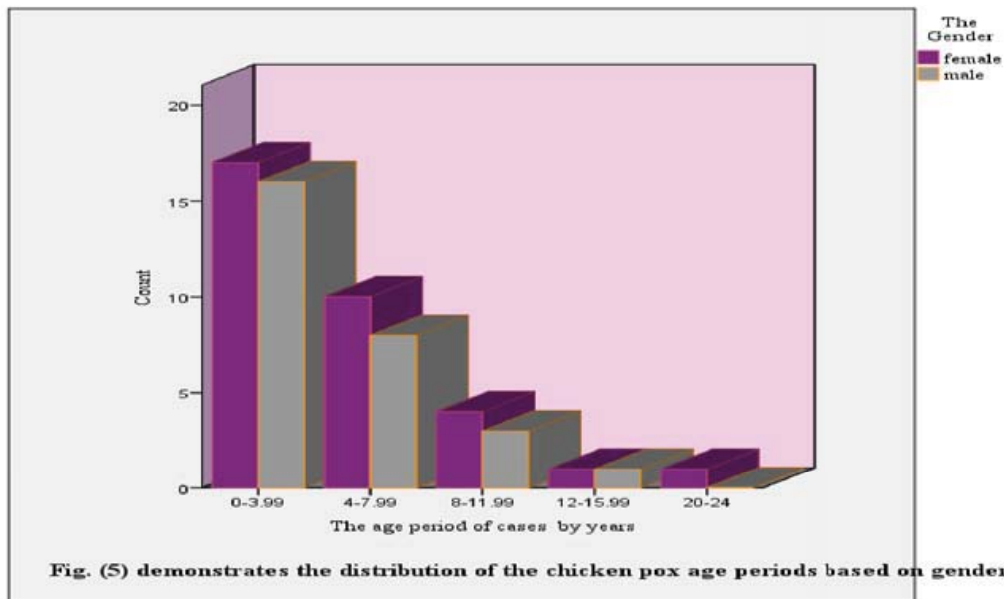


Table (5) shows the comparison between the two genders according to some characteristics of chickenpox cases

Characteristics		Male		Female		P value
		Frequency	Percentage	Frequency	Percentage	
Age intervals for chickenpox cases in years	0-3.99	16	57.1	17	51.5	0.000
	4-7.99	8	28.6	10	30.3	
	8-11.99	3	10.7	4	12.1	
	12-15.99	1	3.6	1	3.0	
	16-19.99	0	0	0	0	
	20-24	0	0	1	3.0	
The month that the rash is appearance	January	4	14.3	2	6.1	0.000
	February	3	10.7	2	6.1	
	March	0	0	2	6.1	
	April	2	7.1	3	9.1	
	May	5	17.9	4	12.1	
	June	8	28.6	13	39.4	
	July	6	21.4	7	21.2	
Period of rash stay	0-6	10	35.7	15	45.5	0.000
	7-12	6	21.4	11	33.3	
	13-18	4	14.3	0	0	
	19-24	2	7.1	3	9.1	
	25-30	3	10.7	3	9.1	

	31-36	2	7.1	0		
	37-42	0	0	0	0	
	43-48	0	0	1	3.0	
	49-54	0	0	0	0	
	55-60	1	3.6	0	0	
Place of residence of cases	El Abiar	0	0	1	3	
	Al militanyah	1	3.6	0	0	
	El Uweilia	1	3.6	0	0	
	Ashallwoni	1	3.6	0	0	
	Battah	1	3.6	2	6.1	
	EL-Marj	22	78.5	23	69.7	
	Jarddass	2	7.1	4	12.2	
	Farzougha	0	0	1	3	
	Suluq	0	0	1	3	
	Taucheira	0	0	1	3	
Total		28	100	33	100	

Discussion

This study evaluated the trends of one of the commonly seen infectious diseases in clinical practice in the EL-Marj region in the east of Libya over 7 months from (January – July 2023) which is chicken pox. The number of chickenpox cases showed an upward trend in the hot months (summer and spring months) more than cold months (winter).

In this study, the highest percentage of cases (54.1%) appeared in the age interval < 4 years, while most of the studies conducted in developing countries reported that chicken pox is more common in the age group 4–10 years such as the study that conducted in Libya (Ismail, et al., 2023)and another conducted in Saudi Arabia (Saleh, et al., 2014)which mentioned the highest percentage of cases (58%) occurred in the age group 5–14 years, however the Saudi study state that the highest percentile for cases in the developed country was in the interval age 0-4 years, as same mentioned in the present study.

Chickenpox is one of the infectious diseases that shows seasonal patterns of incidence. The reason for seasonality might be each of two environmental or social. The study findings indicated that the peak number of cases remained greatest during the June and July months (34.4%) (21.3%) respectively, during the period evaluated. These findings are slightly different from those reported by the Libyan study cited before, which said that the highest frequency of varicella cases

was in May, while in other studies, such as that carried out in the southern region of Saudi Arabia by Saleh, and another conducted in Iraq where both have been found that the peak number of cases was greatest during March and April months throughout the evaluation.

In order of gender, the distribution of the cases throughout the months of study has shown a slight preponderance of females over males, in contrast to the study conducted in Iraq which has shown a preponderance of males over females (Khaleel, et al., 2013)

Conclusion

The present study concluded that there is a rising trend in the registration of clinical chickenpox cases, as for most cases occur in the age group of less than 15 years. Females are a little bit higher than males. Also, the highest frequencies were reported in June and July. Most of the cases were registered in EL-Marj city.

Acknowledgment

We thank all participants for their collaboration in the study. Special thanks to the community health department students in the High Institute for Medical Sciences and Techniques in El-Marj city for their contribution to distribution and help in filling out of questionnaire during the execution of the study, including (Ezzeddine Belhamed, Mohamed Gomaa, Essyed Massad, Esraa Abdel Rahim, Khawla Abdel Karim, and Hanadi Abdel Jalil).

Ethics

The study did not require a review board approval. because this study does not involve any risk to participants and the participant's name is anonymous (no need to write the participant's name). All participants gave informed consent before entering the study. Our gathered data were confidential and no extra cost was constrained on our participants.

Funding:

We haven't received any special funding for this study, but we were depending on personal efforts.

Limitations

A limitation of this study was that some information was dependent on results from private labs which may be incorrect, and the answers to some questions in the questionnaire were dependent on respondents who misunderstood the requirements of the questions. Furthermore, There is no database about the nutritional status of a maternal and her baby. in addition to the hesitating and incomplete of the questionnaire by some respondents who were chosen in the study led to exclude a

number of them consequently leading to a small sample.

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The impacts of Cigarettes on Serum Creatinine levels.

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Abstract

It could be obvious from various studies that one of the causes of kidney diseases has a link to the smoking cigarettes. Therefore, the purpose of this study is to focus on the impacts of the main impacts of cigarettes on serum creatinine., Creatinine clearance This study was carried out on 100 cases (70 smoking and 30 non smoking) with a mean age of (45.06 ± 8 and 42.47 ± 7) years. Moreover, the impacts of numerous variables include age, body mass index (BMI), and, levels of Serum Creatinine and creatinine clearance for all groups were also studied. Results showed that were not affected of smoked on the creatine levels P value =0.054 which was more than 0.05.

Introduction

1.1 Background of the Study:

From recent studies, it has become clear that smoking cigarettes is related to the morbidity and mortality in different diseases precisely lung diseases, cardiovascular and kidney diseases (Adnan Ali and Ehsan Ismaeel, 2012) and gastric ulcer (Eberhard et al, 1997) (Adnan Ali and Ehsan Ismaeel, 2012). As Munzir et al stated that, the kidneys have a significant role in controlling the internal environment's consistency. The passing of blood through the kidneys is firstly by filtering (glomerular filtration), therefore, all constituents, but blood cells and plasma proteins go into the systems of microtubular. The useful substances of the kidneys are reabsorbed fast, meanwhile the unwanted substances are filtrated and excreted from the urine (Munzir et al, 2015)

Chronic kidney disease (CKD) is considered as a significant health problem that associated with the high range of mortality and reducing the quality of life. on the other hand, The impact of cigarettes smoking on functions of kidneys had recently been related with the long - term end - stage kidney disease (ESKD), with ESKD which has become the most common among the addicted of smoking; however, its effects have not been specified on healthy adults yet. Although, the latest studies have pointed out that the decreased rate of glomerular filtration

(eGFR) in diabetic patients that addicted of smoking to who are non-smokers but the confirmed outcomes of healthy population are rare and inconsistent. Microalbuminuria presence in diabetic patients is known as diabetic nephropathy marker, meanwhile its existing in non-diabetic patients is related to the enhanced risk of cardiovascular diseases. The latest studies stated a greater incidence of microalbuminuria in smokers compared to non-smokers and increase the probability that renal glomerular injury and hyper filtration are mechanisms of renal injury in smokers (Yoav Hammer MD et al, 2016). Tanner (2009), stated that, there are a certain processes were engaged in forming urine which includes tubular secretion, glomerular filtration and tubular reabsorption. The functional case of kidney could be assessed by several testes according to the concept of renal clearance. These tests would measure the glomerular filtration rates, the blood flow of renal and the reabsorption of tubular or secretion of various substances. furthermore, some of these tests for instance measurement of glomerular filtration rate are sometimes to the evaluation of kidney function" (Tanner, et al 2009,).

1.2. The Aim of The Study:

This study aims to examine the impacts of cigarettes on serum creatinine, Creatinine clearance.

Participants in this study one hundred of smokers and non-smokers of various ages.

1.3 Materials And Methods:

3.1 Study design:

This study is across sectional study and focuses on the comparison of creatinine level change between smoker and non-smoker were used as control. The scope of the research was included in clinical chemistry. This study was conducted in hospitals and clinics in the central region during the period from November (2022) to January(2023).

3.2 Collection of Study data:

The study data was collected after filling a structured questionnaire by each patient, for smokers and non-smokers.

3.3 The participates of the Study:

Study participants were split into two groups (group I and group II). Group I, consist of 70 smokers male volunteers, Group II composed of 30 cigarette non-smokers male volunteers, the average ages ranged from 18 to 95 years. A complete record of history was obtained,

including age, weight, height, the amount of the smoking, duration of smoking and whether the volunteer suffers from chronic diseases, including pressure, diabetes, dialysis, thyroid disease, or whether he suffers from other diseases.

3.4 Ethical Consideration:

Written consent was taken with regards to participation acceptance in this research from all participants along with the reassurance of confidentiality, prior to the collection of the samples. where the patient was completely aware of that the specimen was collected for study purpose.

3.5 Research Tools and Materials:

Tourniquet and alcohol swab, plain tube, sterile needle, cuvette, automated pipette, centrifuge, spectrophotometer device and reagent kit for estimation of creatinine of Biomaghreb company.

3.6 Principle of the Test and Preparation of Reagent:

Creatinine in a basic picrate solution forms a colored complex. The manual procedure of creatinine (Biomaghreb) After separate the serum, we take 500 microns of R1 and 500 microns of R2 in cuvette, add 50 microns of serum, put the cuvette in the spectrophotometer, then press the timer button for twenty and eighteen minutes.

3.7. Blood Sample Collection and Analysis:

The samples of blood were taken from both groups in order for colorimetric measurement of creatinine which were conducted by reaction kinetic method using a kit supplied by Biomaghreb Company obtaining absorbencies using spectrophotometer. The blood samples of each male have been collected and then the serum separated directly after collected. The level of creatinine was measured in Msallatah Hospital, some data were collected from the results of test.

-A blood sample was taken from each donor in groups where used to determine serum creatinine (creatinine determination was based on the Jaffe reaction with deproteinization- creatinine forms a color in alkaline picrate solution).

The clearance of creatinin determination was according to the Cockcroft and Gault equation(2) utilized Serum creatinine concentration (mg/dl), sex, age (year) and weight (kg) as follow:

$$\bullet \text{ Creatinine Clearance} = \frac{[(140 - \text{age(yr)}) * \text{weight(kg)}]}{72 * \text{serum Cr(mg/dL)}}$$

(multiply by 0.85 for women).

- The present study comprises of 2 groups, group I nonsmokers (control) n=30 and group II cigarette smokers n= 70. Group II were divided into 2 subgroups depending upon intensity of smoking. Each group comprises about 35 volunteers.
- Group II A, light smokers (n =35), smoking < 20 cigarettes / day).
- Group II B, heavy smokers (n=35), smoking $\geq$ 20 cigarettes / day).

3.8. Statistical Analysis:

was performed by using the SPSS version 19 and statistical significance were analysed by unpaired 't' test and ANOVA. P value < 0.05 was considered for statistical significance.

1.4 Results And Discussion:

4.1. General Characteristics of the Study Population:

The study included 100 people, of whom 70 were smokers and 30 were non-smokers as a comparison. The mean age of smokers was 45.06, and the mean age of non-smokers was 42.4. The BMI was 24.8 for smokers and 23.5 for non-smokers.

Table(4.1) Characteristics of the Study Population Among Smoker and Non-smoker

Character	Smokers	Control
N	70	30
Age	45.06 $\pm$ 8	42.47 $\pm$ 7
BMI	24.8	23.5

4.2. Comparison of renal function test parameters between smoker people and controls:

Table (4.1) demonstrates a not significant increase in serum creatinine in smokers (p0.054). Creatinine clearance, , decreased significantly in smokers (p value 0.041

Table (4.2) Comparison of renal function test parameters between smoker people and controls.

Parameters	Smokers(n=70) Mean $\pm$ SD	Control(n=30) Mean $\pm$ SD	P value
Serum Creatinine	1.1 $\pm$ 0.19	0.89 $\pm$ 0.1	0.054

CrCl	79.52±7.3	97.49±8.45	0.041
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Result of creatine =0.054 it's not significant which The level of P value of Creatinine 0.054 which was more than 0.05, in contrast, the Result of CrCl = 0.041. The level of P value in Creatinine clearance 0.041 which was less than 0.05, concluded that creatinine clearance was significant

4.3. Compression of Renal Function Between Smokers:

In the table (4.3) there is no significant increase in serum creatinine level between light smokers and heavy smokers which p value 0.05

Table(4.3) Compression of Renal Function Between Light and Heavy Smokers

Parameters	Light smokers	Heavy smokers	F value	P value
Serum Creatinine	1.02	1.2	0.058	0.195
CrCl (ml/min)	83.1±6.4	76.3±7.2	0.679	0.062

4.4.Discussion:

In this study 100 people were inducted, 70 of them were smokers and 30 were non-smokers as we show that in the results. Their age were ranged about from 20-90 years. Our results demonstrated that there is not significant in serum creatinine and Creatinine clearance in smokers (p0.05). also, there is no significant increase in serum creatinine level between light smokers and heavy smokers which p value 0.05.

The disagreement of our study, the research that done by Adnan Ali,(2011), which is concluded that there is effect of smoking in renal functions, the study summed up that the function of kidney is totally impacted by the smoker individuals as pointed by the obtained consequences through the test of renal function, particularly ten years later.

Moreover, the study that done by Munzir et al (2015), The study concluded that impacts of cigarettes smoking on the functions of kidneys between people. In this study an attempt has been made to detect the biochemical changes reflecting renal function during smoking, The kidney function is affected adversely in smoker group, indicated by the elevation of serum creatinine, urea , and the decline of

serum uric acid. The raise of creatinine and urea nearly attributed to major fall in glomerular filtration rate (GFR), serum uric acid reduction was endorsed to minimise endogenous production as a consequence of exposure to cigarette smoke which is a critical source of oxidative stress.

In contrast, the study of Bassam E. Hanna et al, (2008), concluded that the Serum Uric Acid in Smokers, after exclusion of other factors impacting the level of uric acid, the substantial low level of serum uric acid in smokers was attributed to minimise endogenous production as a consequence of chronic exposure to cigarette smoke which is a crucial source of oxidative stress.

Conclusion And Recommendations:

5.1 Conclusion:

Creatinin levels were measured for 100 people, 70 smokers and 30 non-smokers, whose ages ranged from 18-95 years. The study aims to measure the level of creatinine and its relationship to smoking, as the study demonstrated that there is not significant in serum creatinine in smokers (p value <0.05). also, there is no significant increase in serum creatinine level between light smokers and heavy smokers which (p value <0.05).

5.2. Recommendations:

- Restudy by taking a large number of samples more than the number that we have taken before.
- Use modern devices to save time and effort and give better results
- 2 Take enough serum.
- Do not keep the samples in the freezer for a long time to prevent the sample from decomposing.
- Reduce the amount to smoking in maintain your health.

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Fast Removal of Methyl Green Dye From Aqueous Solutions by Adsorption on Commercial Poly Urethane Foam

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Abstract

Fast removal of dye molecules from their solutions requires appropriate conditions for the technique used in the separation process. So, in this study, the separation of methyl green dye (MG) molecules from their aqueous solutions by adsorption on polyurethane foam (PUF) was conducted in a series of adsorption experiments under different conditions. The main parameters affecting the adsorption efficiency, e.g., pH, dye concentration in the solution, and equilibrium time, have been investigated. High removal percent of 95% with an adsorption capacity of 0.9815 mg/g was obtained when using 20 ppm of 10 pH sample solution after an equilibrium time of 10 min in a first order and monolayer sorption process.

Keywords

Pollution, Methyl Green Dye, Aqueous Solution, Adsorption.

1. Introduction

Water pollution has become a global problem that threatens humans and the environment in recent years. The leakage of some harmful dyes from food, pharmaceutical, textile, etc. factories as a result of the disposal of industrial water without prior treatment to remove these pollutants is considered one of the most major sources of water pollution. There is no doubt that many dyes that are characterized by their stability and non-degradable properties, such as methyl green, have harmful effects on human health and the environment. Some of these risks are effects of blindness, poorly healing wounds and carcinogenic effects, as well as it can affect aquatic life with long-lasting effects by reducing sunlight penetration and/or even causing direct poisoning to living organisms [1-4]. Therefore, effluents

containing dyes must be treated for their removal before disposal into the main water stream. Various industrial-waste disposal techniques for the removal of such colored effluent from water such as ion exchange, oxidation, precipitation, chemical coagulation, biodegradation, extraction, and adsorption have been studied. Adsorption is the most widely used in this regard due to its simplicity of operation, low cost, rapidity, and use of nontoxic adsorbent materials [5, 6]. A number of adsorbent materials for the extraction and adsorption of dyes from effluents, including methyl green, have recently been used [7-15]. Different experimental conditions were investigated. Recycling and using some industrial wastes as adsorbent materials for removal of some organic dyes and other toxic pollutants from effluents has been getting the attention of many researchers recently. Recently, the rest of polyurethane foam as wastes from sponge and furniture manufacturing processes has been widely used as an adsorbent material [16-22] because of the ability to retain different types of hazardous chemicals like organic dyes because of the presence of polar and nonpolar groups in their structures, the large surface area as well as low cost. Therefore, this work aimed to extract methyl green dye from effluents by adsorption on polyurethane foam. The properties and mechanisms of adsorption have been well studied. Optimal conditions e.g., pH, dye concentration, and equilibrium time for best removal were investigated.

2. Experimental method

2.1 Adsorbent material

The sample of foam was obtained from Al-Khums sponge factory (Northwest Libya) and it has been washed many times with 2M of HCl solution then rinsed with water and dried [16].

2.2 Apparatus.

The absorption measurements were made using UV-VIS spectrophotometer JENWAY. The PH measurement were made by JENWAY 3150 PH-METER.

2.3 Test procedure

A stock solution of MG dye, 100 ppm, was prepared and then diluted to 5, 10, and 20 ppm by distilled water. A 25 ml of solution was placed in a 50 ml flask containing 0.5 g of foam. The solution is shaken and investigated at different contact times (0-120 min). The adsorbent material was separated and the rest of the solution was analyzed using a UV-VIS spectrophotometer at maximum wave length of 614 nm. The

same experiment was repeated. The main parameters affecting the adsorption efficiency, e.g., pH number, and dye concentration in the solution were verified each time.

The percentage of removal, $R\%$, and adsorption capacity q_t and q_e (mg/g) before and at equilibrium time, respectively, was estimated from the following equations based on initial and final dye concentrations in the solution before and after adsorption take place [23]:

$$R\% = \left(\frac{C_o - C_e}{C_o} \right) \times 100 \quad (1)$$

$$q_e = \frac{(C_o - C_e)}{m} \times V \quad (2)$$

$$q_t = \frac{(C_o - C_t)}{m} \times V \quad (3)$$

Where C_o , C_t and C_e (mg/L) are the dye concentration in solution at initial, t time and equilibrium, respectively. m (g) is the mass of sorbent and V (L) is the volume of solution used.

3. Results and discussion

In this section, all results obtained from the adsorption experiments will be graphically represented and discussed. It will also be verified that this data is represented correctly by knowing the value of the correlation coefficient R^2 and comparing it with unity.

3.1 Effect of pH.

In order for the adsorption process to occur with very high efficiency, there are several basic factors that must be present. Among these factors is the presence of the appropriate medium for this phenomenon to occur. As it known, this medium depends largely on the pH value. So, the adsorption process was tested over a wide range of pH (3-10). A batch procedure was carried out on a 25 mL dye solution of 5.0 ppm at varying pH values, 3, 4 and 8 was stirred with 0.50 g of PUF for different time intervals. The results are shown in figure 1.

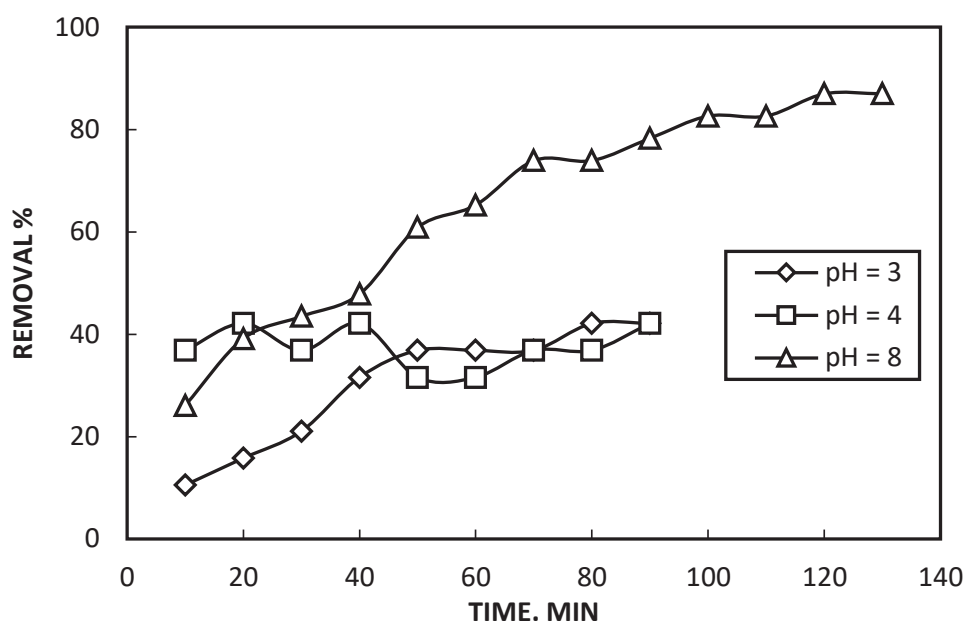


Figure 1. Effect of PH on MG adsorption at different times.

Generally, it can be clearly observed that the percentage of dye molecules removed from the solution increases gradually as the pH value of the solution increases and vice versa. The maximum dye ions removal is 87% with an adsorption capacity of 0.2083 mg/g was observed in the pH of 8 at equilibration time of 120 min. This behavior can be interpreted that as the pH value of the solution increases, the negative ions increase and the medium becomes more alkaline, and this in turn leads to an increase in the bonding between the negative ions of the solution and the positive dye ions and then left the medium to adsorb on the absorbent surface. Therefore, we can say that the best conditions for adsorption will be in an alkaline medium in which the pH value is not less than 8.

3.2 Effect of dye concentration and equilibrium time.

To improve the separation efficiency and reduce equilibrium time, based on the results of the discussion in the previous section, a series of adsorption experiments at different concentrations of 10 and 20 ppm were conducted in an alkaline medium at a pH value of 10 for different time intervals by batch procedure as mentioned above. Figure 2 demonstrates the effect of dye concentration and equilibrium time on the efficiency of the adsorption process.

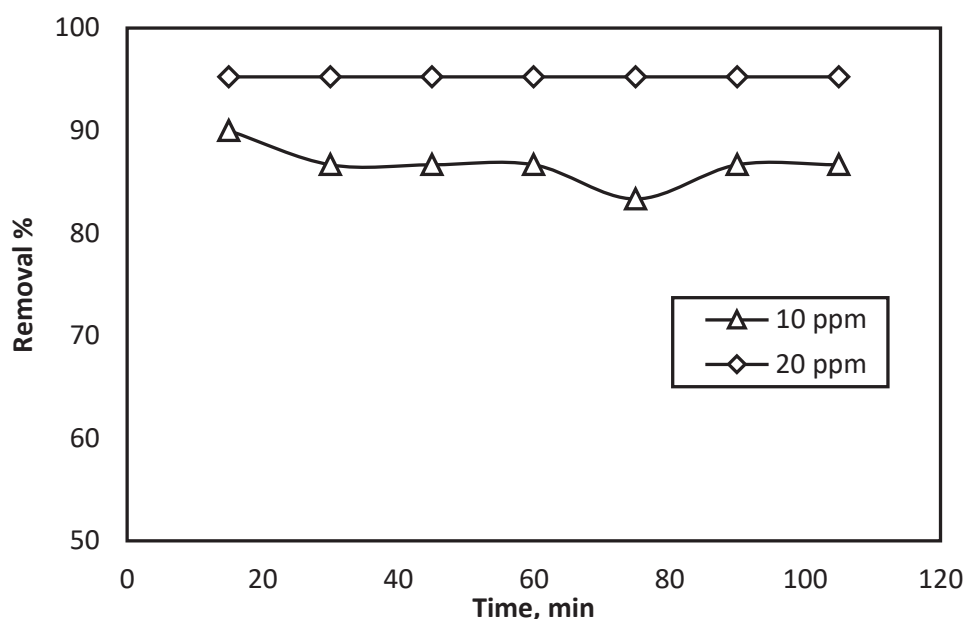


Figure 2. Effect of dye concentration and equilibrium time on the percent removal of dye.

The highest removal efficiency of dye ions (95%) with an adsorption capacity of 0.9815 mg/g was obtained when using 20 ppm of sample solution after equilibrium time of 10 min. A very little change and instability in the percent of removal was observed when decreasing concentration of sample solution to 10 ppm.

3.3 Adsorption Isotherm.

To accurately describe the type of adsorption of MG dye molecules on foam, it is necessary to study the relationship between the change in the amount of the adsorbed dye molecules with pressure or concentration at a certain temperature. Many different adsorption isotherm models as mentioned in [24, 25] have recently been used to describe the mechanism and behavior process of adsorption. Among these models, the Langmuir and Freundlich model is considered the most widely used. In this study, we found that the Freundlich model does not apply well to represent the data, so the adsorption of MG molecules on the surface of PUF has been modeled using the Langmuir model as detailed below.

3.3.1 Langmuir isotherm model.

The Langmuir model assumes that the adsorption process occurs homogeneously, as the substance to be separated from the solution (MG dye) is adsorbed on the surface of the PUF in the form of a monolayer [26, 27]. The linear form of Langmuir adsorption isotherm model is given below in equation (4):

$$\frac{C_e}{q_e} = \frac{1}{bq_m} + \frac{C_e}{q_m} \quad 4$$

Where, the equilibrium constants, q_m and b , in equation 4 related to the sorption capacity and the apparent energy of sorption, respectively. The values of q_m and b for adsorption of MG dye molecules on the surface of PUF sorbent were estimated from the slope and intercept of the linear plot of C_e/q_e versus C_e under the condition of constant temperature and equilibrium.

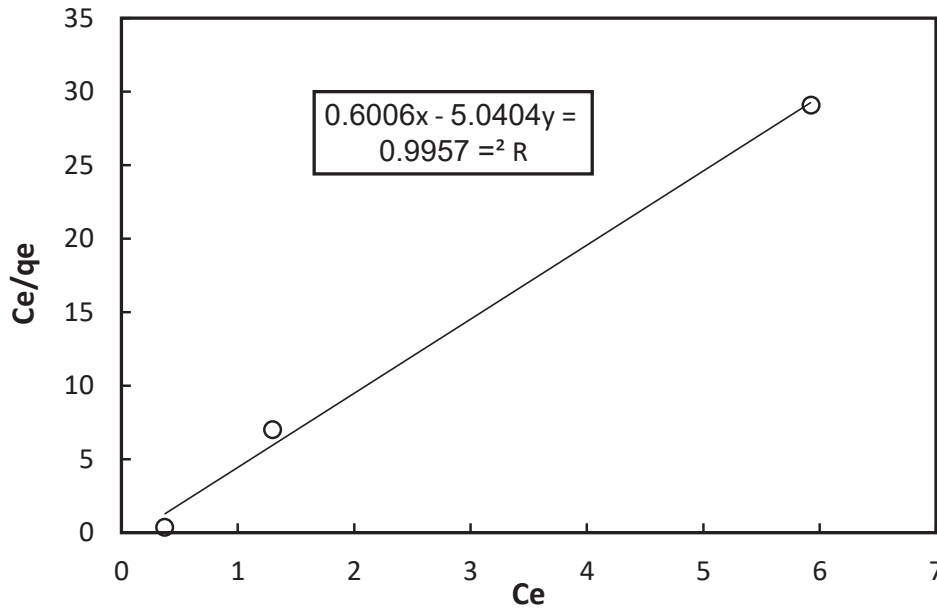


Figure 3. Langmuir adsorption isotherm for MG dye on PUF. The character of the isotherm category was estimated from equation (5):

$$R_L = \frac{1}{1 + bC_o} \quad 5$$

Where, R_L is the separation factor which indicates that the type of sorption isotherm to be linear or irreversible ($R_L = 1$), favorable ($0 < R_L < 1$), unfavorable ($R_L > 1$). In this study, R_L is negative value, which indicates that sorption of MG molecules process.

3.4 Adsorption kinetics.

Removal by the adsorption technology is one of the most widely used processes to separate metal ions or dye molecules from their solutions. This technique depends largely on effective collisions between the adsorbent and the molecules of the substance to be removed from the solution. Therefore, to obtain a faster separation in a shorter equilibrium time, the number of effective collisions in the solution must be increased by shaking. Many kinetic models are reported in [24, 28, 29]

which employ in studying mechanism, reaction limiting stage and complete traits of the adsorption process. In this study, experimental data examination was performed using different kinetic models. The Lagergen and Morris-Weber models are the best fit in representing the adsorption kinetics with the highest value of the correlation coefficient (R^2).

3.4.1 Lagergen model.

This model was applied for mass action phenomenon and which is given by [16]:

$$\log(q_e - q_t) = \log q_e - \frac{k_1 t}{2.303} \quad 7$$

Where, the first-order reaction rate constant, k_1 (1/min), is determined graphically from the linear plot of $\log(q_e - q_t)$ versus t , figure 4. The constant, $k_1 = -0.0114$ (1/min).

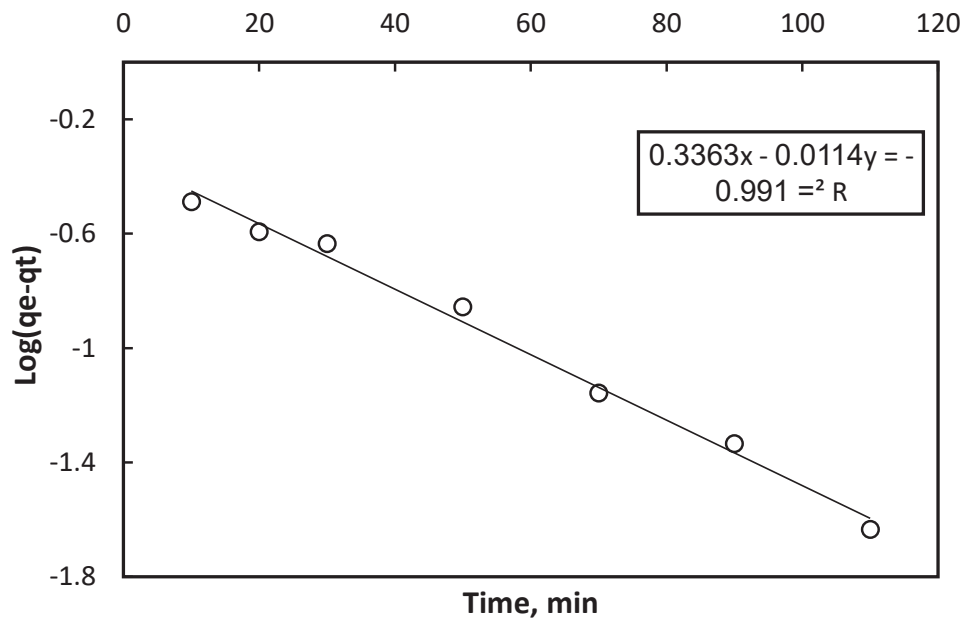


Figure 4. Lagergen plotting for adsorption of dye on foam.

3.4.2 Morris-Weber equation.

The mathematical formula for the Morris-Weber equation is expressed as [16]:

$$q_t = k_i t^{0.5} + C \quad 8$$

Where, the adsorption rate, k_i , was determined graphically from the slope of the straight line of the plot q_t versus t . A high value of the correlation coefficient indicates that the experimental data is well represented by this model. In the diffusion process the slope of the curve

depends on the particle size, film thickness and distribution coefficient of dye molecules where as in mass action, the rate depends on temperature and concentration of solute in solution. The plot of Morris-Weber equation is shown in figure 5. The constant $k_i = 0.0432$.

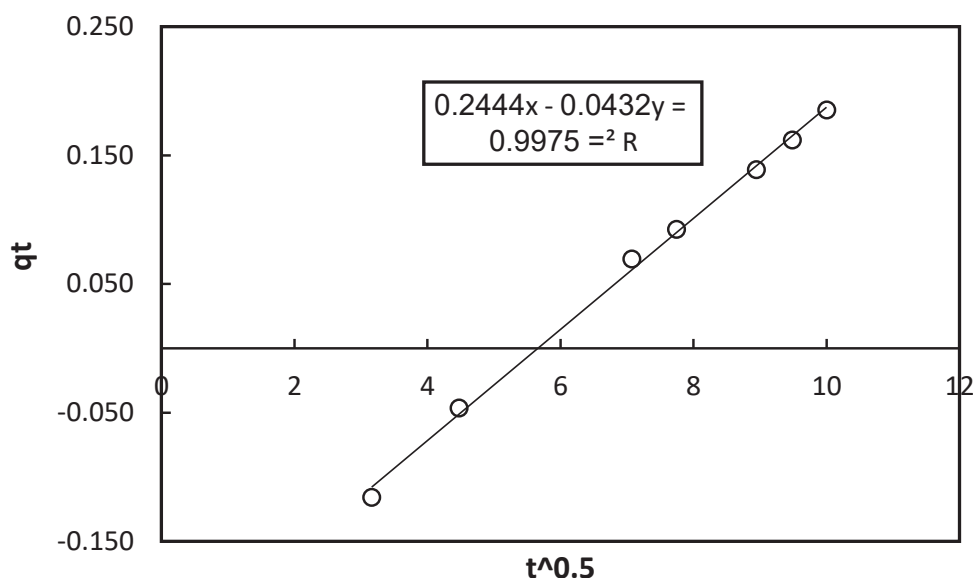


Figure 5. Plotting of Morris –Weber equation for dye- foam interaction.

4. Conclusion

This study demonstrated that it is possible to recycle some cheap materials, such as leftover commercial foam, and use it to extract some harmful pollutants, e.g., methyl green dye, from wastewater. Fast removal at high efficiency of 95% with an adsorption capacity of 0.9815 mg/g has been obtained in a short equilibrium time of 10 min. Behavior of the sorption process seems to be chemical with monolayer when using 20 ppm of 10 pH sample solution.

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PHYCOREMEDIATION USING MICROALGAE IN PUBLIC MARKET WASTEWATER

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ABSTRACT: Public market wastewater (PMW) is rich in nutrients, making it an ideal medium for supporting the growth of microorganisms such as microalgae. Phycoremediation, which utilizes microalgae to treat wastewater, has shown considerable promise for reducing nutrient levels in PMW. However, the effectiveness of this process is influenced by the initial concentration of PMW. This study examines the reduction of total dissolved solids (TDS), sulfate (SO_4), and magnesium (Mg) in PMW through phycoremediation with microalgae, across varying PMW concentrations. Microalgae were inoculated at a concentration of 10^6 cells/mL inside 200 mL of PMW then incubated for 19 days outside in direct sunshine. The outcomes showed that microalgae flourished more successfully in PMW compared to natural water. The highest reductions in nutrient levels 48% for TDS, 46% for SO_4 , and 61% for Mg were achieved with a 50% PMW concentration. These findings confirm that phycoremediation using microalgae is an effective method for reducing nutrient loads in PMW.

المخلص: تحتوي مياه الصرف الصحي في الأسواق العامة مثل سوق الحوت في مدينة زليتن على مستوى عالٍ من العناصر الغذائية التي تعد موردًا لتغذية الكائنات الحية الدقيقة مثل الطحالب الدقيقة. علاوة على ذلك، فإن المعالجة النباتية باستخدام الطحالب الدقيقة لها إمكانات عالية لتقليل الحمل الغذائي في مياه الصرف الصحي الناتجة عن السوق. ومع ذلك، تعتمد كفاءة الاختزال على التركيزات الأولية لمياه الصرف الصحي. في الدراسة الحالية، تم التحقيق في تقليل إجمالي المواد الصلبة الذائبة (TDS) والكبريتات (SO_4) والمغنيسيوم (Mg) في مياه الصرف الصحي الناتجة عن السوق باستخدام الطحالب الدقيقة، كدالة لتركيزات مياه الصرف الصحي المختلفة. تم تلقيح الطحالب الدقيقة بـ 10^6 خلية / مل في 500 مل من مياه الصرف وحضنت في الهواء الطلق تحت أشعة الشمس الكاملة لمدة 19 يومًا. كشفت النتائج عن تسجيل

نمو أعلى للطحالب الدقيقة في مياه الصرف الصحي مقارنة بالمياه الطبيعية. كانت أقصى قيم تقليل للعناصر الغذائية 48% لـ TDS و 46% لـ SO_4 و 61% لـ Mg تم تحقيقها بنسبة 50% من مياه الصرف الصحي الناتجة عن السوق. أشارت النتائج إلى أن المعالجة النباتية باستخدام الطحالب الدقيقة يمكن أن تقلل بنجاح من الحمل الغذائي لمياه الصرف الصحي الناتجة عن السوق.

Keywords: Microalgae, Phycoremediation, Public Market Wastewater

1.INTRODUCTION

Wastewater, encompassing various types of liquid waste generated from activities using large volumes of water, exhibits distinct characteristics based on its source [1,2]. Public market wastewater (PMW) is considered extremely polluted since it contains solids from fish, meat, vegetables, and fruits as well as significant levels of organic matter (more than 600 mg/L biochemical oxygen demand (BOD)). [3,4]. PMW's high levels of total nitrogen (TN), total organic carbon (TOC), and total phosphorus (TP) greatly increase the pollution caused by the material. [5]. Particularly, because of blood residues from processing meat, fish, and poultry, PMW has TP and TN concentrations of up to 25 mg/L and 61 mg/L, respectively. [6]. Additionally, heavy metals such as iron (Fe) and zinc (Zn) have been reported in PMW at concentrations of 1.071 ± 0.0010 mg/L and 0.312 ± 0.0021 mg/L, respectively [6].

Direct PMW discharge causes eutrophication and water contamination in natural water bodies. [7,8]. Thus, effective treatment is necessary to remove organic matter, nutrients, pathogens, and heavy metals before environmental discharge.

Microalgae have been successfully employed in wastewater treatment for biomass production, including dairy, municipal, and industrial wastewater [8,10]. Phycoremediation, utilizing microalgae, is particularly efficient for treating PMW due to its high nutrient load, which supports rapid microalgal growth and nutrient uptake [9,11]. Compared to conventional aerobic systems, phycoremediation is more cost-effective due to its lower energy and operational costs [12]. Previous studies have demonstrated the potential of microalgae to treat various wastewater types, including dairy and municipal waste [11,13,14].

This research investigates microalgal growth and nutrient reduction in different PMW concentrations. Mohamed et al. [3] observed that *Scenedesmus sp.* achieved maximum nutrient reductions of 91.51% for

TN, 92.67% for TP, and 90.2% for TOC in 50% PMW. Welch [16] reported a 97.2% lipid percentage in *Chlamydomonas* and *Chlorella* cultures after 11 days. Thawechai [17] found that *Scenedesmus* sp., *Botryococcus* sp., and *Nannochloropsis* sp. achieved final lipid percentages of 61.5%, 67.5%, and 69.0%, respectively. This study aims to further elucidate the growth rate and nutrient reduction capabilities of microalgae in PMW.

MATERIALS AND METHODS

PMW Collection

PMW samples were collected from the influent discharge of a public market in Zliten, Libya, which handles wastewater from fish, seafood, and meat processing. Samples were brought to the lab, held at temperatures below 4°C, and collected in bottles that had been acid-washed. To remove suspended solids by microorganisms, PMW samples were filtered through a 0.45 µm membrane filter. The characteristics of PMW, including total dissolved solids (TDS), sulfate (SO₄), and magnesium (Mg), were measured according to APHA (2012) standards.

Experimental Setup

The experiment was conducted in 1L Erlenmeyer flasks containing 500 mL of PMW. Natural water samples served as the control. PMW samples were filtered and diluted with distilled water to obtain three different concentrations: 30%, 50%, and 100%. Microalgae were inoculated at 10⁶ cells/mL, and the phycoremediation process was carried out under full sunlight (12/24) for 19 days. Each flask was shaken four times daily to prevent sedimentation [3].

Microalgae Growth

Microalgae growth was measured by harvesting cell biomass through centrifugation at 4000 rpm for 5 minutes. The algal pellets were resuspended in 45 mL of autoclaved Gillard's F/2 solution. Aliquots of 10 mL were taken and analyzed for optical density (OD₆₅₀) using a DR 6000 spectrophotometer (Janway, USA), with Gillard's F/2 solution as the blank [3,15,16].

Nutrient Removal

The removal efficiency of TDS, SO₄, and Mg was calculated using the following equation [3,12,13,14,17].

Removal Efficiency (%) =

$$\left(\frac{\text{Initial Conc.} - \text{Final Conc.}}{\text{Initial Conc.}} \right) 100 \%$$

Eq. (1)

RESULTS AND DISCUSSION

PMW Characteristics

To describe PMW samples, three parameters were examined. These criteria were chosen in accordance with the world health organization, international standards for wastewater disposal (2006) [18]. The data on characterisation PMW are shown in Table 1.

Table 1: Public market wastewater (PMW) characteristics in relation to effluent standards.

		Elements (mg/L)		
		TDS	SO ₄	Mg
PMW concentrations	0%	108	13	3
	30%	12100	1870	847.3
	50%	38460	2560	1023
	100 %	48700	3440	1867. 4
WHO, (2006)		2500	1000	5.00

It is noteworthy that the raw PMW dilutions of 30%, 50%, and 100% exhibit high levels of TDS and SO₄ (12100 - 38460 - 48700 and 1870 - 2560 - 3440 mg/L, respectively), while the amounts of Mg were 847.3 – 1023 - 1867.2 mg/L.

The results indicate that PMW samples, especially at higher concentrations, have TDS, SO₄, and Mg levels well above WHO standards [18]. The high concentrations may be attributed to the organic materials present in PMW, which vary seasonally and geographically [3,19].

Growth of microalgae

The growth of microalgae in different PMW concentrations is

depicted in Figure 1. The highest growth rate occurred in 50% PMW on day 14, with OD650 increasing from 0.802 to 1.287 and decreasing to 1.128 by day 19. This aligns with Chen [4], who reported optimal *Chlorella* growth in 50% piggery wastewater.

In 30% PMW, microalgal growth peaked at OD650 was 1.196 on day 11 and declined thereafter. Conversely, in 0% and 100% PMW, growth rates were lower and declined earlier. This variation is likely due to nutrient levels in the different PMW concentrations.

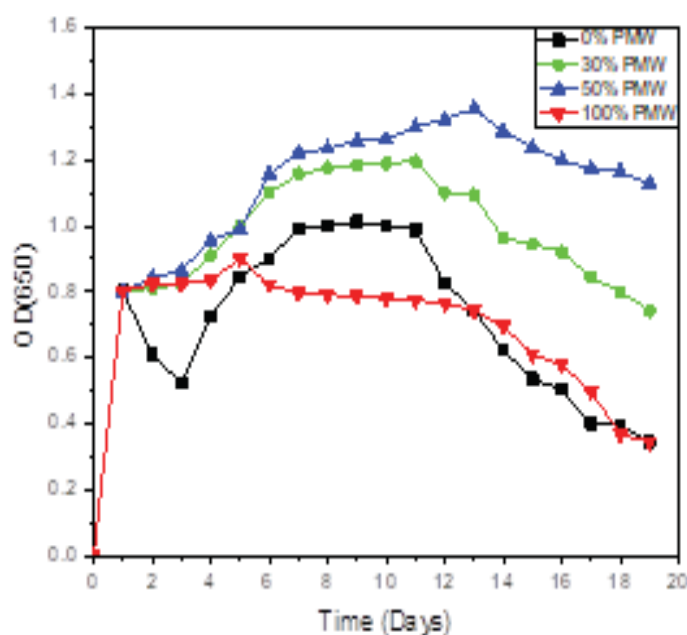


Fig. 1: Growth of microalgae in PMW during phycoremediation

In the meantime, on day 11 of phytoremediation, the microalga growth in 30% PMW reached its maximum

values of 1.196 and thereafter declined. On the other hand, after days 5 and 9 of phycoremediation, respectively, the microalga growth rates in 0% and 100% PMW dropped to 1.012 and 0.901, respectively.

This behavior can be ascribed to either the high nutritional content of 100% PMW or the low nutrient content of 0% PMW as illustrated in Fig. 5. These findings suggest that the PMW had high nutrient loads and that the dilution procedure ought to be carried out prior to the phycoremediation procedure.

Nutrient Removal Efficiency of Microalgae

The removal rates of TDS, SO_4 , and Mg were employed in this investigation as indicators of the microalgae's ability to remove

nutrients. Figures 2 to 5 demonstrate that phycoremediation with microalgae reduced TDS levels by 48% in 50% PMW. As a result, in 50% PMW, TDS levels decreased from 38460 mg/L to 20181 mg/L.

TDS levels in the control samples, on the other hand, dropped by 11% from 108 mg/L to 96 mg/L. TDS removal rates were 26% and 19% in 30% and 100% PMW, respectively. The microalgae's negative growth rate could be the cause of this outcome [7,11].

In 50% PMW, SO_4 removal rates were 46%, nevertheless. In particular, following phycoremediation, SO_4 levels dropped from 2560 mg/L to 1380 mg/L. The elimination rates of SO_4 in PMW concentrations (0%, 30%, and 100%) were roughly 38%,40%, and 31%, respectively.

Mg dropped from 1023 mg/L to 396.3 mg/L in 50% PMW This decrease is similar to a reduction of 61%. The biggest clearance in comparison to the lowest concentrations of PMW was (3 in the beginning and after the phycoremediation process was 2.3 mg/L were corresponding to 23%). In the that period, the percentages of Mg removal in 30% and 100% PMW were 46% and 23%, respectively.

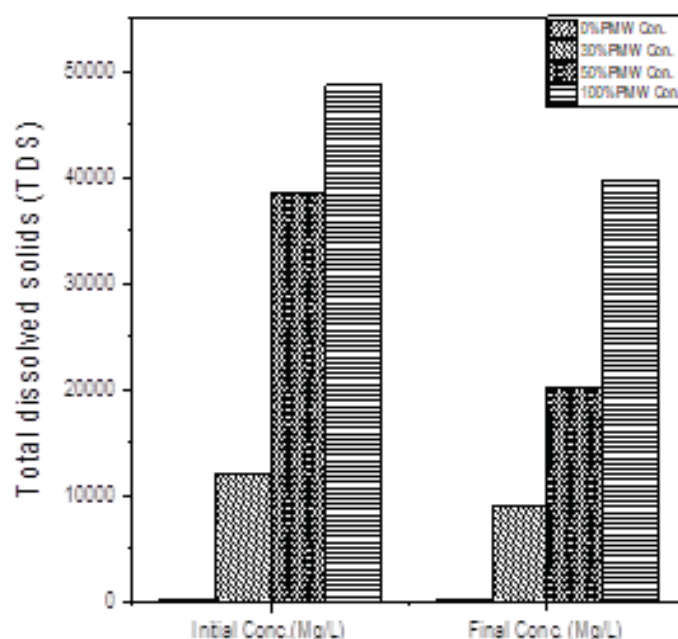


Fig. 2: TDS removal in various PMW ratios.

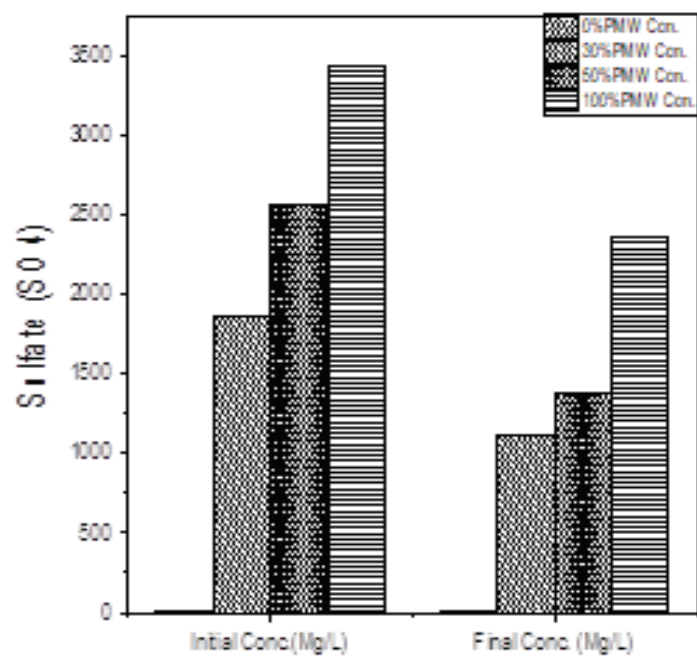


Fig. 3: SO₄ removal in various PMW ratios.

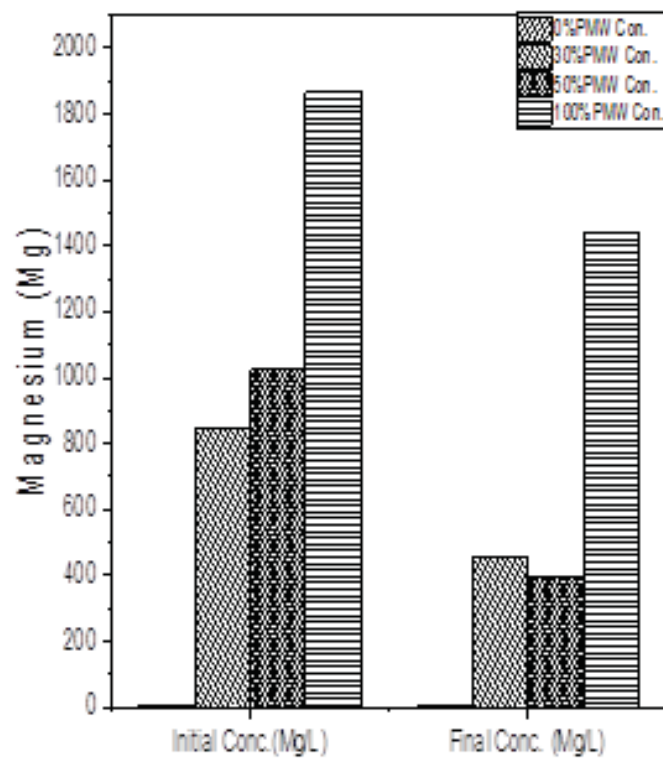


Fig. 4: Mg removal in various PMW ratios.

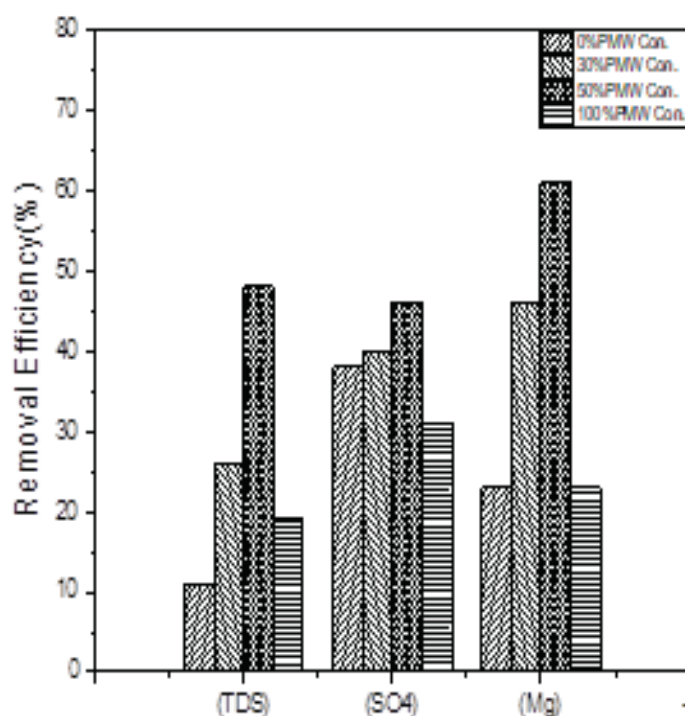


Fig. 5: Shows nutrient analysis the highest removal percentage of public market wastewater.

These behaviors could be explained by the various nutritional burdens connected to various PMW concentrations. Overall, PMW was successfully treated using phycoremediation employing microalga to remove TDS, SO₄, and Mg.

CONCLUSION

The current study showed that the effectiveness of phycoremediation using microalgae to remove nutrients from wastewater is influenced by varying amounts of PMW. 50% PMW showed the greatest rates of nutrient removal. Consequently, for phycoremediation to be efficiently facilitated, the PMW concentration cannot be greater than 50%. Furthermore, on day 14 of phycoremediation, the 50% PMW showed the fastest growth rate. From day 1 to day 14, OD₆₅₀ climbed to 1.287, but on day 19 of phycoremediation, it dropped to 1.128.

Additionally, the removal rates of TDS, SO₄, and Mg in 50% PMW were 48%, 46%, and 61%, respectively.

In conclusion, the best biological wastewater treatment method is phycoremediation with microalgae, which also provides information for future researchers.

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Analyzing the ground water quality between the southern Libyan regions of Al-Fujeij and Al-Kharig using Total Dissolved Solids and PH data

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Abstract

This study was conducted to identify some properties of underground water for several areas located in the south of Libya confined between the regions of Al-Fujeij and Al-Kharig in October 2020. Twenty-four samples were collected from eight wells, with depths ranging from 40-300meters. The investigated properties of the underground water are the pH, the total dissolved solids (TDS) and the electrical conductivity (E.C). The obtained results showed that the average pH ranged between (6.53-7.36), which is within the permissible limits according to the Libyan and the WHO standards, the average total dissolved salts ranged between (38.6-418) mg/L, which is also within the limits and did not exceed 500 mg/L according to the same standards and the electrical conductivity, which was calculated mathematically, it ranged between (60.31-653.13) $\mu\text{S}/\text{cm}$. Also, according to the Food and Agriculture Organization, underground water is considered to be of good quality and can be used for irrigation.

Keywords: Underground water; pH; total dissolved salts (TDS) ; electrical conductivity (E.C) ; Libyan standards and World Health Organization (WHO).

1. Introduction

Water is a natural resource. It is considered as an important and necessary wealth for the life of all beings. The availability of fresh water has become an important and worrying matter in the Arab countries [1]. The State of Libya is considered one of the poorest countries in the world in terms of water resources [2], as it is located in the arid or semi-arid regions [3]. The underground water in Libya

is the main source of water [4], and it constitutes 96% of the water resources available for human consumption whether for drinking, agriculture or industry [5].

According to the United Nations reports, Libya is threatened by drought [6]. The underground water is found at different depths and gathered in the ground, forming two water layers. The first layer is known as the surface reservoir, which is called as the phreatic layer and its water is one of the most widely used. Its depth ranges from 10-100 m, sometimes up to 160 m. The second one is known as the semi-phreatic layer. It ranges from 20-50 m below the first one, and it is characterized by abundant amounts of water. It is considered one of the most important aquifers [4]. The southern region of Libya is rich of underground water, and it can supply the other regions of the country with water. So, the study of quality of this water has been conducted.

In order to safeguard the long-term sustainability of the groundwater resources, The main objective is to quality of underground water for in the south of Libya confined between the regions of Al-Fujeij and Al-Kharig for drinking and irrigation purposes, using Total Dissolved Solids and PH data.

2. Methods

2.1 Study area

The study area is located in the south of Libya in the Murzuq basin [7], between longitudes of 14.427149° and 12.793976° and latitudes of 26.912733°, 26.580079° [17]. It includes (Al-Fujeij, Takerkebeh, Qaraqra, and Al-Kharig) as shown in (Fig .1), and (Table 1) shows the site of the studied wells.



Fig (1): The general location and wells of the study area

Table (1): information about the groundwater wells

Name of area	Well No.	Depth of the well (m)	Axes	
			longitude	Latitude
Al-Fujeij	W ₁	125	13319255	26535606
	W ₂	125	1325413	26523091
Takerkebeh	W ₃	250	13251206	26537073
	W ₄	250	13232471	26559770
	W ₅	40	13243402	26565146
Qaraqra	W ₆	300	13214605	26547219
	W ₇	65	13224122	26557252
Al-Kharig	W ₈	90	13293129	26551413

2.2. Practical Part and Methodology

This study was carried out to find out some of the properties of underground water wells in the south of Libya, including the areas of (Al-Fujeij, Takerkebeh, Qaraqra, and Al-Kharig). Three samples were collected for each well. Each sample was collected in a glass container of 500 mL for eight wells in October 2020. The samples were sent directly to the gas electrical station laboratory in Ubari. The

tests were conducted there for the samples are the TDS and the PH.

3. Results

The collected samples from eight wells were analyzed in the study area, and all the results are shown in (Table 2). It includes the average of both PH and TDS for three samples. The results were compared with the Libyan standards [13, 14] and the standards of WHO [16].

Table (2): Results of tests for underground water wells

	We II No.	Simple No		PH		TDS (mg/L)		E.C (μ S/cm)	
		Value	Average	Value	Average	Value	Average	Value	Average
W ₁	1	7.3	7.3	170	166.9	265.63	260.78		
	2	7.3		180.9		282.65			
	3	7.3		149.8		234.06			
W ₂	1	7.4	7.36	70.01	70.50	109.39	110.15		
	2	7.4		72.50		113.28			
	3	7.3		69.00		107.81			
W ₃	1	7.6	7.5	38.00	38.6	59.37	60.31		
	2	7.4		38.00		59.37			
	3	7.5		40.00		62.50			
W ₄	1	7.0	7.0	73.41	74.47	114.70	116.3		
	2	7.1		73.90		115.46			
	3	7.0		76.10		118.9			
W ₅	1	6.6	6.53	280.0	271	437.5	423.43		
	2	6.6		260.0		406.25			
	3	6.5		273.0		426.56			
W ₆	1	7.1	7.12	45.0	43.9	70.31	68.59		
	2	7.2		44.80		70.0			
	3	7.3		41.90		65.46			
W ₇	1	6.5	6.7	149.0	147.6	232.81	230.62		
	2	6.7		145.50		226.56			
	3	6.9		148.50		231.25			
W ₈	1	6.5	6.83	419.0	418	654.68	653.13		
	2	7.0		420.0		656.25			

	3	7.0		415.0		648.43	
	Libyan Standards			6.5 – 8	100- 500	1600	
	World Health Organization (WHO) [10]			1500	500-1000	6.5 – 8.5	
	Food and Agriculture Organization FAO			6.5- 8	2000 mg/L	3 dS/cm	

4. Discussion

4.1 PH

A total It is a number that expresses the level of acidity or alkalinity of a pure solution at a temperature of 25 CO. The range of pH extends from zero to 14. It gives a neutral pH when it is equal to 7, and the acidic solution is less than 7, while the basic one is more than 7. It is of great importance in evaluating quality of water and its suitability for drinking or other uses. The obtained results are shown in (Table 3). It was found that the pH values of the studied samples ranged between (6.53-7.5).It was noted that the well of Al-Kharig has acidic water due to its concentration of less than 7, while the well in the Qaraqara area it is between acidic and alkaline, and in The Al-Fujeij region is alkaline, and in the Takerkebeh region, it is between acidic, neutral and alkaline.(Fig .2) shows the PH of all samples is within the permissible limits according to the Libyan and the WHO standards (6.5 - 8.5) [13, 16], and the water is considered good and fit to drink.

Table (3): The quality of underground water according to PH

PH value	No. of wells	Water type
< 7	3	acidic
= 7	1	neutral
> 7	4	alkalic

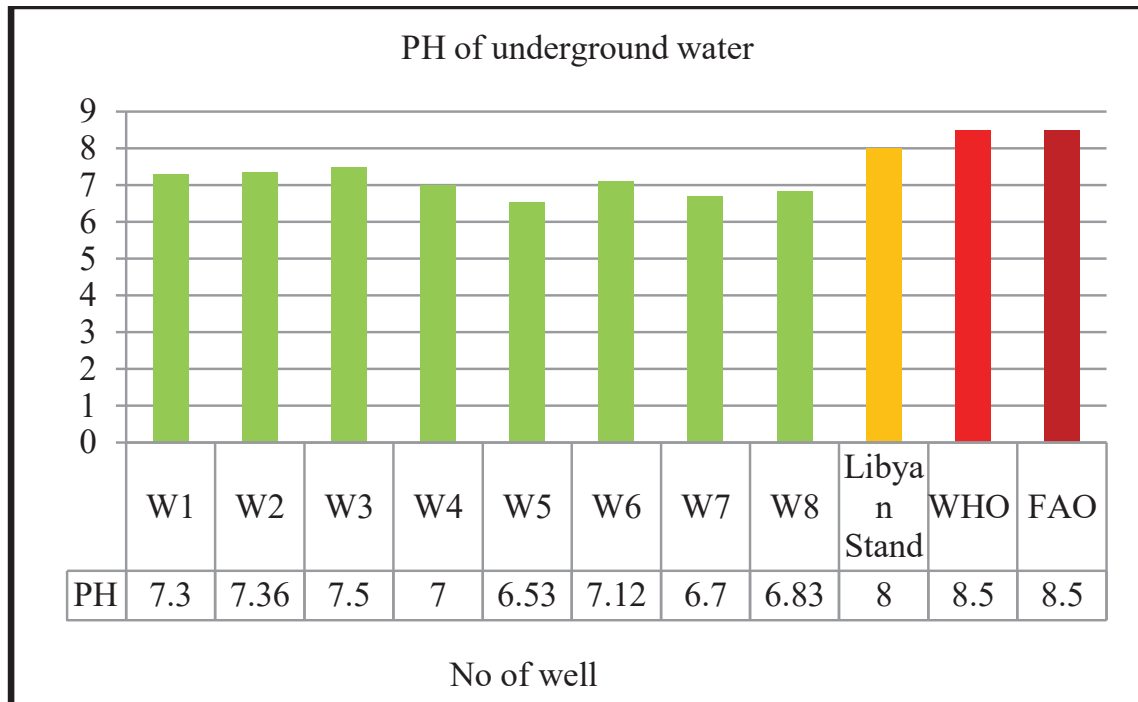


Fig (2): The pH of wells' water

Likewise, according to the Food and Agriculture Organization (FAO, 2006), the pH is considered within the permissible limits (6-8.5), [8].and also within the classification (Ayers and Westcot, 1999), which stipulates the permissible limit in irrigation water (6.5 – 8.4) [10]. According to the Don classification, water is considered well-used and reliable for irrigation, as shown in (Table 4) [11].

Table (4): Water quality for irrigation according to Don 1995 classification

PH	Water quality
< 6.5	super
6.5 – 6.8	good
6.8 – 7	allowed
7 - 8	invalid

4.3 Total Dissolved Salts (TDS)

The obtained results for TDS ranged between (38.6-418) mg/L. The lowest concentration was of Takerkebeh well while the highest concentration was of Al-Kharig well. (Fig. 3) shows the concentrations

of total dissolved salts in the study area. With reference to the standards, all samples are the same within the limits of the Libyan standards (100 -500 mg/L). It is considered good and potable water according to Libyan National Center for Standardization and Metrology2020 [13].

Also, through the results shown in (Table 1), which indicate that its concentration should not exceed the maximum limit (FAO, 2006) allowed in irrigation water (2000) mg/liter, which was mentioned by the Food and Agriculture Organization [8], which is (Fig. 3) shows underground water salinity concentrations.

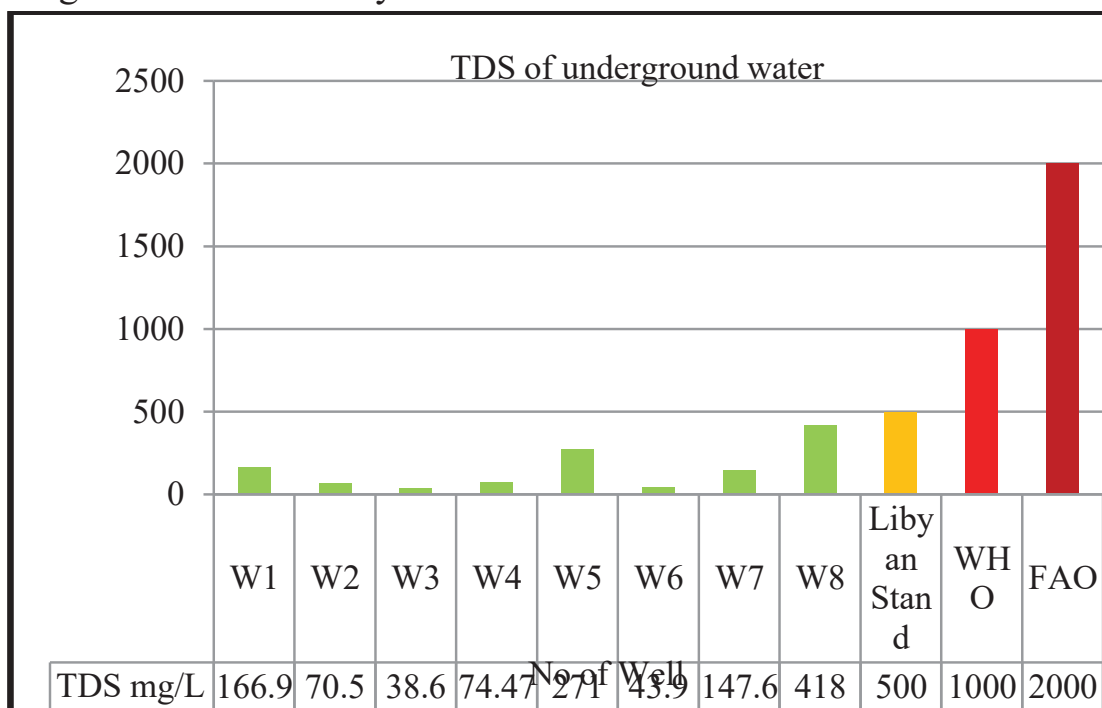


Fig (3): Average dissolved salts of wells' water

4.4 Electrical Conductivity (EC)

The electrical conductivity of water depends on the number of ions of substances dissolved in water that carry positive and negative ions. The conductivity increases directly with the amount of these ions. Electrical conductivity is considered one of the basic and important tests. It is used to figure out the amount of salinity and its suitability for irrigation according to classifications. There are multiple systems for classifying water for irrigation according to the concentration of

conductivity. It has been calculated from the equation below [1], and it is shown in (Table 1) [14,16], and illustrated in (Fig.4).The conductivity values were in the range. It is considered to have low conductivity due to the lack of dissolved salts. (Table 5) shows the quality of water based on electrical conductivity. To determine its suitability [1]:

$$E.C = \frac{TDS}{0.64}$$

Where;

TDS: salinity(mg/L) and,

E.C: electrical conductivity $\mu\text{S}/\text{cm}$.

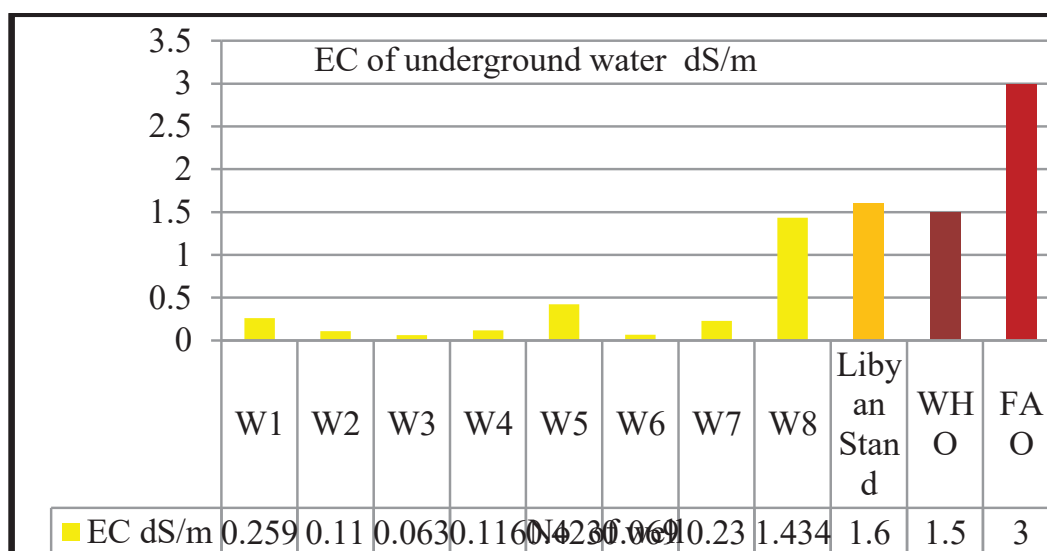


Fig (4): Electrical conductivity of underground water in the study area

Table (5): Irrigation water quality based on electrical conductivity

Water salinity	E.C ($\mu\text{S}/\text{cm}$)	Water quality	Evaluating of targeted wells
Low	0-0.25	super	5
Moderate	0.25-0.75	good	2
Medium	0.75-2.25	allowed	1
High	2.25-4.0	doubtful	-
Very high	4-6	Invalid	-

The results were compared to the system most widely used for irrigation water, which is the salinity laboratory system in the United States of America. (C1, C2, C3). The results can be classified as shown in (Table 6) [11].

Table (6): Classification of water conductivity according to the US Salinity Laboratory System (USSL).

Damage caused by salts	Classification	E.C ($\mu\text{S}/\text{cm}$)
Low	C1	250 <
Medium	C2	750 - 250
High	C3	2250 - 750
Very high	C4	2250>

The results can also be compared with the Don classification, and their quality can be classified between allowed and super [12]. (Table 7) shows the quality of irrigation water for electrical conductivity according to the Don classification.

Table (7): shows the quality of irrigation water for the electrical conductivity, according to the Don classification

Water quality	E.C ($\mu\text{S}/\text{cm}$)
Super	250<
Good	750 – 250
Allowed	2000 – 750
Doubtful	3000- 2000
Inappropriate	3000 >

5. Conclusion

Depending on the obtained results of water analysis in the study area in the south of Libya at Ubarig as electrical station

laboratory and according to the Libyan and the WHO standards, the study recommends preserving water resources as well as:

1. Conducting more chemical, microbial and physical analyses of underground water basin in the study area.
2. Finding alternatives of underground water to meet domestic, agricultural and commercial consumption of water, such as treatment and purification of wastewater and sewage water and desalination of seawater.

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THE FUTURE OF ENGINEERING: INTEGRATING
ARCHITECTURAL DESIGN WITH COMPUTER
TECHNOLOGIES IN THE CITY OF AJDABIYA
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ABSTRACT

The construction industry is undergoing a transformative shift with the integration of advanced computer technologies, such as Building Information Modeling (BIM) and artificial intelligence (AI)-driven generative design. This paper investigates the impact of these technologies on enhancing efficiency, sustainability, and design possibilities within architectural design, with a focus on Ajdabiya, Libya. Through a survey of 100 multidisciplinary professionals—including architects, civil engineers, computer engineers, and business professionals in the city of Ajdabiya—the study explores current adoption levels, evaluates the influence of these tools on project efficiency and sustainable practices, and addresses challenges related to data management, ethics, and skill development. The findings reveal that while BIM is well-established in improving workflows and collaboration, AI-driven design offers unprecedented potential for innovation, with significant hurdles in skill development and ethical concerns. The study concludes by emphasizing the need for targeted training programs, ethical guidelines, and collaborative efforts to fully realize the benefits of these technologies for creating sustainable and resilient built environments in Ajdabiya.

Keywords: Architectural Design, Computational Technologies, Building Information Modeling (BIM), Artificial Intelligence, Sustainability, Future of Engineering, Construction Industry.

1. INTRODUCTION

The traditional approach to architectural design has relied heavily on manual processes and static representations. While these methods have served us well, they often struggle to keep pace with the growing complexity and demands of modern projects.^[1] The advent of sophisticated computer technologies, including Building Information Modeling (BIM), artificial intelligence (AI), and advanced simulation software, is ushering in a new era of design and construction.^[2] This integration of computational techniques with architectural design holds immense potential to transform the engineering landscape, offering a path towards more efficient, sustainable, and innovative built environments. This integration is particularly crucial as we face pressing challenges like climate change, resource scarcity, and rapidly evolving urban environments. Specifically, this paper explores the potential of AI-driven generative design to create more sustainable and resilient buildings in response to these evolving challenges.

1.1.AIM

To investigate the impact of integrating computer technologies with architectural design on the construction industry, specifically examining its potential to enhance efficiency, sustainability, and design possibilities while addressing challenges related to data management, ethical considerations, and skill-set development.

1.2.OBJECTIVES

1. Analyze the current adoption and implementation of BIM and AI-driven generative design in the construction industry.
2. Evaluate the impact of BIM and AI-driven generative design on construction efficiency and project completion time.
3. Assess the contribution of BIM and AI-driven generative design to sustainable building practices.
4. Investigate the potential of BIM and AI-driven generative design to expand design possibilities and creative exploration in architecture.
5. Develop a framework for addressing the challenges related to data management in BIM and AI-driven generative design.
6. Analyze the ethical implications of using AI-driven design tools in architectural practice.
7. Assess the skills and training required for professionals to effectively utilize BIM and AI-driven generative design tools.

1.3.COMPUTATIONAL DESIGN

Computational design is a cutting-edge approach in architecture and engineering that leverages computer algorithms and digital tools to generate and optimize designs. Unlike traditional design methods, which rely on manual drafting and iterative processes, computational design allows for more complex, flexible, and dynamic solutions by utilizing computational power to solve design challenges. ^[3]

At its core, computational design involves using algorithms and data-driven processes to create models that can adapt to varying parameters. This approach empowers architects, civil engineers, and designers to explore a vast range of possibilities, fine-tune designs, and optimize structures for efficiency, sustainability, and aesthetics. ^[4] With the rise of technologies such as Building Information Modeling (BIM), artificial intelligence (AI), and parametric design tools, computational design has become a driving force behind the next generation of innovative architecture. ^[5]

1.3.1. The Rise of Computational Design:

Computational design techniques empower architects and engineers to explore design possibilities beyond human limitations. BIM software facilitates collaborative work, allowing for real-time visualization and analysis of complex structures. AI algorithms can analyze vast datasets to optimize design parameters for structural integrity, energy efficiency, and cost optimization. Advanced simulation software enables the testing of building performance under various conditions, predicting potential issues and identifying solutions before construction commences. ^[5]

1.3.2. Benefits of Integration:

- **Increased Efficiency:** Computational tools streamline design workflows, reducing errors, and facilitating faster project completion.
- **Enhanced Sustainability:** Computational analysis allows for precise energy simulations and the optimization of material usage, promoting sustainable building practices.
- **Innovative Designs:** The integration of AI and machine learning opens up new possibilities for creating complex and aesthetically unique structures.

- **Improved Communication:** BIM platforms facilitate seamless collaboration among architects, engineers, and contractors, enhancing communication and minimizing misinterpretations.
- **Data-Driven Decisions:** Computational models provide rich datasets that inform design decisions, leading to more informed and data-driven outcomes.^[6]

1.3.3. Challenges and Considerations:

- **Data Management:** The increasing volume of data generated by computational tools necessitates robust data management systems and security protocols.
- **Ethical Considerations:** The use of AI in design raises ethical questions regarding bias, transparency, and the potential for job displacement.
- **Skill Gap:** The integration of computational techniques requires architects and engineers to develop new skills and adapt to a rapidly evolving technological landscape.
- **Accessibility and Cost:** Access to sophisticated software and computational resources can be a barrier for smaller firms and developing countries.^[7]

1.3.4. The Future of Engineering:

The future of engineering lies in embracing this convergence of architectural design and computational technologies. Buildings will become intelligent, responsive to environmental conditions, and capable of self-optimization. The construction process will become increasingly automated, with robots and drones playing a key role in site work and assembly.^[8]

Integrating computational techniques with architectural design is not just about enhancing efficiency; it is about fundamentally changing how we think about and interact with the built environment.^[9] This shift promises a future where buildings are not merely structures, but rather complex, intelligent systems that adapt to human needs and contribute to a sustainable future.^[10] As we navigate the challenges of this integration, it is crucial to prioritize ethical considerations, foster collaboration between architects, engineers, and computer scientists, and invest in developing the skills necessary to harness the full potential of this transformative technology.^[11]

2. LITERATURE REVIEW

The Bullitt Center: A Living Building Case Study

The Bullitt Center in Seattle, Washington, stands as a shining example of a Living Building, showcasing a commitment to sustainability and a holistic approach to design. ^[12]

Here's a breakdown of its key features and how it exemplifies the Living Building philosophy:

Core Principles:

- **Net-Zero Energy:** The Bullitt Center generates all the energy it needs through solar panels, reducing its reliance on fossil fuels.
- **Water Positivity:** The building collects and treats rainwater, reusing it for irrigation and sanitation, creating a closed-loop system.
- **Waste Reduction and Recycling:** The building minimizes waste generation and actively composts and recycles its organic waste.
- **Health and Well-being:** The building prioritizes occupant well-being through natural light, ventilation, and healthy materials.
- **Adaptive Design:** The building incorporates features like a green roof and a façade with adjustable shading elements to enhance energy efficiency and create a comfortable indoor environment. ^[13]

Specific Features:

- **Solar Panels:** The roof is covered in 572 photovoltaic panels, generating enough energy to power the entire building, including its heating, cooling, and lighting systems.
- **Rainwater Harvesting:** The building collects and filters rainwater, storing it in tanks for use in toilets, irrigation, and other non-potable needs.
- **Composting System:** A dedicated system composts food scraps and other organic waste, reducing the building's reliance on landfills.
- **Daylight Optimization:** The façade is designed to maximize natural daylight, minimizing the need for artificial lighting.
- **Green Roof:** The rooftop is covered in a living green roof, contributing to stormwater management, insulation, and aesthetics.

- **High-Performance Materials:** The building utilizes sustainable and locally sourced materials, emphasizing low-impact construction practices.
- **Smart Building Systems:** The building incorporates sensors and controls for optimizing energy consumption, water usage, and ventilation, creating a highly responsive and adaptable environment. ^[14]

Impact:

- **Environmental Sustainability:** The Bullitt Center has drastically reduced its carbon footprint, demonstrating the feasibility of achieving net-zero energy and water-positive buildings.
- **Economic Viability:** The building's innovative features have also proven to be cost-effective, leading to lower operational expenses.
- **Social Responsibility:** The Bullitt Center serves as a model for sustainable building practices, inspiring others to adopt similar principles. ^[15]

Challenges:

- **Cost:** The initial construction costs of a Living Building can be higher than traditional buildings due to the incorporation of advanced technology and sustainable materials.
- **Maintenance:** Maintaining a Living Building requires specialized expertise and ongoing monitoring to ensure the functionality of its complex systems.
- **Regulation:** Building codes and regulations often need to be updated to accommodate the innovative features of Living Buildings.

The Future:

The Bullitt Center serves as a blueprint for future buildings, pushing the boundaries of sustainable design and demonstrating the viability of incorporating advanced technologies to create more efficient, resilient, and healthy built environments. ^[16] As technology and design practices continue to evolve, we can expect to see more examples of Living Buildings that further integrate these principles into the urban fabric. ^[17]

3. HOW YOU CAN MAKE A SIMILAR BUILDING A REALITY IN LIBYA, FOCUSING ON ADAPTING IT TO THE LOCAL CONTEXT

3.1. Assess Libya's Specific Conditions:

- **Climate:** Libya has a hot, arid climate with high solar radiation. This is ideal for solar energy generation, but also poses challenges for cooling buildings.
- **Water Resources:** Water scarcity is a major concern. Rainwater harvesting and water conservation technologies will be crucial.
- **Local Materials:** Explore locally sourced materials like stone, clay, and sustainable wood to reduce reliance on imports and support local industries.
- **Regulations and Policies:** Understand existing building codes and identify any potential roadblocks to implementing innovative features. Advocate for changes that promote sustainability.
- **Economic Factors:** Determine the feasibility of such a project considering the current economic landscape and potential funding sources.^[18]

3.2. Adapt the Design and Technology:

- **Solar Energy:** Invest in high-efficiency solar panels tailored to Libya's climate and energy needs. Consider integrating solar thermal for heating water.
- **Passive Cooling:** Utilize passive cooling strategies such as shading, natural ventilation, and thermal mass to minimize energy consumption for cooling.
- **Water Harvesting:** Design robust rainwater harvesting systems and implement greywater treatment for non-potable water use.
- **Waste Management:** Develop a comprehensive waste management strategy that emphasizes composting and recycling within the building itself.
- **Materials and Construction:** Explore locally sourced materials like rammed earth, adobe, or recycled materials that are well-suited to the desert climate and reduce environmental impact.

- **Building Management Systems:** Utilize smart technology to optimize energy use, water conservation, and HVAC systems based on local conditions. ^[19]

3.3. Building a Collaborative Ecosystem:

- **Government Support:** Advocate for policies that incentivize sustainable building practices, including tax breaks, subsidies, and simplified permitting processes.
- **Private Sector Involvement:** Engage with developers, construction companies, and investors to build support for this vision. Highlight the financial benefits of sustainable buildings, including lower operating costs and increased property values. ^[20]
- **Community Engagement:** Educate the public on the benefits of sustainable buildings and involve local communities in the design process.
- **Partnerships and Collaboration:** Seek partnerships with international organizations, research institutions, and other sustainable building experts to share knowledge and expertise. ^[21]

3.4. Addressing Challenges:

- **Funding:** Secure financing through government grants, private investment, green bonds, or crowdfunding initiatives.
- **Technical Expertise:** Develop a local workforce with expertise in sustainable design, construction, and building management.
- **Materials and Technology:** Identify and source sustainable building materials and technologies that are adapted to the Libyan climate and infrastructure.
- **Regulations:** Work with authorities to streamline building codes and regulations to accommodate innovative designs. ^[22]

3.5. Beyond a Single Building:

- **Pilot Project:** Begin with a pilot project to demonstrate the feasibility and benefits of a Living Building in Libya.
- **Replicability:** Aim to create a model that can be replicated across different scales and contexts, promoting a broader shift toward sustainable construction practices.

Building a Living Building in Libya requires a comprehensive and holistic approach that addresses local conditions, adapts technologies, and fosters collaboration. ^[23] By addressing challenges, fostering innovation, and promoting a shared vision, Libya can create sustainable and resilient buildings that contribute to a healthier and more sustainable future. ^[24]

4. CASE STUDY

This study aimed to understand the current state of BIM and AI-driven design adoption within the construction industry, identify challenges and opportunities, and explore potential future trends. To achieve this, we conducted a survey of 100 multidisciplinary professionals, encompassing architects, computer engineers, and civil engineers.

4.1. METHODOLOGY

This study utilizes a survey of 100 construction professionals to explore the adoption and implications of BIM and AI-driven design. While the findings provide valuable insights, it's important to note the limitations of a convenience sample and potential self-selection bias.

4.2. Survey Design and Distribution:

- **Target Population:** The survey targeted multidisciplinary professionals actively involved in the construction industry, with a focus on architects, computer engineers, and civil engineers.
- **Survey Instrument:** A structured questionnaire was developed, encompassing both closed-ended and open-ended questions. (See Appendix 1 for the complete questionnaire).
- **Distribution:** The survey was distributed electronically via email and online platforms frequented by industry professionals.
- **Sampling Technique:** A convenience sampling method was employed, targeting professionals within our existing network and through online industry communities.

4.3. Data Collection and Analysis:

- **Data Collection:** Responses were collected electronically and stored in a secure database.
- **Data Analysis:** The data was analyzed using descriptive statistics (frequencies, percentages, means, standard deviations) to identify key trends and patterns. Qualitative responses were

analyzed thematically, identifying common themes and emerging perspectives.

4.4. Ethical Considerations:

- **Anonymity and Confidentiality:** Participants were assured that their responses would be anonymous and confidential.
- **Informed Consent:** Participants were informed about the purpose of the survey, the use of their data, and their right to withdraw from the study at any time.

4.5. Limitations:

- **Sample Size:** The sample size of 100 participants may not be representative of the entire construction industry.
- **Self-Selection Bias:** Participants who chose to complete the survey may have a different perspective than those who did not.
- **Generalizability:** The findings may not be generalizable to all sectors or regions of the construction industry.

4.6. Future Research:

- **Larger Sample Size:** Future research could benefit from a larger and more representative sample.
- **Qualitative Interviews:** Conducting in-depth interviews with professionals could provide richer insights and contextual understanding.
- **Comparative Analysis:** Comparing findings across different geographic regions or industry sectors could offer valuable insights into global trends.

Well, from the results of our survey of 100 multidisciplinary professionals from different countries. The following trends emerged from the surveyed data:

4.7. Key Findings:

- **BIM Adoption is High, But AI-driven Design is Still Emerging:**
 - 80% of respondents reported using BIM in at least some projects, with 40% using it full-scale.
 - Only 20% reported using AI-driven generative design tools, and most of those were in an exploratory phase.

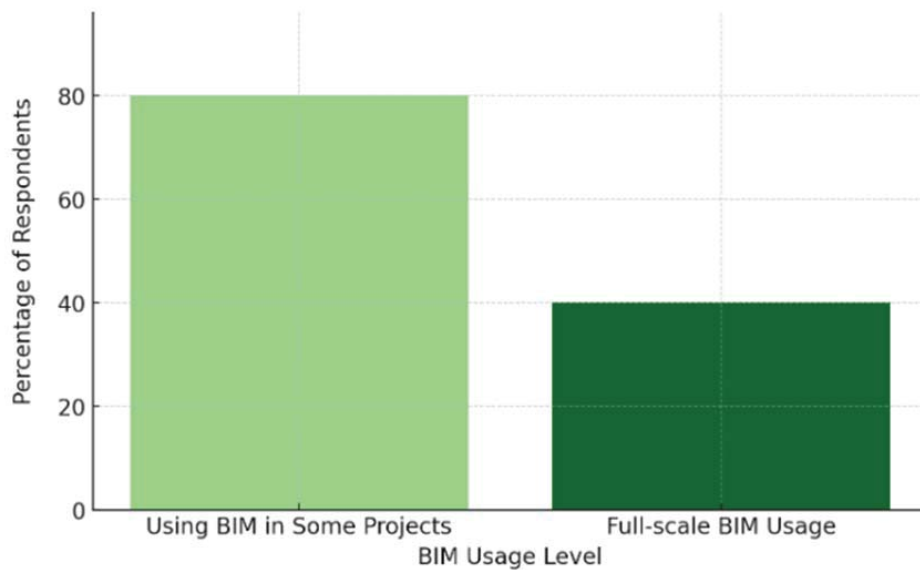


Figure1.a, the chart illustrating BIM usage in projects: 80% of respondents reported using BIM in at least some projects. 40% use BIM on a full-scale basis.

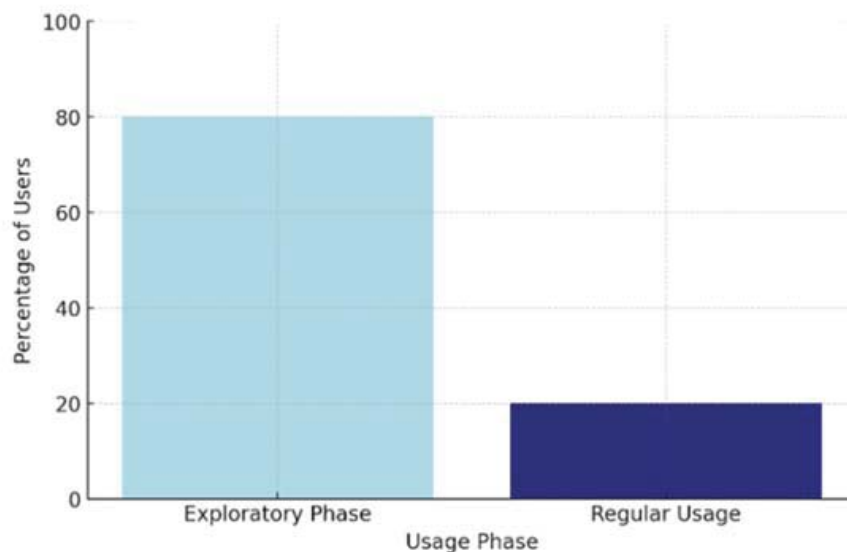


Figure1.b, the chart visualizing the usage of AI-driven generative design tools, where 80% of users are still in the exploratory phase, and only 20% use the tools regularly.

- **Challenges to Adoption:**

- o The biggest hurdle for both BIM and AI-driven design was **lack of skilled personnel** (cited by 60% and 75% respectively).
- o **Cost** was a significant concern, with 50% mentioning it as a barrier for AI-driven design.

- o **Data management** was identified as a challenge by 40% for BIM and 55% for AI-driven design.

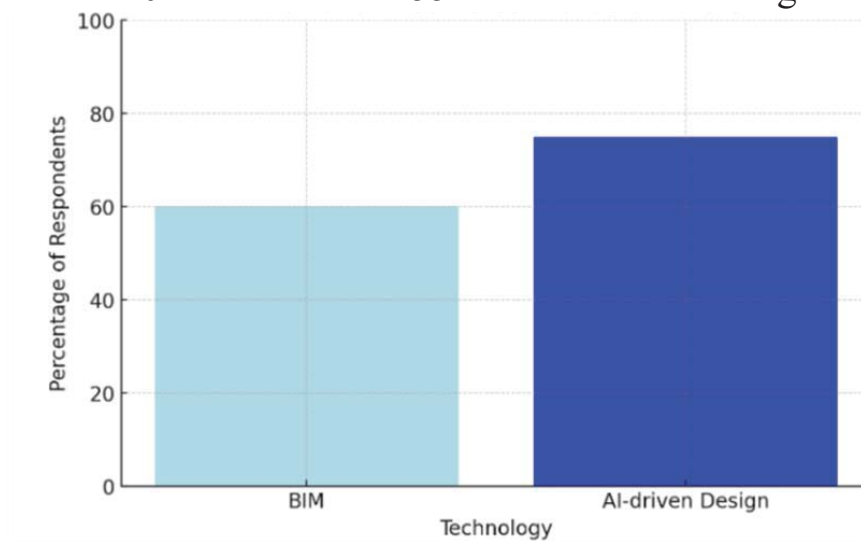


Figure 2.a, the chart visualizing the lack of skilled personnel as the biggest hurdle for both technologies which are 60% for BIM and 75% for AI-driven design. This shows that the lack of skilled personnel is a significant barrier to adopting both BIM and AI-driven design.

- Cost was a significant concern, with 50% mentioning it as a barrier for AI-driven design.

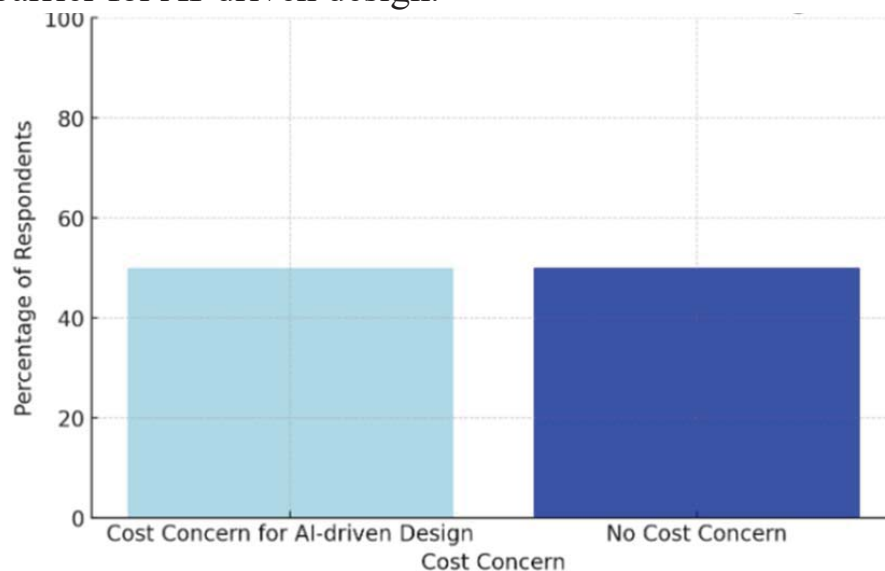


Figure 2. b, the chart visualizing cost as a significant concern for AI-driven design. 50% of respondents mentioned cost as a barrier, while the other 50% did not see it as a concern. This illustrates the divided views on cost being a hurdle for AI-driven design.

- Data management was identified as a challenge by 40% for BIM and 55% for AI-driven design.

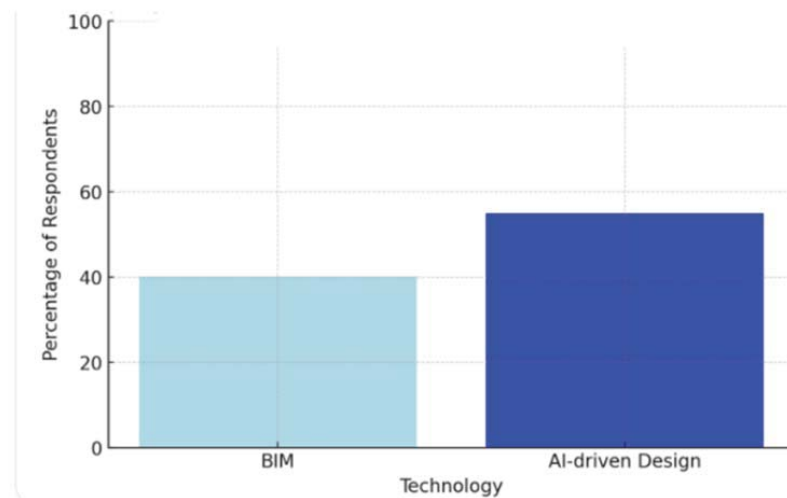


Figure.2.c, the chart visualizing data management challenges which are 40% of respondents identified it as a challenge for BIM. And, 55% reported it as a challenge for AI-driven design. This highlights the importance of addressing data management issues in both technologies.

- **Efficiency Gains Are Real, But Not Always Dramatic:**
 - o 60% reported BIM led to moderate reductions in project completion time, but only 20% saw significant reductions.
 - o AI-driven design was less widely used, but those who did use it reported more significant efficiency gains, with 30% experiencing substantial time reductions.

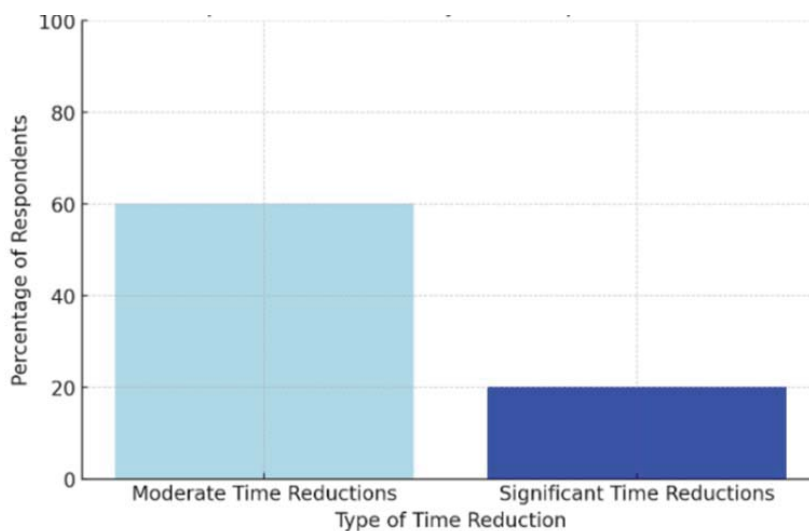


Figure 3.a, the chart visualizing the impact of BIM on project completion time which is 60% of respondents reported moderate time reductions. Only

20% experienced significant time reductions. This emphasizes that while BIM provides time savings, substantial reductions are less common.

- AI-driven design was less widely used, but those who did use it reported more significant efficiency gains, with 30% experiencing substantial time reductions.

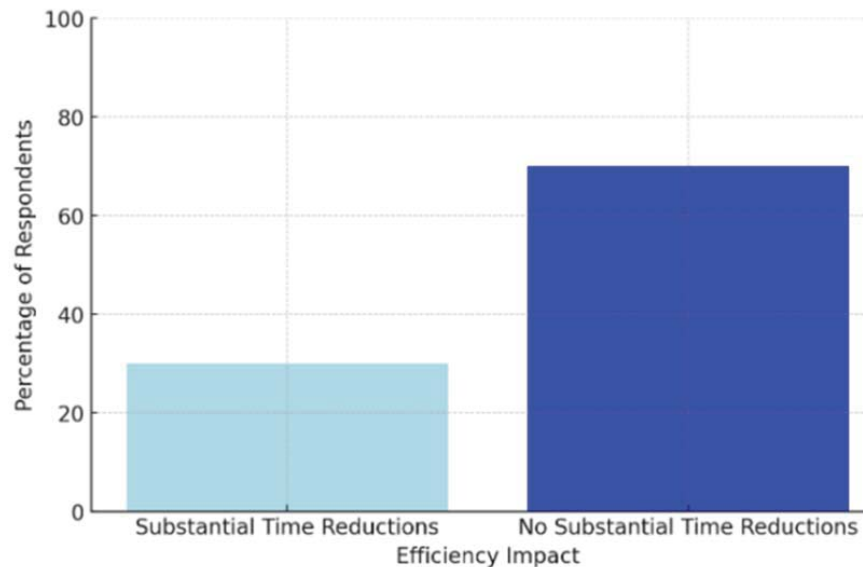


Figure3.b, the chart visualizing the impact of AI-driven design on efficiency gains which is 30% of respondents experienced substantial time reductions. 70% did not report significant reductions. This demonstrates that while AI-driven design is less widely used, it has the potential to offer considerable time savings for those who adopt it.

- **Sustainability is a Key Driver for Technology Adoption:**
 - o 70% reported that BIM and AI-driven design helped improve resource efficiency (materials, energy).
 - o Architects and engineers were particularly enthusiastic about using these technologies to achieve sustainability goals.

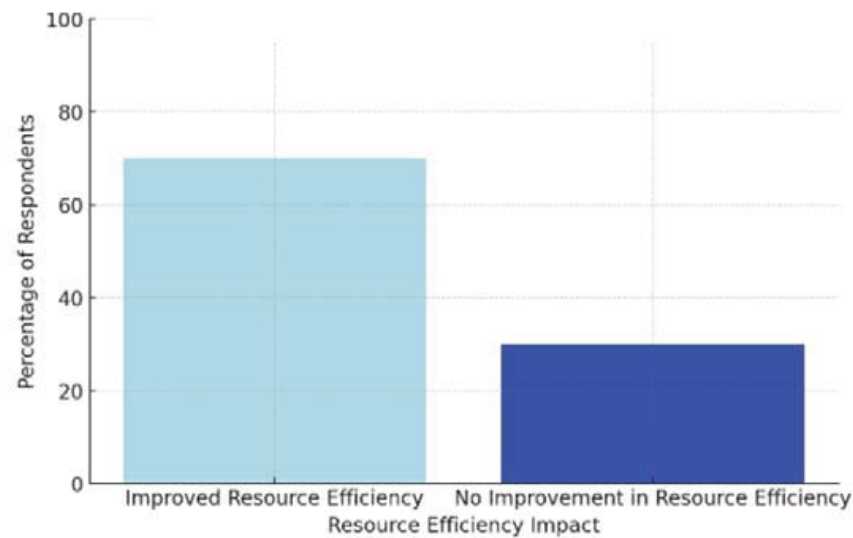


Figure 4, the chart visualizing the impact of BIM and AI-driven design on resource efficiency which is 70% of respondents reported that these technologies helped improve resource efficiency in terms of materials and energy. Also, 30% did not observe such improvements. This highlights the strong potential of these technologies to drive sustainability efforts.

- Architects and engineers were particularly enthusiastic about using these technologies to achieve sustainability goals.
- **Creative Control is a Mixed Bag:**
 - While 50% felt BIM increased their creative control, 30% felt it decreased it.
 - AI-driven design was seen as both an opportunity and a threat to creative freedom. 40% felt it enhanced possibilities, but 30% worried about losing control to algorithms.

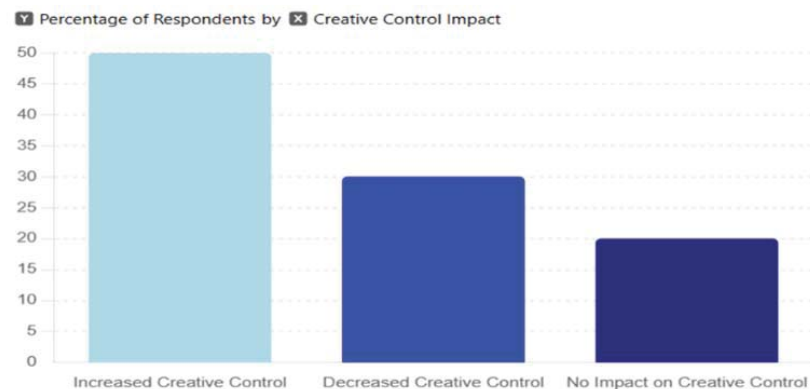


Figure 5.a, the chart visualizing BIM's impact on creative control which is 50% of respondents felt BIM increased

their creative control. Also, 30% felt it decreased their creative control. Also, 20% felt it had no impact. This shows that opinions on BIM's influence on creativity are mixed.

- AI-driven design was seen as both an opportunity and a threat to creative freedom. 40% felt it enhanced possibilities, but 30% worried about losing control to algorithms.

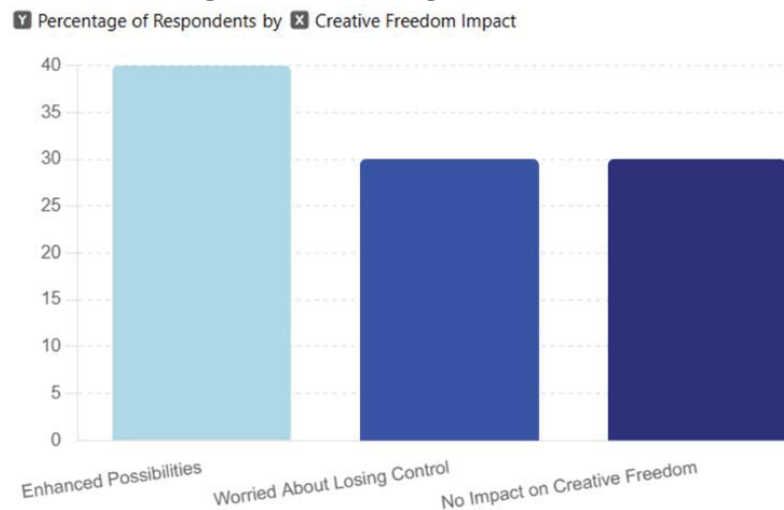


Figure5.b, the chart visualizing AI-driven design's impact on creative freedom which is 40% felt it enhanced creative possibilities. Also, 30% were concerned about losing control to algorithms. And, 30% felt it had no impact on their creative freedom. This reflects the mixed perceptions of AI-driven design as both an opportunity and a potential threat to creativity.

- **Ethical Concerns are Significant:**
 - o Job displacement (50%) and algorithmic bias (40%) were the most prominent ethical concerns.
 - o Many expressed a need for robust ethical guidelines and regulations for AI-driven design.

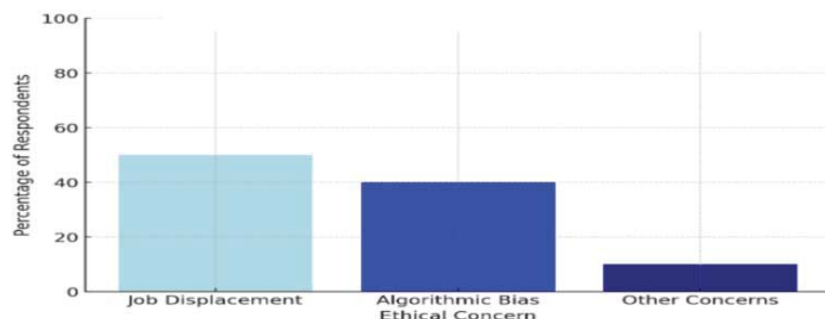


Figure 6, the chart visualizing the ethical concerns related to AI-driven design which is 50% of respondents are concerned about job displacement. Also, 40% are worried

about algorithmic bias. And, 10% mentioned other ethical concerns. These concerns highlight the need for careful consideration of the social impacts of AI-driven design.

- o Many expressed a need for robust ethical guidelines and regulations for AI-driven design.

- **Future Outlook is Positive, But Skills Gap Remains a Concern:**

- o Almost all respondents (90%) believe these technologies will become increasingly important in the construction industry.
- o There's a strong desire for improved training programs and resources to develop the necessary skills.

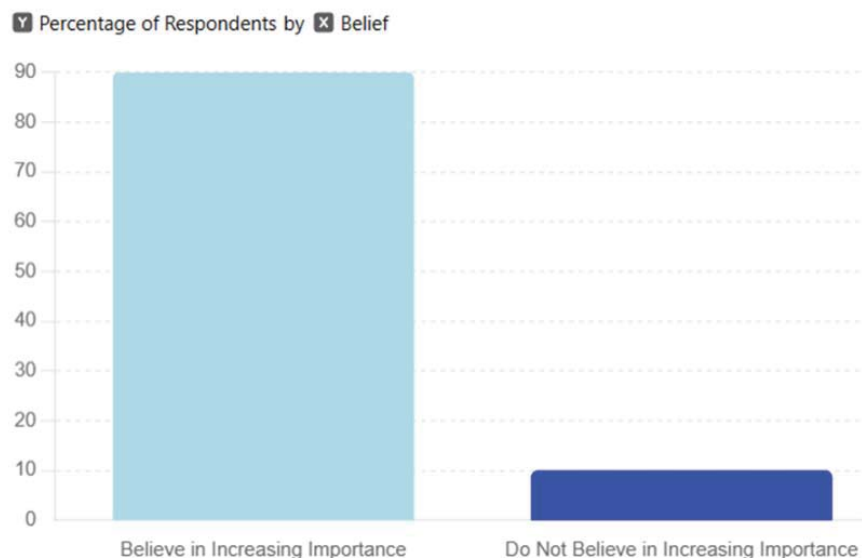


Figure 7, the chart visualizes the belief in the increasing importance of BIM and AI-driven design in the construction industry which is 90% of respondents believe these technologies will become more important. And, 10% do not share this belief.

This demonstrates a strong consensus about the future role of these technologies in the industry.

- There's a strong desire for improved training programs and resources to develop the necessary skills.

4.8. Analysis and Insights:

1. The Power of BIM is Established, but AI Holds the Key to Transformation:

* BIM has clearly demonstrated its value in terms of efficiency and collaboration.

- * AI-driven design is still in its infancy, but its potential for even greater efficiency gains and innovative design is significant.
 - * The construction industry is at a crossroads – how it navigates this technological shift will determine its future.
2. The Skills Gap is the Biggest Obstacle:
- * Training and education must be prioritized to bridge the skills gap.
 - * Industry partnerships with universities and training institutions are crucial.
 - * Companies need to invest in upskilling their workforce and create learning pathways.
3. Balancing Creativity and Automation:
- * AI is a powerful tool, but it shouldn't replace the human element in design.
 - * Architects and engineers need to be empowered to leverage AI while maintaining their creative control.
 - * Ethical guidelines and frameworks are crucial to ensure responsible use of AI in design.
4. Sustainability is a Driving Force:
- * The construction industry has a vital role to play in addressing climate change.
 - * BIM and AI-driven design provide powerful tools for sustainable building practices.
 - * Encouraging the use of these technologies for environmental benefits should be a priority.
5. Data Management is Crucial:
- * Effective data management is essential for the successful implementation of these technologies.
 - * Robust data infrastructure and secure platforms are needed to support the vast amount of data generated.
 - * Clear guidelines and policies for data privacy and security are crucial.

5. DISCUSSION

The survey results reveal that the construction industry is at a pivotal juncture, with BIM adoption already well established but AI-driven design poised to usher in a new era of transformation. While efficiency and sustainability gains are evident with both technologies, the successful integration of AI hinges on overcoming significant challenges. The most prominent obstacle is the lack of skilled

personnel, emphasizing the urgent need for targeted training and education initiatives.

While BIM has demonstrably improved workflow efficiency and collaboration, AI-driven design holds the promise of even greater leaps in speed and innovation. However, concerns around creative control and the ethical implications of algorithmic decision-making require careful consideration and the establishment of robust guidelines for responsible AI implementation.

The survey also highlights the strong desire within the industry to embrace these technologies for achieving sustainability goals. By harnessing the power of BIM and AI, the construction industry can significantly reduce its environmental impact and contribute to a greener future.

6. CONCLUSION

The construction industry stands at a crossroads, poised to harness the transformative power of computer technologies while navigating complex challenges. Our survey reveals that BIM adoption is already deeply integrated into many practices, demonstrating its effectiveness in streamlining workflows, fostering collaboration, and improving efficiency. However, the nascent integration of AI-driven design offers a compelling glimpse into a future where design possibilities expand exponentially, and efficiency gains reach unprecedented levels.

While the promise of AI is undeniable, its successful integration demands careful consideration of ethical implications, data management complexities, and the critical need for skills development. The industry must prioritize training programs that equip professionals with the knowledge and expertise to utilize these tools effectively, ensuring that technology serves as an enabler rather than a barrier to progress.

By embracing a culture of innovation and actively addressing ethical concerns, the construction industry can position itself to reap the full benefits of these technological advancements. This requires a collaborative effort among professionals, policymakers, and technology providers to establish robust ethical guidelines, foster research and development, and invest in a skilled workforce prepared for the future.

The survey's findings underscore the importance of embracing a holistic approach that encompasses not only technical proficiency but also a deep understanding of the ethical, social, and environmental considerations surrounding these technologies. By fostering a proactive and forward-thinking mindset, the construction industry can ensure that computer technologies act as powerful tools for delivering efficient, sustainable, and innovative built environments that benefit society as a whole.

7. RECOMMENDATIONS

- **Prioritize Skills Development:** Invest heavily in training programs that focus on BIM and AI-driven design. Collaborate with educational institutions to develop curriculum and provide industry-relevant learning pathways. Encourage upskilling within existing workforces through professional development programs.
- **Foster a Culture of Innovation:** Encourage experimentation with AI-driven design, supporting early adopters and sharing best practices. Establish industry-wide initiatives to promote research and development in this area.
- **Address Ethical Concerns:** Develop clear ethical guidelines and regulations for AI-driven design in architecture. Establish frameworks for algorithmic accountability, transparency, and bias mitigation. Foster dialogue and consensus building among professionals, policymakers, and technology providers on these critical issues.
- **Invest in Data Management Infrastructure:** Develop robust data management systems that can handle the large volumes of data generated by BIM and AI-driven design. Ensure secure data storage, processing, and retrieval capabilities, while adhering to data privacy and security regulations.
- **Promote Sustainable Building Practices:** Emphasize the role of these technologies in achieving sustainability goals, promoting resource efficiency, and minimizing environmental impact. Provide incentives and recognition for projects that effectively integrate sustainable design principles.

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Evaluation of Intelligent Reflecting Surfaces versus Massive MIMO Technology in Near Field Wireless Communications

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Abstract: The rapid advancement of wireless networks toward 5G and beyond necessitates innovative strategies to improve signal coverage and capacity while ensuring energy efficiency and cost-effectiveness. Intelligent Reflecting Surfaces (IRS) and Massive Multiple Input Multiple Output (mMIMO) systems have emerged as effective technologies to address these challenges. This project provides a comparative analysis of IRS and mMIMO regarding Signal-to-Noise Ratio (SNR) enhancements and power scaling laws across various operational scenarios, with a particular emphasis on near-field communications. Using a deterministic propagation model for planar arrays, we investigate SNR behaviors and derive new expressions for

channel gain, emphasizing key differences between near-field and far-field applications. Our results reveal that while IRS can demonstrate quicker SNR growth rates as the number of elements increases, mMIMO systems can achieve similar SNR levels with the right configurations, particularly in practical near-field environments where the quadratic growth of IRS may not be fully attainable. Additionally, we show that although IRS theoretically offers advantages in improving SNR, mMIMO systems provide strong performance and are less affected by practical implementation challenges.

1. Background

The rapid growth in the demand for higher data rates and more reliable wireless communications has spurred significant advancements in network technologies. Traditional wireless systems face challenges in meeting these demands due to limitations in spectral efficiency and interference management. To overcome these limitations, researchers and industry professionals have been actively exploring innovative approaches to enhance wireless network capacities and efficiencies.

Two emerging technologies that have garnered considerable attention in the field are Massive Multiple Input Multiple Output (MIMO) systems and Intelligent Reflecting Surfaces (IRS). These technologies offer promising solutions to address the increasing demands for higher data rates, improved coverage, and enhanced system performance [1].

Massive MIMO is an evolution of traditional MIMO technology, which involves employing multiple antennas at the base station and user devices to transmit and receive signals simultaneously. However, Massive MIMO takes this concept to a new level by utilizing a significantly larger number of antennas at the base station. By increasing the number of antennas, Massive MIMO systems can exploit spatial multiplexing and beamforming techniques, enabling simultaneous communication with multiple users and enhancing the overall system capacity [2], [3].

The use of a massive number of antennas in Massive MIMO introduces several benefits. Firstly, it improves the signal-to-noise ratio (SNR) by exploiting the spatial diversity and multipath propagation characteristics of wireless channels. The increased number of antennas allows for better spatial separation and interference mitigation, resulting in improved signal quality. Secondly, Massive MIMO enhances the channel capacity by enabling simultaneous transmission

to multiple users in the same time-frequency resource, thereby increasing the system's spectral efficiency [2].

Intelligent Reflecting Surfaces (IRS), also known as reconfigurable intelligent surfaces or met surfaces, represent another emerging technology that can revolutionize wireless communications. An IRS consists of a two-dimensional array of passive elements, such as programmable reflectors or metamaterials, that can manipulate the propagation of electromagnetic waves [3]. By intelligently reflecting and redirecting wireless signals, IRS can enhance signal strength, improve coverage, and increase the received signal power at desired receivers.

The passive nature of IRS elements allows for energy-efficient signal manipulation without the need for additional power sources. By optimizing the reflection coefficients of the IRS elements, the wireless channel can be effectively shaped, leading to improved signal quality and communication performance. IRS can be deployed in various scenarios, including indoor environments, outdoor urban settings, and even satellite communications, offering flexible and adaptable solutions for wireless network enhancement [4].

Both Massive MIMO and IRS have distinct advantages and limitations. Massive MIMO systems excel in scenarios with a large number of users, as they can exploit spatial multiplexing and beamforming to serve multiple users simultaneously. On the other hand, IRS provides a means to enhance wireless communications by intelligently manipulating the wireless channel without the need for extensive infrastructure modifications [5].

In this project, our objective is to analyze and compare the SNR improvements and power scaling laws associated with Massive MIMO systems and IRS-aided communication setups. We will specifically focus on evaluating their performance in both near-field and far-field wireless communication scenarios. By understanding the capabilities and trade-offs of these technologies, we can gain insights into their applicability and potential for improving wireless communication systems.

2. Massive MIMO

Massive MIMO (Multiple-Input Multiple-Output) is an advanced wireless communication technology that utilizes a large number of antennas at the base station to serve multiple users simultaneously. It is considered a key enabler for future wireless networks, including 5G and beyond. Massive MIMO builds upon the principles of traditional MIMO systems but significantly scales up the number of antennas, typically in the order of tens or hundreds.

The concept of MIMO itself originated in the late 1990s and early 2000s, with early research focused on exploiting multiple antennas at both the transmitter and receiver to enhance the capacity and reliability of wireless communication systems. By transmitting multiple spatially separated data streams and taking advantage of the spatial diversity, MIMO systems can achieve higher spectral efficiency and mitigate the detrimental effects of fading and interference[6], [7].

Massive MIMO represents a significant advancement over traditional MIMO by deploying an unprecedented number of antennas at the base station. The large antenna array enables the base station to serve multiple users simultaneously using the same time-frequency resources. This is achieved through spatial multiplexing, where different data streams are transmitted to different users in the same time-frequency resource blocks [8]. Figure (1) shown 5G Massive MIMO technology .



Figure 1 5G Massive MIMO technology .

3 Intelligent Reflecting Surfaces

Intelligent Reflecting Surfaces (IRS) in figure (2), also known as reconfigurable intelligent surfaces or met surfaces, is an emerging technology that has the potential to revolutionize wireless communication systems. IRS consists of a planar array of passive

reflecting elements, such as meta-atoms or metamaterial, that can manipulate and control the propagation of electromagnetic waves. Unlike traditional reflectors, IRS elements can dynamically adjust their reflection properties by changing the phase or amplitude of the incident waves [12].

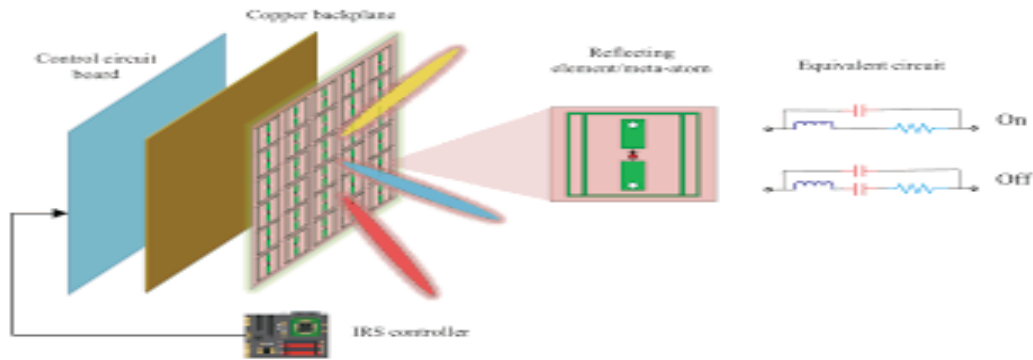


Figure 2 Intelligent Reflecting Surfaces technology.

4 Fundamentals of Near-Field Communications (NFC)

Near-Field Communication (NFC) is a short-range wireless communication technology that enables the exchange of data between devices in close proximity, typically within a range of less than 10 cm. NFC operates primarily within the radio frequency band of 13.56 MHz and is based on electromagnetic theory and principles. Let's delve into the physics and principles of NFC, the technical aspects governing it, and some of its practical use cases [13]. Figure (3) shown Near-Field Communications (NFC).

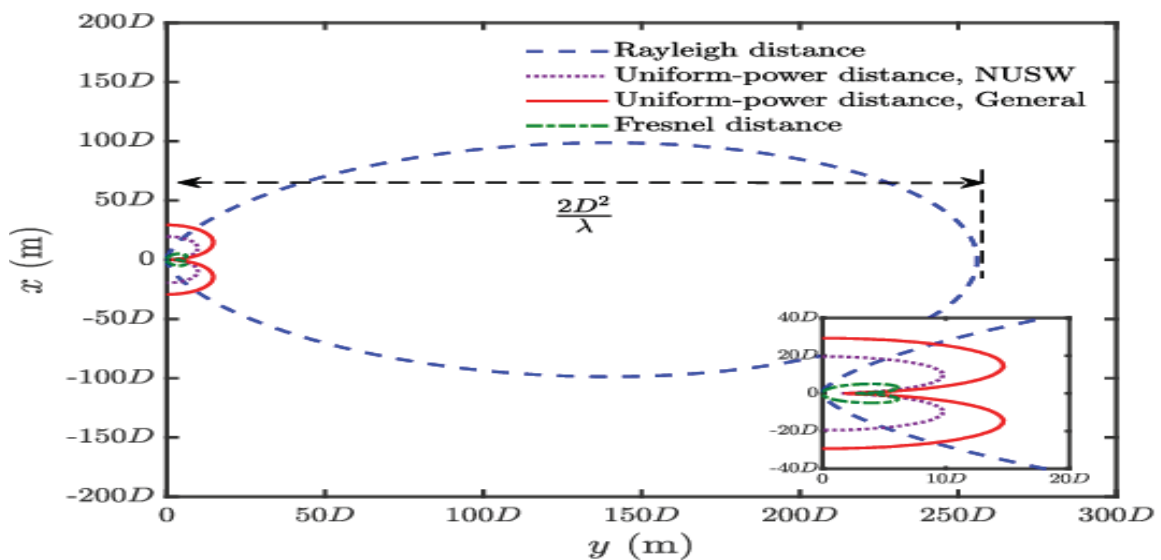


Figure 3 Near-Field Communications (NFC).

5. Results and Discussion

In this section, we delve into the comprehensive analysis and significant findings from our investigation into the power scaling laws and near-field behaviors of Massive MIMO and Intelligent Reflecting Surfaces (IRS). The cornerstone of this research lies in its exploration of the signal-to-noise ratio (SNR) enhancements and power efficiency improvements through the use of large antenna arrays in wireless communication systems.

The Project meticulously examines both the theoretical advancements and practical implications of utilizing massive arrays in enhancing wireless network capacities. Through the application of advanced mathematical modeling and extensive simulations, we dissect the behaviors of Massive MIMO and IRS technologies under varying conditions, particularly focusing on the distinction between far-field and near-field operational regimes.

Our analysis first revisits the conventional power scaling laws, confirming their applicability in the far-field but revealing their limitations in the near-field due to the unique propagation characteristics that emerge as the antenna array size increases. This finding underscores the necessity of reevaluating existing assumptions about antenna array performance, especially in near-field conditions where the physical dimensions of the array significantly influence signal propagation.

Furthermore, we introduce a novel perspective on the comparative analysis of Massive MIMO and IRS technologies. By rigorously examining the power scaling laws and SNR behaviors, our study not only highlights the potential of IRS to offer quadratic SNR improvements in the far-field but also cautions about its reduced effectiveness in the near-field.

This section aims to provide a structured discussion on these pivotal results, presenting both the theoretical underpinnings and practical ramifications. We will explore how these insights could potentially reshape future wireless communication systems, paving the way for more robust and energy-efficient configurations. The subsequent will further detail the specific methodologies employed, the simulation setups, and the critical evaluations that lead to these conclusions.

Figure (4) shows how the Signal-to-Noise Ratio (SNR) varies as a function of the number of receive antennas (N) in a communication system, under different power scaling laws.

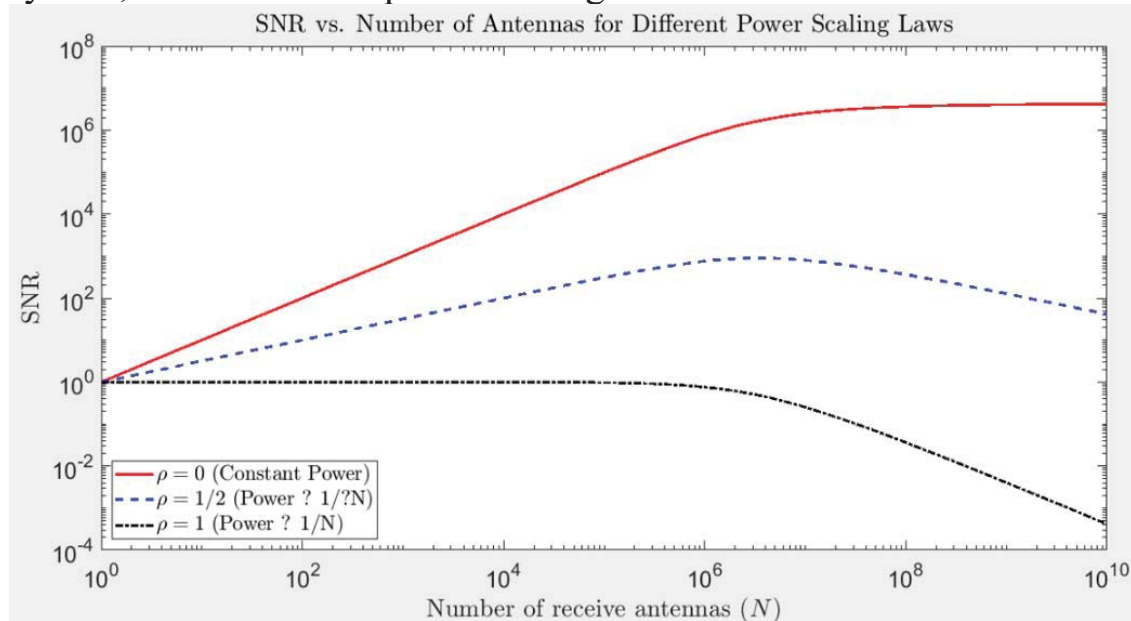


Figure 4 The SNR value SNRmMIMO by different values of the parameter ρ .

Figure (4) showcases the comparative effectiveness of massive MIMO (mMIMO) and Intelligent Reflecting Surfaces (IRS) by illustrating how their total channel gains vary with an increasing number of antennas or elements (N).

Figure (5) features two curves: one for mMIMO, which typically exhibits a linear or sub-linear rise in channel gain with the addition of more antennas, highlighting the benefits of spatial multiplexing and beamforming that mMIMO technologies leverage. In contrast, the curve for IRS shows a sharper increase, suggesting quadratic scaling of channel gain with the number of elements, potentially indicating superior performance enhancements under ideal conditions.

This visualization is crucial for system designers, illustrating that although both technologies significantly enhance gains, IRS's scalability might exceed that of mMIMO at higher element counts. However, it also suggests that the theoretical advantages of IRS could be limited by practical constraints such as array size and engineering limitations. This comparative analysis is instrumental in determining which technology may be more advantageous for specific applications, considering factors such as array size, cost, complexity, and the deployment environment.

Additionally, the figure (5) also likely addresses the influence of near-field effects and other physical limitations on system performance as the scale of the arrays increases, challenging the assumptions made under traditional far-field models. This insight is essential for future planning of wireless communication systems, particularly in choosing the appropriate technology to optimize network performance across various scenarios [13].

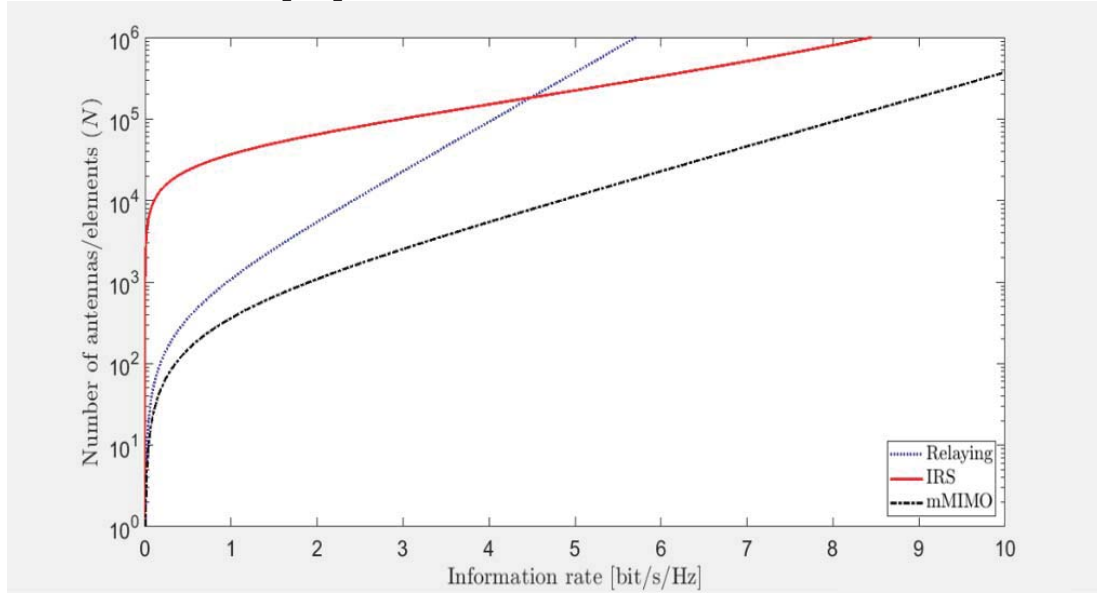


Figure 5 The total channel gain obtained with the mMIMO receiver and with the IRS-aided setup, for different number of antennas/elements N

Figure(6) provides a detailed comparison of how the number of elements, whether antennas in mMIMO systems or reflectors in IRS-aided setups, influences the achievable information rate in wireless communication systems.

Figure (6) includes separate curves for mMIMO and IRS systems. For mMIMO, the curve likely shows a linear or sub-linear increase in information rate as more antennas are added, benefiting from enhanced signal processing capabilities and spatial multiplexing. In contrast, the IRS curve might exhibit a steeper initial increase, suggesting that IRS systems can potentially enhance the information rate more dramatically due to their ability to alter the phase and amplitude of incoming signals for constructive interference at the receiver.

This visual comparison is instrumental in evaluating the efficiency of mMIMO versus IRS systems, showing which technology is more effective at increasing the information rate for a given number of elements. It highlights that while mMIMO provides steady gains; IRS could offer higher rates under optimal conditions but might require

significantly more elements to achieve comparable or superior performance to mMIMO in certain scenarios.

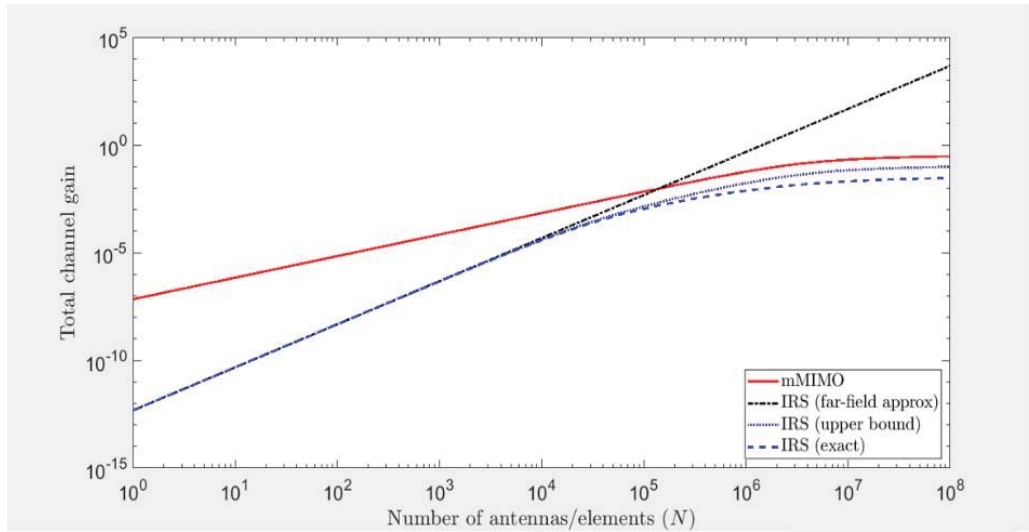


Figure 6 the number of elements/antennas needed to achieve given information rate in the different setups

6. Conclusion

The conclusions section of your project titled "Power Scaling Laws and Near-Field Behaviors of Massive MIMO and Intelligent Reflecting Surfaces" summarizes the study's major findings and their implications for wireless communication system design and deployment. The project clarifies important points regarding the scaling of signal-to-noise ratio (SNR) and the impact of near-field conditions on such scaling, particularly contrasting Massive MIMO (mMIMO) and Intelligent Reflecting Surfaces (IRS).

The SNR in mMIMO systems is shown to scale linearly with the number of antenna elements, which aligns with traditional expectations under far-field conditions. Conversely, IRS demonstrates a quadratic SNR scaling under similar conditions, offering potentially greater enhancements in signal quality. However, these scaling laws do not hold in near-field scenarios where the number of elements is very large, leading to the development of a new model that more accurately represents these effects.

The project also delves into a comparative analysis of mMIMO and IRS, revealing that IRS, despite its theoretical advantages in SNR scaling, cannot outperform mMIMO setups of similar size in terms of SNR under practical conditions. Furthermore, it quantitatively determines how much larger an IRS needs to be compared to an mMIMO system to achieve comparable SNR, emphasizing the limitations of IRS in practical applications. An important insight from the study is that optimized IRS configurations can significantly outperform traditional models by more effectively manipulating incoming signals. This suggests new potential for using IRS technology in enhancing wireless communication systems.

The study concludes with practical guidance for network designers and engineers, stressing the need to consider array size and specific operating conditions—near-Field versus far-field—when deploying advanced antenna systems. These findings are

crucial as they provide a more nuanced understanding of how different technologies perform under a variety of conditions and help guide the design and optimization of future wireless networks.

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Load Frequency Control Stability utilizing a GA-PID Controller
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Abstract: Load Frequency Control (LFC) assumes a pivotal role in the preservation of frequency regulation within electrical power systems. The significance of Load Frequency Control in electrical power systems is paramount to ensure the delivery of reliable electrical energy of high quality. In numerous industrial applications, the operational velocity of machinery is contingent upon the frequency of the system. Any deviations from optimal conditions can precipitate system malfunctions. Load Frequency Control (LFC) serves to reestablish equilibrium between load demands and power generation within each control region through the deployment of speed controllers. Consequently, frequency regulation emerges as a critical concern in power systems. The primary objective of LFC is to mitigate transient deviations and achieve a steady-state error of zero. This paper delineates a comparative analysis of two distinct methodologies for tuning PID controllers. The initial approach involves the formulation of a classical controller through the Ziegler and Nichols methodology, while the alternative approach entails the design of a controller informed by genetic algorithms. It has been observed that the controller based on Genetic Algorithms effectively diminishes the error constant, rise time, and settling time. Based on the findings derived from simulations conducted in the Matlab/Simulink environment, it can be concluded that the PID coefficients adjusted through the application of the genetic algorithm yield superior closed-loop performance in comparison to the Ziegler and Nichols methodology. Furthermore, an analysis of the set point tracking and load disturbances for the proposed

GA-based PID controller was conducted, revealing its enhanced capability for disturbance rejection and its resilience to load variations.

Keywords: Ziegler-Nichols method, the mean squared error (MSE), PID Controller, and genetic algorithm (GA).

1. Introduction

Despite the widespread adoption of the Proportional-Integral-Derivative (PID) controller within the realm of industrial applications, the configuration of its parameters frequently relies on heuristic methods or manual adjustments in conventional control systems.

Therefore, it is not possible to find the most effective function that will capture all design objectives with different characteristics under different processes and disturbances [1-2]. We know that the dynamic and extraordinary demands of the energy system will never stop as consumer loads and industry demand changes. Therefore, income to The Fuel inlet to a turbo generator or the water inlet to a hydroelectric generator must be properly controlled, otherwise variations in engine speed may occur and thus undesirable changes in the performance of the drive system may occur. In fact, you can change a condition such as zero, but in practice this is not possible. Therefore, in most cases there are acceptable deviation limits form. Large changes in conditions produce a negative impact on the consumer and can cause major damage to the factory equipment. Today, all systems are naturally interconnected. Therefore, it is very difficult to keep the frequency constant. Nowadays The inefficiency of manual commands in a large network system leads to the need for automation systems that solve several problems such as communication delays [1-3].

Variability in frequency necessitates the development of a control system that is fundamentally robust and exhibits a high degree of flexibility. It is widely acknowledged that over 90% of industrial applications continue to employ PID controllers owing to their straightforwardness, transparent performance metrics, and user-friendliness. Nevertheless, numerous practitioners have highlighted that the conventional PID controller fails to meet satisfactory performance standards. Therefore, Genetic Algorithm (GA), H-infinity, Feedback Theory (QFT), Linear Matrix Inequality (LMI) etc. and Advanced control techniques and such that as at first glance, it seemed that this technique was superior to other PID design, but it later turned out that these controllers were complex and faced robustness issues in the

environment. The widespread use of PIDs and inaccuracies in the control system caused researchers to feel the need to combine the simplicity of PID controllers with the artificial intelligence [4]. It has been shown that such a controller provides good performance in situations such as measurement uncertainty and rejection. In case of disturbances and unstable behavior. The primary objective of this paper is to ascertain the optimal values of (K_p , K_i , and K_d) for PID control within the context of load frequency control (LFC) employing the Genetic Algorithm-PID (GA-PID) Controller. This paper is systematically organized into distinct sections as follows: the preceding section serves as an introduction to the problem at hand as well as the control systems that will be utilized throughout this study, while Section 2 delineates the model of the LFC for a singular area power system. Section 3 is dedicated to an exploration of the conventional PID controller, including its tuning process via the Ziegler-Nichols methodology. A succinct overview of the genetic algorithm is provided in Section 4. In Section 5, a simulation is conducted to illustrate the efficacy of the closed-loop system utilizing both conventionally tuned PID controllers and those tuned via the GA approach. The concluding observations and suggestions for prospective research endeavors are articulated in Section 6.

2. MODEL OF LOAD FREQUENCY BASED ON DIAGRAM OF POWER SYSTEM PLANT:

The presence of multiple control areas within power systems, each possessing a singular control zone, can be viewed as an amalgamation of various power systems along with the unique challenges faced by each region, integrated with a specific control architecture. Figure 1 illustrates a singular zone represented through a block diagram of a power system. Within this framework, a regulator is tasked with managing the speed of the synchronous generator in tandem with load demand. The variation in load P_d , the time constant associated with the speed regulator T_g , the time constant for the inlet valve T_t , as well as the inertia constant denoted in seconds T_L , and R represents the speed regulation coefficient. The system is depicted as continuously functioning under equilibrium conditions as illustrated in Figure 1.

The alterations in system parameters are considered negligible. Disruptions to the system, resulting from perturbations in the balance

of power associated with load p_d , incite modifications in both the speed and the power output generated.

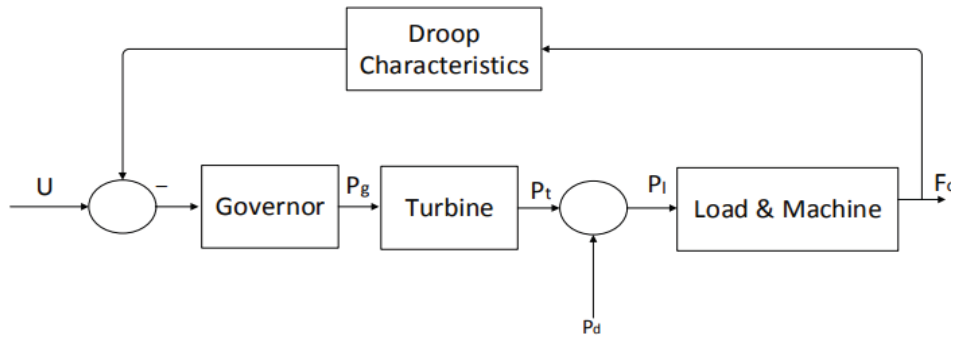


Fig 1- A single area of power generation system with droop characteristics

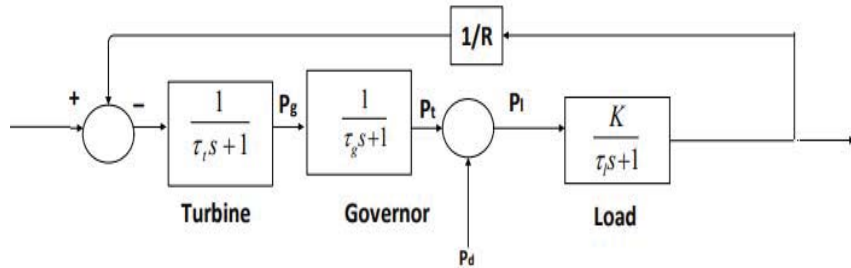


Figure 2- Transfer function model of the LFC for a single area power generation system.

There exist three distinct categories of turbines characterized by the absence of droop properties.

Governor with Dynamics

$$G_g = \frac{1}{1 + t_g s} \quad (1)$$

Turbine with Dynamics

$$G_T(s) = \frac{1}{1 + t_T s} \quad (2)$$

Load and Machine with dynamics:

$$G_l(s) = \frac{K_l}{1 + t_l s} \quad (3)$$

$1/R$ denotes the droop characteristics, which constitutes a form of feedback gain designed to enhance the damping attributes of the power system.

Non-Reheated Turbine

The transfer function in an open-loop configuration, devoid of the droop characteristic pertinent to load frequency control (LFC), is as follows: [4]

$$P(S) = G_g(s)G_T(s)G_l(S) \quad (4)$$

$$P(s) = \frac{K_l}{(1+t_g s)(1+t_T s)(1+t_l s)} \quad (5)$$

$$P(S) = \frac{120}{(1 + 0.08S)(1 + 0.3S)(1 + 20S)} \quad (7)$$

The feedback gain implemented in power systems is referred to as droop characteristics, and it serves to enhance the damping attributes of the power system, typically denoted as $1/R$, and is integrated prior to the design of load frequency control (LFC). Consequently, there exist two methodologies for the design of LFC.

The open-loop transfer function incorporating the droop characteristic of load frequency control (LFC) is [4]:

$$P(S) = \frac{G_g G_t G_p}{1 + G_g G_t G_p \backslash R}$$

(8)

$P(S)$

$$= \frac{K_p}{T_p T_t T_g S^3 + (T_p T_t + T_t T_g + T_p T_g) S^2 + (T_p + T_t + T_g) S + (1 + K_p |R)}$$

Table 1: The nominal parameters value of one area power system [4].

Parameters	Symbol	Value
(Proportional gain constant)	K_p	120
the coefficient of speed regulation	R	2.4
(Time constant of the power generator)	T_g	0.08
(Time constant of the power turbine)	T_t	0.03
(Power system time constant)	T_p	20

Numerically the transfer function become

$$P(S) = \frac{120}{0.48S^3 + 7.624S^2 + 20.38S + 51} \quad (10)$$

$$P(S) = \frac{250}{S^3 + 15.883S^2 + 42.458S + 106.25} \quad (11)$$

3- Tuning of PID Controller Utilizing the Ziegler-Nichols Method

This segment exclusively elaborates on the Ziegler-Nichols methodology for PID control. The application of erroneous control parameters may lead to suboptimal performance or, in extreme cases, instability within the operating system. Consequently, it is imperative to fine-tune the controller's parameters to attain an acceptable level of performance. The tuning process necessitates the identification of the most favorable values for k_c , T_i , and T_d (in instances where the PID algorithm is implemented) [6]. This procedure often embodies a degree of subjectivity and significantly hinges upon the specific process in question. The Ziegler-Nichols method is widely regarded as the most prevalent approach for the integration of PID controllers. The methodology is straightforward. Initially, configure the controller to operate solely in proportional (P) mode. Subsequently, adjust the controller gain (k_c) to a minimal level. Execute minor modifications to the setpoint (or load) and monitor the corresponding response of the control variable. In scenarios where k_c is minimal, the system's response is anticipated to be sluggish. Proceed to double the value of k_c and implement another slight adjustment in position or load. Continue this process of incrementally doubling k_c until oscillations become evident. Following this, fine-tune K_c until a consistent solution is established; this phase is referred to as the final victory.

It is crucial to observe the oscillation period (P_u). The requisite steps for this procedural undertaking are delineated below.

Initially, it is essential to set both the integral and derivative coefficients to zero. Gradually escalate the parameters from zero until the system reaches stability.

The relative coefficient within this framework is designated as the final profit K_u .

The period of oscillation during this phase is termed the final period P_u . K_u is defined as the gain of the system while P_u is calculated as $(2 * \pi) / W_{cg}$, and in this context, W_{cg} signifies a temporary advantage.

This is indicative of the inverse ratio of gain amplitude [7,8]. The audit rules are now accessible in Table 1 below as well as in the context of W_{cg} .

The PID gain value obtained subsequent to simulation is presented in Table II below.

Table2: Ziegler-Nichols Method Control law settings.

Controller	K_p	T_i	T_d
P	$\frac{K_u}{2}$		
PI	$\frac{K_u}{2.2}$	$\frac{P_u}{1.2}$	
PID	$\frac{K_u}{1.7}$	$\frac{P_u}{2}$	$\frac{P_u}{8}$

3- Overview of Genetic Algorithm

The Genetic Algorithm constitutes a heuristic search technique that emulates the principles of genetic evolution within a computational model. Its applicability extends to a diverse array of problem-solving scenarios. In this study, a genetic algorithm is employed to ascertain the optimal parameters for the proportional-integral-derivative (PID) controller, specifically tailored for linear load management in electrical power systems. This approach contributes to the enhancement of the system's transient response characteristics. The evaluation of performance is conducted through the application of a fitness function. Fundamentally, the genetic algorithm encompasses three primary phases: selection, crossover, and mutation. The implementation of these three methodologies facilitates the generation of new individuals that exhibit advantageous traits inherited from their predecessors. This algorithm has been iteratively applied across numerous generations, ultimately culminating when it was determined that this represented the most effective resolution to the identified problem. [8,15,16]. The gain parameters of the PID controller across varying load conditions and operational

speeds are computed utilizing the aforementioned algorithm, as illustrated in Figure 3.

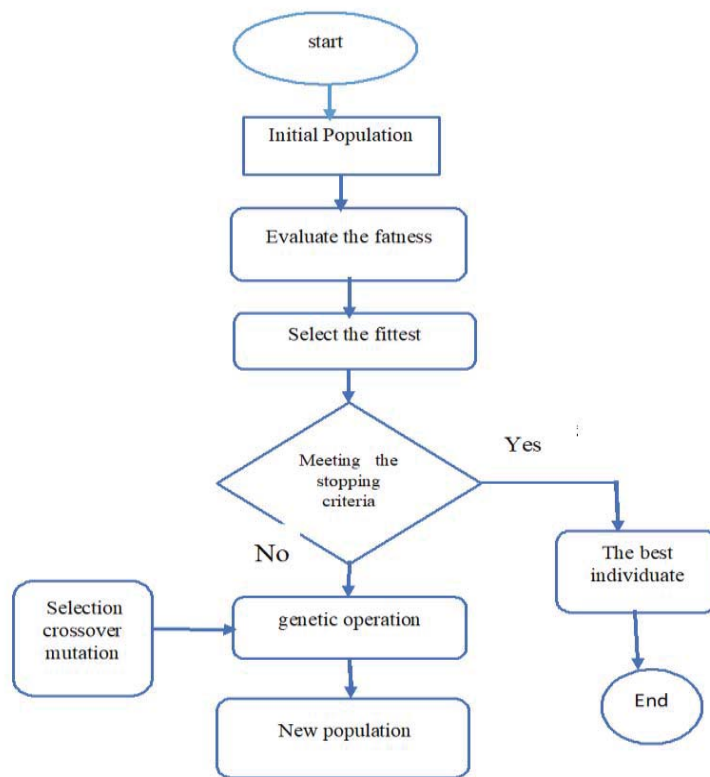


Fig 3: Genetic Algorithms Architecture.

Step -1: Initial Population: The preliminary phase of the genetic algorithm involves the establishment of the initial population, which encompasses the potential solutions pertinent to the specified problem.

Step -2: Evaluate the fitness: During this phase, the fitness level of each individual is assessed. The individuals, representing the possible solutions, are subsequently ranked according to their fitness values.

Step -3: Genetic Operation: The genetic operations adhere to the principles of natural selection. This process comprises three fundamental operations aimed at generating a new population to identify the optimal solution:

1-Selection: In this phase, the individuals (chromosomes) are chosen from the initial population for subsequent processing. The critical inquiry pertains to the methodology utilized for the selection of chromosomes. In accordance with Darwinian principles, the most fit individuals are posited to survive and

propagate new individuals (solutions). Typically, individuals exhibiting elevated fitness values are designated as the parents for the crossover process.

2- Crossover: The crossover operation entails the amalgamation of two selected parents to yield offspring (new solutions). This mechanism serves as a method for generating novel solutions derived from existing solutions. The occurrence of crossover is contingent upon a predetermined crossover probability.

3- Mutation: Following the crossover phase, mutation occurs. Mutation refers to the alteration of bits in the offspring of the individuals, specifically transitioning from 0 to 1 or from 1 to 0. The mutation process involves the random flipping of bits based on a minimal mutation probability.

Subsequently, the process reverts to Step 2 to reassess the fitness. This iterative procedure continues until the established stopping criteria are fulfilled.

The execution of the tuning procedure via genetic algorithms commences with the delineation of chromosome representation; the chromosome is constituted by three

values that correspond to the three gains necessitating adjustment to attain satisfactory performance.

The gains K_p , K_i , and K_d are represented as real numbers and are instrumental in characterizing the individual under evaluation; the adjustment of these three gains is essential for achieving satisfactory performance.

In this manuscript, the genetic algorithm (GA) is employed to ascertain the optimal values (K_p , K_i , and K_d) for the GA controller. The performance indices, specifically the mean squared error (MSE) defined as follows (Eq.12), are conventionally utilized for the optimal tuning of controllers [16,17]. This objective function is:

The Mean of the Squared Error (MSE)

$$MSE = \int_0^t e(t)dt \quad (12)$$

Where t and $e(t)$ represent, respectively, the temporal duration of the actuating signal, which is calculated as the disparity between the reference signal and the resultant output.

4- Simulation Results

In this section the Load frequency control presented by equation (11) is controlled by a Classical Ziegler-Nichols tuned PID controller and GA-based PID Controller tuning method. This section is divided into three parts A, B, and C. In part (A) the classical Z-N tuned PID controller is used, whereas GA based PID Controller tuning method uses the MSE performance indices outlined in part (B). In part(C) the simulation results are discussed. In all simulation results the reference signal is assumed to be a unit step signal.

A. Classical Ziegler-Nichols Tuned PID Controller

This segment employs a traditional Ziegler-Nichols controller. The PID gain parameters determined through this methodology are presented in Table 3. The step response of the closed-loop system is illustrated in Figure (4a), while the Bode plot response is depicted in Figure 4b.

Table 3 Controller gain parameters

Gain Coefficients	T_D	K_P	T_I
Values	0.121	1.354	0.485

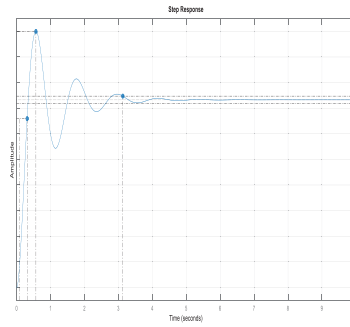


Fig.4a: Response of the system with conventionally tuned PID controller.

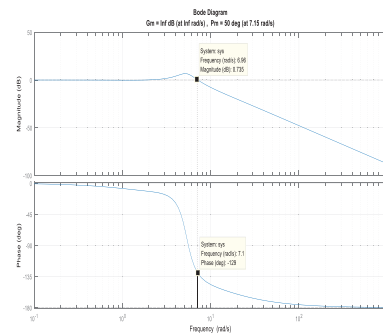


Fig.4b: Gain margin and phase margin response utilizing Z-N tuned PID controller.

B - The tuning methodology for PID controllers based on Genetic Algorithm (GA) utilizing (MSE) performance indices.

In this segment, simulations were conducted to examine the influence of the MSE performance metric on the behavior of the closed-loop system.

The parameters of the proposed GA approach employing performance

GA property	Value / Method
Population size	80
Function of fitness	MSE
Selection method	Geometric Selection
Crossover rate	Arithmetic
N. of crossover points	0.5
Mutation rate	Uniform Mutation
Mutation probability	0.1

indices are delineated in Table I.

Table 4: Parameters of GA

The output characteristics of the Genetic Algorithm (GA) optimized Proportional-Integral-Derivative (PID) controller utilizing the Mean Squared Error (MSE) methodology are illustrated in Fig.5a along with the parameters of the GA-derived PID controller, specifically: $K_d = 0.11768$, $K_p = 0.29362$, and $K_i = 0.9672$, as depicted in Figure 5a. Conversely, the gain margin and phase margin are presented in Figure 5b.

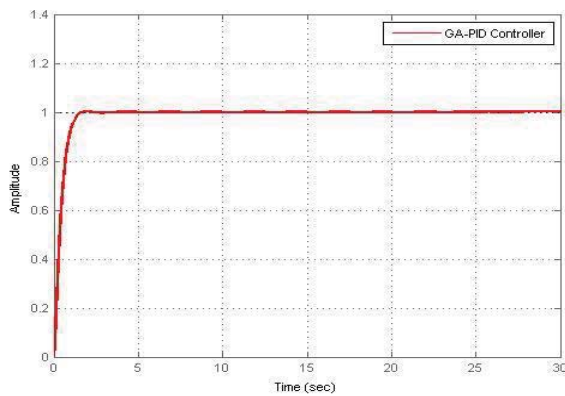


Fig.5a: GA- utilizing PID using MSE method response.

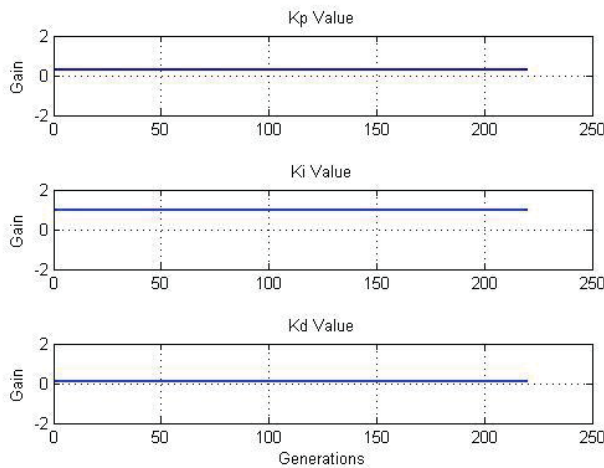


Fig. 5b: Convergence graph of the PID gains value in the GA method.

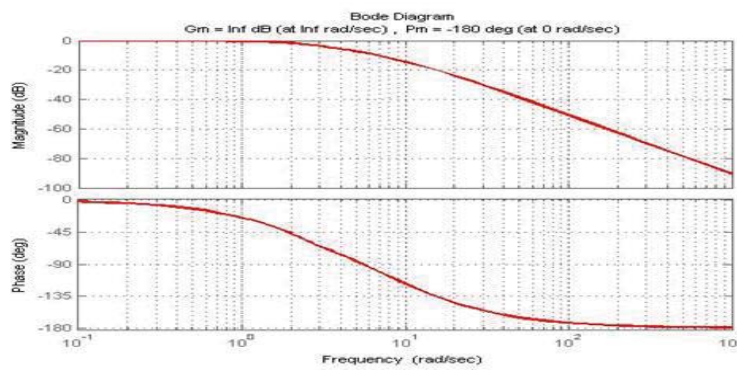
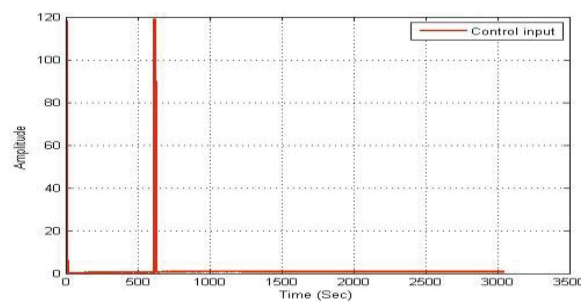


Fig.5c: Gain margin and phase margin response

- **Investigating the effect of set point changes on the performance using GA-based PID controller.**

From Figure (6.a) and (8.b), the tracking of the PID controller could be observed as acceptable, and the PID controller responds very well.

Figure 6 a : : Change the reference input response of the system by utilizing the



GA-PID.

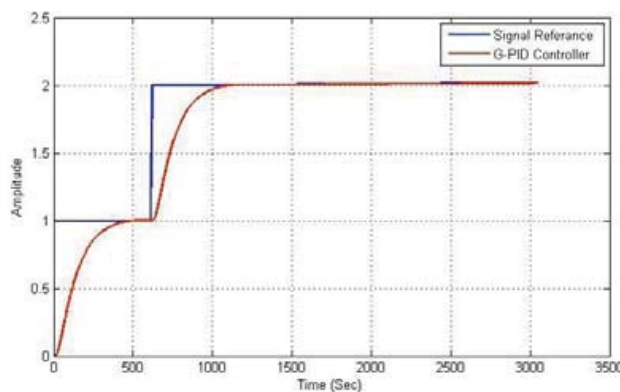


Figure 6c: control input Signal of GA- utilizing PID Controller

- **Investigating the effect of load disturbance on the performance utilizing GA-based PID controller**

To examine the efficacy of the implemented PID controller in mitigating the prevailing disturbances (The assessment of these controllers was conducted under various disturbances and parameter fluctuations, in conjunction with the inherent nonlinearity of the system, abrupt changes, etc.).

Load variations were introduced at distinct intervals. Figures (7.a), (7.b), (7a), and (7b) demonstrate that the PID controller has successfully managed to counteract the introduced disturbances while simultaneously attenuating the overshoots within a judicious timeframe

Figure 7b: Control input of GA-

Fig.7a load change Rejection of Control input of GA - utilizing PID Controller

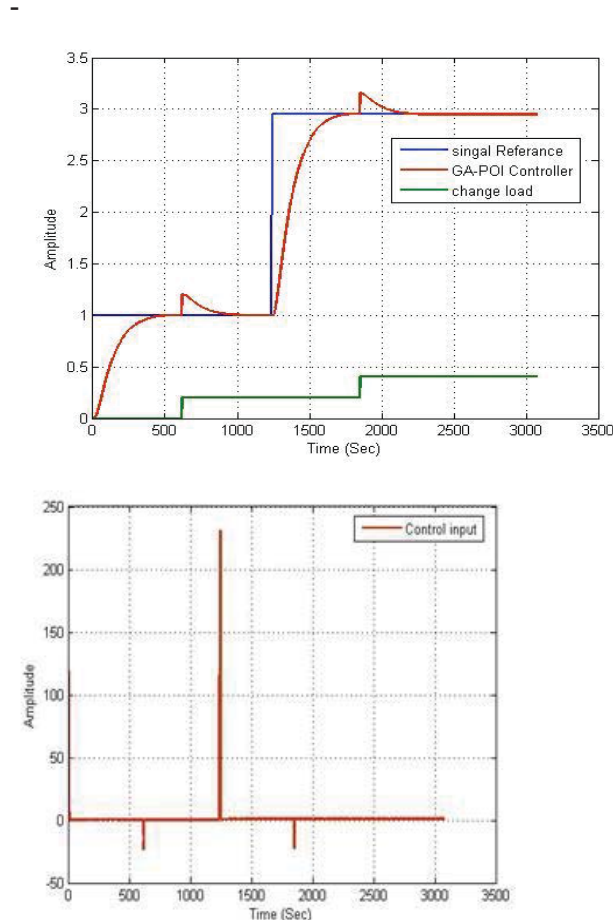


Figure 7b: Control input of GA- Controller

C. Analysis of the Simulation Result

The data presented in Fig. 4a and Fig. 5a indicates that the deployment of a conventionally tuned PID controller fails to yield precise results;

however, the appropriately optimized gain values for the controller are achieved through the implementation of a (GA) based PID controller. A comparative analysis of the results is provided.

Table 4. Comparison of results Parameters

Parameters	K_p	K_i	K_d	t_s (Sec)	t_r (sec)	Op%	G M	PM deg
Z-N							inf	
GA	0.2936 2	0.967 2	0.1176 8	1.3 1	0.8 1	0.27 6	inf	180deg

5- CONCLUSIONS

The proposed model was executed within the MATLAB/Simulink framework (environment). The calibration of the three parameters K_p , K_i , and K_d of the Proportional-Integral-Derivative (PID) controller is essential for optimizing performance in the regulation of load frequency within a power system. It is evident from the simulation outcomes presented in section (5) that the PID controller designed with Genetic Algorithm (GA) exhibits superior responsiveness compared to traditional methods. The classical approach provides valuable preliminary insight into the initial values of the PID parameters prior to deployment. It is apparent from the analysis that the GA-optimized PID controller significantly outperforms the conventional method regarding overshoot and settling time metrics. The results clearly indicate that this controller is capable of effectively managing set-point variations and mitigating step load disturbances to negligible levels. To further evaluate this controller design methodology, it is imperative to advance the concept of its implementation in real-time scenarios.

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THE EFFICIENCY OF PHYTOREMEDIATION IN NUTRIENT REDUCTIONS IN CHICKEN SLAUGHTERHOUSE WASTEWATER

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ABSTRACT: The direct release of wastewater is one of the factors contributing to the decades-long global crisis of various forms of water pollution. Because algae require a lot of carbon dioxide to undergo the phycoremediation process, which produces oxygen and glucose, they are a good answer to many environmental issues facing our planet, including global warming, ozone depletion, and climate change. Algae are adaptable to all situations and environments. In this study, the wastewater from chicken slaughterhouses (CSW) was naturally treated using microalgae to eliminate certain components, including Total Dissolved Solids (TDS), Sulphate (SO_4) and Magnesium (Mg) level in CSW effluent. The phycoremediation process was studied using different concentrations of CSW (0, 30, 50 and 100% CSW) for 19 days of the time period. Hence, the present results proved that the natural treatment of wastewater in chicken slaughterhouses was successful in reducing and removing the elements were studied in this research.

المخلص: إن الإطلاق المباشر لمياه الصرف الصحي هو أحد العوامل المساهمة في الأزمة العالمية التي استمرت لعقود من الزمان من أشكال مختلفة من تلوث المياه. ولأن الطحالب تتطلب الكثير من ثاني أكسيد الكربون للخضوع لعملية المعالجة النباتية، والتي تنتج الأكسجين والجلوكوز، فهي إجابة جيدة للعديد من القضايا البيئية التي تواجه كوكبنا، بما في ذلك الانحباس الحراري العالمي، واستنزاف الأوزون، وتغير المناخ. الطحالب قابلة للتكيف مع جميع المواقف والبيئات. في هذه الدراسة، تمت معالجة مياه الصرف الصحي من مسالخ الدجاج (CSW) بشكل طبيعي باستخدام الطحالب الدقيقة لإزالة مكونات معينة، بما في ذلك إجمالي المواد الصلبة الذائبة (TDS)، ومستوى الكبريتات (SO_4) والمغنيسيوم (Mg) في مياه الصرف الصحي (CSW). تمت دراسة عملية المعالجة النباتية باستخدام تراكيز مختلفة من مياه الصرف الصحي (0، 30، 50 و 100٪). لمدة 19 يوماً من الفترة الزمنية. وبالتالي، أثبتت النتائج الحالية أن المعالجة الطبيعية لمياه الصرف الصحي في مسالخ الدجاج كانت

ناجحة في تقليل وإزالة العناصر التي تمت دراستها في هذا البحث.

1. INTRODUCTION

A wide range of liquid wastes produced by operations involving the use of copious amounts of water are collectively referred to as wastewater.[1]. Wastewater characteristics depends on its sources [2]. Hence proved, It is commonly recognized that pollution from chicken slaughterhouses (CSW) can have detrimental effects on the removal of pollutant loads if they are not managed and stabilized. Wastewater contains nutrients, contaminants, and bacteria in the form of suspended or dissolved particles that pose a risk to human health due to their exposure to pathogenic microorganisms, which are also hazardous to the environment. Moreover, an overabundance of nutrients, particularly nitrogen and phosphorus, can harm the ecosystem, particularly marine and oceanic life.

Wastewater may also contain heavy metals that are harmful to human health and can be found in food chains in terrestrial and aquatic ecosystems [1]. Therefore, the improper treatment of CSW effluent before it is released into a river, lake, sea, or other body of water may increase the number of contaminants in the water and cause environmental issues. These issues may also have long-term effects on the availability of clean, safe water for bathing and drinking. In addition, the wastewater released from chicken slaughterhouses could contain sullage, which means it needs to be pre-treated before being dumped into an aquatic environment [1,3,7].

Additionally, the sources and wet market activity within the time and day had varying quantities and quality [8,9]. There are regulations all around the world for treating sewage, water runoff, wastewater, and industrial effluent. however, very few have been set forth specifically for wastewater treatment [2,3,5]. With all the information available on wastewater, these problems must be resolved before wastewater is released into the environment to guarantee that the pollutant loads comply with the local effluent standard [4].

Wastewater from chicken slaughterhouses (CSW) is high in nutrients including phosphate and nitrogen [5]. According to [6,7], There were feathers, blood, grease, and oil in CSW. Production capacity, animal species and weight, transportation techniques, animal reception and holding, processing technology, quantity of carcasses, washing temperature, cleaning and sanitizing protocol, and worker

behaviour were some of the factors that contributed to the nutrient variance of CSW [7].

Therefore, the goal of this research project is to examine the potential of microalgae in the application of wastewater treatment for CSW in order to reduce the load of contaminants. Live microalgae are used in the research as a treatment for CSW. In addition, a lab experiment was carried out to investigate the microalgae's capacity for cultivation in ambient weather, its efficacy in treating wastewater, and its potential to reduce nutrient levels. In this study, CSW was treated with microalgae for TDS, SO_4 and Mg.

2.MATERIALS AND METHODS

2.1 CSW Collection

Chicken Slaughterhouses Wastewater (CSW) was obtained from a small and medium-sized business that processed chicken meat products in Zliten, Libya. The point before wastewater entered the perimeter drain was where the CSW was gathered. Three point-of-grab samplings were conducted continuously for three hours in order to choose the composite sample. The composite sample was subsequently created by combining the grab samples. Since this kind of sampling will represent the total amount of effluents the factory produces, it is necessary for this kind of wastewater [4].

The total dissolved solids (TDS), sulfate (SO_4), and magnesium (Mg) content of the chicken slaughterhouses wastewater sample were measured in accordance with APHA (2012) in order to estimate the removal percentage at the end of the phytoremediation process and to assess the potential of CSW as a medium for microalgae cultivation [10].

2.2 Experimental Setup

The natural water samples were utilized as the control medium in an experiment that was set up in a 1L Erlenmeyer flask holding 500 mL of CSW. To create three distinct concentrations, distilled water has been used to filter and dilute CSW samples (0%, 30%, 50%, and 100%).

A 10^6 cell/mL inoculum was applied to the microalgae. For 19 days, the phycoremediation process was carried out outside in direct sunlight (12/24). To avoid sedimentation, each flask was shaken four times a day [4].

2.3 microalgae Growth

Centrifugation at 4000 rpm for 5 minutes was used to extract the cell biomass from the culture medium in order to evaluate the growth of the

microalgae. A fixed volume of 10 mL aliquots was taken from the suspended solution and transferred to cuvettes. The optical density of the microalgae growth was estimated at 650 nm (OD₆₅₀) in a DR 6000 spectrophotometer (Janway, USA). Gillard's F\2 solution was used as the blank [4,8,9].

2.4 Nutrient Removal

The decrease in TDS, SO₄, and Mg was calculated using to Eq. 1 [1,4,8,9].

Removal Efficiency (%) =

$$\left(\frac{\text{Initial Conc.} - \text{Final Conc.}}{\text{Initial Conc.}} \right) 100 \% \quad \text{Eq. (1)}$$

3. RESULTS AND DISCUSSION

3.1 CSW Characteristics

To describe CSW samples, three parameters were examined. The World Health Organization's international criteria for wastewater disposal (2006) [11] were followed in the compare of these parameters. Table 1 displays the characteristics data for CSW.

Table 1: Features of CSW compared to effluent standards.

		Components (mg/L)		
		TDS	SO ₄	Mg
CSW conce.	0%	108	13	3
	30%	2840	190	485.6
	50%	6230	420	607
	100 %	8610	640	1456
WHO, (2006)		2500	1000	5.00

Note: CSW conce.: Chicken Slaughterhouses Wastewater concentrations

Noteworthy are the high TDS and Mg values of 2840-6230-8610 and 485.6-607-1456 mg/L for raw CSW with 30%, 50%, and 100% dilutions, respectively. On the other hand, SO₄ was below the 190, 420, and 640 mg/L effluent requirements, respectively.

When compared to the World Health Organization's worldwide

criteria for wastewater disposal (2006) [11], these TDS and Mg.

concentrations are greater. There may be a connection between the high TDS and Mg concentrations and the seasonal and geographic variations in organic compounds observed in CSW [1,4,9].

3.2 Growth of microalgae

Figure 1 shows the growth of microalgae at varying CSW concentrations (0%, 30%, 50%, and 100%).

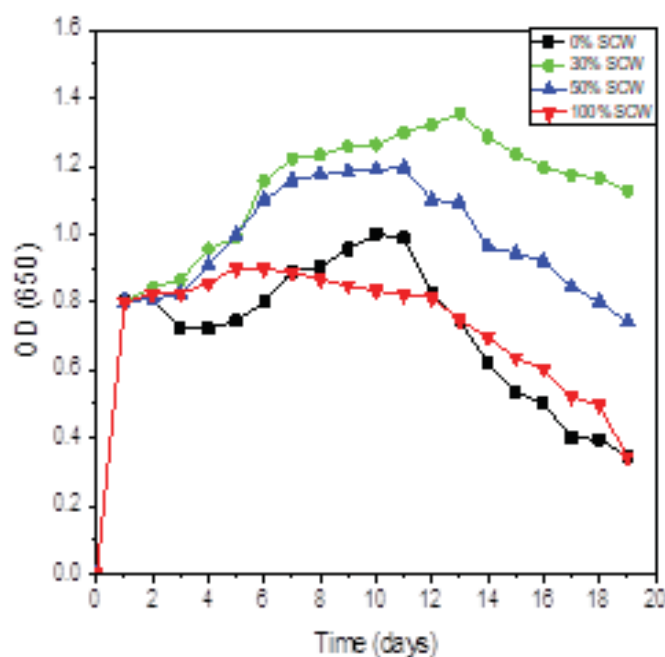


Fig. 1: Waves of microalgae culture within CSW during phycoremediation

On the thirteenth day of phycoremediation, the 30% concentration of CSW showed the highest growth rate. From day 1 to day 13, OD 650 climbed to 1.356, then on day 19, phycoremediation, it declined to 1.128. In a different course of action, current study's findings were consistent with those published by Mohamed, R. M. S. R., ed.al and Mohd Apandi., ed.al, N [4,9], who indicated that optimum microalgae growth was observed in 50% wet market wastewater and public market wastewater.

On days 9 and 5, respectively, the growth of microalgae in 0% and 100% CSW achieved the optimum values for plant treatment of 1.012 and 0.901; this behavior may be related to the low nutrient content of 0% CSW concentration or to the 100% CSW's high nutritional content, as indicated in Table 1. In another aspect, increased thereafter. In contrast, microalga growth rates in 50% CSW was 1.196 in day 11 and decreased in 19 to 0.743 of phycoremediation. These findings suggest that the CSW had high nutrient loads and that the dilution procedure ought to be carried out prior to the phycoremediation procedure. As a result, microalga can be successfully cultivated at various CSW concentrations.

3.2 Nutrient Removal Efficiency of microalga

In this discussion, the removal rates of TDS, SO₄, and Mg were utilized as indicators of the nutrients that the microalgae had eliminated. Table 2 and Figure 3 demonstrate how phycoremediation with microalgae reduced TDS levels by 40% in 30% CSW. Consequently, TDS levels dropped from 2840 mg/L to 1710 mg/L in 30% CSW. In contrast, TDS levels in the 0% CSW samples dropped by 11%, from 108 mg/L to 96 mg/L. The percentages of TDS removed in 50% and 100% CSW were 33% and 22%, respectively.

This outcome could be explained by the algae's negative growth rate [4,8,9]. Nonetheless, SO₄ result was 48% removal rate at 30% concentration of CSW. Particularly, during phycoremediation, SO₄ levels dropped from 190 mg/L to 98.12 mg/L. In the 0%, 50%, and 100% concentration of CSW, the corresponding SO₄ removal rates were roughly 22%, 43%, and 36%.

Mg dropped from 485.6 mg/L to 254.6 mg/L in 30% CSW. This reduction amounts to a 48% decrease. In the meantime, the percentages of Mg removal in 50% and 100% CSW were 35% and 29%, respectively. 0% concentration of CSW showed the lowest Mg removal rate, which saw a 23% drop in magnesium levels from 3 mg/L to 2.3 mg/L. The varying nutrient loads linked to varying CSW concentrations could be the cause of those occurrences.

All things considered, phycoremediation using microalgae eliminated TN, TP, and TOC from public market wastewater. *Scenedesmus sp.* Was able to extract TN, TP, and TOC from public market wastewater at rates of 73.01%, 76.77%, and 71.73%, respectively, according to a prior study by Apandi [12].

Table 2: Nutrient removal efficiency as a function of CSW concentration

CSW conce.	Int. conc. (mg/L)	F. conc. (mg/L)	Removal percentage (%)
TDS			
0 %	108	96	11
30 %	2840	1710	40
50 %	6230	4150	33
100 %	8610	6740	22
SO ₄			
0 %	13	10.1	22
30 %	190	98.12	48
50 %	420	240	43
100 %	640	410	36
Mg			
0 %	3	2.3	23
30 %	485.6	254.6	48

50 %	607	396.3	35
100 %	1456	1040	29

Note: Int. conc.: initial concentration and F. conc.: final concentration.

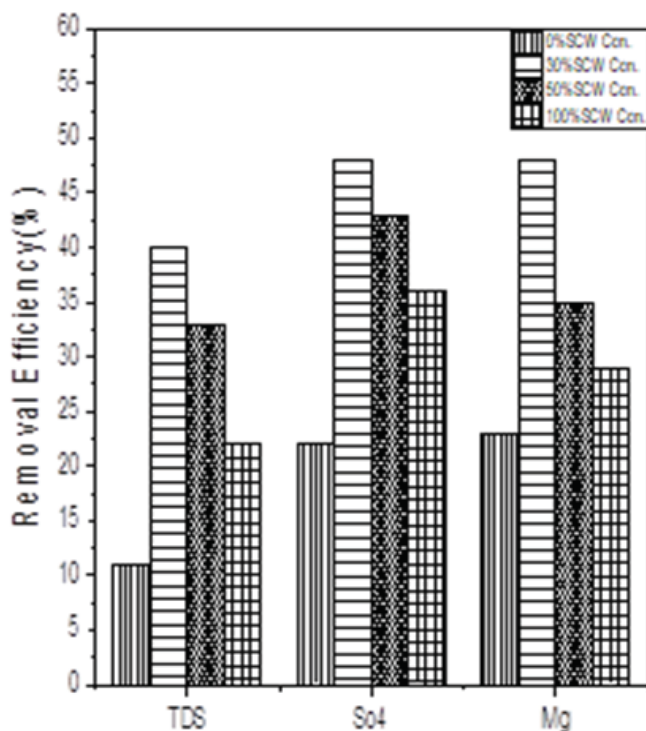


Fig. 2: Shows nutrient analysis the highest removal percentage of public market wastewater

4.CONCLUSION

The current study showed that the effectiveness of phycoremediation using microalgae to remove nutrients from wastewater is influenced by varying concentrations of CSW. Furthermore, on day 14 of phycoremediation, the 30% PMW showed the fastest growth rate. From day 1 to day 13, OD₆₅₀ climbed to 1.356, but on day 19 of phycoremediation, it dropped to 1.128.

30% CSW demonstrated the greatest rates of nutrient removal. Hence, for phycoremediation to be efficiently facilitated, the CSW concentration must remain lowest than than 30%. Additionally, the removal rates of TDS, SO₄, and Mg in 30% concentration of CSW were 40%, 48%, and 48%, consecutively. Wastewater from chicken slaughterhouses can be utilized as a substitute medium for microalgae culture.

In summary, the most effective biological wastewater treatment method is phycoremediation with microalgae, which also yields valuable information for future researchers.

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Joint performance in jointed concrete pavements with focus on dowel and aggregate interlock interaction under various traffic loads

SHABAN SALEM

المخلص

تناول هذا البحث كفاءة الوصلات في الأرصفة الخرسانية المفصليّة، مع التركيز على سلوك الوصلات، وضغوط التلامس بين الأوتاد والخرسانة المحيطة في الرصف الخرساني المفصلي بسبب أحمال العجلات و ذلك لتقييم نموذج غير خطي لتعشيق الركّام المقدم بواسطة باحث سابقون، والذي تم دمجّه في برنامج EverFe، ومقارنة النتائج مع نتائج نماذج خطية لتعشيق الركّام ونتائج الدراسات المعملية السابقة. تعتمد المنهجية على المحاكاة العددية من خلال تطوير نماذج العناصر المحدودة لكل من الأوتاد و تعشيق الركّام. لقد تبين أن نمذجة العلاقة السابقة لآلية التعشيق في الركّام لم تكن دقيقة، خاصة بالنسبة للركّام الخشن الأصغر حجماً المستخدم في الرصف الخرساني. تم اقتراح نموذج غير خطي جديد لتعشيق الركّام، بحيث يلتقط سلوك التعشيق للركّام على طول سطح التشقق. بالإضافة إلى دراسة الاختلافات في استجابة الرصف للأحمال الساكنة والمرورية من خلال قيم الهبوط عبر وصلات الرصف. النتائج المتحصّل عليها أوضحت تباين ملحوظ في القيم بين النموذجين. النتائج المتحصّل عليها باستخدام طريقة العناصر المحدودة أعطت مقارنة جيدة مع نتائج معملية سابقة. تم تحقيق إمكانية تمثيل قيم الهبوط بصورة ممتازة لمجموعة واسعة من عروض الشقوق والركّام الخرساني الخشن.

ABSTRACT

This paper conducts a finite element analysis of jointed concrete pavements, focusing on dowels and aggregate interlock mechanism. Jointed concrete pavements rely on the effective performance of joints to ensure longevity and structural integrity. A primary objective was to investigate existing methods for modeling the shear transfer efficiency of aggregate interlock, including a nonlinear model introduced by Jensen & Hansen, which was integrated into EverFe software. The findings were then compared with linear models and previous experimental data. It was determined that the previously established relationship for modeling aggregate interlock was inadequate, particularly for smaller coarse aggregates used in concrete pavement construction. A new nonlinear model for aggregate interlock was proposed to accurately reflect the behavior at cracked surfaces. The results revealed noticeable differences between the two models at higher crack widths. The analytical results compared well with previous experimental results.

Keywords: aggregate interlock; dowel, concrete; crack; shear; displacement

1 Introduction

Joints and transverse cracks represent weak areas in concrete slabs-on-grade. Generally, joints are equipped with dowels to ensure effective shear load transfer, which is essential for mitigating issues related to pumping, such as faulting and spalling. Transverse cracks occur in jointed reinforced concrete pavements, where the design relies partially on the interlocking of aggregates to facilitate shear load transfer across the crack surfaces (Raja and Snyder, 1991). The extent of crack opening, along with the shearing and frictional characteristics of the aggregate particles along the crack interface, significantly influences the effectiveness of aggregate interlock. Furthermore, the transfer of shear loads through aggregate interlock is contingent upon several factors, including the type and size of the aggregate, the tortuosity of the crack, the strength and stiffness of the concrete, the area of the cracked cross-section, boundary conditions, the magnitude of the load, and the frequency of load repetitions [1].

The main objective of this paper is to investigate the contribution of aggregate interlock model to the joint load transfer using the free software EverFE program [12]. The scope of this paper is:

- Evaluate the joint behavior in terms of shear displacement and shear force transfer across the joint with varying openings as well as with and without dowels
 - Linear load transfer model
 - Nonlinear aggregate interlock models
 - Linear model incorporated in the EverFE material library
 - Bilinear nonlinear aggregate interlock model
- Compare the numerical results with available field and laboratory data.

2 Literature Review

2.1 Load Transfer Efficiency

Load transfer efficiency LTE in cracks and joints is the most important factor that affects the performance of rigid pavement. 1. The occurrence of corner cracking and significant faulting in jointed concrete can result in inadequate load transfer efficiency (LTE). When

traffic loads are applied close to a joint in Portland Cement Concrete pavement, both the loaded and unloaded slabs experience deflection. This is due to the fact that a portion of the load on the loaded slab is transmitted to the unloaded slab. Consequently, the deflections and stresses in the loaded slab are considerably lower than what would be observed if the load were applied at a free edge [10]. The LTE of a joint or a crack is established by calculating the deflection ratio across the joint between loaded and unloaded slab. The following equations are used to calculate the LTE:

$$LTE = \frac{2d_u}{d_i + d_u} * 100$$
$$LTE = \frac{d_u}{d_i} * 100$$

Or in terms of stresses

$$LTE = \frac{\sigma_u}{\sigma_i} * 100$$

Where d_u , σ_u is the vertical displacement and stress of the unloaded slab, while d_i , σ_i represent the vertical displacement and stress of the loaded slab. The deflections for both the loaded and unloaded slabs are determined at a distance of 150 mm from the joint. The second equation, utilized by Jensen and Hansen, is frequently employed to calculate the Load Transfer Efficiency (LTE).

2.2 Aggregate Interlock Mechanism

In the early of 1900s, when the Portland cement concrete has first used as a paving material, the aggregate interlock was considered as an important load transfer mechanism. The loads across the joints and cracks in the rigid pavements transferring by the aggregate interlock mechanism. In the aggregate interlock mechanism the only active operative is the shear action. In contrast, load transfer devices such as dowel bars also involve bending, thus creating an interest to investigate load transfer by aggregate interlock. Many factors can affect the aggregate interlock mechanism such as, crack opening, coarse aggregate gradation, loads, and slab thickness. [4]

2.3 Factors Affecting the Aggregate Interlock Mechanism

Several factors influence the efficiency and durability of aggregate interlock as a load transfer mechanism such as, crack width and surface. The texture of the surface at the crack is influenced by various factors associated with the fracture characteristics of concrete,

including angularity, gradation, and maximum aggregate size. These factors encompass the properties of the coarse aggregate..

2.4 Effect of Crack size on Aggregate Interlock

Many researchers have shown that the crack size is one of the most important parameters that controlling the aggregate interlocks effectiveness, such as (Benkelman, 1933), (Colley & Umphrey, 1967), (Walraven, 1981), (Raja & Snyder, 1995), and (Jensen & Hansen, 2006).

Three distinct stages of load transfer related to crack size have been identified by Jensen and Hansen. Stage one occurs when the crack width is less than 0.5mm. Stage two, occurs when the crack width between 0.5mm to 2.5mm. Stage three for the cracks larger than 2.5mm. In stage one the LTE always close to 100%. In stage two the aggregate interlock mechanism has the major effect on the load transfer efficiency. In stage three the LTE becomes smaller and the loads transferred by the foundation.

2.4.1 Gradation of Coarse Aggregate

The gradation of coarse aggregate significantly influences the aggregate interlock mechanism. Various researchers have examined how the gradation of coarse aggregate affects load transfer mechanisms and the roughness of cracks. Chupanit and Roesler investigated the impact of two types of coarse aggregate dense and open graded on crack surfaces and the fracture energy of concrete. Their findings indicated that the influence of gradation on surface texture is minimal, while the fracture energy of concrete with dense graded aggregate is lower than that of concrete containing open graded aggregate. This difference in fracture energy between the two gradations is associated with the aggregate interlock mechanism.

2.4.2 Max Aggregate size

The maximum size of the coarse aggregate significantly influences the roughness of the crack face. Research indicates that as the maximum size of the coarse aggregate increases, the roughness of the crack face also rises [6]. Concrete containing larger aggregate sizes tends to produce more intricate crack patterns, leading to rougher surfaces as the cracks navigate around the aggregates [5].

Many studies have been done on the effect of the maximum aggregate size on the aggregate interlock such as, (Nowlen, 1968), (Raja & Snyder, 1995), and (Jensen & Hansen, 2001). They found that the load transfer efficiency increases as the max aggregate size increases. The

study by Jensen & Hansen has shown the maximum shear displacement in the crack for the concrete contains hard aggregate is half the displacement for the concrete containing soft aggregate. Also, the predicted deflection based load transfer is 65 % and 88 % for the soft aggregate and hard aggregate concrete, respectively [1].

2.5 Aggregate Interlock Models

Many researchers have endeavored to model the aggregate interlock mechanism through various methodologies. The models pertaining to this mechanism can be categorized into two primary groups: those that rely on field investigations or laboratory experiments, and those that employ a physical approach to elucidate the crack mechanisms. This section will examine the foundational principles of several models utilized to depict the aggregate interlock mechanism.

2.5.1 Two-phase Model

Recently this model proposed by Walraven (1981) has been recognized as an applicable model for concrete highway and air field pavements. This model is developed through a statistical examination of the crack structure and the corresponding contact regions between the crack faces, which depend on factors such as crack width, shear displacement, and the composition of the concrete mixture. The aggregate particles penetrate the crack plane at different depths, influenced by their statistical distribution within the concrete matrix [10]. The stresses at the contact area are resolved into a stress normal to the contact area, σ_{pu} , and a stress tangential to the same area, τ_{pu} Figure (1). The stresses at the contact areas are connected by the circumstance that the contact surfaces are on the verge of sliding, and as a result:

$$\tau_{pu} = \mu \cdot \sigma_{pu}$$

Where μ is the coefficient of friction between the cement paste and the aggregate. Compute the projected contact areas A_x and A_y by using the deformed geometry the forces F_x and F_y required for equilibrium can be determined by using the following equations:

$$\sigma = \sigma_{pu}(A_x - \mu A_y)$$

$$\tau = \sigma_{pu}(A_y + \mu A_x)$$

The identification of the x and y projections relies on the statistical distribution of the aggregate within the concrete matrix, as well as the dimensions of the spherical aggregate particles that intersect the crack plane at specific tangential and normal displacements [2].

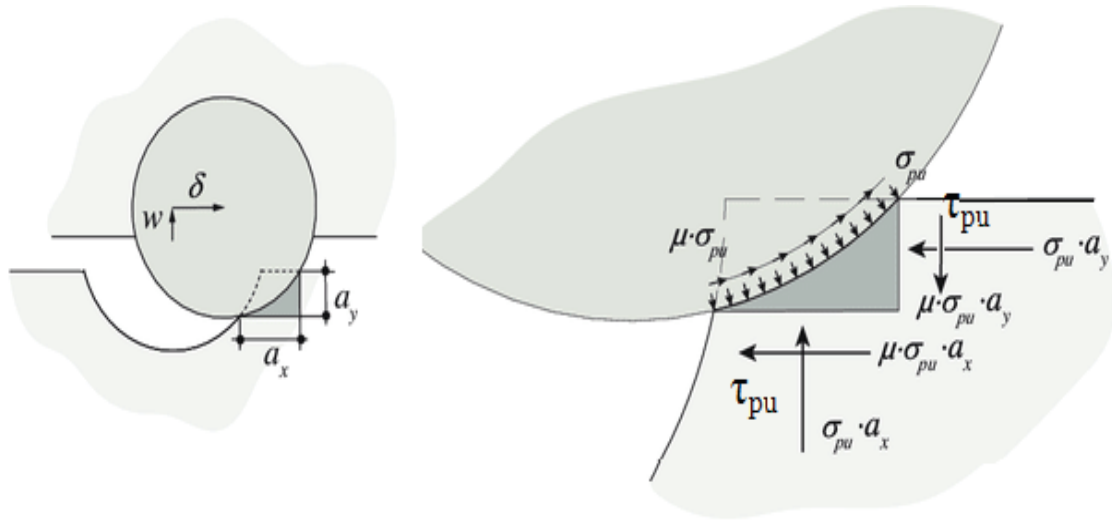


Figure (1) Stress conditions for the contact areas [6].

2.5.2 Jensen and Hansen model

1. Jensen and Hansen (2006) established an aggregate interlock model that utilizes a constitutive relationship to describe the interaction between shear stress and shear displacement at the crack. The quantification of aggregate interlock was achieved by optimizing the model to ensure the closest alignment between the measured data and the calculations produced by the EverFE program. For a specified crack width, w , the shear stress, τ_w , that is transferred can be determined as a function of the shear displacement, Δ , and is calculated as follows:

$$\tau_w = b_i + a_i \cdot \Delta$$

Where: a_i is the slope of the linear segments, and b_i is the intersection with shear stress axis as shown in Figure (2)

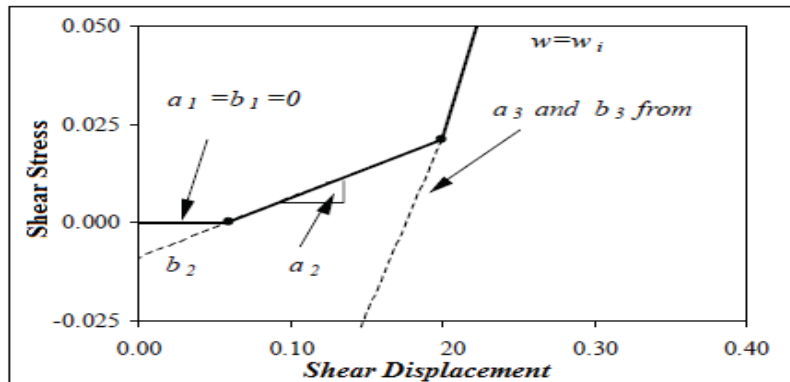


Figure (2) Schematic of aggregate interlock model [1].

3 Methodology

In the early 1900s the behavior of aggregate interlock model has been considered as a series of linear vertical springs that connect the two parts of slab, but in reality the behavior of aggregate interlock is nonlinear. The first modeling of nonlinear aggregate interlock was by Walraven 1981. This model has a deficiency to predict the shear displacement and does not distinguish between the rounded and fracture aggregates. A new aggregate interlock model was developed by (Jensen and Hansen, 2006) which depends on the shear stress and shear displacement that occur in crack.

3.1 Modeling

The modeling is to use the finite element methods for solving the problems that hard to solve by ordinary methods. This section will present the dowel modeling and aggregate interlock modeling used in the EverFE program.

3.1.1 Dowel modeling

The idea of this analysis is to find the max shear in the dowel for different values of pavement properties; as a result we can determine the variables that have the most influence on shear in the dowel. The slab system was modeled with 24 elements along the slab length, 12 elements along the slab width, and 2 over the thickness. 230 mm thick slabs with 9000 mm long and 4500 mm wide; the lengths of the loaded and unloaded slab elements were 4500 mm respectively, with a modulus of elasticity, $E = 28000$ MPa and Poisson ratio, $\nu = 0.2$. The dense liquid foundation was assumed to have a modulus of subgrade reaction of 0.03 MPa/mm.. Dowels are 25 mm diameter, the total number of dowels were 11 dowels spaced at 390 mm on center. The finite element model mesh using EverFe is shown in Figure (3). The properties of materials are shown in table (1).

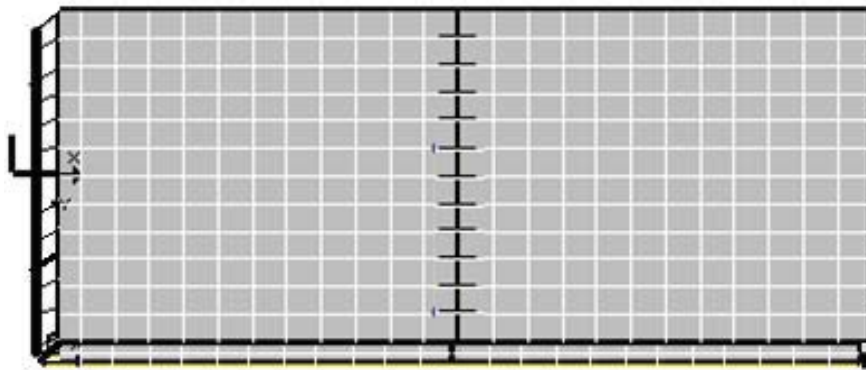


Figure (3) Finite element mesh used in dowel jointed pavement.

Table (1) Geometry and material properties used in the dowel

Parameter	Dimension (mm)	Elastic modulus (MPa)	Poisson ratio
Slab	9000 × 4500	28500	0.2
Load = 40 KN	100 × 100	-	-
Dowel	Diam. = 25	200000	0.3
Base	150	5000	0.2

analysis.

The modulus of subgrade reaction is 0.03 MPa/mm, and the dowel slab support modulus is 1000 MPa.

3.1.2 Aggregate interlock Modeling

The finite element model used in this study has the same slab dimensions and material properties assumed in the study conducted by Jensen and Hansen. The slab system was modeled with 20 elements along the slab length, 18 elements along the slab width, and 5 through its thickness. The slabs, measuring 250 mm in thickness, were 3000 mm in length and 1800 mm in width; the length of the loaded elements was 1650 mm, while the length of the unloaded elements was 1350 mm. The modulus of elasticity was set at $E = 33$ GPa, with a Poisson's ratio of $\nu = 0.15$. The dense liquid foundation was assumed to have a modulus of subgrade reaction of 0.046 MPa/mm. The dowels are 32 mm diameter, the total number of dowels were 8 dowels spaced at 200 mm on center. The finite element mesh used is shown in Figure (4). Table (2) provides a summary of the material properties assumed in this study. The objective of this analysis is to investigate the stresses and displacements along and across the crack joint, considering scenarios both with and without dowels, as well as for linear and nonlinear aggregate interlock models.

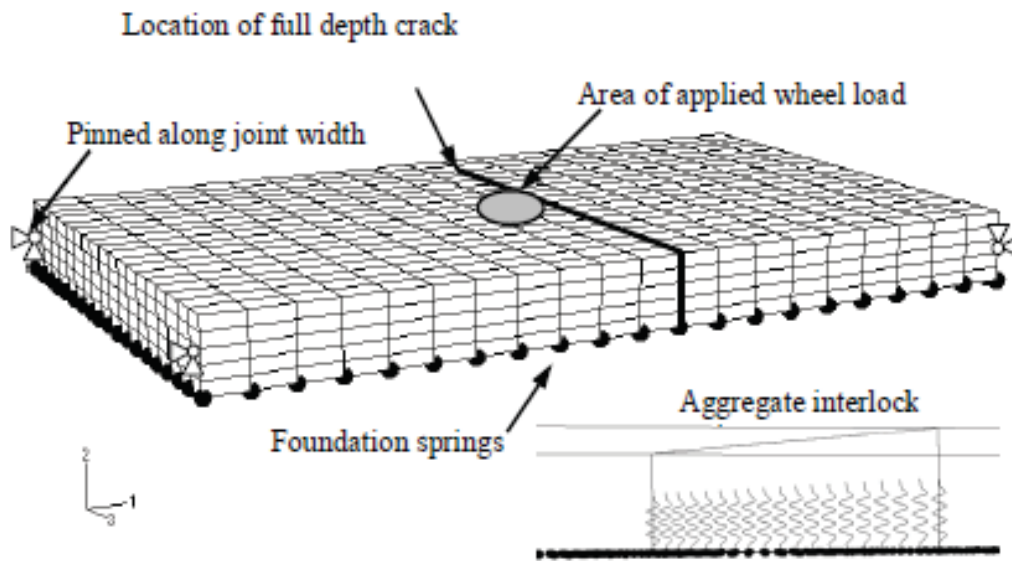


Figure (4) FE slab model with detail of aggregate interlock springs [1].

Table (2) Geometry and material and properties used in the aggregate interlock analysis.

Parameter	Dimension mm	Elastic modulus MPa	Poisson ratio
Slab	3000×1800	33000	0.15
Load = 40 KN	250×250	-	-
Dowel	Diam. = 32	200000	0.3
Base	100	5000	0.2
Sub base	300	200	0.2

The modulus of subgrade reaction is 0.046 MPa/mm, the dowel slab support modulus is 1000 MPa, and the joint stiffness is 0.2 MPa/mm.

4 Stresses in rigid pavements

4.1 stresses due to loading

Three methods can be employed to assess the stresses in concrete pavements: closed-form formulas, influence charts, and finite element methods. The formulas initially introduced by Westergaard are limited to a single wheel load with a contact area that is circular, semicircular, elliptical, or semielliptical. For configurations involving multiple wheel loads, the influence charts created by Pickett and Ray in 1951 are applicable. Both approaches are relevant solely to large slabs resting on a liquid foundation, which treats the subgrade as a

series of independent springs. This assumption is not entirely realistic, as it fails to accurately depict soil behavior; it was utilized in Westergaard's analysis primarily for its simplicity. A more accurate representation of a solid or layered foundation can be achieved using the EverFE Program, which is based on the finite element method [9]. The following tables summarize the results for the analysis of a rigid slab with different loading configurations and different slab dimensions for the center, edge, and corner loadings.

The slab system was modeled with 20 elements along the slab length, 20 elements along the slab width, and 2 over the thickness. The slabs are square with different dimension and 250mm thick, with a modulus of elasticity, E , of 28000 MPa, and $\nu = 0.15$. The modulus of subgrade reaction is 0.03 MPa/mm. For the Westergard's solution the load is a circular with 150mm radius. For the analysis of the axle loading, single wheel axle loading with a magnitude of 44.5 KN is applied.

The relationships between the loading area and the stress were drawn Figures (5, 6, and 7). For the center and edge loading there is a linear negative relation between the loading area and the maximum stresses as shown in the accompanying Figures (5, 6, and 7).

Also, there is a linear positive relationship between the slab area and the maximum stress, as we see in the table for the center loading case for the load 300 x 300 mm gives an increased stress value as the area of slab is increased.

Slab dim. mm	Load dim. mm	Max. stress MPa	3050 x 3050	2550 x 2550
3660 x 3660	355 x 355	0.976		
	300 x 300	1.011	0.983	0.935
	280 x 280	1.025		
	250 x 280	1.031		
	250 x 250	1.034		

Table (3) Analysis results for center loading.

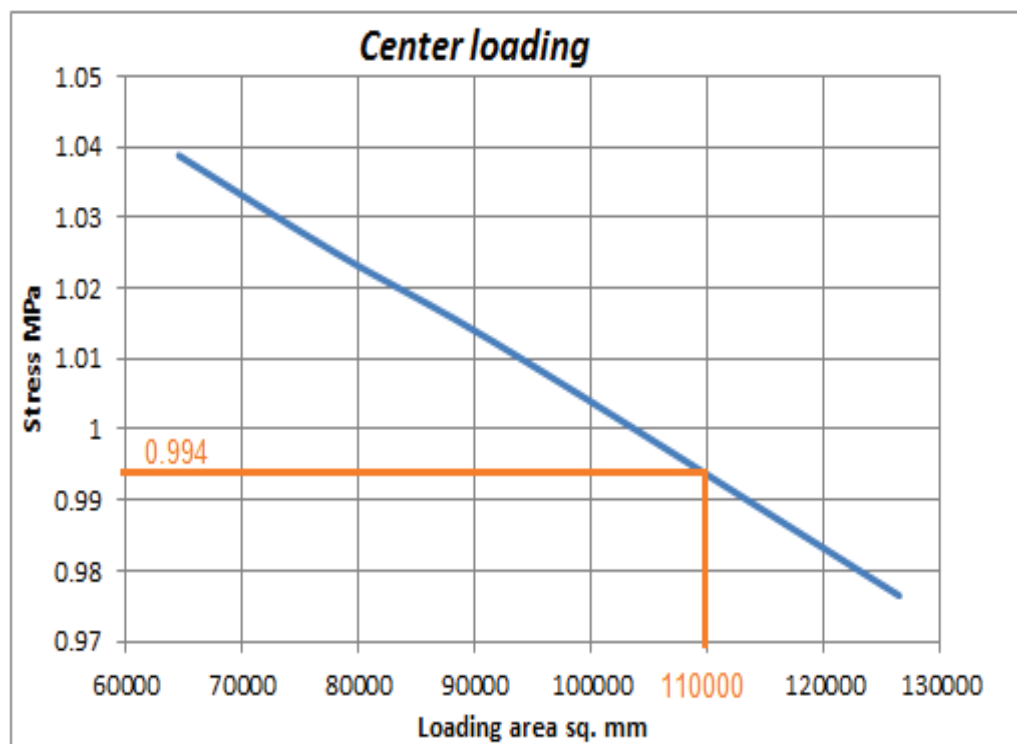
Table (4) Analysis results for edge loading.

Slab dim. mm	Load dim. mm	Max. stress MPa	3050 x 3050	2550 x 2550
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3660 x 3660	355 x 355	1.690		
	300 x 300	1.806	1.600	1.461
	280 x 280	1.849		
	250 x 280	1.897		
	250 x 250	1.911		

Table (5) Analysis results for corner loading.

Slab dim. mm	Load dim. mm	Max. stress MPa	3050 x 3050	2550 x 2550
3660 x 3660	355 x 355	1.288		
	300 x 300	1.392	1.343	1.226
	280 x 280	1.475		
	250 x 280	1.502		
	250 x 250	1.613		

**Figure (5) The relation between the loading area and the max stress for center loading.**

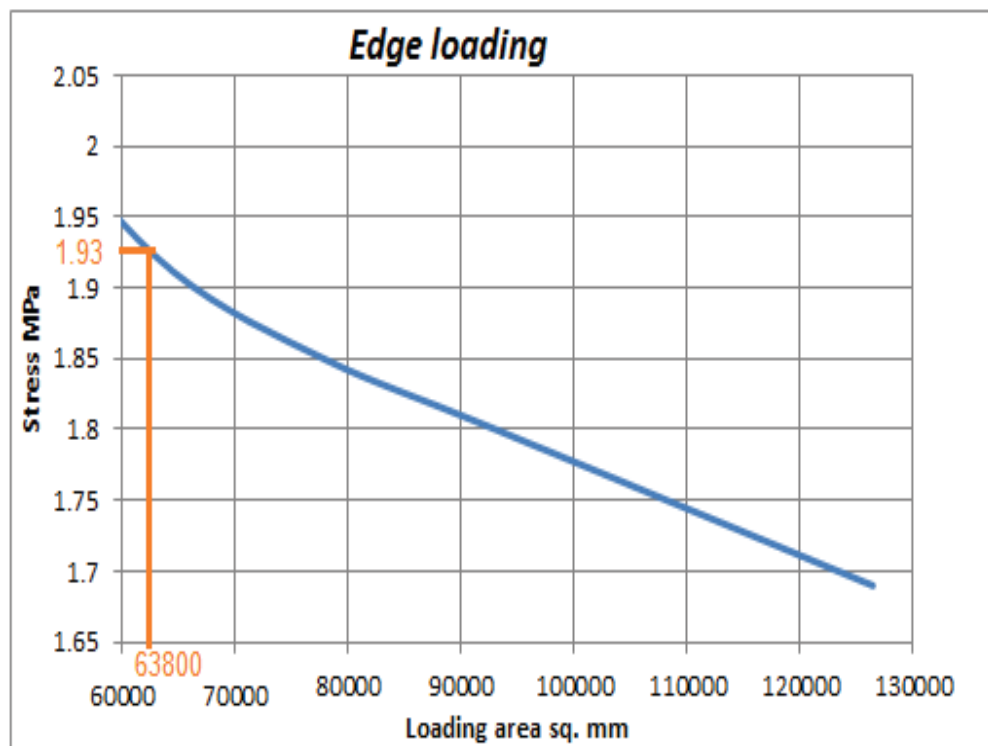


Figure (6) The relation between the loading area and the max stress for edge loading.

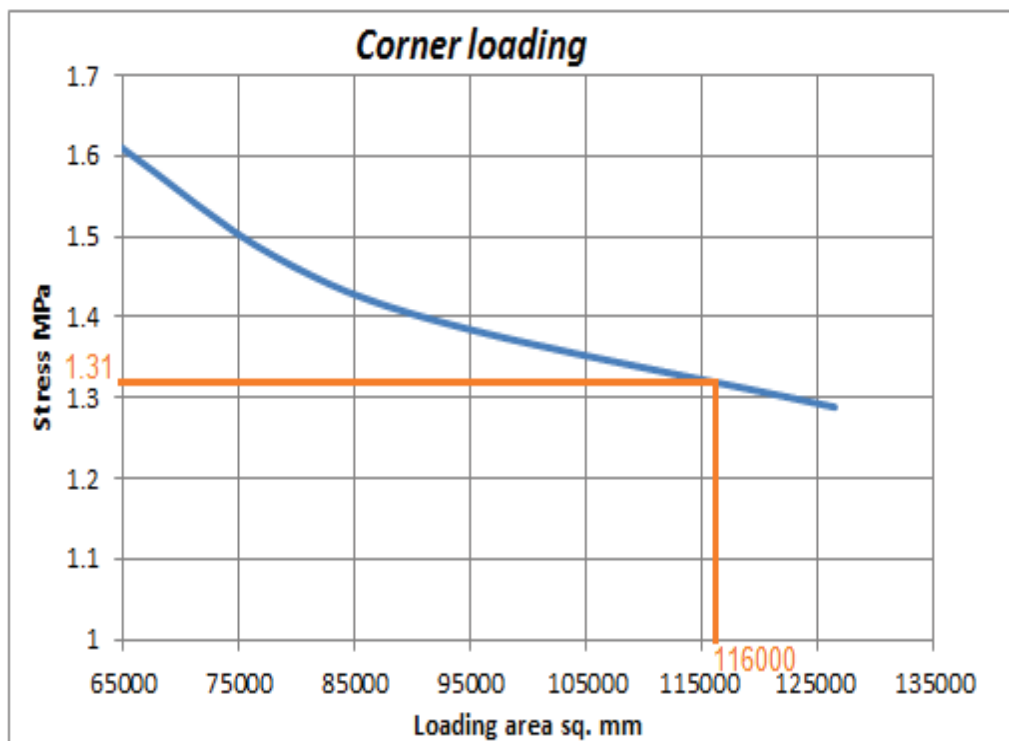


Figure (7) The relation between the loading area and the max stress for corner loading.

In Figures (5, 6, and 7), the red lines represent Westergaard's solutions and their corresponding equivalent areas for a circular loading with a 300 mm diameter. In the case of center and corner loadings, the equivalent rectangular area differs significantly from the circular area, which is 73000 mm². Conversely, for the edge loading, the equivalent rectangular area is almost the same due to the similarity between the shear perimeters of the square edge loading and the circular loading. This provides valuable insights into modifying circular areas to an equivalent rectangular area for use in EverFE program.

4.2 Stresses in dowels

Dowel bars are used to transfer the loads across joints while allowing for horizontal movement caused by thermal expansion and moisture contraction. They are usually smooth, cylindrical steel components. Their primary function is to reduce deflections and stresses resulting from traffic loads, ensuring that concrete slabs maintain both horizontal and vertical alignment. Consequently, they help to reduce and prevent issues such as faulting, pumping, and corner breaking on roadways that experience high volumes of truck traffic and possess extended joint spacing. "The use of dowel bars to minimize faulting and pumping is advisable when slabs exceed 20 feet (6.0 meters) in length, when truck semi-trailer traffic exceeds 80 to 120 vehicles per day per lane, or when the total design traffic reaches four to five million AASHTO ESALs per lane" [8].

4.3 Dowel modeling

EverFE allows modeling the dowels to be located on the mesh line as shown in Figure (8). The slab system was modeled with 24 elements along the slab length, 12 elements along the slab width, 2 over the slab thickness and 1 over the subgrade thickness. The 230 mm thick slabs were 9000 mm long and 4500 mm wide; the length of the loaded and unloaded slab elements was 4500 mm with a modulus of elasticity, $E = 28000$ MPa and Poisson ratio, $\nu = 0.2$. The joint opening is 0.5 mm. The dense liquid foundation is assumed to have a modulus of subgrade reaction of 0.03 MPa/mm. The dowels are 25 mm diameter, the total number of dowels was 11 dowels spaced at 390 mm on centers.

For the analysis of the axle loading, two wheel loads are applied at position as shown in Figure (8) The magnitude of loading is 80 KN.

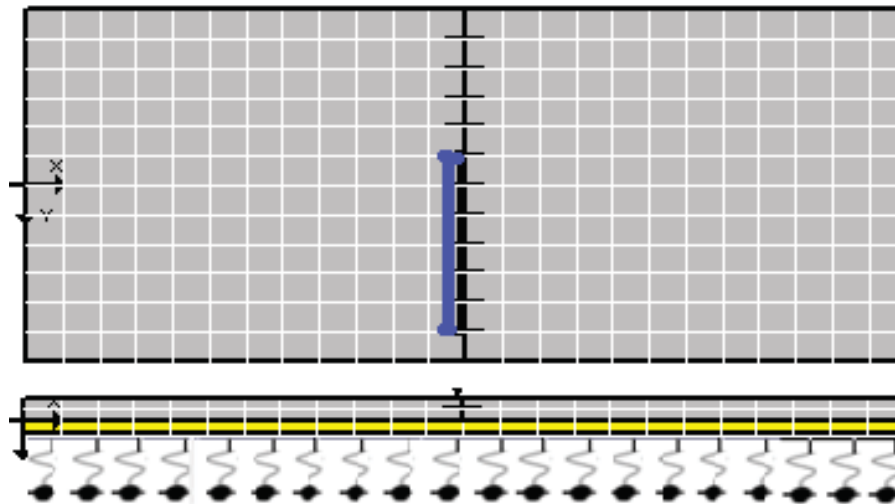


Figure (8) Wheel Load position and dowel.

Table (6) summarizes analyses results of max shear stress on dowels for different materials properties.

Slab thick. m	E.concrete M P a	E. steel M P a	E.base M P a	K.subgrade M P a / m m	D . d o w e l m	Embedment Length mm	L o a d K N	Max force N
200	28500	200000	5000	0.03	25	200	40	171
230								168
250								165
230	25650	200000	5000	0.03	25	200	40	170
	28500							168
	31350							154
230	28500	180000	5000	0.03	25	200	40	158
		200000						168
		220000						178
230	28500	200000	4500	0.03	25	200	40	170
			5000					168
			5500					166
230	28500	200000	5000	0.027	25	200	40	172
				0.03				168
				0.033				165
230	28500	200000	5000	0.03	22.5	200	40	143
					25			168
					27.5			181
230	28500	200000	5000	0.03	25	180	40	166
						200		168

Table (6) Results of analysis for the max shear stress on the most outer dowel.

The variables that have the highest influence on the shear stress on the dowel are shown in the Tornado chart Figure (9). The most significant variables are the diameter of dowel, modulus of elasticity of concrete, and modulus of elasticity of steel. The other parameters have a small effect on the shear stress, such as slab thickness, the stiffness of subgrade, and the embedment length of dowel.

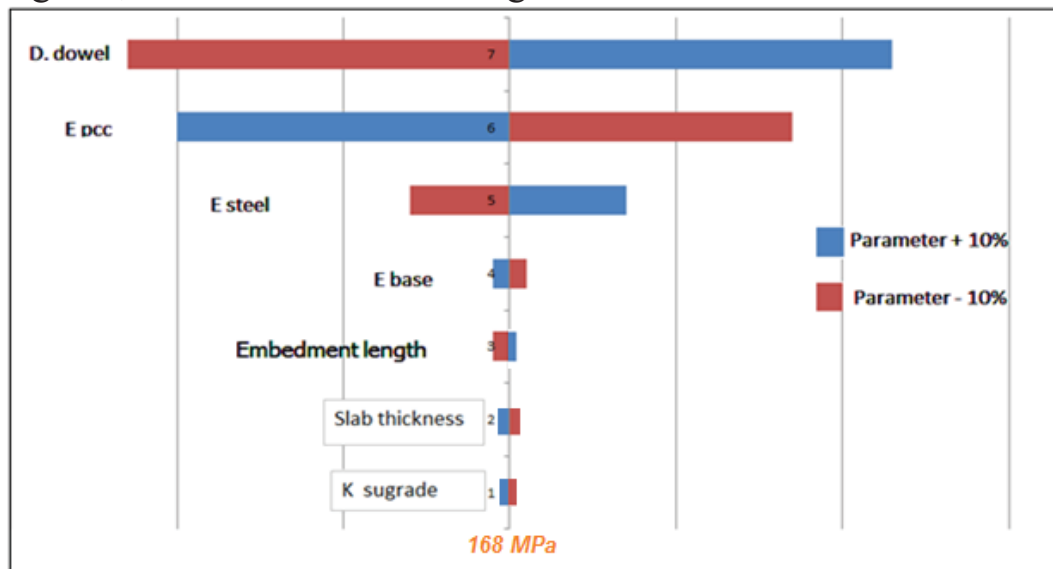


Figure (9) Tornado chart (max. shear stress)

4.4 joint opening

In order to prevent premature cracking due to temperature or moisture variations, joints must be incorporated in concrete pavements. To investigate the impact of joint opening, a single transversely centered axle load of 80 kN was applied at the joint, with joint opening ranging from 0.10 mm to 4.8 mm. The dimensions of the slabs were 3660 mm by 3660 mm with a thickness of 250 mm. The mesh elements consisted of 12 in both the longitudinal and transverse directions, and 2 elements were included along the depth. The modulus of elasticity was set at, $E = 28$ GPa and Poisson ratio, $\nu = 0.2$. The dense liquid foundation was assumed to have a modulus of subgrade reaction ranges from 0.02 to 0.04 MP/mm. The analysis of the slab utilized by EverFe with a nonlinear aggregate interlock model. The relationship between joint opening and load transfer efficiency (LTE) is illustrated in Figure (10), while Figure (11) shows the correlation between joint opening and maximum shear stress.

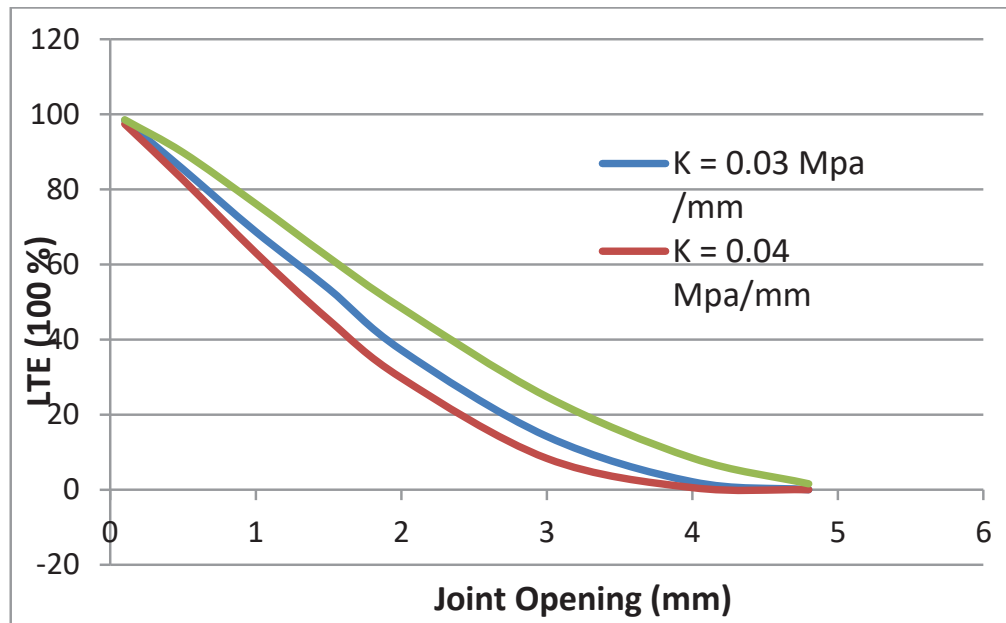


Figure (10) The relation between the joint opening and LTE at different values of subgrade reaction.

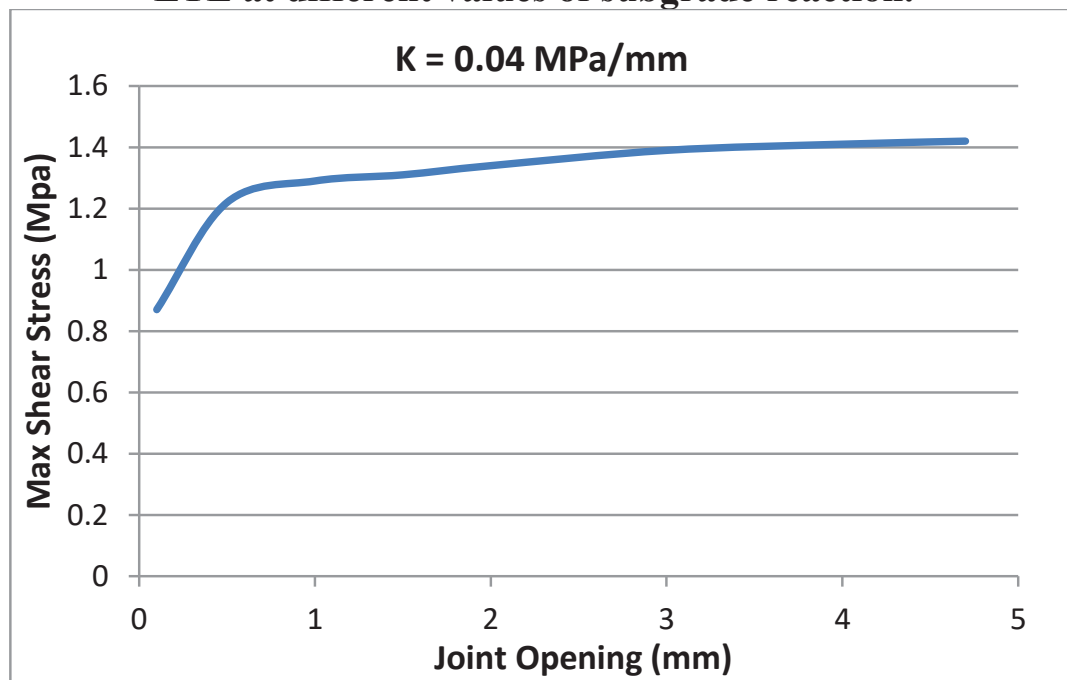


Figure (11) The relation between the joint opening and max shear stress in the slab.

Figure (10) shows that as the joint opening increases the load transfer efficiency decreases for the different values of subgrade reaction. The predicted load transfer efficiency decreases as the modulus of subgrade reaction increases for the crack opening ranges from 0.5 mm to 4.0 mm. For the cracks less than 0.5 mm the change of modulus of

subgrade reaction does not have a big effect on the load transfer efficiency. For the cracks greater than 4.0 mm there is no transfer for the load between the slab segments especially for values of modulus of subgrade reaction greater than 0.02 MPa/mm.

Figure (11) indicates a nonlinear positive relationship between the joint opening and the maximum shear stress, because as the joint opening increases the effective area of slab decreases, as a result the stresses increase.

5 Aggregate Interlock

The phenomenon known as aggregate interlock refers to the interlocking action that occurs among aggregate particles. This mechanism relies on the shear interactions that take place between the aggregate particles at the site of a crack. In roadways characterized by short spans and light truck loads, the load transfer facilitated by aggregate interlock is regarded as the most efficient mechanism for such road types. A study conducted by Minnesota Department of Transportation in 1985 revealed that the load transfer through aggregate interlock yields satisfactory pavement performance when the volume of truck semi-trailers is below 80 to 120 trucks per day per lane. In dry, nonfreezing regions, a higher volume of trucks may be more appropriate. Numerous laboratory and field investigations have demonstrated that the effectiveness of aggregate interlock is influenced by various factors, including maximum aggregate size, slab thickness, joint face roughness, subgrade strength, and the angularity of the aggregate. Further, these studies indicated that the effectiveness of aggregate interlock can be increased in shorter slabs, due to the reducing of the movement of slab and opening at the joints [8].

5.1 Model Description

The finite element model used in this study has the same slab dimensions and material properties assumed in the study done by Jensen and Hansen. The slab system was modeled with 20 elements along the slab length, 18 elements along the slab width, and 5 over the thickness. The 250 mm thick slabs were 3000 mm long and 1800 mm wide; the length of the loaded elements was 1650 mm and the length of the unloaded elements was 1350 mm. with a modulus of elasticity, $E = 33$ GPa and Poisson ratio, $\nu = 0.15$. The dense liquid foundation was assumed to have a modulus of subgrade reaction of 0.046 MPa/mm. The dowels are 32 mm diameter, the total number of dowels were 8 dowels spaced at 200 mm on centers.

1- Along the joint

In order to determine the distribution of shear and displacement across the joint, four finite element analyses were conducted. The initial analysis utilized a linear aggregate interlock model, considering both scenarios with and without dowel. In this particular case, the crack width was established at 0.5 mm, while the slab thickness was set at 250 mm. The aggregate interlock stiffness was defined as zero, indicating the absence of aggregate interlock, and the dowel slab modulus was specified at 1000 MPa. The resulting distributions of shear and displacement over the joint were subsequently illustrated, with the findings presented in Figures (12) and (13).

The second analysis involved both linear and nonlinear aggregate interlock models that did not incorporate dowel elements. In this scenario, the crack width was established at 1.0 mm, while the thickness of the slab was 250 mm. for the nonlinear aggregate interlock the medium model was used which has the max paste strength of 40 MPa, a paste aggregate coefficient of friction of 0.4, an aggregate volume friction of 0.75, and a maximum aggregate size of 20 mm. Additionally, the distribution of shear and displacement across the joint was illustrated. The outcomes of this analysis are presented in Figures (14) and (15).

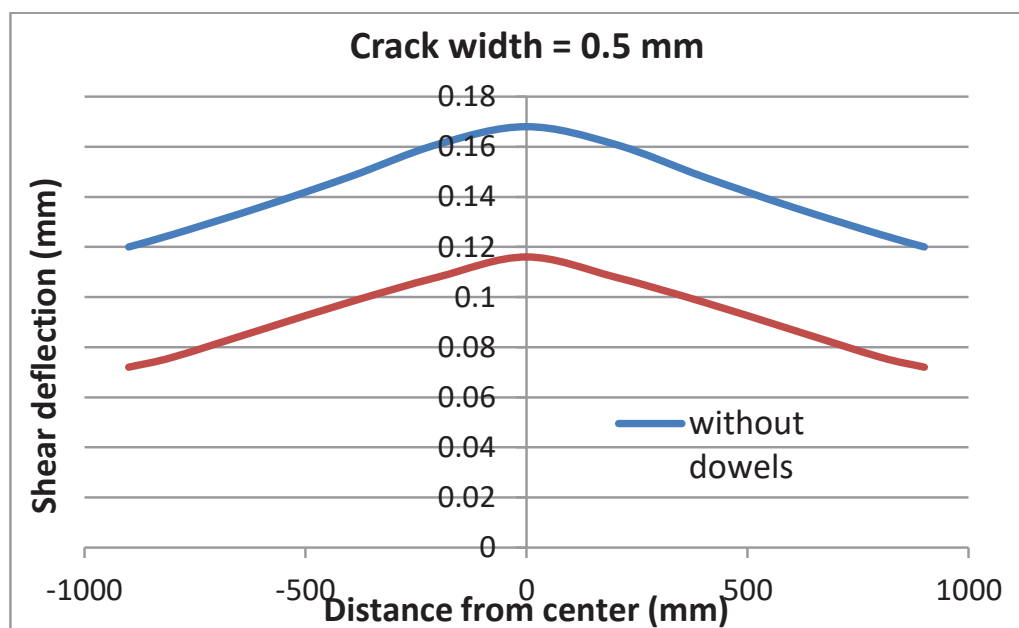


Figure (12) Distribution of shear displacement along the joint of rigid slab with and without dowels.

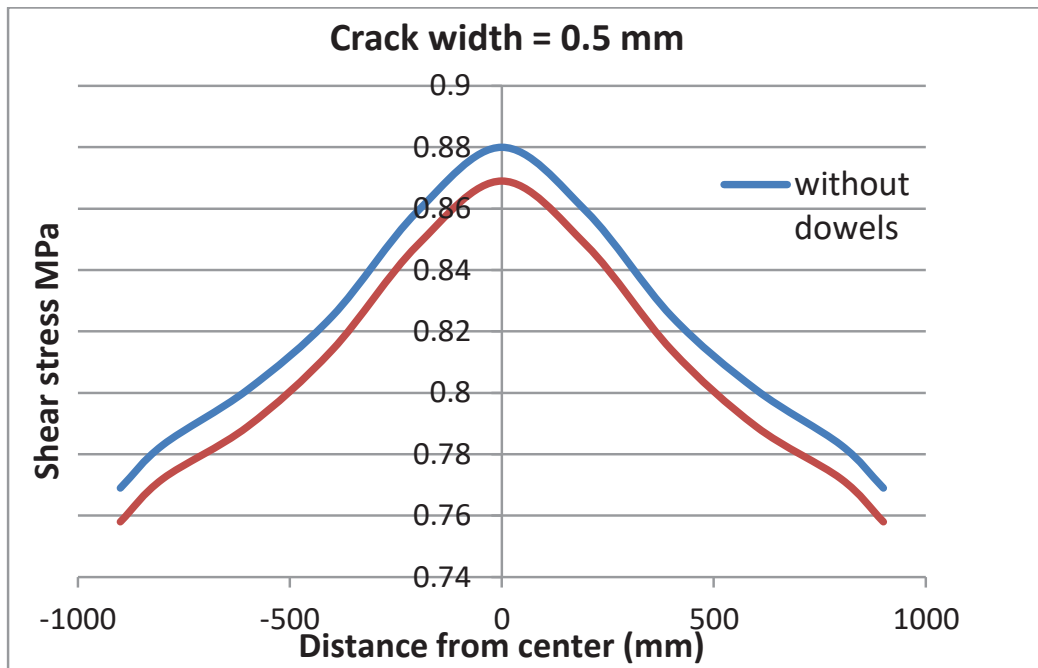


Figure (13) Distribution of max shear stress along the joint of rigid slab with and without dowels.

Figure (14) shows that the shear displacement derived from the linear model exceeds that obtained from the nonlinear model when the crack width equals 1.0 mm, indicating that the linear model tends to overestimate shear displacement. In Figure (15), a minor discrepancy is observed in the shear stresses calculated by both models at the center of the crack joint for a crack width of 1.0 mm; however, the difference in shear stress between the two models converges at distance away from the center of the joint.

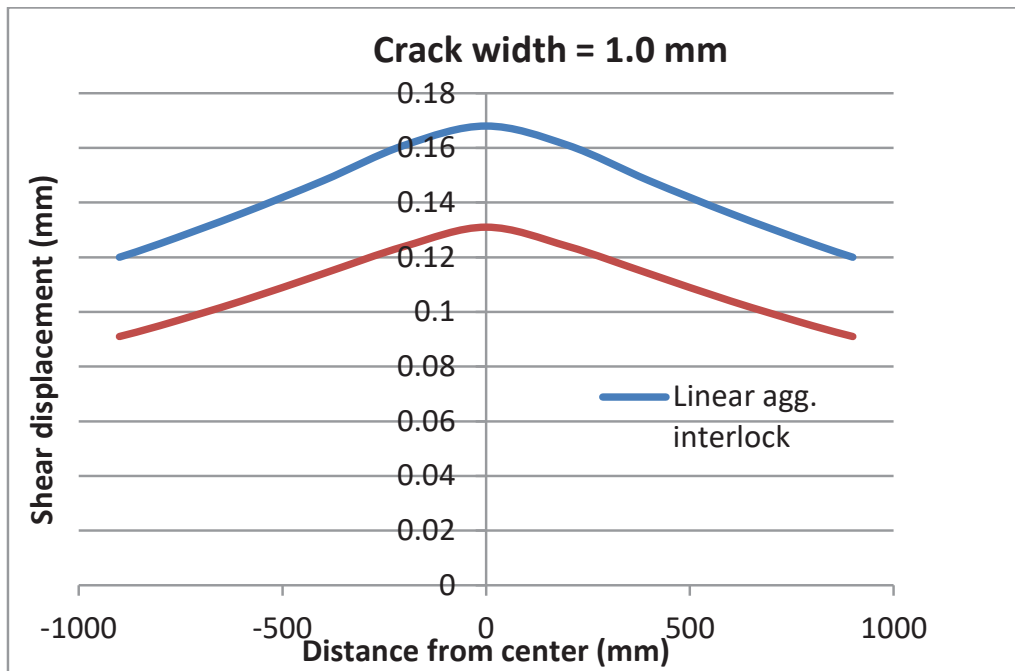


Figure (14) Shear displacement distribution along the crack for linear and nonlinear models.

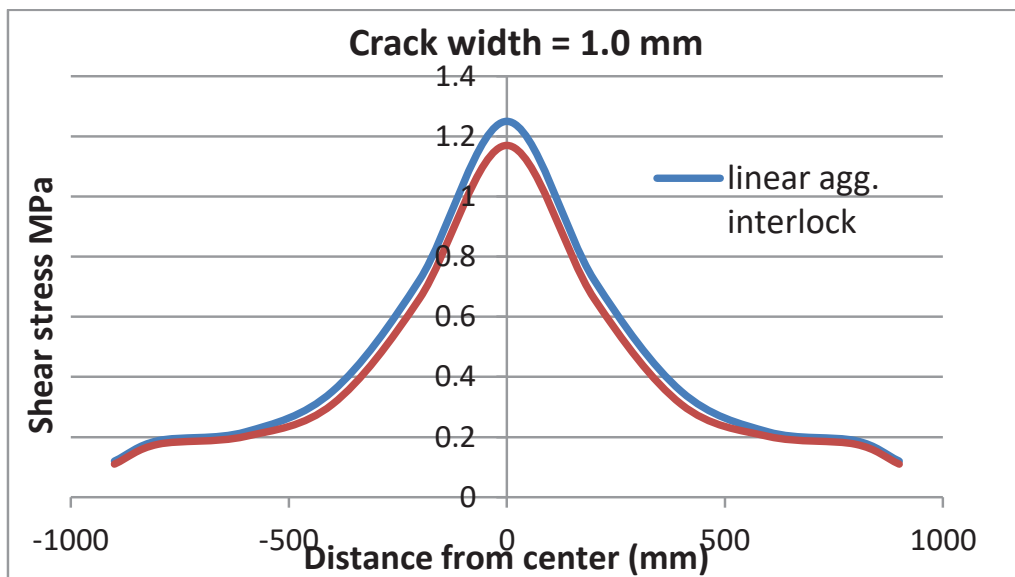


Figure (15) Shear stress distribution along the crack for linear and nonlinear models.

2- Across the joint

It is important to find the deflections before and after the joint in order to calculate the LTE. To find the distribution of the shear and displacement across the joint, four finite element analysis models were run. The first analysis assumed linear aggregate interlock model with both dowel and without dowel. The crack width for this case was 0.5

mm; the slab thickness was 250 mm. the distribution of displacement across the joint was drawn. The results of this run are shown in Figure (16).

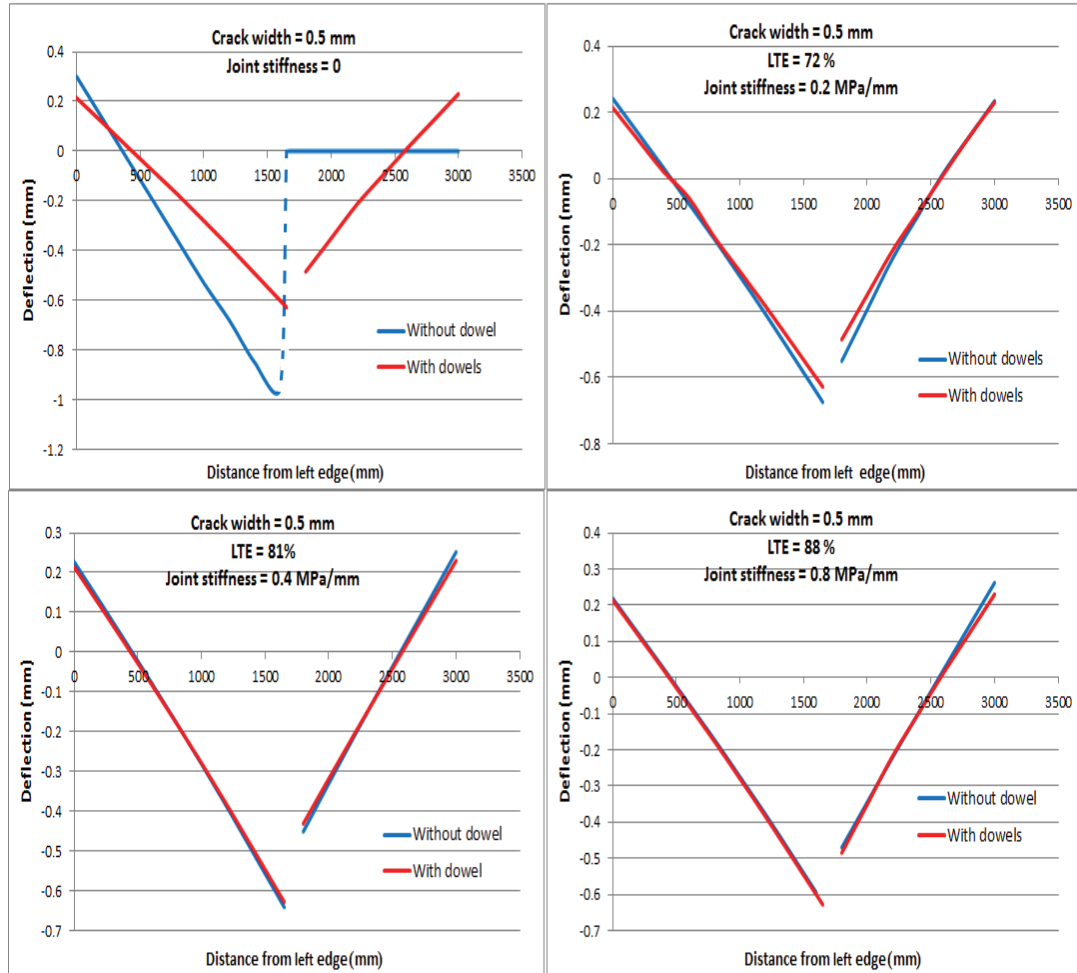


Figure (16) Distribution of displacement across the joint with and without dowels for different joint stiffness.

The second analysis assumed linear and nonlinear aggregate interlock models without dowel. The crack width for this case ranges from 0.5 mm to 2.5 mm; the slab thickness was 250 mm, for the linear model the joint stiffness was 0.2 MPa/mm, for the nonlinear aggregate interlock the medium model was used which has the max paste strength of 40 MPa, paste aggregate coefficient of friction was 0.4, aggregate volume friction of 0.75, and the max aggregate size was 20 mm. the distribution of the displacement across the joint was drawn. The results of this run are shown in Figure (17).

From Figure (16) at crack width equals 0.5 mm the force transferred by aggregate interlock approximately equals to the force transferred by dowels for the given dowels and joint stiffness values greater than

0.4 MPa/mm, this reflects the importance of the aggregate interlock mechanism.

Figure (17) shows that there is no effect for the joint opening on the load transfer efficiency in case of linear aggregate interlock model. At crack width approximately equals (1 mm) and a fixed value of joint stiffness equals 0.2 MPa/mm, LTE approximately the same for both models. For cracks less than (1 mm) we can use either linear or nonlinear aggregate interlock models, but for cracks greater than (1 mm), LTE by linear model becomes unrealistic. The author expects the behavior of the two models will be closer at crack widths tighter than (1 mm) if the joint stiffness be increased for the linear model.

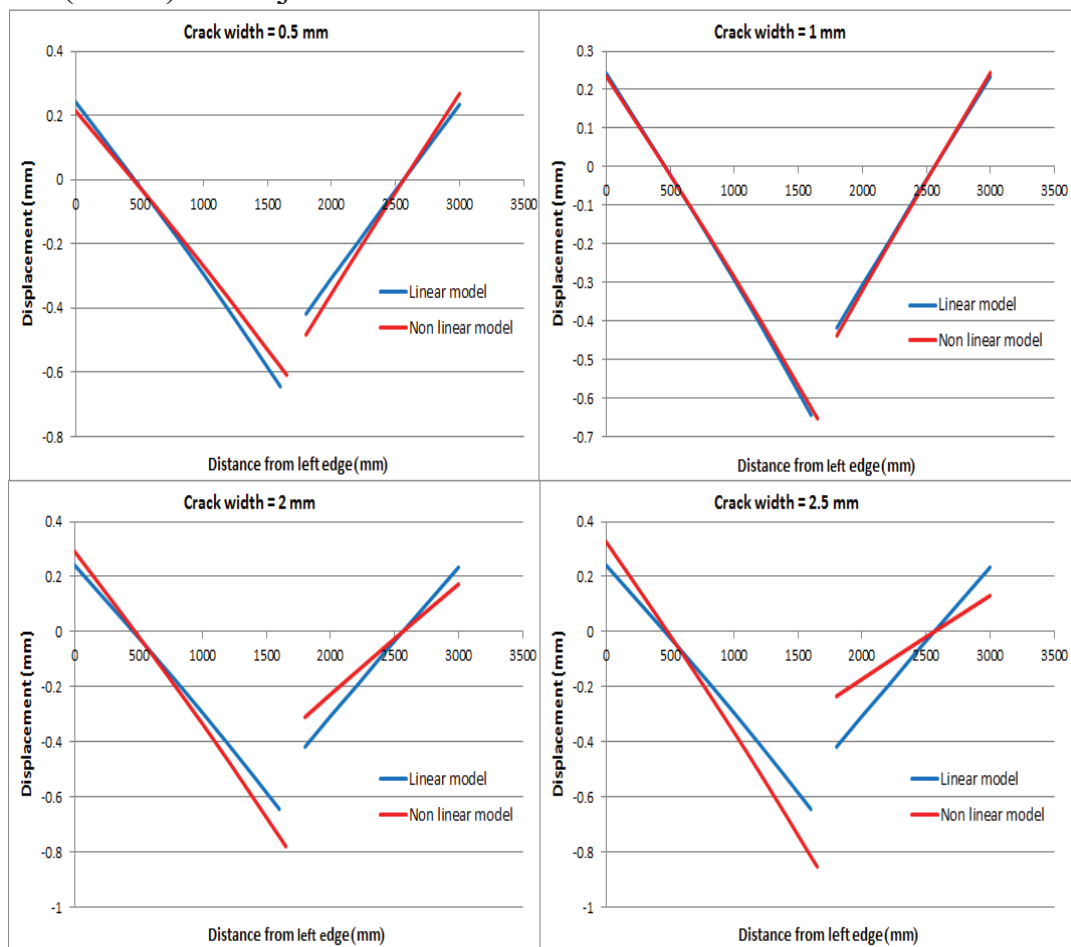


Figure (17) Displacement distribution for linear and nonlinear models across the joint for different crack widths.

5.3 Comparison between experimental and predicted data:

Study by Jensen and Hansen 2006 on large scale concrete slabs with different aggregate types and sizes, two aggregate sizes were studied 25 mm and 37 mm, the aggregate types were blast furnace slag, glacial gravel, and limestone. The glacial gravel and blast

furnace are considered hard aggregate, while the limestone considered soft aggregate. The properties of the assumed materials and the modeling were given in methodology section.

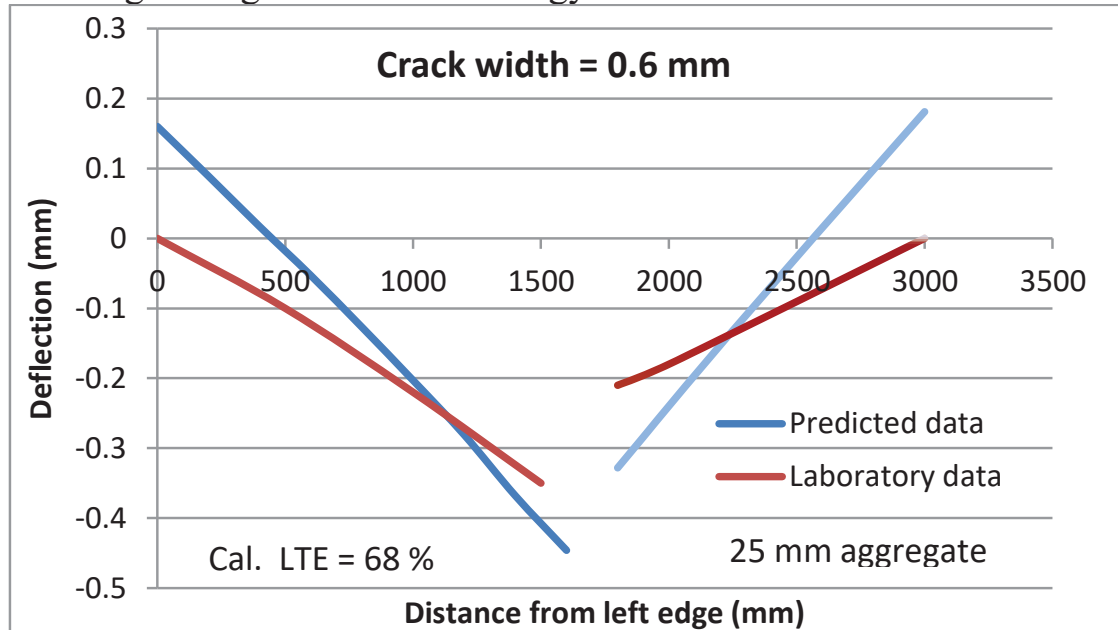


Figure (18) Experimental and calculated slab deflection across the crack joint with (0.6 mm) crack width for concrete contains slag furnace aggregate.

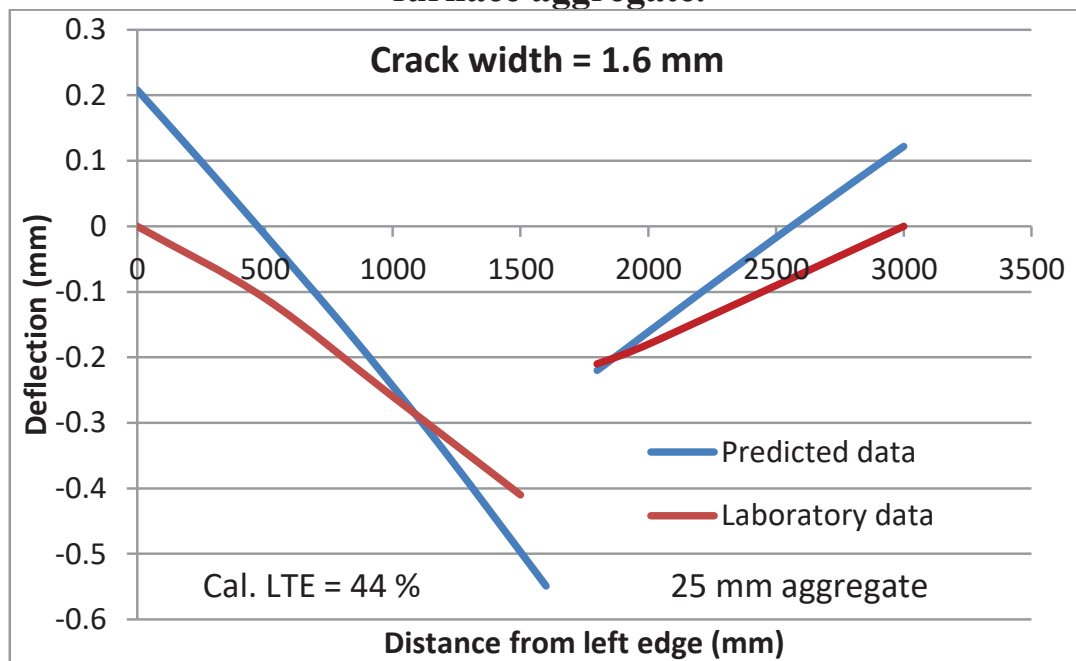


Figure (19) Experimental and calculated slab deflection across the crack joint with (1.6 mm) crack width for concrete contains slag furnace aggregate.

Figures (18 and 19) shows a comparison between the measured and predicted slab deflection across the crack of concrete mix contains blast furnace slag with 25 mm max aggregate size, crack widths were 0.6 mm and 1.6 mm

The difference between measured and calculated results was 2.2 % for crack width of 0.6 mm, and 9.5% for 1.6 mm crack width. The calculated difference depend on LTE values. In general the comparison between the experimental and predicted data is acceptable, and similar to the results by Jensen and Hansen 2006.

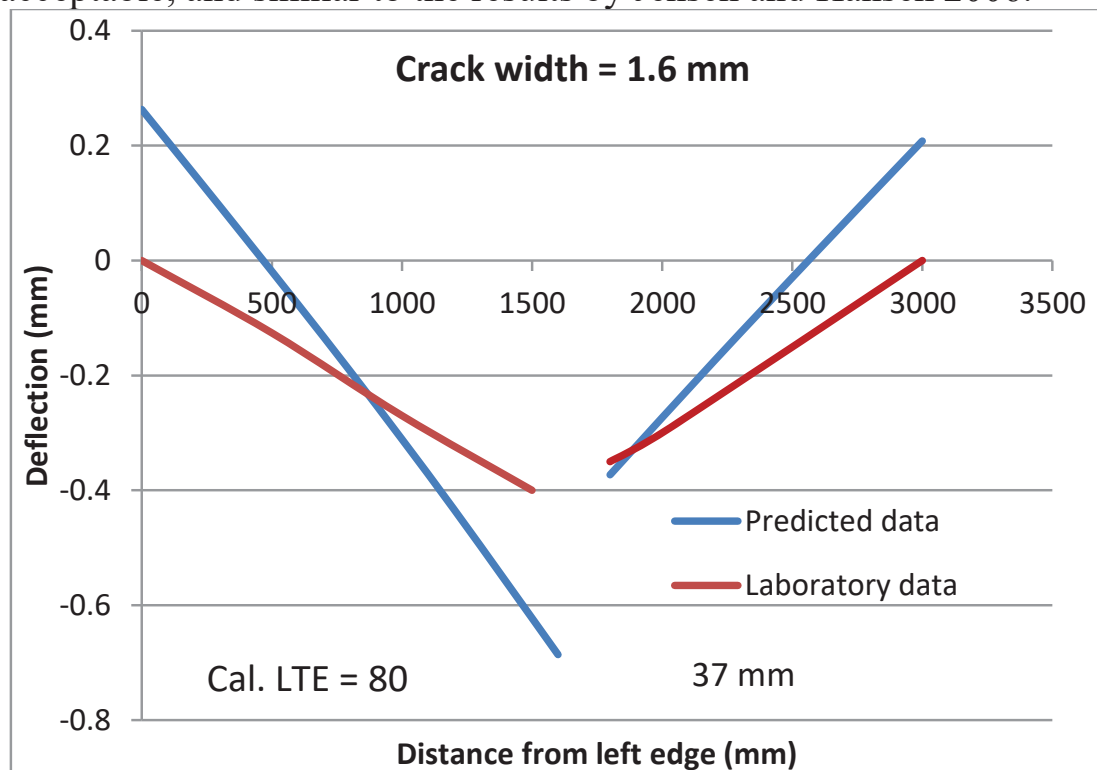


Figure (20) Experimental and calculated slab deflection across the crack joint for concrete contains glacial gravel with $d_{max} = 37\text{mm}$. Figure (20) shows a comparison of the results between the measured and predicted slab deflection across the crack of concrete mixes contains 37 mm max aggregate size, crack width was 1.6 mm. The results indicate a noticeable difference (12.5%) between the measured and calculated data, which is considered higher than the results by Jensen and Hansen (7% to 10%). The calculated difference depend on LTE values. This behavior was expected since the slabs exhibit only a minor deflection variation along the crack, The calculated deflection variation compare well with the experimental measured variation

along the crack length. In general the results showed a good approximation for the aggregate interlock mechanism.

6 Conclusions and Recommendations

This paper deals with joint performance in jointed concrete pavements with focus on dowel and aggregate interlock interaction under traffic loads. Focuses on the joint behavior, the contact stresses between dowels and surrounding concrete in jointed concrete pavement due to wheel loads. Based on the analysis results presented in this study, the following conclusions can be written:

- 1- Dowel bar diameter, slab concrete modulus of elasticity, and the dowel steel modulus of elasticity are the most significant variables that affect the contact stresses between dowels and surrounding concrete in jointed concrete pavement.
- 2- Load transfer efficiency (LTE) is influenced by various factors, including the width of cracks, the modulus of subgrade reaction, the type of aggregate used, and the size of the aggregate.
- 3- Linear aggregate interlock model gives reasonable results for crack widths less than 0.5 mm.
- 4- In case of crack widths ranging from 0.5 mm to 2.5 mm, there is a noticeable discrepancy between the outcomes produced by both linear and nonlinear models.
- 5- Large size aggregate yields higher LTE values compared to those obtained with smaller aggregate sizes.
- 6- The LTE values, by using EverFE shows good results compared to the findings from a large scale study by Jensen and Hansen for concrete contains blast furnace and gravel aggregate.

Recommendations

Based on the research that has been done, then there are some things that are still considered to be developed further to study the effects of different aggregate parameters on aggregate interlock mechanism including , surface texture, angularity, and abrasion of aggregate.

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Full Coverage System Using High Altitude Platforms for Benghazi City

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Abstract

In this paper, a High Altitude Platform System (HAPS) system will be designed in order to provide full coverage for Benghazi - Libya. Such system has the potential capability to serve a large number of users with advanced communications technology, either in dense urban areas or over a wide geographical area. They can be brought in temporarily for disaster relief or temporary coverage of entertainment events. The purpose of this study is to achieve the following objectives:

- i. Determining the location of the M55 aircraft.
- ii. Computing the link budget for the uplink and downlink of the backhaul earth stations located at the edge of service and at 10 Km far from the SPP of footprint.
- iii. Proposing one alternative backhaul earth terminal to improve the availability of the link. Computing the availability improvement to be achieved.

Keywords— overview of HAPS, availability, typical link budget of HAPS, M55 aircraft, rain attenuation, site diversity.

I. INTRODUCTION

High Altitude Platform System (HAPS) holding a fixed station in the stratosphere may offer an ideal platform from which to support a host of wireless services. HAPS can exploit the best features of both terrestrial and satellite schemes.

As Libya is a huge country and there are a wide area without broadband access, this led the country represents an absence of coverage over significant large area. IT means need a lot of base stations where needs to cover uncovered area. As a stratosphere communication system using HAPS (airship) which operate at altitude typically between 17km and 25 km above the ground. There is a

minimum wind speed at these altitudes [1]. The ITU has licensed frequencies based on region (at around 28 GHz downlink and around 31 GHz uplink for use in Africa). and will provide a new wireless communication system with high speed multimedia mobile communication service to satisfy the demands of high data rate , high mobility system roaming and wide area coverage .

A single HAPS can replace a large number of terrestrial masts serve a few number of users which cover narrow area high cost technology compared with HAPS which will serve around 1.5 million users or more with huge coverage. HAPS can keep stationary in its altitude for long period a round 5 years, some features of HAPS system firstly can serve a footprint that extends over 500km radius depend on HAPS type, altitude and elevation angle. Secondly delivery of service softer handoff operation from cell to cell, thirdly, enables point-to-point high speed coverage throughout coverage area, finally HAPS provides communication services including 3G, WiMax, LTE, 4G and 5G. HAPS 5G massive MIMO has great potential for various application in the future 5G era.

The HAPS systems can be designed to essentially replacing the tower bas station network with a base station network in sky or can integrated into a system that employ terrestrial masts and get a coverage for uncovered area

II. DESIGN PARAMETERS

Benghazi is one of the 22 municipality of Libya. Benghazi covers an area of $43,535 \text{ Km}^2$. It is the second largest City in the Libya, Therefore it is not possible to cover the whole area by one space aircraft, but will use one platform to cover the largest populated area of Benghazi municipality; however, by using one aircraft the elevation angle will be 20 degree and that will not interfere the existing terrestrial infrastructure. The coverage areas will has radius of 68.7 Km and aircraft will fly at fixed altitudes.



Figure 1 shows the coverage area of Benghazi city. Having one HAPS we designed the altitude of it 25Km to cover area until AL-Marj city from the east, to Al Maqrun from the west.

III. CALCULATIONS AND DISCUSSION:

As we will install one HAPS. Since the HAPS has fixed parameters such as coverage radius, latitude and Elevation angle the calculations will be shown below.

	Latitude (deg)	Longitude (deg)	Space segment latitude(Km)	Coverage radius (Km)	Elevation angle (deg)
HAPS	31°58'1.20" N	20°26'58.55" E	25	68.7	20

If it is assumed that the user terminal at the edge of coverage receives the downlink signal with 20 (deg) elevation angles, then the radius will be calculated from equation 1. For a radius coverage of HAPS is 68.7 and 25 Km altitude, slant path will be 73.1Km. The calculations and equations are based on ITU Recommendations [2, 3, and 4].

$$R (\text{radius}) = \text{space segment altitude} / \tan (EL) \quad (1)$$

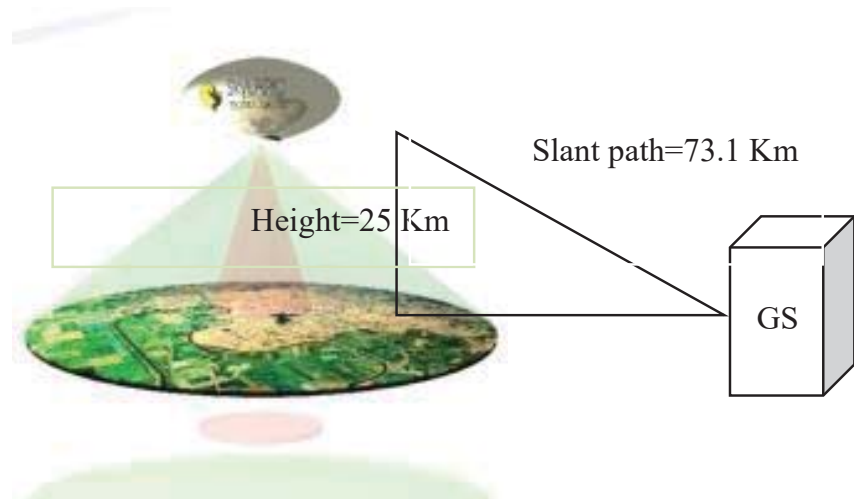


Figure 2 shows a GS located at the edge of the coverage area.

If we assume that, the GS is located 10 Km away from the sub platform point (SPP), the elevation angle can be obtained using equation 3.1. In this case the elevation angle for the HAPS are 68.2 (deg) and the slant path 26.93 Km for HAPS

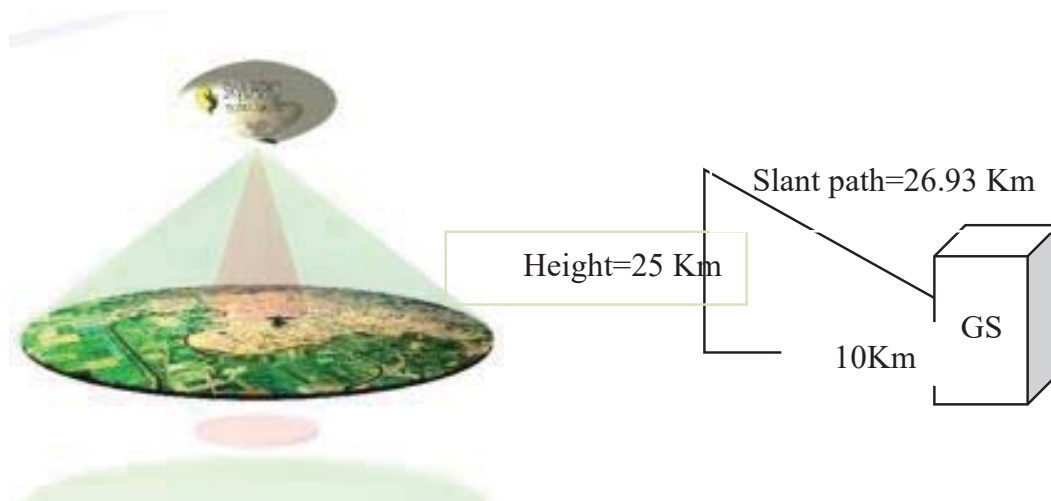


Figure 3 shows a GS located at 10Km from the SPP. The uplink and downlink budget for this GS will be obtained for two scenarios: first with clear sky and the second for rainy condition. The results will be illustrated in Index including the two scenarios respectively. At the same time each scenario will be divided into two sub scenarios in which the calculations will be performed when the GS is located at the edge of the coverage area and when the GS is located 10Km from the SPP.

It is noticed from the two elevation angles, for that angle of 20 deg, the signal will travel longer distance and rain path better than that one resulted with the 64.53 deg angle for HAPS. The elevation angle is very critical parameter in this respect, and it must be calculated carefully to assess how much exactly attenuation that may affect the received signal in case of a rainy –channel condition is found.

It is worth mentioned that, by using simple mathematical calculations, it can be realized that the city of Benghazi can be covered only by using one footprint with radius of 68.7Km.

IV. IMPROVEMENT OF SYSTEM AVAILABILITY

In case we decide to cover a larger area that led to use more than one platform, the link margin in the rain condition scenario is much less than in the clear sky scenario. This will degrade the overall system performance and in order to avoid this drawback there are some techniques that can be used such as: increasing the transmission power as far as we are not exceeding the limited allowable power, we also can use high gain receiving antennas in order to increase the link margin.

The availability of the service can be also improved by applying one common technique such as site diversity as shown in figure (4). In this regard, a redundant earth-space link will be established at a particular distance from the main one. This effort is to make the redundant link avoid the rain cell area. It is experimented that the availability will increase as the separation distance between two links (stations) increase. Since the diversity gain will increase, the rain attenuation effect on the HAPS-based downlink signal will be decreased.

when we use more than one platforms, we can deploy Platform diversity so that the ground stations which are near to the edge of the cell can select the platform which offer a better channel condition amongst two platforms as shown in figure(5) .

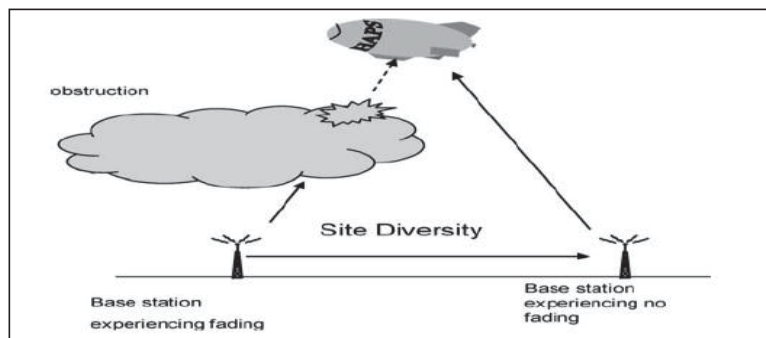
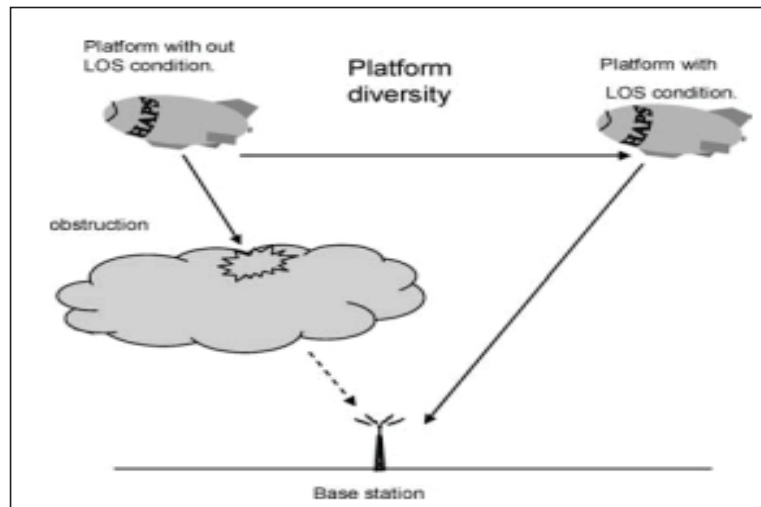


Figure 4 shows site diversity

Figure 5 shows platform diversity

V. CONCLUSION

In this article, the use of high-altitude platforms has been proposed to provide a full coverage for Benghazi state. Results obtained in the system design have shown that they are suitable to implement the coverage of large radius. They support services with better performance with respect to terrestrial stations which make HAPS a promising infrastructure for a future system which will require the co-sitting of navigation and communication stations for the provision of integrated services.

In brief, link budget can be well-calculated by referring to the ITU recommendations regarding this area of engineering. That kind of recommendations shows the how to set the related parameters properly to achieve a good system performance; moreover common HAPS system specifications are also presented.

In order to design a HAPS-based system with acceptable QoS, the design must be based on some considerations. For instance, to cover a wide area, the platform needs to be located in the highest latitude. So that, user terminals in the coverage edge will also receive the signal with acceptable level of strength specially during rain events.

One of the most common and efficient method to increase the system performance when rain event takes place is the site diversity. Many studies have been published about site diversity and it has been reported that the diversity gain and the optimal performance can be achieved by furthering the separation distance as long as possible.

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Assessment of natural radioactivity and radiological risks in the sandy beaches of Qarabulli city, Libya Nuclear Research Center in Tajoura NRCT

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لمدينة القره بولي، ليبيا
مركز البحوث النووية بتاجوراء
خديجة على، أسماء الحاج احمد، سامية الزوبيك، يوسف بيرى

الملخص

تم قياس تراكيز نشاط النظائر المشعة الطبيعية في رمال شاطئ مدينة القره بولي باستخدام مطياف اشعة جاما مع كاشف الجرمانيوم عالي النقاوة. بينت النتائج ان متوسط تركيز اليورانيوم 238 كانت 14.26 بيكريل لكل كجم ومتوسط تركيز الثوريوم 232 كانت 5.26 بيكريل لكل كجم بينما متوسط تركيز البوتاسيوم 40 كانت 124.07 بيكريل لكل كجم على السطح وفي العمق. وفيما يخص النشاط المكافئ للراديوم ومؤشر خطر التعرض الاشعاعي الخارجي ومعدل الجرعة الممتصة كانت النتائج 35.18 بيكريل لكل كجم و0.089 ميكروسيفرت لكل سنة و15.80 نانوجراي لكل ساعة على التوالي، مما يشير الى عدم وجود خطر اشعاعي عالي يتعلق بالأنشطة البشرية في منطقة الدراسة. كذلك يمكن استخدام النتائج التي تم الحصول عليها كمعلومات مرجعية لتتبع أي تغير في مستوى الخلفية الاشعاعية في المنطقة المدروسة.

الكلمات المفتاحية: النشاط الاشعاعي الطبيعي، الرمل، مطياف جاما والخطر.

Abstract

The natural radionuclide activity concentrations in the beach sand of Qarabulli city were measured using a gamma-ray spectrometer with a high-purity germanium (HPGe) detector. The recorded gamma spectra showed that the mean activity concentration values at both surface and depth were 14.26 Bq/kg for U^{238} , 5.26 Bq/kg for Th^{232} , and 124.07 Bq/kg for K^{40} . As per findings of the radium equivalent activity, the external radiation hazards index, and the absorbed dose rate were 35.18 Bq/kg, 0.089 μ Sv/y, and 15.80 nGy/h, respectively. Accordingly, there was no notable radiation hazard associated with human activities in the study area. All the attained results can serve as reference material for monitoring any fluctuations in the background level of radioactivity in the study area.

Keywords: natural radioactivity, sand, spectrometer, and risk,

1-Introduction

People all over the world are drawn to the coasts because of their stunning natural environments, ease of access, and abundance of amenities they provide. Along with living there, people also relocate to the coasts for tourism, leisure, and other reasons. Furthermore, natural sand contains radionuclides, which significantly increase the background radiation exposure of the population by inhalation. As a result, measuring the radionuclide activity in sand is essential to identifying any changes in activity over time due to radioactive emission. A comprehensive understanding of the presence of radioactivity in the environment enables the evaluation of potential radiological hazards to human health and establishes regulations and principles for the utilization and control of these resources. Numerous investigations were carried out in Libya to evaluate radiation in several ecosystem systems, such as El-Kameesy et al., (2008), Tereesh et al., (2013), Alajeeli et al., (2019), Algattawi et al., (2019), Alsaadi et al., (2023) etc. However, the geographical region of Libya is thought to be relatively large; hence, all studies combined are insufficient. Furthermore, one of the coastal cities called Qarabulli City has smooth, scenic beaches. Many investors have expressed interest in building vacation resorts and tourist towns in Qarabulli City in recent years. Nevertheless, some researches have shown that the naturally existing radionuclides belonging to the uranium and thorium families are more concentrated inside the crystal structure of heavy mineral sands (Mbatha, 2007). The majority of naturally occurring radioactive elements found in soil have been found to be primordial radionuclides from the Th^{232} , U^{238} , and K^{40} families (El-Kameesy et al., 2008). Research on the radiation risks associated with using soil or sand revealed that the world's population receives the majority of its external exposure from natural radiation. Algattawi *et al.* (2019) discovered that Qarabulli City has a greater concentration of Th^{232} , with a mean ν -value of 75.56 ± 10.95 Bq/kg, compared to the global average. These findings suggest that several studies in this field should be conducted to assess radioactivity in order to protect the public. The objective of this study is to evaluate the natural radioactive concentrations of U^{238} , Th^{232} , and K^{40} at two distinct depths in the sand beach samples of Qarabulli city. Additionally, the corresponding radiation risk is analyzed.

2-Material & Methods

2.1-Study area

The beach at Qarabulli coast, Libya, stretches along the Mediterranean Sea coast for about 60 kilometers to the east of Tripoli. Its length is commensurate with the quantity of its natural resources, particularly in the areas of raw minerals, energy, and fisheries. Qarabulli city is categorized as an agricultural region. Additionally, it is regarded as the most popular summertime vacation destination for the great majority of the populace.

2.2-Sample collection & preparation

Beach sand samples were collected in November 2023 from five randomly selected places along the shoreline of Qarabulli City. The positions of the sampling spots were recorded using a GPS (Global Positioning System), and table 1 displays each sampling location.

Table 1: illustrating the locations of the sampling areas

Samples code	Sample Location
S1	32°47'29.1"N 13°42'13.7"E
S2	32°47'58.8"N 13°47'35.8"E
S3	32°47'25.2"N 13°40'39.0"E
S4	32°47'21.7"N 13°38'30.0"E
S5	32°47'33.2"N 13°35'53.1"E

Prior to collecting any samples, the top layer of sand was removed. Along the coast, five samples were collected at a depth of 15 cm, while the remaining five samples were collected at a depth of 50 cm at the same spot. The majority of vacationers frequently choose to engage in the pastime of burying themselves in the sand as a way to unwind more while on vacation. This is the reasoning behind collecting samples at depths to understand the change in radioactive concentration of elements and their impact on vacationers. Each sample number and depth were labeled on the plastic bags that held them all. The preparation of the sample was performed at the radiological analysis and measurements laboratory in the radiochemistry building at the Nuclear Research Center in Tajoura (NRCT). To achieve uniform particle size, all samples were sieved after being oven dried for an entire night at 105°C in a Heraeus instrument oven. To create uniform samples, the quartering and coning technique was applied. Less error in the data can be attributed to sample heterogeneity when the sample is homogeneous (Mbatha, 2007). Furthermore, quartering and coning are helpful since they

guarantee that all grain sizes are represented when the sand samples are transferred into a Marinelli beaker. Lastly, sand samples were weighed after being put into Marinelli beakers; each sample weighed between 1.379 to 1.609 kg. To prevent radon leakage (Rn^{222} generated in the U^{238} decay series), tape was used to enclose each beaker. Since it ensures that the radioactivity of the parent and daughter radons is equal, the secular equilibrium is crucial (Ramli et al., 2009). Therefore, in order to attain radioactive secular equilibrium, samples were held for longer than four weeks prior to measurement. Subsequently, all samples were measured in the Environmental Measurements Laboratory located within the calibration building at the Nuclear Research Center in Tajoura by the HPGe detector.

2.3-Gamma-ray spectroscopy

In this investigation, the High Purity Germanium detector (HPGe) spectrometer was used to measure the majority of the natural radionuclides that were studied. The experimental setup comprised of a 25% relative efficiency HPGe detector and resolution 2.2 keV at 1332 keV γ -line. First, various calibration sources were used to perform the detector's energy and efficiency calibrations. Background measurements were taken in the exact same conditions as sample measurements in order to generate net counts for the sample, which were then subtracted. In order to ascertain the concentration of radioactivity in the sand samples, each sample was subjected to the same counting time (25000s) in the (HPGe) detector. The U^{238} and Th^{232} not being direct gamma ray emitters, but it is possible to measure their activity through the gamma rays of their decay products, so the gamma ray line energies of 351.9 keV from Pb^{214} , 609.3 keV, 1120.2 keV and 1764 keV from Bi^{214} were used to represent activity concentration of U^{238} series. The activity of Th^{232} has been calculated by using gamma ray line energies of 911 keV for Ac^{228} , 583 keV from Tl^{208} and 238 keV for Pb^{212} . On the other hand, activity of K^{40} has been determined directly from its 1460 keV gamma ray line of energy (Sarap et al., 2014).

3- Methods for estimating radioactivity and its risks

3.1- Calculate the concentration of radioactivity

The activity concentrations (Ac) of the radionuclides in the samples were computed using the following formula (Alharbi & El-Taher, 2016).

$$Ac = \frac{CPS}{\epsilon \cdot Ir \cdot W} \quad (1)$$

Where,

Ac is the sample's activity concentration (Bq/kg) (becquerel represents the quantity of any radioactive material that decays each second), CPS is the net gamma counting rate at a peak at energy E per second, W is the weight (kg) of the measured sample, Ir is the probability of gamma-ray emission corresponding to the peak energy, and the absolute efficiency at photopeak energy is denoted by ϵ .

The following calculation was used to determine the possible radiation risks connected to the sand samples:

3.2- The radium equivalent activity (Raeq)

To characterize the gamma output from various concentrations of U^{238} , Th^{232} , and K^{40} in sand, the concept of radium equivalent activity was introduced in order to express the activities of naturally occurring radionuclides in materials through a single quantity while accounting for the associated radiation hazard (Tereesh et al., 2013). The radium equivalent activity (Raeq) can be computed using the following formula:

$$Raeq \text{ (Bq/kg)} = AU + 1.43A_{Th} + 0.077AK \quad (2)$$

Where,

AU, A_{Th} and AK are the specific activity in Bq/kg of U^{238} , Th^{232} and K^{40} , respectively, in the sand samples in study area.

3.3- The external radiation hazards index

The following formula determines the external hazards index carried on by gamma ray exposure:

$$H_{ext} = AU/370 + A_{Th}/259 + AK/4810 \quad (3)$$

Where,

AU, A_{Th} and AK are the specific activity in Bq/kg of U^{238} , Th^{232} and K^{40} , respectively, in the sand samples in study area. This index should have a value less than one. Values above unity make the risk unacceptable to members of the general public (Munyao et al., 2020).

3.4-Absorbed dose rate

The following formula can be used to determine the absorbed dose rate (D^R) (Shahul et al., 2012).

$$D^R = 0.462AU + 0.604A \text{ Th} + 0.0417AK \text{-----}$$

$$\text{----(4)}$$

Where,

AU, ATh and AK are the specific activity in Bq/kg of U^{238} , Th^{232} and K^{40} , respectively, in the sand samples in study area.

4-Results & Discussion

Table (2) presents the average activity concentration of the radionuclides (U^{238} , Th^{232} and K^{40}) that were discovered in the samples being examined. The locations are the five chosen places along the shoreline of Qarabulli city. Two values are shown for each site; the first one relates to the concentration of activity at 15 cm below the surface and the second to the concentration of activity at 50 cm below the surface.

Table 2: The concentrations of U^{238} , Th^{232} and K^{40} in Bq/kg for the measured samples

Sample s code	Dep th cm	U^{238} Bq/kg	Th^{232} Bq/kg	k^{40} Bq/kg	Mean of concentration		
					U^{238} Bq/ kg	Th^{232} Bq/ kg	k^{40} Bq/kg
S1	At 15	11.09±0 .53	7.18±0. 52	144.15±7 .2	14.5 0	6.6	131. 11
	At 50	17.9±0. 89	6.02±0. 29	118.06±5 .90			
S2	At 15	15.05±0 .75	6.41±0. 31	163.42±8 .17	12.6 2	6.58	180. 22
	At 50	10.19±0 .50	6.75±0. 33	197.01±9 .85			
S3	At 15	12.87±0 .64	2.15±0. 1	113.84±5 .69	14.1 3	3.98	136. 51
	At 50	15.39±0 .75	5.8±0.2 8	159.18±7 .95			
S4	At 15	7.99±0. 52	7.13±0. 50	63.26±3. 16	13.0 3	5.13	127. 66
	At	18.05±0	3.12±0.	192.05±9			

	50	.89	15	.60			
S5	At	11.76±0	1.04±0.	46.85±2.	17.1 0	4.02	44.9 1
	15	.58	15	34			
	At	22.35±1	7.00±0.	42.96±2.			
	50	.10	34	14			
Mean					14.2 6	5.26	124. 07
Std. Deviati on					1.74	1.29	49.0 8

It is evident that, with the exception of S5, K^{40} activity accounts for the majority of the total activity, whereas Th^{232} is always less than U^{238} . It is noticed from the table (2) that the concentration of uranium at depth is higher than at the surface, except S2.

4.1- U^{238} 's activity concentrations

It is clear that the concentration of U^{238} vary between 7.99 ± 0.55 to 15.05 ± 0.75 Bq/kg with a mean average value of 11.75 ± 0.5 Bq/kg at surface, and it ranged from 10.19 ± 0.50 to 22.35 ± 1.10 Bq/kg with the average mean value of 16.77 ± 0.8 Bq/kg at depth. As shown in Fig. 1, the highest concentrations are in S4 and S5, with 18.05 ± 0.89 Bq/kg and 22.35 ± 1.10 Bq/kg, each, at a depth of 50 cm. In addition, the lowest concentration is 7.99 ± 0.52 Bq/kg in sample 4 at the surface. The study presented indicates a slightly lower value than the world average value, as the reported worldwide limit for U^{238} is 33 Bq/kg. Furthermore, the mean values of U^{238} and K^{40} concentration (p.value = 0.02) are significantly connected. Although the concentration of U^{238} in S1, S3, S4, and S5 at depth is higher than it at the surface, the depth has no statistical effect on concentration (p value > 0.05).

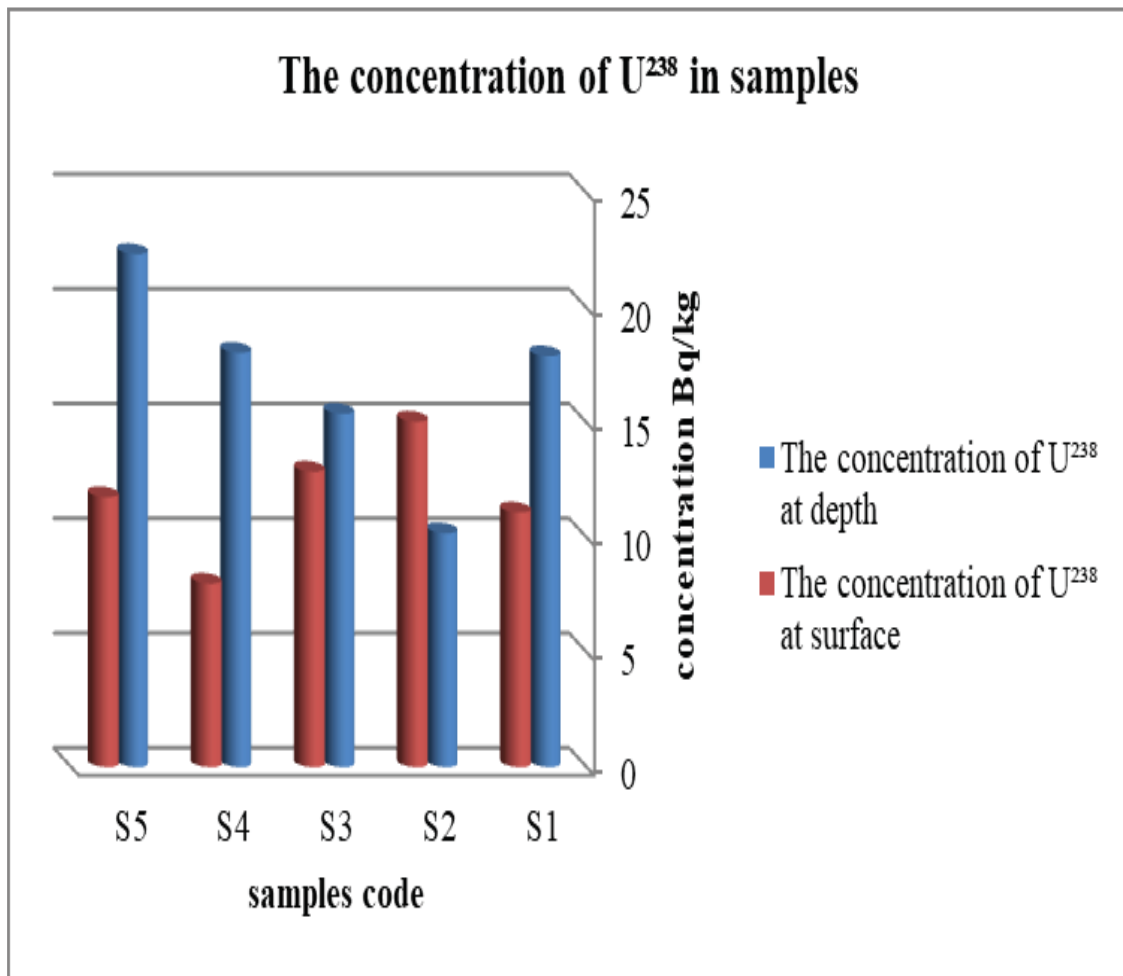


Fig 1: The concentration of U^{238} in samples

4.2- Th^{232} 's activity concentrations

Th^{232} concentration was measured by the samples, with a range of 1.04 ± 0.15 to 7.18 ± 0.52 Bq/kg (mean average = 4.78 ± 0.33 Bq/kg) at the surface and at the depth ranged from 3.12 ± 0.15 to 7.00 ± 0.34 Bq/kg as shown in fig 2. The highest concentration of Th^{232} is found in S5 at depth, with the lowest concentration being on the surface in S4. The results suggest that Th^{232} concentration is below the world's mean value (with a concentration of less than 45 Bq/kg). There isn't a significant relationship between the concentration of Th^{232} and U^{238} , K^{40} ($p.value > 0.05$). In this study, the result of Th^{232} concentration is lower than the results of Algattawi et al. (2019) for the same area referred to in the introduction. This implies that we need to re-investigate the area and collect numerous samples to eliminate any uncertainty in the future.

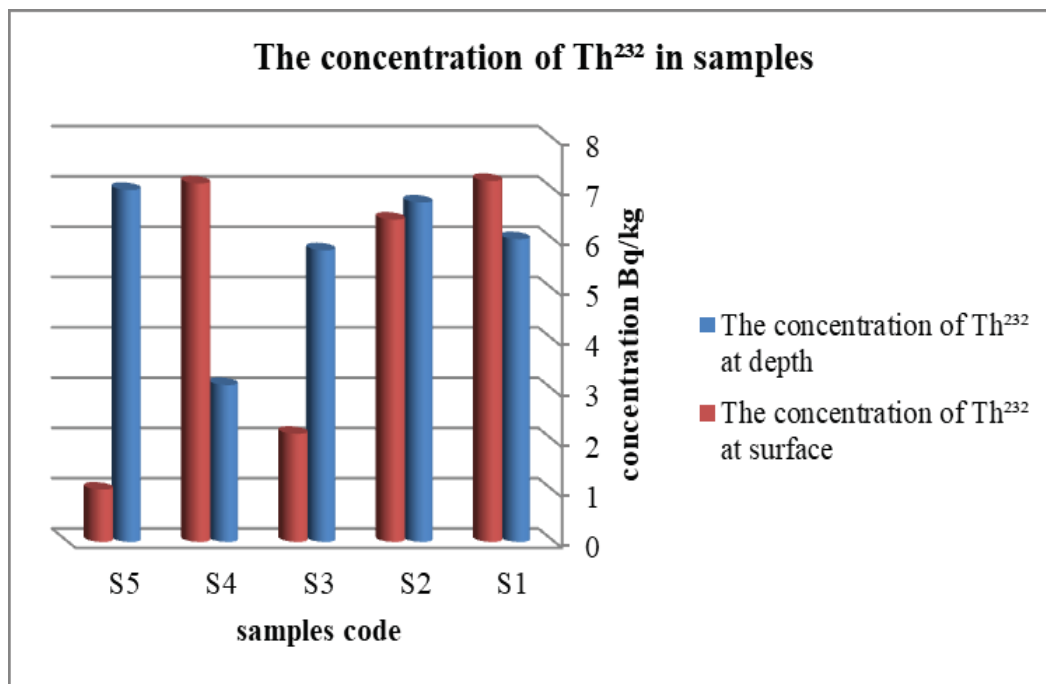


Fig 2: The concentration of Th²³² in samples

4.3- K⁴⁰'s activity concentrations

All samples had the signature gamma ray energy peak of K⁴⁰ at 1460.8 keV, which was observed at various concentrations. The average of K⁴⁰ concentration is 46.85 ± 2.34 to 163.42 ± 8.17 Bq/kg (mean = 106.30 ± 5.25 Bq/kg) at the surface. On the other hand, it is 42.96 ± 2.14 to 197.01 ± 9.85 Bq/kg (mean = 141.85 ± 5.99 Bq/kg) at a depth of 50 cm. The concentration of K⁴⁰ at 50 cm is more than it is at 15 cm according to this result (Fig 3). The decrease in K⁴⁰ concentration on the surface could be caused by wave movement. As evidenced by this result, the concentration of K⁴⁰ is less than the world limit (less than 240 Bq/kg).

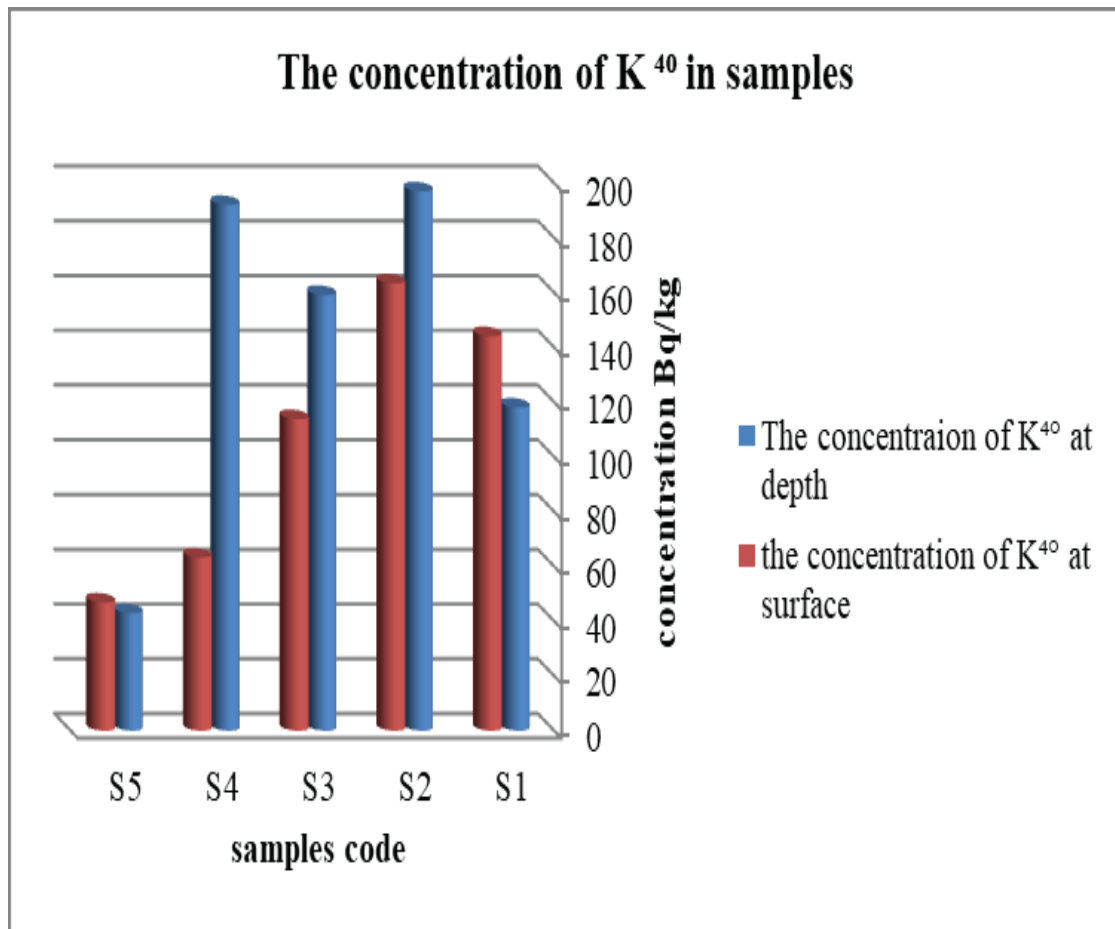


Fig 3: The concentrations of the K^{40} in samples

4.4- Analyzing the risk of radiation in the study area

Understanding the distribution and level of naturally occurring radionuclides is important because it offers valuable data for assessing the impact of radiation and monitoring environmental radioactivity. Since the majority of the radiation that humans are exposed to in their lifetime comes from natural sources. In addition, exposure to ionizing radiation is one of the scientific topics that attracts the attention of researchers. The risk associated with radioactive concentrations in the study area was assessed using a number of indicators, including the radium equivalent activity (R_{eq}), external radiation hazards index (H_{ex}), and absorbed dose rate (D^R). The following table (3) displays these indicators:

Table 3: Calculated R_{eq} , H_{ex} , and D^R for all samples

Samples code	Mean of concentration			R_{eq} Bq/kg	H_{ex} $\mu Sv/y$	D^R nGy/h
	U^{238} Bq/kg	Th^{232} Bq/kg	K^{40} Bq/kg			

S1	14.50	6.60	131.11	43.03	0.091	16.15
S2	12.62	6.58	180.21	35.91	0.096	17.31
S3	14.13	3.97	136.51	30.33	0.081	14.62
S4	13.02	5.13	127.66	40.36	0.109	18.74
S5	17.06	4.02	44.91	26.31	0.071	12.20
Mean	14.26	5.26	124.1	35.18	0.089	15.80
Std. Deviation	1.74	1.29	49.08	6.91	0.144	2.519

It was discovered that the radium equivalent activity (Raeq) values were less than the global mean values (370 Bq/kg), with a range of 26.31 to 43.03 Bq/kg. In order to determine if a study area is harmless in terms of measured radiation, it is necessary to have an external hazard index equal to or below one. This study found that there were different exposure rates for Hex (Hex) that ranged from 0.071 to 0.109 Sv/y, with a mean value of 0.089 Sv/y, which is also less than the safe limit value. The data indicates the absorbed dose rate (DR) was below the approved permitted limit of 55 nGy/h (UNSCEAR, 2000), which was 15.80 nGy/h on average and 12.20 to 18.74 nGy/h in range.

5-Conclusion

Germanium gamma-ray spectrometry was used to measure activity concentrations of U^{238} , Th^{232} , and K^{40} in sand samples collected on the coast of Qarabulli city. In general, the activity concentrations of natural radionuclides are less than the global limits, and the mean values are 14.26 Bq/kg for U^{238} , 5.26 Bq/kg for Th^{232} , and 124.07 Bq/kg for K^{40} at depth and surface. This investigation is carried out on around 60 km, which is a long coastline, and it is known that the naturally occurring radioactive material concentrations are very high due to the geological characterization and environment of different areas. Furthermore, the activity levels of natural radionuclides are higher at depth than at the surface, particularly for U^{238} radionuclides. Radiation hazards were assessed by calculating (the radium equivalent activity (Raeq), external radiation hazards index (Hex), and absorbed dose rate (D^R)), and the results were 35.18 Bq/kg, 0.089 μ Sv/y, and 15.80 nGy/h, respectively. Low levels of radioactivity are detected in all the sand samples collected near Qarabulli city, suggesting there are

no significant radiological hazards related to human activity in the region. In the end, any changes in the radioactivity background level in the study area can be tracked using all the obtained results as reference information. Although the study shows low levels of natural radioactivity, there are some recommendations that must be followed to protect people and the environment:

It is recommended to conduct periodic monitoring studies of radiation levels in the sandy beaches to ensure there is no increase in radioactive concentrations, especially with the rise of human activities such as tourism and investment in resorts.

Local governments should establish policies and regulatory procedures to ensure the safety of coastal areas from activities that may adversely affect radiation levels.

Further research is advisable to identify potential sources of radioactivity in the area and to understand their impact on public health and the environment.

6-References

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Model Reference Adaptive System for Speed Estimation of Permanent Magnet Synchronous Motors

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Abstract— This study introduces an methodology for estimating rotor speed in sensorless vector control of permanent magnet synchronous motor (PMSM). The proposed approach employs a model reference adaptive system (MRAS) estimator. Simulation outcomes reveal a high degree of agreement between the estimated and actual rotor speeds, especially at higher operational speeds. To tackle the difficulties encountered during low-speed operations, Incorporating a speed estimation technique using carrier-frequency excitation enhances the original control framework by improving the accuracy of speed estimates in PMSMs at low speeds, and minimizes disturbances from noise and motor parameters variation. The simulation results were conducted in the MATLAB/Simulink environment demonstrate that this enhanced approach is both stable and robust, effectively managing sudden variations in reference speed or position while adeptly countering load torque disturbances.

Keywords—*Model Reference Adaptive System MRAS; Carrier-Frequency Excitation CF; PMSM;*

I. INTRODUCTION

Permanent Magnet Synchronous Motors (PMSMs) are becoming increasingly popular in industrial applications because their efficiency, high power density, low inertia, and rapid operational capabilities. For instance, in applications like robotics or electric vehicles, where responsiveness is key, PMSMs excel.

To achieve precise control over speed and torque, these motors are typically managed by a voltage-controlled pulse-width modulation (PWM) inverter. This method allows for fine-tuning of the voltage and frequency supplied to the motor, enabling swift adjustments to speed and torque demands. For example, the ability to rapidly change motor speeds while maintaining torque is crucial for precise machining operations. This combination of PMSMs with PWM inverters makes them an ideal choice for such demanding applications.

Accurate knowledge of rotor position is indeed vital for implementing vector control in a PMSM. This information enables the control circuit to effectively sequence the supply switching to the stator phases, ensuring optimal performance. Achieving synchronism is crucial, as the switching frequency is directly tied to rotor dynamics[1]. Without a reliable rotor position sensor, maintaining this synchronism becomes challenging, compromising the motor's efficiency and responsiveness. This need for precise rotor position data underscores the importance of sensors in high-performance applications, despite the associated drawbacks of using them.

The integration of position sensors in motor systems presents several drawbacks, including increased motor dimensions and costs, the necessity for specialized mechanical mounting configurations, susceptibility to temperature fluctuations, and speed limitations of approximately 6000 rpm for certain sensor types. Specifically, resolver rotor position transducers require additional external circuits to deliver precise positional data. Furthermore, it is not always feasible to install a position sensor on the motor itself. Consequently, there has been a growing interest in position sensorless methodologies in recent years [1].

Numerous techniques have been put forth for estimating speed of rotor in motors. Several of these techniques entail examining the voltage and current waveforms of the motor in order to calculate the rotor speed or position using terminal values [1,2]. Nevertheless, the robustness of

these approaches is impacted by their sensitivity to motor parameters. For rotor speed and position estimation, an alternative method recommends applying the extended Kalman filter methodology [3,4]. However, there are disadvantages to this approach, including parameter sensitivity and computing load. A third method involves using state observers to create sensorless control for PMSM drives [5-7]. These observers serve as algorithms that assess the d-axis and q-axis stator currents, as well as rotor speed and position, they utilize current and voltage measurements in the rotor frame to create a real-time estimate of the motor's mechanical and electrical states. Another strategy has also been proposed [8], which makes use of a model reference adaptive system with an adaptive line enhancer. But there are drawbacks to this approach as well, such the online computational load and the difficulty of creating a switching law. There has been another method put forth [9] that is based on a model reference adaptive system. It's crucial to remember that speed tracking may be less effective at low speeds and standstill and that delays may result from initialization problems.

The scientific community is actively investigating the challenges posed by standstill and low-speed operations in electric motor systems. A variety of strategies have been proposed to address these problems, including the application of motor saliency[10] and the utilization of state observers[5]. Another effective approach to the zero-speed problem involves integrating a rotor flux observer with data from Hall effect sensors[7]. A novel method has emerged that utilizes an adaptive observer in conjunction with carrier frequency signal injection to enhance performance at low speeds[12]. Additionally, utilizing the fundamental excitation method not only enhances the accuracy of rotor position estimation but also contributes to the overall dynamic performance and reliability of motor control systems.

This paper introduces a novel methodology for the estimation of rotor speed and position in PMSMs utilizing a MRAS estimator, enhanced by the incorporation of a Carrier Frequency (CF) excitation. The MRAS framework operates effectively across the entire speed spectrum, while the CF excitation method is specifically implemented at lower speeds to enhance the stability of the MRAS. The integration of these techniques involves the manipulation of the direction of the estimated stator flux. Comprehensive simulations and performance analyses were carried out within the MATLAB/Simulink environment,

which validate the effectiveness of the proposed method across varying speed and torque conditions.

II. MATHEMATICAL MODEL OF PMSM

In the Park reference frame that is aligned the rotor, the classical electrical and mechanical equations of a PMSM can be outlined as follows:

$$v_d = R_s i_d + \frac{d\lambda_d}{dt} - \omega_e \lambda_q \quad (1)$$

$$v_q = R_s i_q + \frac{d\lambda_q}{dt} + \omega_e \lambda_d \quad (2)$$

In these equations, v_d and v_q denote the stator voltages, while i_d and i_q indicate the corresponding stator currents. The parameter R_s signifies the stator resistance, and $\omega_e = d\theta_e/dt = P\omega_r$ represents the electrical angular speed of the rotor, where θ_e is the rotor position, ω_r is the mechanical angular speed of the rotor, and P denotes the number of pole pairs.

The stator flux linkage components are defined as follows:

$$\lambda_d = L_d i_d + \lambda_f \quad (3)$$

$$\lambda_q = L_q i_q \quad (4)$$

In these expressions, L_d and L_q denote the inductances associated with the d-axis and q-axis, respectively, while λ_f represents the flux linkage due to the permanent magnet.

The mechanical motion of the PMSM can be described by the equation:

$$T_e = j \frac{d\omega_r}{dt} + B \omega_r + T_L \quad (5)$$

In this equation, T_e represents the electromagnetic torque produced by the motor, which is given by:

$$T_e = (3/2)P[\lambda_f i_q + (L_d - L_q)i_d i_q], \quad (6)$$

and j , B , and T_L are rotor moment of inertia, viscous friction coefficient, and load torque respectively.

The equation (6) reflects how the electromagnetic torque arises from the interaction between the stator currents i_d and i_q and the rotor's magnetic flux λ_f , with contributions from the inductance difference ($L_d - L_q$). This relationship captures the dynamic response of the motor under different loading conditions.

III. MODEL REFERENCE ADAPTIVE SYSTEM STRUCTURE

In the context of MRAS, the stator flux vector is utilized as the error vector to generate an estimate of the rotor speed. This estimate is crucial

for enabling vector control of PMSM. The fundamental implementation of the MRAS that employs the stator flux as the error vector is illustrated in Fig.1. This system builds on the ability to derive the stator flux from either the current or voltage equation model. The flux estimate generated by the current equation model (λ_s^*) is not influenced by rotor speed and functions as a reference model. In contrast, the voltage equation model yields a flux estimate that is inherently dependent on rotor speed. As a result, the rotor speed in the voltage equation model can be fine-tuned to bring the error function reflecting the difference between the estimated fluxes down to zero, ensuring greater accuracy in the flux estimation.

The equations for the stator flux linkage components serve as a reference model, known as the current equation model. In this framework, the estimated components are indicated with an asterisk *, highlighting the differentiation between actual and estimated values. If the stator flux linkage represented as λ_s , the estimated components would be denoted as λ_s^* . This notation helps in comparing the performance of the model against actual measurements.

$$\begin{bmatrix} \lambda_d^* \\ \lambda_q^* \end{bmatrix} = \underbrace{\begin{bmatrix} L_d^* & 0 \\ 0 & L_q^* \end{bmatrix}}_L \begin{bmatrix} i_d \\ i_q \end{bmatrix} + \begin{bmatrix} \lambda_f^* \\ 0 \end{bmatrix} \quad (7)$$

The stator voltage equation in the d-q reference frame, serving as an adaptive model (the voltage equation model), can be expressed as:

$$\frac{d}{dt} \begin{bmatrix} \hat{\lambda}_d \\ \hat{\lambda}_q \end{bmatrix}_v = -\hat{R}_s \underbrace{\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}}_I \begin{bmatrix} \hat{i}_d \\ \hat{i}_q \end{bmatrix} - \hat{\omega}_e \underbrace{\begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}}_J \begin{bmatrix} \hat{\lambda}_d \\ \hat{\lambda}_q \end{bmatrix} + \underbrace{\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}}_I \begin{bmatrix} v_d \\ v_q \end{bmatrix} \quad (8)$$

where the estimated components are denoted by the caret symbol ^ to signify their estimated nature, the estimate of the stator current can be written as:

$$\begin{bmatrix} \hat{i}_d \\ \hat{i}_q \end{bmatrix} = \begin{bmatrix} L_d^{-1} & 0 \\ 0 & L_q^{-1} \end{bmatrix} \begin{bmatrix} \lambda_d^* - \lambda_f^* \\ \lambda_q^* \end{bmatrix} \quad (9)$$

This model allows for real-time adaptations based on the current and voltage measurements, improving control in applications like variable-speed drives.

The error function is characterized as the discrepancy between the flux estimates presented in equations (8) and (7), and it can be formulated as follows:

$$\varepsilon = \lambda_s^* - \hat{\lambda}_s \quad (10)$$

In this context, the estimated electrical angular rotor speed $\hat{\omega}_e$, serves as the adaptive parameter within the adjustable model referenced in equation (8). This estimate is derived through a proportional-integral (PI) adaptation mechanism, expressed mathematically as:

$$\hat{\omega}_e = -k_p \varepsilon - k_i \int \varepsilon dt \quad (11)$$

Here, k_p and k_i represent nonnegative gains of the PI controller.

A. Carrier-Frequency Excitation Technique: An Analytical Approach

A voltage excitation signal characterized by an amplitude v_c and rotating at an angular frequency ω_c is employed [11]. This signal is defined by the following equation:

$$v(t) = v_c \sin(\omega_c t) \quad (12)$$

The excited voltage is subsequently applied to the estimated d-axis stator voltage. Consequently, the steady-state current component along the estimated q-axis, obtained from the band-pass filtering (BPF) of the q component of the measured stator current, results in a current signal i_{qc} that oscillates at the carrier frequency, corresponding to the voltage excitation signal frequency. This current component can be expressed mathematically as[11]:

$$i_{qc} = \frac{v_c(L_q - L_d) \sin 2\tilde{\theta}_e}{\omega_c 2L_d L_q} \cos(\omega_c t) \quad (13)$$

In this equation, $\tilde{\theta}_e = \theta_e - \hat{\theta}_e$ represents the rotor position error.

To bring the rotor position error $\tilde{\theta}_e$ to zero, a demodulation scheme is employed, as illustrated in Fig. 2. This process involves demodulating the current signal followed by low-pass filtering (LPF) to obtain a deviation signal δ . The deviation signal is defined mathematically as follows[11]:

$$\begin{aligned} \delta = LPF(i_{qc} \cdot \cos(\omega_c t)) &= LPF\left(\frac{v_c(L_q - L_d) \sin 2\tilde{\theta}_e}{\omega_c 2L_d L_q} \left(\frac{1 + \cos 2\omega_c t}{2}\right)\right) = \\ &\frac{v_c(L_q - L_d)}{\omega_c 4L_d L_q} \sin 2\tilde{\theta}_e \end{aligned} \quad (14)$$

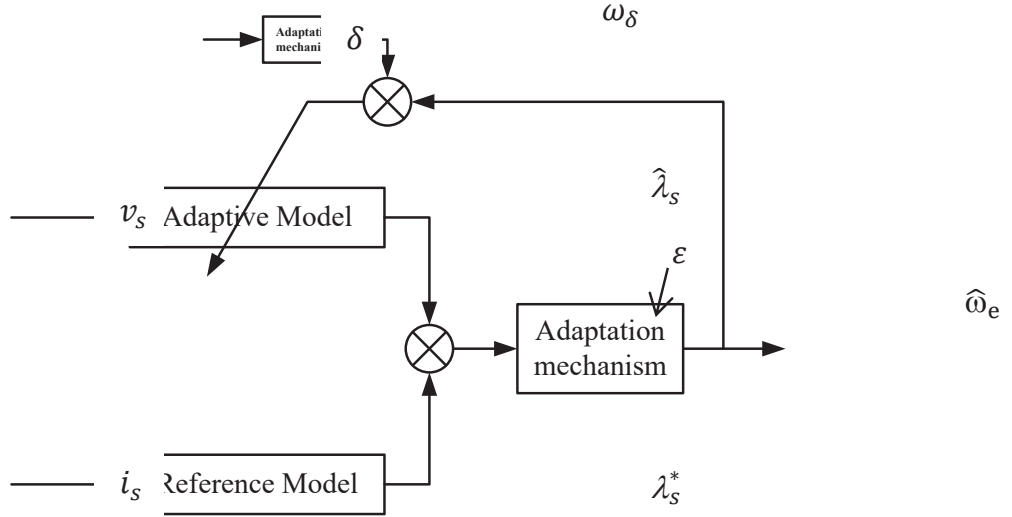


Fig. 1. Schematic diagram of MRAS enhanced with deviation signal from CF excitation technique.

After low-pass filtering, which effectively removes the high-frequency term $\cos(2\omega_c t)$, the resulting expression simplifies to:

$$\delta \approx \frac{v_c(L_q - L_d)}{2\omega_c L_d L_q} \tilde{\theta}_e \quad (15)$$

□ □ □ A □ Co □ □ ine □ □ ith Carrier-Frequency Excitation Technique

Insufficient precision in measurements and parameter estimates at low speeds can lead to orientation errors in MRAS that surpass acceptable limits, resulting in unstable operation. To mitigate this issue, the Carrier-Frequency (CF) excitation technique is utilized to correct the orientation by influencing the direction of the stator flux estimate. This method effectively enhances the accuracy of the flux estimation, particularly in low-speed scenarios, thereby improving overall system stability[12].

Fig. 1 illustrates the schematic diagram of the MRAS enhanced with the (CF) excitation technique. In this setup, the deviation signal δ is crucial for adjusting the adaptive model (8), through the following dynamic equation:

$$\frac{d}{dt} \begin{bmatrix} \hat{\lambda}_d \\ \hat{\lambda}_q \end{bmatrix}_v = -\hat{R}_s \underbrace{\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}}_I \begin{bmatrix} \hat{i}_d \\ \hat{i}_q \end{bmatrix} - (\hat{\omega}_e - \omega_\delta) \underbrace{\begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}}_J \begin{bmatrix} \hat{\lambda}_d \\ \hat{\lambda}_q \end{bmatrix} + \underbrace{\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}}_I \begin{bmatrix} v_d \\ v_q \end{bmatrix} \quad (16)$$

The correction term ω_δ is generated via a Proportional-Integral (PI) adaptation mechanism defined by:

$$\omega_\delta = \beta_p \delta + \beta_i \int \delta dt \quad (17)$$

Here, β_p and β_i are the proportional and integral gains of the PI mechanism, respectively. This feedback loop allows the system to effectively minimize the error signal δ to achieve stable operation, particularly in low-speed conditions where precision is paramount.

The process of speed estimation at low speeds is influenced by both the MRAS estimator and the carrier-frequency excitation technique. In steady-state conditions, the MRAS is predominantly utilized, while the carrier-frequency excitation technique plays a crucial role during transient periods. As the rotor speed exceeds a specific threshold, the estimation relies solely on the $\sin(\omega_c t)$ methodology.

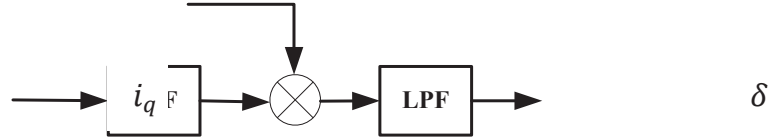


Fig. 2. Block Diagram Illustrating the Demodulation Scheme.

IV. CONTROL SYSTEM

Fig. 3 presents the block diagram of the control system, which integrates cascaded speed and current control loops. The current control loop is implemented using a proportional-integral (PI) controller operating within the estimated reference frame. This configuration facilitates the effective decoupling of cross-coupling terms and the back electromotive force (back-EMF)[13-14].

In Fig. 3, the control system is organized into two primary feedback loops, one for speed control and the other focused on managing d-q currents. The speed error is processed by the speed controller, which produces the torque current command $i_{qref.}$. To achieve proper field orientation, the flux current command $i_{dref.}$ is maintained at zero. The reference currents $i_{dref.}$ and $i_{qref.}$ are then compared to their actual measured values, and the resulting errors are utilized to create the voltage commands $v_{dref.}$ and $v_{qref.}$. These voltage commands are subsequently transformed into three-phase reference values v_a , v_b , and v_c within the stator frame. Finally, these voltage signals are compared with a triangular carrier signal, and the resulting output logic is employed to modulate the PWM inverter, thereby ensuring efficient operation and precise control of the overall system.



environment. The motor model employed the parameters specified in Table I. The carrier-frequency excitation signal was defined by a frequency of 1 kHz and an amplitude of 50 V.

Rated power	2.2 kw
Rated voltage U_N	380V
Rated current I_N	4.1A
Rated speed	1500 r/min
Rated torque T_N	15.0 Nm
Number of pole pairs p	3
Stator resistance R_s	3.61Ω
Direct axis inductance L_d	0.037H
Quadrature inductance L_q	0.052H
Flux of permanent magnet λ_f	0.555 Vs
Total moment of inertia	0.015kgm^2

255

deviation from the actual rotor speed during the transient phase, indicating a satisfactory level of speed estimation at low speeds. However, notable ripples in the steady state are evident, attributed to discrepancies in the measured phase currents and the sensitivity of carrier signal injection to the nonlinearity of the inverter.

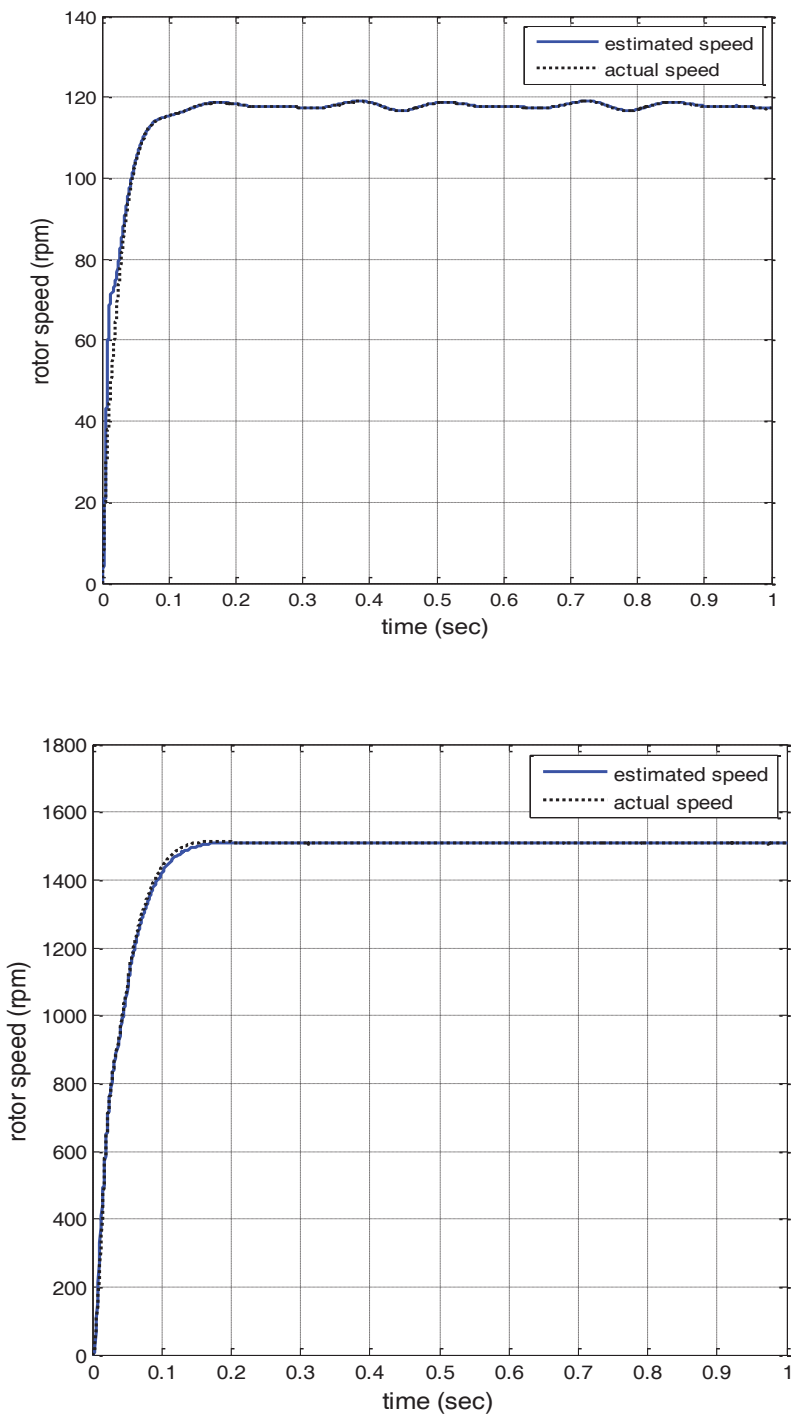


Fig. 4. Estimated and actual rated rotor speed.

Fig. 5. Estimated and actual low rotor speed.

The graphs in Figs. 6 and 7 show the dynamics of estimated and actual speeds when the reference speed is set to the rated value of 1500 rpm at $t = 0$ sec, and then reshifted to a low speed of 120 rpm also at $t = 0$ sec, under rated load torque. At high speeds, the estimated rotor speed closely follows the actual rotor speed, displaying minimal steady-state error. However, during transient phases, there is a slight deviation between the estimated and actual speeds, alongside significant ripples in the steady-state response. This highlights the challenges in maintaining precision during rapid changes in speed while achieving good performance at steady-state conditions.

Fig. 8 illustrates the estimated and actual speed responses under nominal load torque, showcasing the rotor's performance during stepwise changes in reference speed. Initially, the reference speed increased from zero to 200 rpm at $t = 0$ sec, followed by a rise to 600 rpm at $t = 0.2$ sec, a drop to 300 rpm at $t = 0.6$ sec, and finally returning to zero at $t = 0.8$ sec. The estimated rotor speed impressively tracked the actual speed throughout these rapid changes, highlighting its robustness and responsiveness to swift fluctuations even under nominal load conditions. This capability reflects the effectiveness of the control algorithm in maintaining synchronization during dynamic operations.

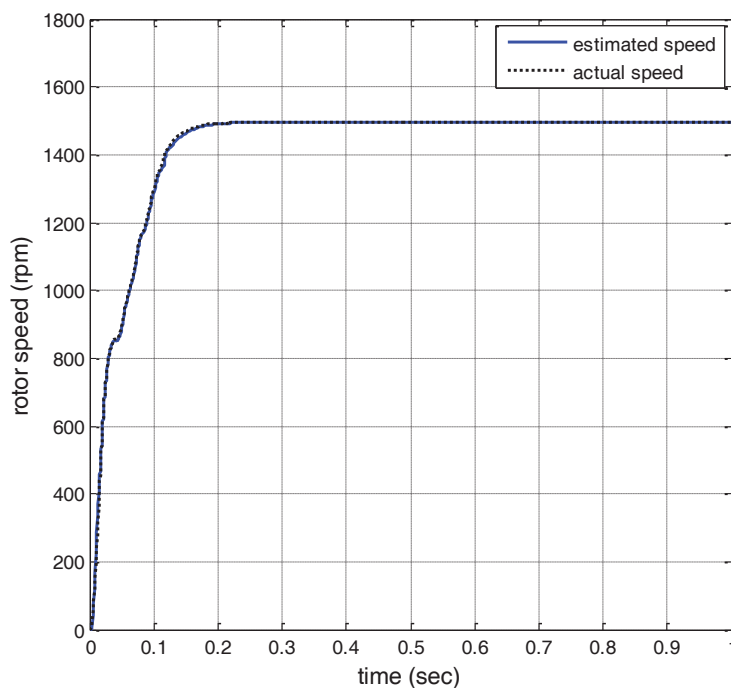


Fig. 6. Estimated and actual rotor rated speed response under rated load torque.

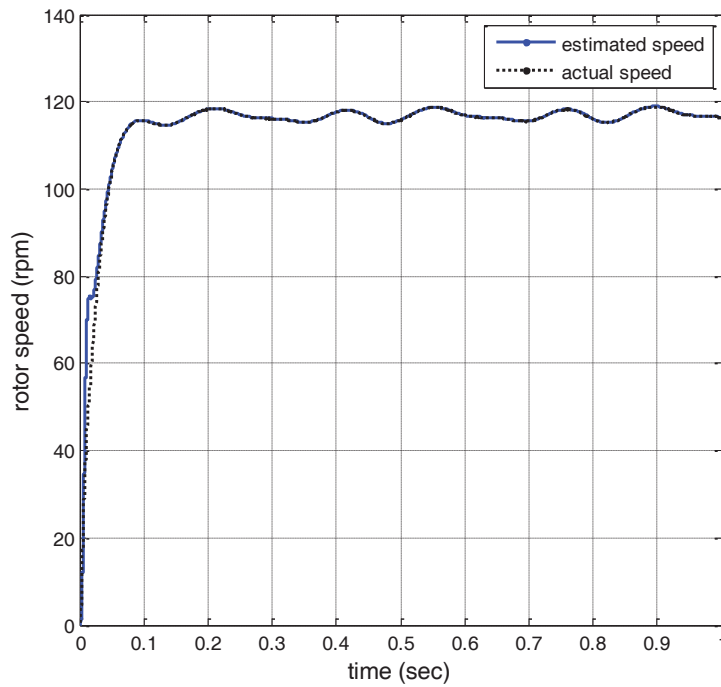


Fig. 7. Estimated and actual rotor speed response under rated load torque.

Fig. 9 depicts the system's impressive response to a rapid reverse step change. At $t = 0.2$ sec, the reference speed jumps from zero to 400 rpm, then reverses to -400 rpm at $t = 0.5$ sec, and lastly returns to zero at $t = 0.8$ sec. Throughout these abrupt changes, the estimated rotor speed closely mirrored the actual speed, demonstrating the system's capability for rapid tracking of the reverse reference speed. The performance of the MRAS and control mode is notably exceptional, effectively managing the transitions and ensuring minimal lag or deviation. This indicates a high level of control accuracy and responsiveness in dynamic conditions.

Fig. 10 presents the simulation results obtained when the reference speed was altered from zero to 1000 rpm at $t = 0$ sec, while the load torque was modified from zero to 7 Nm at $t = 0.5$ sec. The results depicted in Figure 10(a) demonstrate a strong agreement between the estimated and actual rotor speed values during the variation in load torque, indicating a remarkable ability to mitigate rapid load disturbances. Furthermore, Fig. 10(b) illustrates the response of the load torque.

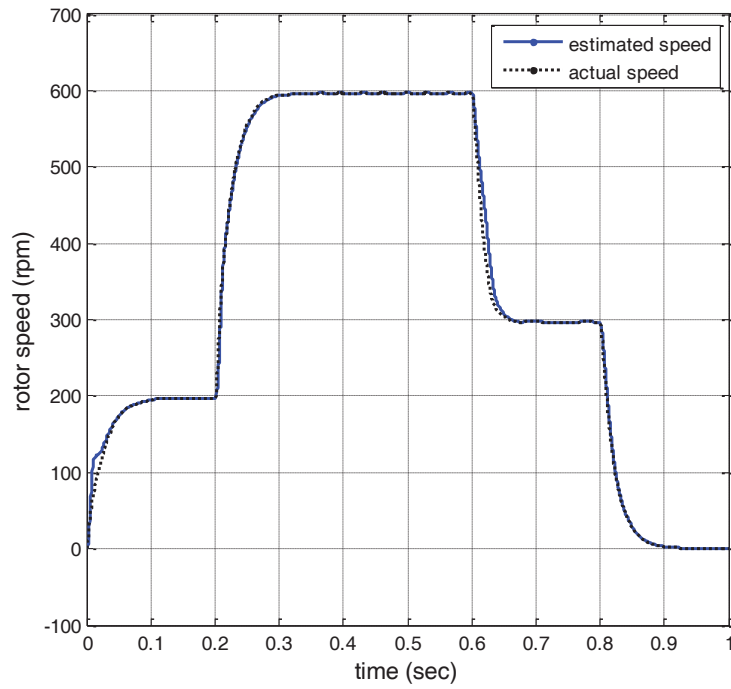


Fig. 8. Estimated and actual rotor speed response to multistep change.

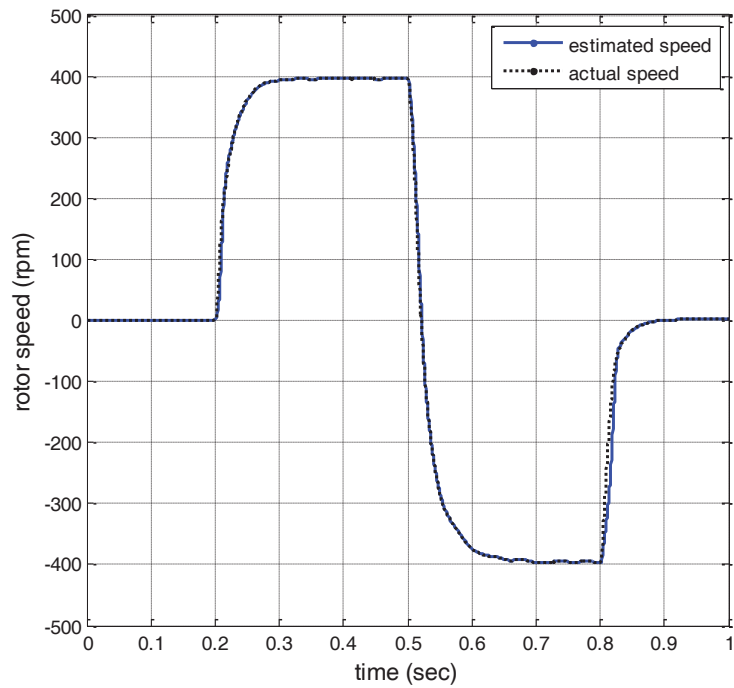


Fig. 9. Estimated and actual rotor speed response to fast revers step

In the assessment of the proposed sensorless scheme's reliability, three motor parameters were modified: winding resistance was

increased by 20% ($R_s \rightarrow 1.2R_s$), flux linkage was reduced by 10% ($\lambda_f \rightarrow 0.9\lambda_f$), and the moment of inertia was doubled ($j \rightarrow 2j$). As shown in Fig. 11, when the reference speed was increased from zero to 1300 rpm at $t = 0$ sec, the system effectively tracked the actual rotor speed throughout most of the speed range, except during startup. This startup discrepancy arose from the MRAS's imperfect estimation in the transient state, which caused signal distortion. Additionally, the high system gains exacerbated the distortion of estimated signals during this initial phase. Notably, the robustness of the proposed scheme was validated across both low and high speeds, even in the presence of parameter mismatches, emphasizing its resilience under varying operational conditions.

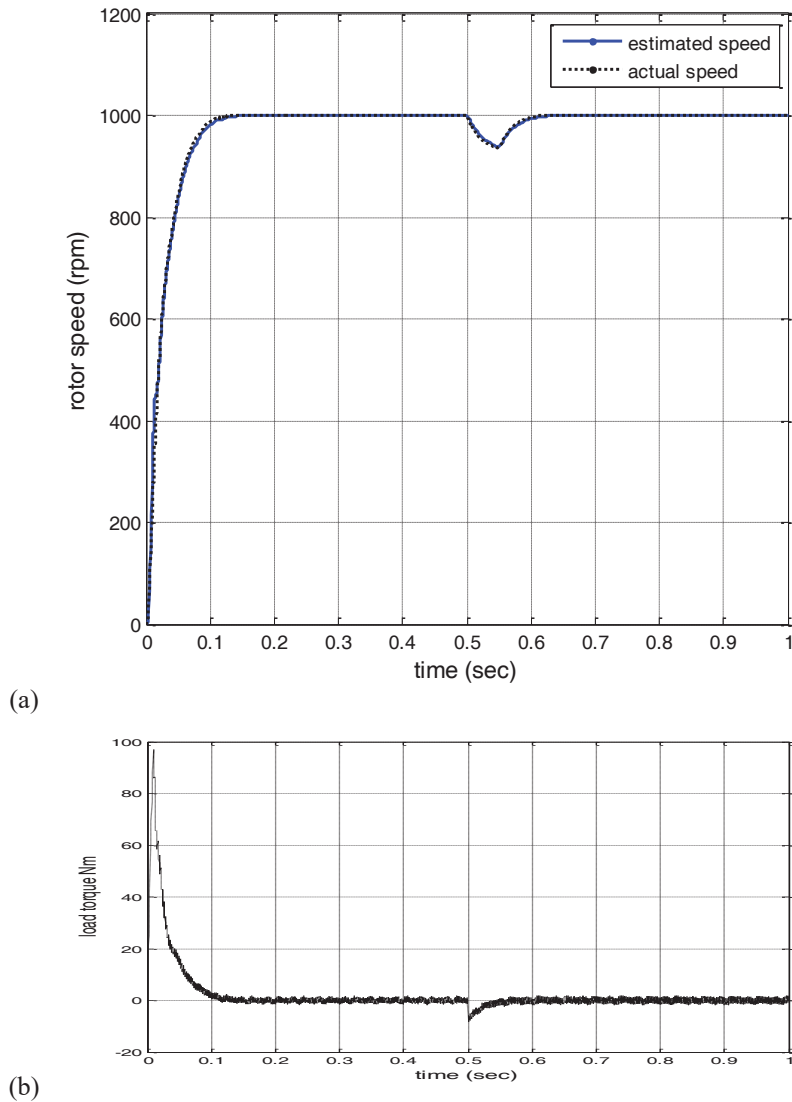


Fig. 10. (a) Speed response and (b) Load torque with step change in LT.

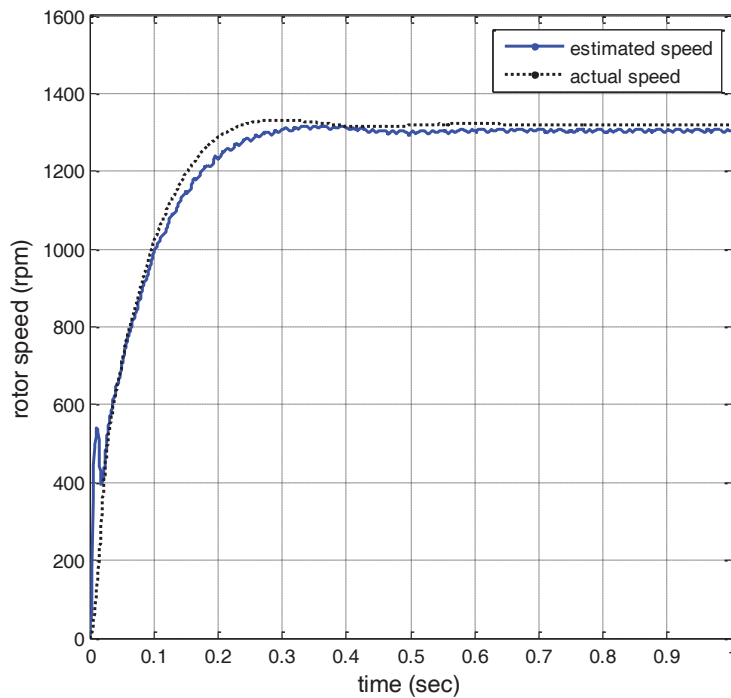


Fig. 11. Estimated and actual rotor speed response with mismatched Parameters.

VI. CONCLUSIONS

The speed and position of a PMSM can be accurately estimated across a wide range of speeds, including at zero speed, by employing a MRAS. Simulation results reveal a strong agreement between the estimated and actual rotor speeds at high speeds. However, utilizing measured stator voltages and currents as inputs to the MRAS estimator leads to estimation difficulties at low speeds and during standstill conditions. To overcome these challenges, a speed estimation technique based on the carrier-frequency excitation method was integrated into the original control scheme. Simulations indicate that the proposed method is stable, robust, and effective in handling abrupt changes in reference speed or position, as well as proficient in rejecting load torque disturbances.

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Adaptive antenna array for improved SNR in MIMO communications

10x4 adaptive antenna array

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Abstract— In an ever demanding world of information, antenna seems to play a big part in the transmission and reception of information. The demand for more data however, places demand on the antenna propagation method. More and more data, with ever increasing speed tops the list of customer demands in recent times. Hence the need for improvement in its size and speed of data transmission. The solution seems to have arrived early, as a more investigation and exploration of the applications of antennas continue to provide alternate ways for improvement of communication services globally.

Multiple input and Multiple (MIMO) Output offers a helping hand to these ever increasing demand, as researchers propose the use of massive MIMO as a propagation means for the sending and receiving of large amount of data to service multiple users at the same time. As a contribution to existing research, this paper seeks to explore the use of beam forming antenna array towards power transmission of large amount of data. The antennas in array helps to focus the beam to specific users, which minimal losses and optimal gain. Here, multiple information is propagated using dedicated channels. While the throughput of communication service favors the suppliers, we seek to ensure optimum customer services.

Keywords—component; Adaptive antenna array; transmission; communications;

INTRODUCTION (*HEADING 1*)

MIMO has emerged as a promising technological solution which uses multiple input, multiple output (MIMO) of various antennas combined to meet the increased demands for large data and efficiency. However, existing MIMO applications are only apply few antennas which generally tend to worsening modeling results. Hence, new research

focuses on higher-channel MIMO systems, also known as Massive MIMO. These new models are built based on the knowledge that increase in the number of antennas can significantly increase the gain in spectral performance and provide power and reduce power consumption in the base station. However, significant research is still necessary to define and solve the technical problems that remain between words installation on massive MIMO and commercial systems.

Scientists have already made significant progress in some areas of MIMO mass research. New groups from Bristol University in the UK and Lund University in Sweden Demonstrated the feasibility of massive MIMO technology using 128 base station antennas, using a beam format for simultaneous communication with the user 22 at the same time and frequency. The demonstration provided the basic elements like large scale MIMO arrays that can provide significant gains at 5G. This displays the massive power which results from the application of more and more transmission antennas.

MIMO basically involves the use of multiple antennas to transmit multiple streams of information in a simple communication system. According to Thomas L, etc, communication with several systems at the same indicates the application of MultiUser, MU-MIMO. The application of hundreds of antennas simultaneously is referred to as Massive MIMO. Massive MIMO basically builds on the already existing MIMO but opens up a larger coverage for future enlargement. Communications in its self involves the basic things we do with internet. Hence, an enlargement in the future is built to affect applications bordering around internet of things. Meaning, an improvement in this data transmission and reception processes, will change the world forever.

Massive MIMO depends heavily on base stations and uplink and downlink channels. The downlink channels are considered heavily burdened in massive MIMO. This is due to the number of time-frequency resources needed, which almost competes with the number

of antennas present. This forces the Massive MIMO to transmit and receive data using hundreds of antennas in arrays.

PREVIEWS

(Paper 2017) The white paper, analyses various hot topics that have emerged over the decade. Noting the recent mass interest in the improvement of communication experience, using the various solution methods in MIMO. The paper also examines the software that have been created so as to aid the fine analysis of its parameters in order to achieve desired result. It highlights the success recorded during the MIMO test run by a combined team from Bristol and Lund University, which used beam forming method to communicate with 22 users at the same time. This speaks volumes of the success rate that will be achieved as more and more researches continue raise new methods of enhancing the output of transmitted data.

(Larsson et al. 2013) presents an overview of MIMO applications and the prospects for the next generation. It considers massive MIMO as a critical application of antennas and also looks to optimization of antenna values and properties as a viable means of improving MIMO to its capacity. Larsson clearly exposes the untapped potentials of the MIMO as a recent revelation that can significantly increase the capacity up to 10 times of its original capacity, and can at the same time improve the radiated energy-efficiency to the tune of over 100 times.

(Paul & Bhattacharjee n.d.) Here, an S-parameter based approach for MIMO computation is proposed. This method relies on the channel matrix using half wave dipoles for improvement of MIMO output. The results collected during the research is compared with existing results of previous researches. The paper went on to model a dual polarized system.

METHODOLOGY

This method applies beam forming as a means of enhancing directivity of the transmitting section of the MIMO wireless system. The block diagram consists of a baseband transmitter, transmit antenna array,

channel, receive antenna array RF receiver and a baseband processing receiver mask. A 4X4 antenna array is used for transmission in the first simulation while a 10X4 antenna array is used for transmission in the second simulation. The results are as shown below. Authors and Affiliations.

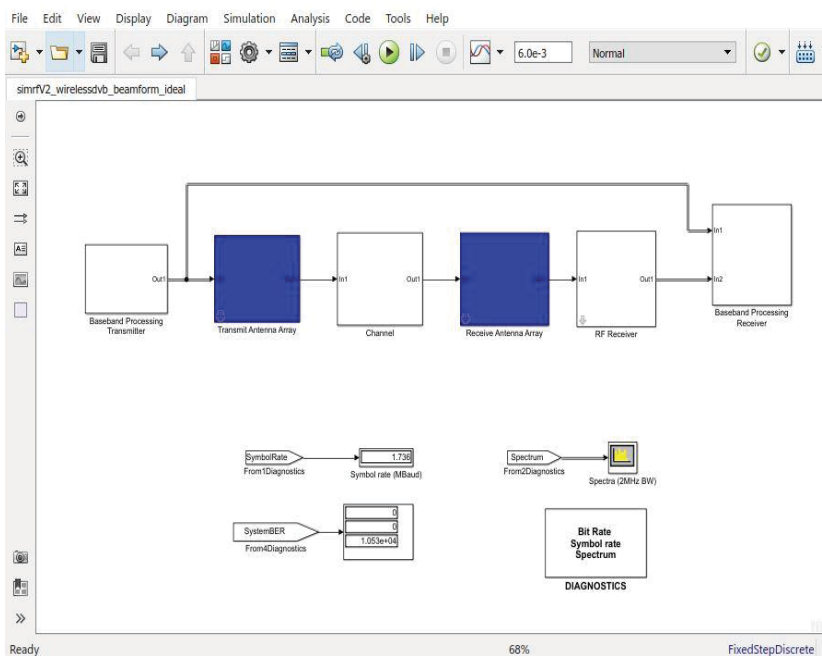
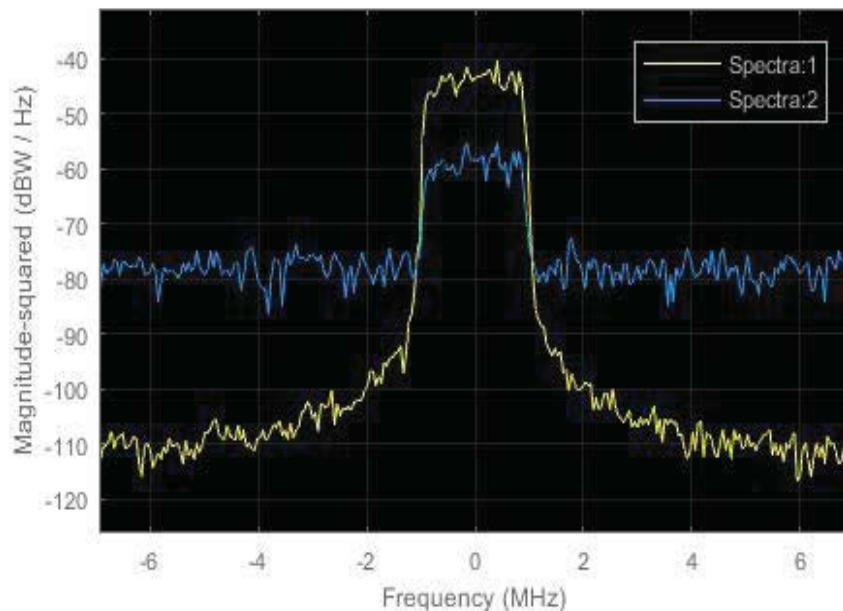
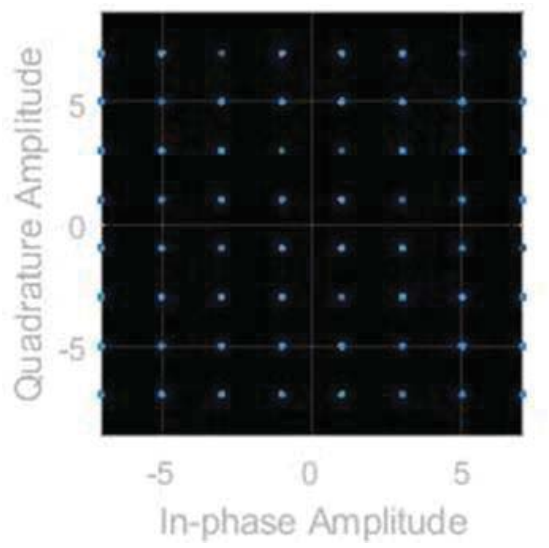


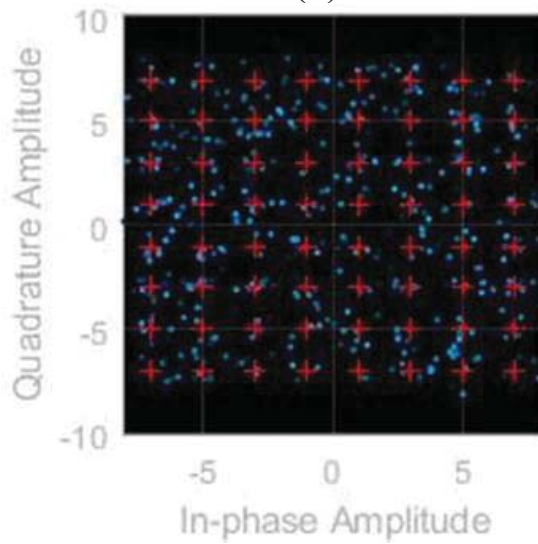
Fig.1 Block diagram of Model



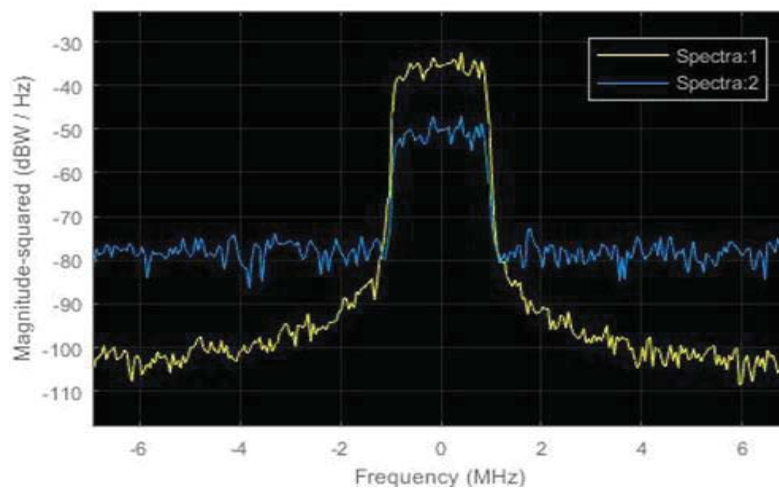
(a)

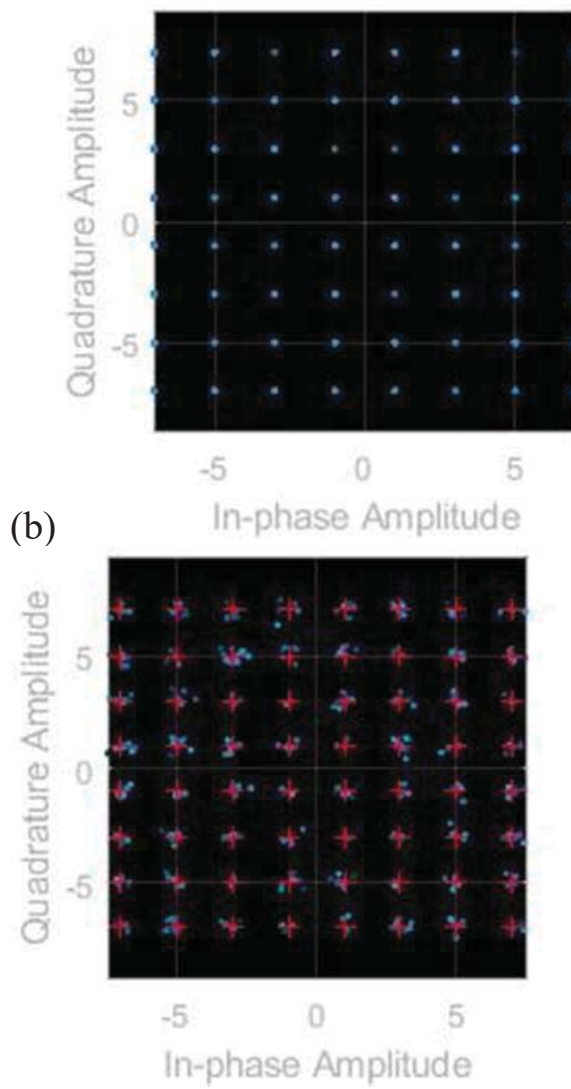


(b)



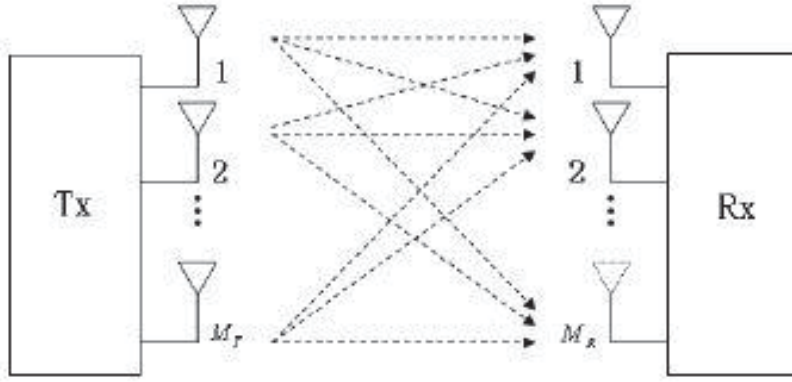
(a) Data transmission power in amplitude (b) transmitted data (c) received signal





(c)
Fig.3 10x10 antenna (a) Data transmission power in amplitude (b) transmitted data (c) received signal

VI. ARRAY SCATTERING PARAMETER



As explained above, a 10 X 10 adaptive antenna array is employed to refine the output signal towards achieving high SNR.

As shown above, the Tx represent the transmission antennas, while Rx represents the receiving antennas. The antennas are arranged in array 10 X 10, and the scattering of the antennas is as follows.

Let $X = [x_1, x_2, x_3, \dots, x_{M_T}]$, transmission antennas

$Y = [y_1, y_2, y_3, \dots, y_{M_R}]$, receiving antennas

The cross vectors becomes n . where n represents the number channels produced using the transmission and the receiving antennas. It is represented by the matrix

$$n = [n_1, n_2, n_3, \dots, n_{M_T}]$$

From these two array antennas, we can form a matrix of $M_T \times M_R$ which represents the number of channels formed. This is shown in the below equation. Here, we assume H to be the response of the channels from (i to j). that is from transmitter to receiver.

$$H = \begin{bmatrix} h_{1,1} & \dots & h_{1,M_T} \\ \vdots & \ddots & \vdots \\ h_{x,1} & \dots & h_{M_R,M_T} \end{bmatrix}$$

In this paper, the S_{11} scattering is show to have improved greatly. We also know that the bit rate depends on the SNR, this is related using the formula;

$$BER = f(SNR, g(\alpha, \beta), m)$$

Where,

$$g(\alpha, \beta) = \begin{cases} a & , \quad \alpha = 2, \beta = 2 \\ b & , \quad \alpha = 2, \beta = 4 \\ c & , \quad \alpha = 2, \beta = 4 \end{cases}$$

Here, α & β are the number of antennas for transmission and number of antennas for reception consecutively. m represents the type of modulation applied. For the simulation of our proposed transmission system, AM is used.

With SNR of 20dB, and antenna matrix of 10 X 4, the Bit per Error rate shows a high rate of about 1.053×10^{-4} with a minimal power of 8.3mW.

VII. CONCLUSION

ADAPTIVE BEAM FORMING ANTENNA ARRAYS NOW TAKES CENTER STAGE IN THE WORLD OF COMMUNICATIONS ALMOST ALL APPLICATIONS IN THE COMMUNICATIONS INDUSTRY MAY NEED THE SERVICES OF ANTENNAS. FROM THE ABOVE RESULTS, WITH A SYSTEM BER OF 1.053×10^{-4} AND SNR OF WE ARE ABLE TO ACHIEVE SIGNIFICANT GAIN OF OVER -40dB AND DIRECTIVITY WITH THE HELP OF BEAM-FORMING .

IN CONCLUSION, IT HAS BEEN EFFECTIVELY SHOWN, THAT THE RECEIVED SIGNAL CAN BE SIGNIFICANTLY IMPROVED BY USING BEAM FORMING ADAPTIVE ANTENNA ARRAY AS TRANSMITTER AND RECEIVER. THE REPLACEMENT OF THE CONVENTIONAL ADAPTIVE ANTENNA IS A NOVEL IMPROVEMENT TOWARDS ACHIEVING QUALITY SIGNAL. THIS IS DONE BY RAISING THE POWER OF THE REQUIRED SIGNAL AS SHOWN BELOW, USING THE INSTRUMENT OF GAUSSIAN NOISE AND A THRESHOLD OF ABOUT -50dB IS USED TO FILTER THE EXCESS NOISE.

THIS PROCESS COULD LEAVE US LOSING A LOT OF INFORMATION, BUT IN THE END FURTHER WORK ON THIS TOPIC COULD IMPROVE UPON THE MODEL.

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Design and Implementation of Sun Tracking System Using Arduino Board

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Abstract:

Previously, photovoltaic panels were installed at a specific inclination angle so that they were exposed to the greatest possible amount of solar radiation throughout their operation. Scientists have found that the productivity of photovoltaic panels can be increased by making them maintain a maximum vertical angle with the radiation falling on them. This is achieved through solar trackers (solar tracking devices), known as “Solar Tracking Devices or Solar Trackers.”

In this paper, the sun's movement table was used to design and implement a sun tracking system in two axes, by operating two servo motors to achieve moving in two-axes at Azimuth and Altitude angles. Arduino board was programmed by listing the Azimuth and Altitude angles of the sun's movement on a specific day of the year, Obtained data and angles was by using the (Astronomical Applications Department) site, and then specifying the location to be measured and determining the day and time range, and the site used in programming is the Institute's website (Higher Institute for Engineering Technologies / Tripoli (32.85642990, 13.26096370)).

Finally, the tracking system was installed, and experiments were conducted to measure the open-circuit voltage (V_{oc}) as well as the short-circuit current (I_{sc}), and compared the results in the case of the fixed position and movement in one axis and in two-axes, where improvement was achieved in the power generated by the panel. Solar power increased by 34.41% by using the dual-axes system with compared to the fixed system, and by 19.03% with compared to the single-axis system (the resulting power in the case of the fixed system was 4.0421 watts, while in the case of movement in one axis the

resulting power was 5.48 watts, and it is increased to 6.1669 watts in the case of dual-axes system).

Keywords: Azimuth, Altitude, one axis sun tracker, stepper motor, dual axes tracker

1. Introduction

We currently live in a world dependent on non-renewable energy sources such as oil and gas, which contribute to air pollution and reduce oxygen levels in the atmosphere, which pose health risks human It is therefore essential to switch to cleaner and safer energy alternatives. This research will discover a method to harness renewable solar energy and maximize its benefits. Traditionally, photovoltaic panels are installed at a certain angle to capture the maximum amount of solar radiation. However, scientists have discovered that the efficiency of photovoltaic panels can be improved by adjusting their position to maintain an optimal vertical angle to incoming solar radiation. This is possible thanks to solar trackers (solar trackers), called "solar trackers" or "solar trackers". A solar tracking system allows solar panels to follow the path of the sun throughout the day and year, optimizing the angle of solar radiation on the panel surface. [1] This dynamic arrangement can increase the production of electricity from photovoltaic (PV) panels by about 40% compared to fixed installations that maintain a single angle throughout the year. Our goal is to develop a reliable device capable of precisely tracking the sun and adjusting the position of the photovoltaic panel accordingly, improve productivity by moving panels in horizontal and vertical directions instead of keeping them at a static angle. This will be achieved by using tables that show the position of the sun in the sky. [2]

1.1 Solar energy:

Solar energy, or what is called solar radiation, is the energy emitted from the sun's rays mainly in the form of heat and light, and it is the product of nuclear reactions inside the star closest to us, which is the sun. This energy is of great importance to the earth and the living organisms on its surface. The output far exceeds the current energy requirements of the world in general, and if harnessed and exploited appropriately, it may meet all future energy needs. The energy resulting from converting sunlight into electricity is done using PV solar cells, and it is one of the most important and fastest growing renewable energy sources. It promises a promising future in providing energy for

various uses.[2],[3] Every location on Earth receives an amount of sunlight throughout the year, but the amount of solar radiation that one spot receives varies from one place to another on the Earth's surface, and that amount is called solar radiation, which is also known as photoelectric radiation. It is emitted from the sun in the form of light that is captured by solar energy technologies and converted into useful forms of energy.

2.1 Solar tracking systems

Photovoltaic panels are usually installed at a specific inclination angle so that they are exposed to the greatest possible amount of solar radiation throughout their operation. Scientists have found that the productivity of photovoltaic panels can be increased by making them maintain a maximum vertical angle with the radiation falling on them. This is achieved through solar trackers (solar tracking devices), known as "Solar Tracking Devices or Solar Trackers." A solar tracker provides the ability to make solar panels follow the path of the sun in order to ensure the best incidence angle of solar radiation on the panel surfaces during the day and throughout the year. This process contributes to increasing the electricity production of photovoltaic panels, as the production of mobile photovoltaic panels increases by about 40% compared to if they were fixed at one angle throughout the year. [4]

2.2 Sun tracking systems:

Types of tracking systems can be divided into several sections as: [5]

1. According to the mode of operation, solar trackers can be classified as follows:
 - Passive tracking device.
 - Active tracking devices.
2. According to the mode of control, they can be classified as follows
 - Open Loop Trackers (tuned algorithms or simple timing systems).
 - Closed loop tracking systems (following the movement of the sun with the help of feedback sensors).
3. By their method of movement or directional flexibility, solar trackers can be classified to:
 - Fixed-axes solar tracking.
 - Single-axis solar trackers.
 - Dual-axis solar trackers.

2.2.1 Fixed Solar Energy:

Fixed solar is a type of solar energy system that consists of installing solar panels firmly and firmly on supporting structures such as the roof of a building or the ground. This is considered the most common and simple technology in installing solar systems. Solar panels rely on being oriented toward the sun steadily for the longest possible period of time to make the most of solar light. Fixed system is sturdy and stable, and requires less maintenance due to no moving parts. [4]

2.2.2 Single-axis tracker: A single-axis tracker adjusts solar panels by rotating around a single axis, typically oriented in the north-south direction. This mechanism allows the photovoltaic panels to follow the sun's path as it moves from east to west during sunrise and sunset, as illustrated in figure (1).

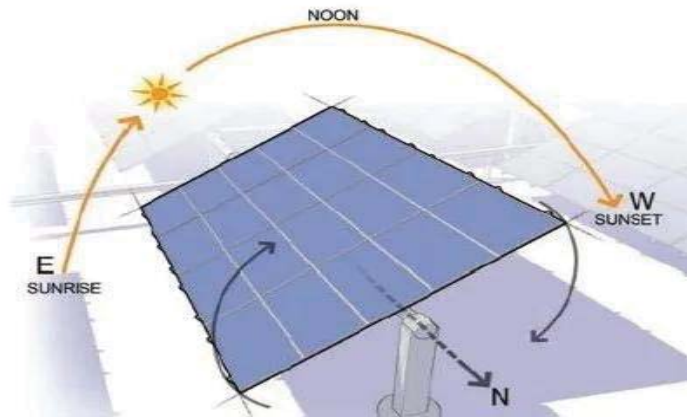


Figure (1) Horizontal single-axis tracking system

It improves the efficiency of solar systems without requiring the installation of additional photovoltaic (PV) modules. It's important to install a single-axis sun tracking system on a flat, sunny, and dry land area. While the initial installation cost of a single-axis sun tracking system is relatively high, it can greatly enhance the productivity of your solar system and can quickly recover the investment. [5]

2.2.3 Dual axes solar tracker:

Dual-axes solar tracker can enhance power output by 30-45% compared to fixed tilt solar systems. While primarily used in residential and small commercial settings, these trackers are beginning to be adopted in larger facilities as well. Each tracker is installed on an elevated platform to accommodate the wider range of angles for the solar panels. A single dual-axis tracker can support up to 20 solar panels. Although the increased height makes the panels less accessible for cleaning, it allows for additional space underneath, which can be utilized for other

purposes like agriculture or parking. This technology remains largely untapped in the market, but solutions for rooftop tracking are starting to appear. Surface-mounted trackers operate similarly to dual-axis trackers, rotating along a circular track at their bases, and adjusting the angle of the plate to follow the sun more accurately than single-axis trackers as shown in figure (2). [2], [6]

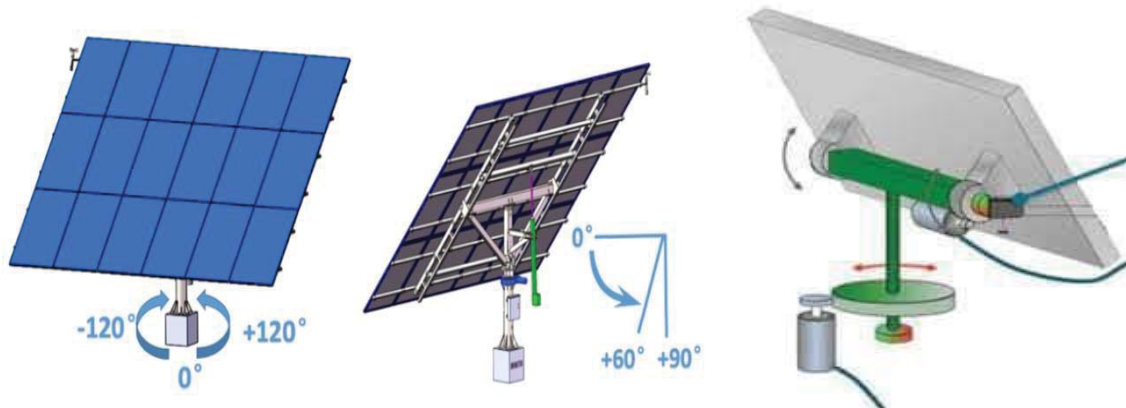


Figure (2) Dual-axis tracking system

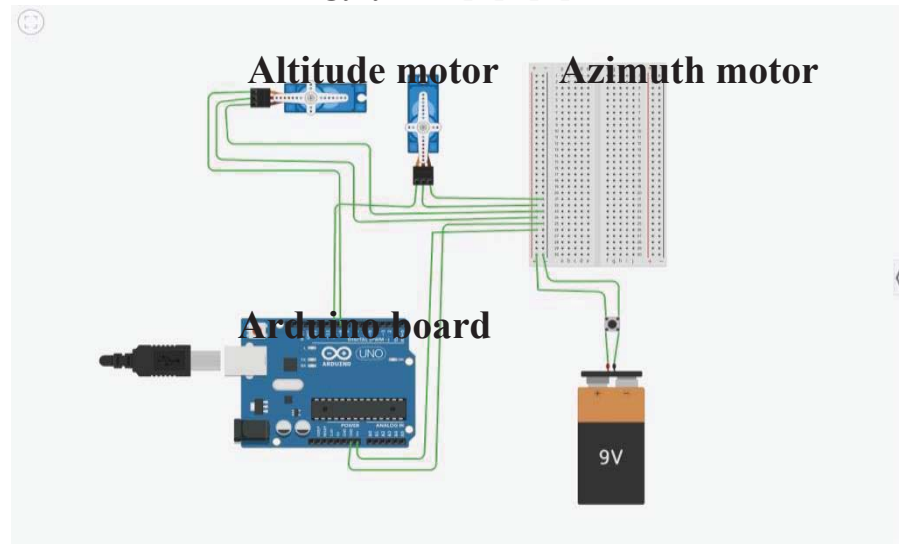
2. Design of dual axes solar tracker:

A dual-axis sun tracking system consists of several main components that work together to achieve accurate tracking of the sun's motion. The main components of the system are as follows: [6], [7]

- **Tracker Structure:** The support structure forms the foundation of system and serves to support and move other components. It is sturdy and durable to withstand changing weather conditions and ensure system stability.
- **Motors:** Motors move the solar panel modules and adjust their angles following on the sun. The motors are directed by the system's automatic control system.
- **Control System:** The controlling system works to manage the movement of the engines and control the orientation of the system based on the information of the sun angle table. The controlling system uses complex algorithms to control the moving of tracking system and ensure accurate tracking of the moving of the sun.
- **Table of sun angles:** The angle table is the main part that controls the movement of the motors and directs the solar panels in the correct direction based on the angles in it.
- **Solar Panels:** Solar panels mounted are the main source of solar energy generation. They mounted on movable modules and move

independently to track the sun and obtain the maximum possible solar radiation.

• **Power Management System:** The power control system controls the distribution of electrical power generated by solar panels to different loads. It is designed to achieve high energy efficiency and achieve the energy balance necessary to operate the system. It should be noted that the exact design and components used in a 2-axis solar tracking system may vary based on manufacturers and specific application requirements. It may also include additional components such as mechanical devices for motion control, indicators, and communications modules for remote control and monitoring of the system. These key components are an essential part of a dual-axis system, working together integrally to achieve accurate and efficient tracking of the sun's movement and increase solar energy yield.[5], [8]



Battery

Figure (3) Design of a control circuit for a dual-axis solar tracker

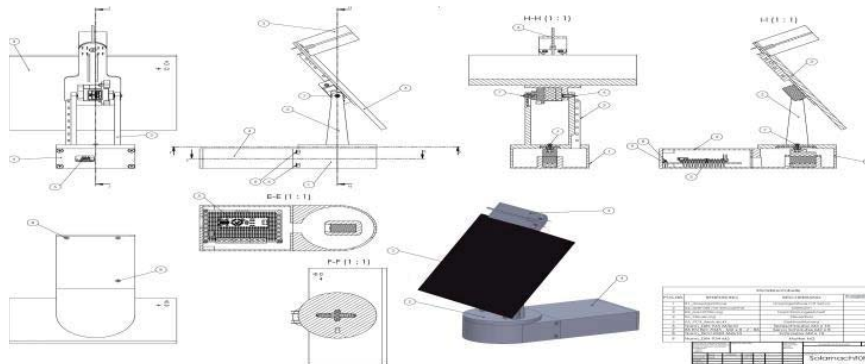
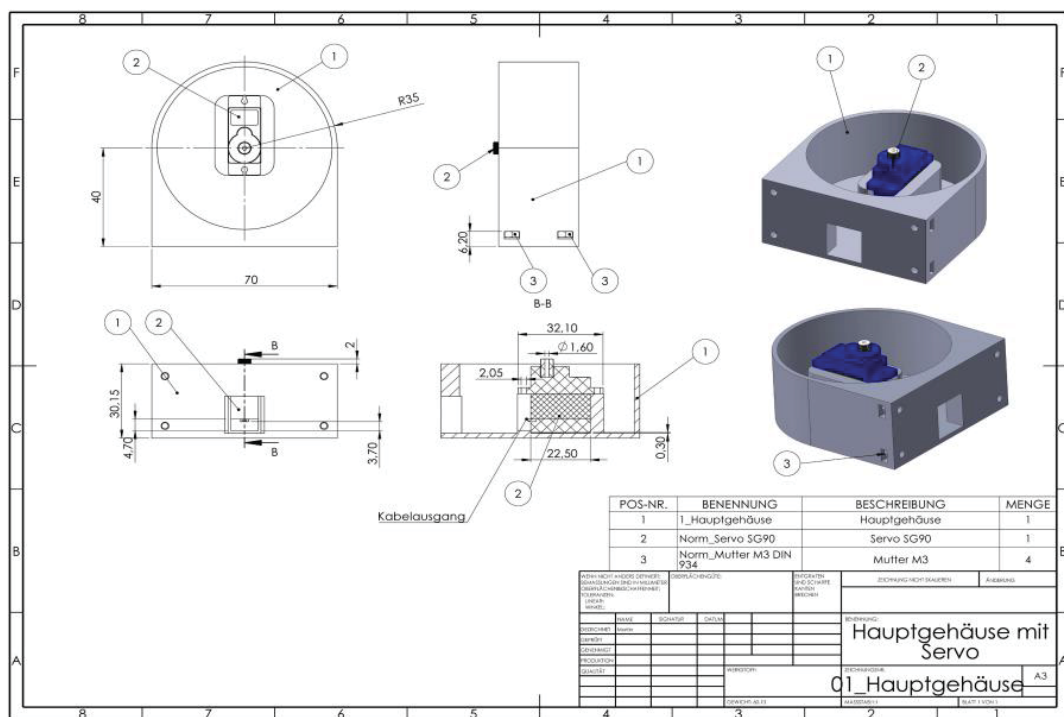
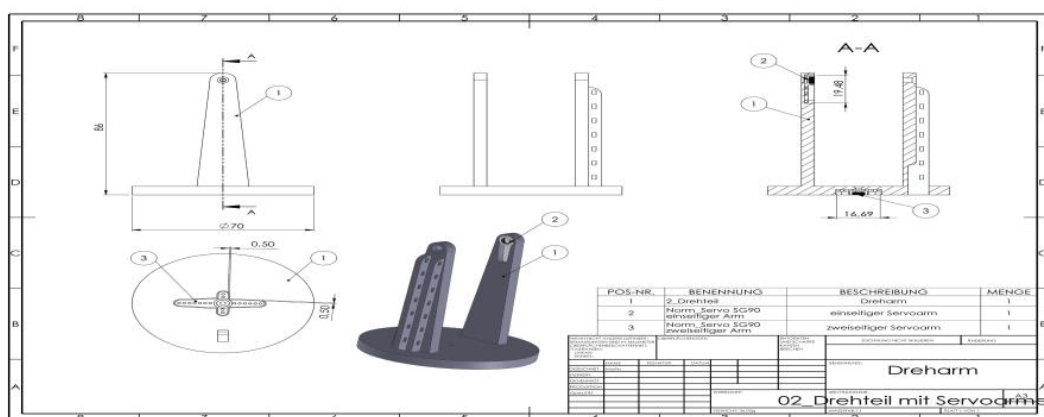


Figure (4) Engineering design of a dual-axis solar tracking device
The appropriate shape of the device was chosen so that it can perform its purpose, which is to move the solar panel in two directions.

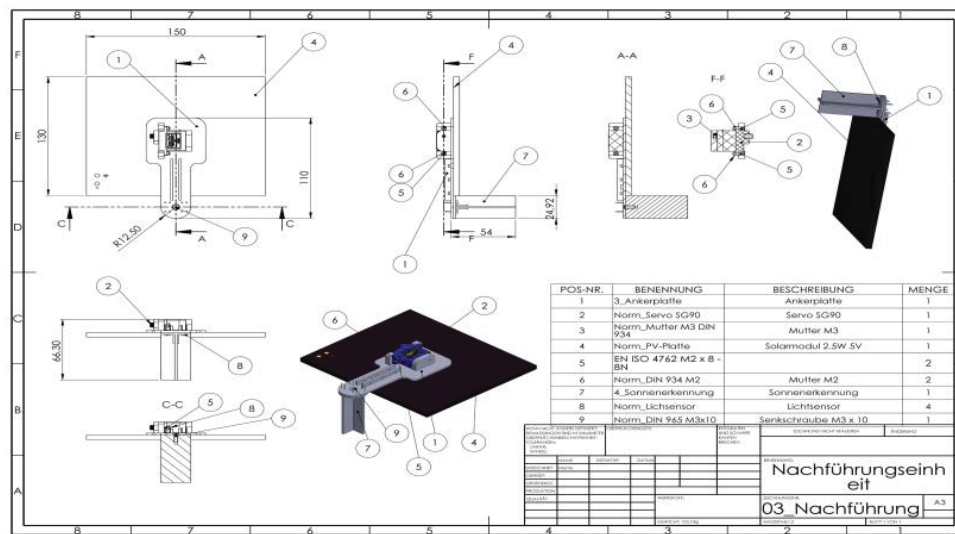
- The initial design of the device has been completed, as in figure (4).
- The measurements of the optical panel and motors were taken to design of the base, horizontal, and vertical axes of the dual-axis solar tracker,, as shown in figures (5a,b, and c).
- The final design of the device was implemented using the Tinker Cad program, and printed in 3D using a 3D printer, as shown in figure (6).



(a)

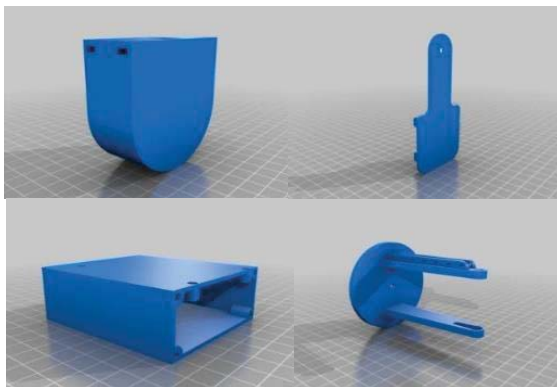


(b)



(c)

Figure (5) Engineering design of: a) the base of the dual-axis solar tracker, b) vertical axis of a dual-axis solar tracker, c) horizontal axis of a dual-axis solar tracking device



(a)



(b)

Figure (6) a) Structural parts of a dual axis solar tracker, b) Final design of a dual-axis solar tracker using the Tinker Cad program.

The components were distributed as follows:

- Mechanical structural parts
- Software parts
- Motion electronic devices

The device contains:

- 1 light panel, size (15*20 cm).

- 1 Arduino UNO board.
- 2 servo motors (MG995).
- 1 operating key (0 – 1).
- 1 lithium battery (V9).
- Connecting wires (male/male).



(a)



(b)

Figure (7) Bottom motor installation responsible for: a) Azimuth angles, b) Altitude angles

Implementation

- After we finished the design process, the matter became clearer and the implementation process began.
- 3D printed design, as shown in figure (7).
- Preparing the locations of the motors and connecting wires.
- Installing devices on the external structure.
- Connecting the external structure to each other using screws and nuts.
- Connect the device wires to the Arduino board, as shown in figure (8).
- Preparing the system and adjusting the angles of the motors to start operation

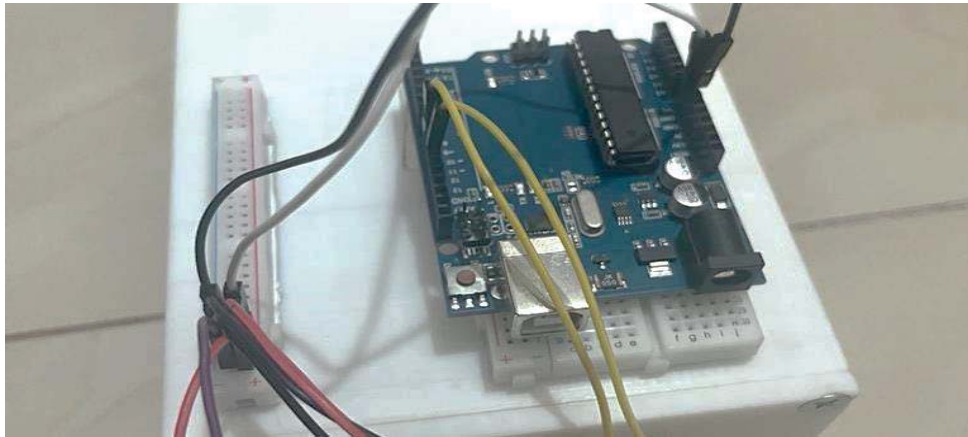


Figure (8) Installing the Arduino and connecting the motor and battery wires

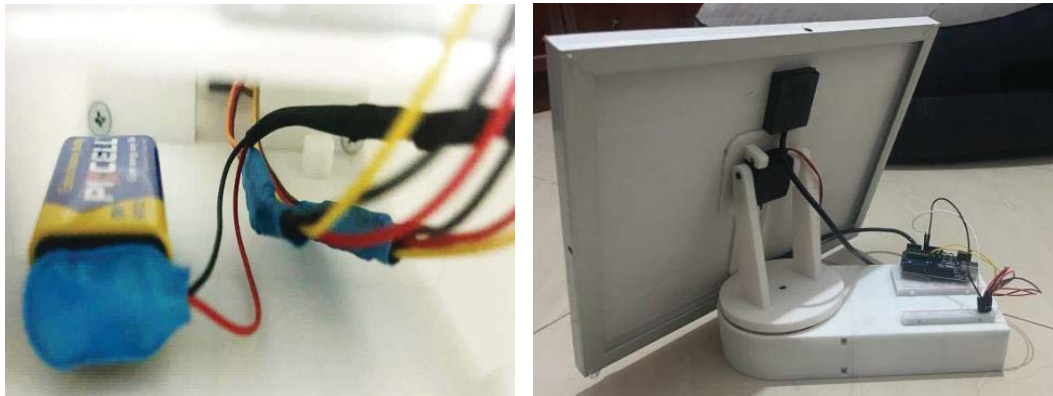


Figure (9) Installing of: a) the battery inside the device, b) the optical panel on the device

3.1 Programming

- We will program the device by listing the Azimuth and Altitude angles of the sun on a specific day of the year, and to obtain this data and angles we have used the (Astronomical Applications Department) program.
- Then specify the location from which you want to measure, specify the day, and specify the time range.
- The website used in programming is the website of the Higher Institute of Engineering Technologies / Tripoli (32.8564299, 13.2609637). [2], [7]

Table (1) Azimuth and Altitude angles used in programming:

Altitude and Azimuth of the Sun
N 32° 51', E 13° 16'

Tripoli city 2023-12-21 Zone: 2.0 hours East of Greenwich		
Time (h)	Altitude	Azimuth
07:20	-9.5°	111.9°
07:40	-5.6°	114.4°
08:00	-1.8°	116.9°
08:20	2.2°	119.7°
08:40	5.6°	122.5°
09:00	9.1°	125.5°
09:20	12.4°	128.7°
09:40	15.6°	132.1°
10:00	18.6°	135.7°
10:20	21.4°	139.5°
10:40	24.0°	143.6°
11:00	26.4°	148.0°
11:20	28.4°	152.6°
11:40	30.2°	157.4°
12:00	31.7°	162.5°
12:20	32.7°	167.8°
12:40	33.4°	173.2°
13:00	33.7°	178.7°
13:20	33.6°	184.2°

13:40	33.1°	189.6°
14:00	32.2°	195.0°
14:20	31.0°	200.1°
14:40	29.3°	205.1°
15:00	27.4°	209.8°
15:20	25.2°	214.3°
15:40	22.7°	218.5°
16:00	20.0°	222.5°
16:20	17.0°	226.2°
15:30	24.0°	216.4°
16:40	13.9°	229.7°
15:50	21.4°	220.5°
17:00	10.7°	233.0°
17:20	7.3°	236.0°
17:40	5.6°	237.5°
18:00	0.5°	241.8°
18:20	-3.8°	244.4°
18:40	-9.5°	248.2°
19:00	-11.5°	249.4°

3. Results:

3.1 In the case of a fixed system:

Measuring the voltage and current generated by the solar panels using a fixed tracker using a solar panel with a voltage of 6V, a current intensity of A1.16, and a power of 7W. It was installed at an angle of

300 with the horizontal axis, and the experiment was carried out on Wednesday, 11/15/2023.

3.1.1 Measurement of open circuit voltage (V_{oc}):

In this case, we place a voltmeter between the two ends of the board, and since the resistance of this device is large, the current does not pass and the circuit is considered open. The results recorded in this experiment are recorded in table (2):

Table (2) open circuit voltage (V_{oc}) for fixed tracking system

Open circuit voltage (V_{oc}) (V)	Time
6.30	8:00
6.44	9:00
6.52	10:00
6.64	11:00
6.73	12:00
6.80	13:00
7.00	14:00
6.77	15:00
6.64	16:00
6.33	17:00
5.90	18:00
6.52	المعدل

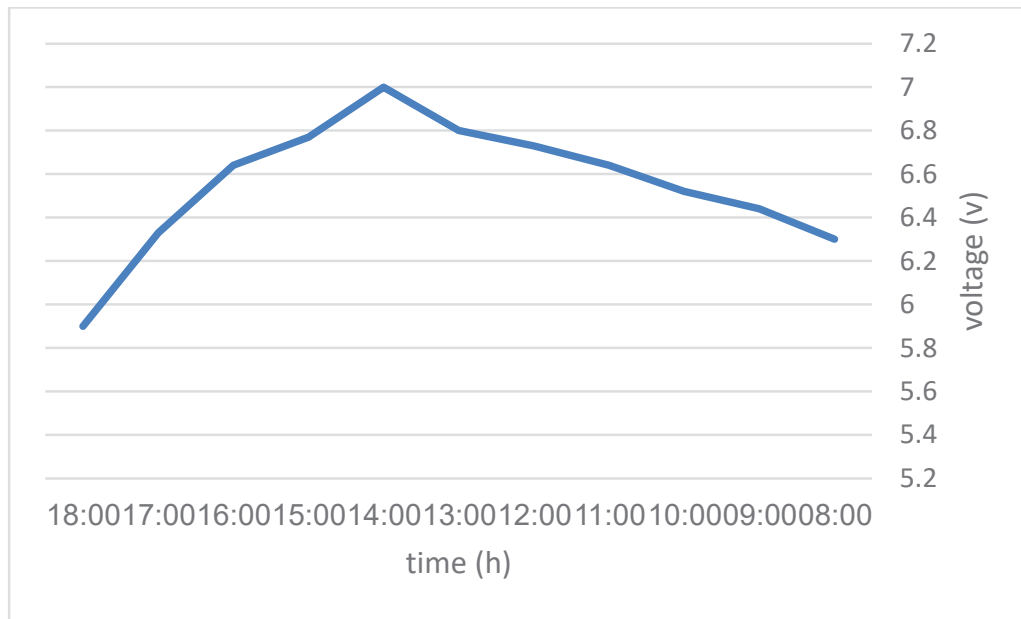


Figure (10) Rate of change of voltage productivity in the fixed tracker

3.1.2 Measuring short circuit current (I_{sc}):

We short the poles of the optical panel using an ammeter to measure the intensity of the shorting current, and the results obtained are recorded in table (3):

Table (3) Short circuit current (I_{sc}) for fixed tracking system

Short circuit current (I_{sc}) (A)	Time
0.33	8:00
0.55	9:00
0.62	10:00
0.68	11:00
0.71	12:00
0.86	13:00
0.94	14:00
0.83	15:00
0.66	16:00
0.45	17:00
0.21	18:00

0.62	المعدل
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Average output in watts (4.0421 watts)

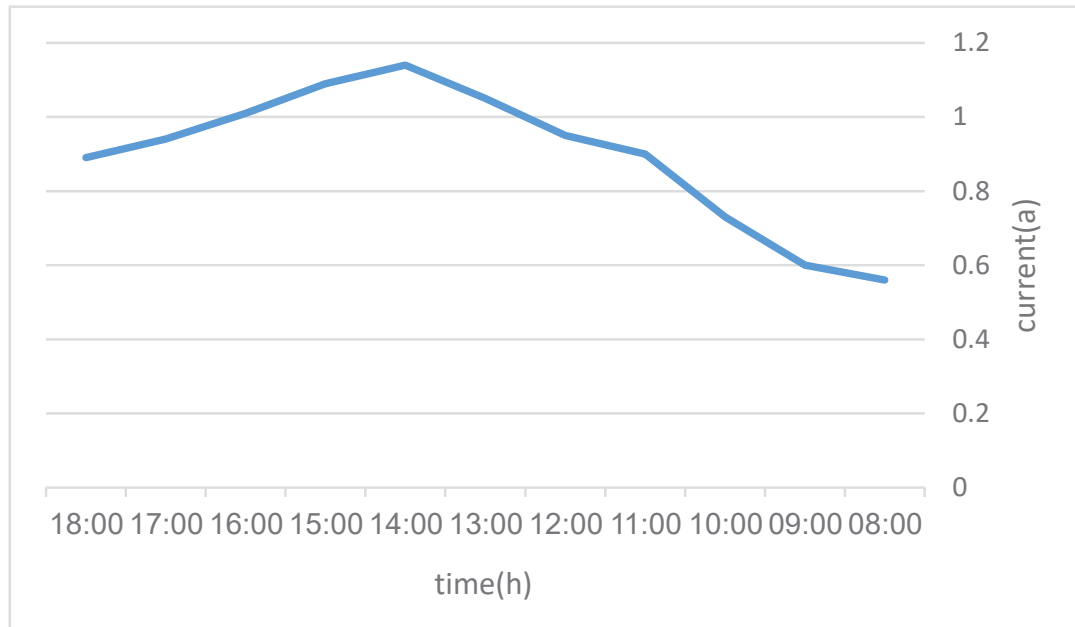


Figure (11) Rate of change of current throughput in the fixed tracer

3.2 In the case of the single-axis system:

Measuring the voltage and current resulting from solar panels using a single-axis tracker using a solar panel with a voltage of 6V, a current intensity of A1.16, and a power of 7W, in which the vertical axis was fixed at 320 with the horizontal axis on Wednesday, 11/15/2023..

3.2.1 Measurement of open circuit voltage (Voc):

In this case, we place a voltmeter between the two ends of the board, and since the resistance of this device is large, the current does not pass and the circuit is considered open. The results recorded in this experiment are recorded in table (4):

Table (4) open circuit voltage (Voc) for single-axis tracking system

Open circuit voltage (Voc) (V)	Time
6.41	8:00
6.50	9:00

6.59	10:00
6.70	11:00
6.81	12:00
6.91	13:00
7.09	14:00
6.85	15:00
6.73	16:00
6.62	17:00
6.56	18:00
6.70	المعدل

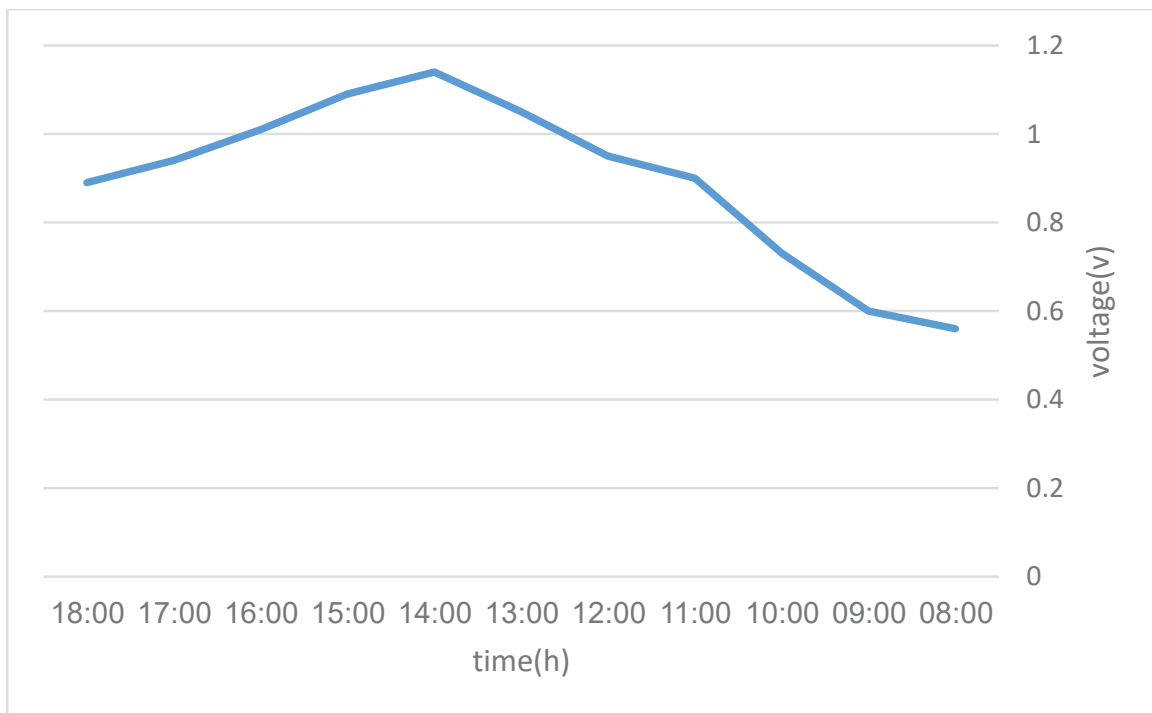


Figure (12) Rate of change of voltage productivity in the single-axis tracker

3.2.2 Measuring short circuit current (I_{sc}): We short the poles of the optical panel using an ammeter to measure the intensity of the shorting current, and the results obtained are recorded in table (5):

Table (5) Short circuit current (I_{sc}) for single-axis tracking system

Short circuit current (I_{SC}) (A)	Time
0.41	8:00
0.58	9:00
0.67	10:00
0.81	11:00
0.89	12:00
0.98	13:00
1.04	14:00
0.96	15:00
0.84	16:00
0.73	17:00
0.60	18:00
0.80	المعدل

Average output in watts (5.48 watts)

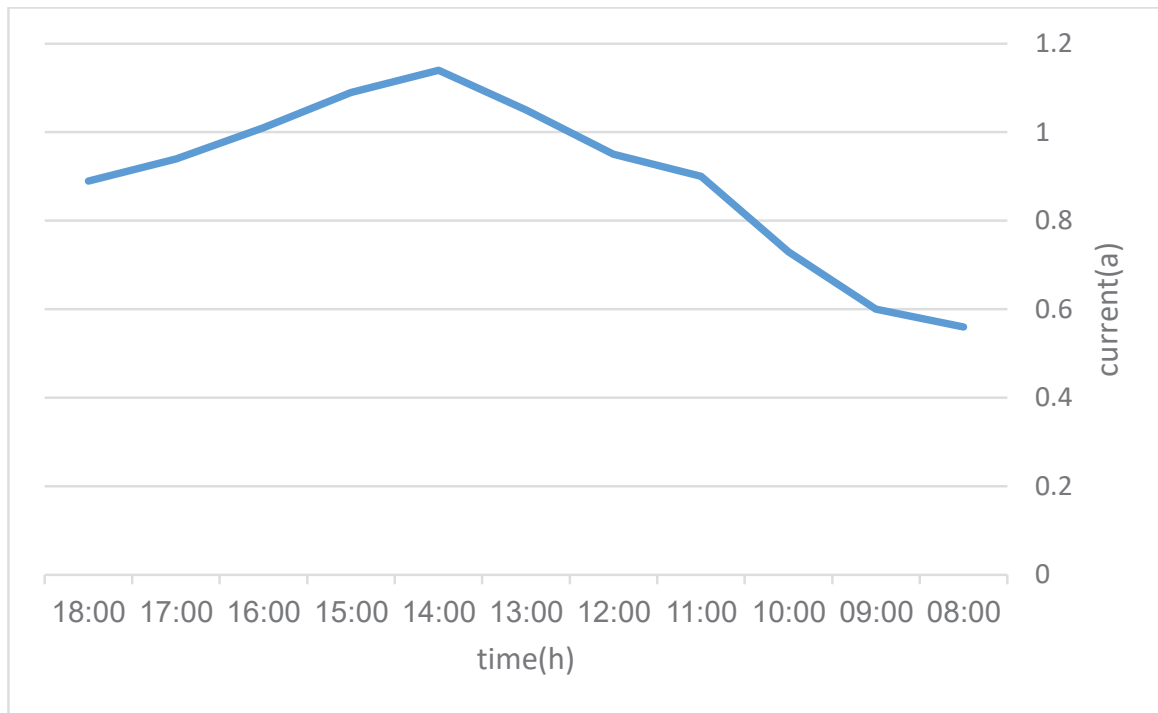


Figure (13) Rate of change of current throughput in the single-axis tracker

3.3 In the case of the dual-axis system:

Measuring the voltage and current resulting from the solar panels using a dual-axis tracker using a solar panel with a voltage of 6V, a current intensity of A1.16, and a power of 7W, which was placed on the project's factory device on Wednesday, 11/15/2023.

4.3.1 Measurement of open circuit voltage (V_{oc}):

In this case, we place a voltmeter between the two ends of the board, and since the resistance of this device is large, the current does not pass and the circuit is considered open. The results recorded in this experiment are recorded in table (6):

Table (6) open circuit voltage (V_{oc}) for dual-axes tracking system

Open circuit voltage (V_{oc}) (V)	Time
6.44	8:00
6.56	9:00
6.64	10:00
6.75	11:00

6.85	12:00
7.03	13:00
7.16	14:00
7.04	15:00
6.92	16:00
6.85	17:00
6.71	18:00
6.88	المعدل

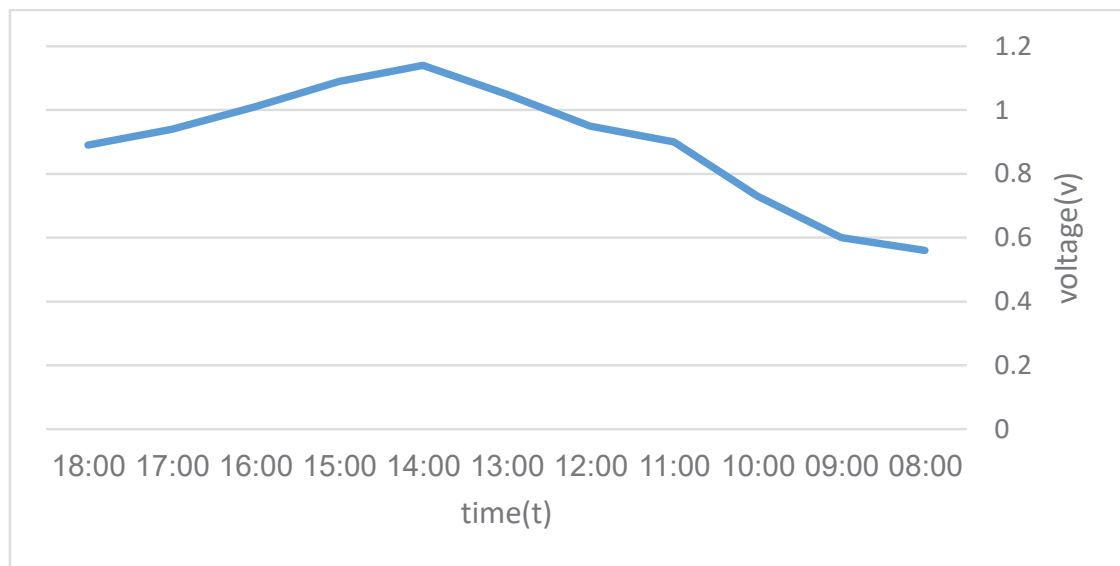


Figure (14) Rate of change of voltage productivity in the dual-axis tracker

4.3.2 Measuring short circuit current (I_{sc}): We short the poles of the optical panel using an ammeter to measure the intensity of the shorting current, and the results obtained are recorded in table (7):
Table (7) Short circuit current (I_{sc}) for dual-axes tracking system

Short circuit current (I_{sc}) (A)	Time
0.56	8:00
0.60	9:00
0.73	10:00

0.90	11:00
0.95	12:00
1.05	13:00
1.14	14:00
1.09	15:00
1.01	16:00
0.94	17:00
0.89	18:00
0.89	المعدل

Average output in watts (6.1669 watts)

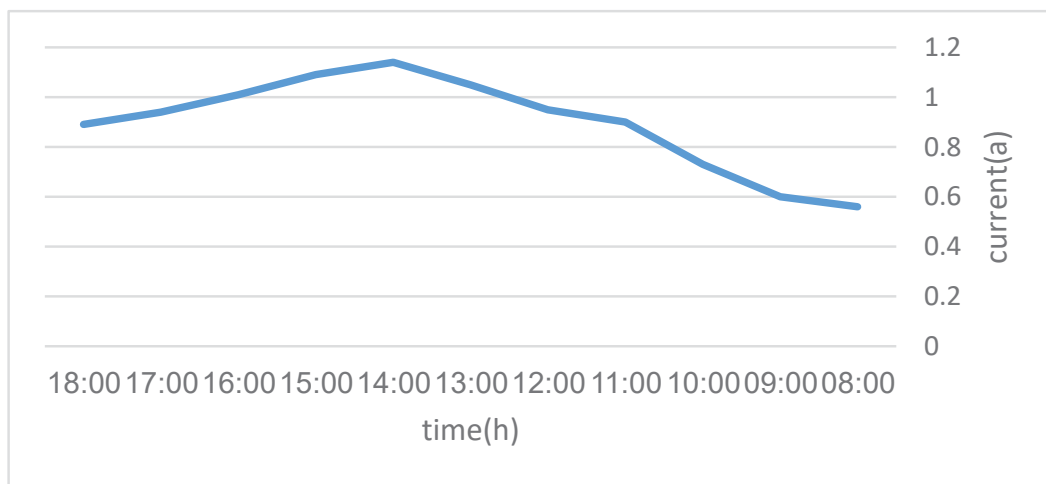


Figure (15) rate of change of current throughput in the dual-axis tracker

3.4 Experiment curves:

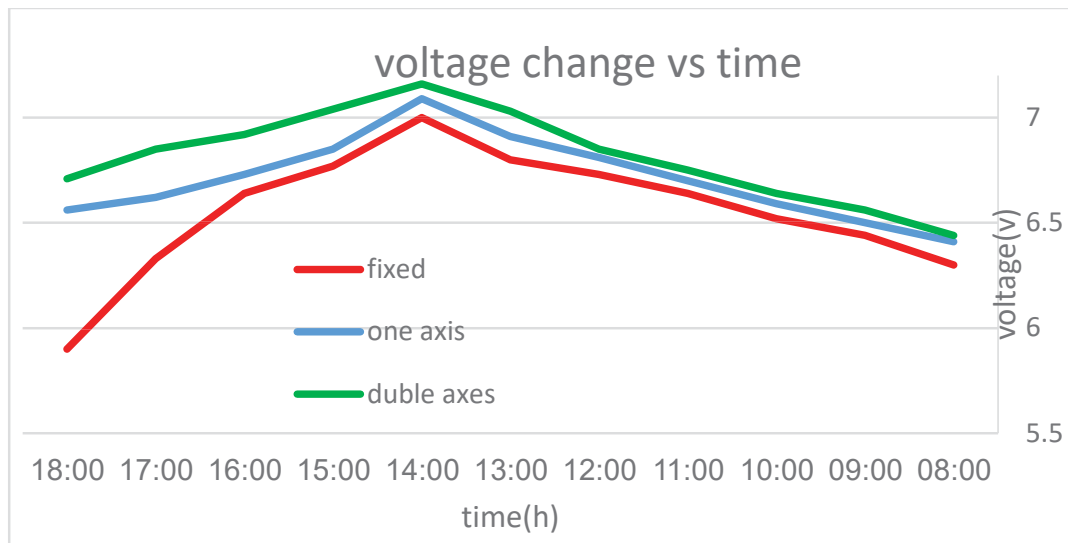


Figure (16) comparing the change in effort productivity according to the tracking system

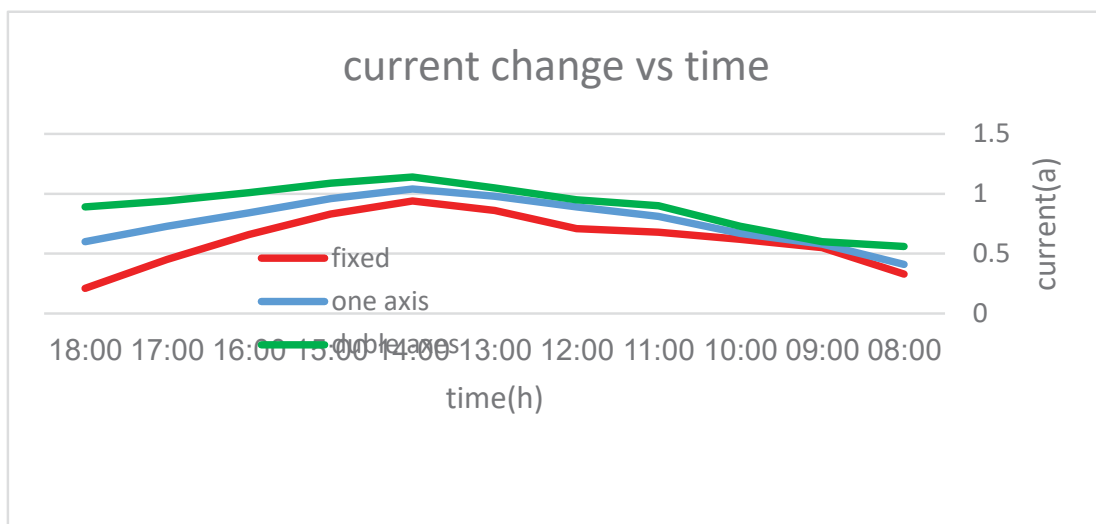


Figure (17) comparing the change in stream productivity according to the tracking system

From figures (16,17), one can note that the power generated (voltage and current) by dual axes tracking system is greater than that generated by one axis tracking system, where the lowest is that generated in the case of fixed one.

Conclusion:

For an open-loop solar tracking system, an electromechanical mechanism was developed. Simulations using azimuth and elevation data from Tripoli, Libya, have shown high effectiveness. The entire system has been designed and implemented successfully. This proposed system tracks the sun with a significant level of precision, repositioning

the photovoltaic panel to its original location at the end of each day. The open-loop solar tracking mechanism is based on real data from a specialized table and algorithm. There is no need for feedback, because the open approach eliminates the need to adjust or modify the hardware or software of the system during seasonal changes or cloudy days. This improves the reliability, flexibility and cost effectiveness of the proposed system. The design may include the drive mechanism, which includes motors and solar panels. However, during the design process, it is important to consider the drive mechanism, dimensions and total weight of the solar panels

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Design Solar Panel Cleaning Robot to Optimise System Efficiency

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Abstract:

in this paper, a solar panel cleaning robot is designed to increase the efficiency of the solar energy system smartly and efficiently, as this robot automatically cleans the panels without the need to waste water or cause any damage to the panels. Using the Arduino Cloud remote control software, we were able to efficiently monitor and control cleaning operations, and this approach reduced the time spent cleaning, and reduced water consumption, resulting in lower costs due to labor and periodic maintenance. Through this design and results, the overall efficiency of solar panel cleaning operations has been improved, thereby improving their performance sustainably and economically.

Keywords—*Solar Panel, Cleaning Robot, Arduino Cloud, Remote control, Renewable Energy*

INTRODUCTION

Solar energy has become a popular alternative to fossil fuels in the field of renewable energy sources. However, things like dirt, dust, and

bird droppings can reduce the effectiveness of solar panels by building up on the surface and obstructing the absorption of sunlight. The creation of a solar panel cleaning robot has been suggested as a workable remedy for this problem. With its ability to clean the panels on its own without human assistance, this robot uses less water and lowers the possibility of damaging the panels. The entire efficiency and performance of the solar energy system may be enhanced by effectively monitoring and managing the cleaning activities through the use of Arduino Cloud remote control software [1].

Many factors affect the energy efficiency of photovoltaic panels, such as shade, snow, high temperatures, pollen, bird waste, sea salt, dust, and dirt. The main factor affecting the efficiency of photovoltaic panels is dust, which can reduce their efficiency by up to 18%, depending on the environment [2]. Cleaning dirty panels with commercial cleaners can be time-consuming, costly, environmentally hazardous, or even corrosive to the solar panel frame. Ideally, solar panels should be cleaned every few weeks to maintain peak efficiency, which is particularly difficult to do. For large solar panel arrays, an automated cleaning solution is needed for this issue that can service a wide range of ground solar panels up to an operating area of 22,000 panels (20,000 square meters) [3]. Cleaning dust particles on solar panels is a big problem because it is time-consuming and requires a lot of human labor and money. To remove this constraint, robots can be used because they eliminate human labor and at the same time are more economical and independent [4].

The problem facing the use of solar panels is the dust that forms above them, as the dust on solar panel cells greatly reduces the efficiency of solar panels, especially in Libya where dust and sand storms are widespread, and then there will be an automated system that periodically cleans solar panels to ensure that they perform at the highest level of performance. Using the right manufacturing and controllers will help make this project possible [5].

A research study reported on providing a design and application for a solar panel cleaning robot. The propulsion system consists of electric motors that allow the robot to move along the rows of solar panels. The cleaning system consists of a rotating brush and a water pump. The rotating brush removes dirt and dust from the surface of the solar panels while the water pump washes the panels with water. The robot was successfully tested on a range of solar panels and the results showed that

the robot can clean the solar panels efficiently, improving the efficiency of electric power generation by up to 10% [6].

This is a major problem in areas with high levels of air pollution, especially in Africa. However, the maintenance of panels is a very important issue that is often ignored due to the difficulty of accessing some panels and their seriousness. Robots were created to clean solar panels as a smart solution that combines the latest technologies to move and do so quickly and efficiently without the need for manual work to maintain their performance at its best. Solar panels are equipped with a variety of tools to clean dust, dirt, and other pollutants from their surfaces, which are typical in Africa [7].

Another study indicated that solar panels are mostly used in desert areas, which causes the accumulation of dust particles on the surface of the panel and blocks sunlight, reducing the power generation capacity of the panel. In this case, periodic cleaning of solar panels is required to improve solar energy. In this study, a cleaning robot was designed and developed to continuously clean the dust particles on the solar panel. The robot cleans the solar panels using a rotating brush with water spray, sun tracking is also integrated to improve the efficiency of the panel [8].

The application of solar photovoltaic units should be promoted. Solar photovoltaic units are generally used in dusty environments. For example, tropical countries such as India accumulate dust on the surface of the unit and block light from the sun. It reduces the power generation capacity of the unit. The power output is reduced by up to 50% if the unit is not cleaned for a month. The cleaning system is designed to clean the unit by controlling the Arduino programming. The main goal is to remove dust in the photovoltaic units to improve the power generation efficiency of the solar power generation system [9]. Arduino is a program used in the design of various electronic projects. This program consists of a programmable circuit board, also known as a microcontroller, in addition to an integrated development environment called (Integrated Development Environment), which is used on the computer to write and upload code to the board. This program allows users to use multiple programming languages such as MATLAB LabVIEW, and Python. Arduino boards have become popular among people new to the field of electronics, for various reasons [10].

Furthermore, a paradigm change in solar panel maintenance techniques is represented by the development of intelligent cleaning

modes that incorporate cutting-edge sensors and user-scheduled cleaning features, as covered in [11]. The overall performance and sustainability of solar energy systems may be improved by incorporating these technical developments into the design of solar panel cleaning robots, which will ultimately lead to a more effective and affordable renewable energy solution [12]. Moreover, adding solar panels directly to the robot would be one way to solve the problem and enable it to use solar energy for self-charging while it is in use. This would render the robot completely self-sufficient and remove the need for external power sources. To further improve the robot's sustainability and save running costs, energy-efficient parts, and power management systems can assist optimize the robot's overall power usage. The solar panel cleaning robot can function independently for prolonged periods by thoughtfully building the power supply system, optimizing its cleaning efficiency and overall effectiveness its cleaning efficiency and overall effectiveness [13].

Additionally, the robots' movement pathways and cleaning techniques may be optimized by adding intelligent control algorithms, which will save cleaning time and increase coverage efficiency. Remote monitoring and diagnostics features should also be included in the control system so that operators can keep tabs on the robots' performance, spot possible problems, and make necessary modifications. The solar panel cleaning robot can function autonomously with great accuracy and efficiency by building a strong and responsive control system, which improves the general maintenance of solar energy systems for maximum performance and sustainability [14].

Furthermore, in [15] the field of solar energy has emphasized how important it is to maximize the effectiveness of robots that clean solar panels to increase the power capacity of solar systems. Solar energy research has shown how important it is to maximize the effectiveness of robots that clean solar panels to increase the power capacity of solar systems. The need to create cutting-edge cleaning solutions is shown by combining research from [16], which highlights the influence of dust and other environmental variables on solar panel performance, and [17], which presents the idea of semi-automatic cleaning mechanisms to increase efficiency. The efficiency of solar panel cleaning robots may be increased by utilizing cutting-edge technologies like Arduino Cloud remote control software.

OPERATION OF THE PROPOSED SYSTEM

It represents the monitoring unit through the special account through the Internet. In this system, a special account is designed for the user that allows him to monitor all the variables (water level in the tank, battery voltage, and current value) of the robot remotely. “Fig. 1”, shows the operation and operation of the proposed system summarized below with details.

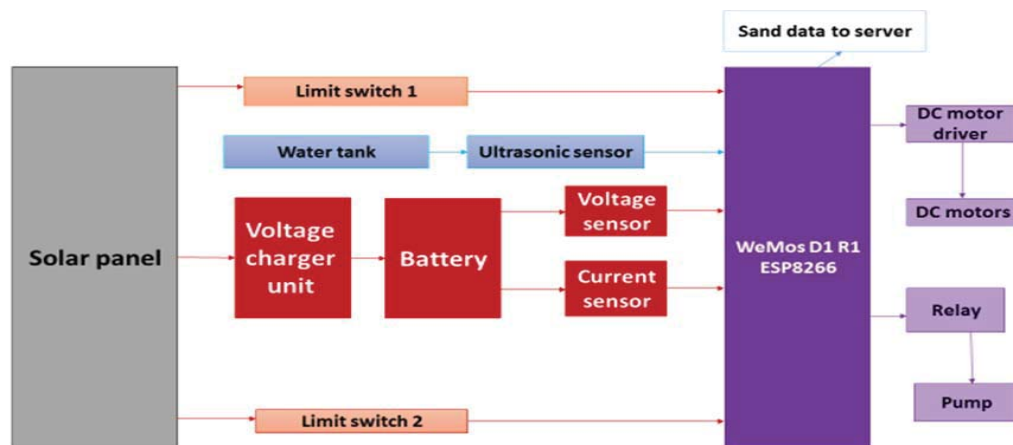


Fig. 1 The work and operation of the proposed system.

The accumulation of dust even on one panel reduces its efficiency in power generation which is why, the surface of the panel should be kept as clean as possible. Current human cleaning methods for solar panels are costly in terms of time, water, and energy use. Therefore, there is a need to develop automatic cleaning machines that can easily clean and move on the glass surface of the panels where in this project:

1. Design and implement a solar panel cleaning system that can increase the efficiency of solar panels.
2. Design and implement an (IoT) system to monitor robot variables via the Internet.
3. Make solar panel cleaning simple and automated.
4. human machine

SOLAR PANEL CLEANING ROBOT SYSTEM

The world is witnessing a tremendous increase in the demand for Internet services, leading to an urgent need to invent more efficient ways to collect and exchange data. In this context, Internet of Things (IoT) technology has emerged as a promising solution to meet this need, promising to improve data storage and exchange by connecting physical

devices and vehicles via electronic sensors and global networks. For (IoT) to play its role effectively, a proper sensing and monitoring system is required. The sensor unit usually consists of a set of different sensors, such as temperature, humidity, and gas sensors, while the monitoring unit monitors vital variables such as current and voltage.

Most of the civil and government sectors in the developed countries of the world are also adopting (IoT) technologies due to their enormous importance in every field. Much more, as it has reached the idea of security, control, and supervision of transport and health care, and in the current situation that we can easily locate every object and person, this technological progress can create more areas of work and research ideas. It is predicted that by 2030, computers can lead like humans to run things. The complexity in sensors and communication of many sensors in a system has enhanced data measurement and analysis and also data aggregation at the local level, Bluetooth technology is a great technology that enables us to remotely transfer data and even control electrical devices through electronic devices, especially smartphones.

Online Solar Panel Cleaning Robot System

The automatic cleaner is designed using a lightweight material which is aluminum. The automatic cleaning system uses a brush element to clean the panels so that the water is not wasted in the process. After the cleaning process is completed, the robot is transferred to another path of solar panels. This system can clean multiple panels in the solar farm. Innovative solutions, such as robotic devices made for cleaning solar panels, have been developed in response to the growing demand for effective maintenance and optimization of solar panels. Dust buildup on panel surfaces is a serious problem that these robots solve since it may drastically lower power-generating efficiency.

The work proposed consists of the design of a control and monitoring unit for the solar panel cleaning robot system as shown in “Fig, 2”, where this robot performs the cleaning process at any time determined by the maintenance group from anywhere in the world through the Internet using either the computer or mobile phone using the (ESP8266 D1) panel.

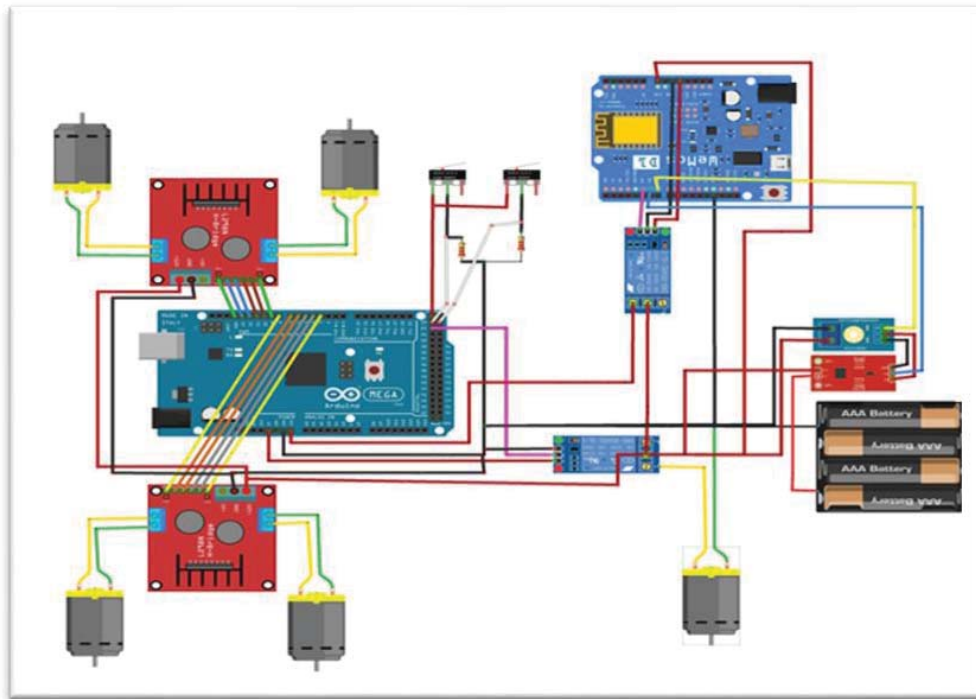


Fig. 2 Solar Panel Cleaning Robot System

Working Principle of Solar Panel Cleaning Robot:

The middle coil begins to rotate in which the current must be reversed every half cycle. This is done by an electric exchanger that derives direct current from a battery through two conductive brushes (black color) and connects it to the coil. The brush consists of copper strips. The DC motor is characterized by low cost, sustainable performance, and easy control of the motor speed, but it needs to replace the brushes and clean the electrodes of the electric exchanger from time to time. As in all rotary motors, the principle of rotating the motor is based on the intersection of two or more magnetic fields in moving the rotor according to the direction of torque of the strongest magnetic field among them. A section in a DC motor operated by an electric exchanger magnet is clear in this figure and is here a metal ring divided into two parts (brown). The brushes are marked with (+) and (-) to enter and exit the current from the coil.

DESIGN CONSIDERATIONS FOR SOLAR PANEL CLEANING ROBOT

The most crucial elements utilized in the design are displayed in the following “Fig. 3”. It consists of a voltage and current sensor, relay, battery charger, Arduino mega board, DC motor drive circuit, 12V

battery, and stroke end switch: Voltage and Current Sensor: This part gauges the circuit's voltage and current flow. It gives the Arduino feedback, which it may use to monitor and regulate the system and ensure it stays within safe bounds.

The system's 12V battery provides power to the whole thing. It is crucial for supplying the voltage and current required to run the motor, sensors, and Arduino. Arduino Mega Board: This microcontroller board serves as the system's central nervous system. It interprets sensor inputs, regulates the relay and motor driving circuit, and may be configured to carry out particular actions in response to input. Relay: A relay is an electromechanical switch that enables high-power Arduino devices to be controlled, such as motors using low-power signals. It can turn the motor on and off based on the logic defined in the Arduino program.

Battery charger: When the 12V battery has to be recharged, this part takes care of it. It guarantees that the battery stays charged and operational, which is crucial in situations when the system could be utilized sporadically. Motor Drive Circuit: This circuit manages the DC motor's functioning, enabling direction and speed control. After receiving inputs from the Arduino, it modifies the power sent to the motor. DC Motor: The motor, which functions as the system's actuator, transforms electrical energy into mechanical energy to carry out tasks like operating a mechanism or moving a load. Stroke End Switch: This limit switch measures the motor or mechanism's position. The motor may be stopped using it when a certain position is reached, preventing damage to the system and ensuring safe operation.

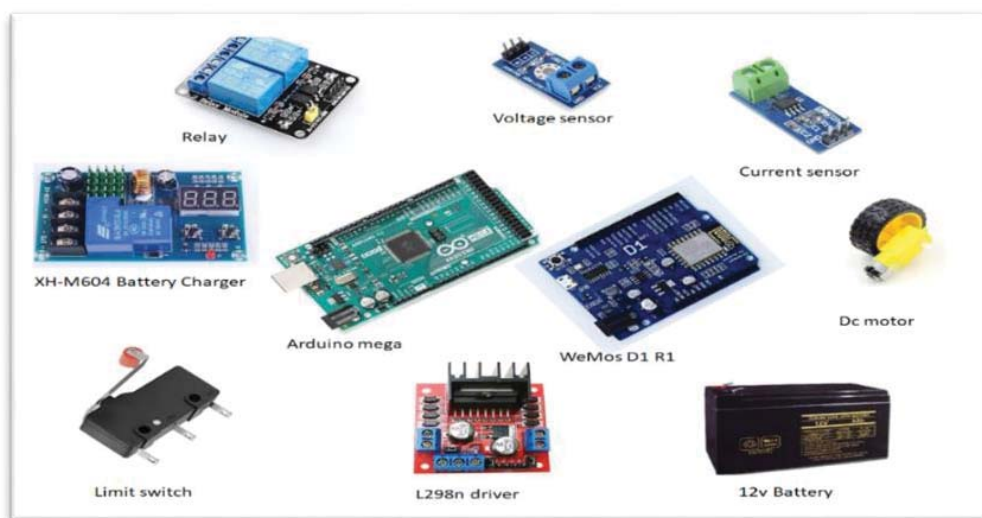


Fig. 3 most important components used in the design

Solar panel cleaner robot practical part

The practical work of a solar panel cleaner robot system model is shown in “Fig 4”. It highlights that all components of the robot system are organized and assembled into a single panel. This design choice is made to enhance the visual appeal of the engineering project, suggesting that a tidy and cohesive appearance is important in engineering design. By consolidating the components, the overall aesthetic and functionality of the robot system are improved, making it look more professional and streamlined, the design focuses on functionality, ease of use, and the ability to operate autonomously while maintaining the integrity of the solar panels.

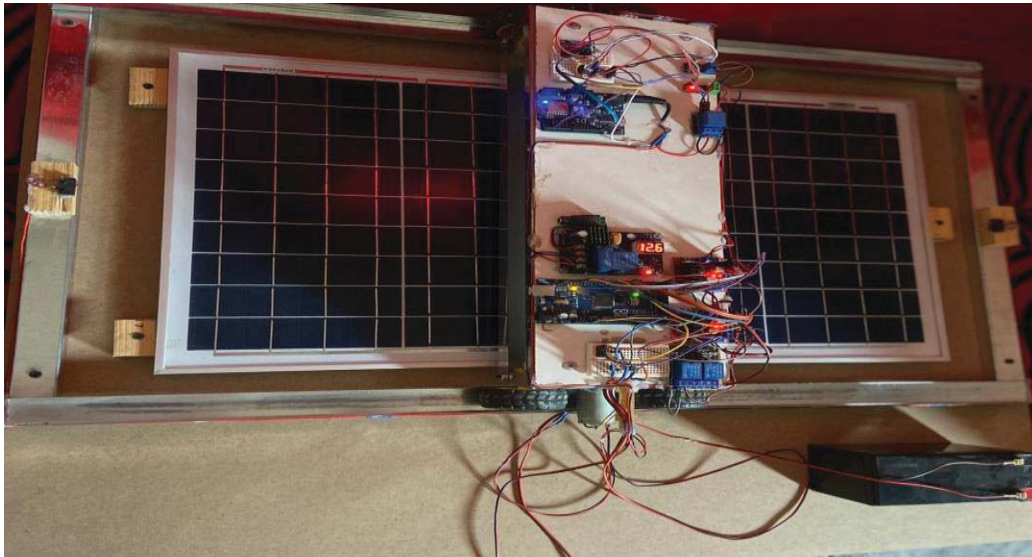


Fig. 4 The practical picture of the robot model

Arduino panel microcontroller in the model

Panel Arduino The Internet of Things capability, which enables connecting and comprehending objects over the Internet, is provided by this programmable board. The word "things" refers to any smart device, including watches, glasses, alarm clocks, mobile phones, televisions, and other gadgets that may be linked to one another online. As shown in “Fig. 5”, this Arduino Panel contains a (ESP8266-D1) chip. Express If manufacturing systems of the Wi-Fi-enabled microcontroller.

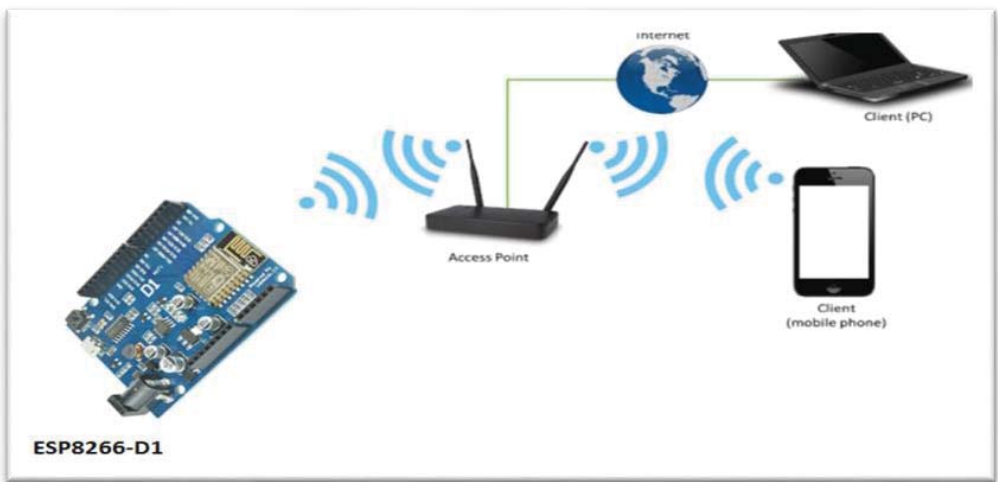


Fig. 5 Arduino Panel contains an ESP8266-D1 chip.

With its integrated Wi-Fi radio and antenna on a single board, the (ESP8266-D1) is a more compact version that is ideal for integrating into various gadgets and projects. A frequent module for Arduino-based boards and applications is the (ESP8266-D1) module. It makes it possible for Arduino projects to connect to the internet and Wi-Fi networks. Wi-Fi connection and internet-enabled functionality may be added to Arduino projects and designs with ease by integrating the (ESP8266-D1) into an Arduino-based project or board. Now we will download the library of the WeMosD1 control panel and this step will be illustrated in the formal sequence of figures. We will then select the panel for the WeMosD1 control panel. We will then identify the serial port of the panel as shown in “Fig. 6”, below:

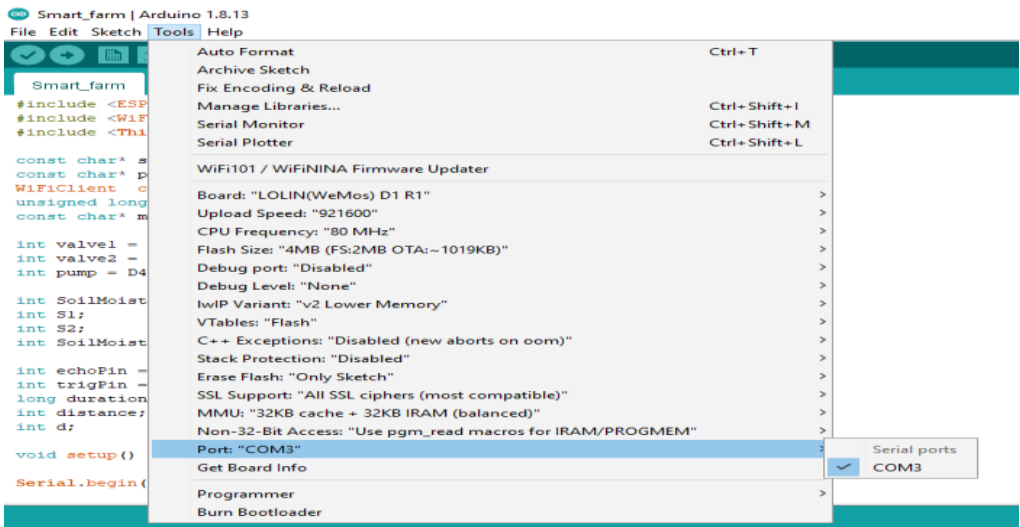


Fig. 6 Serial port identification

After connecting all the electrical components, we now connect the control panel to the computer and download the software to the control panel. As shown in “Fig. 7”, below:



```

Smart_farm | Arduino 1.8.13
File Edit Sketch Tools Help

Smart_farm
#include <ESP8266WiFi.h>
#include <WiFiClient.h>

const char* ssid = "XXXXXXXXXX"; //user name LTT4G-BJ43
const char* password = "XXXXXXXXXXXXXXXXXXXX"; //pass wordHH0ERH84
WiFiClient client;
const char* myWriteAPIKey = "XXXXXXXXXXXXXXXXXXXXXXXXXXXX";

int valvel = D7;
int valve2 = D8;
int pump = D4;

int SoilMoisture_1 =D2;
int S1;
int S2;
int SoilMoisture_2 =D3;

int echoPin = D6; // attach pin D6 Arduino to pin Echo of HC-SR04
int trigPin = D5; //attach pin D7 Arduino to pin Trig of HC-SR04
long duration; // variable for the duration of sound wave travel
int distance; // variable for the distance measurement
int d;

void setup() {
  Serial.begin(9600);
  pinMode(valvel, OUTPUT);
  pinMode(valve2, OUTPUT);

```

Fig. 7 Uploading programs to the control panel

Remote Sensing

We execute the system and obtain the system's output remotely. As the value is kept in minutes, days, months, and years, the Arduino application also offers the ability to save data. A reading may be taken as soon as the mouse head is positioned on the necessary curve, as shown in “Fig. 8”.



Fig. 8 The results of the remote operation

CONCLUSION

The objective of the solar panel cleaning robot design showcased in this work is to increase the sustainability and efficiency of solar energy systems. It was developed at the College of Renewable Energy Tajoura. Compared to conventional panel cleaning techniques, this robot uses less water and does away with the need for manual labor by automating the cleaning process. The cleaning activities were effectively monitored and managed by integrating the Arduino Cloud remote control software with the (ESP8266-01) microcontroller. It has been demonstrated that using this strategy would cut down on cleaning time and total solar energy system maintenance expenses. The results show that using a smart and economical approach to maintain optimal panel performance is possible with our solar panel cleaning robot. The robot enhances the overall efficiency of the solar energy system and maximizes energy output by autonomously cleaning dirt, dust, and debris off the panel surfaces. Overall, this solar panel cleaning robot concept is an inventive way to improve solar power technology' affordability and sustainability. Its automatic cleaning, remote monitoring, and low resource consumption make it a desirable choice for enhancing the performance and viability of solar energy systems.

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CFD Analysis of Finned Tube Heat Exchanger to Impact the Heat Transfer Performance by Geometric Modification

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Abstract- This work investigates the impact of fin shapes on the efficiency of heat exchangers with small finned tubes. Model A, Model B, and Model C are the various heat exchanger fin shapes: rectangular plate fins, tapered fins, and annular fins respectively. This work presents the geometric modification and thermal analysis of finned tube heat exchangers through the use of computational fluid dynamics (CFD), and Solid Work software for modelling the fins, all models were made using the two distinct materials copper and aluminium wherein the analysis took into account a hot water/liquid and air flow. The air velocity and the tube inclination angles were changed in addition to the fin forms. On the other hand, to maintain a constant heat flow throughout the investigation, the entrance hot water/liquid temperature and pressure at the tube domain were maintained constant. The temperature of the surrounding air flow was maintained outside the tube surface the findings demonstrated that, in accordance with three models, the impacts of the fin shape of the finned tube heat exchanger on heat flux on various heat exchanger domains, static temperature, friction factor, and streamline velocity magnitude and heat flux have been analysed. The result shown that the Rectangular plate fin shape heat exchangers with maximum airflow and increased heat transfer rate result and has lowest heat flux and friction factor than tapered fins and annular fins. Moreover, the rectangular fin is the best in terms of high heat transfer however the fins of lower friction factor leads the fin to have the best efficiency of all. Furthermore, the rectangular fin is the best in terms of high heat transmission. Conversely, annular fins achieved the highest friction factor and static temperature As a result; rectangular fins should be used when high heat transfer is required. Additionally, heat exchangers made of copper material have higher heat transfer than those made of aluminium in all models, but aluminium is preferred for lightweight, particularly in cooling systems found in cars and airplanes.

Keywords- Finned tube heat exchanger, Efficiency, Heat Transfer Performance and computational fluid dynamics (CFD).

Nomenclature

Symbols	Parameters	Units
$\dot{m}$	mass flow rate	kg/s
ΔT	temperature difference	K
C_p	specific heat capacity	J kg ⁻¹ K
Q_a	heat transfer rate	W
H	forced convection heat transfer coefficient	W/m ² K
A_{ts}	total heat transfer area	W
$LMTD$	log mean temperature difference	K
Nu	Nusselt number	/

J	<i>Colburn factor</i>	/
F	<i>friction factor</i>	/
Pr	<i>Prandtl Number</i>	/
Δp	<i>pressure difference</i>	<i>Pa</i>
PEC	<i>performance evaluation criteria</i>	/
Re	<i>Reynolds number</i>	/
Dh	<i>hydraulic diameter</i>	<i>mm</i>

1. INTRODUCTION

Heat transfer improvement techniques have been used for well over a century in an attempt to create heat exchangers that are more efficient. However, because industry needs for heat exchange equipment that is less expensive to manufacture and maintain than typical heat exchange devices have increased, the study of improved heat transfer has acquired significant pace in recent years. Improvements in material and energy efficiency also serve as a powerful incentive for the creation of better improvement techniques. [1] When developing cooling system for autos and spaceships, it is vital that the heat exchangers are extremely compact and lightweight. [2] Furthermore, the high heat duty exchangers present in power plants require augmentation devices. Air-cooling condensers and nuclear fuel rods are two examples. A variety of improved heat transfer surfaces have been developed as a result of these and many more applications. [3]

To lower the total volume and perhaps the cost of heat exchangers, improved heat transfer surfaces can often be employed to make them more compact to raise the heat exchanger's total UA value or to lower the pumping power needed for a particular heat transfer operation. [4] One can take use of a larger UA value in two ways: either to minimize the mean temperature difference for the heat exchange, which intensifies the thermodynamic process, or to increase the heat exchanger rate for fixed fluid inlet temperatures. efficiency, which may lead to a reduction in running expenses[5]. This research focuses exclusively on improving fluid side heat transfer using unique surface shapes and various materials.

Common devices, finned-tube heat exchangers have complicated performance characteristics. As previously mentioned, this study focuses on the airside performance of fin tube heat exchangers, with water-liquid selected as the working fluid. While the water side heat transfer and pressure drop behaviour inside the tubes is well-established and relatively straightforward, the air side behaviour has been the subject of numerous research studies and is much more complex. Designers are forced to rely on software for analysis during the fabrication process. [6]

Heat exchangers are essential parts of many engineering systems and facilities. Therefore, heat exchanger design and construction are frequently essential to the correct operation of such systems. According to research by Barron (1985), low temperature plants using the Linde–Hampson cycle stop producing liquid when the heat exchanger's efficiency falls below 86.9%. [7] Conversely, in cars and airplanes, the smallest possible volume and weight of heat exchangers is required for a given heat duty. Thus, the primary prerequisite for any heat exchanger is its exceptional efficacy in transferring the necessary quantity of heat. [8] Convective heat transfer and fin improvement techniques, like slotting the fin, should be used primarily in the

rear of the fin when the temperature gradient and local velocity synergy worsen. [9] In practice, increasing the temperature differential may not have much of an impact. Either way, heat should be transferred to a cooler fluid when accessible, or a hotter fluid should be provided to the heat exchanger. More work must be done in both situations in order to supply the hot fluid at a high temperature or the cold fluid at a lower temperature. [10] Moreover, creating an excessive temperature differential between two fluids will result in unwelcome thermal stresses on the metal surface. This typically causes the materials to distort and shortens their lifespan. Given these facts, the optimal engineering technique is often to increase the heat transfer surface area.

2. METHODOLOGY

2.1 CFD analysis

The angles of 60° and 1.5 mm are suitable for enhanced heat transfer, according to Ramesh K Shal study [8], which was used in the fin design. For the tapering fins, the height and dimensions of an equilateral triangle were used from their work. Regarding the fin with a rectangular groove, no prior research has been done on its form. As a result, the parameters were established at 2 mm x 2 mm x 2 mm. Once the fin specifications were decided upon, Solid Works was used to simulate the parameters for easier CFD analysis. A total of 20 fins per fin type were used, spaced evenly apart **figure 1**. displays a whole and sliced segment of various finned tube heat exchanger Models.

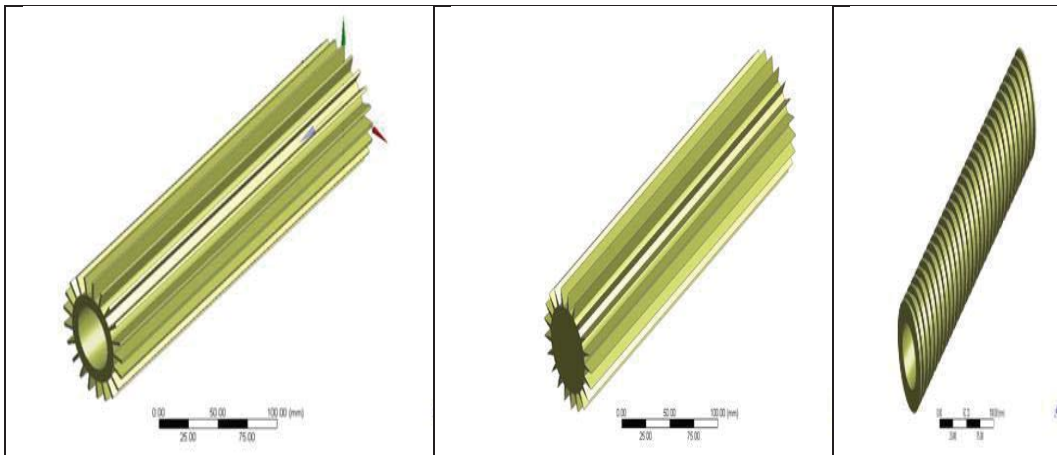


Fig 1: 3-D modelling of different types of finned tube heat exchanger with (A,B and C) full isometric view

A: Geometry

Finned tubes are used when the heat transfer coefficient on the outside of the tubes is appreciably lower than on the inside; as in heat transfer from a liquid to gas, such as steam to air heat exchangers, thermic fluid to air heat exchangers; when an extended surface is needed on only one fluid side (such as in a gas to liquid exchanger); or when the operating pressure needs to be contained on one fluid side, a finned tube heat exchanger may be chosen. Fumed tubes are made up of a shell and finned tube assembly. Fins are used to increase the effective surface area of heat exchanger tubing. Solid Works was used to create the finned tube heat exchanger, which was then exported as an IGS file into ANSYS Fluent. A number of processors were created

during the workbench stage, including ones that combined, merged, and filled the tube's surfaces. These processors were eventually given the moniker cell zone selection, which will aid in the selection of unique materials for each domain. Materials made of copper and aluminum, as well as shapes of rectangular, tapered, and circular fins, were chosen. Figure 1 depicts the full isometric view and A1 cut section view of three distinct models of finned tube heat exchangers—Models A, B, and C—designed using ANSYS Workbench R16.0.

B: Meshing

A crucial step in the simulation process for computer-aided engineering is meshing. The mesh should be created on the necessary surfaces and edges since it has an impact on the accuracy, convergence, and speed of the solution result. A geometry with a large number of elements will produce more accurate results and be very visible at first glance. The meshed model of the finned tube heat exchanger in the ANSYS fluent, produced by the double precision and two processes approach, is displayed in **Figure 2**. **Table 1** displays the quantity of elements utilized in this meshing for various models. Face meshing, inflating, and edge sizing of the meshing are carried out in this phase to update the setup stage for process analysis.

Table 1: The quantity of meshing nodes and elements across various models

Domain	Elements	Nodes
<i>Model A</i>	53997718	3967001
<i>Model B</i>	52559492	3363389
<i>Model C</i>	54193942	3525401

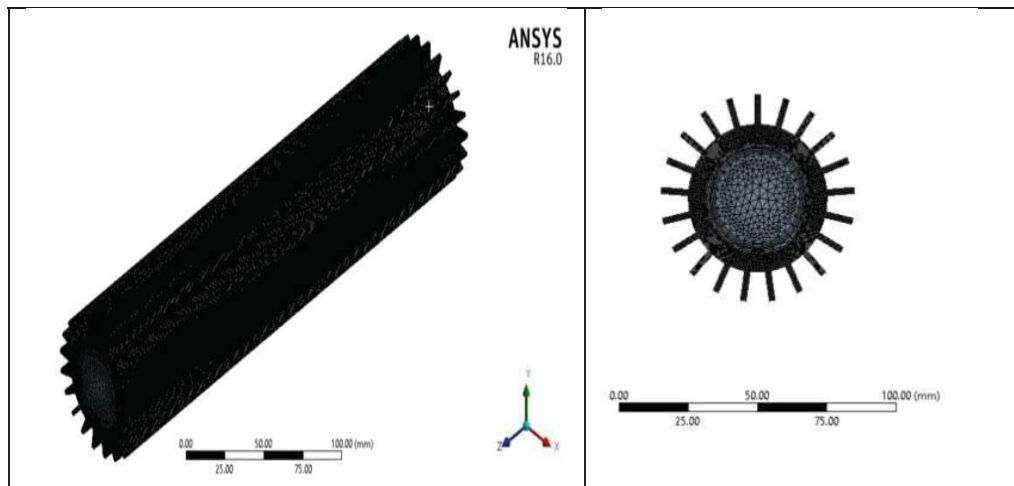


Fig 2: Meshing model a (rectangular plate finned tube heat exchanger), (a) Isometric view and (b) side view.

C: Setup

ANSYS Fluent 16, a CFD model, was first used to confirm that finned tube heat exchangers worked as intended. The setup for the analysis consisted of two cell zone conditions, tubes and fins made of solid material with different compositions of copper and aluminum, fluid flow at a high temperature in the tube, and hot fluid (water). For increased accuracy, the analysis was conducted with double precision; theoretical calculations and fluid properties were displayed in **Tables 2 and 3**, which were used as input data for the setup stage's boundary conditions; the standard

initialization method option was computed from all zone conditions in the solution monitors; 1000 iterations were taken for the CFD analysis run calculation. Model A, Model B, and Model C are the various heat exchanger fin shapes: rectangular plate fins, annular fins, and tapering fins, respectively. The models' varying fin shapes are intended to produce variations in the flow velocity and friction factor between the fins, which in turn will produce variations in the rate of heat transfer.

Table 2: Properties of Water (liquid) and air at input temperature [9]

Property of the Fluid	Hot Water	Air
Temperature (K)	350	300
Specific Heat (J kg ⁻¹ K)	4.182×10^{-3}	3.808×10^{-3}
Thermal Conductivity (W/m K)	0.667×10^{-3}	0.0242×10^{-3}
Density (kg/m ³)	998.2	1.006
Dynamic Viscosity (N s/m ²)	0.1003×10^{-3}	1.7894×10^{-5}
Prandti Number	2.266	0.72

Table 3: Modeling Data for working fluid

Data	Tube side	Fins side
Fluid Name	Water (H ₂ O)	Air
Input Temperature (°k)	350	300
Input velocity Magnitude (m/s)	0.001	50
Mass Flow rate (kg/s)	0.0313	/
Inner Diameter (mm)	35	/
Outer Diameter (mm)	50	--
Length(mm)	300	300
Thickness (mm)	1	0.7
Input Pressure (psi)	14.5	1.0697

Determining the convective heat transfer coefficient of the air side by directly measuring the heat exchanger's wall temperature is a challenging task. The primary goal of data reduction is to compute the Nusselt number (Nu), friction factor (f), and Colburn factor (j) of the finned tube heat exchanger from the CFD analysis results that were recorded during each simulation calculation run. This will allow us to determine the heat transfer coefficient of the air side through the heat exchanger. The following formula is used to calculate the air side's heat transfer rate (Q_a), which is used to calculate the heat transfer coefficient. [11][12]:

$$Q_a = Q_{conv} = \dot{m}C_p(\Delta T) \quad (1)$$

Heat transmission by radiation and conduction from the tube wall in terms of heat transfer rate, total surface area, and log mean temperature difference, the forced convection heat transfer coefficient (h) is expressed. [13]

$$h = \frac{Q_{conv}}{A_{ts}LMTD} \quad (2)$$

The next step is to assess the air side's convective heat transmission level. The following can be stated as the numeric value that is used in this investigation. [14]

$$Nu = hD_h/k \quad (3)$$

The following formulas have been used to get the finned tube's Colburn factor(j) and friction factor (f).[15]:

$$j = \frac{h}{\rho v_{max} C_p} Pr^{\frac{2}{3}} \quad (4)$$

$$f = \frac{D}{L \rho} \frac{2\Delta P}{V_{max}^2} \quad (5)$$

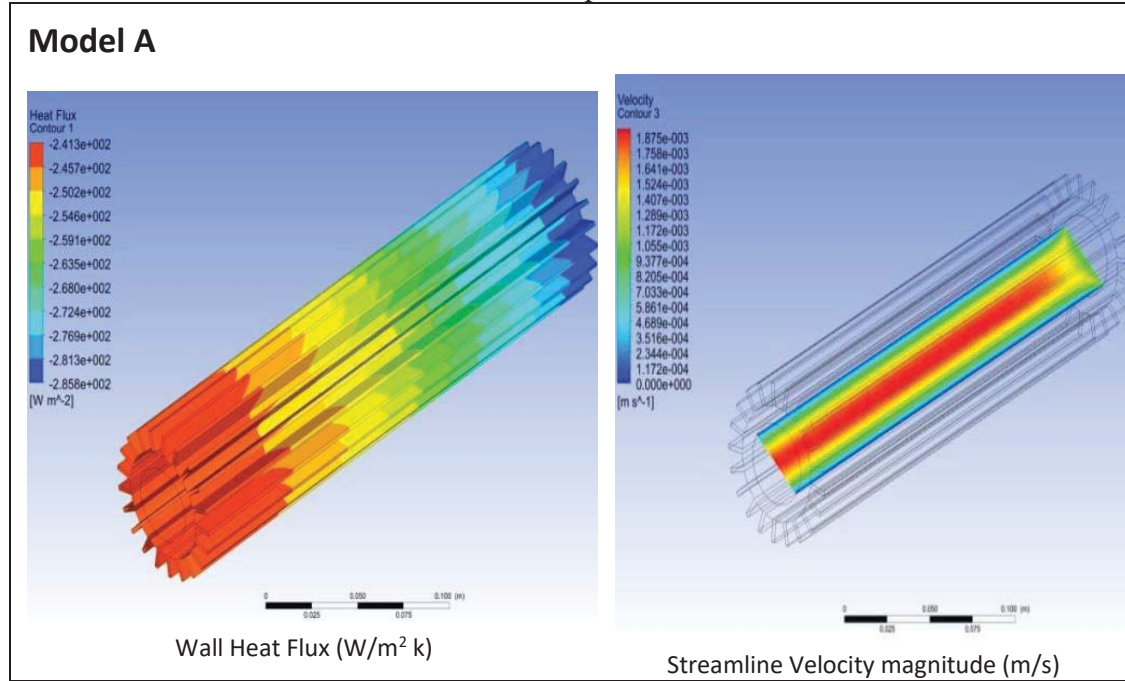
To compare the performance of the air side, the thermal performance coefficient JF was computed. As a result, the finned tube heat exchanger's performance evaluation criteria are described as [16]:

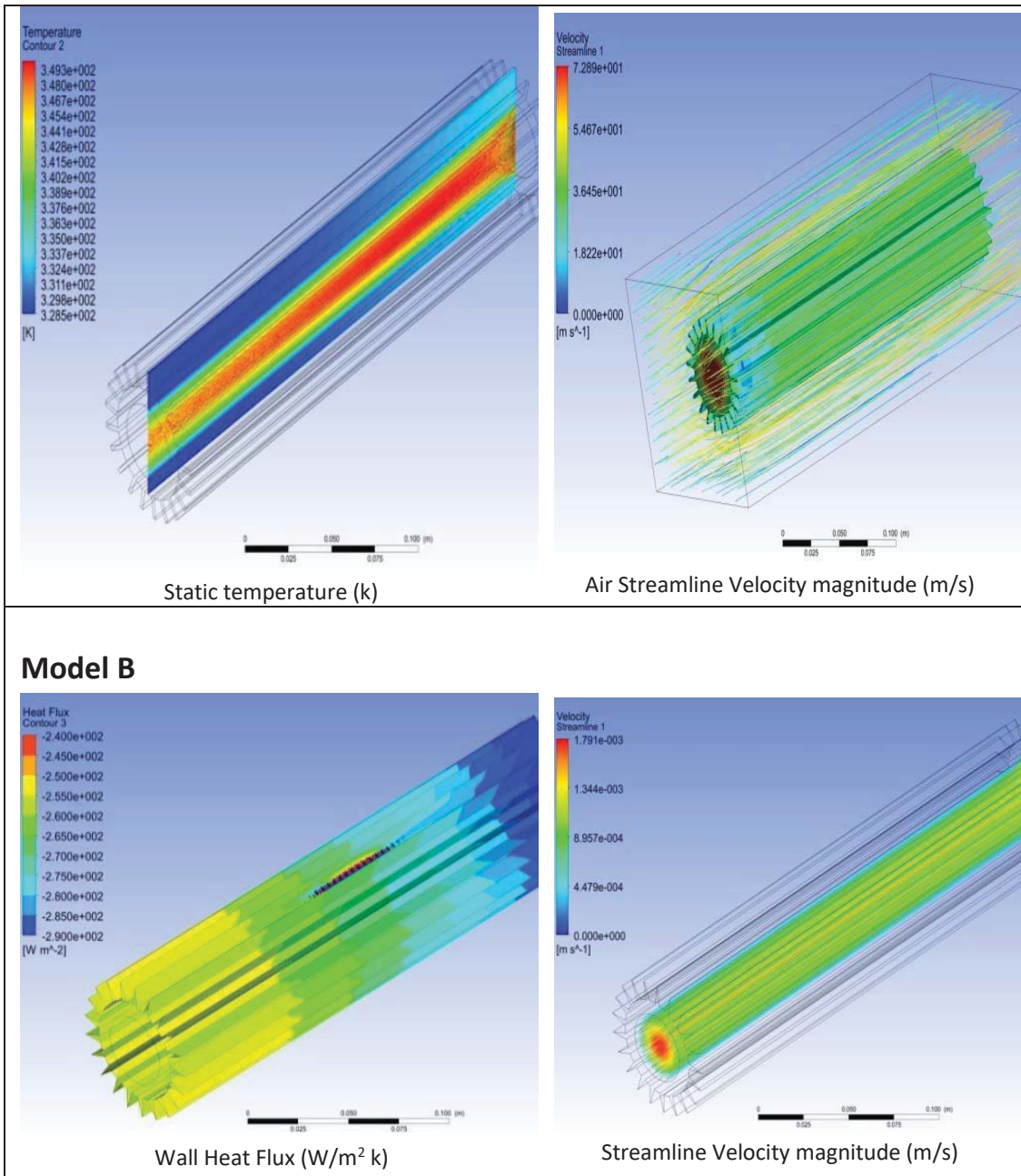
$$PEC = JF = j/f \quad (6)$$

3. RESULTS

The comparative results of the CFD analysis for all models are summarized in **Table 4**, which also shows the four essential parameters: wall heat flux (i), stream velocity (ii), air streamline velocity magnitude (iv), and static temperature. the heat flux distribution throughout the heat exchanger's various surfaces in several models, and it is evident that the fins surface of every model had the greatest heat flow to the environment, Rectangular fins heat exchanger model has lowest outlet average temperature of 328K, tapered fins exchanger of about 330K, and annular fins heat exchanger of 334K; inlet water temperature was constant at 350K. Additionally, water streamline velocity magnitude decreases from model A to model C by 11.46%. The rectangular fins heat exchanger model has the highest heat transfer rate as air flow contacts more on fins surface, but the friction factor decreases. All digital values for the CFD results for the models with varying parameters are displayed in **Table 5**.

Table 4: CFD results of different parameters for different models





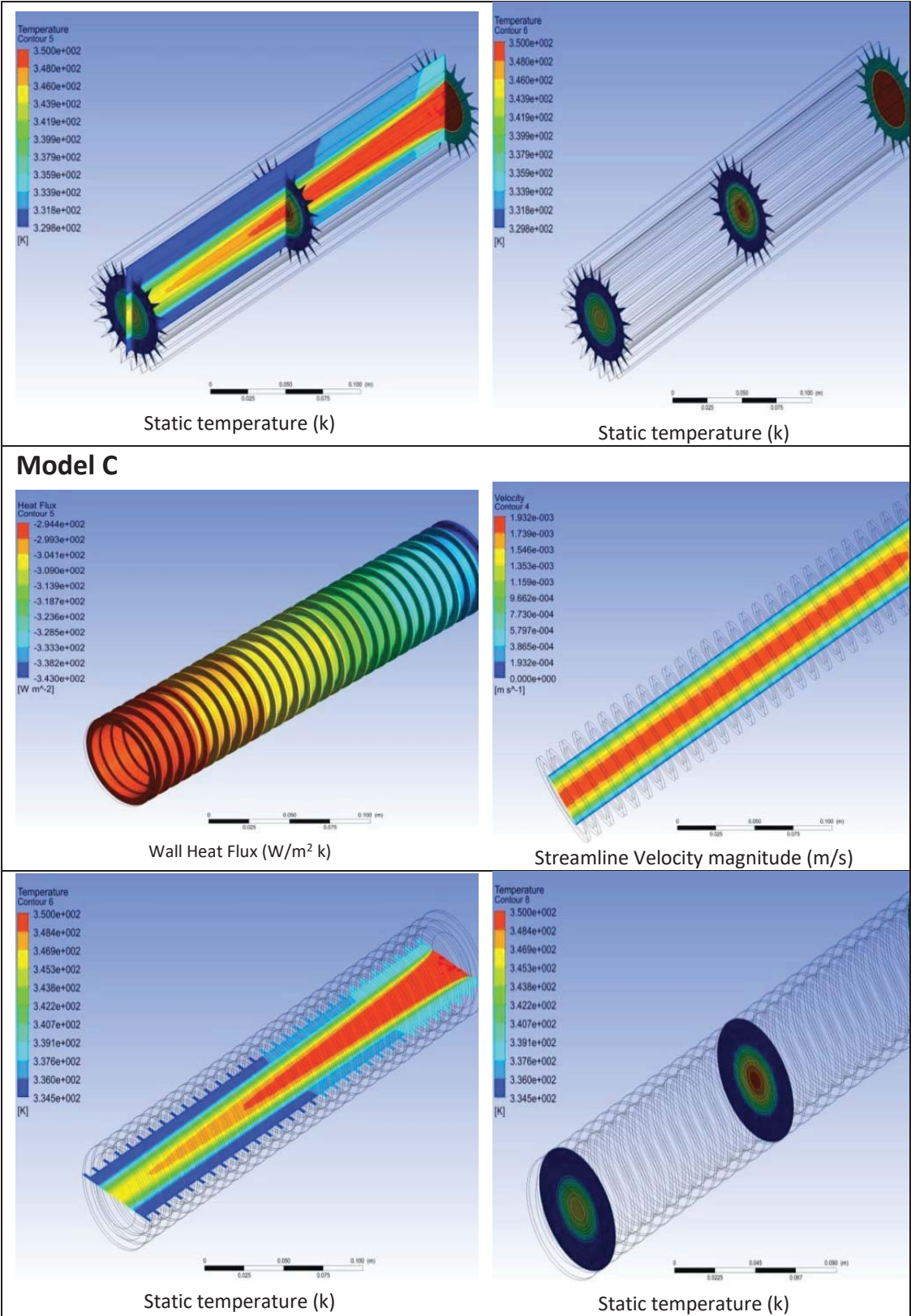


Table 5: showing digital value of CFD results of different parameters for the models

Parameters	Model A	Model B	Model C
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<i>Static temperature (k)</i>	328.83	330.168	332.021
<i>Static pressure (Pa)</i>	Constant	/	/
<i>Water streamline velocity magnitude (m/s)</i>	855×10^{-3}	837×10^{-3}	757×10^{-3}
<i>Air streamline velocity magnitude (m/s)</i>	50.30	47.27	38.57
<i>Wall heat flux (W/m²k)</i>	45.1072	42.035	31.5061

Table 6 presents the theoretical outcome derived from the software's calculation of various parameters. It illustrates that the Reynolds number decreases by 3% between Model A and Model C, while the friction factor increases. The heat exchanger with rectangular fins performed the best in terms of high heat transfer rate, while the one with annular fins had the lowest heat transfer performance but the highest efficiency.

Table 6: displays the potential outcome of certain parameters.

<i>Parameters</i>	<i>Model A</i>	<i>Model B</i>	<i>Model C</i>
<i>Heat transfer rate, (W/m²k)</i>	45.1072	42.035	31.5061
<i>Heat transfer coefficient, (W/m²k)</i>	5.875	5.591	5.230
<i>Area (finned surface), (m²)</i>	0.240	0.226	0.1725
<i>log mean temperature difference (LMTD)</i>	31.36	33.24	34.92
<i>Reynolds number</i>	8768	8661	8505
<i>Nuzzle number</i>	46.49	46.04	45.37
<i>Friction Factor</i>	0.03267	0.03278	0.03295
<i>Colburn factor</i>	3.965×10^{-3}	3.975×10^{-3}	4.189×10^{-3}
<i>PEC</i>	0.1213	0.1212	0.1271

The heat flux in **Table 7** is displayed for various models' surfaces. The heat supplied at the inlet heat exchanger, which is 207.41 w/m².k, is constant for all models, while the outlet decreases by 8% from Model A to Model C. Additionally, the heat flux from the hot fluid through the wall tube to the fins surface is 45.10 w/m².k at the rectangular fins (Model A) and 31.50 w/m².k at the annular fins (Model C). The symbol (-) denotes heat rejected to the environment outside the system.

Table 7: illustrates the heat flux in various model surfaces.

<i>Parameters</i>	<i>Model A</i>	<i>Model B</i>	<i>Model C</i>
<i>Fins Surface (W/m²k)</i>	-45.108	-42.035	-31.516
<i>Side Surface (W/m²k)</i>	0	0	0
<i>Wall Fluid Tube (W/m²k)</i>	45.107	42.035	31.506
<i>Inlet (W/m²k)</i>	207.413	207.368	207.120
<i>Outlet (W/m²k)</i>	-162.30	-165.36	-175.62

The heat exchanger's static temperature distribution across different models is depicted in **figures 3, 4, and 5**. These graphics illustrate how the static temperature varied between the models when compared with variations in tube length; all models had a constant inlet temperature. The second figure provides the most clear definition of temperature performance; a lower outlet temperature indicates a higher heat transfer at the fins surface. Additionally, the average outlet temperature for Model A, Model B, and Model C was 328k, 330k, and 334k, respectively; furthermore the static temperatures of the fins surface, side surface, and wall tube have been studied.

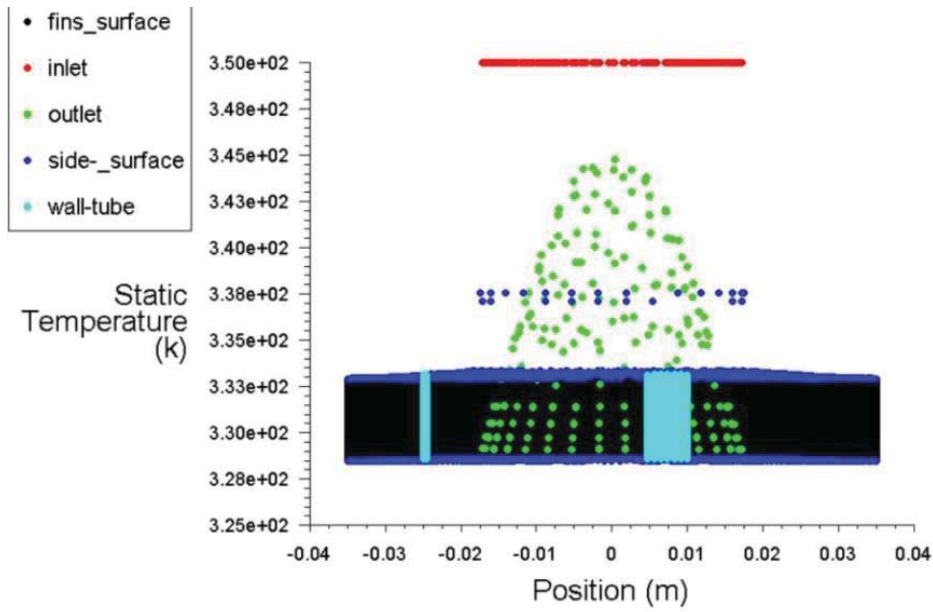


Fig 3: Comparisons of static temperature distributions with iterations in model A

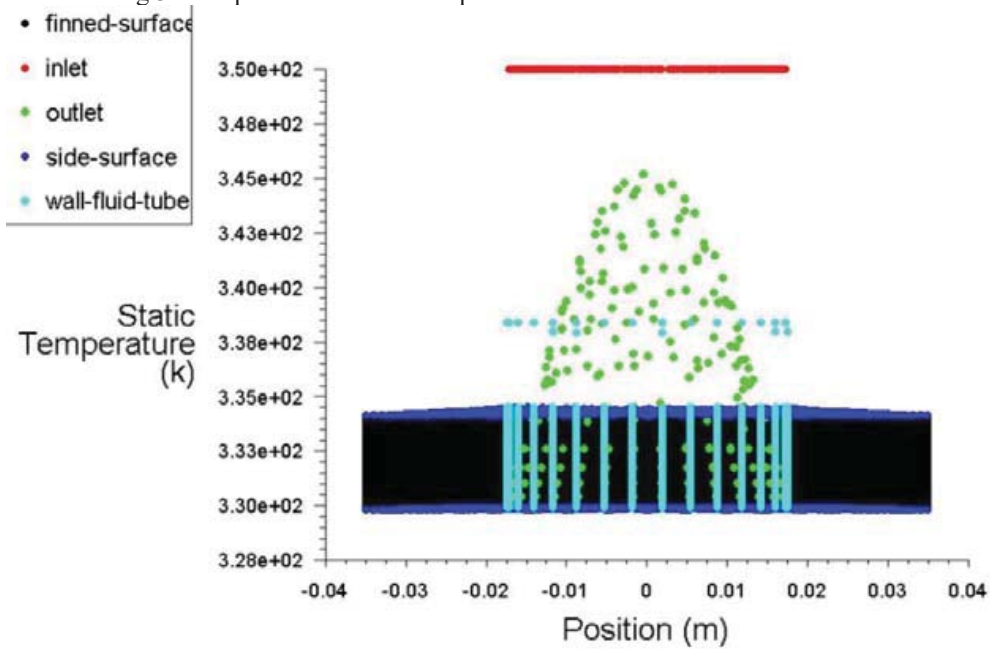


Fig 4: Comparisons of static temperature distributions with iterations in model B

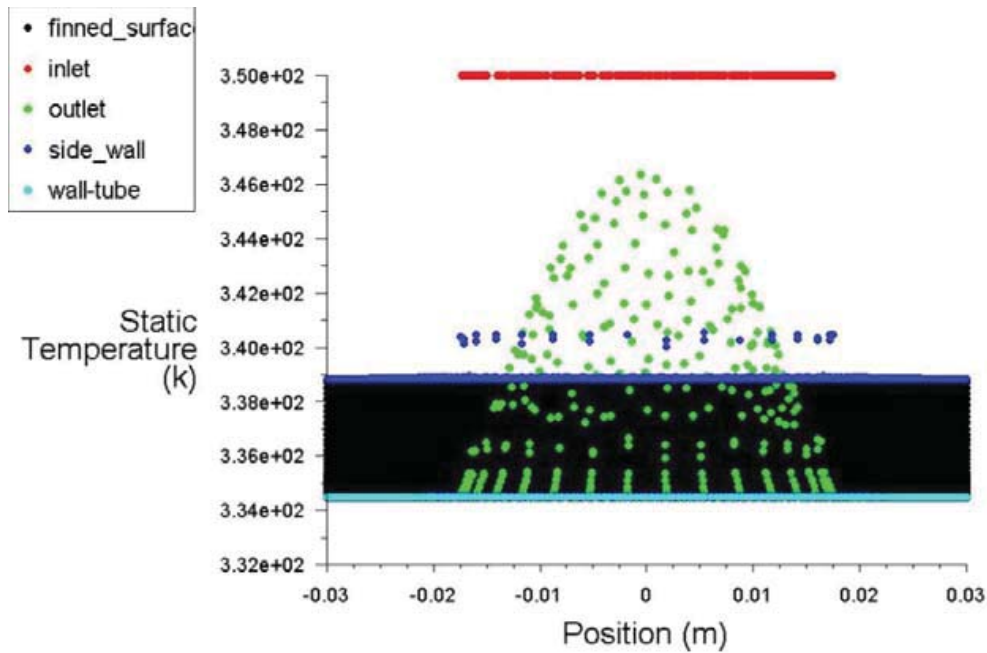


Fig 5: Comparisons of static temperature distributions with iterations in model C.

4. CONCLUSION

This investigation indicated that, when compared to tapered and annular fins, the rectangular fin performs the best in terms of heat transfer, with tapered fins performing better than annular fins. Because of the fins' shaped surfaces to the flow and temperature boundary layers along the flow orientation, which reduce friction factor, rectangular fins produce the maximum heat transfer performances. Compared to tapered and annular fins, the arrangement of rectangular fins results in higher heat transfer and a lower friction factor. The fin with the highest heat transfer efficiency is the rectangular one, whereas the fin with the lowest efficiency is the one with tapered fins and a high friction factor. Conversely, annular fins achieved the highest static temperature. As a result, rectangular fins should be used when high heat transfer is required. Additionally, heat exchangers made of copper material have higher heat transfer than those made of aluminium in all models, but aluminium is preferred for lightweight, particularly in cooling systems found in cars and airplanes.

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COMPRESSION CHARACTERISTICS OF LIME STABILIZED COHESIVE SOIL

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Abstract:

- The increase in the coefficient of consolidation (C_v) with the change in curing time observed in the study was unexpected, as the typical behavior of lime-stabilized soil would suggest a decrease in C_v over time. This deviation is likely due to the flocculation effect, which alters the soil structure. Lime stabilization often leads to particle aggregation and a reduction in plasticity, which can impact the soil's compressibility and permeability. In this case, the flocculated structure formed during lime stabilization may have allowed for faster dissipation of pore water pressure, thereby increasing C_v over the curing period. Additionally, the change in C_v with time would have varied depending on several factors, including the type of soil, lime content, and curing conditions, which may have been applied differently across the tests. This could explain the differences in the rate of change of C_v with curing time for various applications or scenarios.

Keywords: *Coefficient consolidation(C_v), Reduction settlement(%), lime*

1.1 INTRODUCTION

We always face the problem in geotechnical engineering where the soil can not reach the required specification for some construction, example the unstabilty of soil, reduce the compressibility of soil, and soil stabilization is very important part to be done before the construction carried out.

since consolidation of the soil is a critical problem at the construction site, geotechnical engineers always take this problem as their main challenges in the construction project. hence; the determination of the soft soil consolidation characteristics becomes very important before the construction phase.

In this research, which title “compression characteristics of lime stabilized soil”, we will look into the problems facing by using the lime as stabilizer, and using 6% limes can help us in solving these

problems. And effect lime on the soil related time. Based on two tests, The compaction test is used to establish the relationship between moisture content and dry density in soil. This allows for the determination of the optimum moisture content and maximum dry density. and consolidation test defined The process you are referring to is known as soil consolidation. This phenomenon occurs when stress is applied to soil, leading to a reduction in its volume as the soil particles are compressed more tightly together. Here are some essential aspects of soil consolidation: . This consolidation behavior is study the change in initial void ration, e_o and coefficient of consolidation, c_v [1].

Lime stabilization is a well-established technique in geotechnical engineering used to enhance soil properties. By incorporating lime into the soil, several advantageous modifications can take place:.

Lime, in its various forms, serves a vital purpose in soil treatment and stabilization. Here's a summary of how each type of lime is utilized in construction and soil enhancement:

When lime is added to clay soils, it reacts chemically with the soil particles. The calcium ions from the lime replace the sodium, potassium, and magnesium ions on the clay's surface, leading to flocculation of the clay particles. This process reduces plasticity and increases the soil's load-bearing capacity.

Lime treatment of soil is an effective technique that can save both time and money on construction projects. By drying out wet soils, lime reduces construction delays caused by weather conditions, allowing work to resume within hours. The process of lime modification chemically alters clay soils, transforming them into friable, manageable, and compactable materials. Additionally, lime stabilization induces long-lasting chemical changes in unstable clay soils, creating robust yet flexible structural layers in soil systems and foundations. This method not only enhances the engineering properties of the soil but also contributes to significant cost savings over time.

2.1 Soil Sample Collection

undisturbed sample were collected from both sits and brought to the geotechnical laboratory for identification and testing .The undisturbed samples were cleaned and placed in an oven 24 hours operating at 105c for 24 hours to remove all the moisture content. Then the samples were crushed using manual timber hammer and cleaned again by removing the undesired materials such as roots, trunks, rock and etc[2].

2.2 Description of Equipment

consolidation cell is comprised of a mold designed to hold and support the test specimen, along with upper and lower drainage surfaces, a loading cap, and an outer casing filled with water for immersion. A typical oedometer consolidation cell is depicted in Figure 2.1 [Head (1982a)]. Prior to commencing the test, the oedometer cell will be placed on a loading system, as illustrated in the accompanying diagram, as shown in Figure 2.2

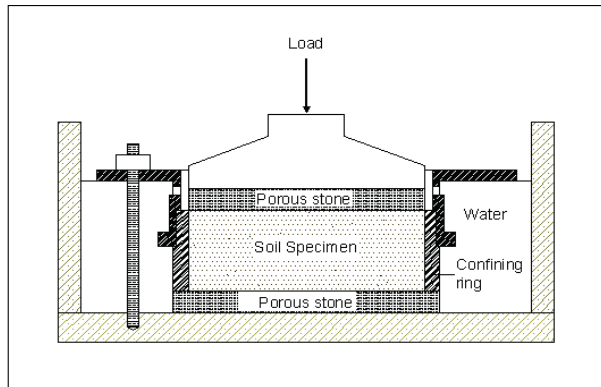


Figure 2.1 The Odometer test



Figure 2.2 Typical Consolidation

2.3 Coefficient of Consolidation c_v

The coefficient of consolidation (C_v) is a vital parameter in geotechnical engineering that helps in understanding how soil compresses over time under applied loads. It quantifies the rate at which a saturated soil layer experiences volume reduction due to the expulsion of pore water when subjected to increased loads. This coefficient represents the ratio of the increment in vertical effective stress to the rate of change of pore water pressure. It determines the speed

at which consolidation occurs over time, significantly influencing predictions of settlement in foundation design.

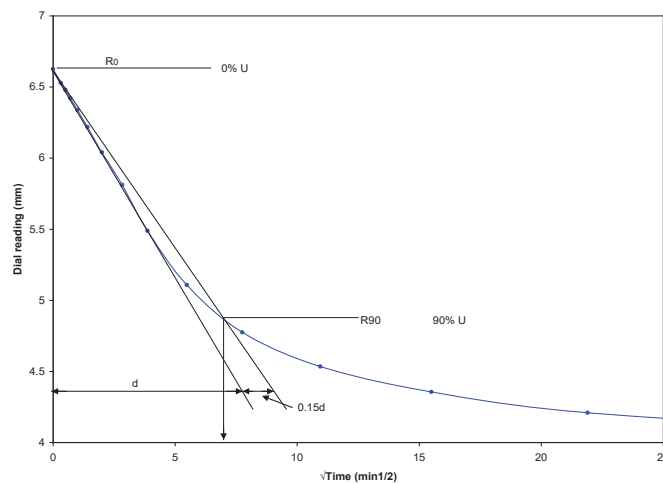


Figure. 2.3 Determination of c_v , using Taylor square root of time method

3 RESULTS AND DISCUSSION

3.1 Summary of Soil (Kaolin) Classification

From all classification tests that have been done, specimen behaviors for compaction and oedometer test is shown in table 3.1 below.

Soil Properties	Value
Liquid Limit	41.5
Plastic Limit	30.8
Plastic Index	10.70
Soil Type	Intermediate silt(CI)

Table 3.1: Summary of Soil Classification

3.2 Compaction test

The table 3.2 shows are the result of data compaction test, performed on Kaolin .

Sample	Maximum Dry Density (mg/m ³)	Optimum Moisture Content (%)
Koalin+0%lime	1.67	19.10
Koalin+6%lime	1.54	21.30

Table 3.2 Compaction Test Result

The addition of lime to kaolin decreases the dry density while simultaneously increasing the moisture content. This phenomenon

occurs due to the changes and flocculation of soil particles, which make the soil more friable and conducive to compaction (Assarson et al., 1974; Kairul Anuar and Kok Kai Chern, 2004).

3.3 Displacement versus time

3.3.1 Kaolin+0%lime (0day)

It seems you're looking to explore how the coefficient of consolidation (C_v) changes with different curing times and possibly different applied conditions. Here's a structured way to approach this: effective stress also displacement decrease as shown Figure (3.3).

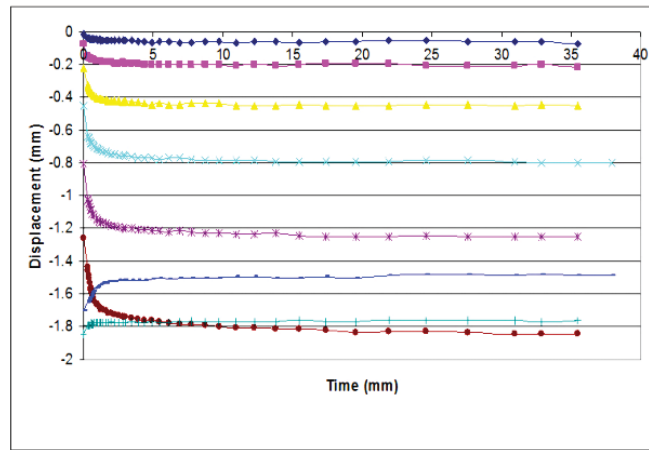


Figure (3.3) displacement versus time

3.3.2 Kaolin+6%lime (0day)

The Coefficient of consolidation c_v of treated soil increases with the change in curing time was also different effective also displacement decrease as shown Figure (3.4). There are seven steps of loading and two steps of unloading. The loading sequences 50kpa, 100kpa, 200kpa, 400kpa, 800kpa, 1600kpa and 3200kpa. Unloading steps sequences 800kpa and 400kpa. The calculation of the coefficient of consolidation and void ratio.

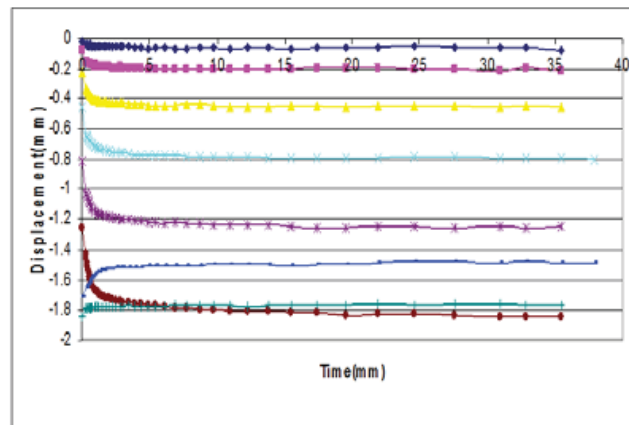


Figure :(3.4) displacement versus time

3.3.3 Kaolin+6%lime (after 7days)

The Coefficient of consolidation c_v of treated soil through 7days increase with It seems like you're discussing the relationship between curing time and the coefficient of consolidation (C_v) in a geotechnical or material science context. The coefficient of consolidation is a key parameter in soil mechanics, particularly in the study of the consolidation of saturated soils.

effective also displacement decrease as shown Figure (3.5). There are seven steps of loading and two steps of unloading.

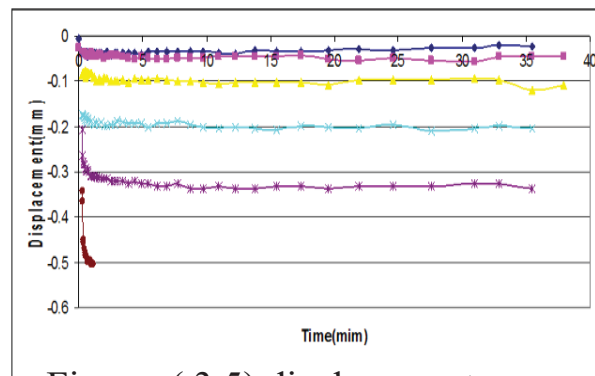


Figure :(3.5) displacement versus time

3.3.1.4 Kaolin+6%lime (after 14days)

The Coefficient of consolidation c_v of treated soil through 14days increase with the change in curing time was also different effective also displacement decrease as shown Figure (3.6). There are seven steps of loading and two steps of unloading.

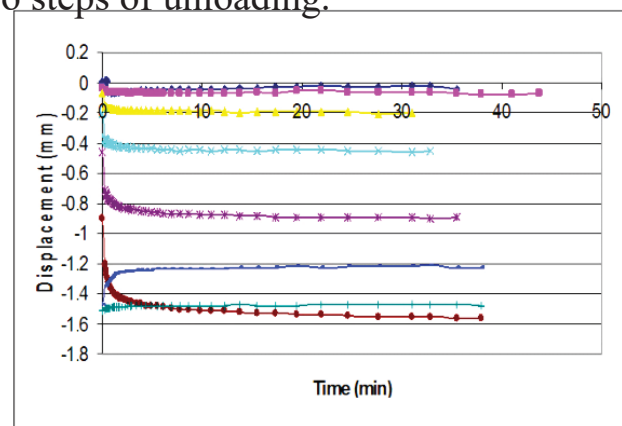


Figure :(3.6) displacement versus time

3.3.1.5 Kaolin+6%lime (after 28days)

The Coefficient of consolidation c_v of treated soil through 28 days increase with the change in curing time was also different effective also displacement decrease as shown Figure (3.7). There are seven steps of loading and two steps of unloading.

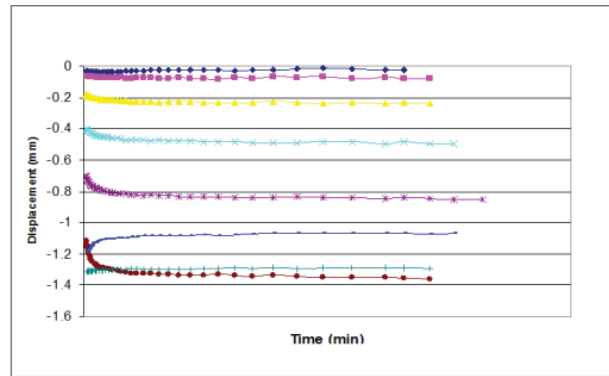


Figure :(3.7) displacement versus time

3.3.1.6 Summary of Oedometer Test Result

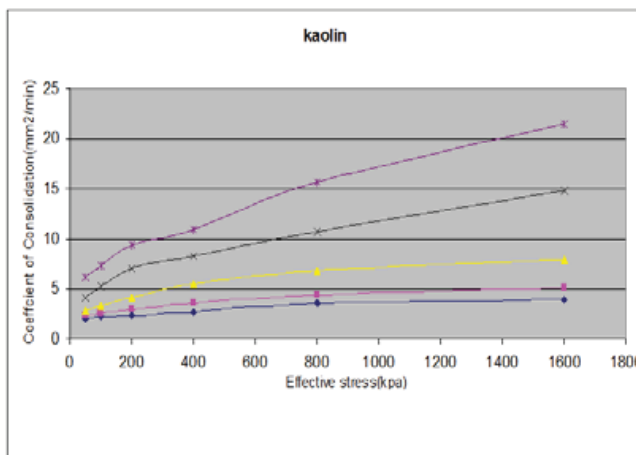


Figure (3.8.)Effective stress versus coefficient consolidation (C_v)

The coefficient consolidation of C_v is expected to decrease with curing period due to the formation of new compound, that causes the pore to become smaller. There is significant increase in coefficient of consolidation C_v immediately. This is due to the process where the soil become flocculated as the particles size rearrangement. However the C_v values remain in the increase trend with age. It sounds like you're discussing the coefficient of consolidation (C_v) in the context of soil mechanics, particularly how it varies with curing time. Here's a brief overview of these concepts: as the new compound developed does not effect the pore size.

The variation in coefficient of consolidation C_v was observed the change in effective stress and at curing time (0,7,14,28days).In general it was found that coefficient of consolidation C_v values of lime treated samples were greater than those of untreated samples indicating that the soil become more porous. It reach the maximum value of 21.43(mm²/min)for kaolin and 16.16(mm²/min)for yellow soil at 28days then decreases within curing sequences at (14,7and0days).Higher C_v means faster time for consolidation.

The rate increase in coefficient of consolidation C_v during curing period 7to 14 days. This is because of modification process where rapid ion exchange occurs in the mixture making it more porous. Hence the value coefficient consolidation C_v value become higher.

4 CONCLUSION

Based on the test results and analysis, the conclusion can shown as follows.

1. The coefficient consolidation of C_v is expected to decrease with curing period due to the formation of new compound ,that causes the pore to become smaller.
2. There is a significant increase in coefficient of consolidation C_v immediately. This is due to the process where the soil become flocculated as the particles size rearrangement
- 3This could be due to the less significant change in the pore of the soil particles as the new compound developed does not effect the pore size
4. This could be due to the less significant change in the pore of the soil particles as the new compound developed does not effect the pore size
5. In general it was found that coefficient of consolidation C_v values of lime treated samples were greater than those of untreated samples indicating that the soil become more porous. It reach the maximum value of 21.43(mm²/min)for kaolin).Higher C_v means faster time for consolidation

The rate increase in coefficient of consolidation C_v during curing period 7to 14 days. This is because of modification process where rapid ion exchange occurs in the mixture making it more porous. Hence the value coefficient consolidation C_v value become higher

Acknowledgement

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Eco-Friendly Biodiesel Production from Waste Cooking Oil

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Abstract

Biodiesel has emerged as a viable alternative diesel fuel in developed nations, gaining prominence due to the diminishing availability of fossil fuels and the increasing demand for environmentally sustainable energy sources. This study addresses the high costs associated with conventional biodiesel production by utilizing waste cooking oil as a raw material, sourced from a local restaurant in Zliten, Libya. The primary objective was to convert waste cooking oil into biodiesel through a transesterification process. Optimal reaction conditions were established at a temperature of 60°C, with a methanol-to-oil weight ratio of 1:6, a catalyst (sodium hydroxide) concentration of 1% by weight relative to the oil, a reaction time of 60 minutes, and a mixing speed of 300 rpm. Under these conditions, a biodiesel yield of 64.16% by weight was achieved.

Chemical analysis revealed that approximately 70% of the product consisted of unsaturated fatty acid methyl esters. The physical properties of the biodiesel were found to be comparable to those of conventional fossil fuels, exhibiting a low pH of 0.14 mg KOH/g oil and a kinematic viscosity of 4.03 mm²/s at 40°C. The findings suggest that waste cooking oil can be effectively converted into biodiesel, thereby mitigating environmental disposal issues and reducing associated risks. Future research should explore the potential of various feedstock, including different types of fats, for biodiesel production.

Keywords

Biodiesel, waste cooking oil, transesterification, environmental sustainability

1. Introduction

Growing uncertainty in global energy supply, environmental concerns about fossil fuels, and high petroleum prices have spurred interest in alternatives like biodiesel [1]. A study indicates that conventional oil

and gas sources may not meet energy demand over the next 25 years, highlighting the need for biodiesel as a sustainable diesel substitute [2]. Biodiesel, derived from renewable biomass sources like plants and animal fats, offers environmental benefits, including lower emissions and biodegradability [3].

However, high production costs, primarily from feedstock prices, hinder biodiesel's competitiveness with diesel [4]. Factors such as plant size and glycerin byproduct value also affect its economics [5, 6]. Despite these challenges, biodiesel is gaining market acceptance in Europe and the U.S. due to its renewable and nontoxic qualities, with production from both vegetable oils and waste oils [7].

Biodiesel is produced through transesterification, where triglycerides react with lower alcohols to form fatty acid esters [8]. Although production costs remain a barrier, exploring cheaper feedstocks like used cooking oil can help optimize costs. In 2005, global diesel consumption reached 960 billion liters, while biodiesel production was just 4.2 billion liters, indicating significant potential for growth if biodiesel adoption increases.

To improve quality and reduce costs, researchers are investigating various production methods, including batch processes and microwave irradiation, to enhance transesterification efficiency [9, 10, 11].

1.1 Classification of catalyst

Three distinct types of catalysts can be utilized in the transesterification process for biodiesel production: acid catalysts, base catalysts, and biocatalysts (see Figure 1) [12]. Recent advancements have shifted the focus from homogeneous catalysts to heterogeneous catalysts, owing to the latter's superior performance in terms of production quality and efficiency [13, 14].

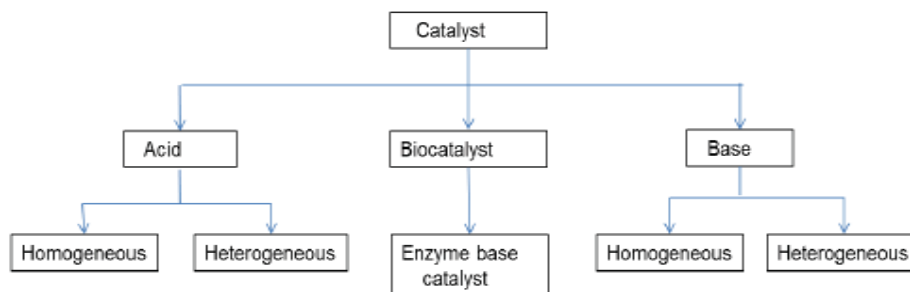


FIGURE 1. Classification of catalyst

1.2 Homogeneous base catalysts

Homogeneous catalysts are frequently employed in commercial biodiesel production due to their effectiveness, achieving yields exceeding 97% within a time frame of 10 minutes to 2 hours at temperatures ranging from 25°C to 70°C [15, 16]. These catalysts are in the same phase as the reactants, facilitating a seamless reaction process. However, they necessitate anhydrous feedstock with an acid value below 1 mg KOH/g oil to ensure optimal performance [15, 17]. Homogeneous catalysts can be classified as either acidic, such as sulfuric acid (H_2SO_4) and hydrochloric acid (HCl), or alkaline, including sodium hydroxide (NaOH) and potassium hydroxide (KOH). However, they have several drawbacks, including soap formation with free fatty acids (FFA) above 0.5%, equipment corrosion, high energy consumption, and challenges in separating glycerol from methyl esters, which can create emulsions [13, 16]. They also require low water content (below 0.3%) to maintain yield and are less effective with high water or FFA levels, complicating recovery and increasing costs [11, 18, 19]. While metal alkoxides are more active at lower concentrations, their expense makes alkaline metal hydroxides the preferred choice for high conversion rates [20].

Basic homogeneous catalysts are favored for their rapid reaction rates—4000 times faster than acid catalysts—but they are sensitive to water and FFA, leading to operational issues [18, 21, 22]. Despite their advantages, high energy demands and feedstock costs drive a shift toward heterogeneous catalysts [9].

2. The study aims:

- Investigate the production of biodiesel from waste cooking oil using less alcohol than theoretically required by stoichiometric equations, while identifying standard parameters.
- Reduce the environmental impact of discarded oils by reusing them to produce biofuels.
- Determine the optimal operating conditions for biodiesel production.

The hypothesis posits that the large disposal quantities of frying oil waste in Zliten contribute to environmental issues. Converting waste cooking oil into biodiesel is both environmentally and economically feasible, offering a renewable and low-cost alternative to fossil fuels. Utilizing waste oil can enhance the sustainability of the food industry in Zliten. While transesterification methods for producing fatty acid methyl esters (FAME) are well-documented, this study will uniquely

explore batch reactors in the biodiesel process, providing valuable insights for the community.

3. Methodology

3.1 Apparatuses

The laboratory utilized several pieces of equipment, including 250 ml glass beakers, a thermometer, porous cloth, filter paper, a separating funnel, and distilled water. The raw materials consisted of wasted vegetable cooking oil samples (frying oil residues) collected from a popular restaurant in Zliten, noted for their dark color, indicating use at temperatures up to 600 °C. Methanol with 99.5% purity was supplied by Fischer Chemicals, UK, while sodium hydroxide powder with 99% purity was obtained from Riedel-Dehaen AG, Seelze-Hannover, Germany. Additional apparatus included an electric mixer in a sealed glass container for preparing the methoxide solution, a digital temperature-controlled electric heater with a digital magnetic stirrer (Stuart UC 152), and a sensitive balance (0.01 g) for weighing the oil, methanol, and sodium hydroxide samples.

3.2 Pretreatment of the Waste Cooking Oil

The waste frying oil undergoes purification by being poured through a porous cloth to eliminate contaminants from food residues. The filtered oil is then collected in a glass container and further purified using filter paper to remove any remaining small particles and impurities. Then, the oil is heated for one hour at 120°C using a digital electric heater, with mixing set at 300 rpm. After heating, the oil is allowed to cool. This step is crucial for removing moisture from the purified oil in preparation for the transesterification process.

3.3 Transesterification Process

Biodiesel is typically produced through transesterification, which involves reacting vegetable oil or animal fat (triglycerides) with an alcohol in the presence of a catalyst (acid, base, or enzyme) [23,24,25,26]. This process, first employed in 1846 with castor oil and later initiated in South Africa in 1979, yields alkyl esters (biodiesel) and crude glycerol [21].

Transesterification requires catalysts or supercritical conditions, as the reaction is reversible and can't achieve 100% conversion. The process includes three steps: converting triglycerides to diglycerides, then to monoglycerides, and finally to glycerol [7, 21,27,28].

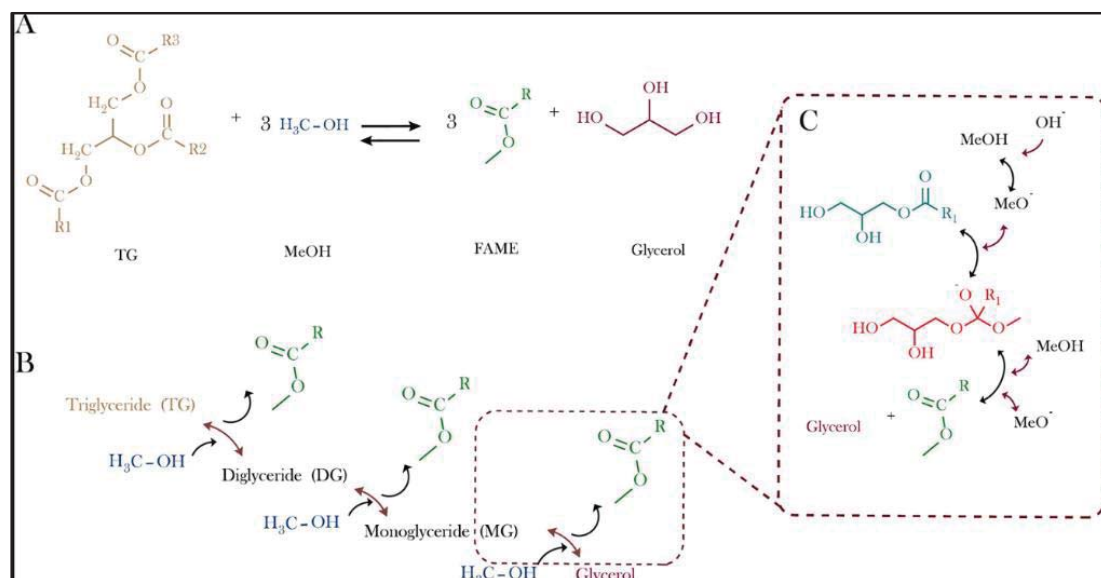


Figure 1. (A) The complete transesterification reaction using CH₃OH (MeOH). (B) The formation of intermediates: first diglyceride, then monoglyceride, and finally glycerol. (C) The reaction mechanism of monoglyceride transesterification with methanol (MeOH) and sodium hydroxide (NaOH) as the catalyst [29].

Methanol is the most widely used alcohol in the transesterification process, primarily due to its low cost and rapid reaction rate [7, 9, 21, 30, 31]. However, ethanol is often preferred because it can be derived from renewable agricultural products and is less environmentally harmful. The primary objectives of the transesterification process are to reduce the viscosity of the oil, lower its density, and enhance the volatility of the resulting biodiesel. The use of various alcohols, including methanol, ethanol, propanol, and butanol, has been shown to be an effective approach for biodiesel production [9, 32].

The transesterification reaction is affected by various parameters including, reaction temperature and time; water content and free fatty acid content; type of alcohol and molar ratio of alcohol-to-vegetable oil; choice of catalyst and catalyst concentration; and rate of mixing, intensity and stirring mode.

The experimental methodology involved conducting a series of laboratory experiments using dried vegetable frying oils sourced from a local restaurant in Zliten. Various tests were performed to produce biodiesel by varying the reaction conditions, including the alcohol-to-oil ratio and the catalyst-to-oil weight ratio.

In the transesterification process, 120 mL of waste cooking oil is first poured into a conical flask and heated to 40 °C while being stirred at 300 rpm using an electric heater. Based on the weight of the oil, 0.5% of solid sodium hydroxide is measured and added to methanol at a 4:1 ratio of methanol to oil. This sodium hydroxide-methanol mixture is blended in a closed electric mixer for 15 minutes to create a homogeneous methoxide solution. The methoxide solution is then gradually added to the waste oil at 40 °C, where it is mixed and heated for 60 minutes. After this reaction time, the conical flask is rapidly cooled with cold water to halt the transesterification process.

3.4 Separation Process

The solution is transferred to a separating funnel was used and allowed to stand for 24 hours to facilitate the separation of glycerol, which appears as a heavy-duty red-orange biodegradable layer. After this period, the valve at the bottom of the funnel is opened to withdraw and separate the glycerol from the biodiesel. The biodiesel is then washed by adding one-third of its volume in warm distilled water at 40°C. The funnel is gently cooled, allowing the cloudy solution to sit for an hour, during which time the water separates and turns white, indicating the removal of the residual catalyst. It was observed that with repeated washing, the biodiesel color improved to a cleaner yellow, signifying increased purity. Upon completion of the washing process, the biodiesel is heated to 120 °C to eliminate any remaining moisture and is then stored in a tightly sealed vial, with the final volume recorded. In some instances, during washing, an emulsion may form that is challenging to separate physically, typically due to the presence of free fatty acids creating monoclonal and bivalent glycerides. To address this, an equivalent of 10 g of solid sodium chloride (table salt) is added per 100 mL of biodiesel, gently mixed, and allowed to sit for 24 hours before proceeding with the washing and separation process to remove soap residues resulting from saponification.

4. Results and Discussion

4.1 Variables Affecting the Process of Biodiesel Production

To identify the optimal conditions for biodiesel production, the yield is calculated using the formula:

$$Yield = \frac{\text{amount of biodeasel produced}}{\text{amount of wasteoil}} * 100$$

Previous laboratory tests were conducted under various operational conditions, including different ratios of alcohol (methanol) to oil by weight (1:4, 1:5, 1:6, and 1:7), and varying amounts of catalyst (sodium hydroxide) at weight percentages of 0.5%, 1%, and 1.5% of the sample weight [20]. The reaction temperature was set at 40, 50, 60, and 80 °C. All experiments were performed with a reaction time of 60 minutes and a mixing speed of 300 cycles per minute, based on optimal conditions identified in prior studies. To enhance accuracy and minimize error, each laboratory experiment was repeated three times.

4.2 Effect of Catalyst Concentration (NaOH)

The impact of varying catalyst concentrations (sodium hydroxide, NaOH) on biodiesel production during the transesterification process is illustrated in Figure 3. The experiments were conducted under controlled conditions, including a mixing time of 60 minutes, a mixing rate of 300 rpm, an oil-to-methanol ratio of 1:5 by weight, and a reaction temperature of 60 °C. The catalyst concentrations tested were 0.5%, 1%, and 1.5% by weight relative to the used waste oil.

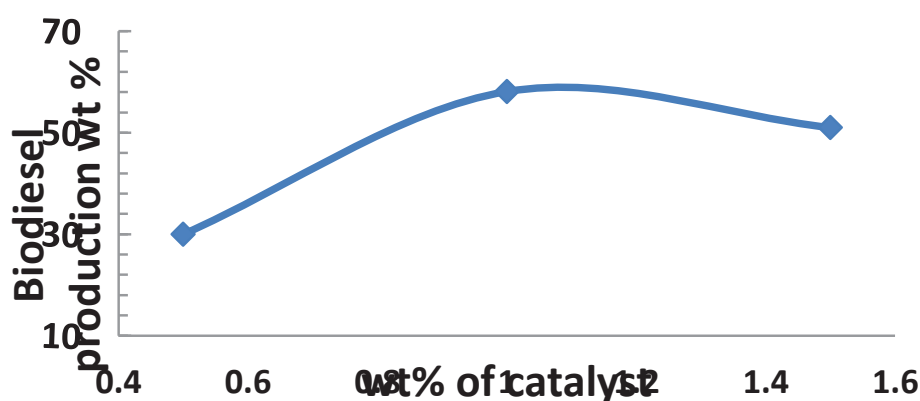


Figure 3 Effect of changing catalyst concentration on biodiesel production

The results indicate a clear trend: biodiesel production increases with the catalyst concentration up to a certain point. At 0.5% NaOH, the biodiesel yield was recorded at 30%. As the concentration increased to 1%, the yield peaked at 58.5%. This increase can be attributed to the greater surface area of the catalyst, which facilitates the transesterification reaction, aligning with findings from previous studies [33].

However, an interesting observation was made at the 1.5% NaOH concentration, where the yield decreased to 51%. This decline in

productivity is likely due to the formation of soap from excess base, which interferes with the separation of biodiesel during the washing process. The presence of soap creates emulsions with water, complicating the separation of glycerol and biodiesel, as noted in prior research [34]. To address this issue, the glycerol-biodiesel mixture was treated with solid sodium chloride before washing, which aids in the separation of glycerol by promoting faster settling [35].

In summary, while increasing NaOH concentration enhances biodiesel yield up to 1%, excessive amounts can hinder production by generating emulsions that complicate separation. This underscores the importance of optimizing catalyst concentration for effective biodiesel production. It is worth mentioning that the optimal catalyst concentration for the production process is 1% wt, which agrees with other studies. The higher the proportion of FFA in WCO, the greater the concentration of catalysts required for interaction [36]

4.3 Effect of Molar Ratio of Alcohol to Oil

The influence of the molar ratio between waste cooking oil (WCO) and methanol on biodiesel production was investigated under specific operational conditions, including a reaction time of 60 minutes, a mixing speed of 300 rpm, and a catalyst concentration of 1% by weight at 60 °C. The methanol weight was varied across four ratios of oil to methanol: 1:4, 1:5, 1:6, and 1:7.

Figure 4 illustrates the relationship between the WCO-to-methanol ratio and biodiesel yield. Notably, productivity peaked at 64.16% when the ratio was set at 1:6, indicating an optimal balance between oil and methanol. This increase can be attributed to the biodiesel production equation, which states that each mole of oil requires four moles of methanol to produce four moles of biodiesel (methyl esters) and one mole of glycerol. As methanol content increased, productivity initially rose, achieving a yield of 41.6% at the 1:7 ratios. However, when methanol was further increased to the 1:5 and 1:4 ratios, yields dropped to 58.33% and 51.66%, respectively.

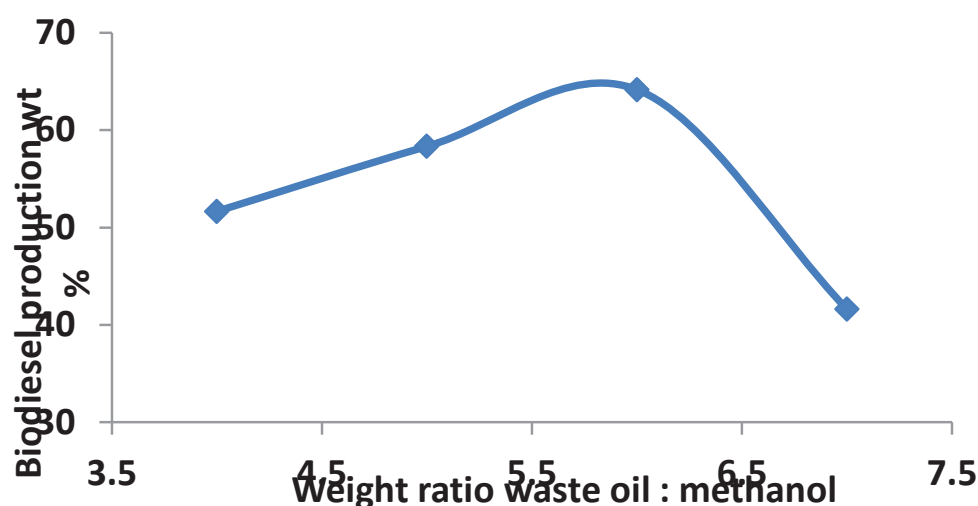


Figure 4 Effect of changing the amount of methanol on biodiesel production

The decline in biodiesel production at higher methanol ratios is primarily due to the excess methanol interfering with the separation of biodiesel from glycerol. Excess methanol can become suspended in the biodiesel phase, complicating the sedimentation process and ultimately reducing biodiesel yield [36]. Additionally, at lower methanol amounts, such as in the 1:5 and 1:6 ratios, the reaction may take longer to reach equilibrium, resulting in residual diglycerides remaining in the biodiesel phase. This can lead to a longer settling time and a lower-quality product characterized by a cloudy, impure yellow color.

In contrast, using a larger amount of methanol at the 1:4 ratio keeps the biodiesel phase mixed with foam, further complicating separation. Consequently, the highest biodiesel yield was achieved at a 1:6 weight ratio, highlighting the importance of optimizing the methanol-to-oil ratio for effective biodiesel production.

1.1 Effect of Temperature

The impact of temperature on biodiesel production was assessed under controlled conditions, with a mixing time of 60 minutes, a mixing speed of 300 cycles per minute, an oil-to-methanol ratio of 1:6 by weight, and a catalyst concentration of 1% by weight, as illustrated in Figure 3.3. The temperature was varied within the range of 40 °C, 50 °C, 60 °C, and 80 °C.

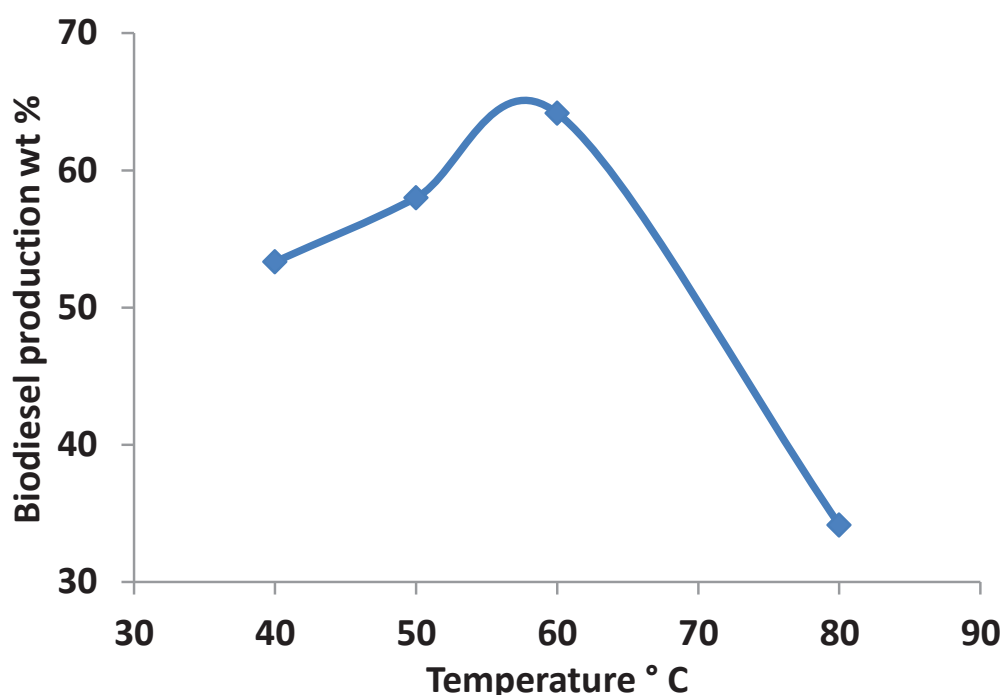


Figure 5 Effect of temperature change on biodiesel production

Results indicated a significant increase in productivity as the temperature rose from 40 °C to 50 °C, yielding 53.33% and 58%, respectively. The optimal yield was achieved at 60 °C, where the productivity peaked at 64.16%. However, this trend reversed at 80 °C, where the yield dropped sharply to 34.16%. This decline at higher temperatures can be attributed to the evaporation of methanol, which is detrimental to the transesterification process.

From these findings, it is evident that the optimal temperature for biodiesel production lies between 50 °C and 60 °C. Previous studies support this observation, emphasizing that temperature is a critical factor influencing the transesterification process and is largely dependent on the chemical composition of the raw oil used [12]. Higher temperatures enhance the reaction rate and the formation of biodiesel by reducing the viscosity of the reactants, thereby minimizing the time required for the reaction to reach completion. However, exceeding appropriate temperature limits can negatively impact biodiesel production; excessive heat can lead to rapid evaporation of methanol and may promote unwanted side reactions, such as saponification [36,37].

In summary, maintaining a temperature within the optimal range is crucial for maximizing biodiesel yield and ensuring the efficiency of the transesterification process.

5 Conclusion

The findings of this study highlight several key outcomes related to the production of biodiesel from waste cooking oil through the transesterification process using sodium hydroxide in a batch system. Notably, a biodiesel production yield of 64.16% was achieved, accompanied by the generation of glycerol as a byproduct.

Laboratory tests identified optimal operational conditions for biodiesel production, which included a reaction temperature of 60 °C, an oil-to-methanol weight ratio of 1:6, and a sodium hydroxide catalyst concentration of 1% by weight. Additionally, the reaction time was set at 60 minutes with a mixing speed of 300 rpm, under which a biodiesel yield of 64.16% was consistently obtained.

Importantly, no environmental pollutants were generated during the production process. The byproduct glycerol can be effectively purified and repurposed as a raw material for soap production.

Overall, the results underscore that the environmentally responsible disposal of waste cooking oil residues can facilitate the production of a high-purity renewable resource—biodiesel—thereby mitigating the environmental issues associated with discharging such waste into sewage treatment facilities. The resulting biodiesel represents a sustainable alternative to fossil diesel, aligning with ecological and energy goals.

6 Recommendation

Based on the findings of this study, we strongly recommend that researchers in the field pursue further investigations to build upon the insights gained. Specifically, we suggest conducting additional laboratory tests on a broader range of feedstocks, including animal fats and marine algae, to explore their potential for biodiesel production.

Moreover, we advocate for the investigation of a two-stage transesterification process and the evaluation of its performance in comparison to traditional alkaline catalysts. Research into the use of enzymatic catalysts for transesterification could also yield valuable insights, potentially enhancing the efficiency and sustainability of biodiesel production.

Furthermore, we encourage the exploration of continuous production systems, which could significantly improve productivity and reduce economic costs associated with biodiesel manufacturing.

These future studies are crucial not only for advancing biodiesel technology but also for contributing to environmental sustainability. As

global energy demands continue to rise, the development of renewable energy sources such as biodiesel will play an essential role in mitigating climate change and reducing reliance on fossil fuels. By fostering innovation in this field, we can enhance the viability of biodiesel as a sustainable alternative, ultimately supporting a cleaner, healthier future for our planet.

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Plasma amino acid levels in children with autism: An Libyan sample

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Abstract:

Autism, or autism spectrum disorder (ASD), refers to a broad range of neurological conditions characterized by challenges with social skills, repetitive behaviors, speech and nonverbal communication, autism is a complex and life-long behavioural disorder of unknown aetiology. A retrospective study conducted on a total of 20 children known to autism cases of both gender (males and females), age from ranged 6 months – 9 years, (mean age 5.3 ± 2.2 years) during the period of 2013 to 2020.

As regards essential amino acid levels, autistic children had significantly elevated Alpha alanine, serine, and Histidine. In contrast, their plasma level of aspartic acid and cystine were significantly lower and the level of the amino acids Taurine, Threonine, Glutamic acid, Glutamine, Glycine, Citrulline, Valine, Methionine, Isoleucine, Leucine, Tyrosine, Phenylalanine, Ornithine, Arginine, and Hydroxyproline all fall within the normal range.

It's important to note that research in this area is ongoing, and not all studies have consistently found the same patterns of amino acid dysregulation in children with autism.

Key words: Plasma amino acids; autism spectrum disorder; children.

مستويات الأحماض الأمينية في البلازما لدى الأطفال المصابين بالتوحد

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الملخص:

يشير التوحد أو اضطراب طيف التوحد (ASD) إلى مجموعة واسعة من الحالات العصبية التي تتميز بالتحديات في المهارات الاجتماعية والسلوكيات المتكررة والكلام والتواصل غير اللفظي، والتوحد هو اضطراب سلوكي معقد يستمر مدى الحياة لسبب غير معروف. أجريت دراسة استرجاعية على إجمالي 20 طفلاً معروفاً بحالات التوحد من كلا الجنسين (ذكور وإناث)، تتراوح أعمارهم من 6 أشهر إلى 9 سنوات (متوسط العمر 2.2 ± 5.3 سنة) خلال الفترة من 2013 إلى 2020.

أما فيما يتعلق بمستويات الأحماض الأمينية الأساسية، فقد كان لدى الأطفال المصابين بالتوحد مستويات مرتفعة بشكل ملحوظ من ألفا ألانين، وسيرين، وهستيدين. في المقابل، كان مستوى حمض الأسبارتيك والسيستين في بلازما الدم لديهم أقل بشكل ملحوظ، وكان مستوى الأحماض الأمينية تورين، وثريونين، وحمض الجلوتاميك، والجلوتامين، والجليسين، والسيترولين، والفالين، والميثيونين، والإيزوليوسين، والليوسين، والتيروزين، والفينيل ألانين، والأورنيثين، والأرجينين، والهيدروكسي بروتين جميعها تقع ضمن النطاق الطبيعي.

من المهم أن نلاحظ أن الأبحاث في هذا المجال مستمرة، ولم تتوصل جميع الدراسات إلى نفس أنماط خلل تنظيم الأحماض الأمينية لدى الأطفال المصابين بالتوحد.

الكلمات المفتاحية: الأحماض الأمينية في البلازما؛ اضطراب طيف التوحد؛ الأطفال.

1. Introduction:

Autism spectrum disorder (ASD) can be described as neurodevelopmental disabilities, They often include communication problems, repetitive behaviours, and challenges with social interaction. Diagnosis of ASD usually focuses on observable behaviours related to communication and social participation. With less attention paid to potential biomedical factors [1]. Autism disorder, Asperger's syndrome, and widespread developmental disorders falls under the ASD umbrella, although the exact cause remains unclear. However brain imaging suggests that abnormalities in brain structure and function may contribute to ASD [2]. The disorder can lead to restricted and repetitive behaviour. This includes difficulties in social interactions and communicate. Children with ASD may show fluctuating levels of aggression, hyperactivity, and concentration problems. In addition to symptom challenges, ASD presents lifelong challenges to individuals and caregivers with standard care that often requires comprehensive behavioural therapy and education [3].

One of the common feeding problems in most autistic children is food selectivity, which in the majority of cases develops a food aversion for certain types of food. Feeding problems put them at a higher risk for nutritional deficiencies. Some autistic children have exhibited food neophobia and picky eating [4]. As high as 90 percent of such children reported food refusal and selectivity.[5]

Regarding protein intake, the reports are heterogeneous. For example, some reports have found that children with ASD are consuming a far lesser amount of this nutrient

compared to their age-matched normally developing children [6]. On the other side, another group of studies found that their protein intake was, in fact, significantly higher as compared to the control subjects [7, 8]. While some other studies find no difference in protein intake among autistic and control children.[10,9]

Since amino acids, especially the essential amino acids, have to be derived from the diet, it is a worrying eating pattern when chosen selectively. Children with autism may also not effectively digest ingested proteins into amino acids, which are needed by the body to synthesize systemic proteins.

Certain important amino acids may not be effectively produced in the course of metabolism, leading to an imbalance in the synthesis of proteins like metallothionein (MT) and hormones along with adrenaline, which could trigger surprising stress in people with autism. This deficiency suggests that many crucial amino acids required to shape systemic proteins, including MT, are unavailable [11]. MT is a vital protein concerned with numerous organic strategies, which include the regulation of zinc and copper and the chelation of poisonous heavy metals together with cadmium, mercury, and lead. It also supports immune function, neuronal improvement, coronary heart and mind protection, liver cellular proliferation, nutrient absorption inside the small intestine, protein breakdown, cellular respiratory, electricity metabolism, and exhibits antioxidant homes. Research has indicated that MT is not characteristic optimally in kids with autism, even though it remains doubtful whether this dysfunction is because of genetic factors or decreased MT stages inside the body [12, 13].

The aim of this study is to investigate plasma amino acid levels in autistic children, with the goal of advancing our understanding of the biological underpinnings of autism and may lead to new avenues for treatment approaches in the future.

2. Materials and methods:

Study subjects and Protocol

A retrospective study conducted on a total of 20 children known to autism cases, from the city of Tripoli-Libya. The study population consisted of 20 plasma sample autistic people of both gender (males and females), age from ranged 6 months – 9 years, (mean age 5.3 ± 2.2 years) during the period of 2013 to 2020.

Blood samples were collected in different clinical laboratories into 4.5-ml lithium heparin Vacutainer tubes and centrifuged at 3000 rpm for 15 min to obtain platelet-rich plasma After separating the blood plasma. The frozen blood plasms was sent to a French laboratory for analysis to compaired between both plasma essential and non-essential amino acid levels.

According to the protocol in force in the laboratory in which the analysis were conducted, Protein from the plasma samples was precipitated with 2 vol of HPLC-grade methanol. Derivatization was achieved using O-phthalaldehyde (OPA) (50 mg) in ethanol (750 μ l) containing mercaptoethanol (150 μ l) in sodium borate buffer (100 mM, pH 10.4, 25 ml) Deproteinized plasma (100 ml) and OPA solution (100 μ l) were vortexed for 1 min before a 20- μ l flushed loop injection onto the HPLC system [14].

The biochemical analysis and the amino acid levels data for children with autism spectrum disorder were analyzed using SPSS version 24 software (SPSS Inc, Chicago, IL, USA). Continuous variables were expressed as mean $\pm$ standard deviation (SD).

3. Results and discussion:

Differences in amino acid levels between autistic children and the mean of the expected normal range for each amino acid.

The mean of the normal range of the Ammonia, lactic acid, pyruvic acid and amino acid levels was calculated and used as a reference for comparison. a one-sample t-test was conducted to determine whether the mean of the observed data significantly differed from the mean of the expected normal range. Additionally, Pearson correlation

analysis was employed to assess the relationship between variables. This analysis provided insight into whether the results aligned with established normative values, with a significance level set at 0.05. The obtained result was in line with previous study conducted in United Kingdom [15].

TABLE 1. Show the levels of amino acid and the established normal range

No	Amino acid	Normal Range	Mean Value $\pm$ Std.Deviation	P Value
1	Taurine	48-92	73.35 $\pm$ 26.821	0.613
2	Aspartic acid	44-66	11.18 $\pm$ 5.823	< 0.0001
3	Threonine	72-130	104.53 $\pm$ 51.528	0.781
4	Serine	101-167	166.24 $\pm$ 53.100	0.024
5	Glutamic acid	9-107	66.18 $\pm$ 27.600	0.24
6	Glutamine	432-706	526.71 $\pm$ 96.953	0.091
7	Glycine	182-262	395.06 $\pm$ 339.982	0.052
8	Alpha alanine	215-343	433.71 $\pm$ 186.425	0.003
9	citrulline	16-34	26.18 $\pm$ 8.840	0.591
10	Valine	187-295	215.44 $\pm$ 55.13	0.083
11	Cystine	58-94	16.59 $\pm$ 9.118	<0.0001
12	Methionine	17-27	21.65 $\pm$ 8.261	0.862
13	Isoleucine	49-73	59.35 $\pm$ 22.402	0.766
14	Leucine	94-148	120.71 $\pm$ 35.350	0.973
15	Tyrosine	49-77	68.35 $\pm$ 19.371	0.271
16	Phenylalanine	43-59	57.12 $\pm$ 13.453	0.079
17	Ornithine	40-74	66.76 $\pm$ 23.204	0.102
18	Histidine	65-89	89.47 $\pm$ 23.297	0.042
19	Lysine	24-202	168.59 $\pm$ 68.399	0.004

20	Arginine	56-92	91.71±40.507	0.09
21	Hydroxyproline	<30	16.82±5.747	0.209
22	Proline	127-201	211.76±71.109	0.014

Overall, while there are some significant differences observed in amino acid levels between autistic children and the normal range (e.g., aspartic acid, serine, cystine, proline, lysine, histidine), most amino acids show no significant deviation from the normal range. The amino acids Taurine, Threonine, Glutamic acid, Glutamine, Glycine, Citrulline, Valine, Methionine, Isoleucine, Leucine, Tyrosine, Phenylalanine, Ornithine, Arginine, and Hydroxyproline all fall within the normal range, the mean levels fall within the normal range, indicating no significant difference ($p>0.05$). The mean aspartic acid and cystine levels (11.18 ± 5.8 , 16.59 ± 9.11) are significantly lower than the normal range (44-66, 58-94) respectively ($p<0.0001$). The mean Alpha alanine, serine, and Histidine levels (433.71 ± 186.425 , 166.24 ± 53.1 , and 89.47 ± 23.3) are significantly higher than the normal range (215-343, 101-167, and 65-89) ($p<0.05$). These results were in line with previous study conducted in Egypt [16].

These findings suggest potential metabolic disturbances in specific amino acids in autism spectrum disorders children.

The biochemical analysis of children with autism spectrum disorder revealed that the mean ammonia level was $80.63\text{ }\mu\text{mol/L}$ ($\text{SD} = 52.8\text{ }\mu\text{mol/L}$), which exceeds the normal range of $16\text{-}60\text{ }\mu\text{mol/L}$. The P-value of 0.056 indicates a tendency toward statistical significance, but it does not meet the standard cutoff of 0.05. The mean pyruvic acid level was 6.48 mmol/L ($\text{SD} = 5.13\text{ mmol/L}$), within the normal range of $2.73\text{-}7.28\text{ mmol/L}$, with a P-value of 0.384, indicating no significant deviation from expected values. In contrast, the mean lactic acid level was 2.35 mmol/L ($\text{SD} = 0.62\text{ mmol/L}$), slightly above the

normal range of 0.5-2.2 mmol/L, and this elevation was statistically significant, with a P-value of 0.003. These findings suggest that while pyruvic acid levels remain within normal limits, both ammonia and lactic acid levels are elevated in these children, with the increase in lactic acid being statistically significant.

TABLE 2. bioanalysis test of Ammonia, Pyruvic acid and lactic acid levels

No	Biochemical analysis	Normal range	Mean Value $\pm$ Std.Deviation	P Value
1	Ammonia	16-60	80.63 $\pm$ 52.8	0.056
2	Pyruvic acid	2.73-7.28	6.48 $\pm$ 5.13	0.384
3	Lactic acid	0.5-2.2	2.35 $\pm$ 0.62b	0.003

The differences observed in the biochemical analysis of children with autism spectrum disorder (ASD) likely reflect underlying metabolic abnormalities associated with the condition. The elevated lactic acid levels, which were statistically significant, suggest that these children may experience mitochondrial dysfunction or an increased anaerobic metabolism. Mitochondria are responsible for energy production, and any dysfunction can lead to an accumulation of lactic acid, as cells may rely more on anaerobic glycolysis when oxygen utilization is impaired. This is a common finding in several neurodevelopmental disorders, including ASD, where energy metabolism might be compromised. These findings are consistent with those reported by Maier et al [17], who also observed elevated lactic acid levels, reinforcing the association with mitochondrial dysfunction. Additionally, the trend towards elevated ammonia levels, although not reaching conventional statistical significance, could indicate potential disruptions in the urea cycle, a metabolic pathway that removes excess nitrogen from the body. Elevated ammonia levels may suggest an inefficiency in this cycle, possibly due to enzyme deficiencies or other metabolic stressors associated with ASD. Ammonia is a neurotoxin,

and its accumulation might contribute to neurological symptoms or exacerbate the severity of ASD. Such findings are consistent with those reported by Maier et al and Saleem et al [17, 18].

TABLE 3. The correlation between amino acids and lactic and pyruvic

	Lactic acid	pyruvic acid	ammonia
	Pearson Correlation	Pearson Correlation	Pearson Correlation
	<i>P</i> Value	<i>P</i> Value	<i>P</i> Value
Taurine	-.093-	0.467	-0.857-
	0.882	0.290	0.064
Aspartic acid	0.777	0.273	-0.227-
	0.122	0.554	0.713
Threonine	0.429	0.199	0.182
	0.471	0.670	0.770
Serine	0.912*	-0.089-	-0.306-
	0.031	0.849	0.616
Asparagine	0.469	0.154	0.373
	0.426	0.742	0.537
Glutamic acid	-0.024-	0.252	0.672
	0.969	0.586	0.214
Glutamine	0.683	-0.801-*	-0.122-
	0.203	0.030	0.846
Glycine	-0.315-	0.301	0.974**
	0.606	0.512	0.005
Alpha alanine	0.863	-0.077-	-0.065-
	0.060	0.870	0.917
citrulline	0.566	-0.074-	-0.522-
	0.320	0.874	0.367
Vline	-0.240-	0.223	-0.932-*
	0.697	0.631	0.021
Cystine	0.117	-0.049-	-0.527-
	0.851	0.917	0.361
Methionine	0.855	-0.127-	-0.060-

	0.065	0.786	0.924
Isoleucine	-0.634-	0.178	0.143
	0.251	0.703	0.819
Leucine	-0.277-	-0.038-	-0.090-
	0.652	0.935	0.886
Tyrosine	0.804	-0.342-	-0.043-
	0.101	0.453	0.945
Phenylalanine	0.859	-0.249-	-0.348-
	0.062	0.590	0.566
Ornithine	0.628	0.105	-0.130-
	0.257	0.823	0.836
Histidine	0.714	-0.333-	-0.518-
	0.176	0.466	0.371
Lysine	0.803	-0.574-	-0.111-
	0.102	0.178	0.859
Arginine	0.947*	-0.601-	-0.332-
	0.014	0.154	0.585
Hydroxyproline	-0.272-	0.803*	0.837
	0.658	0.030	0.077
Proline	0.433	0.096	0.269
	0.467	0.838	0.661

For Ammonia no significant positive correlation with Threonine, glutamic acid, glycine, isoleucine, hydroxyproline, asparagine, and proline. There is only one significant strong positive correlation between ammonia and Glycine (0.974**/ P=0.005). this suggests that increased ammonia levels may be associated with increased levels of glycine in autistic children and no significant negative correlation with Taurine, aspartic acid, serine, glutamine, Alanine, citrulline, cystine, leucine, tyrosine, phenylalanine, ornithine, histidine, lysine, methionine, and the only significant strong negative correlation is valine (-0.932/ P=0.021). This suggests that elevated ammonia levels may be correlated with reduced valine levels in children with autism.

For Lactic Acid no significant positive correlation with taurine, threonine, asparagine, aspartic acid, glutamic acid, glycine, valine, isoleucine, ornithine, and proline,

while "Hydroxyproline showed a significant strong positive correlation with ammonia levels ($r = 0.803$, $p = 0.03$). This suggests that increased lactic acid levels may be associated with increased amount of these amino acids in autism children and non-significant negative correlation with serine, alanine, citrulline, cystine, leucine, tyrosine, phenylalanine, histidine, lysine, arginine, methionine, and the only significant strong negative correlation is glutamine ($-0.801^*/p=0.03$): This suggests that increased lactic acid levels may be associated with decreased levels of these amino acids in autism children.

For Pyruvic Acid non-significant positive correlation with aspartic acid, asparagine, threonine, alpha alanine, citrulline, glutamine, tyrosine, phenylalanine, ornithine, histidine, lysine, proline, cystine, methionine, while serine and arginine were have a significant correlation to pyruvic acid: ($0.912^*/0.031$, $0.947^*/0.014$) This suggests that increased pyruvic acid levels may be associated with increased levels of these arginine and serine amino acids in autism children and no significant negative correlation with taurine, glutamic acid, leucine, valine, isoleucine, glycine, and hydroxyproline: This suggests that increased pyruvic acid levels may be associated with decreased levels of these amino acids in autistic children.

In our study the level of the amino acids Taurine, Threonine, Glutamic acid, Glutamine, Glycine, Citrulline, Valine, Methionine, Isoleucine, Leucine, Tyrosine, Phenylalanine, Ornithine, Arginine, and Hydroxyproline all fall within the normal range, The mean levels fall within the normal range, indicating no significant difference ($p>0.05$), and the mean Alpha alanine, serine, and Histidine levels (433.71 ± 186.425 , 166.24 ± 53.1 , and 89.47 ± 23.3) are significantly higher than the normal range (215-343, 101-167, and 65-89) ($p<0.05$), While mean aspartic acid and cystine levels (11.18 ± 5.8 , 16.59 ± 9.11) are significantly lower than the normal range (44-66, 58-94) respectively ($p<0.0001$). This is consistent with [13] and

[16]. Both studies found that autistic children had lower serum methionine and serum cysteine levels than control children. Significantly controlled Overall, the data presented here suggest that there may be an imbalance in excitatory/inhibitory amino acid metabolism in ASD children.

In the observe conducted by [15], concentrations of amino acids which include glutamic acid, phenylalanine, asparagine, tyrosine, alanine, and lysine had been discovered to be higher in check samples in comparison to controls (p, .05, Wilcoxon Rank Sum Test). However, glutamine stages have been decrease inside the check samples than inside the manipulate group. Both research concur that alanine ranges were extended above the ordinary variety. The discrepancies located may be attributed to limitations inside the contemporary observe, inclusive of a small sample size, and further research is vital to discover this difficulty in greater element.

Recommendation :this was retrospective research, so prospective large sample cohort studies are needed to further verify the findings of this study in the future.

4. Conclusion:

The findings suggest that there may be metabolic differences or dysregulations in children with autism that affect amino acid levels. Alpha alanine, serine, and Histidine levels are increased in patients, while aspartic acid and cystine levels are decreased, these metabolic differences could potentially influence brain function and behavior, contributing to the characteristic symptoms of autism spectrum disorder (ASD).

It's important to note that research in this area is ongoing, and not all studies have consistently found the same patterns of amino acid dysregulation in children with autism. Factors such as age, sex, severity of symptoms, and comorbid conditions can also influence these findings. Therefore, further research is needed to fully understand the role of amino acids in the pathophysiology

of autism and their potential as targets for therapeutic interventions.

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