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Table of Contents

Volume: 7 Issue: 1 June 2023

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The outcome of Photocoagulation Treatment of Retinal Vascular Diseases

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Keyword: Effect of Photocoagulation Macular Edema & Visual Acuity, Effect of Photocoagulation Macular Edema & Visual Ac

Article History

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Abstract:

Due to the significance of macular edema in retinal vascular diseases, this study aims to determine whether laser photocoagulation is effective in the treatment of macular edema and in the improvement of visual acuity. This is a prospective data study considering 80 patients with 52 eyes, with a follow-up of 6 weeks, 3 months, and six months with macular edema treated with double frequency yag laser photocoagulation in Aso Eye Hospital in Sulaymaniyah City, Kurdistan, Iraq, from February 2010 to October 2010. With six months of follow-up, visual acuity was improved in 36.4% of eyes, unchanged in 61.3%, and worsened in 2.3%. After this period the macular edema was improved in 78.85% and not improved in 21.15%. According to this study, baseline visual acuity and retinopathy severity were two important intervening factors in response to laser therapy. Comparing the current results with other studies, it has been found that, in assessing visual outcomes, laser photocoagulation is an effective modality in the treatment of macular edema, and it improves visual acuity in retinal vascular diseases.

Keywords: Photocoagulation, Macular Edema, Visual Acuity.

دراسة سريرية حول تأثير التخثير الضوئي على الوذمة البقعية والحدة البصرية في أمراض الأوعية الدموية في شبكية العين

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نظرًا لأهمية الوذمة البقعية في أمراض الأوعية الدموية في شبكية العين، تهدف هذه الدراسة إلى تحديد ما إذا كان التخثير الضوئي بالليزر فعال في علاج الوذمة البقعية وتحسين حدة البصر. هذه دراسة بيانات استباقية تناولت ٨٠ مريضاً ب ٥٢ عين ، مع متابعة لمدة ستة أسابيع و٣ أشهر وستة أشهر مع الوذمة البقعية، عولج المرضى بالتخثير الضوئي الليزري ياج ذو التردد المزدوج في مستشفى آسو للعيون في مدينة السليمانية، إقليم كردستان العراق، من فبراير ٢٠١٠ إلى أكتوبر ٢٠١٠. مع ستة أشهر من المتابعة، تحسنت حدة البصر في ٣٦,٤٪ من العيون ، دون تغيير في ٦١,٣٪ وتفاقمت في ٢,٣٪، وبعد هذه المدة تحسنت الوذمة البقعية بنسبة ٧٨,٨٥٪ ولم تتحسن في ٢١,١٥٪. وفقًا لهذه الدراسة، كانت حدة البصر الأساسية وشدة اعتلال الشبكية عاملين متداخلين مهمين في الاستجابة للعلاج بالليزر، وبمقارنة النتائج الراهنة مع الدراسات الأخرى، فقد وجد أنه التخثير الضوئي بالليزر هو طريقة فعالة في علاج الوذمة البقعية وتحسين الرؤية في تقييم النتيجة البصرية وانه يطور حدة البصر في أمراض الأوعية الدموية الشبكية.

الكلمات المفتاحية: التخثير الضوئي ، الوذمة البقعية، حدة البصر.

1. INTRODUCTION:

LASER technology has revolutionized many medical fields. In ophthalmology, lasers are used to photocoagulate, cut, remove, shrink and stretch ocular tissues. New types of lasers and novel applications continue to be developed. This article will focus on the role of photocoagulation in retinal vascular diseases [1]. Laser may work through the absorption of laser by melanin pigments in retinal pigment epithelium and choroid, and also by the haemoglobuline in the micro aneurysm or both. [2, 3]. The most commonly used modes of laser treatment for macular edema are focal, grid and modified grid. In focal treatment, microaneyrysms causing macular edema are treated directly; in grid treatment, the areas of diffuse capillary leakage and of capillary non perfusion are lasered in a grid pattern; a modified grid is a combination of focal and grid treatment [4-6]. The aim of this study is to determine the effect of laser photocoagulation on preventing vision loss and on the resolution of macula edema in retinal vascular diseases.

2. Patients and Methods

This is a case series studies where 'treatment and follow up of the patients was up to 6 months after laser photocoagulation', involving 80 eyes of 52 patients with macular edema. The study was done in Aso Eye Hospital in Sulaymaniyah Province in Kurdistan Region of Iraq. The study extended from February 2010 to October 2010; each patient was carefully informed about the purpose of the research; they were given an explanation of the procedure prior to laser therapy. The reasons and steps were explained to the patients as well as the duration of the procedures to seek their cooperation. The painless nature of procedure was explained, and the importance of steady fixation was emphasized. Ophthalmological exclusion criteria include all the following preretinal or vitreous hemorrhage at the time of evaluation, history of retinal detachment or retinoschisis, significant media opacity and congenital ocular anomalies. Those who had cataract extraction before enrollment into the study were not excluded, and those who had ocular media opacity were illegible in the study. The process included a review of detailed medical and ocular history and ocular examination. Best corrected visual acuity "BCVA" by using the "illiterate E Snellen's chart" snellen's and pin hole test was noted prior to laser photocoagulation and on each follow-up visit. Detailed anterior segment examination was done by using slit lamp; intraocular pressure measurement was also done before laser photocoagulation and on each follow- up visit; posterior segment examination was examined after maximum pupillary dilatation using tropicamide 1% eye drop. The methods included a direct ophthalmoscope and binocular slit lamp examination with +78 or +90 or goldmann's 3 mirror contact lens. The indication of treatment was macular edema: the thickening that involves or threatens the center of macula "even when vision is not affected. The treatment was done by a coherent double frequency laser machine by using green light. A follow-up examination was done 6 weeks, 3 months, and 6 months of laser treatment and subsequently, the frequency of follow-up varied for individual cases depending on the resolution of macular edema. Retreatment for persistent macular edema was done when indicated. The laser used is grid laser and considering all laser treatment, spot size for all was 50 mics., duration was 0.1 sec., mean power was 210.77 =V. for numbers of laser shoots were 167.58/eye, as in **Table 1** below.

Table (1) Laser treatment summary

	Range	Minimum	Maximum	Mean	Standard Deviation
Numbers of shoots	190	110	300	167.58	46.201
Laser therapy power	160	120	280	210.77	33.872

Post laser Treatment

Once the procedure was completed, one tablet of acetazolamide 250 mg was also given. In all patients, intraocular pressure was measured immediately after laser photocoagulation and later on prednisolone eye drop 1%. 3 times a day at least for one week. Patients were scheduled to visit after 6 weeks, 3 months and six months subsequently. Data regarding type, duration, and mode of retinal vascular diseases were noted; the changes in visual acuity post laser treatment was recorded. Post laser visual acuity was taken as the best corrected visual acuity by using Snellen's visual acuity chart in each follow up visit. Any post laser stable vision or improvement at least one line was taken as a positive visual outcome while any significant visual loss was taken as decreased vision of more than two lines of Snellen's visual acuity chart.

3. Results:

During the period of study, there were 80 eyes for fifty-two patients, 31 female and 21 males, out of whom (67.31%) were between forty and sixty years old and (32.69%) were sixty-one to eighty years old. Among those patients (73.1%) patients had no insulin treatment & (126.9%) had insulin treatment with thirty-two patients only have controlled hyperglycemia with antidiabetic treatment. In this study, there were 16 patients with hypertension, eight with hyperlipidaemia, two with cardiovascular diseases, one with asthma, two with peptic ulcer, and one patient had cerebrovascular accident as in **Table 2**.

Table (2) Frequencies of Medical Illnesses

Variables	Frequency
Diabetic patients use insulin	9
Diabetic patients not use insulin	38
Hypertension	16
Hyperlipidaemia	8
Asthma	1
Ischemic Heart Disease	2
Cerebrovascular accident	1
Peptic ulcer	2

Note: Some patients have more than one disease at the same time.

In this study fifteen patients had only right eye involvement; 9 patients had only left eye involvement and 28 patients had both eyes involved. Besides, 23.1% of the eyes had background diabetic retinopathy, 34.6% had pre-proliferative diabetic retinopathy, 17.3% had proliferative diabetic retinopathy, and 1.9% had advanced diabetic retinopathy. Furthermore, 5.8% of the eyes had hypertensive retinopathy, 9.6% had central retinal vein occlusion,1.9% had branch retinal vein occlusion, and 5.8% had advanced diabetic retinopathy with hypertension retinopathy; all of them with clinically significant macular edema, as shown in

Figure (1). In each follow up visit, visual acuity was calculated and the changes in lines was recorded as shown in **Figure (3)** for right eye and **Figure (4)** for left eye.

CSME: Clinically Significant Macular Edema, BGDR: background diabetic retinopathy, DR: diabetic retinopathy, CRVO: Central Retinal Vein Occlusion, BRVO: branch retinal vein occlusion.

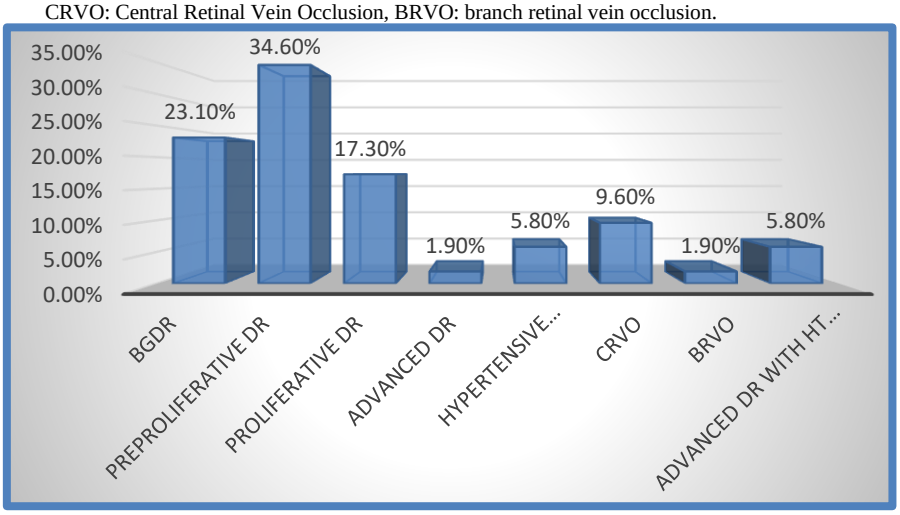

Figure 1: Distribution According to Type and Degree of Retinopathy

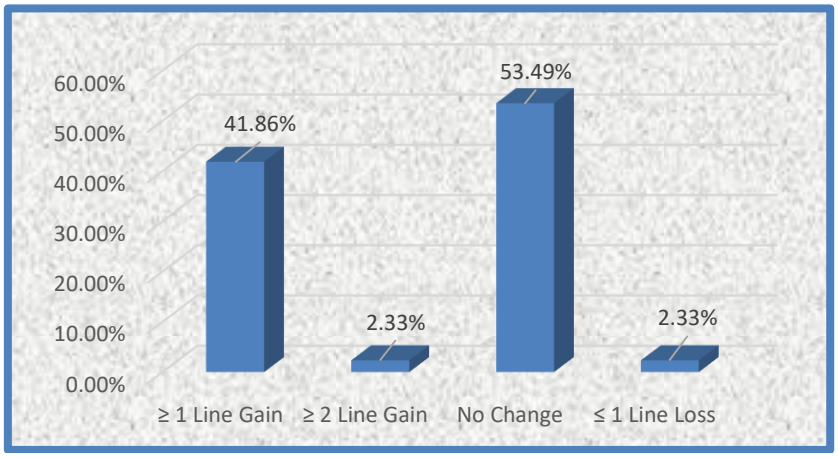

Figure 3.Changes in lines in the Right Eyes

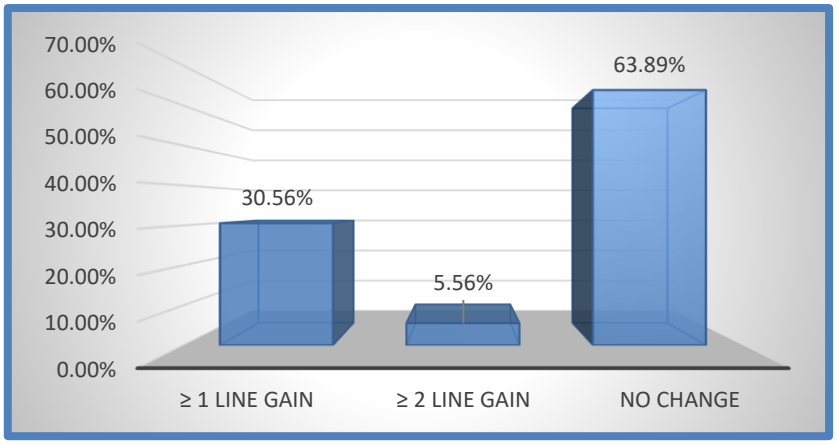

Figure 4. The Changes in lines in the Left Eyes

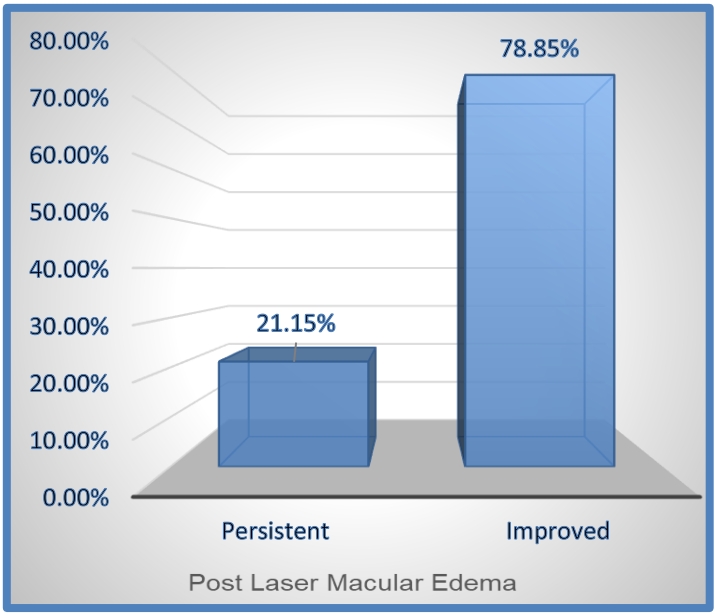

Figure 5. The state of macular edema after laser therapy

Table (3) type of retinal diseases in relation to change in vision.

Type of retinal disease	Changes in vision			Total	P value
	No change N (%)	Better N (%)	Worse N (%)		
Background Diabetic Retinopathy + CSME	6(50)	6(50)	0(0.0)	12(100%)	P-value = 0.003
Preproliferative Diabetic Retinopathy +CSME	12(75)	4(25)	0(0.0)	16(100%)	
Proliferative Diabetic Retinopathy + CSME	6(60)	3(30)	1(1.0)	10(100%)	
Advanced Diabetic Retinopathy + CSME	1(100)	0(0.0)	0(0.0)	1(100%)	
Hypertensive Retinopathy + CSME	1(20)	4(80)	0(0.0)	5(100%)	
CRVO+CSME	2(50)	2(50)	0(0.0)	4(100%)	
BRVO+ CSME	1(100)	0(0.0)	0(0.0)	1(100%)	
Advanced Diabetic Retinopathy +Hypertension+CSME	3(100)	0(0.0)	0(0.0)	3(100%)	
Total	32(61.3)	19(36.4)	1(2.3)	52(100%)	

CSME: Clinically Significant Macular Edema, CRVO: Central Retinal Vein Occlusion, BRVO: Branch Retinal Vein Occlusion

In this table, there are 12 patients with background diabetic retinopathy, 6 of them developed no change in vision and six of them developed a better vision and no one of them had a worse vision.

In addition, in pre-proliferation diabetic retinopathy, there are 16 patients, 12 developed no change in vision and 4 patients had better vision with no one of them had worse vision. In proliferative diabetic retinopathy, there are 10 patients, 6 of them developed no change in vision and 3 patients had better vision and 1 patient had worse vision. In advanced diabetic

retinopathy, there is one patient only; he developed no change in vision. In hypertensive retinopathy, there are 5 patients,1 patient developed no change in vision and 4 patients had better patients while in central retinal vein occlusion there are 4 patients, 2 of them had no change in vision and 2 patients had better vision. In branch retinal vein occlusion, there is one patient only who had no change in vision, and finally in advanced diabetic retinopathy & hypertensive retinopathy there were 3 patients, all of them had no change in vision. The final result was that among those 52 patients, 32 (61.3%) patients had no change in vision and 19 (36%) patients had better patients, and only 1 (2.3%) patient had worse vision after laser treatment.

4. Discussion

The current study has revealed that laser treatment indicated a prevention of visual loss rather than visual improvement in patients with retinal vascular diseases. It should be offered before the vision loss when the risk of visual loss justifies the adverse effect of laser treatment. Dowler JG in 2003 found that all of the cases with stable or one line improvement in visual acuity as positive outcome[7]. Fu DJ et al in 2022 found that visual outcome for sight threatening retinopathy can be excellent; a key factor, especially in maculopathy, is early commencement of laser therapy before visual acuity has dropped[8].

Zafar A. Zaidii in 2009 found that the visual outcome as a whole can be: 29.7% of the patients maintained their visual acuity; 35.6% showed improvement in vision; and 34.7% showed a decrease within 16 to 24 months, it was found visual acuity. Visual improvement in terms of visual acuity was as follows: 27.6% improved by up to one line of Snellen's visual acuity chart, 7% by one to two lines, and 1% by more than two lines. Further, 34.7% patients showed a decrease in the visual acuity, 23.8% had a decrease by one line, 9.9% by one to two lines, and 1% by more than two lines. A significant visual loss (decrease in visual acuity of two or more lines) was observed in 4%, and this agreed with the present study. [9]

The current study agrees with Kayhan et al (2021) who found that the best corrected visual acuity demonstrated the increase of 2 lines or more in 20.7% of the eyes, stabilization within 2 lines in 60.7% of the eyes, and loss of 2 lines or more in 18.3% of eyes. The eyes with baseline best corrected visual acuity lower than or equal to 0.50 showed a statistically significant increase (p=0.001) whereas the eyes with baseline best corrected visual acuity of more than 0.50 did not show a statistically significant change (p=0.070) after laser photocoagulation

treatment. This indicates that conventional laser photocoagulation is an effective treatment in diabetic macular edema including center-involved type and stabilizes visual in the majority of the patients. Improvement in the best corrected visual acuity is significant in the group with lower baseline best corrected visual acuity[10].

In the current study, more than one line gain has been found in 41.86% of the patients and more than two lines gain 2.33% and no change has been found in 53.49%. this was higher than what found by Alvi R in 2016 who found that after a follow up of 12 to 45 months patients had Grid laser done in (99%) and focal laser in (1%) and that best corrected visual acuity had declined in 2.4% of eyes, stabilized in 67% of eyes and improved in 30.7% eyes. They also found that one line improvement on Snellen's chart was fond in 21.3% eyes, 2 lines in 8% eyes, 3 lines in 1.2% eyes and 4 lines in one (0.1%) eye with p-value of 0.000[11].

The current study has revealed that 78.85% of macular edema improved and 21.15% in those whom their macular edema is persistent after laser therapy. This agreed with Jorge EC study in 2018 who found that at one year, people with diabetes macular edema receiving laser were less likely to lose best corrected visual acuity compared with no intervention (risk ratio (RR) 0.42, 95% confidence interval (CI) 0.20 to 0.90; 3703 eyes; 4 studies; I2 = 71%; moderate-certainty evidence). There were also favorable effects observed at two and three years.

In addition, Jorge EC reported on partial or complete resolution of clinically significant diabetes macular edema and found moderate-certainty evidence of a benefit at three years with photocoagulation (RR 1.55, 95% CI 1.30 to 1.86)[12]. Zas M found that there is a resolution of lipid exudates upon treatment with xenon photocoagulation and that the likelihood of visual improvement was greater in eyes that had undergone macular laser photocoagulation compared to those eyes that did not undergo macular laser photocoagulation[13]. Zur et al in 2022 found that macular laser treatment has its place as an efficient and safe treatment, that judicious evaluation of the edema, disease dynamics and patient compliance need to be taken into consideration. And that the macular laser treatment reduces the risk of moderate vision loss by 50% by 3 years.[14]

Fong et al in 2007 studied a modified early treatment diabetic study research laser protocol or mild macular grid laser photocoagulation in previously untreated diabetic macular edema. In patients who had 12-month follow-up, they found that the reduction in macular thickness was significantly greater in the group treated with the modified early treatment diabetic study

research laser protocol, but no difference was noticed in terms of the mean change in best-corrected visual acuity, suggesting that modified early treatment diabetic study researches focal photocoagulation should continue to be the standard treatment for diabetic macular edema[15]. Recently, a randomized controlled trial conducted by diabetic retinopathy clinical research network (DRCR.net) protocol B found that focal/grid photocoagulation was more effective and was associated with fewer side effects than Intravitreal injection of triamcinolone acetonide in diabetic macular edema patients at both 2 and 3 years of follow-up [16, 17]. The researchers suggested that focal/grid laser treatment should remain to be the standard against which other diabetic macular edema treatments are compared. However, Elman et al in 2011 found that some laser-treated patients (10%) in the DRCR.net protocol I study lost 15 letters or more in visual acuity at 2 years of follow-up. Although it is obviously essential to prevent further loss of vision, the need to restore visual acuity via a laser therapy has, until recently, been unmet in diabetic macular edema patients[18].

5. Conclusions

As a conclusion, the present study demonstrates that a good visual outcome is achievable in sight threatening retinopathy especially in case of early detection and treatment. These results emphasize the importance of early detection of sight threatening retinopathy through the implementation of high-quality screening services; since patients are usually asymptomatic when their eye disease is in its early stages.

6. References

[1] Everett, L.A., Paulus, Y.M. Laser Therapy in the Treatment of Diabetic Retinopathy and Diabetic Macular Edema. Curr Diab Rep 2021; 21(9):35 .

[2] Young Jung Roh. Laser-Based Strategies to Treat Diabetic Macular Edema: History and New Promising Therapies. Journal of Ophthalmology 2014:1-9.

[3] Nailul Authoriyah, & Amin, R.. Laser Photocoagulation : Literature Review. Sriwijaya Journal of Ophthalmology2018, 1(2), 54-62.

[4] Jorge EC, Jorge EN, Botelho M, et al. Monotherapy laser photocoagulation for diabetic macular oedema. Cochrane Database Syst Rev. 2018 Oct 15;10(10):CD010859.

[5] Vasilijević JB, Kovačević IM, Bukumirić ZM, et al. Vision-Related Quality of Life and Treatment Satisfaction Following Panretinal Photocoagulation in Diabetic Retinopathy-A Panel Study. Medicina (Kaunas). 2022 Nov 28;58(12):1741.

[6] Subash M, Comyn O, Samy A, et al. The Effect of Multispot Laser Panretinal Photocoagulation on Retinal Sensitivity and Driving Eligibility in Patients With Diabetic Retinopathy. JAMA Ophthalmol. 2016;134(6):666–72.

[7] Dowler JG. Laser management of diabetic retinopathy. J R Soc Med. 2003;96(6):277-9.

[8] Fu DJ, Thottarath S, Faes L, et al. Visual acuity outcome of stable proliferative diabetic retinopathy following initial complete panretinal photocoagulation. BMJ Open Ophthalmol. 2022;7(1):e001068.

[9] Zafar A Zaidii, Many K. Jackob. Oman Journal of ophthalmology, 2009;2(2):62-.6.

[10] Kayhan B, Burumcek E. Does conventional laser photocoagulation still have a place in the treatment of diabetic macular edema?. Rom J Ophthalmol. 2021;65(2):130-5.

[11] Alvi R, Memon MS, Shera S, et al. Visual outcome of laser treatment in diabetic macular edema: Study from an Urban Diabetes Care Center. Pak J Med Sci. 2016;32(5):1229-33.

[12] Jorge EC, Jorge EN, Botelho M, Farat JG, Virgili G, El Dib R. Monotherapy laser photocoagulation for diabetic macular oedema. Cochrane Database Syst Rev. 2018 Oct 15;10(10):CD010859.

[13] Zas M, Cotic M, Wu M, Wu A, Wu L. Macular laser photocoagulation in the management of diabetic macular edema: Still relevant in 2020?. Taiwan J Ophthalmol. 2020;10(2):87-94.

[14] Zur, D., Loewenstein, A. Should we still be performing macular laser for non-centre involving diabetic macular oedema? Yes. Eye 2022; 36:483–4.

[15] Writing Committee for the Diabetic Retinopathy Clinical Research Network; Fong DS, Strauber SF, Aiello LP, et al. Comparison of the modified Early Treatment Diabetic Retinopathy Study and mild macular grid laser photocoagulation strategies for diabetic macular edema. Arch Ophthalmol. 2007 Apr;125(4):469-80.

[16] Diabetic Retinopathy Clinical Research Network, "A randomized trial comparing intravitreal triamcinolone acetonide and focal/grid photocoagulation for diabetic macular edema," *Ophthalmology*2008; 115(9):1447–59.e10.

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The Seven Sources of Information Technology and Its Role in the Development of Scientific Research

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Abstract:

With the rapid technological development in various walks of life, Information Technology (IT) resources play an exceptional and key role in the advancement of the field of scientific research, as data sources and electronic content E-Data & E-Content transfer scientific and research resources in a digital (electronic) format to achieve communication and understanding. Among the researchers, the sources of the containers of storing electronic content in its various capacities and forms are indispensable for any researcher to save the research material in the short or long term, while the sources of software from operating systems, software and various applications play an essential role to help the researcher to collect the research material and see the continuous updates in the field of his research and facilitate his work whether before or during the writing of the research or even after writing the research and publishing and tracking its impact and impact, and these facilities provided to the researcher are more evident in the resources of electronics Microelectronics, which are represented by the size of the memory RAM & ROM and also CPU, and the researcher can only do the above through the sources of computers Computer HW of various sizes and types, network sources and communication technology (CT) systems, and all of the above sources of information technology are

transmitted between users of End Users Information systems specialists, which represent the seventh source of information technology, namely the sources of specialized human resources for the system.

Keywords: IT sources - ICT - scientific research.

المصادر السبعة لتكنولوجيا المعلومات ودورها في تطوير البحث العلمي

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الخلاصة: مع التطور التكنولوجي السريع في مختلف مناحي الحياة، تلعب موارد تكنولوجيا المعلومات دوراً استثنائياً ورئيسياً في النهوض بمجال البحث العلمي، حيث تقوم مصادر البيانات والمحتوى الإلكتروني بنقل البيانات الإلكترونية والمحتوى الإلكتروني إلى الموارد العلمية والبحثية بصيغة رقمية لتحقيق التواصل والتفاهم بين الباحثين، كذلك مصادر أوعية تخزين المحتوى الإلكتروني بسعاته وأشكاله المختلفة لا غنى عنها لأي باحث لحفظ المادة البحثية على المدى القصير أو البعيد، بينما تلعب مصادر البرمجيات من أنظمة تشغيل وبرمجيات وتطبيقات مختلفة دوراً أساسياً لمساعدة الباحث على جمع المادة البحثية والاطلاع على التحديثات المستمرة في مجال بحثه وتسهيل عمله سواء قبل أو أثناء كتابة البحث أو حتى بعد كتابة البحث ونشره وتتبع أثره وتأثيره، وهذه التسهيلات المقدمة للباحث تكون أكثر وضوحاً في موارد الإلكترونيات الدقيقة والتي تتمثل بحجم ذاكرة الوصول العشوائي وذاكرة القراءة، وأيضا وحدة المعالجة المركزية، ولا يمكن للباحث القيام بما سبق إلا من خلال مصادر أجهزة الكمبيوتر بمختلف أحجامها وأنواعها، ومصادر الشبكات وأنظمة تكنولوجيا الاتصالات وجميع مصادر تكنولوجيا المعلومات المذكورة أعلاه تنتقل بين المستخدمين النهائيين المتخصصين في نظم المعلومات، وهي مصادر الموارد البشرية المتخصصة للنظام.

الكلمات المفتاحية: مصادر تكنولوجيا المعلومات، تكنولوجيا الاتصالات والمعلومات، البحث العلمي.

1. INTRODUCTION:

Information technology sources are the main pillar of the development and upgrading of scientific research at the moment, given the rapid developments in the world during the past few years in these sources, which serve all fields, including the field of scientific research, in the past the researcher suffered a lot to collect information in the field of his research, and is forced to move between remote areas and sometimes between countries to find out the latest developments of scientific research, but now within minutes in front of his electronic device can access the finest Universities and access to the latest research, and even the participation of other researchers, which works to improve the level and efficiency of scientific research.

Data &E-Content have provided huge digital libraries accessible to researchers, and a study conducted on graduate students by Hadagali et al. [1] has confirmed that the information contained in electronic resources is better than the content printed in MKTP versions and that most researchers have access to electronic resources to search library information. The study by Thabet Hassan and Omar Tawfik [2] also indicated that information technologies play an important role and influence in enhancing the efficiency and productivity of scientific research despite the obstacles that crown its employment.

Information and Communications Technology ICT participates actively in many aspects of the research process because of the facilities and benefits it provides, which improve the quality of academic research output. Nakhai et al. [3] listed some of these benefits, including reaching universality and achieving more references and quotations, saving time by searching, collecting, and analyzing information quickly using a variety of techniques, such as the technology of information tools, and achieving more references and quotations. Using a computer speeds up the various stages of research, ensures the accuracy of even minute details, and prevents the information from remaining hidden. It also protects researchers from many common human errors and improves the accuracy of research work, and discipline through Structure, classification, and other methods. Enhancing motivation, which is one of the attractions and features of the computer and the Internet, are some of the tools, planning programs, archive features, and time management in arranging activities and observations and carrying out different stages of productive study. It is efficient in raising researcher motivation and lowering research fatigue, teamwork, and the availability of communication facilities and the chance to use networks in this technology, as well as the configuration of the right conditions for large-scale and collective organizational and research activities, durability, and scientific sobriety, and provided by this technology to store results, ease of maintenance, decreased volume of information and increased rob. The use of multimedia in research that is based on textual material and information technology improves the effectiveness and appeal of the study. With the possibilities of information and communication technology and the Internet, researchers can publish their work more simply and quickly than ever before, and anyone may access and utilize it for free. This feature can increase the motivation and efforts of students and newcomers to the area of scientific research and make their studies permanent. They can publish each piece of their study internationally and in endless editions freedom from space and time to conduct research and gather information, a variety of resources can be carried easily in the form of

a CD or other storage device for electronic content, reducing the researcher's interest in the specific time and location and making it possible for them to conduct research in areas where ICT is available. We can say that without this technology, it would be nearly impossible to prepare comparative studies, various technical lists, statistical graphs, virtual experiments, basic searches, and modernization, where the use of information technology makes the research current and in line with the most recent information and scientific findings and allows the researcher to access the most recent theories and findings at any time.

We discuss the active involvement of the seven ICT sources **(Figure 1)** in the growth of scientific research in the paragraphs that follow by elaborating on each source individually.

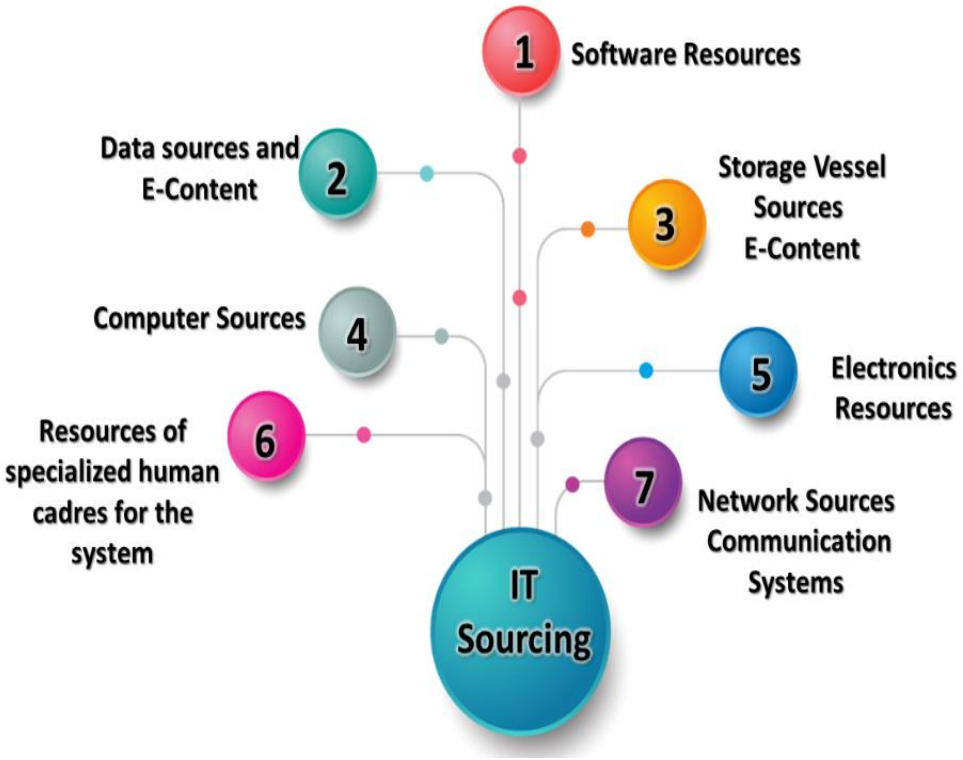

Figure -1 The Seven IT Sources (prepared by the researcher)

1.1 The role of data sources and electronic content in the development of scientific research

E-Data is facts that are displayed in many forms, which may be words, numbers, images, symbols, graphics, sounds, signals, visual clips, or animations, which are transmitted in the form of electronic digital symbols to achieve their purpose and to communicate these forms with the same quality, the same shape, and the same quantity.

According to the Annie study [4] findings, there is a strong correlation and a positive impact between faculty members' productivity and the use of electronic resources, especially at the level of international publishing. As a result, it is essential to upgrade digital content for scientific research in general and digital Arabic content. As previously mentioned,[5] there are several ways to do this.

1- Translation: Obliging specialists in scientific research to obtain a degree in translation as a basic qualification to join the field of scientific research.

2- The quality of research products available in digital content: the need to adopt the citation of elaborate and reliable digital content, cooperation between researchers in the same institution and international external institutions, diversity, and overlap of the field, and the involvement of young researchers with expert researchers.

3- Access mechanisms: Securing access to digital content from classification, indexing, and easy access to digital content, saving time, effort, and money for researchers.

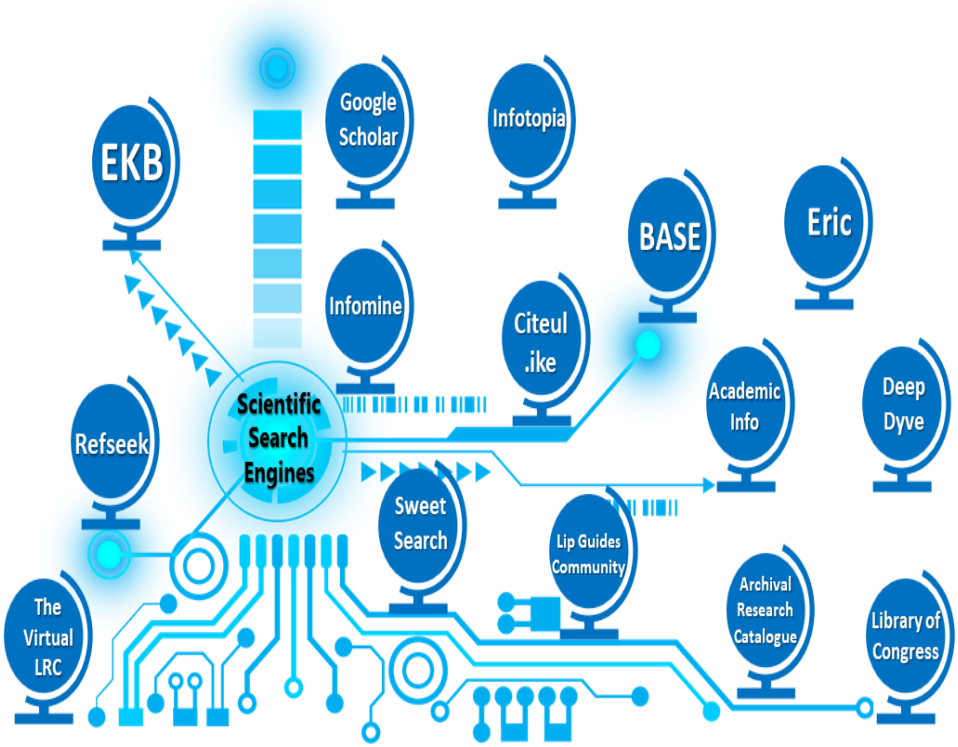

Figure -2 Some academic scientific search engines (prepared by the researcher)

There are many search engines (**Figure 2**) that carry within them a prolific digital content of the researcher considered specialized academic research sources as mentioned by Maoush Abdel Hamid and Makhloufi [6], the most important of which are:

1- *Lib Guides Community:* It is a site that offers you the service of searching and exploring over 318968 research supervised by more than 53,731 librarians in 3,856 libraries worldwide "https://community.libguides.com".

2- *Academic Info***:** It provides the links and resources most relevant to the research topic in your field of specialization, through a list of search results that are printed references or electronic sources. "http://www.academicinfo.net/subject-guides".

3- *Archival Research Catalogue* :It is the official signature of the National Archives and Documents Administration of the United States of America and provides research into documents that this institution preserves and documents, as well as searches of references provided by some U.S. presidential libraries. "https://www.archives.gov/research/catalog".

4- *BASE***:** It is one of the largest open electronic scientific resource search engines in the world, and it is run by the German Bielefeld University Library."https://www.base-search.net/".

5- *CiteuLike***:** A free service for the management and discovery of scientific references, offering approximately 7 million scientific materials and academic research. "https://citeulike.date/".

6- *Eric***:** It is a digital library of educational research that is supported by the Institute of Educational Sciences (IES) at the U.S. Department of Education. It offers simple access to educational resources and supports their use in enhancing instruction and instructional practices, in guiding educational decisions, and in the dissemination of research. "https://eric.ed.gov/".

7- *Infomine***:** A digital repository for university-related information about staff, students, and researchers. It includes crucial resources including databases, electronic magazines, electronic books, message boards, mailing lists, articles, researcher's aids, and other kinds of data."www.infomine.com".

8- *Infotopia***:** A search engine that provides information and archiving of the sites and topics of art, history, social sciences, and societal issues and problems."https://www.infotopia.info/".

9- *Google Scholar***:** sources, articles, dissertations, books, abstracts, and peer-reviewed views from academic publishers, professional associations, online repositories, universities, and other websites for in-depth study of the scientific content across many fields. It helps you to collect scientific research work relevant to your topic around the world, with a monthly visitor of more than 50 million. "https://scholar.google.com/".

10- *Library of Congress :*The Library of Congress provides you with a search service on primary sources of documents, including photographs, maps, manuscripts, and historical newspapers "https://www.loc.gov /".

11- *Refseek*: a search engine with over a billion items, including web pages, books, encyclopedias, periodicals, and newspapers that is designed for students and scholars. "https://www.refseek.com/".

12- *The Virtual LRC***:** To give students and instructors accurate information for academic assignments, hundreds of the top academic information sites have been indexed. These sites were chosen by teachers and library experts from across the world. "https://www.virtuallrc.com/".

13- *Sweet Search***:** A website that assists students in gathering information fast, selecting the most pertinent discoveries from a list of reliable sources, and facilitating the discovery of primary sources away from unwelcome and unimportant sites lacking in academic quality. "https://www.sweetsearch.com/".

14- *Deep Dyve***:** A site that allows you to search thousands of leading scientific journals such as springer, and Elsevier. Nature, IEEE, Wiley-Blackwell. "https://www.deepdyve.com/".

In addition to the Egyptian Knowledge Bank (EKB), the Egyptian Knowledge Bank is the largest digital library in the world "https://int.ekb.eg/" which grants unlimited resources to all Egyptians and is one of the national projects within the plan for the development of education in Egypt, where it aims to make available a huge and diverse amount of research and knowledge sources to the Egyptian citizen for free, and the website of the Egyptian Knowledge Bank contains 4 portals to include the student portal, The Knowledge Bank aims to raise the level of knowledge of the Egyptian people by providing a huge and diverse amount of audio, visual and read knowledge sources and is characterized by ease of use and availability at the level of the Arab Republic of Egypt in general and without conditions, in addition to many search engines that have recently appeared, including:

1- *Research Gate*: The Research Portal, a social network website and free collaboration tool aimed at scientific researchers from all disciplines of science, provides web applications including semantic research, file sharing, sharing of the Baya Nat database, forums, methodological discussions, groups, and subscribers can also create their blog in the network. "https://www.researchgate.net/".

2- *MICROSOFT ACADEMIC*: The academic search engine is Microsoft, which searches more than 80 million scientific papers in all fields. "https://academic.microsoft.com/".

3- *ISEEK Education*: A scientific search engine that searches hundreds of thousands of reliable sources from universities, scientific institutions, and scientific research. "http://education.iseek.com/#/education".

4- *Science Direct*: It is not only a research news site but also acts as a powerful search engine, with search results reaching more than 10,000 research papers and 25,000 scientific books. "https://www.sciencedirect.com/".

5- *Internet Public Library IPL*: It is a large library with many sources that have been compiled over 20 years."https://www.ipl.org/".

6- *Archive Hub*: It is a British institution, and it can be researched, as it is a real wealth of information for researchers. "https://archiveshub.jisc.ac.uk/".

7- *Academia.Edu*: It allows its users to create a profile upload their work and identify their areas of interest, and it has just over 99 million users. It enables researchers to share, monitor, and measure scientific research and outputs using special academic metrics, as well as allows users to follow scientists or research in specific fields. "https://www.academia.edu/".

1.2 The role of the sources of electronic content storage vessels in the development of scientific research

The researcher must periodically save his scientific product, and this preservation is through storage vessels, due to the rapid development in the field of information technology, these vessels have become digital most often due to their speed of preservation, ease of retrieval, and small size, where information is retrieved from them by computer or by devices dedicated to it, and their storage area is measured in different units of measurement starting with bits, which are the smallest standard unit, passing through bytes, kilobytes, and megabytes Bytes, gigabytes, which are considered the most common, then terabytes, beta-bytes, exabytes, zettabytes, and utasbits.

In addition to many forms of digital storage vessels that have emerged recently due to the urgent need to use them in the storage of digital data and information, which has benefited researchers and those working in the field of scientific research, which has helped the development of this field, increasing its efficiency and accelerating the pace of development and advancement, such as USB storage units or flash memory, which are the latest current technological inventions in the field of saving data or transferring it from one device to another, and are characterized by being small in size easy to use and readable Easily on computers and do not need other programs or devices to deal with them, but their disadvantage is the small

storage capacity in them, also memory cards, which are the most common and used storage units in our time, and are represented in memory cards used to increase the storage space of phone or tablet devices, and are characterized by their very small size, and perhaps the most prominent types of them are SD, MMC Despite its multiple advantages, it is easily susceptible to damage with wrong use, These vessels have evolved over the ages and times as reported by the Encyclopedia website **[7]** until they have taken different forms (**Figure 3**).

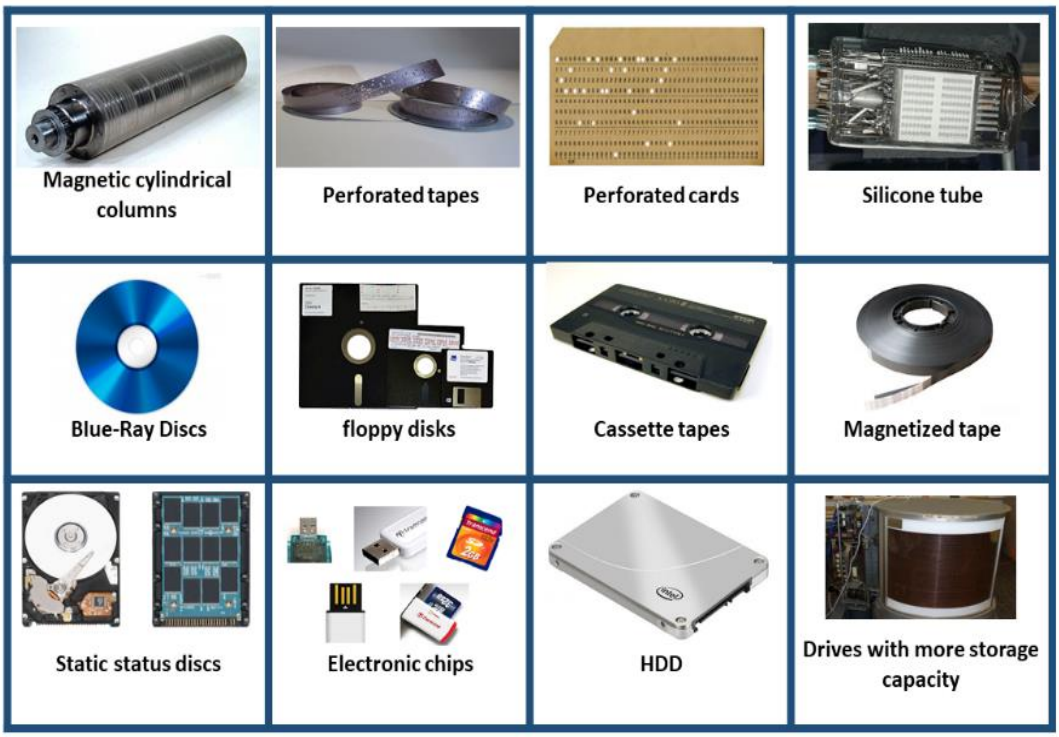

Figure -3 The evolution of electronic content storage vessels (prepared by the researcher)

1.3 The Role of Software Resources in the Development of Scientific Research

Software Resources are one of the most important sources of information and communication technology ICT used by researchers and scientific research workers, with all its operating systems System Software OS, Application Software, which is the most used part, and methods and methods of individuals using information systems, where these systems and software work by entering data Then process this data and then output the information products through the processes of adjustments and control of the performance of the system. Control of System Performance

There are many applications and programs that are indispensable for any researcher during his research career and appoint him in it, and where these programs play a great role such as

translation from any language and into any language, converting illustrated papers into electronic files in multiple formats, recording and saving references, classifying and citing them within the research in several ways, converting sound into writing, which facilitates the researcher physical effort and time, spelling review and language correction, statistical analysis of data, and many others mention some of these programs and applications:

1- *Producteev*: Organizes the researcher's time and prevents him from being distracted, by allowing the researcher to create a list of tasks he wants to do in his scientific research and ironing out the timelines.

2- *Libgen:* Allows free of charge many research papers, scientific research, master's and doctoral theses, sources, and references that the researcher needs his research career, and the applications characterized by the speed of extracting the research that the student is looking for, which saves effort and time on it.

3- *Mendeley:* It collects all the research that the researcher wants to rent to while writing, the place of research within the reference, and access to the paragraphs that benefit the student in his scientific research, and enables him to take notes, which will be served by more than three million researchers.

4- *Zotero*: This application organizes and manages scientific research according to the way the researcher wants, as it gives him many options such as arranging them according to the name of the reference, the date of pub, cation, or the publisher, and is characterized by its ability to read e-books.

5- *Grammarly*: corrects spelling and linguistic errors in research written in English and makes several suggestions for correction.

6- *World Cat*: The library database, which contains more than 74,000 libraries from 170 countries of the world, thus allows a researcher to benefit from the global in service while writing for research.

7- *Endnote*: A program to manage references and research sources and organize the references that he used in his scientific research, enables you to create a library for t researcher that includes the research he wants and arranges them according to the way the researcher wants.

8- *Paperrater*: Is a custom for evaluating the search, where it analyzes the research and then determines the percentage of citations contained in several sources quoted from it.

9- *Prezi*: This application allows the researcher to make presentations of his scientific research and is characterized by its ability to apply mind maps easily, and add an unlimited number of images, text, and video.

10- *Microsoft translator*: has more than 70 languages, provide pronunciation with control of pronunciation speed, and provides translation service by entering text in writing, voice, or image.

11- *Cited*: Provides writing the master data of the reference to be documented, with the possibility of choosing the type of d augmentation, copying the documentation, and using it in the list of references.

12- *Assembly*: Design scientific posters and, infographic design, and logo designs, and provide many formats to save work.

13- *Forms App*: Allows the researcher to create forms (questionnaires – tests), share forms to get responses, provide illustrations of responses, and export response data as a file.

14- *Text scanner* converts: Image texts into copied written text and supports 55 languages including Arabic.

15- *Dict Plus*: It is characterized by providing ready-made and classified lessons, changing the dialect of the English language: (British, American, Australian, and others), the possibility of translation in multiple ways (text, audio, image), and the availability of some services offline.

16- *Mappy*: Creates unlimited mind maps, adds images and emojis to the map, controls color selection, and supports Arabic.

17- *Office Suite & PDF editor*: Is comprehensive for all Microsoft Office applications (Word, PowerPoint, Excel), performs advanced PDF options, scans paper documents, converts them to digital using the camera, and provides support for cloud storage.

18- *AirDroid*: Sending different, types of files between iPhone, Android, and Windows devices, and does not need an Internet connection.

19- *Recuva*: A pa program to recover deleted files from a computer.

20- *PDF converter*: A program to convert text file formats.

21- *Light shot*: A program to make a screenshot and save it as an image.

22- *Microsoft Word*: Is one of the most important programs that are relied on in the processing of various types of text, and it is a program commonly used among researchers in writing and coordinating research of various kinds, because of the tools that the program contains to make the task of the researcher easier in doing the writing and formatting of texts adjust the margins and direction of the paper, paper measurement, printing options and more.

1.4 The role of microelectronics sources in the development of scientific research

Microelectronics **[8]** The goal of understanding them is to develop a comprehensive picture of the micro-level processes that occur in electronic devices, to assimilate the principles of controlling the flow of charge carriers in electronic devices, to gain knowledge about the physical processes involved in the operation of quasi-catalyst devices, to hone one's

computational modeling abilities, and to develop one's critical thinking abilities. Study the characteristics of contemporary microelectronics' practical applications within the context of professional endeavors, as understanding the operation of contemporary computers is crucial for researchers and other personnel engaged in scientific study, it comprises microelectronics from integrated circuits, memory, and central processing units, and is required to enhance scientific research and train future IT workers. Three ways and methods for gaining access to data and information kept in the computer's memory **[9]** will be discussed:

1- *Sequential Access*: The data is in the form of balanced units in the form of a third where the transition to a particular unit must pass all units between the current reading place and the required unit, hence we note that the necessary time may reach minutes, for example, the recording bar.

2- *Direct Access*: This method divides memory into units that can be moved between them quickly without entering their contents, so the arrival time consists of two elements, namely the time of transition from one unit to another, which is relatively rendering, and the time of successive search within the unit, and the time of access reaches a fraction of a second, for example, the s stacking of steel and the s of integrated stacking.

3- *Random Access*: In this type of memory each site has an address, the time it takes to read is equal and does not depend on the current location, and the speed of access reaches nanoseconds, and this method uses both the main memory: RAM, permanent memory in both parts of read-only ROM, read-only and programmable PROM, and Cache Memory is as follows:

- *RAM* **:** Fixed RAM SRAM **&** DRAM animated RAM which have three types: Simultaneous Mobile RAM SDRAM, Concurrent Moving RAM with Double Speed DDR-S DRAM, Animated RAM R DRAM.

- *Cache Memory***:** In general, DRAM memory is slow compared to the speed of the CPU, so the computer developers used a memory called cache or SRAM cache which is placed between the central processor and the main memory, where they are all connected by the main bus (**Figure 4**).

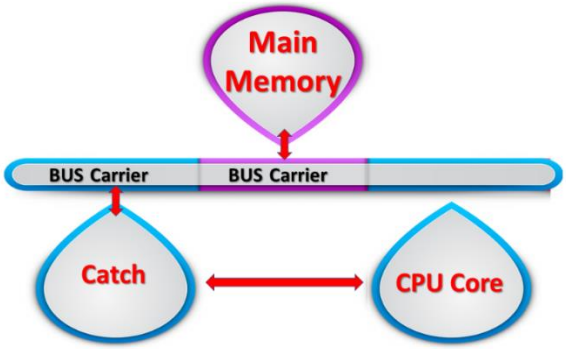

Figure 4: Cache Memory (prepared by the researcher)

- *Permanent ROM memory:* It is read-only, where the information was entered when manufacturing, and the information is not lost when the power is outraged.

- *Programmable ROM PROM*: Non-volatile, information enters it during programming once and is not a requirement in the manufacturing phase so it can be programmed by the user only once, and then used for read-only.

1.5 The role of computer resources in the development of scientific research

Computer Hardware sources include computer systems and computer accessories, and every researcher who wants to use information technology in his academic career must get acquainted with the basic computer components, so that he is aware of and understand what is happening inside this device and thus explain the technical problems that can be faced and overcome, the hardware of the computer system includes the motherboard Mother Board, GPU, CPU, PSU power supply, hard drive, and RAM (**Figure. 5**), Even though a computer can only function when its hardware and software cooperate, the speed of the system will largely depend on the hardware of the device, which helps the researcher to advance more quickly, saving time and effort, and improving scientific output. The following list summarizes the computer's most crucial hardware: CPU (Central Processing/Processor Unit), Random Access Memory (RAM), Hard Drive, Graphics Processing Unit (GPU**),** Power Supply Unit (PSU).

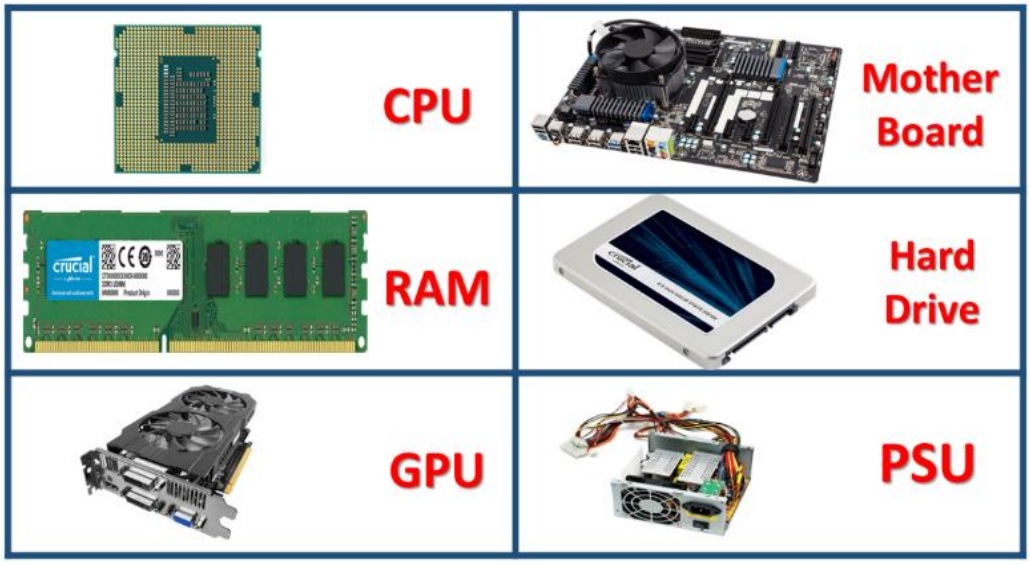

Figure -5 Computer Hardware (prepared by the researcher)

Motherboard is the serves as the brain of the computer, controlling power when required, communication, and coordination between all other components of the computer, making it one of the most crucial parts of the devices in the computer. Therefore, it is crucial to consider the ports of devices that the motherboard provides when choosing a motherboard, even though it is

only one component of the circuit. (USB 2.0, 3.0 and 3.1), The ports on the motherboard will also assist you in determining whether additional devices will be compatible with the computer, in addition to the display ports utilized (HDMI, DVI, and RGB) and the number of ports per display port. Your computer's RAM **[10]** and graphics card type that you can utilize to meet your needs for specialized scientific study and your requirements.

1.6 The role of network sources and communication systems in the development of scientific research

There are several types of computer networks, which the researcher must know to preserve his personal, research, and scientific information, especially if he works within an institutional framework and computers own that institution, but he must warn of scientific thefts, especially if his specialization is accurate and rare.

Networks, which are the foundation of modern business and are used for everything from accessing the Internet to printing documents to downloading MLVs from emails, can refer to a small group of devices in a single room or millions of devices dispersed around the globe, depending on their purpose or size. Here, we review 11 different types of networks **[11]**: Personal Area Network (PAN), Local Area Network (LAN), Wireless Local Area Network (WLAN), Campus Area Network (CAN), Metropolitan Area Network (MAN), Wide Area Network (WAN), Storage-Area Network (SAN), The term is new, Passive Optical Local Area Network (POLAN), Enterprise Private Network (EPN),Virtual Private Network (VPN).

1.7 The role of the sources of specialized human cadres of the system in the development of scientific research

ICT has helped researchers in many academic aspects during the different stages of writing scientific research and finally by publishing it and tracking its impact and impact but has helped in identifying researchers and maintaining their scientific and academic identity, biography, and academic scientific output of each researcher through several sites and systems that each researcher must have an identity and record of his research output on these sites, it serves as a statistical record for researchers from all over the world, to get to know each other, and to see the scientific output of each other. Among them, but also for scientific communication between researchers, and between researchers and scientific and academic institutions, to produce joint research, and use the required expertise from all parts of the world, thus opening the horizon for researchers and academics to know and exchange experiences, but also the material benefit and material funding of research by the institutions concerned, and these sites include: ORCID

"https://orcid.org/", Research Gate "https://www.researchgate.net/", Google Scholar "https://scholar.google.com/", Publons "https://publons.com/about/home/", Scopus "https://www.scopus.com/", Academia "https://www.academia.edu/", Researcherid "http://www.researcherid.com/", Arid أريد"https://portal.arid.my/ar-LY/Account/Login", Slide Share "https://www.slideshare.net/", Mendeley "https://www.mendeley.com/newsfeed", Live DNA "https://livedna.net/form.php", SciProfiles "https://sciprofiles.com/", Kudos "https://info.growkudos.com/", LinkedIn "https://www.linkedin.com/".

2. References

[1] Hadagali GS, Kumbar BD, Nelogal SB, Bachalapur MM. Use of electronic resources by graduate students at various Karnataka State universities. Int J Publ Inf Technol. 2012;2(3):189-95.

[2] Thabet TH, Rahman OTA. The role of information technologies in enhancing the efficiency of scientific research. 2020. Available from: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3547701

[3] Nakhai A, Hashemi SAB, Ghafouri M. The feasibility of ICTs for better research. IJCSNS Int J Comput Sci Netw Secur. 2016;16(10):93-7.

[4] Annie OE. The accessibility and use of electronic information resources for research purposes and their impact on the productivity of faculty at selected Nigerian universities between 2005 and 2012. University of South Africa; 2013.

[5] Shaqour AZ. Promote Arabic digital content for scientific research for sustainable development. Arab Forum for Scientific Research and Sustainable Development, Beirut; 2015 Dec. Available from: https://www.researchgate.net/publication/286929130_tzyz_almhtwy_alrqmy_alrby_llbhth_allmy_mn_ajl_tnmyt_mstdamt

[6] Hamid MA, Ali M. The development of information technology and the digitization of scientific research Scholar (Google Scholar), features, and uses. J Humanit Commun Sci. 2019;5(July 2019):52-72.

[7] Al Azizi H. Types of storage media and preservation of information and data. The site of the innovative encyclopedia; 2015 Sep 2. Available from: http://innoopedia.blogspot.com/2015/09/SSDVSHDD.html

[8] Semenikhina O, Drushlyak M, Lynnyk S, Kharchenko I, Kyryliuk H, Honcharenko O. About computer support for the "Fundamentals of Microelectronics" course by specialized software: the results of the pedagogical experience. TEM Mag. 2020;9(1):309-16.

[9] Science for everyone. Types of memory in the computer. Electronics for everyone; 2019 Jul 7. Available from: https://www.electronics212.com/2019/07/computer-memory-classifications.html

[10] Micron Technology. Crucial by Micron. 2017. Available from: https://www.crucial.com/articles/pc-builders/what-is-computer-hardware

[11] Bourgeois S. Explained 11 types of networks: VPN, LAN, and more. Bilden; 2016 Jun 10. Available from: https://www.belden.com/blogs/network-types

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Synthesis, characterization, and biological activity assessment of new metal complexes of Schiff bases produced from benzoin

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Keyword: Schiff Bases; Zn++ , Mn++ ,Ag+ Complexes ; Benzoin ; Biological Activities.

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Abstract:

By the reaction of Benzoin with melamine and Benzoin with 5-aminosalysilc acid a new Schiff base is obtained the reaction of the legends with Mn++, Zn++, and Ag + salts leads to the complexes [M (L)2] X at PH=7-6, and [M (L)2] at PH=9-10, L= BMA, BMS M= Mn++ Zn++ and Ag +, Several chemical and physical measurements, such as melting point, molar conductivity, and magnetic properties, as well as FT-IR spectroscopy, UV-VIS spectroscopy element analysis (C.H.N.), and (1 H-NMR)spectroscopy, and GC-MASS. was used to identify the produced ligands and complex structures, the complexes of Mn++, and Znand ++ give hexacoordinated complexes having the shape octane al but Ag+ gives tetracoordinate complexes. having shape tetrahedral. then they were screened for biological activity using agar plate diffusion technique against Gram(+) (Staphylococcus aureus bacteria, pseudomonas aeruginosa bacteria) and Gram(−) (Escherichia coli bacteria, Klebsiella pneumonia bacteria) When compared to streptomycin and trimethoprim drug, all these ligands and their complexes show good antimicrobial effectualness.

Keywords: Schiff Bases; Zn++ , Mn++ ,Ag+ Complexes ; Benzoin ; Biological Activities.

تحضير وتشخيص وتقييم الفعالية الحيوية لمعقدات فلزية جديدة لقواعد شف المشتقة من البنزوين

رنا رمزي عبد & حسين احمد إسماعيل الكيكاني

جامعة الموصل / كلية التربية للعلوم الصرفة / قسم الكيمياء

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من مفاعلة البنزوين مع الميلامين مرة والبنزوين مع ٤-امينو حامض السالسيلك تم الحصول على ليكندات جديدة لقواعد شيف أعقبها تحضير معقدات للمنغنيز والخارصين الثنائي والفضة الأحادية التأكسد باستخدام أملاح الفلزات حيث نتجت معقدات لها الصيغة التركيبية X_2 [M $(L)_2$] في الوسط المتعادل PH=7-6 و [M (L)2] في الوسط القاعدي PH=9- 10 حيث M, $^+$BMA, BMS = L and Ag = Zn^{++} , Mn^{++} , أعطت معقدات للمنغنيز والخارصين (II) الشكل الهندسي ثماني السطوح في حين نتجت معقدات رباعية السطوح للفضة (١) تم إجراء العديد من القياسات التشخيصية الكيميائية والفيزيائية مثل قياس درجة الانصهار والتوصيلية المولارية والخصائص المغناطيسية وكذلك طيف الأشعة تحت الحمراء وطيف الأشعة فوق البنفسجية وقياس تحليل العناصر C.H.N. وطيف الرنين النووي المغناطيسي ١ H-NMR و GC-MASS (طيف الكتلة) كما أجريت قياسات لتقييم الفعالية الحيوية لليكندات ومعقداتها تجاه أنواع مختلفة من البكتيريا الموجبة الغرام مثل بكتيريا الستافيلوكوكس اوريس وبكتيريا السيدوموناس اوراجينوزا والبكتيريا السالبة الغرام مثل البكتيريا الاشيريكية ايكولاي وبكتيريا الكليبسيلا بينومونيا، حيث سجلت كلا من الليكندات ومعقداتها فعالية جيدة مقارنة بالأدوية القياسية مثل الستربتومايسين والترايميثوبريم.

الكلمات المفتاحية: قواعد شف، معقدات فلزية Ag, Mn++ , Zn+++ , بنزوين ، فعالية بيولوجية.

1. INTRODUCTION:

Schiff bases are considered one of the most important organic compounds that are easy to prepare and of wide importance because they possess important medicinal properties as substances with high efficacy against bacteria, fungi, and anti-tumors, which increases the effectiveness of these compounds, and their consistency with transition metals that have high effectiveness in increasing the immunity of living cells, such as zinc, manganese, and silver **[1]** Schiff base compounds are known to be prepared by a condensation reaction between amine and carbonyl compounds such as aldehydes and ketones, which produces a compound with a functional group called the azomethine which is considered a very effective group in terms of pharmacology. In addition to their consistency with metal atoms through the donation of the double electron to the nitrogen atom, where they are stable complexes with important therapeutic properties in the preparation of many anti-inflammatory drugs**[2]**.

Chemical sciences are currently heading towards the preparation of more drugs, antibiotics, and anti-cancer drugs that can be said to be new drugs or drugs developed from existing ones to help humans combat stubborn germs that are beginning to show resistance to traditional drugs used at the present time. In our research, after preparing complexes of Schiff bases with Zinc, Manganese, and Silver, we studied their biological effect against different types of bacteria, as they showed clear effectiveness against these pathogenic bacteria **[3]**.

2. EXPERIMENTAL SECTION

2.1 Materials

All the chemicals and solvents required to create the compounds came from several suppliers, including Merck, BDH, Fluke, and Sigma Aldrich.

2.2 Synthesis Methods

Synthesis of ligand ((E)-2-((4,6-diamino-1,3,5-triazin-2-yl) imino)-1,2-diphenylethan-1-ol) BMA (0.047 mole of Benzoin (10g) dissolved in 50 mL ethanol then (0.047 mole, 5.94 g of melamine) as 1:1 molar ratio dissolved in 20 mL ethanol with few drops of glacial acetic acid, the mixture of the two solutions was refluxed for (2 h.). The yellow precipitate was filtrated and washed with water after cooling to room temperature. and recrystallization by hot ethanol then dried in the oven at 40 °C. Synthesis of ligand) (E)-2-hydroxy-5-((2- hydroxy-1,2- diphenyl ethylidene)amino) benzoic acid) BMS follows the same method as (0.047 mole of Benzoin (10g) dissolved in 50 mL ethanol then (0.047 mole, 7.21 g of mesalazine) 1:1 molar ratio **Fig.1** and **Fig.2** (Scheme 1, 2) then the metal complexes were prepared **[4]**, depicts the general reactions of prepared compounds, while **Table 1** lists all physical properties.

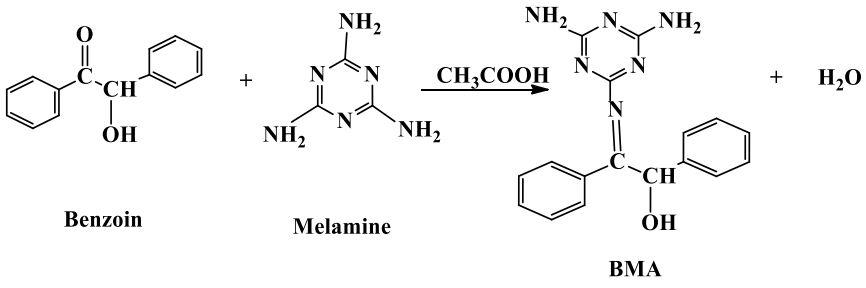

Fig. 1: Scheme 1

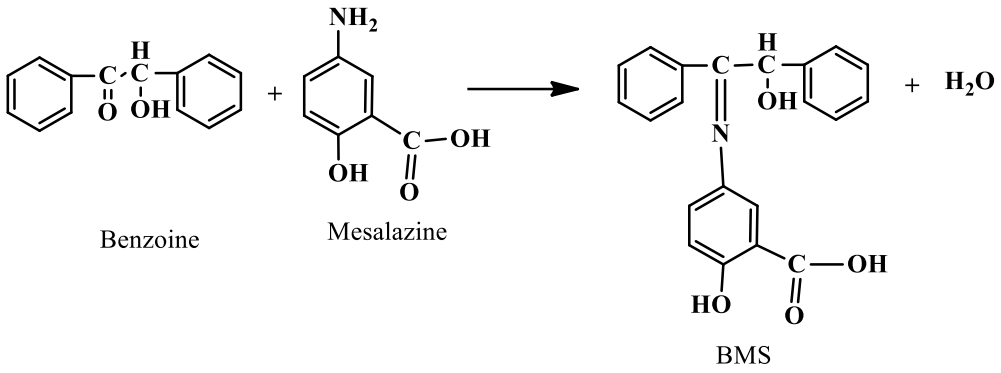

Fig. 2: Scheme 2

2.3. Preparation of complexes

The coordination of Manganese (II), Zinc(II), and Silver (I) with ligands is carried out with a 1:2, (M-L) molar ratio. The coordination reaction is carried out in the neutral medium and basic medium as follows (Scheme. 3) **Fig. 3**.

2.3.1. In a neutral medium.

[Zn(BMS)$_2$] AOc$_2$ was prepared by dissolving 0.945 g (0.0027 mole) of BMS ligand in 15 mL of ethanol with 0.25 g (0.0013 moles) of Zn(AOc)$_2$. 2H$_2$O which dissolved in distilled water in a (2:1) ratio. For three hours, the mixture has been refluxing. half of its capacity evaporated before being allowed to cool. The resultant complex was filtered out, washed twice with diethyl ether, then cold distilled water, and dried. Using the same method, BMA complexes with the other Zn^{++}, Mn^{++}, and Ag^{+} salts were synthesized **[4]**. (Scheme 2) **Fig. 2**. According to the combination ratio the suggested formula of the complex in the neutral medium and basic medium is presented in **Table 1**.

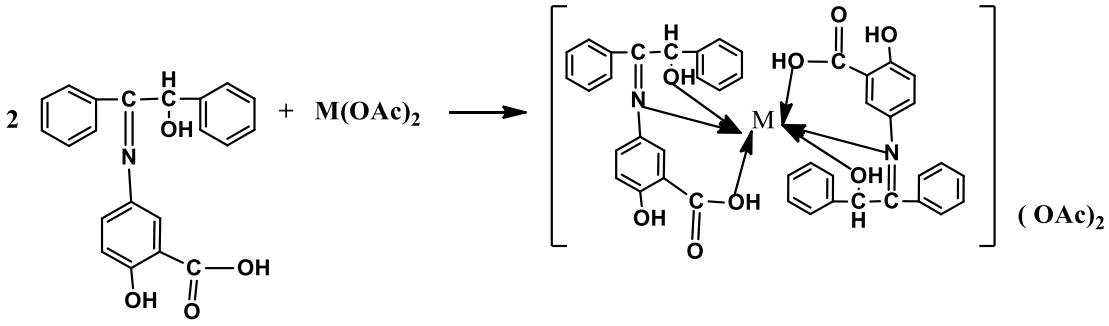

Fig.3: Scheme 3

2.3.2. In a Basic medium

$[Zn(BMS)_2]$ OAc_2 was prepared by dissolving 0.945 g(0.0027 moles) of BMS ligand in 15 mL of ethanol with 0.25 g (0.0013 moles) of $Zn(Ac)_2$. $2H_2O$ which dissolved in distilled water (2:1) ratio. A few drops of KOH (1M) were then added, and the precipitation was finished. The resultant complex was filtered out, washed twice with diethyl ether, and dried after each wash with cold distilled water. Using the same method, BMA complexes with the other Zn^{++}, Mn^{++}, and Ag^{+} salts were created [4]. (Scheme 4) Fig. 4. The complex's recommended formula in the neutral medium and basic medium is as follows, depending on the combination ratio in Table 1.

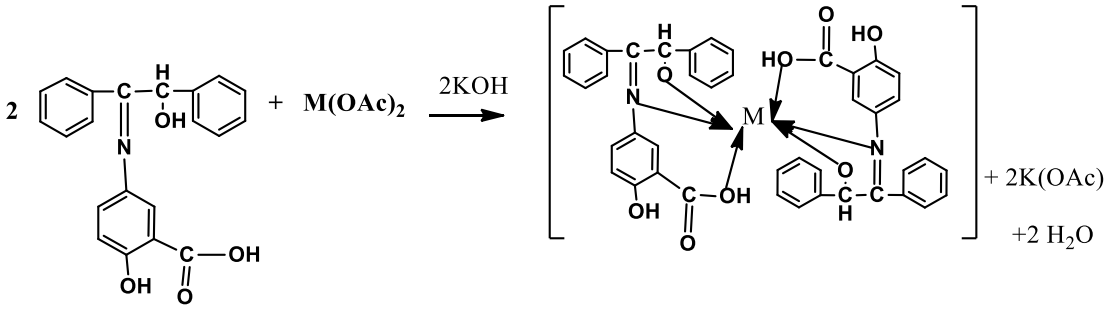

Fig. 4: Scheme 4

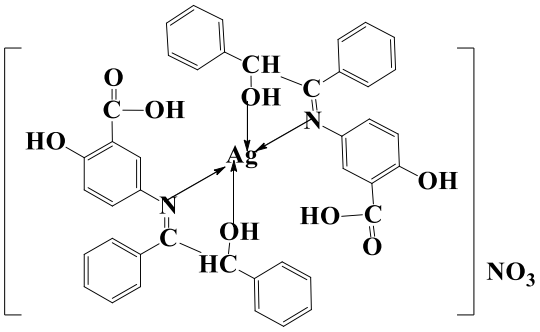

Fig. 5: tetra coordination Silver(I) complex

Table 1: Amounts, Yield, and Formulae of the prepared complexes

No.	Wt. Of BME, BMS in gram	Salts 0.25 g	yield %	Complexes
1	0.872	$Zn(OAc)_2 2H_2O$	79	$[Zn(BMA)_2](OAc)_2$
2	0.872	$Zn(OAc)_2 2H_2O$	77	$[Zn(BMA)_2]$
3	0.652	$Mn(OAc)_2 4H_2O$	75	$[Mn(BMA)_2](OAc)_2$
4	0.652	$Mn(OAc)_2 4H_2O$	87	$[Mn(BMA)_2]$
5	0.941	$AgNO_3$	81	$[Ag(BMA)_2]No_3$
6	0.941	$AgNO_3$	83	$[Ag(BMA)_2]$
7	0.945	$Zn(OAc)_2 2H_2O$	89	$[Zn(BMS)_2](OAc)_2$
8	0.945	$Zn(OAc)_2 2H_2O$	87	$[Zn(BMS)_2]$
9	0.707	$Mn(OAc)_2 4H_2O$	88	$[Mn(BMS)_2](OAc)_2$
10	0.707	$Mn(OAc)_2 4H_2O$	80	$[Mn(BMS)_2]$
11	1.021	$AgNO_3$	83	$[Ag(BMS)_2]No_3$
12	1.021	$AgNO_3$	86	$[Ag(BMS)_2]$

4. RESULTS AND DISCUSSION

4.1. physical and Analytical measurements

The produced ligands and complexes are identified using a variety of approaches. The elements of carbon, hydrogen, and nitrogen (CHN), as well as the complex's infrared spectrum, melting point, and molar conductivity, have all been analyzed. NMR of the "Bruker Ultra Shield 300 MHz" type was used to record the H-NMR for the ligand [4].

4.2. Physical properties

The compounds that were created were yellow solids that were air-stable, insoluble in water, but soluble in DMSO. The complexes with the metal ions Mn^{++}, Zn^{++}, and Ag^{+} had relative molecular weights that could be estimated, and it was discovered that these complexes might have the molecular formulas $[M(L)_2]X2$ in neutral medium and [M(L)2] in basic medium. The ligands are tridentate when it is ready. Using the nitrogen and oxygen atoms that formed Octahedral geometry with Mn (II), Zn (II) [5], it acts as bidentate when it is ready. Using the nitrogen and oxygen atom that formed tetrahedral geometry with Ag (I).

4.3. The molar conductivity.

The determined values of the molar conductivities of the prepared complexes of Mn^{++} and Zn^{++} were found to be in the range of (77-80 Ω^{-1} cm^2 mol^{-1}). This range approaches the values expected for complexes of 1:2 electrolytes, and 1:1 electrolyte. the molar conductivities of the

prepared Ag $^{+}$complexes were found to be in the range of (32-35 Ω^{-1} cm^2 mol^{-1}). This range approaches the values expected for complexes of 1:1 [6]. In basic medium, all the complexes are non-electro let.

4.4.Elemental analysis (CHN).

CHN elemental analysis is carried out on the isolated complexes to prove their formation. The results obtained from this analysis are given in **Table 3**. The results in Table 3 show good consistency between the calculated and experimental ratio of the elements CHN, of the proposed structure. This agreement supports the formation of the synthesized complex [7].

4.5. Determination of Zn^{++}, Mn^{++}, and Ag^{+} ions.

By using flame atomic absorption spectrometry to a monomeric structure, the concentrations of Zn and Mn ions are determined. The findings demonstrated that the compounds under study have octahedral geometries [8], **Table 2**.

Table 2: CHN analysis, Metal contents of the prepared complexes

NO.	Structure	M.wt	color	M.P	Mol\Cond	C% Cal/Exp	H% Cal/Exp	N% Cal/Exp	M% Cal/Exp
BMA	$C_{17}H_{16}N_6O$	320	Off White	155	-	63.74 64.01	5.03 5.21	26.23 26.43	-
BMS	$C_{21}H_{17}NO_4$	347	yellow	152	-	72.61 72.13	4.93 4.57	4.03 3.98	-
1	Zn C_{38} $H_{38}N_{12}O_6$	823	Pale yellow	140	87	55.4 55.5	4.61 4.87	20.41 21.00	9.26 8.49
2	Zn C_{34} $H_{30}N_{12}O_2$	703	Pale yellow	144	16	57.87 57.99	4.53 4.93	23.82 24.03	9.28 8.98
3	Mn C_{38} $H_{38}N_{12}$ O_6	813	Pale yellow	143	79	56.08 55.87	4.67 4.98	20.66 21.04	6.75 6.87
4	Mn C_{34} $H_{30}N_{12}$ O_2	693	Pale yellow	145	11	58.70 59.09	4.60 4.80	24.17 23.99	7.92 8.06
5	Ag C_{34} $H_{32}N_{13}$ O_5	810	Pale yellow	149	35	50.37 51.14	3.95 4.23	22.46 22.56	13.30 12.95
6	Ag C_{34} $H_{30}N_{12}$ O_2	746	Pale yellow	137	15	54.54 55.05	4.27 4.33	22.45 23.22	14.45 14.44
7	Zn C_{46} $H_{40}N_2$ O_{12}	877	Pale yellow	135	80	62.94 61.99	4.56 4.65	3.19 3.42	7.44 7.73
8	Zn C_{42} $H_{32}N_2$ O_8	757	Pale yellow	142	16	66.40 66.87	4.47 5.06	3.68 4.12	8.62 8.56
9	Mn C_{46} $H_{40}N_2$ O_{12}	867	Pale yellow	148	77	63.66 64.31	4.61 4.89	3.22 3.76	6.33 7.07
10	Mn C_{42} $H_{32}N_2$ O_8	747	Pale yellow	146	19	67.28 67.66	4.53 5.05	3.73 3.84	7.34 7.44
11	Ag C_{42} $H_{34}N_3$ O_{11}	864	Pale yellow	144	32	58.33 58.06	3.93 4.00	3.24 3.54	12.47 12.82
12	Ag C_{42} $H_{32}N_2$ O_8	800	Pale yellow	141	11	62.84 61.97	4.23 4.33	3.49 3.53	13.47 13.13

4.6. FT-IR

Some important bands of the infrared spectra of BMA ligands and their complexes are listed in **Table 4**. Comparison between bands of ligands and complexes may help to predict useful information **[9]**. The band at 1632-1650 cm^{-1} is due to C=N stretching of the azomethine group, in complexes, this band is observed in the range between (1604 −1621) cm^{-1} which refers to coordination between these groups and the metal ion **[10]**. Another band is observed in the infrared spectra at 1338 cm^{-1} due to C-N pyridine groups· On coordination, this band was observed at the same frequency This demonstrates that is no coordination of the nitrogen atom with the metal ion.

Various local bands 3416-3329 cm^{-1} in ligand due to OH group of benzoin, in complexes, this band is observed in the range between 3318-3435 cm^{-1}, This demonstrates that these groups and the metal ion are coordinated. The band at 3160-3476 cm^{-1} is due to two NH_2 groups stretching in complexes this band is observed in the range between (3109 – 3379 cm^{-1}) which refers to coordination between one of these groups and the metal ion **[10]**.

Some important bands of the infrared spectra of BMS ligand and their complexes. The band at 1617- 1645cm^{-1} is due to C=N stretching groups of Schiff bases in complexes this band is observed in the range between (1598 – 1556) cm^{-1} which refers to coordination between these groups and the metal ion **[10]**. Another band is observed in the infrared spectra of the BMS ligand at 1725-1645cm^{-1} due to C=O groups· On coordination, this band was observed at the same frequency that demonstrates no coordination between the oxygen atom of the C=O groups· with metal ions **[11]**.Other bands in the region 3395 cm^{-1} in ligand due to OH group of Benzoin part. in complexes in a neutral medium this band is observed in the range between 3302-3374 cm^{-1}, This gives an indication there is coordination between this group and the metal ion. The band in the region 2498-3200 cm^{-1} in ligand due to OH group carboxylic acid in complexes this band is observed in lower frequency in the range between 2317-3210cm^{-1}, This gives an indication there is coordination between the oxygen of this group and the metal ion .but this band observed in the same frequency in silver complexes This demonstrates that is no coordination between the oxygen atom with the silver ion. The band in the region 3375 cm^{-1} in ligand due to OH phenolic group this band was observed at the same frequency and demonstrates no coordination between the oxygen atoms and metal ion.

The bands in the range between 415-421 and 450-496cm^{-1} in complexes are due to the M-N and M-O connection which demonstrated the coordination of two nitrogen and Oxygen atoms

with a metal ion [11]. Important Bands in FT- IR spectra of the ligand and their complexes are listed in Table 3.

Table 3: Some Important Bands in FT- IR Spectra

No.	C=N	C=O	C-N $_{Py}$	OH $_{benzoin}$	OH $_{phenol}$	OH, $_{salicylic\ acid}$	NH_2	M-O	M-N
BMA	1650-1632	-	1338	3416-3329	-		3160-3467	-	
BMS	1617-1645	1677	-	3395	3375	2498-3200	-		
1	1604	-	1337	3337-3321	-		3110-3405	479	416
2	1614	-	1337	-	-		3109-3379	480	415
3	1620	-	1338	3404-3318	-		3111-3376	480	416
4	1615	-	1337	-	-		3113-3379	481	416
5	1621	-	1327	3336-3435	-		3466-3125	485	418
7	1634	1678	-	3302	3396	2354-3138	-	460	421
8	1638	1678	-	-	3378	-	-	462	420
9	1648	1678	-	3378	3406	2522-3210	-	481	417
10	1595	1678	-		3409	-	-	482	420
11	1619	1678	-	3374	3394	3217	-	481	416

4.7. UV-VIS

UV-VIS spectroscopy of the complexes is recorded by using dimethyl sulfoxide as a solvent the results refer to the manganese complexes is Hight spin containing (5 electrons in d orbitals) the obtained band was church transfer also $Mn^{+2,}$ $Zn^{+2,}$ and Ag^{+1} complexes [11].as Table 4.

Table 4:UV-VIS ligand bands

No.	Ligand	n → π* cm^{-1}	π → π* cm^{-1}
2	BMA	33783.78	39215.68
3	BMS	34013.60	37453.18

Table 5:UV-VIS of complexes, charge transfer bands

No.	cm^{1-} C.T
1	37313.43
2	37313.43
3	37313.43
4	37037.03
5	36764.70
6	35971.22
7	36496.35
8	32467.53
9	36496.35
10	37037.03
11	35971.22
12	32467.53

4.8. Magnetic properties :

The magnetic sensitivity of the manganese complexes was measured only, where the magnetic moment values proved the presence of five single electrons in the d orbitals, which confirms to us that the manganese complexes have para-magnetic properties and have a highly spiral octahedral geometry, while the zinc and silver complexes have Daya-magnetic properties.

Table 6: magnetic properties values

NO	Molecular structure	D. 10^{-6}	$\chi_g.10^{-6}$	$\chi_M.10^{-6}$	$\chi_A \times 10^{-6}$	μeff B.M	ن ح
3	Mn C_{38} $H_{38}N_{12}$ O_2	398.28	17.41477	14158.20801	14556.48801	5.89	Oh
4	Mn C_{34} $H_{30}N_{12}$ O_2	332.4	17.30034	11989.13562	12321.53562	5.41	Oh
9	Mn C_{46} H_{40} N_2 O_{12}	464.4	16.86179	14619.17193	15083.57193	5.99	Oh
10	Mn C_{42} H_{32} N_2 O_8	398.52	17.79901	13295.86047	13694.38047	5.71	Oh

4.9. H^1-NMR

The H -NMR spectra of the ligand are recorded by using deuterated dimethyl sulfoxide as an internal reference. The results as following bands appeared at chemical shifts supporting the structure of the ligand under investigation [11]. The spectrum was recorded using deuterated dimethyl sulfoxide as a solvent and at a frequency equal to 400 MHZ.

4.9.1. BMA Giving Nuclear Magnetic Resonance Data:

($CDCl_3$, 400 MHZ) ^{1}H NMR (400 MHz, $CDCl_3$, δ, ppm):

(1H, s, C*H*) δ: 6.06 ppm).

(H, m, OH), δ: 6.10 ppm).

(10H, m, Ar-*H*), δ: 7.24 – 8.02ppm). :

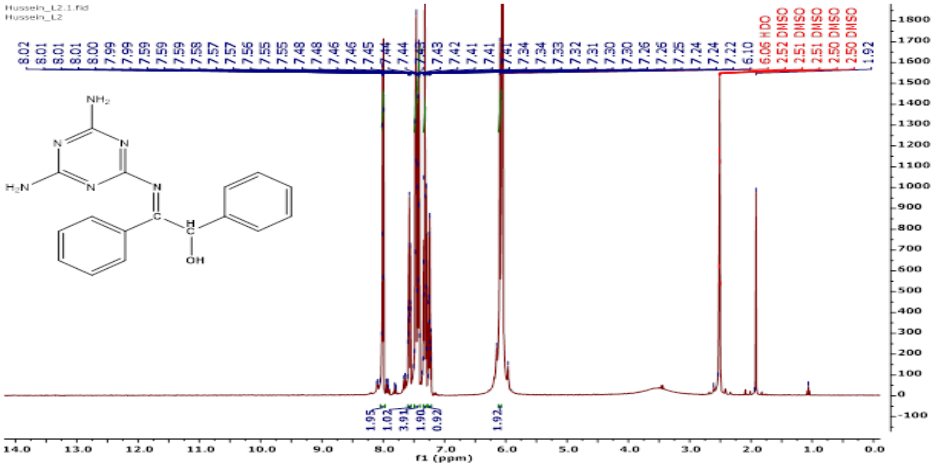

Fig 5: BMA Nuclear Magnetic Resonance

4.9.2 BMS Giving Nuclear Magnetic Resonance Data ($CDCl_3$, 400 MHZ)

1H NMR (400 MHz, $CDCl_3$, ,):

1H, s, C*H*) δ: 6.07 ppm).

(1H, s, O*H cholic*) δ: 6.71 ppm).

(2H, m, AR-*H*), δ: 7.17 – 8.01ppm).

(1H, s, O*H phenol*) δ:6.73 ppm

(1H, s, O*H carboxylic*) δ: 10.4 ppm).

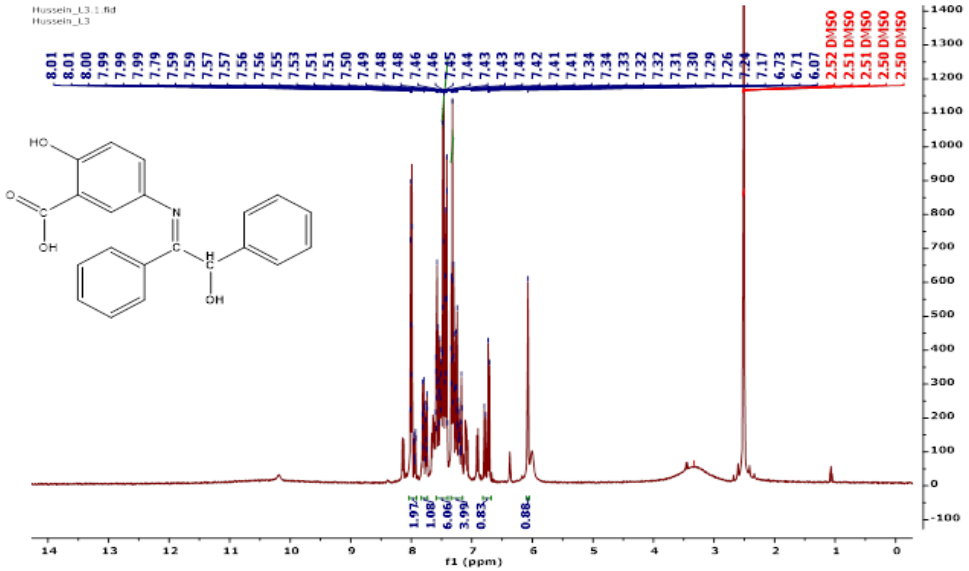

Fig 5: BMS Nuclear Magnetic Resonance

4.10. GC-MASS :

The suggested compounds of GC-MASS type Agilent GC-MS/ Turkey approach 90% of prepared compounds.

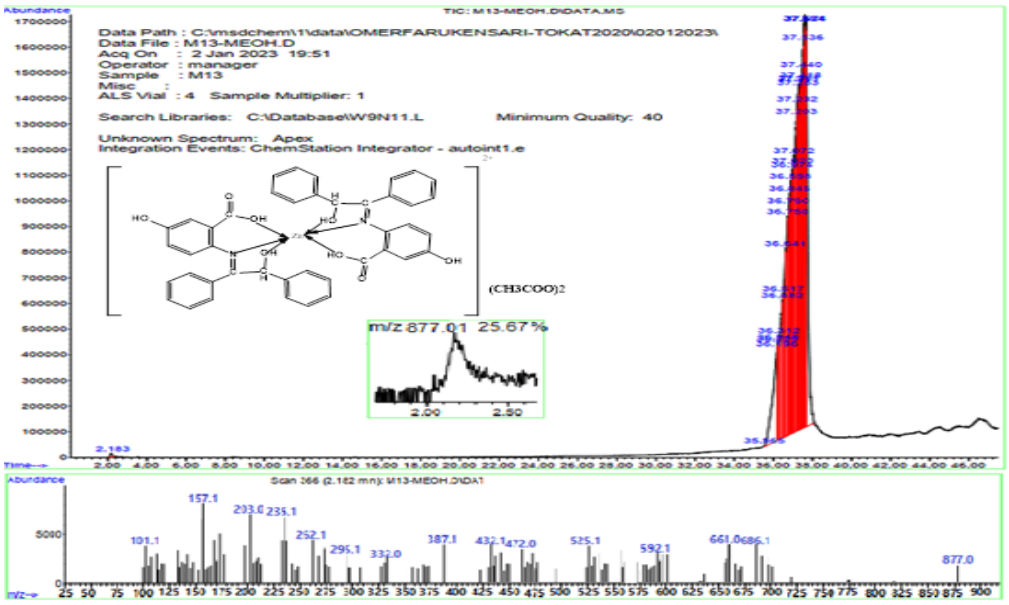

Fig 6: GC-MASS of complex NO.7

4.11. Biological Activity

A variety of bacteria, including "*Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, and Klebsiella spp*.," were used to screen the antibacterial properties of the ligand and their metal complexes The -C=N- group of the cell enzyme was one of the examined complexes that were engaged in a competitive equilibrium. **[12]** The molecules that were predicted to be attached to the cell enzyme's -OH group in this instance had a stronger reaction than the oxygen in the ligand's donor atom effect.

An active diffusion technique was used in agar plates to evaluate the synthesized ligand and complexes that were dissolved in DMSO **[13]**. After that, the plates were incubated for 24 hours at 37^{o}C. The zones of inhibition were measured in millimeters following the incubation period. The ligand and metal complexes showed impressive antibacterial properties **[14]**.

Table 7:Antibacterial activity (inhibition zone) of different concentrations of the ligand and complexes (µg/mL)

Compound	***Staphylococcus aureus***			***Escherichia coli***			***Psudomonus auruginosa***			***Klebsiella spp***		
Cons\µg	125	250	500	125	250	500	125	250	500	125	250	500
BMA	10	14	17	9	11	13	10	12	15	11	14	15
BMS	9	16	18	9	13	15	8	11	14	8	9	9
1	9	10	13	6	12	13	7	11	13	9	11	14
2	7	11	15	7	11	12	8	10	12	8	14	11
3	8	12	14	8	9	9	6	10	11	9	15	13
4	9	11	14	8	14	17	7	12	11	7	14	17
5	8	14	11	6	8	9	7	15	16	9	13	18
6	9	15	13	6	13	14	8	9	12	8	14	17
7	7	14	17	8	12	12	8	12	11	7	11	15
8	9	13	18	8	14	18	9	12	19	9	12	18
9	8	14	17	7	12	19	8	14	18	8	11	21
10	7	11	15	8	16	18	7	16	20	7	9	12
11	7	12	19	7	11	17	6	13	20	7	10	18
12	8	10	17	9	17	20	7	12	18	8	11	19
CIPS	10			10			10			10		
TMP	12			4			10			0		

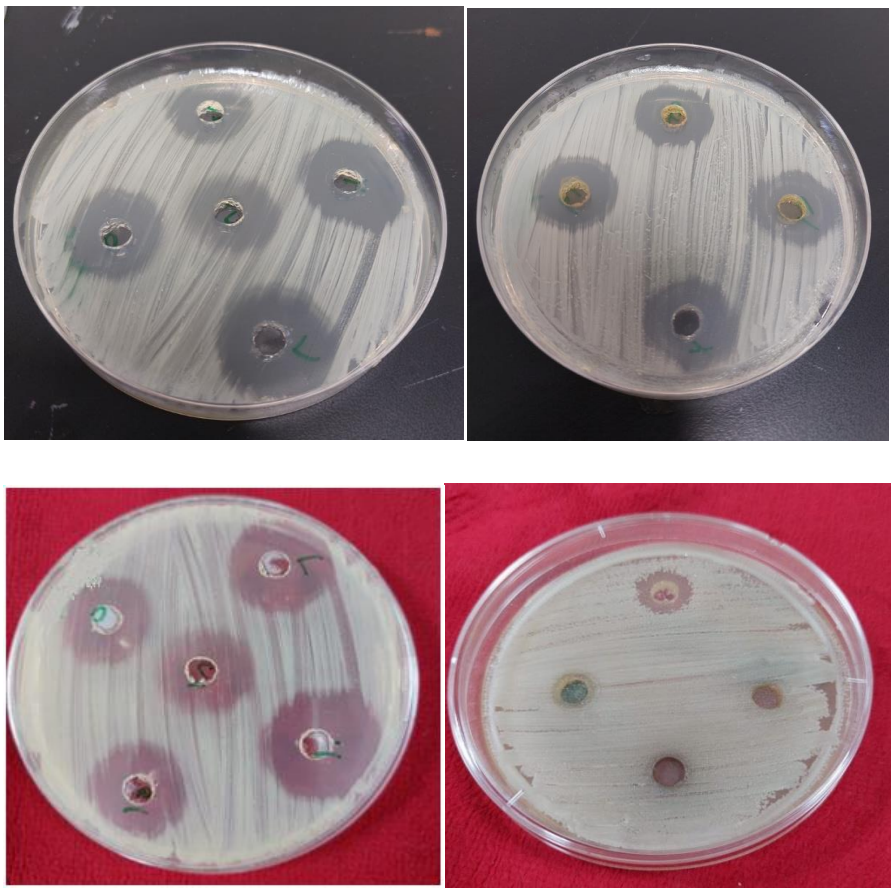

Fig 7: petri dish showing the inhibition zone of different bacteria

5. Conclusion.

According to the analytical, physical, and spectral results the data observed have established the following points: Both ligands BMA and BMS acted as tridentate chelating ligands, joined to the metal ion through the nitrogen and oxygen atoms.in neutral and basic medium All the resulting complexes in the neutral medium were ionic and had the formula [M $(L)_2$]$(X)_2$, X= NO_3 or CH_3COO, and having the formula [M $(L)_2$] basic medium. Zn^{++}, Mn^{++} (II), and Ag^{+} complexes of Zn^{++}, and Mn^{++} were proposed to be hexa-coordinated and forming octahedral geometries. But Ag^{+} complexes were proposed to be tetra-coordinated and form tetrahedral geometries The ligand and metal complexes showed very good antimicrobial properties.

6. References

[1] Shakir M, Hanif S, Sherwani MA, Mohammad O, Azam M, Al-Resayes SI. Pharmacophore hybrid approach of new modulated bis-diimine CuII/ZnII complexes based on 5-chloro Isatin Schiff base derivatives: Synthesis, spectral studies and comparative biological assessment.

Journal of Photochemistry and Photobiology B: Biology. 2016;157:39-56. doi.org/10.1016/j.jphotobiol.2016.01.019

[2] Kuchana M, Telu K. SYNTHESIS OF NOVEL 5-AMINOSALICYLIC ACID SCHIFF BASES BY GRINDING METHOD: EVALUATION FOR IN VITRO ANTIOXIDANT AND ANTIBACTERIAL ACTIVITIES. International research journal of pharmacy. 2018;8:99-103. DOI: 10.7897/2230-8407.0812256

[3] Elmacı G, Duyar H, Aydıner B, Seferoğlu N, Naziri MA, Şahin E, et al. The syntheses, molecular structure analyses, and DFT studies on new benzil mono hydrazone-based Schiff bases. Journal of Molecular Structure. 2018;1162:37-44. https://doi.org/10.1016/j.molstruc.2018.02.035

[4] Abendrot M, Chęcińska L, Kusz J, Lisowska K, Zawadzka K, Felczak A, et al. Zinc (II) complexes with amino acids for potential use in dermatology: Synthesis, crystal structures, and antibacterial activity. Molecules. 2020;25(4):95 https://doi.org/10.3390/molecules25040951

[5] Guven O, Ciftci H, Tateishi H, Koga R, Radwan MO, Sever B, et al. Structural Characterization of TRAF6 N-terminal for Therapeutic Uses. bioRxiv. 2023:2023.02. 25.529911. doi: https://doi.org/10.1101/2023.02.25.529911

[6] Mohapatra RK, Kudrat-E-Zahan M. Antimicrobial activity of Mn complexes incorporating Schiff bases: A short review. Scientific Reviews and Chemical Communications. 2019;5:27-36 doi: 10.11648/j.ajhc.20190502.12.

[7] Abed RR, Ahmed AE. Some complexes of Zink (II) and Manganese (II) with Schiff base derived from nicotinamide, synthesis and characterization, and antibacterial evaluation. Research Journal of Pharmacy and Technology. 2021;14(3):1711-5 DOI : 10.5958/0974-360X.2021.00304.8.

[8] Geary WJ. The use of conductivity measurements in organic solvents for the characterization of coordination compounds. Coordination Chemistry Reviews. 1971;7(1):81-122. https://doi.org/10.1016/S0010-8545(00)80009-0

[9] KULAKSIZOĞLU S, GÖKÇE C, GÜP R. Synthesis and characterization of bis (azine) ligands and metal complexes: DNA-interaction and extraction properties for metals and dichromate anions. Turkish Journal of Chemistry. 2012;36(5):717-33. doi:10.3906/kim-1110-3 36.

[10] Badertscher M, Bühlmann P, Pretsch E. Structure determination of organic compounds: Tables of Spectral Data: Springer; 2009. ISBN: 978-3-540-93810-1

[11] Nakamoto K. Infrared and Raman spectra of inorganic and coordination compounds, part B: applications in coordination, organometallic, and bioinorganic chemistry: John Wiley & Sons; 2009. ISBN: 978-0-471-74339-2.

[12] Jaividhya P, Ganeshpandian M, Dhivya R, Akbarsha MA, Palaniandavar M. Fluorescent mixed ligand copper (II) complexes of anthracene-appended Schiff bases: studies on DNA binding, nuclease activity, and cytotoxicity. Dalton Transactions. 2015;44(26):11997-2010. DOI:10.1039/c5dt00899a

[13] Shahid SM, Umar N. Spectrum of antimicrobial susceptibility of E. coli and Staphylococcus aureus isolates from clinical samples. Research Journal of Pharmacy and Technology. 2015;8(10):1399-402. doi: 10.5958/0974-360X.2015.00251.6

[14] Bashar A, Mannan A, Hossen F, Islam MS. The synthesis, characterization and biological activity investigation of mixed ligand Coordinated Ni (II) Complexes. Asian Journal of Research in Chemistry. 2015;8(1):56-9. DOI: *10.5958/0974-4150.2015.00012.7*

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Rapid diagnostic test for renal failure accompanying toxic digitalis heart failure patients by estimating Na, K in serum.

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Keywords: Digoxin, Heart failure, Renal function.

Article History

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Abstract:

This study was undertaken to compare the electrolytes K, and Na levels serum of (67) toxic digitalis uremic heart failure patients and their levels in the serum of 50 digitalis (not toxic) heart failure patients.

The electrolyte level of K and Na was found to be very low and severe hyponatremia and hypokalemia in the serum of toxic uremic and heart failure patients while their levels were found to be near normal values or slightly higher in digitalis heart failure patients. This study does not support that digoxin might have a protective effect against renal dysfunction in heart failure patients.

Keywords: Digoxin, Heart failure, Renal function.

تشخيص سريع لمرضى عجز الكلية المصاحب لعجز القلب وبحالة تسمم بالديجوكسين باستخدام قياس الصوديوم والبوتاسيوم في مصل الدم

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تم مقارنة مستوى الالكتروليتات الصوديوم والبوتاسيوم في مصول ٦٧ مريض بعجز القلب المصاحب لعجز الكلية وبحالة تسمم بعقار الديجوكسين مع مستواهما في مصول ٥٠ مريضاً بعجز القلب وبدون حالة تسمم بعقار الديجوكسين حيث أن مستوى البوتاسيوم والصوديوم منخفض جداً في حالة التسمم بالديجوكسين المصاحب لعجز الكلية بينما يكون مستوى الصوديوم والبوتاسيوم طبيعياً في حالة عجز القلب والمسيطر عليه بواسطة عقار الديجوكسين بدون حالة تسمم.

الكلمات المفتاحية: عجز الكلية، عجز القلب، الديجوكسين.

1. INTRODUCTION:

Uremic patients are particularly sensitive to digitalin because they excrete less digoxin than patients with normal renal function and often cannot take even the usual therapeutic doses without developing digitalin toxicity. Delay or diminished excretion of digoxin can lead to toxicity [1], and accumulation can occur in severe kidney dysfunction, leading to digoxin toxicity and potentially cardiac arrhythmias [2] Consequently, changes in its metabolism might increase the risk of toxicity and effects. Such changes may occur in elderly patients, patients treated concomitantly with concurrent drugs [3] kidneys regulate sodium and water excretion and thereby play a dominant role in the long—term control of blood pressure natriuresis and diuresis and it secretes several vasoactive hormones [4]. Digoxin has a narrow therapeutic window and therefore needs to be carefully dosed according to age, weight, and renal function, and then subsequently monitored [5].

The guidance also advises frequent monitoring in patients taking thiazide diuretics alongside aldosterone antagonists, as well as advising monitoring of potassium when digoxin is prescribed concurrently, but no frequency is specified. [6] mortality increases with increasing serum digoxin levels. The sodium/potassium ATPase pump normally causes sodium to leave cells and potassium to enter cells, blocking this mechanism using digoxin results in higher serum potassium levels and a decline in renal function [7], the damage to the kidney occurs and this clinical picture is called uremia [8].

A diagnostic test for digitalis toxicity based on the interpreted changes i.e. (electrolyte changes) in saliva was first developed by Watman et al., (1971) [9] and widely investigated

[10] hypokalemia and hypomagnesemia in patients receiving digitalis were under continuous investigation many workers attempted to find a correlation between electrolyte concentration and digitalis toxicity in the serum of digitalized patients [11]. A study by AL-Sammarieyet al., (1998) suggests a method for. identifying patients with digitalis toxicity from the elevation of electrolyte (K, Ca, and Na) concentration in saliva [12].

The present study was undertaken to compare the electrolyte K and Na levels in the serum of digitalis heart failure patients and digitalis uremic heart failure patients.

2. MATERIALS AND METHODS:

Heart failure patients receiving digoxin drugs were studied and all patients with clinical uremia and heart failure digitalis toxicity were diagnosed by the physician. All patients were lying down in Baghdad Medical City Teaching Hospital. All patients were admitted for one week on a hospital diet. The dose of the digoxin drug was 0.25mg /day. They were receiving other drugs such as diuretics and KCl drugs. Serum potassium was maintained at the physiological level by KC1 drug or potassium given in infusion.

The serum was separated and centrifugated and estimated for K and Na levels by using EEL. Flame photometer. In the same way, the Na, and K levels were estimated in the serum of normal persons for comparison.

3. Statistical analysis

One-way analysis of variance followed by Newman-Keuls post hoc test comparison procedures was used to compare between means of different groups. Data are represented as the mean± standard error (M±SE). GraphPad Prism program, version 6.01, a computer program was used for statistical analysis. $P<0.05$ was considered statistically significant.

4. Results:

Table 1: Electrolyte K, Na in digitalis uremic. H.F. patients

	Normal Values	Digitalis Patient	Sever toxic Digitalis H.F. and uremic
K Me Eq/L.	3.3±_0.6 2.7—.9	4.5_±_0.4 4.1 -5	2.3 ±0.35 2.0—2.7
Na Me Eq/L.	141 ± 6 13:5- 146	151±19 132—170	84.5±17 87—102

Table 1 shows the mean values of electrolyte K, Na [12] digitalin heart failure patient, and digitalin H . F. uremic patient as follows: -

The mean values of K in the serum of digitals patient without poisoning was (4.5 ± 0.41) with a range of (4.1 — 5) Me Ed / L. The values obtained here are near normal values or slightly higher.

In toxic digitalis uremic patients, the mean values of K were very low, and hypokalemia was found to be in the range (2.35 ± 0.35) (2 —2.7), respectively the mean values of Na in the serum of digitalin patients were (151 ± 19) and ranged from (132 — 170) which. was within the normal value. A few cases were hypernatremia while in severe- digitalis uremic heart failure the mean value was (84.15 ± 17) with a range of (87 — 102) in which severe hyponatermia was occur.

5. Limitations:

This was a retrospective analysis of patients with heart failure and therefore there may be confound in factors contributing to the changes in renal function. Patients may have other co-morbidities such as hypertension and diabetes which may contribute to impaired renal function.

6. Discussion:

The present study shows a significantly lower value of K in the serum of digitalis uremic heart failure patients in comparison with digitalis heart failure patients in which the K and Na levels in the serum were controlled and about normal values while they were higher in toxic digitalis cases The sodium/potassium ATPase pump normally causes sodium to leave cells and potassium to enter cells, blocking this mechanism using digoxin results in higher serum potassium level [8]. Hypo kalmia may be related to the lowered blood and tissue potassium when the patient is treated with potassium-losing diuretics [13].

Severe heart failure may exhibit a reduced capacity to excrete water load which may result in dilutional hyponatremia [14]. Excessive water or insufficient salt intake leads to hyponatremia while a supply of an inadequate volume of water reduces urine volume ln uremic patients [15]. Also, the long-continued osmotic diuresis interferes with distal tabular function resulting in some increasing loss of sodium and potassium in the urine leading to hyponatremia and hypokalemia [16].

7. Conclusions:

The electrolyte level of K and Na was found to be very low and severe hyponatremia and hypokalemia in the serum of toxic uremic and heart failure patients while their levels were found to be near normal values or slightly higher in digitalis heart failure patients so it can be used as a rapid diagnostic test for renal failure accompanying toxic digitalis heart failure patients by estimating Na, K in serum. This study does not support that digoxin might have a protective effect against renal dysfunction in patients with heart failure.

8. References:

[1] Arbeit S, Landau T. Recognizing digitalis toxicity. Am J Nurs. 1977;1936.

[2] Shlipak MG, Smith GL, Rathore SS, Massie BM, Krumholz HM. Renal function, digoxin therapy, and heart failure outcomes: evidence from the digoxin intervention group trial. J Am Soc Nephrol. 2004;15:2195-203.

[3] Kern N, Castellsague J, Perlman GD, Ostfeld A. Incidence of hospitalization for digitalis toxicity among elderly Americans. Am J Med. 1994;96:426-31.

[4] Blumenfeld JD. Renal and cardiac complications of hypertension. Clin Symp. 1994;46(4):1-2.

[5] Falk V, González-Juanatey JR, Harjola VP, Jankowska EA, Jessup M, Linde C, et al. ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure. Eur Heart J. 2016;18:891-975.

[6] National Institute for Health and Care Excellence (NICE). Chronic heart failure in adults: management (CG108). NICE. 2010. Available from: https://www.nice.org.uk/guidance/cg108 (last accessed 29 August 2017).

[7] Shah et al. The effect of digoxin on renal function in patients with heart failure. BMC Nephrol. 2021;22:349. Available from: https://doi.org/10.1186/s12882-021-02562-0

[8] Houston JC. A short textbook of medicine. Selwyn Taylor. 1973;376.

[9] Watman S, Biggai J, Mandels ID. The New Eng J Med. 1971;285(16):871-6.

[10] Avissar R, Menach R, Mandel EM, Rubinstein J. Intern Med. 1975;135:1020.

[11] Whong RO, Oei TO, Wataman S. Arch Intern Med. 1985;145(14):655.

[12] Al-Sammaricy MT, Al-Mashhadany FA, Al-Ekabe MA. Ibn Al-Haitham Pure Appl Sci. 1998;9:1.

[13] Braunwald E, Isselbacher KJ, Wilson JD. Principles of Internal Medicine. 11th ed. Harrison's. 1987;105.

[14] Braunwald E, Isselbacher KJ, Wilson JD. Principles of Internal Medicine. 11th ed. Harrison's. 1987;907.

[15] Livingstone D. Textbook of medical treatment. 10th ed. Sir Derrick Dunlop. 1966;752-6.

[16] Houston JC. A short textbook of medicine. Selwyn Taylor. 1973;375.

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Generation S-box and P-layer For PRESENT Algorithm Based On 6D Hyper Chaotic System

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Keywords: S-Box, P-Layer, random generation,6D 6D Chaotic System, PRESE Block cipher.

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Abstract:

In the era of data-driven applications and resource-constrained devices, the need for lightweight algorithms has become increasingly important. Lightweight algorithms refer to computational techniques that strike a balance between efficiency and resource utilization, making them well-suited for low-power devices, embedded systems, and scenarios with limited computational capabilities. For the new encryption method PRESENT, which was put forth in 2007, S-box directly affects the algorithm's security, whereas the p-layer mostly functions as a confusing factor during the encryption process. This paper provides a brief explanation of the PRESENT algorithm's operation and suggests an enhanced S-box and p-layer to address the issue that the main PRESENT S-box and P-layer have an anti-fixed point. The random generate of S-boxes and P-layers for PRESENT algorithms using 6D chaotic systems to generate 10 new S-boxes and 10 new P-layers. Finally, the security analysis has been completed, and the results indicate that the chaos S-box and P-layer are better able to with stand differential attacks and linear assaults and are suitable for protecting sensitive data.

Keywords: S-Box, P-Layer, random generation, 6D Chaotic System, PRESENT, Block cipher.

التوليد العشوائي S-BOX و P-LAYER لخوارزميات PRESENT باستخدام أنظمة فوضوية D6 لتوليد عشرة S-BOX جديدة و عشرة P-LAYERS جديدة

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في عصر التطبيقات القائمة على البيانات والأجهزة ذات الموارد المحدودة، أصبحت الحاجة إلى خوارزميات خفيفة الوزن ذات أهمية متزايدة. تشير الخوارزميات خفيفة الوزن إلى التقنيات الحسابية التي تحقق التوازن بين الكفاءة واستخدام الموارد، مما يجعلها مناسبة تمامًا للأجهزة منخفضة الطاقة والأنظمة المضمنة والسيناريوهات ذات القدرات الحسابية المحدودة. بالنسبة لطريقة التشفير الجديدة PRESENT، والتي تم طرحها في عام ٢٠٠٧، يؤثر S-BOX بشكل مباشر على أمان الخوارزمية، بينما تعمل P-LAYER في الغالب كعامل مربك أثناء عملية التشفيرK تقدم هذه الورقة شرحًا موجزًا لعملية خوارزمية PRESENT وتقترح وجود S-BOX وP-LAYER محسّنًا لمعالجة المشكلة المتمثلة في أن PRESENT S-BOX يحتوي على نقطة مقاومة ثابتة. التوليد العشوائي S-BOX وP-LAYER لخوارزميات PRESENT باستخدام أنظمة فوضوية D٦ لتوليد عشرة S-BOX جديدة وعشرة P-LAYERS جديدة. أخيرًا تم الانتهاء من تحليل الأمان، وتشير النتائج إلى أن الفوضى S-BOX وP-LAYER أكثر قدرة على تحمل الهجوم التفاضلي والاعتداء الخطي ومناسبان لحماية البيانات الحساسة.

الكلمات المفتاحية: S-BOX، P-LAYER، التوليد العشوائي ، نظام الفوضى D6، خوارزميات التشفير PRESENT.

1. INTRODUCTION:

The Internet of Things (IoT) is a transformative force that connects interconnected physical objects, enabling seamless communication and data exchange [1]. Encryption is crucial for data security and privacy in IoT ecosystems [2], [3]. Lightweight block ciphers are popular for securing IoT devices and communications, as they are computationally efficient and require minimal hardware and memory resources [4], [5]. These ciphers strike a balance between security and efficiency, using techniques like substitution-permutation networks, bitwise operations, and compact key schedules [4], [6]. Cryptography and secure communication techniques ensure the confidentiality and integrity of sensitive information [7], [8]. One such technique is substitution-permutation (SP) networks, which consist of two components: S-boxes and P-layers[7]. S-boxes introduce nonlinearity into the encryption process, making it more resistant to cryptanalysis techniques [9], [10]. P-layers, also known as permutation layers, enhance the diffusion of information throughout the encryption process, achieving higher security and resistance against attacks [11], [12]. The

hybridization of lightweight systems and chaotic dynamics aims to leverage the strengths of both approaches [13], [14]. By combining lightweight algorithms with chaotic behavior, it becomes possible to achieve enhanced security, robustness, and efficiency in resource-constrained environments [13], [15]. This integration allows for the development of novel encryption schemes, data-hiding techniques, and optimization algorithms that can withstand cryptographic attacks, adapt to changing environments, and operate effectively with limited resources [13], [15].

The 6D-chotic system [16].Combines chaos theory with substitution and permutation principles, employing S-boxes and P-layers in a unique way [17], [18]. This approach offers advantages in security, efficiency, and resistance to attacks, enhancing the robustness and effectiveness of encryption techniques and protecting sensitive data in various applications [13].

2. Research Methods:

A. Chaotic System

Chaos, is sometimes known as the "butterfly effect [16].Is a phenomenon that results from the complex, aperiodic behavior of deterministic systems that exhibits remarkable sensitivity to minute changes in initial conditions [15].In the framework of Shannon's confusion and diffusion principles, this characteristic of chaos has been used in cryptography [13]. Chaotic events have demonstrated potential as a source of pseudo randomness in information security by utilizing their mixing property and great sensitivity to tiny fluctuations [2], [13], [17]. Due to their deterministic character, chaotic maps—nonlinear dynamical systems that display chaotic behavior—have proven to be especially helpful in the field of cryptography. Numerous cryptographic applications, such as picture encryption methods, and block and stream ciphers, have been made more secure by researchers using these chaotic system properties [2], [4]. Hyper chaotic behavior can be seen in the six-dimensional hyper chaotic system. It can be formulated mathematically as Eq. (1) [16].

$$\begin{aligned} \dot{x} &= -ax + by + cw - dv \\ \dot{y} &= ex - fxz - ge^{v} \\ \dot{z} &= -hz + xy + iv \\ \dot{w} &= -w - yz - gv \\ \dot{v} &= x + jy - iz \end{aligned} \qquad (1)$$

$$\dot{u} = kx - Lu - jzw$$

The system outlined in Eq. (1) has seven states, including x, y, z, w, v, u, and t R, and exhibits hyper chaotic behavior. The constants for the following parameters are all positive: a, b, c, d, e, f, g, h, i, j, k, and l **[16].**

B. PRESENT Algorithm:

Is a simple block cipher developed for restricted settings, such sensor networks and RFID tags. It supports key sizes of 80 or 128 bits and works with 64-bit blocks of data. In order to achieve non-linearity, PRESENT employs an S-box and a substitution-permutation network (SPN) topology **[4]**.

In **Table 1**, a lookup table called the PRESENT S-box is displayed. It accepts a 4-bit input and generates a 4-bit output **[19]**.

Table 1: PRESENT algorithm of the S-box table

X	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
S(x)	C	5	6	B	9	0	A	D	3	E	F	8	4	7	1	2

In PRESENT algorithm, the P-layer (Permutation layer) is a diffusion operation that operates on the output of the S-box substitution. It is a simple transposition layer that reorders the bits within a 64-bit block is shown in **Table 2 [4],[19]**.

Table 2: PRESENT algorithm of the Player substitution table

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
p(i)	0	16	32	48	1	17	33	49	2	18	34	50	3	19	35	51
i	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
p(i)	4	20	36	52	5	21	37	53	6	22	38	54	11	27	43	59
i	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
p(i)	8	24	40	56	9	25	41	57	10	26	42	58	11	27	43	59
i	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
p(i)	12	28	44	60	13	29	45	61	14	30	46	62	15	31	47	63

3. Proposed Method:

The suggested encryption method uses a hybrid technique to safely encrypt a variety of data types, including photos, text, documents, and videos. The proposed scheme constructs 10 new S-boxes and 10 new P-layers to enhance the security of the encryption process. The input initial state parameters x, y, z, w, v, u, t R, a, b, c, d, e, f, g, h, i, j, k, and l, as given in Eq. (1), are used to produce the S-boxes and P-layer. Calculations and hexadecimal code conversions are performed on the values of xi, yi, zi, wi, vi, and ui. For each number, the first five digits, ranging from 7 to 11, are extracted, and duplicates are checked and eliminated. The resulting cipher text is highly secure and suitable for protecting sensitive data. Show in **Figure 1**.

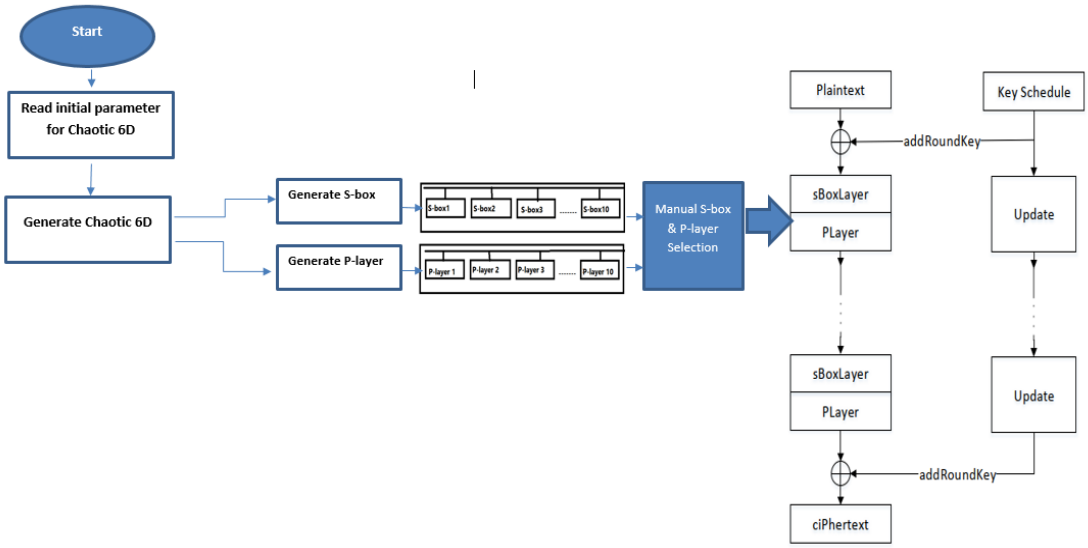

Figure 1: Random Generate S-box and P-layer For PRESENT Algorithm Based on Chaotic 6D

Algorithm 1 :S-Box Generation:

Input: SBox=[0xc,0x5,0x6,0xb,0x9,0x0,0xa,0xd,0x3,0xe,0xf,0x8,0x4,0x7,0x1,0x2],

Initial parameter for Chaotic 6D: a = 18, b = 16, c = 0.5, d = 5.3, e = 32, f = 9, g = 5,

h = 2, i = 4.1, j = 3, k = 12, l = 4

Output: generate Ten S-box

1-Start

2-Read parameters x, y, z, w, v, u, and dt R, as well as Eq. (1)

3-Generate Chaotic 6D

4-index=0,

5- **While(index<10)**

6- i=0 , SBoxv =[]

7- While (i <16)

8- The xi, yi, zi, wi, vi, and ui numbers are computed and translated to hexadecimal form. For each number, the first five digits (7 to 11) are retrieved, and any duplicates are verified for and eliminated.

9- If (S[i] contents in SBox [])

a-Yes, i=i+1 , if(i<6) , yes-move to step 9, no- move to step 3

b. **No**, SBoxv[index]=S[i], index=index +1,

10- End.

Algorithm 2 :P-layer Generation:-

Input: PBox = [0,16,32,48,1,17,33,49,2,18,34,50,3,19,35,51,

4,20,36,52,5,21,37,53,6,22,38,54,7,23,39,55,

8,24,40,56,9,25,41,57,10,26,42,58,11,27,43,59,

12,28,44,60,13,29,45,61,14,30,46,62,15,31,47,63]

Initial parameter for Chaotic 6D: a = 18, b = 16, c = 0.5, d = 5.3, e = 32, f = 9, g = 5

h = 2, i = 4.1, j = 3, k = 12, l = 4

Output: generate Ten P-Layer

1-Start

2-Read parameters x, y, z, w, v, u, and dt R, as well as Eq. (1)

3-Generate Chaotic 6D

4-index=0,

5- **While(index<10)**

6- i=0 , PBoxv =[]

7- While (i <64)

8- The xi, yi, zi, wi, vi, and ui numbers are computed and translated to hexadecimal form. For each number, the first five digits (11 to 15) are retrieved, and any duplicates are verified for and eliminated.

9- If (S[i] contents in PBox [])

a-Yes, i=i+1 , if(i<6) , yes-move to step 9, no- move to step 3

b. **No**, PBoxv [index]=S[i], index=index +1,

10- End.

4. Results and Calculations:

On a machine running 64-bit Windows 10 Home with an Intel Core i5-6300U processor clocked at 2.40 GHz to 2.50 GHz, 8 GB of RAM, and the Python programming language, the proposed solution was experimentally tested. the proposed solution was experimentally tested to generate 10 new S-box and inverse S-box in **Figure 2**,and to generate 10 new P-layer and inverse P-layer respectively as shown in **Figure 3**, **4**, and **Figure 5**.

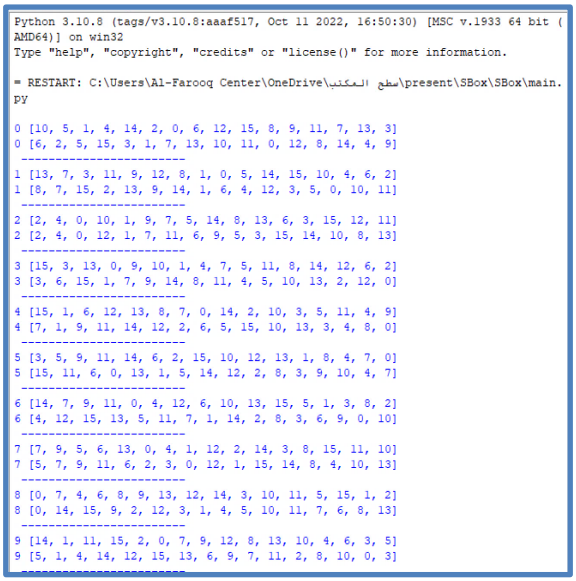

Figure 2: Radom generation S-box and inverse

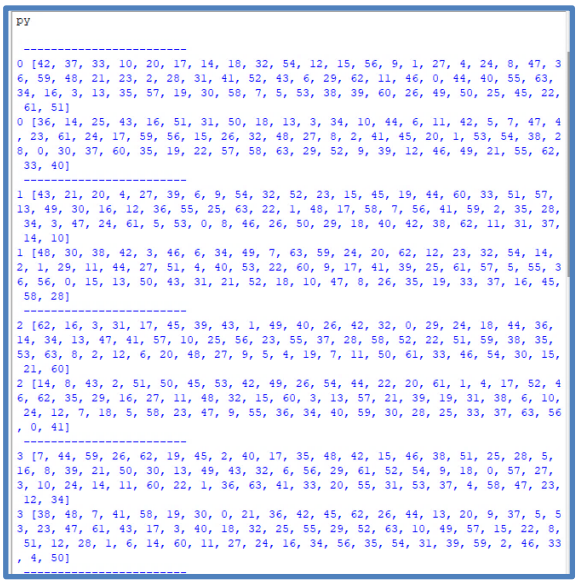

Figure 3: Radom generation P-layer and inverse

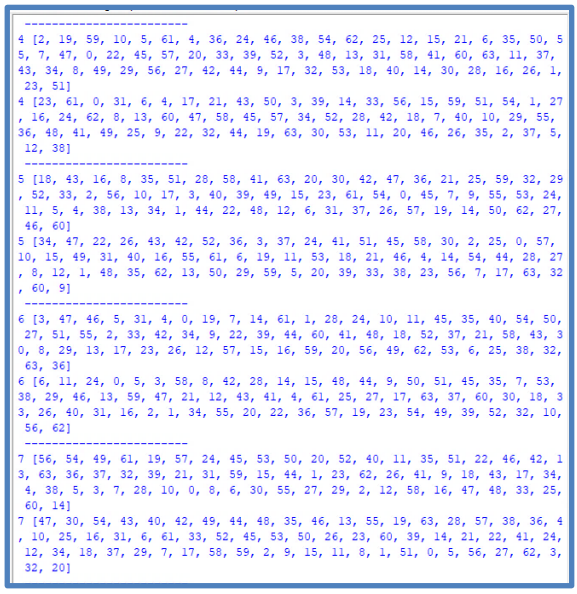

Figure 4: Result 3; Radom generation P-layer and inverse

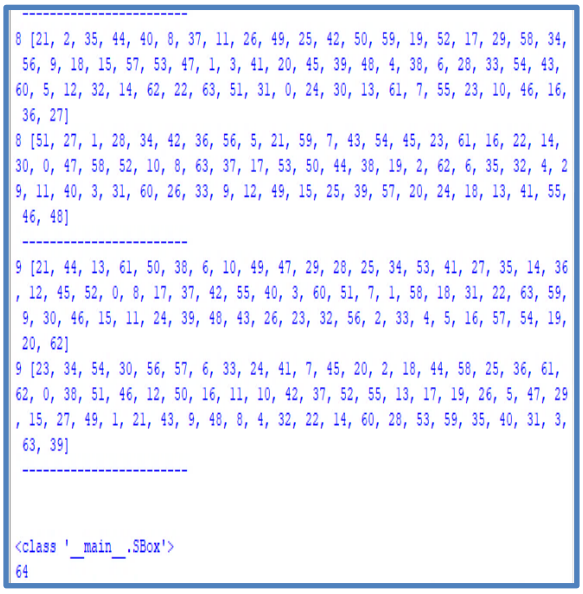

Figure 5: Result 4; Radom generation P-layer and inverse

5. Conclusion

The random generation of an S-box and a P-layer is a common technique used in cryptography to enhance the security of symmetric key algorithms. The main PRESENT S-box and P-layer have an anti-fixed point, which is resolved by the random generation of S-boxes and P-layers for PRESENT algorithms using a 6D chaotic system; the algorithm's resistance to differential and linear assault has been well established. we introduce additional unpredictability and confusion into the encryption process. This randomness makes it more difficult for an attacker to analyze and exploit patterns in the data. It enhances the resistance against various cryptographic attacks, such as differential cryptanalysis and linear cryptanalysis. It increases complexity and makes it more challenging for attackers to decrypt encrypted data.

6. Reference:

[1] Naru ER, Saini H, Sharma M. A recent review on lightweight cryptography in IoT. Proceedings of the International Conference on IoT in Social, Mobile, Analytics and Cloud, I-SMAC 2017. 2017. p. 887-90. doi: 10.1109/I-SMAC.2017.8058307.

[2] Rashid AA, Hussein KA. Image encryption algorithm based on the density and 6D logistic map. Int J Electr Comput Eng. 2023;13(2):1903-13. doi: 10.11591/ijece.v13i2.pp1903-1913.

[3] Jasim OA, Hussein KA. Parallel key generation based on nonlinear feedback shift registers and hyper chaotic system. 2021. p. 1-8.

[4] Bogdanov A, Knudsen LR, Leander G, Paar C, Poschmann A, Robshaw MJ, et al. PRESENT: An ultra-lightweight block cipher. 2007. p. 450-66.

[5] Said G, Shahab M, Ali M, Ahmed A, Aijaz A, Khan M. Lightweight secure aggregated data sharing in IoT-enabled wireless sensor networks. IEEE Access. 2022;10:33571-85. doi: 10.1109/ACCESS.2022.3160231.

[6] Santos JC. Choosing the future of lightweight encryption algorithms. 2018. p. 124.

[7] Wang H, Zheng H, Hu B, Tang H. Improved lightweight encryption algorithm based on optimized S-box. Proceedings - 2013 International Conference on Computational and Information Sciences, ICCIS 2013. 2013. p. 734-7. doi: 10.1109/ICCIS.2013.198.

[8] Rashid AA, Hussein KA. A parallel programming for robust chaotic map generation based on two and dimensional equation system. J Eng Appl Sci. 2019;14(11):3741-5.

[9] Jasim OA, Hussein KA. A hyper-chaotic system and adaptive substitution box (S-Box) for image encryption. 2021 International Conference on Advanced Computer Applications (ACA), Maysan, Iraq, 2021. p. 144-9. doi: 10.1109/ACA52198.2021.9626793.

[10] Taher HM, Abd Al-Rahman SQ, Shawkat SA. Best S-box amongst differently sized S-boxes based on the avalanche effect in the advance encryption standard algorithm. Int J Electr Comput Eng. 2022;12(6):6535-44. doi: 10.11591/ijece.v12i6.pp6535-6544.

[11] Kubba ZM, Hoomod HK. Modified PRESENT encryption algorithm based on new 5D chaotic system. IOP Conf Ser Mater Sci Eng. 2020;928(3). doi: 10.1088/1757-899X/928/3/032023.

[12] Hussein KA, Mahmood SA, Abbass MA. A new permutation-substitution scheme based on Henon chaotic map for image encryption. 2019 2nd Sci Conf Comput Sci. 2019. p. 63-8.

[13] Hoomod HK, Naif JR, Ahmed IS. A new intelligent hybrid encryption algorithm for IoT data based on modified PRESENT-Speck and novel 5D chaotic system. Period Eng Nat Sci. 2020;8(4):2333-45. doi: 10.21533/pen.v8i4.1738.

[14] Mohammed AH, Shibeeb AK, Ahmed MH. Image cryptosystem for IoT devices using 2-D Zaslavsky chaotic map. Int J Intell Eng Syst. 2022;15(2):543-53. doi: 10.22266/ijies2022.0430.48.

[15] Zhou S, Tang Y, Liu Y, Wang X, Zhou X. Novel image cryptosystem based on new 2D hyperchaotic map and dynamical chaotic S-box. Nonlinear Dyn. 2023. doi: 10.1007/s11071-023-08312-1.

[16] Mehdi SA, Ali ZL. A new six-dimensional hyper-chaotic system. 2019 Int Eng Conf. 2021. p. 211-5.

[17] Salman RS, Farhan AK, Shakir A. Creation of S-box based one-dimensional chaotic logistic map: Colour image encryption approach. Int J Intell Eng Syst. 2022;15(5):378-89. doi: 10.22266/ijies2022.1031.33.

[18] Mahmood SA, Hussein KA, Jurn YN, Albahrani EA. Parallelizable cipher of color image based on two-dimensional chaotic system. Indones J Electr Eng Comput Sci. 2019;18(1):101-11. doi: 10.11591/ijeecs.v18.i1.pp101-111.

[19] Tang Z, Liu X, Liu J, Sun X, Xu G. A random PRESENT encryption algorithm based on dynamic S-box. Int J Secur Its Appl. 2016;10(3):383-92. doi: 10.14257/ijsia.2016.10.3.33.

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Optimizing Image Processing with CNNs through Transfer Learning: Survey

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Keywords: Convolutional Neural Networks, CNNs, transfer learning, image processing, deep learning.

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Abstract:

The field of image processing has been revolutionized by Convolutional Neural Networks (CNNs), which exhibit exceptional capability in feature extraction and accurate image classification. However, training CNNs requires large volumes of annotated data and significant computational resources. Considering these challenges, transfer learning has emerged as a promising approach to reducing the dependence on labeled data and computational resources. Transfer learning involves utilizing knowledge gained from a source task to improve the training process for a target task. This technique has demonstrated considerable benefits; however, it also possesses certain limitations. Consequently, this survey explores the advantages and constraints of transfer learning and the various factors that influence its effectiveness in optimizing image processing using CNNs. Additionally, the survey investigates the most recent advancements and research in the field of transfer learning specifically for image processing with CNNs. In summary, this comprehensive analysis highlights the significance of transfer learning in the context of optimizing image processing with CNNs, providing unique insights into this rapidly evolving domain.

Keywords: Convolutional Neural Networks, CNNs, transfer learning, image processing, deep learning.

تحسين معالجة الصور باستخدام الشبكات العصبية العميقة من خلال التعلم النقلي: مسح استقصائي

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شهدت مجال معالجة الصور ثورة بفضل الشبكات العصبية العميقة المُستخدَمة في التعلم التحويلي، حيث تظهر تلك الشبكات قدرة استثنائية في استخراج الميزات وتصنيف الصور بدقة. ومع ذلك، فإن تدريب الشبكات العصبية العميقة يتطلب كميات كبيرة من البيانات المعلَّقة وموارد حسابية مهمة. ونظرًا لهذه التحديات، ظهر التعلم التحويلي كنهج مشجع لتقليل الاعتماد على البيانات الموسومة والموارد الحسابية. ينطوي التعلم التحويلي على استخدام المعرفة المكتسبة من مهمة مصدر لتحسين عملية التدريب لمهمة هدف. وقد أظهرت هذه التقنية فوائد كبيرة؛ ومع ذلك، فإنها تحمل أيضًا بعض القيود. ونتيجة لذلك، يستكشف هذا الاستطلاع المزايا والقيود للتعلم التحويلي، بالإضافة إلى العوامل المختلفة التي تؤثر في فعاليته في تحسين معالجة الصور باستخدام الشبكات العصبية العميقة. وبالإضافة إلى ذلك، يتحقق الاستطلاع من أحدث التطورات والأبحاث في مجال التعلم التحويلي خصوصًا لمعالجة الصور باستخدام الشبكات العصبية العميقة. وفي الختام، يسلط هذا التحليل الشامل الضوء على أهمية التعلم التحويلي في سياق تحسين معالجة الصور باستخدام الشبكات العصبية العميقة، ويوفر رؤى فريدة في هذا المجال الذي يتطور بسرعة.

الكلمات المفتاحية: الشبكات العصبية العميقة، الشبكات العصبية العميقة المُستخدَمة في التعلم التحويلي، التعلم التحويلي، معالجة الصور، التعلم العميق.

1. Introduction:

Convolutional Neural Networks (CNNs) have revolutionized the field of image processing with their outstanding ability to extract features and classify images. CNNs learn hierarchical representations of visual patterns through multiple layers of processing raw image data, making them highly efficient at identifying patterns and features. One of the most significant achievements of CNNs is their success in improving image resolution. Traditional methods like interpolation and bicubic upscaling have limitations and may result in blurry and distorted images. CNNs, on the other hand, employ super-resolution techniques to produce high-quality and sharp images with increased resolution **[1]** CNNs have also proven effective in image restoration tasks such as denoising. CNNs for denoising are capable of enhancing low-light images by eliminating noise patterns, resulting in more detailed and clearer images **[2]**. In the field of medical imaging, segmentation techniques based on CNNs have been utilized to identify and isolate specific organs or abnormalities in medical images. This application has

proven helpful in diagnosing medical conditions and improving treatment planning [3]Transfer learning is a technique widely used in machine learning to improve model performance on related tasks [4] In this method, knowledge gained from a pre-existing model is used to enhance the effectiveness of a new task involving a smaller data set. Typically, a pre-existing model undergoes training on a large data set designed for a specific task, such as image classification [5]. The knowledge learned from the pre-trained model's weights and biases is then transferred to the new task, improving the new model's performance. In the process of transfer learning, it is common to keep the bottom layers of the pre-trained model in a frozen state, which act as immutable feature extractors. At the same time, the upper layers are tuned or tuned to get task-specific features [6] A pre-trained model can learn general features that apply to various tasks, including edge detection, texture recognition, and object representation. These features can be utilized for a new task to minimize the amount of data required for training and enhance the performance of the new model, especially when the new dataset is small and has similarities with the original dataset. Transfer learning has become an important technique for researchers and practitioners in diverse fields since it enables them to utilize pre-trained models to decrease the time required for training and enhance the accuracy of their models [4]. Given the ongoing progress in deep learning architectures and the abundant availability of extensive datasets, transfer learning is anticipated to play a pivotal role in the advancement of machine learning and artificial intelligence in the foreseeable future. In essence, transfer learning stands as a potent technique with diverse applications across various domains, including computer vision, natural language processing, speech recognition, and medical image analysis. This survey report serves as a comprehensive overview of the most recent advancements in transfer learning techniques and their practical implementations for optimizing image processing using CNNs. It serves as an invaluable resource for researchers and professionals in the field, offering valuable insights into cutting-edge approaches to enhance the performance of CNN-based image processing applications.

2- How does Transfer Learning Work?

Transfer learning is a popular machine learning technique that aims to improve the performance of models on related tasks by leveraging knowledge gained from pre-trained models [7]. Typically, the pre-trained model undergoes training on an extensive dataset tailored to a particular task, like classifying images [8]. The knowledge gained from the pre-trained model's weights and biases is then transferred to a new task with a smaller dataset, improving the performance of the new model. This technique is particularly useful when there is a lack of sufficient training data for the new task or when training a new model from scratch is

computationally expensive [9]. In the process of transfer learning, it is common practice to keep the lower layers of the pre-trained model unchanged and utilize them as fixed feature extractors. Meanwhile, the higher layers are adjusted or fine-tuned to acquire features specific to the task at hand [10]. The pre-trained model has acquired generic features that hold significance across numerous tasks, including edge detection, texture recognition, and object representation. These features can be leveraged for a new task, leading to a reduction in the volume of training data needed and enhancing the performance of the new model, particularly when the new dataset is small and like the original dataset. This technique has been successfully applied to various fields, including computer vision, natural language processing, and speech recognition [7].The **figure 1, [11]** illustrates the use of a pre-trained model that was trained on a large image dataset (ImageNet) and fine-tuned on a new dataset with different classes and updated weights.

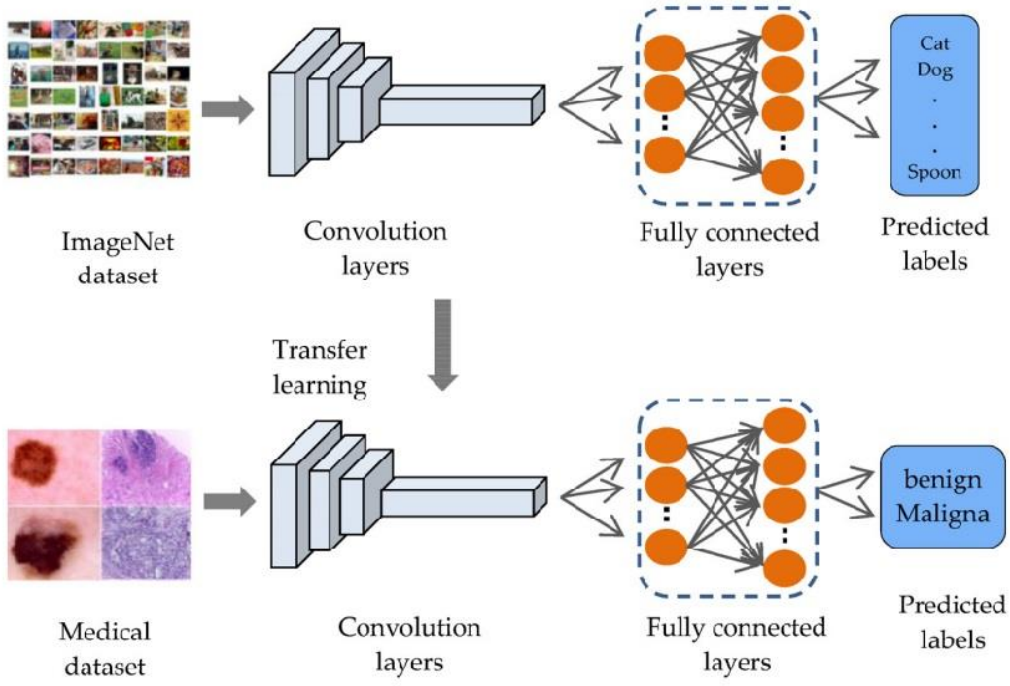

Figure 1: Transfer learning from ImageNet.

In the context of image classification, **Table 1** presents an overview of the top five CNN models, each offering pre-trained weights and biases that can be effectively employed for transfer learning. To determine the parameter, count for each filter, we employ the formula (a * b * c) + 1, where a * b represents the filter dimensions, c denotes the number of filters in the preceding layer, and the additional 1 account for the bias. The models are arranged chronologically, commencing with the initial-generation LeNet [12] and AlexNet [13], which were developed in 1998 and 2012, respectively. VGG16 [14] stands out as the pioneering deep

model, while GoogleNet [15] introduced the innovative concept of blocks, and ResNet50 [16] introduced residual blocks featuring skip connections between layers. ResNet effectively resolves the vanishing gradient problem, ensuring adequate updates to the weights of earlier layers during training. Notably, all models employ the SoftMax function in the classifier head, except for LeNet-5, which utilizes the hyperbolic tangent function.

Table 1: presents a comprehensive overview of five key backbone models.

Model	Released Year	Total Parameters	FE Parameters	Trainable Layers	Dataset
VGG16	2014	134.2 million	14.7 million	16	ImageNet
AlexNet	2012	62.3 million	3.7 million	8	ImageNet
LeNet5	1998	60,000 thousand	1,716 thousand	4	MNIST
GoogLeNet	2014	5.3 million	5.3 million	22	ImageNet
ResNet50	2015	25.6 million	23.5 million	51	ImageNet

Note: Abbreviations: FE stands for feature extraction, FC stands for fully connected layers. The MNIST database refers to the Modified National Institute of Standards and Technology database, which includes 60,000 training and 10,000 test images of handwritten digits. The ImageNet database is a vast collection of over 14 million hand-annotated images organized based on the WordNet hierarchy and is commonly used for research on visual object recognition.

3- Literature Review

Transfer learning has found its application in a multitude of tasks related to image processing that employ CNNs, like image classification, object detection, and semantic segmentation. In a study by Yosinski et al. [16], transfer learning was used to improve image classification performance by fine-tuning pre-trained CNNs on a target dataset. They found that the pre-trained CNNs were able to learn task-specific features more quickly and effectively than training from scratch, leading to significant improvements in classification accuracy. Similarly, in a study by Girshick et al. [17], transfer learning was used for object detection by adapting a pre-trained CNN for region proposal generation and fine-tuning for object classification. The results showed that transfer learning significantly improved the accuracy of object detection. For semantic segmentation, Chen et al [18] used a pre-trained CNN as an encoder and combined it with a decoder network to generate pixel-wise segmentation masks. They found that the pre-trained CNN significantly improved the performance of the segmentation network, especially when fine-tuning on a smaller target dataset. Other studies have also shown the effectiveness of transfer learning with CNNs for image processing tasks, such as face recognition [19], medical image analysis, and natural language image retrieval [20]. Some additional studies that have applied transfer learning with CNNs to various image processing tasks .Cui et al. [21] used

transfer learning with CNNs to improve the performance of facial expression recognition in low-resource settings. They fine-tuned pre-trained CNN models on small datasets of facial expression images and achieved better accuracy than training from scratch. Shi et al. **[22]** applied transfer learning with CNNs to improve the classification of mammograms for breast cancer diagnosis. They fine-tuned pre-trained CNN models on mammogram images and achieved better accuracy and specificity than traditional methods. A recent study by Wu et al. **[23]** applied transfer learning with CNNs to a large dataset of dermo copy images to detect and classify skin lesions. The study found that fine-tuning pre-trained CNN models on the skin lesion dataset achieved high accuracy in detecting and classifying different types of skin lesions, including melanoma. In a study by M. S. Ahmed and A. M. Fakhrudeen **[24]** **[25]** used transfer learning with CNNs to detect and diagnose COVID-19 from chest X-ray images. They fine-tuned pre-trained CNN models on a dataset of COVID-19 chest X-ray images and achieved high accuracy in identifying COVID-19 cases. In other study conducted by Shaheen Mohammed et al. **[26]**, transfer learning was employed for object detection by adapting a pre-trained convolutional neural network (CNN). The research specifically focuses on utilizing a dataset of high-resolution satellite images to distinguish between tsunami-stricken and non-stricken areas. The authors investigate various parameters and learning rates to improve the detection of small objects and achieve enhanced accuracy. Han et al. **[27]** used transfer learning with a pre-trained CNN to improve the accuracy of object detection in satellite imagery The research revealed a substantial enhancement in object detection accuracy through the utilization of transfer learning, particularly for smaller objects and in low-resolution imagery. In a study by Hu et al. **[28]** transfer learning was applied to improve the classification accuracy of crop types from remote sensing images. The study found that using transfer learning with a pre-trained CNN model significantly improved the accuracy of crop classification compared to training a CNN from scratch. Another study by Zhang et al. **[29]** Transfer learning was employed to enhance the precision of ship target detection in remote sensing images. Furthermore, Wang et al. **[30]** applied transfer learning to improve the performance of medical image segmentation, specifically for MRI brain tumor segmentation. by K. Kowsari, et al. **[31]** This study explored the use of transfer learning with CNNs to perform image classification tasks with limited amounts of data. Enhancing Image Classification with Transfer Learning and Convolutional Neural Networks" by A. Karpathy and L. Fei-Fei **[32]** This study explores the effectiveness of transfer learning with CNNs for image classification tasks using a large-scale image dataset. The authors fine-tuned pre-trained CNN models and achieved high accuracy even with limited training data. “Transfer Learning with Convolutional Neural Networks for

Skin Lesion Classification" by A. Esteva et al. [33] This study applies transfer learning with CNNs to classify skin lesions in dermoscopic images. The authors fine-tuned pre-trained CNN models and achieved high accuracy, outperforming traditional machine learning approaches. “Transfer Learning with Convolutional Neural Networks for Malaria Diagnosis" by A. Rajaraman et al. [34] This study applies transfer learning with CNNs to detect malaria parasites in thin blood smear images. The authors fine-tuned pre-trained CNN models and achieved high accuracy, with potential for use in resource-limited settings. "Transfer Learning for Image Captioning" by L. Yao et al. [35] This study explores the use of transfer learning with CNNs for image captioning tasks. The authors fine-tuned pre-trained CNN models and achieved high accuracy in generating natural language descriptions of images. These studies demonstrate the versatility of transfer learning with CNNs across different image processing tasks and datasets. They also highlight the potential of this approach for improving accuracy and reducing the need for large amounts of training data.

Table 2: Summarize the studies of literature review

Ref.	Year of Publication	Title of the Study	Type of Data Used	Time Series	Approach Used	CNN	Known Models Used in the Study	Dataset Field
[36]	2022	“Crack Detection in Concrete Structures Using Deep Learning”	Image	No	Transfer Learning	yes	VGG16	Surface Crack Detection
[37]	2022	“Classification of analyzable metaphase images using transfer learning and fine tuning”	Image	No	Transfer Learning	yes	VGG16, Inception V3	Medical Images
[38]	2022	“UAV swarm-based radar signal sorting via multisource data fusion: A deep transfer learning framework”	Image	No	Transfer Learning	yes	Cascade-RCNN Yolo and Faster-RCNN	Radar images
[39]	2022	“Deep transfer learning based visual classification of pressure injuries stages”	Image	No	Transfer Learning	yes	MobileNetV2, Dense-Net 121, Red-Nets, VGG16, Inception V3	Medical Images
[40]	2021	“Progressive Transfer Learning Approach for Identifying the Leaf Type by Optimizing Network Parameters”	Image	No	Transfer Learning	yes	Res-Net 50	Plant science
[41]	2020	“A deep transfer learning model with classical data augmentation and CGAN to detect COVID-19 from chest CT radiography digital images”	Image	No	Transfer Learning	yes	VGGNet16, VGGNet19, Alex-Net Google-Net, Res-Net50	Medical image
[42]	2020	“Automated invasive ductal carcinoma detection based	Image	No	Transfer Learning	yes	Dense-Net ,Res-Net,	Medical Images

		using deep transfer learning with whole-slide images"						
[43]	2022	"CNN Based on Transfer Learning Models Using Data Augmentation and Transformation for Detection of Concrete Crack"	Image	No	Transfer Learning	yes	VGG16, ResNet18, DenseNet161, and AlexNet.	Surface Crack Detection
[44]	2020	"Concrete Cracks Detection Using Convolutional Neural Network Based on Transfer Learning"	Image	No	Transfer Learning	yes	EfficientNetB0 MobileNetV2 DenseNet201 InceptionV3	Surface Crack Detection
[45]	2021	"MCFT-CNN: Malware classification with fine-tune convolution neural networks using traditional and transfer learning in Internet of Things"	Image	No	Transfer Learning	yes	Res-Net50	Malware-classification
[46]	2019	"Deep Transfer Learning for Multiple Class Novelty Detection"	Image	No	Transfer Learning	yes	VGGNet ,Alex-Net	Vision
[47]	2019	"Brain tumor classification using deep CNN features via transfer learning"	Image	No	Transfer Learning	yes	Google-Net	Medical Images
[48]	2018	"Deep Transfer Learning for Image-Based Structural Damage Recognition"	Image	No	Transfer Learning	yes	VGG-Net	Civil engineering

4- Discussion

The survey report highlights the power of transfer learning in training CNNs for image processing tasks. CNNs have shown impressive results in image processing tasks such as image classification, super-resolution, denoising, and medical image segmentation. However, the training process for these models necessitates substantial quantities of annotated data and computational resources. Transfer learning addresses these challenges by reusing the knowledge learned from a pre-trained model for a source task and applying it to a new task with a smaller dataset. [14] The report also discusses the best practices and limitations of using transfer learning in different scenarios. One of the limitations of transfer learning is that the source task and the target task need to be like some extent. Otherwise, the performance gain from transfer learning may be limited. Another limitation is the risk of transferring irrelevant or harmful features from the source task to the target task, which may lead to overfitting or poor performance.[49] The report highlights that transfer learning is widely used in various fields, including computer vision, natural language processing, and speech recognition. As such, transfer learning is Anticipated to have a significant role a crucial role in advancing the fields of machine learning and artificial intelligence in the future.[50] The report also provides an overview of the latest developments in transfer learning techniques and their applications. The

top five CNN models widely recognized for image classification, which come with pre-trained weights and biases that can be used for transfer learning, have been summarized in **Table1**.

5- Conclusion and Future Work

Transfer learning has emerged as a promising solution to reduce the dependency on labeled data and computing resources. The pre-trained model has acquired generic characteristics that are pertinent to various tasks, such as edge detection, texture recognition, and object representation. Utilizing these features for a new task allows for a reduction in the necessary training data and an enhancement in the performance of the new model, especially when the new dataset is small and bears resemblance to the original dataset. The survey report offers valuable perspectives on cutting-edge techniques to optimize the performance of image processing applications based on CNNs. The report also discusses the limitations and best practices for using transfer learning in different scenarios in the future, there is potential for further exploration of transfer learning methods in diverse domains and applications beyond its current scope, including natural language processing and speech recognition. Moreover, the applicability of transfer learning can be extended to other neural network architectures like recurrent neural networks and generative adversarial networks, to improve their performance on related tasks. Additionally, research can be conducted to optimize transfer learning techniques for specific types of datasets and tasks, as well as explore the potential of unsupervised transfer learning for improving model performance.**[24]**

6. References.

[1] Lim B, Son S, Kim H, Nah S, Mu Lee K. Enhanced deep residual networks for single image super-resolution. Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition Workshops. 2017. p. 136-44.

[2] Zhang K, Zuo W, Chen Y, Meng D, Zhang L. Beyond a Gaussian denoiser: Residual learning of deep CNN for image denoising. IEEE Trans Image Process. 2017;26(7):3142-55.

[3] Huang G, Liu Z, Van Der Maaten L, Weinberger KQ. Densely connected convolutional networks. Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition. 2017. p. 4700-8.

[4] Radford A, et al. Learning transferable visual models from natural language supervision. International Conference on Machine Learning. 2021. p. 8748-63.

[5] Dong X, et al. CSWin transformer: A general vision transformer backbone with cross-shaped windows. Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition. 2022. p. 12124-34.

[6] Tan M, Le Q. EfficientNetV2: Smaller models and faster training. International Conference on Machine Learning. 2021. p. 10096-106.

[7] Pan SJ, Yang Q. A survey on transfer learning. IEEE Trans Knowl Data Eng. 2010;22(10):1345-59.

[8] Deng J, Dong W, Socher R, Li LJ, Li K, Fei-Fei L. ImageNet: A large-scale hierarchical image database. 2009 IEEE Conference on Computer Vision and Pattern Recognition. 2009. p. 248-55.

[9] Yosinski J, Clune J, Bengio Y, Lipson H. How transferable are features in deep neural networks? Adv Neural Inf Process Syst. 2014;27.

[10] Goodfellow I, Bengio Y, Courville A. Deep learning. MIT Press; 2016.

[11] Mukhlif AA, Al-Khateeb B, Mohammed MA. Incorporating a novel dual transfer learning approach for medical images. Sensors. 2023;23(2):570.

[12] LeCun Y, Bottou L, Bengio Y, Haffner P. Gradient-based learning applied to document recognition. Proc IEEE. 1998;86(11):2278-324.

[13] Krizhevsky A, Sutskever I, Hinton GE. ImageNet classification with deep convolutional neural networks. Adv Neural Inf Process Syst. 2012;25:1097-105.

[14] Simonyan K, Zisserman A. Very deep convolutional networks for large-scale image recognition. arXiv Prepr arXiv1409.1556. 2014.

[15] Szegedy C, et al. Going deeper with convolutions. Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition. 2015. p. 1-9.

[16] He K, Zhang X, Ren S, Sun J. Deep residual learning for image recognition. Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition. 2016. p. 770-8.

[17] Girshick R, Donahue J, Darrell T, Malik J. Rich feature hierarchies for accurate object detection and semantic segmentation. Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition. 2014. p. 580-7.

[18] Chen LC, Papandreou G, Kokkinos I, Murphy K, Yuille AL. Deeplab: Semantic image segmentation with deep convolutional nets, atrous convolution, and fully connected CRFs. IEEE Trans Pattern Anal Mach Intell. 2017;40(4):834-48.

[19] Sun Y, Wang X, Tang X. Deep learning face representation from predicting 10,000 classes. Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition. 2014. p. 1891-8.

[20] Shin HC, et al. Deep convolutional neural networks for computer-aided detection: CNN architectures, dataset characteristics and transfer learning. IEEE Trans Med Imaging. 2016;35(5):1285-96.

[21] Deshpande N, Nunnari F, Avramidis E. Fine-tuning of convolutional neural networks for the recognition of facial expressions in sign language video samples. Proceedings of the 7th International Workshop on Sign Language Translation and Avatar Technology: The Junction of the Visual and the Textual: Challenges and Perspectives. 2022. p. 29-38.

[22] Cai X, Li X, Razmjooy N, Ghadimi N. Breast cancer diagnosis by convolutional neural network and advanced thermal exchange optimization algorithm. Comput Math Methods Med. 2021.

[23] KhoKhar FA, Shah JH, Khan MA, Sharif M, Tariq U, Kadry S. A review on federated learning towards image processing. Comput Electr Eng. 2022;99:107818.

[24] Ahmed MS, Fakhrudeen AM. COVID-19IraqKirkukDataset: Development and evaluation of an Iraqi dataset for COVID-19 classification based on deep learning. Int J Nonlinear Anal Appl. 2023.

[25] Ahmed MS, Fakhrudeen AM. Deep learning-based COVID-19 detection: State-of-the-art in research. Int J Nonlinear Anal Appl. 2023;14(1):1939-62.

[26] Ahmed SMS, Güneyli H. Automatic post-tsunami loss modeling using deep learning CNN case study: Miyagi and Fukushima Japan tsunami. Nat Hazards. 2023.

[27] Chen L, Li S, Bai Q, Yang J, Jiang S, Miao Y. Review of image classification algorithms based on convolutional neural networks. Remote Sens. 2021;13(22):4712.

[28] Xiao R, Yu C, Li Z, He X. Statistical assessment metrics for InSAR atmospheric correction: Applications to generic atmospheric correction online service for InSAR (GACOS) in Eastern China. Int J Appl Earth Obs Geoinf. 2021;96:102289.

[29] Grabska E, Hawryło P, Socha J. Continuous detection of small-scale changes in Scots pine dominated stands using dense Sentinel-2 time series. Remote Sens. 2020;12(8):1298.

[30] Enderich L, Timm F, Burgard W. SYMOG: Learning symmetric mixture of Gaussian modes for improved fixed-point quantization. Neurocomputing. 2020;416:310-5.

[31] Guo H, Mao Y, Zhang R. Augmenting data with mixup for sentence classification: An empirical study. arXiv Prepr arXiv1905.08941. 2019.

[32] Karpathy A, Fei-Fei L. Deep visual-semantic alignments for generating image descriptions. Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition. 2015. p. 3128-37.

[33] Esteva A, et al. Dermatologist-level classification of skin cancer with deep neural networks. Nature. 2017;542(7639):115-8.

[34] Rajaraman S, et al. Pre-trained convolutional neural networks as feature extractors toward improved malaria parasite detection in thin blood smear images. PeerJ. 2018;6

[35] Yao L, et al. Describing videos by exploiting temporal structure. Proceedings of the IEEE International Conference on Computer Vision. 2015. p. 4507-15.

[36] Golding VP, Gharineiat Z, Munawar HS, Ullah F. Crack detection in concrete structures using deep learning. Sustainability. 2022;14(13):8117.

[37] Albayrak A. Classification of analyzable metaphase images using transfer learning and fine-tuning. Med Biol Eng Comput. 2022;60:239-48.

[38] Wan L, Liu R, Sun L, Nie H, Wang X. UAV swarm based radar signal sorting via multi-source data fusion: A deep transfer learning framework. Inf Fusion. 2022;78:90-101.

[39] Ay B, Tasar B, Utlu Z, Ay K, Aydin G. Deep transfer learning-based visual classification of pressure injuries stages. Neural Comput Appl. 2022;34(18):16157-68.

[40] Joshi D, Mishra V, Srivastav H, Goel D. Progressive transfer learning approach for identifying the leaf type by optimizing network parameters. Neural Process Lett. 2021;53(5):3653-76.

[41] Loey M, Manogaran G, Khalifa NEM. A deep transfer learning model with classical data augmentation and CGAN to detect COVID-19 from chest CT radiography digital images. Neural Comput Appl. 2020.

[42] Celik Y, Talo M, Yildirim O, Karabatak M, Acharya UR. Automated invasive ductal carcinoma detection using deep transfer learning with whole-slide images. Pattern Recognit Lett. 2020;133:232-9.

[43] Islam MM, Hossain MB, Akhtar MN, Moni MA, Hasan KF. CNN based on transfer learning models using data augmentation and transformation for detection of concrete crack. Algorithms. 2022;15(8):287.

[44] Su C, Wang W. Concrete cracks detection using convolutional neural network based on transfer learning. Math Probl Eng. 2020;

[45] Kumar S. MCFT-CNN: Malware classification with fine-tune convolution neural networks using traditional and transfer learning in Internet of Things. Futur Gener Comput Syst. 2021;125:334-51.

[46] Perera P, Patel VM. Deep transfer learning for multiple class novelty detection. Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition. 2019. p. 11544-52.

[47] Deepak S, Ameer PM. Brain tumor classification using deep CNN features via transfer learning. Comput Biol Med. 2019;111:103345.

[48] Gao Y, Mosalam KM. Deep transfer learning for image-based structural damage recognition. Comput Civ Infrastruct Eng. 2018;33(9):748-68.

[49] Bengio Y. Deep learning of representations for unsupervised and transfer learning. Proceedings of ICML Workshop on Unsupervised and Transfer Learning. 2012. p. 17-36.

[50] Weiss K, Khoshgoftaar TM, Wang D. A survey of transfer learning. J Big Data. 2016;3(1):1-40.

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Designing a Wearable EEG Device and Its Benefits for Epilepsy Patients: A Review

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Keywords: Wearable EEG device, Epilepsy patients, Electroencephalography, Signal quality.

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Abstract:

Epilepsy is a neurological disorder that causes repeated seizures in millions of people worldwide. Traditional Electroencephalography (EEG) systems can be cumbersome and limited to clinical settings, but they have helped diagnose and monitor epilepsy. Wearable EEG devices have transformed epilepsy management by providing real-time, non-invasive, and continuous monitoring capabilities. This review paper investigates the design considerations and technological advancements in wearable EEG devices, emphasizing their numerous benefits in treating epileptic patients and the limitation of designing wearable devices. In conclusion, the integration of multimodal data can offer a comprehensive overview of a patient's health, enabling the implementation of personalized and efficient treatment approaches.

Keywords: Wearable EEG device, Epilepsy patients, Electroencephalography, Signal quality.

تصميم جهاز مخطط كهربائية الدماغ قابل للارتداء وفوائده لمرضى الصرع: مراجعة

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الصرع هو اضطراب عصبي يسبب نوبات متكررة لملايين الأشخاص في جميع أنحاء العالم. يمكن أن تكون أنظمة مخطط كهربية الدماغ التقليدية مفيدة في تشخيص الصرع ومراقبته لكنها مرهقة ومقتصرة على الإعدادات السريرية. لقد حولت أجهزة التخطيط الكهربائي للدماغ القابلة للارتداء إدارة الصرع من خلال توفير إمكانيات المراقبة المستمرة في الوقت الفعلي. تبحث ورقة المراجعة هذه في اعتبارات التصميم والتقدم التكنولوجي في أجهزة مخطط كهربائية الدماغ القابلة للارتداء، مع التركيز على فوائدها في إدارة مرض الصرع والمحددات التي تواجهها عملية تصميم مخطط كهربائية الدماغ القابلة للارتداء. وكاستنتاج، يمكن أن توفر البيانات المأخوذة من وسائط متعددة نظرة عامة شاملة على صحة المريض، مما يتيح تنفيذ أساليب العلاج الشخصية والفعالة.

الكلمات المفتاحية: جهاز مخطط كهربائية الدماغ القابل للارتداء، مرضى الصرع، تخطيط كهربية الدماغ، جودة الإشارة.

1. Introduction:

Epilepsy is a neurological condition impacting about 1% of the global population and millions worldwide **[1-3]**. It is distinguished by recurrent seizures that vary in frequency and intensity, making managing it challenging. Electroencephalography (EEG) has long been used to diagnose and monitor epilepsy, providing valuable insights into the brain's electrical activity during seizures and interictal periods **[4,5]**.

Traditional EEG systems are frequently restricted to clinical settings, necessitating patient visits to healthcare facilities for intermittent monitoring. This limitation limits the continuous monitoring required to capture the full spectrum of seizure patterns and accurately identify potential triggers **[6,7]**. Furthermore, traditional EEG systems can be cumbersome and uncomfortable to use, reducing patient compliance and the overall effectiveness of epilepsy management **[8]**.

The development of wearable EEG devices has resulted in a new era in epilepsy care, allowing for real-time, non-invasive, and continuous monitoring **[9]**. These cutting-edge devices are lightweight, comfortable, and simple, allowing patients to actively participate in their healthcare journey **[10]**. Wearable EEG devices enable healthcare professionals to better understand each patient's unique seizure patterns and responses to treatment by capturing EEG signals over extended periods of time in real-life situations **[11]**. **Fig. 1** shows an example of a wearable EEG device.

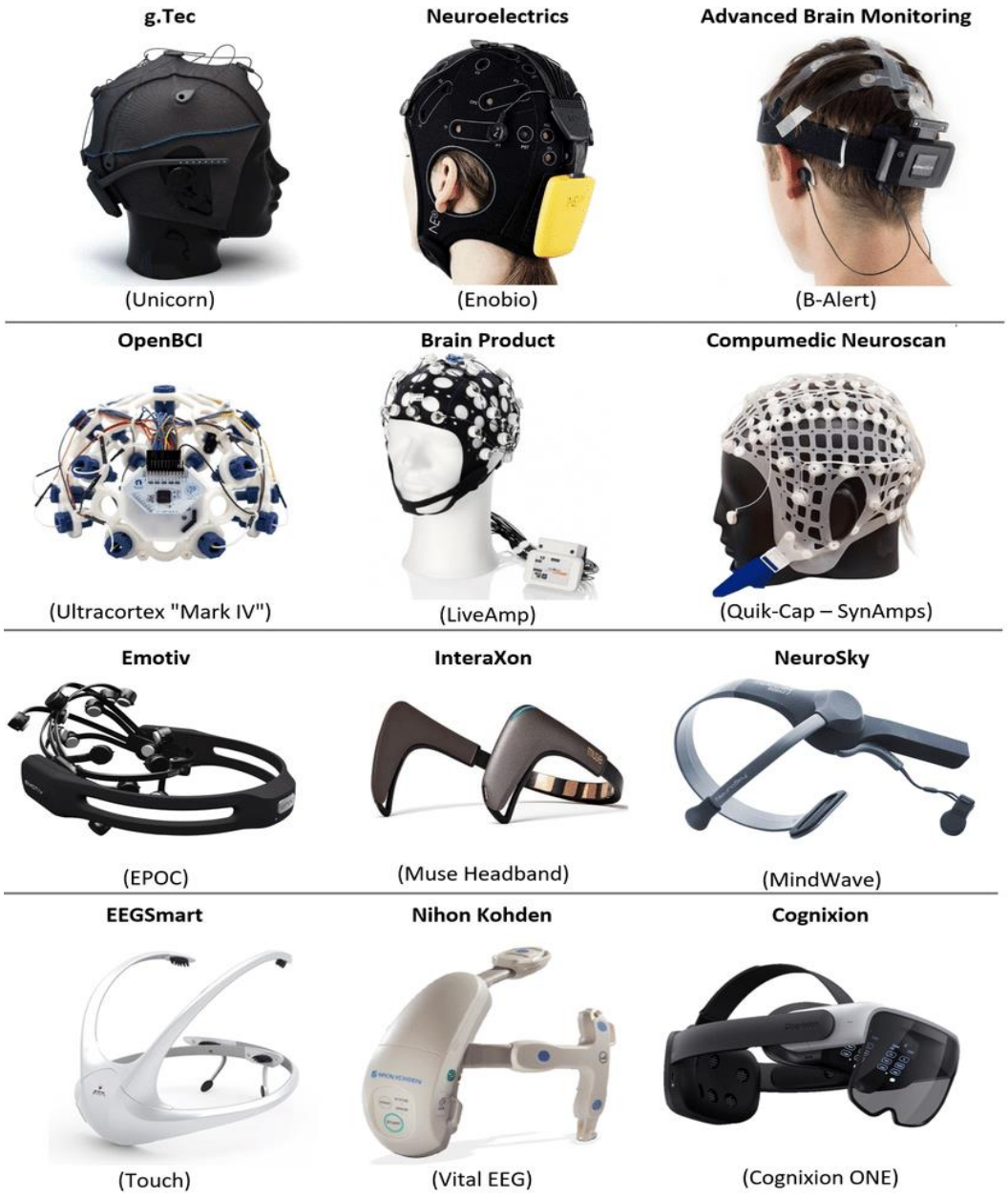


Fig. 1: Wearable EEG device.

The details of some of these devices (For example wearable EEG devices g.Tech, Open BCI, Emotive, and Muse headband.), how to use them for monitoring epilepsy patients, and their cost are explained in **Table 1**.

Table 1: Wearable EEG Devices Details

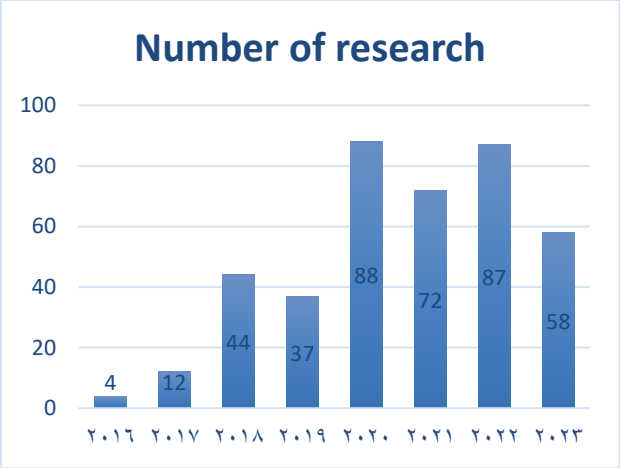
Device	Description	Number of channels	Monitor epilepsy patients	Cost
g.Tec [12]	High-performance medical products for invasive and non-invasive brain use in research and clinical settings.	8/16/32/64 EEG channels are available	• The g.tec EEG system can continuously monitor the patient's brain activity, allowing healthcare professionals to identify and characterize epileptic seizures. The EEG data can help determine the type, duration, and frequency of seizures. • aim to predict epileptic seizures before they occur. By analyzing the EEG patterns that precede seizures, the system may be able to provide an alert or warning to patients or caregivers, allowing them to take preventive measures.	(329-4.950 €)
Open BCI [13-16]	Open BCI provides hardware and software tools for recording brain signals (EEG, EMG, ECG, and more) and experimenting with brain-computer interfaces.	4/8/16 EEG channels are available	By combining the machine learning model with the 16-channel 10-20 system Ultra cortex Mark IV, the user, and their family will be notified if a seizure occurs. The electrode system will be linked to an Open BCI, which will filter raw EEG signals. These signals will be wirelessly transmitted to a Raspberry Pi, which will contain a machine-learning model. If the model detects preictal waveforms in sensor data, indicating the onset of a seizure, the Pi emits a loud, ambulance-like sound. This would alert nearby pedestrians that the user requires assistance.	(885-3450 $)
Emotive [17-19]	EMOTIV has maintained its leadership in wireless EEG innovation, developing solutions for a wide range of applications such as scientific and consumer research, product innovation, and workplace wellness.	2/5/14/32 EEG channels	• Analyze the EEG data collected during the study to observe patterns associated with epileptic seizures. While Emotive headsets are not typically used for medical diagnosis, researchers might observe trends or correlations that could inform further studies or clinical investigations. • explore seizure prediction algorithms using EEG data	(849-2099 $)

			collected from Emotive headsets. It's important to remember that seizure prediction is a complex and challenging task that requires rigorous validation before clinical applications.	
Muse headband [20- 22]	the brain-sensing device developed by Intera Xon. It is a consumer-grade EEG (electroencephalogram) headband designed to measure brainwave activity and provide real-time feedback for meditation and stress management.	multiple EEG sensors that contact the user's forehead (4 channels).	While consumer EEG devices like the Muse headband can measure brainwave activity, they lack the necessary validation and regulatory approvals required for medical applications. As such, they should not be used as a substitute for medical-grade EEG equipment in any medical context, including epilepsy monitoring or seizure prediction.	(295-445 $)

Numerous research studies have been published in scientific journals, conference proceedings, and dissertations that focus on different aspects of wearable EEG devices for example the number of research using open BCI was shown in Table 2.

Table 2: Number of research using open BCI device.

Year	Number of research
2016	4
2017	12
2018	44
2019	37
2020	88
2021	72
2022	87
2023	58



It's important to note that designing a wearable EEG device for medical purposes, especially epilepsy monitoring, requires expertise in medical device development, data processing, and compliance with relevant regulations. Working with a team of medical professionals, engineers, and researchers is crucial to ensure the device's safety, efficacy, and usability for epilepsy patients.

Overall, wearable EEG devices represent a promising paradigm shift in epilepsy management, presenting an opportunity to improve patient well-being, optimize treatment strategies, and advance our understanding of this complex neurological condition. Through this comprehensive review, we aim to shed light on the transformative impact of wearable EEG devices and stimulate further research and development in this crucial area of healthcare technology.

The following is how the rest of the paper is organized: Section II provides design considerations for wearable EEG devices. Section III presents the Benefits of Wearable EEG Devices for Epilepsy Patients. Section IV discusses Challenges and Future Directions. Section V shows the Limitations of Wearable EEG Devices. Finally, Section VI concludes the paper.

2. Design Considerations for Wearable EEG Devices:

2.1 Electrode Placement: Electrode placement is critical for capturing reliable EEG signals **[23]**. Wearable electrodes are dry, flexible, and comfortable, allowing long-term use without discomfort or skin irritation **[24,25]**. **Fig. 2** presents the international 10-20 electrode placement system.

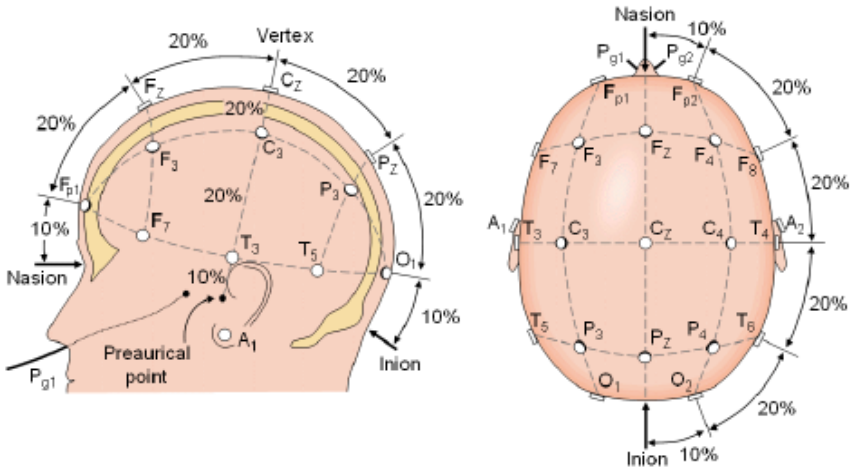


Fig. 2: international 10-20 system.

2.2 Signal Quality: Maintaining signal quality in wearable EEG devices presents challenges due to motion artifacts, ambient noise, and electrode-skin impedance **[26]**. Advances in signal processing and noise reduction techniques have improved signal fidelity **[27]**.

2.3 Power Efficiency: Because wearable EEG devices are designed for continuous monitoring, power efficiency is critical to extending battery life **[28-30]**. Some strategies to address this

issue include low-power components, wireless data transmission, and energy-saving algorithms [31].

2.4 Data Storage and Transmission: Wearable EEG devices store and transmit data to a centralized system or cloud platform for analysis and monitoring. Maintaining patient privacy requires secure and efficient data transfer [32].

3. Benefits of Wearable EEG Devices for Epilepsy Patients:

1. Early Seizure Detection: Continuous monitoring with wearable EEG devices allows for the early detection of seizures, providing patients and caregivers with timely alerts. This feature enables proactive responses and lowers the risk of injury during a seizure [33].
2. Seizure Pattern Analysis: Long-term EEG data collected via wearable devices allows for in-depth analysis of seizure patterns, which can aid in identifying triggers and personalizing treatment plans [34].
3. Improved Treatment Compliance: By tracking brain activity and medication adherence, wearable EEG devices enable patients to participate in their treatment actively; increased compliance results in better seizure control and overall health outcomes [35].
4. Patients in faraway locations or with limited access to healthcare facilities can benefit from wearable EEG devices, which enable remote monitoring and telemedicine consultations with healthcare professionals [36].
5. Advances in Research and Treatment: The massive amount of EEG data collected by wearable devices contributes to research efforts to understand epilepsy better. This data-driven approach has the potential to yield novel treatment options and better management strategies [36].

4. Challenges and Future Directions:

- Standardization: Establishing standardized protocols for data acquisition, analysis, and interpretation of wearable EEG devices is essential for practical integration into clinical practice [37].
- Designing User-Friendly Interface: is crucial to encourage patient compliance and engagement with wearable EEG devices [38].
- Data Privacy and Security: Addressing data privacy and security concerns is vital in gaining patients' trust and ensuring the ethical use of EEG data [39].
- Multimodal Integration: Future wearable EEG devices may integrate other physiological sensors better to understand a patient's health status and potential seizure triggers.

Combining EEG data with metrics from heart rate monitors, accelerometers, or other physiological sensors may enable an improved comprehension of the relationship between physical and neurological health, as well as aid in the identification of additional seizure triggers **[40].**

- Furthermore, research and development efforts should focus on enhancing signal quality, reducing motion artifacts, and extending battery life to improve wearable EEG devices' overall performance and usability. Advancements in machine learning algorithms can aid in real-time data analysis, enabling faster and more accurate seizure detection and prediction **[41-42]**.

5. Limitations of Wearable EEG Devices:

Wearable EEG devices provide numerous benefits for epilepsy management **[43]**, but they do have some limitations that must be recognized and addressed:

A. Limited Channel Configurations: To maintain device portability and comfort, wearable EEG devices frequently have fewer electrodes than traditional clinical EEG systems. Because there are fewer channels, the spatial resolution and comprehensiveness of the recorded brain activity may be limited, potentially missing subtle abnormalities or localized epileptic activity **[44]**.

B. Battery Life and Power Efficiency: Continuous monitoring necessitates energy-efficient and long-lasting wearable EEG devices. However, balancing power consumption with the need for prolonged monitoring can be difficult, potentially resulting in limited recording duration and frequent recharging **[45]**.

C. Calibration and Individual Variability: Accurate data collection requires properly calibrating wearable EEG devices. Individual differences in head shape, skin conductivity, and electrode-skin contact can all impact signal quality and consistency. To account for these variations, careful calibration and user-specific adjustments may be required **[46]**.

D. External Device Interference: Wearable EEG devices, especially those that use wireless data transmission, Other electronic devices, or environmental factors may cause interference. To ensure data integrity and reliability, proper shielding and robust communication protocols are required **[47]**.

E. Data Security and Privacy: Continuous monitoring generates much sensitive neurological data. To comply with ethical and legal standards, it is essential to ensure the security of this data. To build patient trust and protect their information, strict data encryption, secure data storage, and clear data ownership policies are required **[48].**

F. Clinical Validation and Standardization: While wearable EEG devices show promise, rigorous clinical validation and standardization of their use are required to ensure their efficacy and reliability. Comparison studies against traditional clinical EEG systems and standardized protocols for data collection and analysis are critical steps in establishing the clinical utility of these devices **[49,50]**.

G. Cost and Accessibility: The high price of wearable EEG devices may prevent widespread adoption, particularly in resource-constrained healthcare settings. Making these devices affordable and accessible to a larger patient population will be critical to their general use **[51]**.

6. Discussion:

Wearable EEG devices represent a significant advancement in the management of epilepsy patients, allowing for a transformative approach to continuous monitoring and personalized care. This review has focused on the numerous advantages these devices bring to the field of epilepsy management.

Wearable EEG devices allow for early seizure detection, providing patients and caregivers with timely alerts that can lead to proactive responses and reduce the risk of injury during a seizure. These devices capture long-term EEG data, allowing for in-depth analysis of seizure patterns, assisting in identifying triggers, and tailoring treatment plans to each patient's specific needs. Furthermore, monitoring patients in real-time allows them to actively participate in their treatment actively, promoting better treatment compliance and, ultimately, better seizure control and overall health outcomes. Wearable EEG devices' remote monitoring and telemedicine capabilities expand the reach of healthcare services to patients in remote or underserved areas. This feature improves access to expert consultations, reduces travel burdens, and promotes ongoing care for those far from specialized epilepsy centers. The wealth of EEG data collected by wearable devices contributes to ongoing research, fueling a better understanding of the complexities of epilepsy. This data-driven approach can open up new treatment options while optimizing current therapeutic strategies, paving the way for better patient outcomes and quality of life.

While wearable EEG devices appear to have promising benefits, challenges remain. Standardizing data acquisition, analysis, and interpretation protocols will ensure consistent and reliable results across devices and clinical settings. To encourage patient acceptance and

maintain trust in these technologies, user-friendly interfaces and data privacy and security concerns must be treated.

In the future, integrating wearable EEG devices with other physiological sensors could lead to a more comprehensive understanding of patients' health status and potential seizure triggers. Multimodal data integration can provide a complete picture of a patient's health, allowing for more tailored and effective treatment strategies.

7. Conclusion:

Wearable EEG devices are a potent tool in the modern epilepsy management landscape. Their real-time, continuous monitoring capabilities, combined with the possibility of personalized care and remote access, offer promising avenues for improving patient outcomes and revolutionizing epilepsy care. Wearable EEG devices will undoubtedly play a pivotal role in empowering epilepsy patients and healthcare professionals alike as research and technology advance, bringing us closer to a future of improved seizure management and a better quality of life for those living with epilepsy.

8. References:

[1] Giovagnoli AR, Paterlini C, Meneses RF, da Silva AM. Spirituality and quality of life in epilepsy and other chronic neurological disorders. Epilepsy & Behavior. 2019 Apr 1;93:94-101.

[2] Guekht A, Brodie M, Secco M, Li S, Volkers N, Wiebe S. The road to a World Health Organization global action plan on epilepsy and other neurological disorders. Epilepsia. 2021 May;62(5):1057-63.

[3] Kuroda N. Mental health considerations for patients with epilepsy during COVID-19 crisis. Epilepsy & Behavior. 2020 Oct 1;111:107198.

[4] Burakgazi E, French JA. Treatment of epilepsy in adults. Epileptic Disorders. 2016 Sep;18(3):228-39.

[5] Kuroda N. Mental health considerations for patients with epilepsy during COVID-19 crisis. Epilepsy & Behavior. 2020 Oct 1;111:107198.

[6] Sokhadze TM, Cannon RL, Trudeau DL. EEG biofeedbackas a treatment for substance use disorders: review, rating of efficacy, and recommendations for further research. Applied psychophysiology and biofeedback. 2008 Mar;33:1-28.

[7] Gotman J, Gloor P, Schaul N. Comparison of traditional reading of the EEG and automatic recognition of interictal epileptic activity. Electroencephalography and clinical Neurophysiology. 1978 Jan 1;44(1):48-60.

[8] Kakumanu RJ, Nair AK, Venugopal R, Sasidharan A, Ghosh PK, John JP, Mehrotra S, Panth R, Kutty BM. Dissociating meditation proficiency and experience dependent EEG changes during traditional Vipassana meditation practice. Biological psychology. 2018 May 1;135:65-75.

[9] Casson AJ. Wearable EEG and beyond. Biomedical engineering letters. 2019 Feb 8;9(1):53-71.

[10] Park S, Han CH, Im CH. Design of wearable EEG devices specialized for passive brain–computer interface applications. Sensors. 2020 Aug 14;20(16):4572.

[11] Casson AJ, Yates DC, Smith SJ, Duncan JS, Rodriguez-Villegas E. Wearable electroencephalography. IEEE engineering in medicine and biology magazine. 2010 May 10;29(3):44-56.

[12] Lee HS, Schreiner L, Jo SH, Sieghartsleitner S, Jordan M, Pretl H, Guger C, Park HS. Individual finger movement decoding using a novel ultra-high-density electroencephalography-based brain-computer interface system. Frontiers in Neuroscience. 2022 Oct 19;16:1009878.

[13] Almeida P, Faria BM, Reis LP. Brain Waves Classification Using a Single-Channel Dry EEG Headset: An Application for Controlling an Intelligent Wheelchair. InInternational Conference on Practical Applications of Agents and Multi-Agent Systems 2023 Jul 12 (pp. 3-14). Cham: Springer Nature Switzerland.

[14] Nwagu C, AlSlaity A, Orji R. EEG-Based Brain-Computer Interactions in Immersive Virtual and Augmented Reality: A Systematic Review. Proceedings of the ACM on Human-Computer Interaction. 2023 Jun 19;7(EICS):1-33.

[15] Cardona-Álvarez YN, Álvarez-Meza AM, Cárdenas-Peña DA, Castaño-Duque GA, Castellanos-Dominguez G. A Novel OpenBCI Framework for EEG-Based Neurophysiological Experiments. Sensors. 2023 Apr 6;23(7):3763.

[16] Shivaraja TR, Remli R, Kamal N, Wan Zaidi WA, Chellappan K. Assessment of a 16-Channel Ambulatory Dry Electrode EEG for Remote Monitoring. Sensors. 2023 Mar 31;23(7):3654.

[17] Duvinage M, Castermans T, Petieau M, Hoellinger T, Cheron G, Dutoit T. Performance of the Emotiv Epoc headset for P300-based applications. Biomedical engineering online. 2013 Dec;12:1-5.

[18] Benitez DS, Toscano S, Silva A. On the use of the Emotiv EPOC neuroheadset as a low cost alternative for EEG signal acquisition. In2016 IEEE Colombian Conference on Communications and Computing (COLCOM) 2016 Apr 27 (pp. 1-6). IEEE.

[19] Kasim MA, Low CY, Ayub MA, Zakaria NA, Salleh MH, Johar K, Hamli H. User-friendly labview gui for prosthetic hand control using emotiv eeg headset. Procedia Computer Science. 2017 Jan 1;105:276-81.

[20] Krigolson OE, Williams CC, Norton A, Hassall CD, Colino FL. Choosing MUSE: Validation of a low-cost, portable EEG system for ERP research. Frontiers in neuroscience. 2017 Mar 10;11:109.

[21] Przegalinska A, Ciechanowski L, Magnuski M, Gloor P. Muse headband: Measuring tool or a collaborative gadget?. Collaborative Innovation Networks: Building Adaptive and Resilient Organizations. 2018:93-101.

[22] Herman K, Ciechanowski L, Przegalińska A. Emotional well-being in urban wilderness: Assessing states of calmness and alertness in informal green spaces (IGSs) with muse—Portable EEG headband. Sustainability. 2021 Feb 19;13(4):2212.

[23] Finley CC, Skinner MW. Role of electrode placement as a contributor to variability in cochlear implant outcomes. Otology & neurotology: official publication of the American Otological Society, American Neurotology Society [and] European Academy of Otology and Neurotology. 2008 Oct;29(7):920.

[24] Briggs RJ, Tykocinski M, Stidham K, Roberson JB. Cochleostomy site: implications for electrode placement and hearing preservation. Acta oto-laryngologica. 2005 Jan 1;125(8):870-6.

[25] Graham BM, Adler A. Electrode placement configurations for 3D EIT. Physiological measurement. 2007 Jun 26;28(7):S29.

[26] Ball T, Kern M, Mutschler I, Aertsen A, Schulze-Bonhage A. Signal quality of simultaneously recorded invasive and non-invasive EEG. Neuroimage. 2009 Jul 1;46(3):708-16.

[27] Satija U, Ramkumar B, Manikandan MS. A review of signal processing techniques for electrocardiogram signal quality assessment. IEEE reviews in biomedical engineering. 2018 Feb 28;11:36-52.

[28] Ingolfsson TM, Cossettini A, Wang X, Tabanelli E, Tagliavini G, Ryvlin P, Benini L, Benatti S. Towards long-term non-invasive monitoring for epilepsy via wearable eeg devices. In2021 IEEE Biomedical Circuits and Systems Conference (BioCAS) 2021 Oct 7 (pp. 01-04). IEEE.

[29] Xu J, Yazıcıoğlu RF, Van Hoof C, Makinwa K. Low power active electrode ICs for wearable EEG acquisition. Berlin: Springer; 2018 Feb 12.

[30] Ghomian T, Mehraeen S. Survey of energy scavenging for wearable and implantable devices. Energy. 2019 Jul 1;178:33-49.

[31] Jiang S, Li Z, Zhou P, Li M. Memento: An emotion-driven lifelogging system with wearables. ACM Transactions on Sensor Networks (TOSN). 2019 Jan 9;15(1):1-23.

[32] Duun-Henriksen J, Baud M, Richardson MP, Cook M, Kouvas G, Heasman JM, Friedman D, Peltola J, Zibrandtsen IC, Kjaer TW. A new era in electroencephalographic monitoring? Subscalp devices for ultra–long-term recordings. Epilepsia. 2020 Sep;61(9):1805-17.

[33] Bruno E, Simblett S, Lang A, Biondi A, Odoi C, Schulze-Bonhage A, Wykes T, Richardson MP, RADAR-CNS Consortium. Wearable technology in epilepsy: the views of patients, caregivers, and healthcare professionals. Epilepsy & Behavior. 2018 Aug 1;85:141-9.

[34] McGonigal A, Bartolomei F, Chauvel P. On seizure semiology. Epilepsia. 2021 Sep;62(9):2019-35.

[35] Cao Z, Lin CT, Ding W, Chen MH, Li CT, Su TP. Identifying ketamine responses in treatment-resistant depression using a wearable forehead EEG. IEEE transactions on biomedical engineering. 2018 Oct 23;66(6):1668-79.

[36] Alshammari HH. The internet of things healthcare monitoring system based on MQTT protocol. Alexandria Engineering Journal. 2023 Apr 15;69:275-87.

[37] Chen YH, Yang J, Wu H, Beier KT, Sawan M. Challenges and future trends in wearable closed-loop neuromodulation to efficiently treat methamphetamine addiction. Frontiers in Psychiatry. 2023 Feb 23;14:1085036.

[38] Shi H, Zhao H, Liu Y, Gao W, Dou SC. Systematic analysis of a military wearable device based on a multi-level fusion framework: research directions. Sensors. 2019 Jun 12;19(12):2651.

[39] Shi H, Zhao H, Liu Y, Gao W, Dou SC. Systematic analysis of a military wearable device based on a multi-level fusion framework: research directions. Sensors. 2019 Jun 12;19(12):2651.

[40] Davey Z, Gupta PB, Li DR, Nayak RU, Govindarajan P. Rapid response EEG: current state and future directions. Current neurology and neuroscience reports. 2022 Dec;22(12):839-46.

[41] He C, Chen YY, Phang CR, Stevenson C, Chen IP, Jung TP, Ko LW. Diversity and Suitability of the State-of-the-Art Wearable and Wireless EEG Systems Review. IEEE Journal of Biomedical and Health Informatics. 2023 Jan 24.

[42] Kim H, Kwon YT, Lim HR, Kim JH, Kim YS, Yeo WH. Recent advances in wearable sensors and integrated functional devices for virtual and augmented reality applications. Advanced Functional Materials. 2021 Sep;31(39):2005692.

[43] Titgemeyer Y, Surges R, Altenmueller DM, Fauser S, Kunze A, Lanz M, Malter MP, Nass RD, von Podewils F, Remi J, von Spiczak S. Can commercially available wearable EEG devices be used for diagnostic purposes? An explorative pilot study. Epilepsy & Behavior. 2020 Feb 1;103:106507.

[44] Lee K, Choi KM, Park S, Lee SH, Im CH. Selection of the optimal channel configuration for implementing wearable EEG devices for the diagnosis of mild cognitive impairment. Alzheimer's Research & Therapy. 2022 Nov 12;14(1):170.

[45] Rong G, Zheng Y, Sawan M. Energy solutions for wearable sensors: A review. Sensors. 2021 May 31;21(11):3806.

[46] Carvalho D, Mendes T, Dias AI, Leal A. Interictal spike quantification in continuous spike–wave of sleep (CSWS): Clinical usefulness of a wearable EEG device. Epilepsy & Behavior. 2020 Mar 1;104:106902.

[47] De Zambotti M, Cellini N, Goldstone A, Colrain IM, Baker FC. Wearable sleep technology in clinical and research settings. Medicine and science in sports and exercise. 2019 Jul;51(7):1538.

[48] Karydis T, Aguiar F, Foster SL, Mershin A. Performance characterization of self-calibrating protocols for wearable EEG applications. InProceedings of the 8th ACM International Conference on PErvasive Technologies Related to Assistive Environments 2015 Jul 1 (pp. 1-7).

[49] Zhong B, Jiang K, Wang L, Shen G. Wearable sweat loss measuring devices: From the role of sweat loss to advanced mechanisms and designs. Advanced Science. 2022 Jan;9(1):2103257.

[50] Piciucco E, Di Lascio E, Maiorana E, Santini S, Campisi P. Biometric recognition using wearable devices in real-life settings. Pattern Recognition Letters. 2021 Jun 1;146:260-6.

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Review Study: Blockchain Application in Payroll System

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Keywords: Blockchain, ECC, Payrol Merkel tree, Hash, HR.

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Abstract:

In this era, where business execution is primarily reliant on information, the sooner and more precisely it is received, the better. Blockchain is great for information sharing because it provides instant, shareable, and entirely transparent data kept in an immutable ledger that only network users with permission may access. On the blockchain network, virtually any asset may be recorded and exchanged, reducing risk and expense for all parties involved. This research focuses on blockchain payroll implementation. It is critical to employ the proper tactics to preserve and improve payroll, as blockchain technology is critical for securing the payroll system because it can move both value and information. This review paper's main point is that blockchain technology can be used to reduce overhead and administrative burden, reduce tax spending, and promote openness and accountability in a variety of situations. Blockchain challenges to the payroll system and implementation issues have been highlighted. Given the quantity and complexity of blockchain issues, many of the most significant blockchain roadblocks are characteristic of any new technology's growing pains. The benefits and challenges of using blockchain technology in payroll procedures were discussed after the study. It was determined that doing so would make all employee

records and employer payments matching instantly available at the minute level to various governmental organizations. At a fraction of the cost of current payroll compliance utilizing a fiat cryptocurrency, a blockchain payroll application will provide quick payroll compliance. A blockchain framework that is approved for use with payroll systems and is encrypted using the high-efficiency encryption algorithm to ensure its high security will need to be designed and evaluated.

Keywords: Blockchain, ECC, Payroll, Merkel tree, Hash, HR.

مراجعة البحوث والأدبيات: تطبيق البلوكشين في نظام الرواتب

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في هذا العصر الذي يعتمد تنفيذ الأعمال في المقام الأول على المعلومات، كلما استقبلت المعلومات بشكل أسرع وأكثر دقة، كان ذلك أفضل. يعتبر البلوكشين تقنية لمشاركة المعلومات لأنها توفر بيانات فورية وقابلة للمشاركة وذات شفافية يتم الاحتفاظ بها في دفتر الأستاذ غير القابل للتغيير والذي لا يمكن الوصول إليه إلا لمستخدمي الشبكة الذين لديهم إذن الوصول. تسجل الأصول القيمة والمعلومات على شبكة البلوكشين ويمكن تبادله ، مما يقلل المخاطر والنفقات لجميع الأطراف المعنية. يركز هذا البحث على عمل كشوف أنظمة الرواتب المستخدمة للبلوكشين، حيث من الأهمية استخدام التكتيكات المناسبة للحفاظ على كشوف المرتبات وتحسينها، حيث إن تقنية البلوكشين ضرورية لتأمين نظام كشوف الرواتب لأنها يمكن أن تنقل القيمة والمعلومة. النقطة الرئيسية لورقة المراجعة هذه هي أنه يمكن استخدام تقنية البلوكشين لتقليل النفقات العامة والأعباء الإدارية، وتقليل الإنفاق الضريبي، وتعزيز التوسع بالتقنية في مجموعة متنوعة من المواقف. تم تسليط الضوء على تحديات أنظمة الرواتب المستخدمة للبلوكشين وقضايا التنفيذ. بالنظر إلى كمية وتعقيد مشكلات البلوكشين، تمت مناقشة فوائد وتحديات استخدام تقنية البلوكشين في إجراءات الرواتب بعد الدراسة. تقرر أن القيام بذلك سيجعل جميع سجلات الموظفين ومطابقة مدفوعات الرواتب متاحة على الفور لمختلف المنظمات الحكومية بأقل تكلفة باستخدام عملات مشفرة ، سيوفر أنظمة كشوف الرواتب المستخدمة للبلوكشين امتثالًا سريعًا لكشوف المرتبات. يجب تصميم وتقييم إطار عمل البلوكشين المعتمد للاستخدام مع أنظمة كشوف المرتبات والذي تم تشفيره باستخدام خوارزمية تشفير قوية الكفاءة لضمان أمانها العالي.

الكلمات المفتاحية: بلوكشين، طريقة تشفير **ECC**، شجرة ميركل، طريقة الهاش الترميزية، **HR**.

1. Introduction:

A blockchain is a distributed system composed of growing collections of information known as blocks that are securely linked using cryptography [1]. Each block additionally carries a timestamp and the previous block's cryptographic hash. Although blockchain records are not immutable, they are secure by design and represent a distributed computational system with a high degree of fault tolerance. **Figure 1** below depicts how a blockchain works[2].

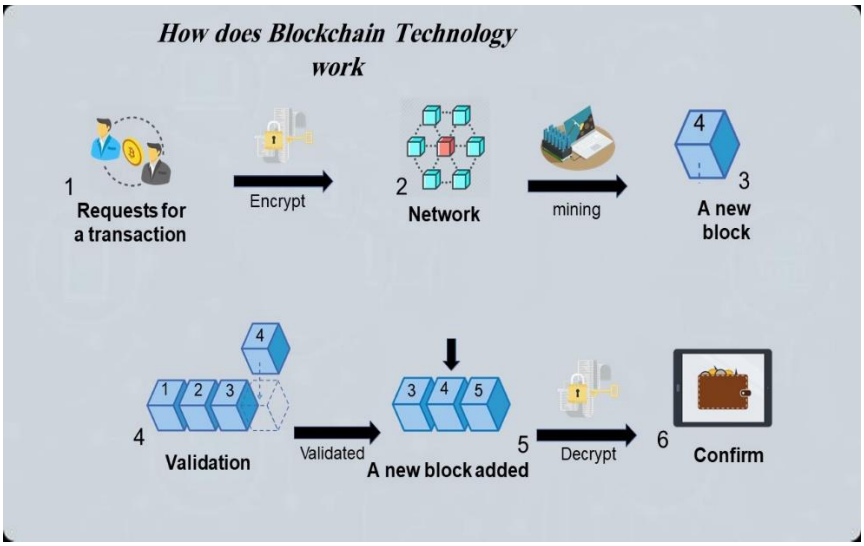

Figure 1. How blockchain works[3]

It necessitates the processing of massive amounts of personal data about employees, such as names, addresses, bank account information, Social Security numbers, and payroll information. All this private information needs to be protected from theft, loss, snooping eyes, hackers, and denial of service attacks. Given that it involves processing personal data, payroll is one of the important human resources areas that blockchain data protection regulations have an impact on. As a result, appropriate technologies must be employed to safeguard and positively affect payroll. Blockchain is a fundamental technology for protecting the payroll system that will herald in the second phase of the Internet, one in which value may be traded as opposed to only information. The General Data Protection Regulation requires the implementation of organizational and technical protections to protect personal data [4]. These metrics could include, for example, the following:

- Workstations, servers, and storage areas must be kept secure.
- Encryption protocols should be established to secure data in transit and at rest.
- Specific security policies should be developed and implemented to protect confidential data.

- Confidentiality requirements must be established to develop best practices for data protection.

  Payroll management software may have features (such as password protection, access control, secure storage, and so on) that are by certain sections of General Data Protection Regulation (GDPR) security regulations.

  Protect private payroll information; A risk assessment can help in identifying whether users, procedures, and systems put private payroll information in danger. Once possible risks have been identified, internal controls and policies can be put in place to mitigate them. Blockchain adoption will make employee payments and all associated deductions and deposits in real-time using a payroll application on the distributed ledger of the blockchain. All employee records and employer-matching payments will be immediately accessible at the audit level to different government entities. A payroll application on the blockchain will enable immediate worldwide payroll compliance at a fraction of the cost of existing payroll compliance using a fiat cryptocurrency [5].

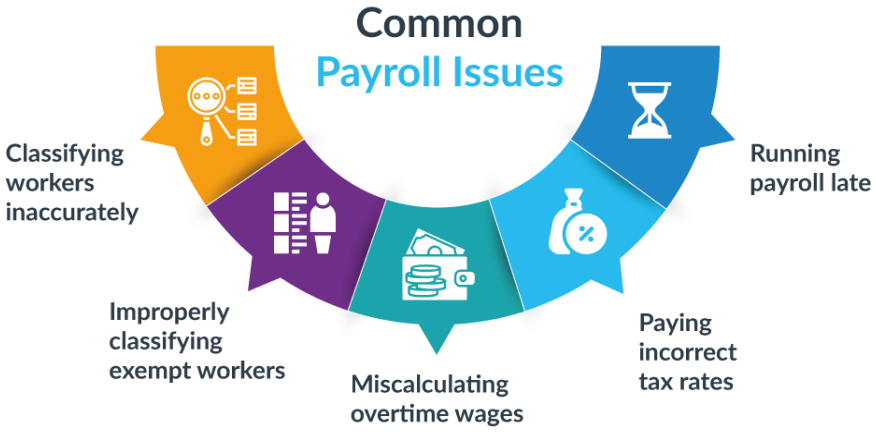

Figure 2. Risk Assessment of Payroll System[6]

2. Previous Studies

1. Bello, Musa Ibrahim, et al. were interested in Blockchain technology to reduce fraud and improve payroll system efficiency. They observed that payroll systems in poor nations suffer issues such as a lack of decentralization, phantom workers, cybercrime, and other manipulations by various groups of individuals. The difficulties of developing-country salary systems have been investigated, as well as how blockchain capabilities might be used to fix them [7]. Given the results, no proposed solution was presented to improve the efficiency of the salary system, and the matter was limited to a general proposal for

blockchain technology. This study proposed an encryption technology with a data ingestion method to protect and improve data. system efficiency.

2. Helliar et al. investigate the prevalence of both unauthorized and authorized blockchain technology in organizations. This study surveyed 67 businesses and discovered that unlicensed blockchains were less likely to be adopted due to security, scalability, and regulatory compliance concerns. Permissioned blockchains, on the other hand, were seen as more appealing due to their greater access control, lower risk of attack, and ability to integrate with existing systems. The authors do, however, point out that the level of control over licensed blockchains can limit their potential for innovation and growth. Overall, the study suggests that organizations carefully weigh the benefits and drawbacks of various types of blockchain before deciding on adoption **[8]**.
3. R. T. Ainsworth and V. Viitasaari were interested in payroll tax and blockchain technology. As financial transactions have a natural affinity with the blockchain, they positioned the development of blockchain as a technology found in the payroll path and anticipated the enormous efficiencies of the technology in reducing the cost of taxes and payments in traditional payroll services during the development of this application. The financial sector is firmly headed in this way. The experts also talked about the several obstacles that now stand in the way of applying technology around payroll, the most significant of which are: what will it take to get the blockchain up and running; regulatory compliance; and whether will businesses be able to use the blockchain. And how will you raise awareness across organizations so that everyone can see the advantages of it? Some locations might only need to upgrade to the most recent technology, depending on where it is typical to create value through technology. The second is that several legacy systems need to be migrated, and adopting blockchain technology will cost time and money **[9]**. They concluded that it would not be difficult to locate businesses willing to move their payroll to the blockchain. Of course, smaller IT firms will probably want to test the new technology on their payroll systems first. The issue was that no practical application of the study that was intended to address the issues with wage systems was offered. Restricted to field studies for other studies without putting out fresh concepts or methods.
4. P. M. Madhani Focus on Blockchain research in the industrial sphere and the key benefits of being of interest to firms, researchers, and practitioners alike. Conclude Blockchain technology can aid in the simplification of work operations and the resolution of numerous process challenges. The report outlines many blockchain qualities and derived benefits that can be used as building blocks for HR managers in various businesses to utilize blockchain

solutions [10]. The report detailed the following benefits of using blockchain in HR in several industries:

- It aids in the improvement of several HR operations.

The blockchain allows HR managers to focus more on strategic HR duties while reducing time, cost, and administrative work, allowing them to improve overall process efficiency and effectiveness.

- Blockchain deployment allows HR managers to spend more time on other strategies by more successfully managing some essential resource procedures.
- Blockchain technology improves the performance of human resources in firms where process automation is allowed by the smart contract system.
- The blockchain's state of development, prioritizing and choosing a particular human resource procedure.
- Blockchain use in the HR sector is being hampered by organizations and change resistance.

There was a discussion of the challenges facing technology applications. Human resources' ignorance of the workings of blockchain technology as well as its functions:

- Blockchain developers and the lack of qualified resources to manage it.
- The inflexibility of IQ contracts is another barrier because it could result in unfavorable outcomes (lack of accountability) in unanticipated circumstances (ie, scenarios that are not accounted for in computer codes).

The highest administrative support, organizational technological readiness, employee motivation, and training of HR specialists in blockchain adoption are the major forces behind a successful blockchain application in HR [11]. Because of the results, it was confusing for the blockchain system and devoid of a coherent conclusion for the application of the system in human resource management, and the contributions were modest without proposing and implementing new blockchain technologies.

5. H. Demirhan Discuss the efficiency of the tax collection system and how to collect taxes at the lowest possible cost. It is critical to ensure the effectiveness of the tax collection system by providing clear, controllable, secure, and real-time information. Changes and advancements in information and communication technology have driven the government to seek innovative methods of revenue collection. Where debates have focused on the application of blockchain technology (or, more colloquially, cryptocurrencies) to the public sector, as well as the application of blockchain technology in a tax system. In terms of data and transparency, the qualities, and benefits of several blockchain systems were examined.

It was determined that blockchain technology can be used in a variety of contexts to lessen the overhead expenses and administrative burden of tax collecting. Therefore, the researcher attempted to explain how blockchain technology could be used concerning taxation. Some

points were made, including how blockchain technology represents a new approach to taxation, how it decreases tax spending, how it increases transparency and accountability, how it can be used to reduce tax evasion, and how it can lighten the administrative burden of collecting taxes[12]. In this study, the characteristics, and benefits of many blockchain systems were examined and it was found that they have a benefit for the tax system, but there was no direct contribution or testing of this system. It aims to add the contribution related to the actual application of the cryptocurrency system with an encryption algorithm to obtain tangible results that support the hypotheses.

6. D. Hanggoro, et al. They talked about data storage and how it may provide privacy, security, and data integrity to keep sensitive data healthy. The researchers planned to create a blockchain application to store employee attendance data from the company's human resources department. The results of the installation reveal that the blockchain may be utilized functionally as a data storage system for attendance management and payroll systems. Furthermore, a new blockchain called Hyperledger Composer has been proposed, which has a rapid validation time and a representational state transfer API (REST API) called composer-rest-server that allows the Hyperledger blockchain to connect with other components **[13]**. Block transaction times are used to assess Hyperledger Composer's performance. The blockchain was assessed in three ways:

1. Directly inside Hyperledger Composer.
2. Using Angular web application through REST API.
3. Using JMeter through the REST API.

Consequently, testing for constructing transaction blocks varies from 1 to 17 milliseconds in a live experience in Hyperledger Composer, from 5 to 296 milliseconds when using JMeter tools with the REST API, and from 1 - 4270 milliseconds when using the Angular Web Application. The outcome demonstrates that the composer-rest-REST server's API performs better than Ethereum in terms of clock speed. Given the typical transaction time, it was found through these results that the composer-rest-server can manage systems that need quick transaction times, like voting systems, health monitoring, and Internet of Things (IoT) applications. It has been concluded from this study that there are techniques and a practical application used that show the success of the blockchain system in managing the payroll system, but there was no contribution in the aspect of protection and data security, as no algorithm was proposed to protect and encrypt the data. The aim is to propose an encryption algorithm such as ECC to ensure high security in the payroll system.

7. Huaqun Wang, et al. are interested in the secure storage of remote data by cloud computing, to verify the integrity of the data remotely. A special model based on a proven secure blockchain and relying on RSA encryption technology is proposed. At the same time, the system performance is analyzed in two parts: Analysis of theory and model implementation. The results show that the proposed PDP scheme is safe, effective, and practical. The conclusion from this study is good in the field of building a system based on blockchain technology to store and protect data. The weakness of this study lies in the use of the RSA algorithm to protect data, as its encryption is weak and takes a long time due to the use of two keys for encryption and decryption. The authors demonstrated that their scheme can effectively protect the privacy and integrity of outsourced data while maintaining high efficiency **[14]**.
8. Chen, Lanxiang, et al. in this article stated, electronic health records (EHRs) have data leaks that jeopardize patient privacy (eg health conditions). Since the EHR data often doesn't change after being uploaded to the system, the blockchain can be utilized to make it easier to share this data. A searchable, blockchain-based encryption scheme for electronic health records has been made. The results showed that the proposed technology ensures the integrity, anti-tampering, and traceability of the electronic health record index. Because of the conclusions, we find that there is a lack in the process of securing data content and weak encryption methods that are not based on advanced protection algorithms. Protecting data content is not only preventing access to it. The content must be encrypted to prevent unauthorized persons who have succeeded in accessing the data from reading its content. The study concluded that blockchain-based searchable encryption is a promising approach for improving the security and privacy of EHR sharing, and the proposed scheme offers good performance and scalability for practical applications **[15]**.
9. Owoh, N.P., and M.M. Singh, the Proposed study was concerned with the implementation of the blockchain on a large scale. It proposed securing. Sensitive sensor data in a mobile (client/server) blockchain. To this end, an integrated mobile blockchain framework has been proposed that guarantees the master agreement between clients and edge nodes. For efficient encryption of the sensor data, the Diffie-Hellman algorithm was used. Finally, the processes in the framework were analyzed and the results showed that the key pairing between the blockchain client and the edge node is a good process and the data encoded in the framework file is secure as the attacker cannot gain privacy **[16]**. The conclusion from this study is that mobile applications with blockchain did not give convenient and strong connections due to

edge nodes (mining). In addition, the encryption process is heavy and not fast and requires a small key level to obtain the maximum level of security using a shared secret.

10. [17] Feng, Qi, et al. suggested protecting cryptocurrencies and discovered that key protection alone is not sufficient in protecting currencies, and to avoid hacking, a fraudulent key or key theft was used. It has been focused on the Edwards-curve Digital Security Algorithm (EdDSA), which contains many technologies that have been implemented in many cryptocurrencies (such as Cardano, Zcash, and Decred) and designed EdDSA's first effective two-party signature protocol. The security of the proposed protocol is mathematically proven. Results from a performance evaluation of the protocol show that it performs well for the Ed25519 curve, with a single signature operation in the malicious setup taking about 3.32ms between two devices. It was concluded that there are more processes and devices to work using the multiplier EdDSA's proposed protocol incurs fairly large computational and communication costs. Therefore, one possibility is to design an optimized version that is compatible with many devices. The contribution of this study lies in the development of a practical and secure two-party EdDSA signature scheme with key protection, which can enhance the security of cryptocurrency systems and other applications that use EdDSA signatures.
11. Liang, Yifei, and others concluded that a blockchain-based DSA test platform should be built for spectrum management. They state that deploying blockchain in future networks has the advantage of addressing problems exposed in traditional centralized spectrum management systems, such as high-security risks and low allocation efficiency. It was found that the blockchain-based spectrum reference architecture can be employed in the next generation of mobile communications, 6G **[18]**. The problems of this research are related to testing the proposed mechanisms and system evaluation for each form in various 5G and/or 6G mobile communications. A series of mechanisms need to be developed to support the proposed blockchain-based spectrum management architecture, which includes a capacity generation mechanism, an incentive mechanism, and a pricing mechanism, among many others.

3. Discussion

As previously stated, Blockchain technology can boost the effectiveness of payroll systems, which is a critical operation for every government, industry, and other organization because it ensures it.

Employees should be paid on time and accurately. Furthermore, payroll systems face challenges from decentralized Blockchain technology, ghost workers, cybercrime, and other human manipulations. Depending on **Table 1** the blockchain's capabilities can be used to overcome problems with payroll systems in developing countries. The proof of authority for the encryption algorithm used was the best study result also, the security requirement was the most logical and successful in security applications in terms of verification and scalability as well as audibility, privacy, and Anonymity. The remainder of the paper demonstrates how blockchain technologies are a promising approach to minimizing payroll system issues. the challenges It was explained by an examination of the current literature. The significance of blockchain technology in general, as well as its application in payroll, has been explained.

In **Table 1** Requirement for Studies has been mentioned. From the Security requirement field, some criteria were used to measure the efficiency and safety of the system in the studies presented.

- Verifiable has an Information Security Program in place to secure the confidentiality, integrity, and availability of information assets while also meeting regulatory, industrial, and contractual obligations **[19]**.
- Security Compliance is a process that an organization undergoes to ensure that it complies with the set standards and regulations **[20]**.
- System Capability is the ability of a system to execute a particular course of action or achieve a desired effect, under a specified set of conditions **[21]**.
- Expense Management and Processing ensures that every expense claim is accounted for and reimbursed as quickly as possible while keeping tabs on all activities **[22]**.
- Payroll Tax Management software mitigates the organization's and payroll system's responsibilities for payroll tax rates **[23]**.
- Scalable security is a security approach and toolset that may grow or decrease capacity to handle a greater or smaller load, based on demand changes **[24]**.
- Completeness is to ensure that a comprehensive set of requirements has been produced and documented that describes all security system functions required to meet needs, as well as their associated performance, environmental, and other non-functional requirements **[25]**.
- Privacy is the right to decide how information is viewed and utilized, and it includes skills like using tools and managing information shared online **[26]**.
- Eligibility is a determination that a system is able and willing to safeguard classified security information. The three security clearance eligibility levels are: Confidential, Secret, and Top Secret **[27]**.

Table 1. Blockchain Requirement for Studies

References	Schema name	Publication year	Blockchain Type	Framework	Encryption algorithm used	Security requirement								
						Eligibility	Security and Compliance	Privacy	Completeness	System Capabilities	Payroll and Tax Management	Expense Management and Processing	Scalability	Verifiability
[7]	Potentials of Blockchain Technology for Payroll Systems	2022	Private	Hyperledger	Symmetric key crypto	√	√	√	x	√	√	√	x	√
[8]	Permissionless and permissioned blockchain diffusion	2020	Private	Ethereum	cryptocurrency	√	√	x	x	√	√	√	x	x
[9]	Payroll tax & the blockchain	2017	Private	Ethereum	cryptocurrency	x	√	√	x	√	√	√	x	√
[10]	Blockchain Applications in HR: Key Advantages	2022	Public	Hyperledger	Symmetric key crypto	√	√	√	x	√	√	√	x	√
[11]	Role of Blockchain in HR's Response to new-normal	2021	Private	Hyperledger	Proof of Authority	√	√	√	x	√	√	√	√	√
[12]	Effective taxation system by blockchain technology	2019	Public	Hyperledger	Symmetric key crypto	x	√	√	x	√	√	√	x	√
[13]	Blockchain-based Attendance Management and Payroll System using Hyperledger Composer Framework	2022	Private	Hyperledger	Proof of Authority	√	√	√	√	x	√	√	x	√
[14]	Blockchain-based private provable data possession	2019	Private	Hyperledger	RSA	x	√	√	x	√	√	√	x	√
[15]	Blockchain-based searchable encryption for electronic health record sharing	2019	Private	Ethereum	Symmetric key crypto	x	√	√	x	x	√	√	√	√
[16]	Applying the Diffie-Hellman algorithm to solve the key agreement problem in mobile blockchain-based sensing applications	2019	Public & Private	Ethereum	Diffie-Hellman	x	√	√	x	√	x	√	x	√
[17]	Practical Secure Two-Party EdDSA Signature Generation with Key Protection and Applications in Cryptocurrency	2020	Public & Private	Hyperledger	EdDSA	√	√	√	x	√	√	√	x	√
[18]	Interference-based consensus and transaction validation mechanisms for blockchain-based spectrum management	2021	Private	Ethereum	Asymmetric key crypto	x	√	√	x	√	√	√	x	√

4. Challenges of Blockchain for Payroll System

Relying on previous studies and conclusions, the major challenges of blockchain technology were diagnosed as mentioned below:

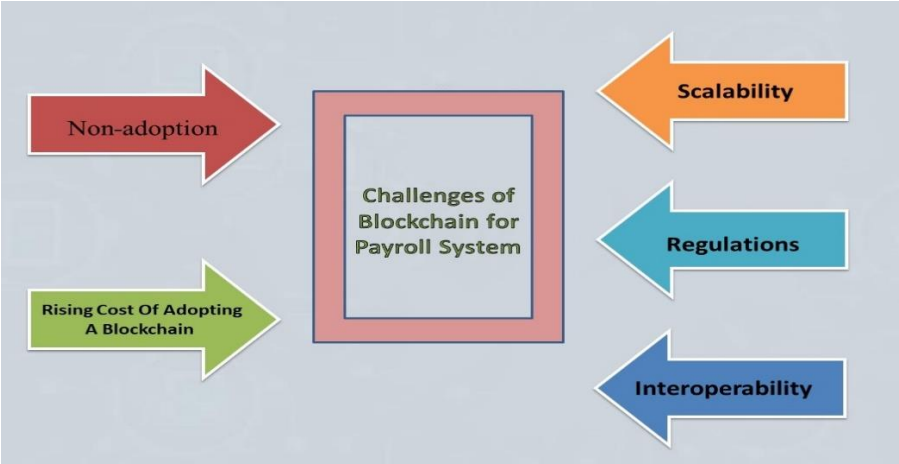

Figure 3. Blockchain challenges[28].

- **Non-adoption**

When used by a large user base, blockchains operate more effectively and efficiently. For instance, the blockchain ecosystem will need suppliers as well as users to sign up for the network. However, according to researchers, only 29% of businesses are actively experimenting with or utilizing the blockchain. Blockchains will remain inefficient and scalable without mass usage **[29]**.

- **The rising cost of adopting a blockchain**

It all comes down to early financial investments. Implementation costs can be prohibitively expensive for some businesses. Even though most existing solutions are free, significant expenditure is required when hiring qualified software engineers that specialize in blockchain development, license fees if moving to a downloadable software version, thorough maintenance, and other costs. It is one of the most significant obstacles to blockchain implementation **[30]**.

- **Scalability**

The key challenge in implementing it is scalability. Although transaction networks can handle hundreds of transactions per second without fail, transaction processing slows significantly when it comes to Bitcoin (approximately 3-7 transactions per second) and Ethereum (about 15-20 transactions), making the blockchain not widely useful. applications of scope

- **Regulations**

The next area that may encounter challenges is a lack of regulation. Scams and market manipulation that could lead to a worldwide economic collapse are not unthinkable. As a result, Bitcoin has received a great deal of unfavorable attention from people all around the world. Some nations have explicitly outlawed Bitcoin, while others have attempted, with limited success, to regulate blockchain networks **[31]**.

- **Interoperability**

One of the key problems that needs to be solved is interoperability, as this is one of the main reasons why businesses have been slow to adopt blockchain technology. Due to its inability to send and receive data from other blockchain-based systems, the majority of the blockchain is kept in isolation and does not interact with peer networks **[32]**.

Other difficulties are caused by the absence of a universal standard. The lack of a global standard led to interoperability issues that increased costs and complicated procedures. The lack of a specific version of blockchain technology discourages new investors and developers from entering the market.

Given the number and complexity of these blockchain issues, though, many of the blockchain's biggest hurdles reflect the typical growth pains with any new technology. We conclude that the above-mentioned difficulties give the need for technological improvements, as evidenced by the list of challenges of Blockchain adoption. Also, payroll systems are busy dealing with it. Things will undoubtedly become more interesting if they are fixed and the many bottlenecks that currently prevent widespread adoption can be narrowed down and can be used in different storage areas as these problems do not affect the business fundamentally.

5. Blockchain Benefits in Payroll Processes

In a decentralized system, blockchain transaction ledgers may be easily tracked. It contributes to a more transparent and indisputable transaction history. The employee payroll management system must adhere to numerous rules, and blockchain will aid in reducing inconsistencies and saving time for the HR department.

Payroll management software today aids in the tracking of time, attendance, benefits, payroll, fraud prevention, and schedule management. Business HR leaders are investigating the use of blockchain in the aforementioned processes to streamline and power them **[33]**.

The use of blockchain technology will improve the payment procedure for contract workers. Organizations, institutions, and universities will have a workforce that functions on a contract basis in addition to full-time personnel. Because the bills must be verified, these contract workers must wait longer to be paid. Companies that use blockchain payroll processing software may automate the verification process and pay contract workers as soon as the work is performed **[34]**.

Blockchain will offer precise time and attendance information. Blockchain technology protects the accuracy of the employee database and prevents tampering with it. This means that payroll software with blockchain for small enterprises, schools, and colleges will ensure that the time, attendance, and departure data recorded by the system is true and that no one has tampered with the database **[35]**.

Businesses and governmental entities will be able to use cryptocurrency for payment. Decentralization is the best feature of cryptocurrencies, so it will be advantageous for many reasons if the payroll processing software pays the employee in cryptocurrencies. The first step will be the adoption of uniform remuneration for the whole workforce, which will end global inequity. Many governments throughout the world either do not accept or outright forbid cryptocurrencies. These nations must pay in local currency because using cryptocurrency is not an option for them. Blockchain-enabled payroll software will guarantee the accuracy, speed, and transparency of payroll processes **[36]**.

We determined that incorporating blockchain into payroll software will completely transform the labor and payment processes. Blockchain can transform many facets of human resources and payroll operations.

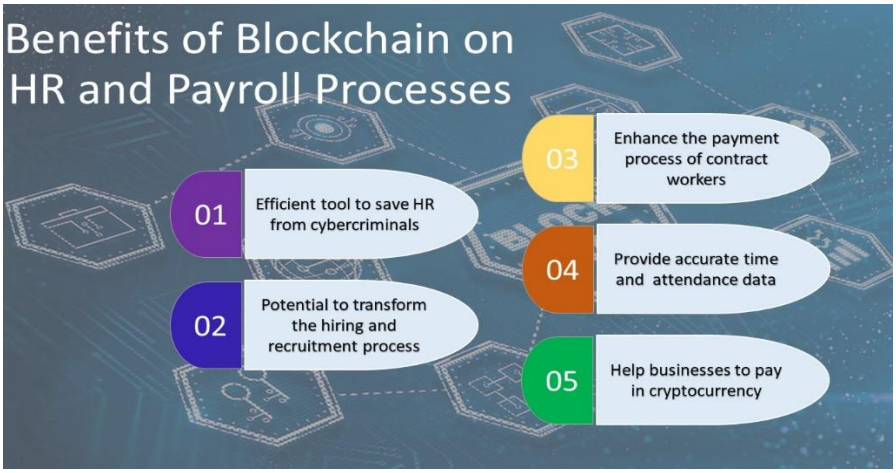

Figure 4. Blockchain Benefits on Payroll System[37].

6. Conclusion

It was concluded that the blockchain is solution-driven in the issues of the payroll system and in managing the business efficiently and effectively. It is a technology that has the ability and capabilities to solve problems related to payroll systems.

Such as centralization, data manipulation and inconsistency, cybercrime, phantom workers, and seamless auditing. An authorized blockchain will establish decentralization, data integrity, data availability, transparency, and space for data auditing. In this paper, we have outlined the capabilities and capabilities of the blockchain and how it can fit into solving salary issues as well as challenges in applying the technology. It was concluded that the application of blockchain technology to the payroll system will make all records of employees and matching payments of employers immediately available at the audit level to various government agencies. Implementing payroll on the blockchain will enable instant payroll compliance around the world at a fraction of the cost of current payroll compliance using a fiat cryptocurrency.

Future research is required to design and evaluate a blockchain framework that is authorized for payroll systems and is encrypted by the high-efficiency block encryption algorithm to ensure their high security.

7. References

[1] Jumaa MH, Shakir AC. Iraqi E-Voting System Based on Smart Contract Using Private Blockchain Technology. 2022.

[2] Vivekanadam B. Analysis of recent trend and applications in blockchain technology. 2020.

[3] National Institute. How does a transaction get into the blockchain. 2020 [cited 2022 Dec 22]. Available from: https://www.euromoney.com/learning/blockchain-explained/how-transactions-get-into-the-blockchain

[4] Shilpa K, et al. Blockchain Based Freelancing System. Integrated Emerging Methods of Artificial Intelligence & Cloud Computing. 2022. p. 315-27.

[5] Berryhill J, Bourgery T, Hanson A. Blockchains unchained: Blockchain technology and its use in the public sector. 2018.

[6] Lucas S. Payroll Audit: Objectives, Process & Checklist. 2022 [cited 2022 Dec 22]. Available from: https://www.aihr.com/blog/payroll-audit/

[7] Bello MI. Potentials of Blockchain Technology for Payroll Systems. 2022.

[8] Helliar CV, et al. Permissionless and permissioned blockchain diffusion. 2020.

[9] Ainsworth RT, Viitasaari V. Payroll tax & the blockchain. 2017.

[10] Madhani PM. Blockchain Applications in HR: Key Advantages. 2022.

[11] Chillakuri B, Attili VP. Role of blockchain in HR's response to new-normal. 2021.

[12] Demirhan H. Effective taxation system by blockchain technology. 2019. p. 347-60.

[13] Hanggoro D, Windiatmaja JH, Sari RF. Blockchain-based Attendance Management and Payroll System using Hyperledger Composer Framework. 2022 IEEE Region 10 Symposium (TENSYMP). 2022. p. 1-6.

[14] Wang H, Wang Q, He D. Blockchain-based private provable data possession. 2019.

[15] Chen L, et al. Blockchain based searchable encryption for electronic health record sharing. 2019.

[16] Owoh NP, Singh MM. Applying Diffie-Hellman algorithm to solve the key agreement problem in mobile blockchain-based sensing applications. 2019.

[17] Feng Q, et al. Practical Secure Two-Party EdDSA Signature Generation with Key Protection and Applications in Cryptocurrency. 2020 IEEE 19th International Conference on Trust, Security and Privacy in Computing and Communications (TrustCom). 2020. p. 137-47.

[18] Liang Y, et al. Interference-based consensus and transaction validation mechanisms for blockchain-based spectrum management. 2021.

[19] Hao Z, Zhong S, Yu N. A privacy-preserving remote data integrity checking protocol with data dynamics and public verifiability. 2011.

[20] Julisch K. Security compliance: the next frontier in security research. Proceedings of the 2008 New Security Paradigms Workshop. 2008. p. 71-4.

[21] Geudtner D, et al. Sentinel-1 system capabilities and applications. 2014 IEEE Geoscience and Remote Sensing Symposium. 2014. p. 1457-60.

[22] Fletcher WL. Expense management strategies within financially successful Christian universities. 2015.

[23] Tang J, Feng J. Collecting system and payroll tax compliance: Evidence from Chinese firm-level data. 2021.

[24] Oh SR, Kim YG. Security requirements analysis for the IoT. 2017 International Conference on Platform Technology and Service (PlatCon). 2017. p. 1-6.

[25] Firesmith D. Are your requirements complete? 2005.

[26] Jumaa MH, Shakir AC. Review Study of E-Voting System Based on Smart Contracts Using Blockchain Technology. 2023.

[27] Borjas GJ. Social security eligibility and the labor supply of older immigrants. 2011.

[28] Iredale G. Top 10 Blockchain Adoption Challenges. 2021 [cited 2022 Dec 23]. Available from: https://101blockchains.com/blockchain-adoption-challenges/

[29] Batubara FR, Ubacht J, Janssen M. Challenges of blockchain technology adoption for e-government: a systematic literature review. Proceedings of the 19th annual international conference on digital government research: governance in the data age. 2018. p. 1-9.

[30] Tasatanattakool P, Techapanupreeda C. Blockchain: Challenges and applications. 2018 International Conference on Information Networking (ICOIN). 2018. p. 473-5.

[31] Monrat AA, Schelén O, Andersson K. A survey of blockchain from the perspectives of applications, challenges, and opportunities. 2019.

[32] Khan D, Jung LT, Hashmani MA. Systematic literature review of challenges in blockchain scalability. 2021.

[33] Viriyasitavat W, Hoonsopon D. Blockchain characteristics and consensus in modern business processes. 2019.

[34] Karaszewski R, Modrzyński P, Modrzyńska J. The use of blockchain technology in public sector entities management: an example of security and energy efficiency in cloud computing data processing. 2021.

[35] Ismatov A, Enriquez VG, Singh M. FaceHub: Facial Recognition Data Management in Blockchain. 2021. p. 135-53.

[36] Tasca P, Hayes A, Liu S. The evolution of the bitcoin economy: Extracting and analyzing the network of payment relationships. 2018.

[37] Kotwal M. How Will Blockchain Revolutionize The Payroll System. 2021 [cited 2022 Dec 23]. Available from: https://technologycounter.com/blog/blockchain-revolutionize-the-payroll-system

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Active and phenolic compounds in Spirogyra sp. PDNA1 is an antibiotic for some bacteria and fungi

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Keywords: Algal Antibiotics, Spirogyra sp. Phenols, Algal extract active compounds.

Article History

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Abstract:

Green algae are a biological source rich in phenolic compounds and potentially inhibit the growth of microorganisms. Spirogyra sp. PDNA1 is one of the most types of green algae found in freshwater. Because of the increasing resistance of most bacteria and fungi to available antibiotics, a continuous search is required for the most effective, economical, and environmentally friendly alternatives. There are 30 compounds were identified, including alkaloids, phenols, and esters, and the highest percentage was oleic acid, with a retention time of 21.949 min and a concentration of 32.89%. The highest percentage of inhibition showed on the bacteria for the methanolic algal extract was against Salmonella typhi (22.5 mm), while the lowest percentage of it was against Bacillus cereus (10 mm). The hexane extract had the highest inhibition percentage against Salmonella typhi (19.5 mm) and the lowest inhibition percentage against Klebsiella pneumoniae (11 mm). It was also noted that the effect of the methanolic extract was highest against Trichoderma asperallum (22 mm) and the lowest percentage of inhibition against Candida albicans (7 mm), while the hexane extract recorded the highest percentage of inhibition against Candida albicans (15 mm) and the lowest percentage of inhibition was against the fungus Aspergillus Niger with inhibition diameter (8 mm). Phenols

were identified by HPLC technology. The phenolic compounds included Rutin, Gallic acid, Tannic acid, Quercetin, and Kaempferol, where the highest percentage of Rutin was in the phenolic methanolic extract (240.99) ppm, Kaempferol (7.2124) ppm, while the phenolic hexane extract had the highest percentage of Rutin (19.606) ppm, Kaempferol (10.997) ppm. The phenols showed the highest inhibition rate of the phenolic-methanolic extract against (Klebsiella pneumoniae) (30) mm and the least inhibition against (Escherichia. coli) (11) mm while the phenolic hexane extract has the highest inhibition to (Salmonella typhi) (27) mm and the lowest effect was against (Escherichia coli) (10) mm. The antifungal effect of the phenolic methanolic extract recorded the highest percentage against (Candida albicans) (30) mm and had the lowest effect on Mucor racemosus (18) mm, while the phenolic hexane extract had the highest effect with Candida albicans (22.5) mm, and the least inhibition percentage was in Mucor racemosus with (11) mm. Therefore, the study aimed to isolate and identify the effective compounds of the methanolic and hexanoic extract of this algae, and active phenolic compounds were detected using GC-MS and HPLC technology.

Keywords: Algal Antibiotics, Spirogyra sp. Phenols, Algal extract active compound.

المركبات الفعالة والفينولية في طحلب *Spirogyra* sp. PDNA1 كمضاد حيوي لبعض البكتريا والفطريات

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تعد الطحالب الخضراء مصدرًا بيولوجيًا غنيًا بالمركبات الفينولية ولها دور محتمل في تثبيط نمو الكائنات الحية الدقيقة مثل البكتيريا والفطريات المسببة للأمراض للإنسان. أن طحلب Spirogyra sp. PDNA1 هو أحد أكثر أنواع الطحالب الخضراء الموجودة في المياه العذبة، بسبب المقاومة المتزايدة لمعظم البكتيريا والفطريات للمضادات الحيوية المتاحة والشائعة، يتوجب البحث المستمر عن البدائل الأكثر فعالية واقتصادية وصديقة للبيئة. تم تحديد ٣٠ مركبًا ، بما في ذلك القلويدات والفينولات والإسترات في مستخلصات الطحلب، وكانت أعلى نسبة هي لحامض الأوليك ، مع زمن احتباس ٢١,٩٤٩ دقيقة وبتركيز ٣٢,٨٩٪. كانت أعلى نسبة تثبيط لمستخلص الطحالب الميثانولي ضد Salmonella typhi بقطر (٢٢,٥ ملم) ، بينما وكانت أقل نسبة له ضد بكتيريا Bacillus cereus (١٠ ملم) أما بالنسبة لمستخلص الهكسان فقد كان له أعلى نسبة تثبيط ضد Salmonella typhi بقطر تثبيط (١٩,٥ ملم) وأقل نسبة تثبيط ضد Klebsiella pneumoniae بقطر تثبيط (١١ ملم). كما لوحظ أن تأثير المستخلص الميثانولي ضد الفطريات كان أعلى ضد فطر Trichoderma asperallum بقطر (٢٢ ملم) وأقل نسبة تثبيط ضد Candida albicans بقطر (٧ ملم). بينما سجل المستخلص الهكساني أعلى نسبة تثبيط لفطر Candida albicans بقطر تثبيط (١٥ ملم) وأقل نسبة تثبيط كانت ضد فطر **A.** Niger بقطر تثبيط

(٨ ملم). علاوة على ذلك ، تم عزل الفينولات وتشخيصها بواسطة تقنية HPLC. اشتملت المركبات الفينولية على Rutin, Gallic acid, Tannic acid, Quercetin, Kaempferol ، حيث كانت أعلى نسبة Rutin في مستخلص الفينول الميثانولي (٢٤٠,٩٩ ppm) Kaempferol (٧,٢١٢٤ ppm)، بينما احتل مستخلص الفينول الهكسان أعلى نسبة من Kaempferol (١٠,٩٩٧ ppm) بالإضافة إلى ذلك ، أظهرت الفينولات أعلى معدل تثبيط Rutin (19.606) ppm للمستخلص الفينول الميثانولي كان ضد (Klebsiella pneumoniae) بقطر تثبيط (٣٠) ملم وأقل تثبيط ضد (Escherichia coli) مع قطر تثبيط (١١) ملم بينما أظهر مستخلص الهكسان الفينولي أعلى نسبة تثبيط لـ (Salmonella typhi) بقطر (٢٧) ملم وأقل تأثير كان ضد (Escherichia coli) بقطر (١٠) ملم. سجل تأثير المستخلص الفينولي الميثانولي أعلى نسبة ضد (Candida albicans) بقطر ٣٠ملم وأقل تأثير عـــــلى 18 ((Mucor racemosus ملم ، بينما كان لمستخلص الفينول الهكسان أعلى تأثير مع (Candida albicans) بقطر ٢٢,٥ ملم واقل نسبة تثبيط كانت في Mucor racemosus بقطر (١١) ملم. هدفت الدراسة إلى عزل وتحديد المركبات الفعالة للمستخلص الميثانولي والهكساني لهذا الطحلب والمركبات الفينولية التي تم الكشف عنها باستخدام تقنيتي GC-MS وHPLC.

الكلمات المفتاحية: المضادات الحيوية الطحلبية ، فينولات.*Spirogyra* sp ، المركبات الفعالة للمستخلص الطحلبي.

1. Introduction:

Algae are living, autotrophic organisms, and they represent a wide range of organisms that can carry out the process of photosynthesis, and they are widespread on the surface of the globe as they live in land and water areas [1], and they have recently found popularity in scientific research and various industrial fields because of their direct and indirect relationship in different areas of human life, as they are a source of many vital active compounds [2].

Algae produce various compounds such as alkaloids, carbohydrates, fatty acids, vitamins, enzymes, and proteins [3]. It is also a useful source of phenolic compounds. Although these compounds are usually associated with plants, algae are also a rich source of these compounds [4]. Phenols are used in various fields such as the agricultural, food, industrial, and pharmaceutical fields, they are anti-inflammatory and effective against the human immunodeficiency virus (HIV) [5].

Phenols are a class of organic chemical compounds that are structurally composed of a hydroxyl functional bond directly to an aromatic hydrocarbon. The name phenols are attributed to the simplest of these compounds, which is phenol C_6H_5OH. Phenols can be simple, or they can be multiple according to the number of phenol groups in the molecule. Phenols exist in nature in the form of several compounds, and they can also be obtained industrially [6].

Spirogyra alga

This alga classification is Division: Chlorophyta, Class: Charophyceae, Order: Zygnematales, Family: Zygnemataceae, Genus: *Spirogyra* [7, 8].

It is a genus of filamentous green algae consisting of thin, unbranched chains of cylindrical cells whose width ranges between (10-100) micrometers and whose length is greater than its width and may reach several centimeters. The cell wall is made of an inner layer of cellulose and an outer layer of pectin, which is responsible for the sticky texture of algae, so it is called water silk and can produce masses that float near the surface of streams and ponds supported by oxygen bubbles emitted in the process of photosynthesis **[9,10].**

2. Materials and Methods

2.1 Preparation of crud alga extract

These samples (*Spirogyra* sp.) of algae were obtained from environments in Nineveh governorate in Bartella sub-district / Shaquli village (East of Mosul city). They were obtained from a narrow stream estimated at (1.0 m) coming from the connection of a small spring of water (freshwater) to a spring of water smaller than Ein al-Awwal (sulfuric water) that pass through the village of Shaquli toward the village of Karmelos in the Hamdaniya district, where it is located near the mountain of Ain al-Safra. To the southwest, it is bounded by the Tigris River, and the Bartella district represents a raining area of 425 mm/year (The algae samples were collected then washed and dried in Oven at 40 C° to obtain algae dry weight (DW). The dry mass of the alga under study was used and crushed using a small ceramic mortar and an electric grinder. The dried alga powder was placed in a Whatman type 1 filter paper and arranged in such a way as to be a cellulose thimble (Soxhlet) **[11]**. Then, the transferring of the extract was done to the round flask (after emptying the separation column) of the rotary evaporator to reduce the volume of the solvent and reuse it again and transfer the resulting extract to a small airtight container for use in measurements and determination of the active compounds in it **[12]**. The methanolic algae extract was prepared in the same way with the change of the solvent (hexane) using methanol. The chemical constituents of *Spirogyra elongate*, successively extracted with petroleum ether, methylene chloride, chloroform, acetone, and methanol were determined by GC–MS. The extract percentage varied greatly between different solvents, with the highest one (4.83%) recorded for methanol **[13,14]**As well as, the highest yield of total phenolic compounds for *Spirogyra* was found when sonicated at 45 kHz with methanol **[15]**.

2.2 Identification of biologically active compounds using Gas Chromatography-Mass Spectrometry(GC-MS)

To identify the active compounds using GC-MS, the volume of the methanolic extract was reduced and the solvent was removed by a rotary evaporator device. The analysis of the

components of the methanolic extract was carried out in the central chromatography laboratory / College of Agriculture and Forestry / Food Research and Protection Laboratories Consumer - University of Basrah using gas chromatography connected to the mass spectrometer. The GC-MS type (QP 2010) supplied by a Japanese company, Shimadzu, contains a capillary separation column with dimensions (diameter 0.32, thickness of the static phase 0.25 micrometers, length 30 meters) in which high-purity helium gas was used as a directed gas with a flow rate of (1.69 ml/min) and the initial temperature was programmed in it from 50 to 280 ˚m. Samples were injected into it by direct injection at the top of the separation column through a plug The compounds were identified by comparing them with materials with known structure by comparing them with the database of known compounds in the GC-MS library and relying on the evidence of retention for each compound. Whereas the hexane extract was detected previously for the same sample of this alga in the study of **[16]**.

2.3 Acidolysis and isolation of phenols from crude hexane and methanolic extracts

Since phenols do not exist in a free form, but are linked by a glycosidic bond with sugar, so they are in the form of glycosides inside the plants, and to purify and characterize the phenols, the process of acid hydrolysis is carried out to break the glycosidic bonds and liberate the phenols from the sugar, depending on the method of the researcher Harborne (1973) and using 200 ml of hydrochloric acid (HCL) with a concentration of 2 molars as a solvent for 4 ml of the alcoholic extract of the algae under study as they were placed In a glass beaker, the mixture was heated in a rocking water bath at a temperature of 100-90 °C for half an hour, then it was left to cool at the laboratory temperature, then it was placed in a separating funnel and 200 ml of ethyl acetate was added to it in two stages. Ethyl for all algae species under study is placed on the bottom layer and shaken well in the separation funnel. Two layers are also formed and concentrated using a rotary vacuum evaporator to obtain the ethyl acetate extract and then kept in the refrigerator until use. The phenolic extract is separated from the hexane algae extract in the same way **[17].**

2.4 Identification of active phenolic compounds using high-performance liquid chromatography (HPLC)

The separation device used is High-Performance Liquid Chromatography (HPLC), which relies on the capillary and polar property, to separate the phenolic compounds separated from plants, as most of these compounds are characterized by being weakly acidic, that is ionizes under basic conditions and dissolves in polar solvents easily **[18,19]**. As the diagnostic process for these compounds was carried out in the HPLC Lab/Mosul the decomposition process for them using a high-performance liquid chromatography (HPLC) type. Shimadzu, Japan) where

the carrier phase was used: methanol: distilled water (75: 25) and the separation column was (C18 - ODS) with dimensions (25 cm * 4.6 mm) to separate phenols and the use of an ultraviolet detector: UV 280 nm, where the flow rate of the carrier phase was 1ml/min. The concentration of the unknown sample (ml/µg) was calculated = area of the sample \ area of the standard x concentration of the standard solution x volume of extract (ml) \ weight of the unknown sample (g) **[20]**.

2.5 Antibacterial activity of green algae extracts

The sensitivity method (diffusion in agar well) was used according to the method of **[21]** and to test the inhibitory effectiveness of the extracts used under study. Young colonies of pathogenic bacteria were transferred to the nutrient broth medium and incubated at a temperature of 37 °C for 24 hours. The diluted bacterial suspension was spread on the nutrient agar medium in a homogeneous manner using a sterile cotton swab. The Agar Wells Diffusion Method was adopted to study the effect of the extracts on the bacteria, as holes were made in the nutrient agar using a stainless still pourer with a diameter of 6 mm and the extracts were added at a volume of 50 microliters to each hole.

2.6 Antifungal activity of green algae extracts

The Well Diffusion Method **[22]** was prepared. Potato dextrose agar (PDA) fungus development medium was prepared under sterile conditions, poured into Petri dishes, then inoculated with pathogenic fungi with a diameter of 6 mm, and extracts were added at a volume of 50 microliters to each well.

3. Results and Discussion

The results of the GC-MS technique for the methanolic extract of *Spirogyra* alga showed the active compounds, where 30 compounds were identified including alkaloids, phenols, and esters, and the highest percentage was for the compound Oleic acid for a retention time of 21.494 minutes and a concentration of 32.89%, as in Table (1) and Figure (1,2). One of the reasons for inhibition with algae extracts is that they contain steroidal fatty and protein compounds that have an inhibitory effect on bacteria. Also, pigments and their derivatives such as chlorophyll and carotene have activity against bacteria, and fatty acids have antibacterial activity against positive and negative bacteria. The fatty acids alone or in combination have either a Bacteriostatic or a Bactericidal effect **[23]**. The terpenes, Neophytadiene and Phytol, were present in methanolic extracts of the (*Spirogyra longata*). Both phytocompounds were detected in several plants and some microalgae **[24]**.The phytocompounds constituents of two species of Rhodophyta, *Liagora divaricata* and *Trematocarpus flabellatus* methanol solvent.

GC-MS analysis allowed the identification of 42 phytocompounds from methanolic extracts of the red seaweed *L. divaricate* and *T. flabellatus*. Diverse groups of secondary metabolites were found within the phytocompounds, such as sterols (Cholesterol and Desmosterol), fatty acids (Hexadecanoic acid methyl ester and n-Hexadecanoic acid), and terpenes (Neophytadiene and Phytol). **[13]**.Neophytadiene was identified as strong bactericidal, antifungal, antipyretic, analgesic, antioxidant, and vermifugic **[24]**.

Table 1: the active compounds identified in the *Spirogyra* methanolic extract by the GC-MS technique.

Peak#	R. Time	Area	Area%	Name
1	3.771	58514	0.41	L-(-)-Fucose, tetrakis(trifluoroacetate), benzyl oxime (isomer 2)
2	4.099	601515	4.23	o-Xylene
3	18.566	64050	0.45	Phthalic acid, isobutyl 2-(2-methoxyethyl)hexyl ester
4	18.648	625070	4.39	Neophytadiene
5	18.902	112434	0.79	Neophytadiene
6	19.103	148093	1.04	1-Octadecyne
7	19.452	953219	6.70	7,10,13-Hexadecatrienoic acid, (Z,Z,Z)-
8	19.506	371645	2.61	E-11-Tetradecenoic acid
9	19.764	3395961	23.86	n-Hexadecenoic acid
10	20.741	152538	1.07	Arachidonic acid
11	21.075	95758	0.67	8-Tetradecyn-1-ol acetate
12	21.114	106892	0.75	trans-1,4-Cyclohexanedimethanol, bis(heptafluorobutyrate)
13	21.162	126900	0.89	Hexadecane, 1,1-bis(dodecyloxy)-
14	21.347	568436	3.99	Phytol
15	21.494	4681401	32.89	Oleic Acid
16	21.731	321098	2.26	Octadecanoic acid
17	22.000	101307	0.71	Hexacontanoic acid
18	22.214	90455	0.64	Pentadecafluorooctanoic acid, tetradecyl ester
19	22.456	88952	0.63	Tributyl acetylcitrate
20	22.866	126024	0.89	1-Hexadecanaminium, N,N,N-trimethyl-, octadecanoate
21	23.275	149753	1.05	Glycerol 1-palmitate
22	23.387	228539	1.61	9-Amino-1-methyl-3,6-diazahomoadamantane
23	23.550	326246	2.29	9-octadecenoic acid, 2,2,2-trifluoroethyl ester
24	23.617	144082	1.01	Tetratriacontyl pentafluoropropionate
25	23.933	105062	0.74	Diethyl docosanedioate
26	24.414	48568	0.34	Hexacontanoic acid, propyl ester
27	24.642	79442	0.56	Octaethylene glycol monododecyl ether
28	25.483	149768	1.05	Octatriacontyl pentafluoropropionate
29	25.617	44575	0.31	Hexadecane, 1,1-bis(dodecyloxy)-
30	25.704	165224	1.16	
31		14231521	100.00	

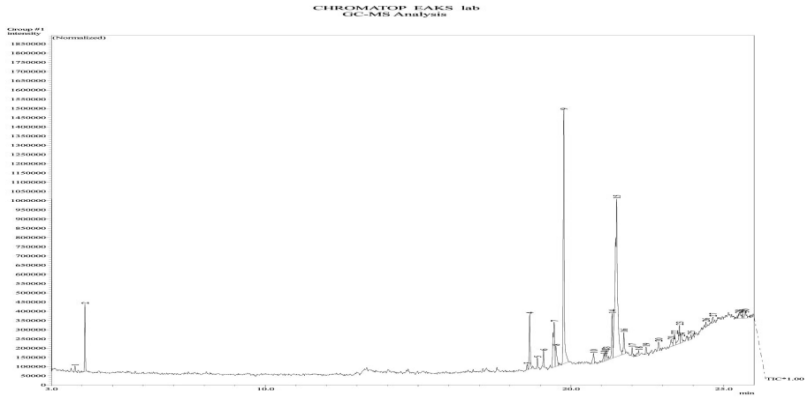
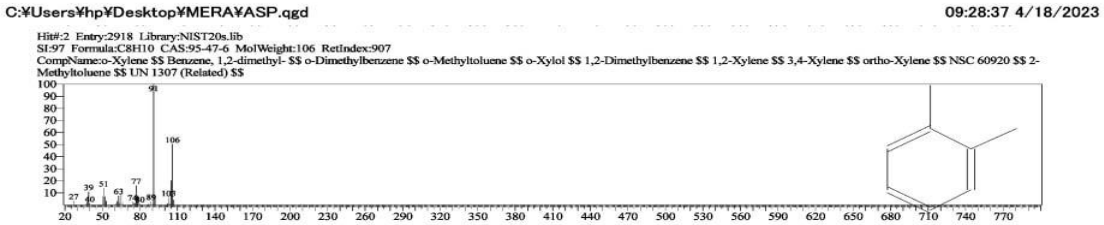
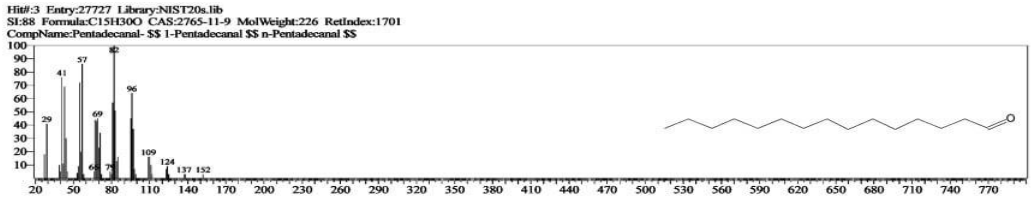


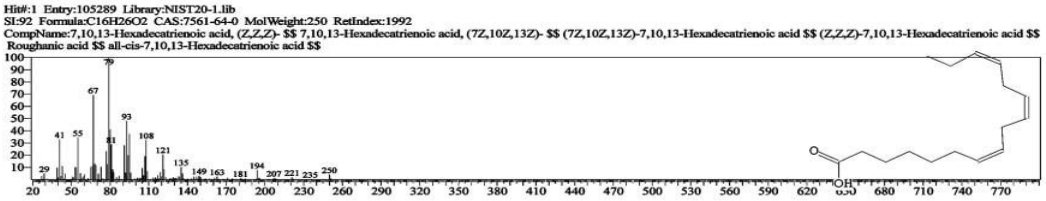
Figure 1: Active compound bands identified in the *Spirogyra* methanolic extract.



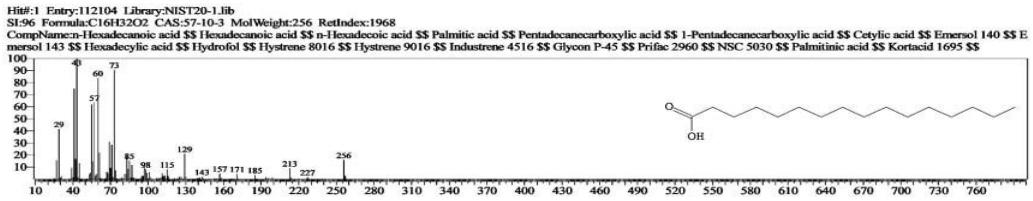
o-Xylene



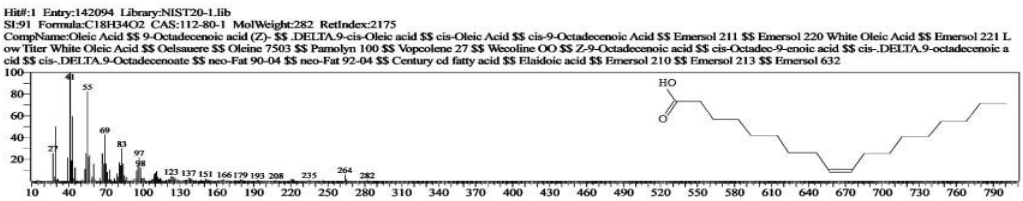
Neophytadiene



7,10,13-Hexadecatrienoic acid, (Z,Z,Z)-



n-Hexadecanoic acid



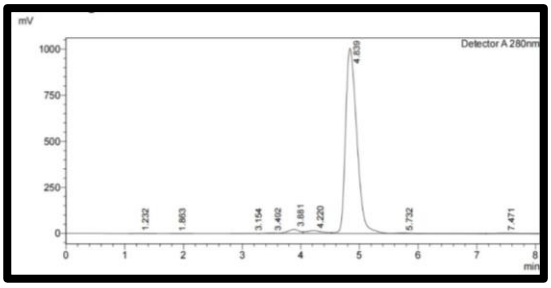
Oleic Acid

Figure 2: Structural formulas and bands of the active compounds identified in the methanolic extract.

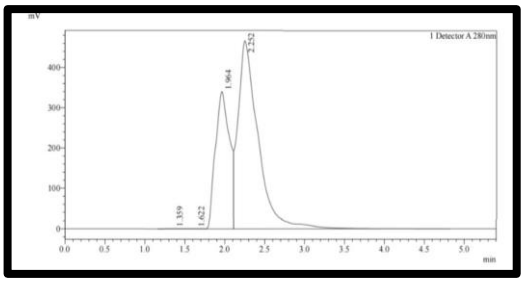
An HPLC analysis was conducted for the phenolic extracts after they were isolated from the crude extracts of alga, where the results showed the presence of phenolic compounds: Rutin, Gallic acid, Tannic acid, Quercetin, Kaempferol, where the highest percentage of Rutin was in the phenolic methanolic extract (240.99ppm), Kaempferol (7.2124ppm), while the phenolic hexane extract had the highest percentage of Rutin (19.606ppm), Kaempferol (10.997ppm) Table (2) and **Figure 3**.

Table 2: The phenolic compounds identified in *Spirogyra* alga by the HPLC technique.

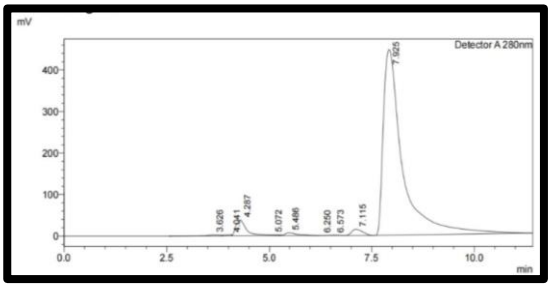
No.	Stan. Phenols	Rt. Time (min)	Methanol Extract Phenols Rt. Time (min)	Hexane Extract Phenols Rt. Time (min)
1	Quercetin	4.839	10.150	2.3317
2	L- Rutin	1.964	-	17.736
3	Rutin- R	2.252	240.99	19.606
4	Kaempferol	7.925	7.2124	10.997
5	Titanic acid_L	2.906	61.213	-
6	Tanic acid_R	3.601	-	-
7	Gallic acid	3.561	-	-



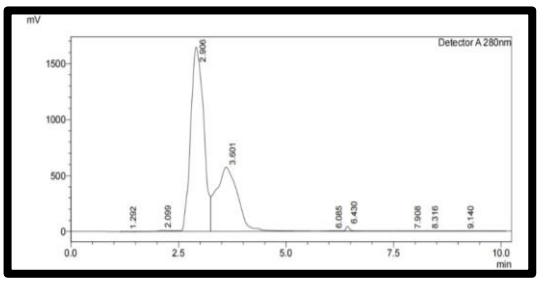
Quercetin



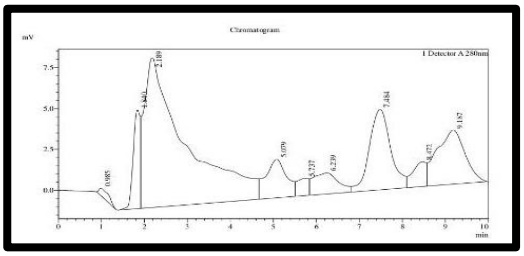
Rutin



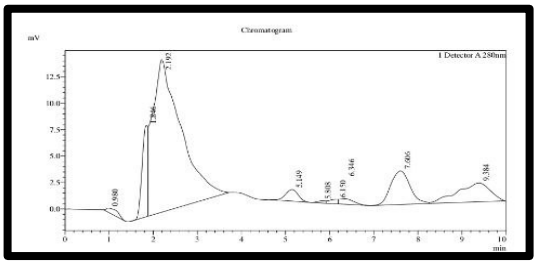
Kaempferol



Tanic acid



Phenol hexane *Spirogyra* extract



Phenol methanolic *Spirogyra* extract

Figure 3:The HPLC Data for alga phenolic compounds

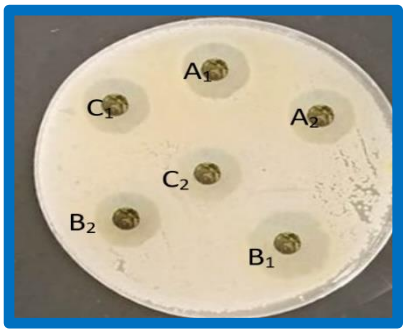
The effectiveness of the methanolic and hexane extracts of algae against bacteria was studied, where the highest percentage of inhibition on bacteria was for the methanolic extract of algae against *Salmonella typhi* with a diameter of inhibition (23 mm) and the lowest percentage of inhibition was against *Pseudomonas aeruginosa* with a diameter of inhibition (9 mm). The hexane extract had the highest percentage of inhibition against *Salmonella typhi* with a diameter of inhibition (20 mm), and the lowest percentage of inhibition against Pseudomonas aeruginosa with a diameter of inhibition (8 mm). As for the effect of methanolic extract against fungi, it had the highest inhibition against *Trichoderma asperallum* with a diameter of inhibition (20 mm) and the lowest percentage of inhibition against *Mucor racemosu* with a diameter of inhibition (10 mm). The effect of the hexane extract of moss against fungi showed the highest inhibition rate against the fungus *Trichoderma asperallum* with a diameter of inhibition (18 mm) and the lowest inhibition was against the fungus *Candida albicans* with a diameter of inhibition (10 mm), as shown in Figure (4) and (5) the effect of the phenolic and hexane extract on bacteria and fungi.

Salmonella typhi | Bacillus cereus | Staphylococcus aureus

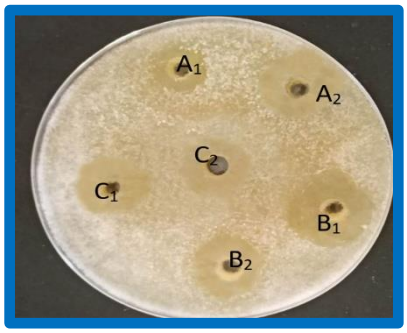
Escherichia coli | Klebsiella pneumoniae | Bacillus coagulase

A_1= Methanol *Chara* Extract(for thesis), B_1= Methanol *Spirogyra* Extract, C_1= Methanol *Cos Marium* Extract(for thesis)

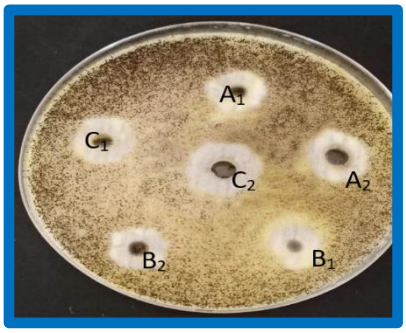
Figure (4) Effect of phenolic and hexane extract on bacteria



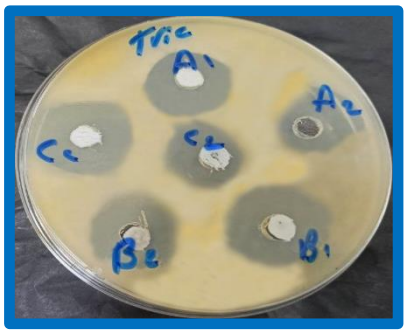
Candida albicans



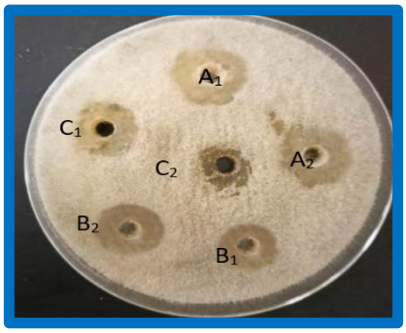
Trichoderma asperallum



Aspergillus Niger



Trichoderma harzianum



Mucor racemosus

$A_{1=}$ Hexane *Chara* Extract(for thesis), $B_{1=}$ Hexane *Spirogyra* Extract, $C_{1=}$ Hexane *Cosmarium* Extract(for thesis)

Figure 5: Effect of phenolic and hexane extract on fungi

Then, the effect of the phenolic-methanolic and hexane extracts on the bacteria and fungi used in the study, where the results showed that the highest inhibition rate of the phenolic-methanolic extract was against bacteria (*Klebsiella pneumoniae*) with a diameter of (21) mm., *Salmonella typhi* with a diameter of (14) mm, and the least inhibition percentage was against (*Pseudomonas aeruginosa*) with a diameter of (12) mm. The effect of phenol on the fungi used in the study was recorded by the phenolic methanolic extract, the highest percentage of inhibition against (*Candida albicans*) was with a diameter of (26) mm, and the least inhibition was against the fungus (*Aspergillus niger*) with a diameter of (20) mm, and the phenolic hexane extract had the highest inhibition against (*Candida albicans*) fungus, with a diameter of (26) mm, and the lowest inhibition rate was in (*Aspergillus niger*), with a diameter of (18) mm. The Inhibition diameters higher than the crude extract of algae indicated that it affected its pure isolated form better than it was mixed with the rest of the materials and components, which reduces its effect and concentration in the concentration used against bacteria, and this result was consistent with a study [25].

4. Conclusions

The quantitative and qualitative diagnosis of some different phenolic compounds and other biologically active compounds in the extracts of the crude methanolic *Spirogyra* sp. was carried out using the GC-MS technique. The study also succeeded in isolating phenols from the crude methanolic and hexane extracts of the alga. In addition to the identification of the isolated phenols by HPLC technique. Including fatty acids such as oleic acid in the crude methanolic extract, and phenols, the predominant of which is Rutin in the phenolic extracts.

5. References

[1] Lee R.E. Phycology. Fourth Ed. Cambridge University Press. Cambridge, UK.2008; 614pp.www.Cambridge.org/9780521864084.

[2] Wolkers H., Barbosa M. J., Kleinegris D. M. M., Bosma R., Wijffels R. H., Harmsen P. F. H. Microalgae: The Green Gold Of The Future?: Large-Scale Sustainable Cultivation of Microalgae For The Production of Bulk Commodities. 2011.Wageningen UR-Food & Biobased Research. https://edepot.wur.nl/170781

[3] Cameron H., Mata M. T.,Riquelme C. The Effect Of Heavy Metals On The Viability Of Tetraselmis Marina AC16-MESO And An Evaluation Of The Potential Use Of This Microalga In Bioremediation. In Peer J Chemistry Journals.2018; 6, E5295. PeerJ 6:e5295; DOI 10.7717/peerj.5295.

[4] Heffernan N., Smyth T. J., Soler-Villa A., Fitzgerald R. J., Brunton N. P. Phenolic content and antioxidant activity of fractions obtained from selected Irish macroalgae species (Laminaria Digitata, Fucus serratus, Gracilaria gracilis and Codium fragile). Journal of applied phycology. 2015; 27(1):519-530.

[5] Machu L., Misurcova L., Vavra Ambrozova J., Orsavova J., Mlcek J., Sochor J., Jurikova T. Phenolic Content And Antioxidant Capacity In Algal Food Products. Journal Molecules.2015;20(1):1118-1133.

[6] Amorati R., Valgimigli L. "Modulation of the antioxidant activity of phenols by non-covalent interactions". Org Biomol. Chem. 2012;10(21), 4147-4158.doi:10.1039/c2ob25174d. PMID 22505046.

[7] Prescott G.W. Algae of the Western Great Lakes Areas. Willam C., Brown C.O . 1982; Pub. Dubuque. I. Iowa,16th printing.

[8] Bellinger E.G., Sigee D.C. Freshwater Algae Identification and Use as Bioindicators. 2010; John Wiley and Sons, Ltd pp.271.

[9] Sahoo D., Baweja P. General characteristics of algae. *The algae world*.2015; 3-29.

[10] Vashishta B. R. , Sinha A. K. , Singh V P. Botany for Degree stuents Algaes. Chand Higher Academic. Printed on Gnviron mental friendly ECF paper.2012;. S. Chanl Qublishing S. Chand and Company LTD

[11] Verawaty M., Melwita E., Apsari D., Wiyahsari M. Cultivation strategy for freshwater Macro- and Micro- algae as Biomass stock for lipid production. J. Eng. Technol. Sci. 2017; 48(2): 261- 274.

[12] Alfekaik D. F. , AL-Hilki S. A. Fatty Acids Composition by (GC-MS) and Most Important Physical Chemicals parameter of Seed Oil Pomegranate and Grap Seeds. Journal of Biology, Agriculture and Healthcare. 2016; 6 (8) :25- 32.

[13] Dias V, Uqueio M, Nhaca A, Salência H, Qualitative Analysis of Phytocompounds of Liagora divaricata and Trematocarpus flabellatus, Journal of Drug Delivery and Therapeutics. 2020; 10(5):75-81 http://dx.doi.org/10.22270/jddt.v10i5.4355

[14] Zahir Shah",SYED BADSHAH[1],Arshad Iqbal[1],Abdul-Hamid Emwas[2],Mariusz Jaremko GC-MS based metabolomics and lipidiomics analyses of selected freshwater green macroalgae.2022; https://doi.org/10.21203/rs.3.rs-1324666/v1

[15] Pornphan Champa, Niwooti Whangchai, Somkiat Jaturonglumlert, Nomura Nakao , Kanda Whangchai DETERMINATION OF PHYTOCHEMICAL COMPOUND FROM *Spirogyra* sp. USING ULTRASONIC ASSISTED EXTRACTION .International Journal of GEOMATE . 2016, 11(24: 2391-2396. Geotec., Const. Mat. & Env., ISSN: 2186-2982(Print), 2186-2990(Online), Japan

[16] Khorshid Badr Hussein , Al-Katib Mira Ausama. Screening of Some Algal Oils to Select the Best Algal Biodiesel Resource. Egyptian Journal of Aquatic Biology & Fisheries Zoology Department, Faculty of Science Ain Shams University, Cairo, Egypt. ISSN 1110-6131. 2021; Vol. 25(3): 571-588.

[17] Al-Hayali Anfal Zuhair , Al-Katib Mira Ausama. ISOLATION AND DIAGNOSIS OF PHENOLIC COMPOUNDS OF GLOEOCAPSA SP PCC7428 AND THEIR ANTIMICROBIALACTIVITY. Plant Archives.2020; Volume 20 No. 2: 8773-8783.

[18] Liang H. R., Siren H., Reikkola M. L., Vuorela P., Vuorela H., Hiltunen R. Characterization Of Flavonoids In Extracts From Four Species Of Epimedium By Micellar Electrokinetic Capillary Chromatography With Diode-Array Detection. Journal Of Chromatographic Science.1997; 35(3): 117-125.

[19] Majors R. E. New Chromatography Columns And Accessories At The 2001 Pittsburgh Conference, Part I. Journal of LC GC Europe.2001; 14(5): 284-301.

[20] Michel Piotr, Owczarek Aleksandra, Kosno Martyna, Gontarek Daniel, Matczak Magdalena , Olszewska Monika A. Variation in polyphenolic profile and in vitro antioxidant activity of eastern teaberry (Gaultheria procumbens L.) leaves following foliar development. Phytochemistry Letters. 2017; 20: 356-364.

[21] Perez C., Pauli M., Bazerque P. An antibiotic assay by the well Agar method. Journal of Acta biologiae et medicinae experimentalis. 1990. 15: 113-115.

[22] Magaldi S., Mata-Essayag S., De Capriles C. H., Perez C., Colella M. T., Olaizola C., Ontiveros Y. Well Diffusion For Antifungal Susceptibility Testing. International Journal Of Infectious Diseases.2004; 8(1): 39-45.

[23] Aubert M., Aubert J., Gauthier M. Antibiotic substances frommarin flora. In: Marine algae in pharmaceutical science (eds. H. A. Hoppe; T. Levring and Y. Tanaka). Water de Gruyter, Berlien. 1979;pp: 267-292

[24] Abdel- Aal EI, Haroon AM, Mofeed J.Successive solvent extraction and GC–MS analysis for the evaluation of the phytochemical constituents of the filamentous green alga *Spirogyra longata*, Egyptian Journal of Aquatic Research, 2015; 41(3):233-246.

[25] Santhosh, S., Manivannan, N., Ragavendran, C., Mathivanan, N., Natarajan, D., Hemalatha, N., ,Dhandapani, R. (2019). Growth Optimization, Free Radical Scavenging And Antibacterial Potential Of Chlorella Sp. SRD3 Extracts Against Clinical Isolates. Journal Of Applied Microbiology, 127(2), 481-494.