وزارة التعليم العالي والبحث العلمي
جامعة الموصل

مجلة بيئة الرافدين

مجلة معتمدة تصدر عن كلية العلوم البيئية

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رقم الإيداع في دار الكتب والوثائق ببغداد 2597 **لسنة** 2022

تعليمات النشر في مجلة بيئة الرافدين

1. تنشر المجلة البحوث العلمية (النظرية والتطبيقية) في مجالات البيئة في علوم البيئة والعلوم ذات الصلة بها كالبايولوجي والكيمياء والهندسة والطب والزراعة وغيرها.
2. المجلة فصلية حسب قرار الوزارة وسيحدد عدد إصداراتها في السنة إعتماداً على عدد البحوث التي تقدم للنشر فيها.
3. يجب أن تكون البحوث غير منشورة أو مقبولة للنشر في مجلات أخرى.
4. يكون طبع البحث بإستخدام نظام معالج النصوص (Microsoft Word) ونوعية الخط باللغة الإنكليزية (Times New Roman) بحجم خط (12) وباللغة العربية نوعية الخط (Simplified Arabic) وبحجم خط (12) ويجب إستعمال الحروف العربية الأصيلة (1,2,3) خلال البحث, أما عنوان البحث (عربي وإنكليزي) فيكون بحجم (16) وأسماء الباحثين بحجم (12) غامق مائل, وتكون العناوين الرئيسية ضمن المتن بحجم (14) وتدرج الأشكال والصور بهيئة أمام النص.
5. تطبع البحوث على ورق (A4) وذلك لتسهيل طبع الأشكال والمقاطع والجداول, مع ترك مسافة (2.5) من جميع الجهات للبحوث العربية والإنكليزية, تكون المسافة بين الأسطر (Single Space) وبحيث لايتجاوز عدد الأسطر على (48) سطراً مع ضرورة مراعاة نفس الأبعاد على الصفحات المتضمنة الأشكال والخرائط والرسوم التوضيحية والجداول –إن وجدت في البحث– والتي تطبع على أوراق مستقلة وترقم حسب تسلسلها في متن البحث.
6. يكون ترتيب البحث كالآتي:

أ. عنوان البحث ب. إسم الباحث أو الباحثين بدون اللقب العلمي وعناوينهم

ج. ملخص البحث باللغة العربية أو الإنكليزية, والملخص الأول يجب أن يكون في نفس لغة البحث ويحتوي الملخص الثاني على إسم الباحث والباحثين.

د. المقدمة وتتضمن موقع الدراسة والهدف من البحث ومعلومات أخرى مثل جمع النماذج والمصطلحات الدالة (Key Words).

هـ. طرق العمل. و. النتائج والمناقشة والإستنتاجات. ح. المصادر.

7. تقدم ثلاث نسخ من البحث المطلوب نشره مع الشفافيات الأصلية والصور الملونة (إن وجدت) ويتم تقديم طلب للتقديم والنشر ويدون فيه إسم الباحث الثلاثي وأسماء الباحثين باللغتين العربية والإنكليزية E-mail (إن وجد) وعنوان الباحث الكامل أو الباحثين وتوضع علامة النجمة على إسم الباحث الذي تتم المراسلة معه.
8. يجب أن تكون الصور والأشكال والجداول مطبوعة بشكل واضح. وتثبت مقياس الرسم على الأشكال وحجم التكبير على الصور ويكون الشرح (Caption) للجداول فوقها والصور والأشكال تحتها أو على ورقة منفصلة. وتعد الصور أشكالاً (Figures) إذا كان عددها لايزيد على ثلاثة, ولوحات إذا زادت عن ذلك, وتعد كل أربعة صور فأكثر لوحة واحدة, ويشار إلى الصور كجزء من رقم اللوحة.(مثلاً إما (لوحة 2 شكل 3) أو (لوحة C:2)).

9. في حالة إحتواء البحث على التحاليل بإستعمال أجهزة يطالب الباحث بتدوين نوع الجهاز وموقع المختبر وتاريخ التحليل بصورة واضحة مع إقرار رسمي من قبل القسم أو الجهة التي أجريت فيها التجارب.
10. يجب أن تكتب الأسماء العلمية للكائنات (ضمن الممالك الخمسة المختلفة) بالخط المائل (Italic) مع ذكر لمصنفها في بداية البحث.
11. يشار للمصدر في المتن بكتابة الإسم الأخير للباحث والسنة وإذا إشترك باحثان فيكتب إسماهما مع السنة أما إذا كان الباحثون ثلاثة أو أكثر فيذكر إسم الباحث الأول مع لاحقة (*etal.,*) والسنة بالنسبة للبحوث المكتوبة باللغة الإنكليزية, أما البحوث المكتوبة باللغة العربية فيذكر إسم الباحث الأول وآخرون مع السنة إذا كانوا ثلاثة أو أكثر.
12. ترتب المصادر في قائمة المصادر حسب الأحرف الهجائية (Alphabetical) للإسم الأخير وتدون جميع أسماء الشهرة أو العائلة (Surename) للباحثين مع الحرف الأول للأسماء الشخصية أو الأسماء الشخصية الكاملة للمصادر العربية وبدون ترقيم المصادر ولاتوضع سنوات النشر بين قوسين, وبالنسبة للبحوث المأخوذة من مجلات تنزل على الشكل الآتي:

إسم الباحث أو الباحثين, سنة النشر, عنوان البحث, إسم المجلة, رقم المجلد, رقم العدد(إن وجد), أرقام الصفحات, مثال:

العود، محمد رشيد و قشوط ، صالح محمد وسلامة ،احمد محمد ومسعود ،فتحي عبدالعزيز(2015) "النفايات البلاستيكية وآثارها على البيئة والإنسان والطرق الحديثة للاستفادة والتخلص منها". مجلة علوم البحار والتقنيات البيئية ،المجلد (1)،العدد (2).ديسمبر.

Lopes, J. M., Marques, N. C., dos Santos, M. D. d. M. C., Souza, C. F., Baldissera, M. D., Carvalho, R. C., *et al.* (2020) Dietary limon Citrus× latifolia fruit peel essential oil improves antioxidant capacity of tambaqui (Colossoma macropomum) juveniles. *Aquaculture Research,* **51**, 4852-4862.

13. إذا كان المرجع رسالة ماجستير أو دكتوراه: يكتب إسم صاحب الرسالة بدءاً بإسم العائلة أو الشهرة, السنة, عنوان الرسالة, إسم الجامعة, القطر, أرقام الصفحات. مثال:
14. في حالة إستخدام بحوث مأخوذة من الإنترنيت يكتب المصدر كاملاً مضافاً إليه المعلومات من الموقع:

Bs.html,Accessed June, @, 2000 www.press.edu/jep/03-01/Ejc

15. أجور نشر البحث الواحد (15) صفحة هو (100000) مأئة ألف دينار ويدفع الباحث (3000) ثلاثة آلاف دينار لكل صفحة إضافية حسب تعليمات جامعة الموصل.

16. تحتفظ هيئة التحرير بحقها في حذف أو إختزال بعض الجمل لأغراض الضبط اللغوي وكذلك في إعادة مواقع الصور, الأشكال والجداول لتتماشى مع نهج التحرير.
17. تكون قرارات هيئة التحرير نهائية في حالة رفض البحث وتحتفظ بكافة الأوليات لديها وفي حالة رغبة الباحث بالإطلاع على أسباب الرفض يتوجب عليه تقديم طلب رسمي للمجلة.
18. بعد نشر البحث وظهوره في المجلة تقوم هيئة التحرير بإتلاف كافة أوراق البحث وليس من حق الباحث المطالبة بها في أي حال من الأحوال.
19. يحق للباحث المطالبة بسحب بحثه وهو قيد التقييم وذلك بتقديم طلب خطي ودفع أجور تحكيم البحث.
20. ترسل البحوث إلى العنوان الآتي:

أ. مدير تحرير مجلة بيئة الرافدين

كلية العلوم البيئية, جامعة الموصل, الموصل, جمهورية العراق.

ب. أو عن طريق البريد الإلكتروني الخاص بالمجلة: Raf.Env22@uomosul.edu.iq

الفهـــــرس

تقييم مياه نهر دجلة قبل وبعد مصفى القيارة

ميعاد سليمان الجبوري [1] ,يسرى مجيد الشاكر [2], محمود احمد الفخري [3]

[1,2] كلية العلوم البيئية/ جامعة الموصل [3] كلية العلوم/ جامعة الموصل

تاريخ الإستلام 2024/11/26, تاريخ المراجعة 2024/12/22, تاريخ القبول 2024/12/26

الخلاصة

يعد نهر دجلة من اهم المصادر المائية في العراق وبذلك يجب مراقبة نوعية مياهه باستمرار خاصة من الناحية البيئية، هدفت الدراسة الحالية الى تقييم نوعية مياه نهر دجلة في محافظة نينوى، قبل وصول مياه نهر دجلة إلى مصفى القيارة وبعد طرح المياه من محطة المعالجة الموجودة داخل المصفى ، تم اخذ عينات المياه في شهر أيلول، وتشرين الثاني وكانون الثاني وآذار بواقع عينة واحدة شهرياً لدراسة بعض الخواص الفيزوكيميائية كاالدالة الحامضية ودرجة الحرارة والتوصيلية الكهربائية والمواد الصلبة الذائبة الكلية والعكورة والعسرة الكلية وعسرتي الكالسيوم والمغنيسيوم والكبريتات والنترات والشحوم والدهون والمتطلب الحيوي للاوكسجين والمتطلب الكيميائي للاوكسجين وعنصري الرصاص والكادميوم. كانت بعض الخواص الفيزيائية والكيميائية تقع ضمن حدود الطرح العراقية الموصى بها لسنة 2009 ماعدا العكورة والمتطلب الحيوي للاوكسجين والعسرة الكلية وعسرتي الكالسيوم والمغنيسيوم إضافة إلى عنصري الرصاص والكادميوم كانت متجاوزة لحدود الطرح العراقية الموصى بها لمياه الشرب لسنة .2009

الكلمات المفتاحية: *مصفى القيارة، نهر دجلة، تلوث المياه، نفط ثقيل.*

Evaluation of Tigris River water before & after Qayyarah refinery

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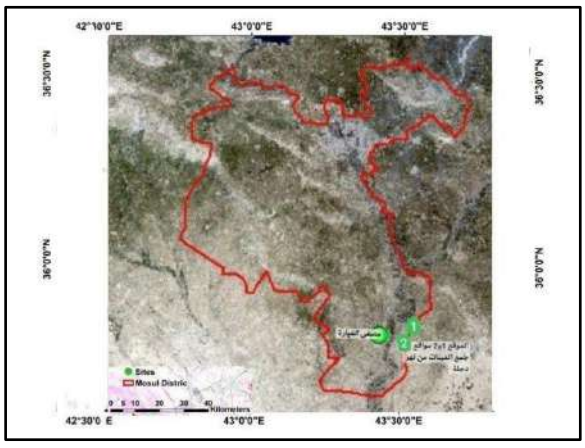
Abstract

The Tigris River is one of Iraq's most important water resources; therefore, its water quality must be monitored continuously, especially from an environmental perspective. The current study aimed to evaluate the quality of Tigris River water in Mosul before entering the filtered Tigris River water and after the Tigris River water exits the Qayyarah filter. Water samples were taken in September, November, January, and March at a rate of one sample per month to study some physicochemical properties such as acidity, temperature, electrical conductivity, total dissolved solids, turbidity, total hardness, calcium and magnesium hardness, sulfate, nitrate, fats and lipids, biological oxygen demand, chemical oxygen demand, lead, and cadmium. Some physical and chemical properties were within the

recommended Iraqi disposal limits for 2009, except for turbidity, biological oxygen demand, total hardness, calcium, magnesium hardness, and lead and cadmium, which exceeded the recommended Iraqi disposal limits for drinking water for 2009.
Keywords: *Qayyarah Refinery, Tigris River, Water Pollution, Heavy Oil.*

المقدمة

يعتبر تلوث المياه جوهر المشكلة البيئية وقضية العصر وبعداً رئيسيا من ابعاد التحديات وذلك بسبب الندرة الحاصلة لموارد المياه العذبة في العالم حيث يعاني اكثر من ربع سكان العالم من شح المصادر المائية النظيفة والامنة للاستعمال والتي تعتبر متطلب حيوي لكل كائن حي على وجه الكرة الارضية (Abdullah & Farhan, 2023) ويحدث تلوث المياه بصورة طبيعية مثل الفيضانات والسيول والبراكين وغيرها او بصورة غير طبيعية كالحروب واستعمال الاسمدة والمبيدات ومواد التنظيف وتسرب النفط وغيرها من الاسباب (Al-Ubaid,2022)من الممكن ان تشكل مواقع تخزين النفط خطرا على المياه السطحية والجوفية اذا تسربت او انسكبت ولم يتم استخدام التدابير الكافية في مواقع الانسكاب وغالبا ما تتسرب هذه المواد الى التربة مما يزيد المشكلة سوءا و يعد النفط او كما يسمى بالذهب الاسود المصدر الرئيسي للتمويل في العراق وتمتاز صناعة النفط الخام بتعدد المنتجات الخارجة من تكريره والتي اما ان تكون منتجات مفيدة او منتجات ثانوية قليلة الاهمية ((Ibrahim *et al.,* 2022 .النفط المستخرج من مصفى القيارة يحتوي على كميات كبيرة من الكبريت تصل الى 50% الذي كان عائقا في استخلاص الغاز والبنزين والنفط الابيض والمواد الاخرى على الرغم من محاولات الحكومة العراقية ادخال تحسينات على النفط المستخرج الا انه لم يطرأ أي تغيير بسبب نوعه الرديء والثقيل لدرجه تعذر ضخه من الابار اذ انه لا يصلح الا لإنتاج مادة القير)الأسفلت(التي تستخدم في تبليط الشوارع-AL) Sabahy, 2020)



وصف منطقة الدراسة الخريطة **(1)** توضح موقع منطقة الدراسة

في دراستنا الحالية تم اختيار مصفى القيارة لغرض دراسة وتقييم الاثار التي يسببها المصفى على نوعية مياه نهر دجلة، تقع ناحية القيارة جنوب محافظة نينوى على الضفة الغربية لنهر دجلة تبعد عن المركز حوالي 60 كلم وتمتاز بوجود العديد من حقول النفط القريبة منها كونها تحتوي على خزين نفطي كبير فضلا عن وجود العديد من الابار النفطية,

سميت بهذا الاسم نسبة الى)عين القير(اذ يمكن مشاهدة القير الراشح الى سطح الارض والتي تسمى بمقالع البتيومين،وتمثل الخريطة رقم (1) .موقع الدراسة

أهداف البحث

يهدف البحث الى تقييم حالة التلوث التي يسببها مصفى القيارة على نهر دجلة حيث تم قياس درجات الحرارة للمياه والحامضية والتوصيلية الكهربائية والمواد الصلبة الذائبة الكلية والعكورة والمتطلب الحيوي للاوكسجين والمتطلب الكيميائي للاوكسجين والشحوم والزيوت والكبريتات والنترات الرصاص و الكادميوم والعسرة الكلية وعسرتي الكالسيوم والمغنيسيوم ومقارنتها مع المحددات العراقية لمياه الشرب لسنة 2009 لغرض معرفة ما يسببه المصفى من ضرر على نوعية المياه ضمن منطقة الدراسة.

طرائق البحث

تمت عملية جمع العينات بواسطة قناني من البولي اثيلين محكمة الاغلاق لقياس كلاً من المتطلب الحيوي للاوكسجين والمتطلب الكيميائي للاوكسجين لضمان عدم فقدان الاوكسجين من العينة، اما بقية الفحوصات فقد تم جمع مياه العينات بواسطة قناني زجاجية بعد غسلها بالماء المقطر ومجانستها بماء العينة حقلياً، تم اجراء الفحوصات المختبرية في مختبرات كلية العلوم البيئية عدا فحصي الرصاص والكادميوم فقد تم اجراؤهما في المختبر المركزي في كلية الزراعة والغابات .

- المتطلب الحيوي للاوكسجين تم قياس ال BOD وذلك باتباع طريقة Manometric Method قمنا باخذ حجم 432مل من العينة ووضعها في القناني الخاصة للقياس مع اضافة المحرك المغناطيسي مع قرصين من KCL كمغذي للبكتيريا النامية في القناني وضبط الحاضنة على درجة حرارة 20 درجة مئوية ولمدة خمسة ايام ((Al−Hamdani,2022)

الفحوصات الحقلية:

- تم قياس الدالة الحامضية باستخدام جهاز pH-meter
- درجات الحرارة فتم قياسها باستخدام المحرار الالكتروني وذلك بغمر الجزء الحساس في الماء ثم تسجل القراءة

الفحوصات المختبرية:

تم قياس التوصيلية الكهربائية باستخدام جهاز EC – meter نوع HI99301ماليزي الصنع

- تم قياس المواد الصلبة الذائبة الكلية باستخدام جهاز T.D.S-meter
- العكورة: تم قياس العكورة بواسطة جهاز Lovibond Turbidity بوحدة ((NTU
- العسرة الكلية: تم قياس العسرة الكلية بالتسحيح مع EDTA باستخدام دليل ايروكرومات بلاك−. T
- عسرة الكالسيوم: تم قياس عسرة الكالسيوم بالتسحيح مع EDTA باستخدام دليل الميروكسيد .
- عسرة المغنيسيوم: تم قياس عسرة المغنيسيوم باتباع المعادلة التالية

Mg mg\l as CaCo3 = (Total Hardness – Ca Hardness)×0.224

- المتطلب الكيميائي للاوكسجين: تم اجراء القياس بواسطة الجهاز التجاري نوع COD − Reactor وذلك باستخدام المحاليل القياسية الجاهزة حيث تم اضافة 2مل من ماء العينة الى المحاليل القياسية الجاهزة ثم بعد

ذلك قمنا بوضعها في حاضنة الCOD ولمدة ساعتين وعلى درجة حرارة 120 درجة مئوية لاتمام عملية الهضم ثم نقوم بقياس العينات بواسطة جهاز ال COD - Reader بعد تبريدها ثم تسجل القراءة من الجهاز مباشرة.

- الشحوم والزيوت تم اجراء القياس بطريقة الاستخلاص اذ تم اخذ حجم 500مل من العينة في قمع الفصل ثم اضافة 5مل من حامض الهيدروكلوريك المخفف بنسبة (1:1) واضيف المذيب بحجم معين فوق ماء العينة تم رج قمع الفصل عدة مرات ثم ترك القمع لعدة دقائق لتستقر الطبقتان اذ يمكن رؤية الطبقات مفصولة بشكل واضح في القمع نقوم بفصل الطبقة العضوية عن الطبقة المائية ثم نقوم بوضع الطبقة العضوية في فرن التجفيف بدرجة حرارة 105 درجة مئوية ولمدة ساعتين ثم تطبق المعادلة التالية

$$G\backslash O = (A-B) \times 1000 \backslash V \text{ ml}$$

حيث ان :

A : يمثل وزن الدورق والمواد المتبقية بالملغرام

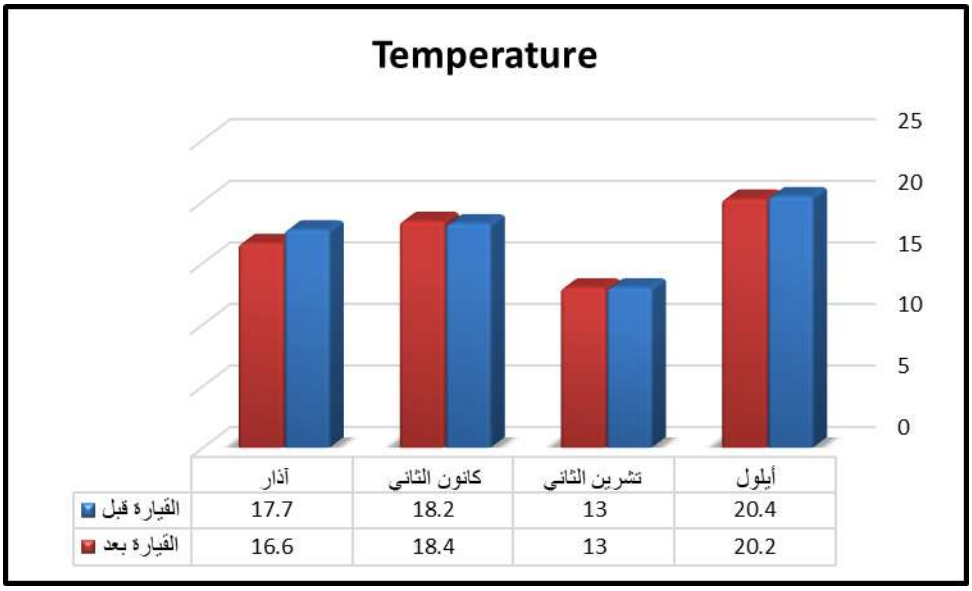
B : يمثل وزن الدورق الفارغ بالملغرام

- الكبريتات تم اجراء القياس باتباع طريقة العكورة باستعمال جهاز المطياف الضوئي - Spectrophotometer UV عند طول موجي 420 نانوميتر .
- النترات تم قياسها بواسطة جهاز Spectrophotometer- UV وذلك باتباع طريقة Ultra violet screeningعند طول موجي 220 و 270 نانوميتر .
- العناصر الثقيلة (الرصاص + الكادميوم) تم قياس تركيز هذه العناصر بواسطة جهاز طيف الامتصاص الذري Atomic Absorption Spectrophotometerموديل NovAA 350\Analytikjena الالماني المنشأ .

النتائج والمناقشة

درجة الحرارة Temperature

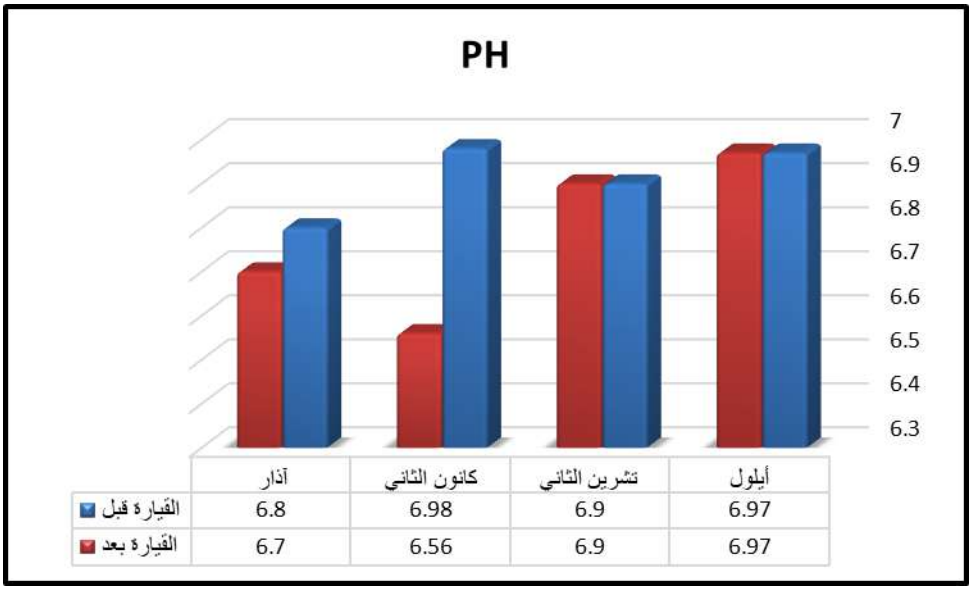
تعدُ درجة الحرارة للماء أهم العوامل التي تحدد استمرار الحياة وتوزيعها في النظم المائية حيث يمكنها التحكم في العديد من العمليات الكيميائية والفيزيائية و البايولوجية مثل الطعم والرائحة سرعة التفاعلات الحيوية ومعدل النمو وعمليات الاكسدة والاختزال ومعدل ذوبان الغازات في الماء (Larnier *et al.,* 2010) الشكل (1) يوضح قيم درجات الحرارة اثناء مدة الدراسة اذ ان التغاير في درجات الحرارة بين اشهر السنة هي نتيجة متوقعة وطبيعية بسبب تذبذب درجة حرارة المناخ في العراق وكذلك الموقع الجغرافي والتغاير اليومي في حرارة الهواء اذ يمتاز مناخ العراق بانه حار وجاف صيفاً بارد وممطر شتاءاً اتفقت قيم درجات الحرارة مع دراسة (Al–Zubaidi & Al-Nama ,2021)



الشكل (1) يوضح قيم درجة الحرارة (وحدة درجة مئوية) أثناء فترة الدراسة

الدالة الحامضية **pH**

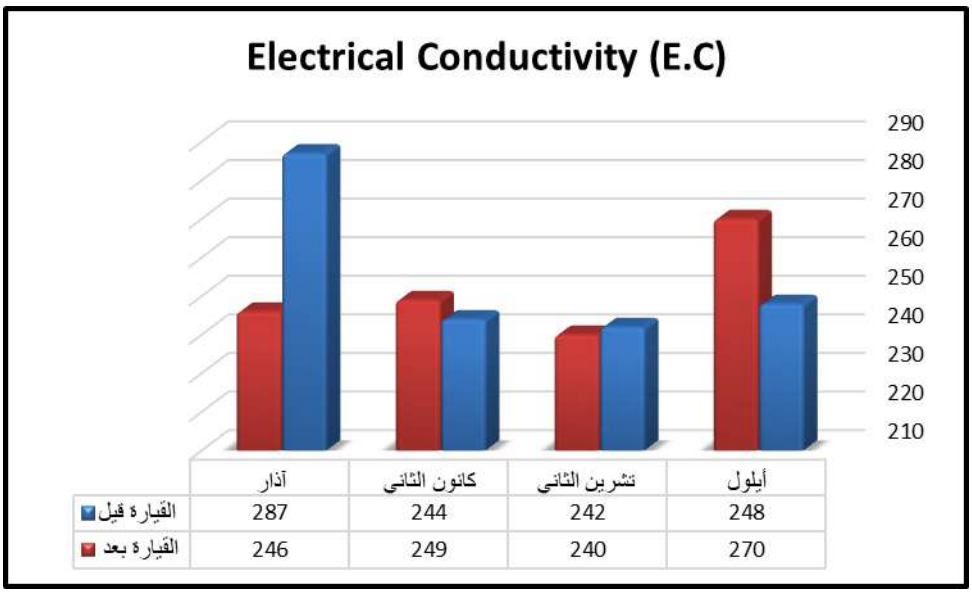
هي دالة تعبر عن نشاط أيون الهيدروجين في الماء وتتراوح بين(14–0) ,فاذا كانت القراءة اكثر من (7) يكون الوسط قاعديًا وحامضيًا إذا كانت الدرجة اقل من (7) وتعدُّ ال (7) هي نقطة التعادل (Dabdoub & Saleh, 2011) .سجلت اعلى قيمة للدالة الحامضية في شهر كانون الثاني (6.9) كما في الشكل (2) وربما يعزى ذلك إلى سقوط الأمطار وانجراف التربة التي ساعدت في جرف واذابة بعض المواد مثل الكبريتات والنترات والكلوريدات وغيرها من (Al-Bajji , 2014).



الشكل (2) يوضح قيم الدالة الحامضية (**pH**) أثناء فترة الدراسة

التوصيلية الكهربائية **Electrical Conductivity**

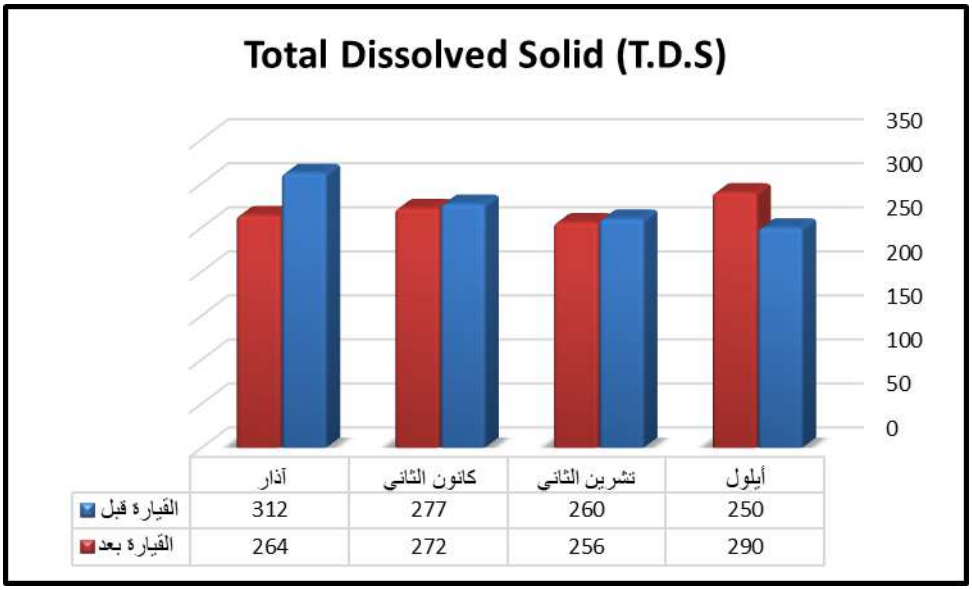
وهي قابلية توصيل (1سم^3) من الماء للتيار الكهربائي عند درجة حرارة 25 درجة مئوية وتعتمد التوصيلية الكهربائية على كمية الايونات السالبة والموجبة الذائبة في الماء (Al-Sayegh, 2021) .سجلت اعلى قيمة للتوصيلية الكهربائية قبل المصفى (287مايكروسيمينز/سم^2) في شهر آذار كما في الشكل (3) ويرجع سبب ذلك الى كون النهر يمر باراضي زراعية على طول مجراه اضافة الى طرح مخلفات الصرف الصحي ومخلفات عمليات الدباغة التي تدخل الاملاح بكميات كبيرة ضمن عملياتها التصنيعية ولهذا يزداد تركيزها كلما اتجه النهر الى الجنوب, اتفقت دراستنا مع دراسة (Shihab & Kanna, 2021)



الشكل (3) يوضح قيم التوصيلية الكهربائية (وحدة مايكروسيمينز/سم2) أثناء فترة الدراسة

Total Dissolved Solidالمواد الصلبة الذائبة الكلية

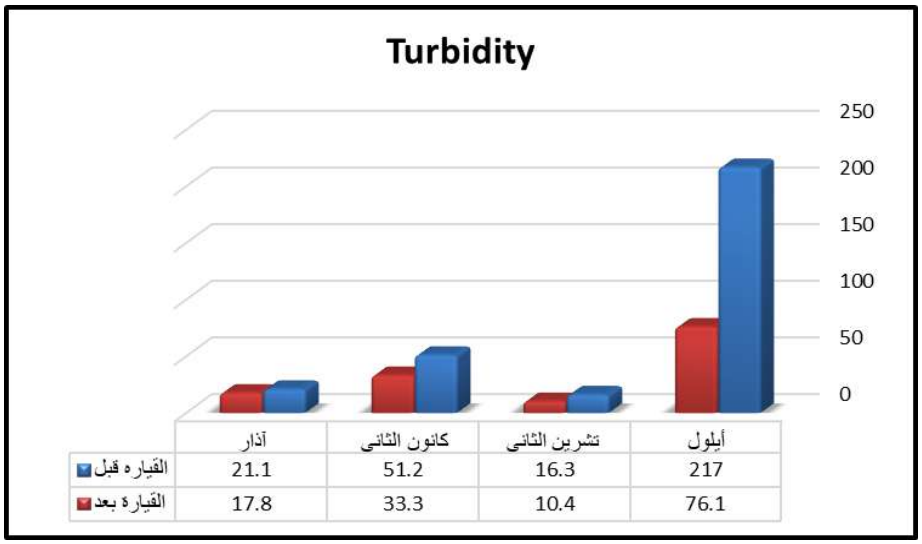
هي نسبة التركيز الكلي للأملاح الذائبة في الماء مثل البوتاسيوم، المغنيسيوم، كالسيوم، صوديوم، وتنشأ في المياه بعدة طرق ابرزها مياه الصرف الصحي ومياه الصرف الصناعي في المناطق الحضرية وما إلى ذلك. (Dhanoon & Mahmoud, 2014) .سجلت اعلى قيمة للمواد الصلبة الذائبة قبل المصفى (312 ملغم/لتر) في شهر آذار كما في الشكل (4) ويعود سبب ذلك الى العلاقة الطردية بين التوصيلية والمواد الصلبة الذائبة الكلية لكونهما يعتمدان على تركيز كلا من الايونات السالبة والموجبة في عينة الماء وبذلك كلما زادت التوصيلية زادت المواد الصلبة الذائبة (Al-Mandeel *et al*, 2018)



الشكل (4) يوضح قيم المواد الصلبة الذائبة الكلية (وحدة ملغم/لتر) أثناء فترة الدراسة

العكورة **Turbidity**

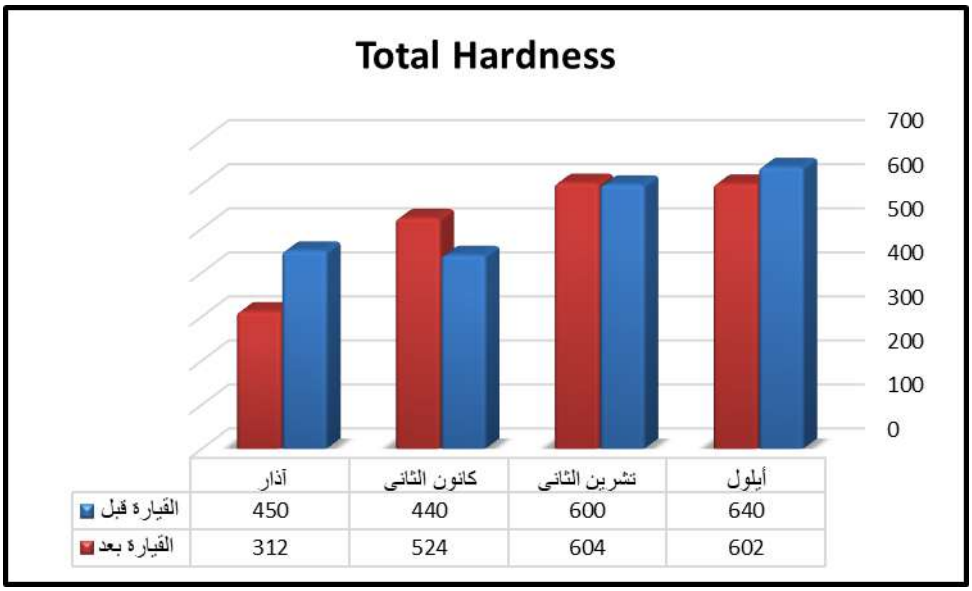
وتعرف بانها مقياس للوضوح النسبي للمياه حيث تعتبر المواد الصلبة في المسطحات المائية الطبيعية مؤشر هام على جودة المياه والمتمثلة بالطمي والطين والطحالب والمواد العضوية والجسيمات الدقيقة المختلفة والتي تتسبب في اعاقة نفاذية الضوء عبر الماء وترتبط العكورة ارتباطًا وثيقًا بالظروف المناخية وظروف المياه السطحية، (Sader, 2017) سجلت اعلى قيمة للعكورة قبل دخول مياه نهر دجلة الى المصفى بتركيز (217) وحدة نيفيلومترية اذ يمكن أن تساهم التصريفات الصناعية والتطور الحضري في ازدياد العكورة بشكل كبير. مثل البناء والتخلص من النفايات بالقرب من ضفاف الأنهار إلى تفاقم الترسيب خلال الأشهر الرطبة من السنة ، اضافة الى وجود العديد من مقالع الرمل والحصى على ضفتي النهر، اتفقت دراستنا مع(Al-Hadidi, 2017) التي قيمت مياه نهر دجلة للمنطقة الواقعة بين سد الموصل وناحية القيارة اذ بلغ تركيز العكورة في مياه نهر دجلة 123.25 وحدة نيفيلومترية .



الشكل (5) يوضح قيم العكورة (وحدة نيفيلومترية) أثناء فترة الدراسة

العسرة الكلية **Total Hardness**

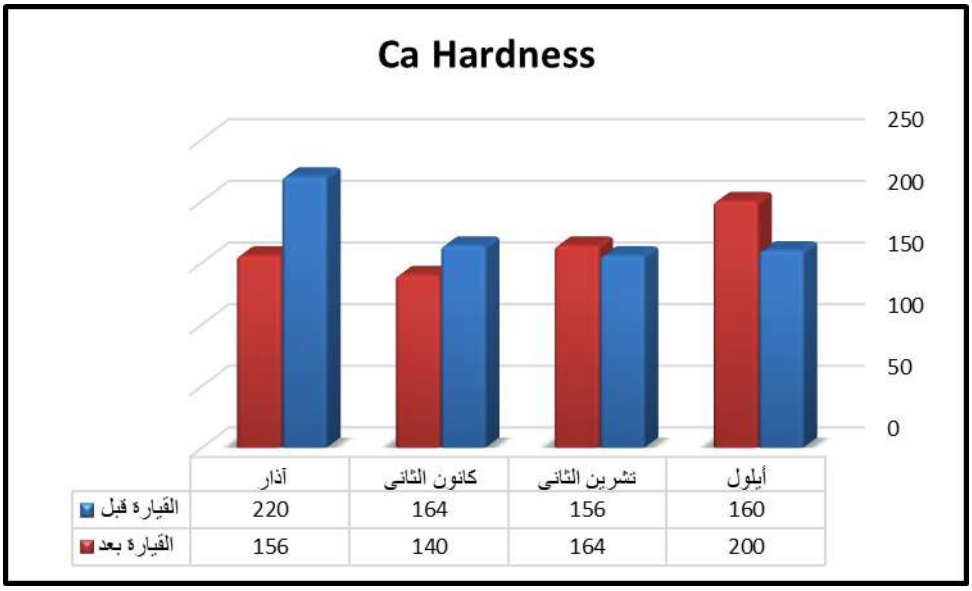
تعد عسرة المياه عامل مهم في جودة المياه، اذ تشير إلى مستوى أيوني الكالسيوم والمغنيسيوم في الماء. اظهرت النتائج ارتفاع قيم العسرة الكلية على طول اشهر السنة وسجلت اعلى قيمة قبل دخول مياه نهر دجلة للمصفى في شهر ايلول اذ بلغت (640 ملغم/لتر) كما في الشكل(2) متجاوزة بذلك المحددات العراقية لمياه الشرب التي اوصت ان لا تتجاوز قيم العسرة الكلية (500 ملغم/لتر) وبذلك تصنف مياه نهر دجلة على انها من النوع العسر جدا وقد يرجع سبب ذلك الى ذوبان الصخور الجيرية المكونة لحوض النهر، كذلك بسبب طرح الفضلات الصناعية الى النهر بشكل مباشر دون معالجة أضافة إلى الفضلات المنزلية التي تحتوي على ملح الطعام خاصة الاملاح غير النقية التي تحتوي على املاح الكالسيوم والمغنيسيوم اتفقت دراستنا مع (Al-Tayyar *et al,* 2005) الذي صنف مياه نهر دجلة انها تتراوح بين العسرة الى العسرة جدا عند المنطقة الواقعة بين منطقة قبر العبد والقيارة



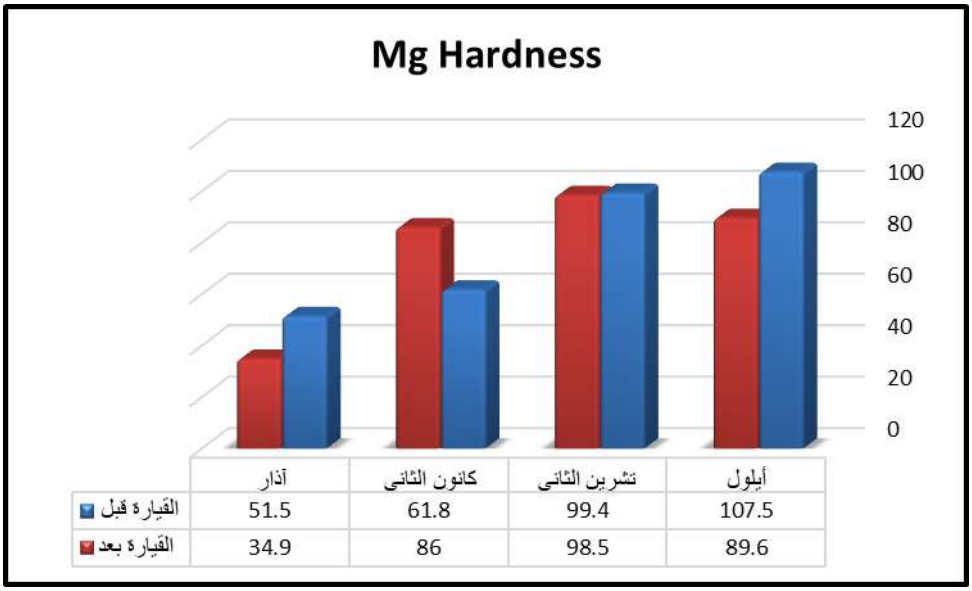
الشكل (6) يوضح قيم العسرة الكلية (وحدة ملغم/لتر) أثناء فترة الدراسة

عسرتي الكالسيوم والمغنيسيوم **Ca & Mg Hardness**

سجلت عسرتي الكالسيوم والمغنيسيوم اعلى التراكيز قبل دخول مياه نهر دجلة الى المصفى اذ بلغ تركيز عسرة الكالسيوم (220) ملغم/لتر اما عسرة المغنيسيوم بلغ تركيزها (107.5) ملغم/لتر وتصنف المياه على انها عسرة وذلك بسبب وجود الايونات الموجبة الثنائية والمتمثلة في ايون الكالسيوم والمغنيسيوم التي تعد من اكثر مسببات العسرة شيوعا ويرجع سبب ذلك الى صخور الحجر الجيري والدلومايت والصخور الجبسية الموجودة في حوض ومجرى نهر دجلة خاصة مع فترات سقوط الامطار الذي يؤدي الى اذابتها وانجرافها باتجاه المدينة كذلك من تسرب الاسمدة والمخصبات من الاراضي الزراعية والمخلفات المدنية والصناعية المختلفة الواصلة الى النهر اتفقت دراستنا مع (Ibrahim *et al,* 2022)



الشكل (7) يوضح قيم عسرة الكالسيوم (وحدة ملغم/لتر) أثناء فترة الدراسة



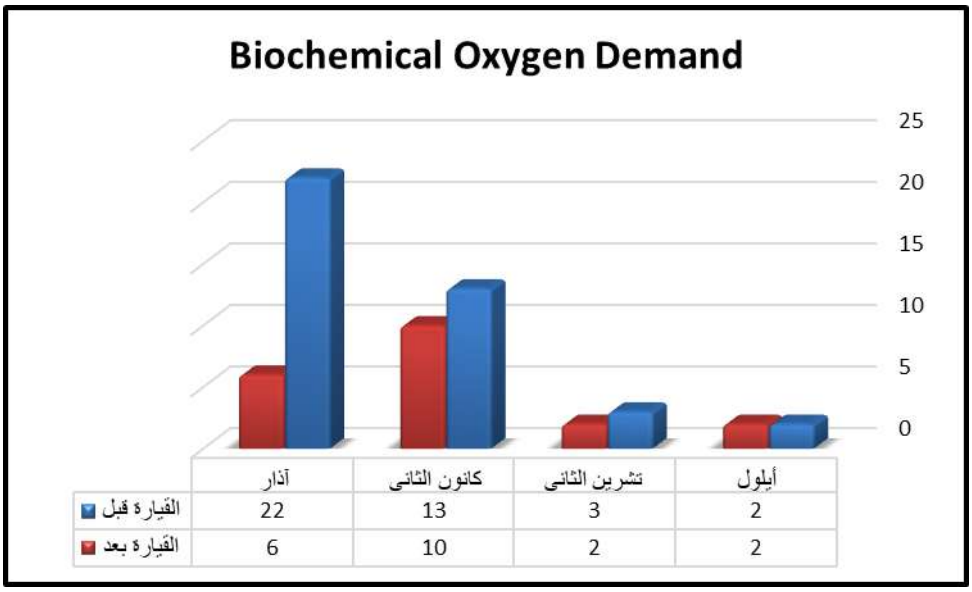
الشكل (8) يوضح قيم عسرة المغنيسيوم (وحدة ملغم/لتر) أثناء فترة الدراسة

Biochemical Oxygen Demandالمتطلب الحيوي للأكسجين

يستعمل هذا الفحص لتقدير الحمل العضوي في المياه اذ يعطي دلالة على كمية الاوكسجين المذاب المستهلك بواسطة الاحياء المجهرية والتي تقوم بتفكيك وهضم المواد العضوية في عينة المياه ولمدة خمس ايام

(Al-Qbidi, 2012) سجلت اعلى قيمة في نهر دجلة قبل دخوله للمصفى في شهر آذار وبتركيز 22 ملغم/ لتر وبذلك فان مياه نهر دجلة تصنف من النوع السيئ وذلك لتجاوزها (5ملغم/لتر) وفقا للمحددات العراقية لسنة 2009 حتى قبل دخولها للمصفى والذي يدل على تلوث مياه النهر بمياه الصرف الصحي (ملوثات عضوية) بسبب ما يصلها من ملوثات

متعددة من الوديان والمصبات الموجودة على ضفتي النهر الايمن والايسر كنهر الخوصر ووادي عكاب وهذا التفسير يتفق مع ما توصل اليه (Al-Sarraj *et al, 2014*)

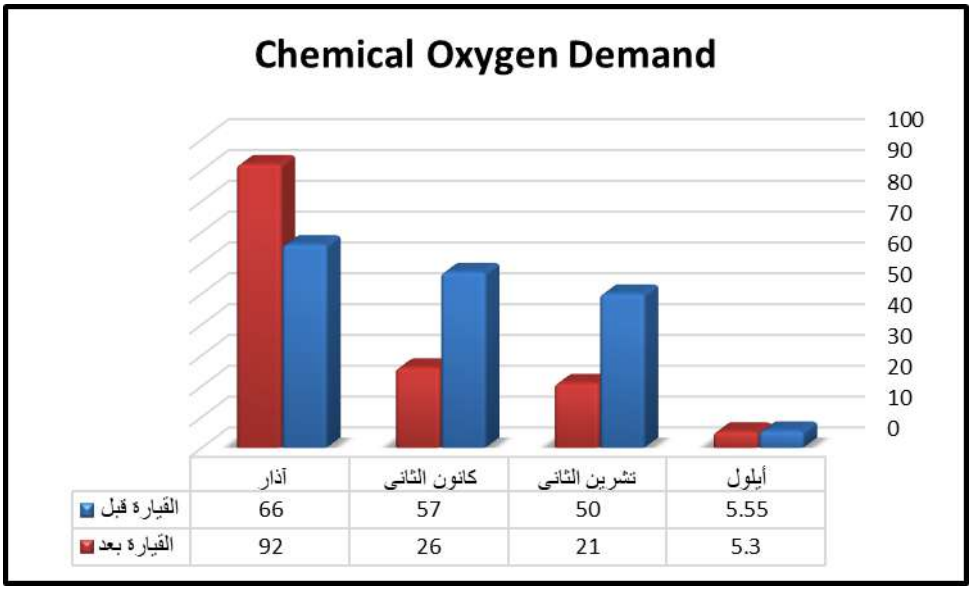


الشكل (9) يوضح قيم المتطلب الحيوي للاوكسجين (وحدة ملغم/لتر) أثناء فترة الدراسة

المتطلب الكيميائي للاوكسجين **Chemical Oxygen Demand**

يعد من اهم فحوصات جودة المياه اذ يعطي مقدار تقريبي لكمية المواد العضوية التي يمكن اكسدتها بطريقة كيميائية بدون اي تدخل احيائي (Al-Fatlawi & Mohammed, 2019)سجلت اعلى قيمة عند القيارة بعد خروج الماء من المصفى في شهر آذار وبتركيز 92 ملغم / لتر ويعود ذلك الى وجود المواد الهيدروكاربونية في المياه المطروحة اضافة الى المواد الكيميائية المختلفة المستخدمة في عمليات الاستخراج والفصل وعمليات المعالجة المختلفة وعلى الرغم من ان تركيز الCOD بعد خروج المياه المطروحة من المصفى اعلى من المياه الداخلة للمصفى الا انها لم تتجاوز حدود الطرح للمحددات العراقية لسنة 2009 التي اوصت ان يتجاوز تركيز المتطلب الكيميائي للاوكسجين 100 ملغم/لتر . اتفقت دراستنا مع

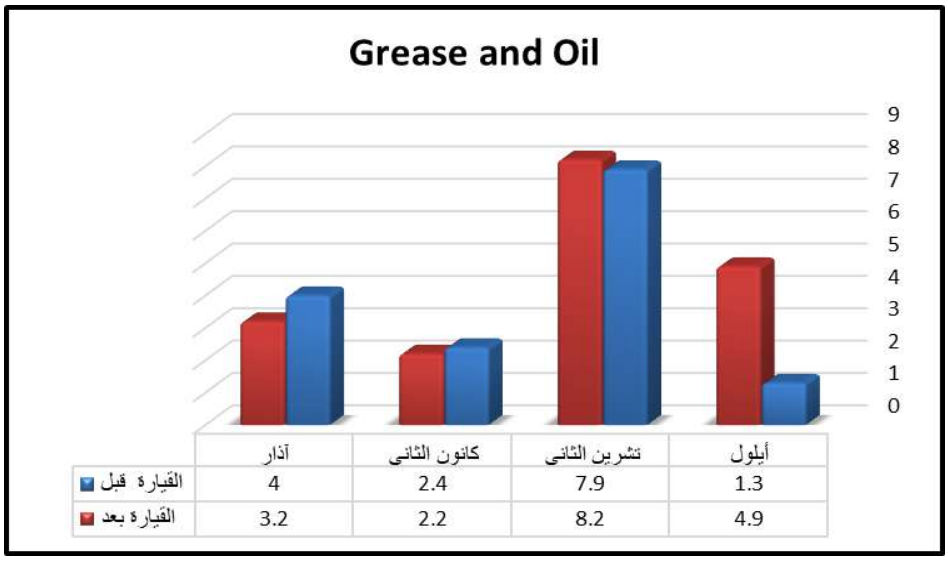
(2009, Saad alah *et al*)



الشكل (10) يوضح قيم المتطلب الكيميائي للاوكسجين (وحدة ملغم/لتر) أثناء فترة الدراسة

الشحوم والزيوت **Grease & Oil**

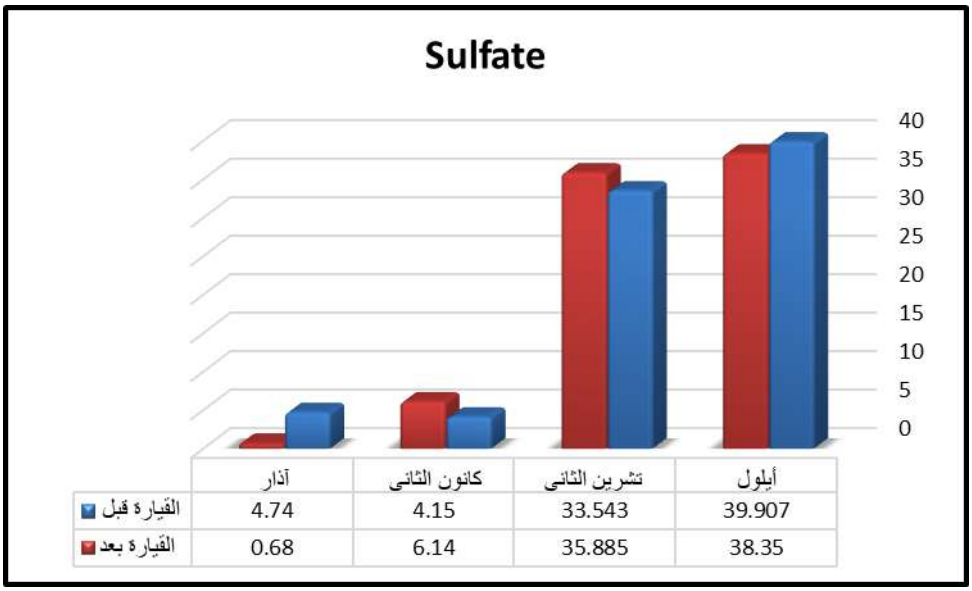
هي عبارة عن مجموعة من المركبات العضوية والتي تختلف في الاوزان الجزيئية الجزء الاكبر منها يطوف في الماء اما الجزء الباقي فيذوب بعد فقدانه للجزء الطيار ويؤثر الجزء الطافي منها على نوعية المياه اذ يقلل من كمية الضوء المخترق وذوبان الاوكسجين واعاقة البناء الضوئي في القعر (Husseini et al , 2021) سجلت اعلى قيمة في شهر تشرين الثاني بعد خروج المياه من المصفى وبتركيز 8.2 ملغم /لتر ويرجع سبب ذلك الى تسرب الزيوت من الالات المستخدمة في المصفى كاآلات استخراج وتكرير وفصل النفط او الاجهزة المستخدمة في التبريد كذلك التسرب الزيتي من النفط المستخرج اضافة الى حدوث بعض النضوحات من فترة الى اخرى وهذا يتوافق مع ما توصلت اليه الباحثة (Duaij, 2016) اذ بينت ان المياه الخارجة من المصافي تكون حاوية على الدهون ونفط خام وكيروسين والفينولات التي تعطي لون غير مقبول وطعم غير مستساغ للماء .



الشكل (11) يوضح قيم الدهون والشحوم (وحدة ملغم/لتر) أثناء فترة الدراسة

الكبريتات **Sulfate**

الكبريتات عبارة عن ايونات شائعة الوجود في المسطحات المائية اذ توجد متحدة مع الايون الموجب في الماء وعندما تتواجد بشكل كبريتات الكالسيوم والمغنيسيوم فانها تسبب عسرة دائمية اما اذا زاد تركيزها عن (200) ملغم /لتر فانها تسبب الطعم المالح للمجرى المائي (Mohsin *et al,* 2013)سجلت اعلى قيمة عند نهر دجلة قبل دخوله للمصفى في شهر ايلول وبتركيز 39.907 ملغم /لتر ويعزى سبب ذلك الى طبيعة الصخور الجبسية والتي تكون ضمن تكوين النهر وكذلك ما يطرح الى النهر من الصناعات المختلفة مثل استخدام حامض الكبريتيك في صناعة البطاريات والصناعات الجلدية والدباغة وغيرها كذلك التسربات والنضوحات من العيون الكبريتية ذاتية التدفق في منطقة حمام العليل اضافة الى منجم كبريت المشراق الذي يؤثر على نوعية مياه نهر دجلة ويرجع سبب التغاير في قيم الكبريتات بين أيلول وآذار إلى حدوث عملية التنقية الذاتية وعمليات الانتشار عند زيادة منسوب نهر دجلة في الافصل المطيرة . اتفقت دراستنا مع (Al-Saeedi & Al-Salman,2024)

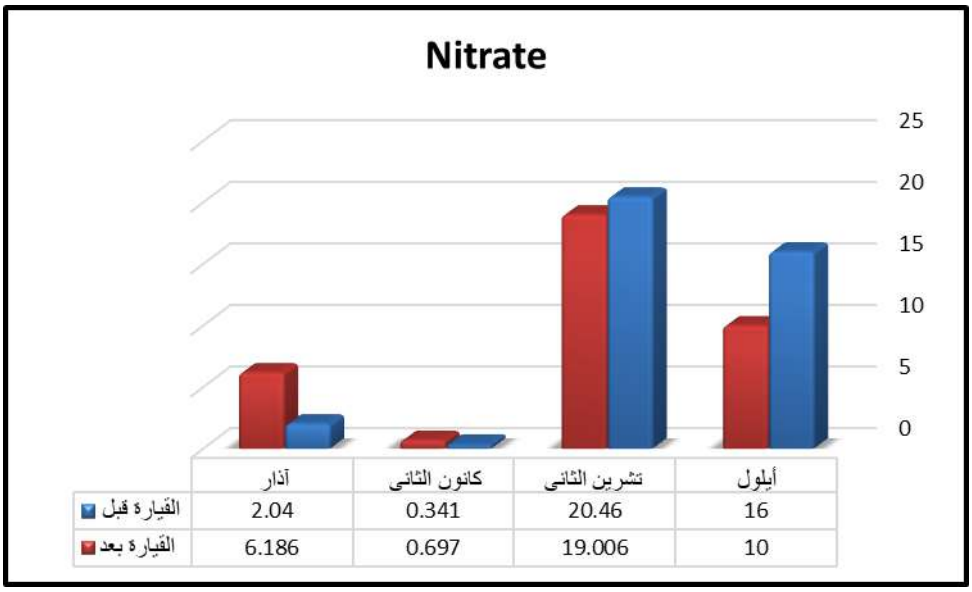


الشكل (12) يوضح قيم الكبريتات (وحدة ملغم/لتر) أثناء فترة الدراسة

النترات **Nitrate**

تعد النترات من ملوثات المسطحات المائية والتي تنتج بشكل رئيسي من الانشطة البشرية المختلفة مثل الاسمدة والصناعة وتربية الحيوانات ومواقع طمر النفايات وتزداد هذه المشكلة في الوقت الحالي بسبب التطور الحاصل في الصناعات اذ اصبحت هذه المشكلة تهديد للصحة والبيئة حيث ان تواجد النترات في الماء بتركيز اعلى من (45) ملغم /لتر فانها تسبب ميتهيموغلوبينية الدم لدى البشر وخاصة الاطفال (Wakejo *et al*,2022).سجلت اعلى قيمة في شهر تشرين الثاني وبتركيز 20.46 ملغم /لتر قبل دخول المياه الى المصفى ويمكن تفسير ارتفاع النترات في مياه النهر الى تسرب الاسمدة سواء كانت عضوية او مصنعة من الاراضي الزراعية التي توجد على طول ضفتي النهر منذ دخوله المدينة حتى خروجه منها اضافة الى مطروحات من المصانع مثل صناعة الالبان كذلك طرح فضلات الماشية وخاصة في منطقة جنوب

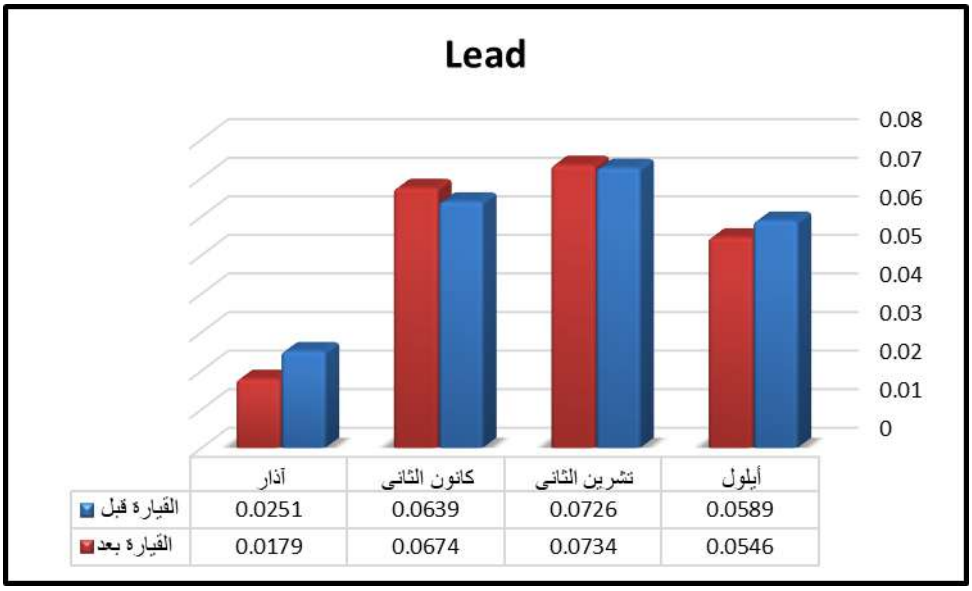
الموصل بشكل مباشر الى النهر اتفقت دراستنا مع (Al-Sarraj, 2014) التي فسرت ارتفاع تركيز النترات بسبب الاضافات الزراعية والبشرية التي تصل الى النهر كذلك وتحول الاحماض الامينية الى امونيا ثم الى نترات بعملية النترجة



الشكل (13) يوضح قيم النترات (وحدة ملغم/لتر) أثناء فترة الدراسة

الرصاص **Lead**

يعد من اشهر العناصر الثقيلة عالي السمية يدخل في العديد من الصناعات اهمها المبيدات والبطاريات والاصباغ والبنزين وغيرها , خطورة الرصاص تكمن في انه عنصر لا يتحطم بيولوجيا ويتمتع بخاصية التراكم الحيوي في انسجة الكائن الحي ((Abdul Latif,2020سجلت اعلى قيمة في شهر تشرين الثاني بعد خروج المياه من المصفى وبتركيز 0.0734 ملغم /لتر ان اهم المكونات الموجودة في النفط هي العناصر الثقيلة كالرصاص الذي يستخدم بخلطه مع البنزين لتحسين فعاليته .اتفقت الدراسة مع (Amhani et al,2022) الذي بين ان المياه الخارجة من المصفى النفطي تكمن خطورتها باحتوائها على كميات كبيرة من الاملاح الذائبة ومركبات عضوية وعناصر ثقيلة كالزئبق والرصاص والكادميوم والتي تطرح دون مراعاة لما يمكن ان تسببه للمياه السطحية والجوفية

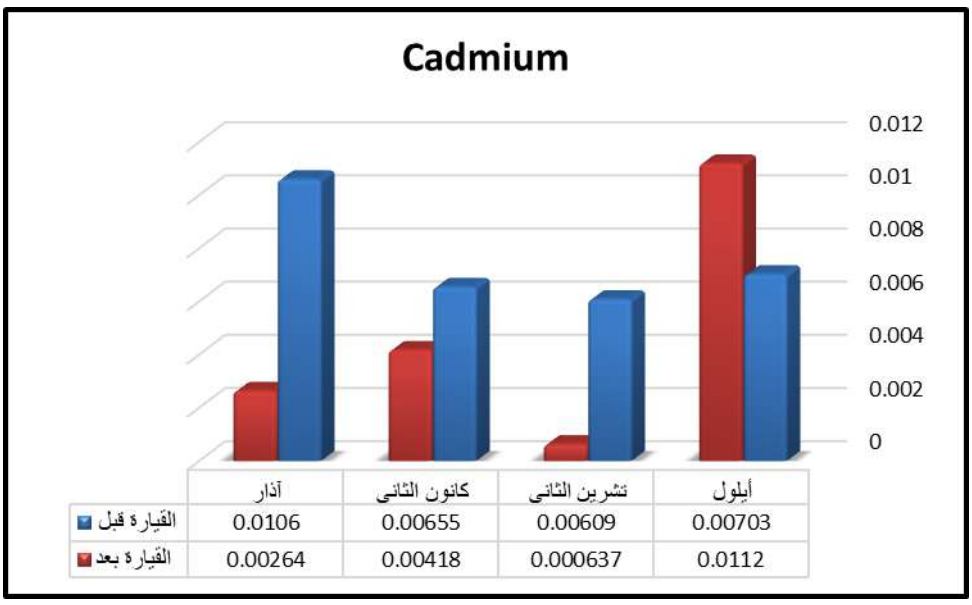


الشكل (14) يوضح قيم الرصاص (وحدة ملغم/لتر) أثناء فترة الدراسة

الكادميوم **Cadmium**

ثالث اشهر العناصر الثقيلة بعد الزئبق والرصاص وعبارة عن عنصر تراكمي تكمن خطورته في تراكمه في المراكز الحيوية المهمة في جسم الكائن الحي واهمها الكبد والكلى والطحال ((Abdul Latif,2016

سجلت اعلى قيمة في شهر أيلول بتركيز 0.0112 ملغم /لتر بعد خروج المياه من المصفى وقد يعود ذلك الى طبيعة النفط الحاوي على العناصر الثقيلة اضافة الى الحوادث العرضية الحاصلة كالنضوحات والتسربات الى المياه اتفقت دراستنا مع (Al-Sarraj, 2019)



الشكل (15) يوضحقيم الكادميوم (وحدة ملغم/لتر) أثناء فترة الدراسة

الاستنتاجات

من خلال الدراسة الحالية تبين ان المياه المطروحة من المصفى تقع ضمن حدود الطرح ماعدا عنصري الرصاص والكادميوم حيث سجلت اعلى قيمة للرصاص عند خروج المياه من المصفى وبتركيز 0.0734 ملغم /لتر اما الكادميوم كان بتركيز 0.0112 ملغم /لتر, اذ اوصت المحددات العراقية لمياه الشرب لسنة 2009 ان لايتجاوز تركيز عنصر الرصاص 0.01 ملغم /لتر وتركيز عنصر الكادميوم 0.003 ملغم /لتر في المياه المطروحة إلى مجاري الأنهار

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دراسة بيئية لبعض الخصائص الفيزوكيميائية والبكتريولوجية لمياه وادي سلمى في قضاء تلعفر /غرب محافظة نينوى وإمكانية استخدامها لأغراض الري

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تاريخ الإستلام 2025/1/20, تاريخ المراجعة 2025/2/18, تاريخ القبول 2025/2/25

الملخص

هدفت الدراسة الحالية لتقييم نوعية مياه وادي سلمى في قضاء تلعفر ضمن محافظة نينوى/ العراق موسمياً وإمكانية استخدامها لأغراض الري للمدة من شهر تشرين الثاني 2023 وحتى شهر تموز 2024، اذ قيست بعض الخصائص الفيزوكيميائية والبكتريولوجية التي تمثلت بالدالة الحامضية، التوصيلية الكهربائية، تركيز العسرة الكلية، المواد الصلبة الذائبة الكلية، أيونات الأورثوفوسفات، الكبريتات، أيوني الكلوريد والنترات، وعددي البكتيريا الكلي وبكتيريا القولون. بينت نتائج الدراسة الحالية بعدم وجود تغاير كبير في الخصائص المدروسة خلال فصول السنة إذ تراوحت قيم الدالة الحامضية ما بين (7–7.3) اما قيم التوصيلية الكهربائية فقد تراوحت ما بين (1124–1211) مايكروسيمنز/سم، وعن تراكيز العسرة الكلية فقد أظهرت النتائج ان مداها تراوح ما بين (730–806) ملغم/لتر، فيما تراوحت تراكيز المواد الصلبة الذائبة الكلية ما بين (587–786) ملغم/لتر، كما بينت نتائج الدراسة الحالية أيضاً أن تراكيز الأورثوفوسفات والكبريتات تراوحت ما بين (2.11–2.61) (389–357) ملغم/لتر على التوالي، اما تراكيز أيوني الكلوريد والنترات فقد تراوحت قيمهن ما بين (74–98) (20.124–22.145) ملغم/لتر على التوالي، أخيراً سجلت النتائج أن اعلى عددي للبكتيريا الكلية وبكتيريا القولون على التوالي كان (44×10^3–22×10^3) خلية/100مل.

بينت النتائج إن المياه الوادي ومن خلال دراسة بعض الصفات الفيزكيمائية و البكتريولوجية تقع ضمن محددات المياه العراقية لأغراض الري.

الكلمات المفتاحية: *وادي, تلعفر، تلوث المياه, الخصائص الفيزوكيمائية.*

Environmental study of some physicochemical and bacteriological properties of valley Salma water in Tal Afar district/west of Nineveh Governorate and the possibility of using it for irrigation purposes

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Abstract

The current study aimed to evaluate the quality of the water of valley Salma Dara in Tal Afar District within Nineveh Governorate/Iraq seasonally and the possibility of using it for irrigation purposes for the period from November 2023 to July 2024. Some physicochemical and bacteriological properties were measured, which were represented by the acidity function, electrical conductivity, total hardness concentration, total dissolved solids, orthophosphate ions, sulfates, chloride and nitrate ions, and total bacterial counts and coliform bacteria. The results of the current study showed a clear variation in the properties, as the acidity function values ranged between (7-7.3), while the electrical conductivity values ranged between (1124-1211) microsiemens/cm, and as for the total hardness concentrations, the results showed that their range ranged between (730-806) mg/l, while the concentrations of total dissolved solids ranged between (587-786) mg/l. The results of the current study also showed that the concentrations of orthophosphate and sulfate ranged between (2.11-2.61) (357-389) mg/l, respectively, while the concentrations of chloride and nitrate ions ranged between (74-98) (20.124-22.145) mg/l, respectively. Finally, the results recorded that the highest number of total bacteria and colonic bacteria, respectively, were (44×10^3-22×10^3) cells/ml during the four seasons.

The results showed that the valley water, through some of the studied physicochemical and bacteriological characteristics, falls within the determinants of Iraqi water for irrigation purposes.

Keywords: *valley, Tal Afar, water pollution, physicochemical properties.*

المقدمة

المياه من الضرورات المهمة في حياتنا كونه متطلباً أساسيا كما يعد عماداً للحضارات وسراً لوجودها اذ تشير أغلب الدراسات المتعلقة بالمياه الى تزايد مشاكل العالم والوطني العربي ولاسيما العراق جراء ما النقص الحاد في الموارد المائية وتدني حصة الفرد منها وهو ما يستدعي العمل على استغلال جميع المصادر المائية الممكنة والاستعانة بالتجارب و الممارسات الناجحة التي اعتمدتها بعض الدول التي تواجه مشاكل مماثلة والتي تتمثل في برامج معالجة المياه الرمادية ومياه الصرف الصحي، لتغطية قسم من احتياجات الري الذي يستنفذ ما بين (70–80%) من الموارد المائية المتاحة (FAO, 2017).

الوديان هي مناطق جغرافية فريدة ومهمة من الناحية البيئية والاقتصادية والاجتماعية. تشكل الوديان مساحات طبيعية فريدة تتميز بخصائصها الجيولوجية والبيئية والمناخية. تتميز الوديان بتضاريسها المتنوعة، مثل الأنهار والجداول

والبحيرات، والتي تلعب دورًا هامًا في دعم الحياة البرية والبشرية. أكد (Machado and Soares, 2018) ان الوديان جزءًا هامًا من النظام البيئي، حيث يلعب دورًا مهمًا في دعم الحياة البرية والبشرية. مياه الوادي تعتبر موردًا هامًا للشرب والري والصناعة، ولكنها تعرضت لتلوث بسبب النشاطات البشرية (Pinto, 2019) في ظل التحديات البيئية والاقتصادية التي تواجه العالم اليوم، أصبح من الضروري البحث عن مصادر بديلة للمياه للري. مياه الفضلات المطروحة في الوديان تعتبر مصدرًا هامًا للمياه في مناطق الجافة، ولكنها تتطلب معالجة وتحسين جودة قبل استخدامها (Thapa *et al.*, 2020). أن مياه الفضلات المطروحة في الوديان قد تحتوي على تراكيز عالية من الصوديوم، المغنيسيوم والأيونات، والمواد الصلبة الذائبة الكلية وعناصر الثقيلة وأن تراكيزها ليست ثابته كونها تعتمد على أنشطة الانسان المختلفة مثل المياه المطروحة من الصناعات المختلفة ومياه الصرف الصحي (Jalali *et al.*, 2024).

ساهمت موجات الجفاف والتطور الزراعي والعمراني في المنطقة الى زيادة الحاجة لاستخدام البدائل المتاحة من المياه، يُعد وادي سلمى جزءًا هامًا من النظام البيئي في منطقة الدراسة، حيث يتميز بتنوعه الحيوي وثرائه بالموارد الطبيعية. يعتبر الماء من أهم هذه الموارد، حيث تتدفق المياه في الوادي طوال العام، مما يجعله مصدرًا محتملاً للري. يهدف هذا البحث إلى تقيم بعض الخصائص الفيزيائية والكيميائية والبكتريولوجية لمياه وادي سلمى في قضاء تلعفر ضمن محافظة نينوى ، وتقييم جودتها، وتحديد إمكانية استخدامها في ري الأراضي الزراعية، بما يسهم في تعزيز التنمية الزراعية المستدامة في المنطقة.

المواد وطرائق العمل

وصف منطقة الدراسة:

لتقييم نوعية مياه الوادي أجريت الدراسة الحالية في مختبرات كلية العلوم البيئية، تقع منطقة الدراسة بالقرب من بساتين تلعفر في جنوب القضاء وعند خط الطول (42°27'22" E) وخط العرض (36°22'27" N) إذ تصب فيه مياه الفضلات المطروحة من مدينة تلعفر فضلا عن مياه عين صوباشي وتروى مياهها العديد من البساتين في القضاء.

الشكل (1) مياه وادي سلمى (الباحث)

جمع العينات:

جمعت العينات من منطقة الدراسة الحالية ابتداء من شهر تشرين الثاني 2023 وحتى شهر تموز 2024، وبمعدل نموذج فصلياً وقيست النماذج حسب (APHA and WCPE, 2017). إذ جمعت العينات من منطقة التي تروي بساتين المدينة.

الفحوصات الحقلية:

قيست درجة حرارة المياه باستخدام محرار كحولي مدرج ($^{-}10-110$) مْ، أما الدالة الحامضية والتوصيلية الكهربائية فقد تم قياسهما باستخدام pH & EC meter نوع HANNA INSTRUMENTS، وكذلك تم قياس المواد الصلبة الذائبة الكلية باستخدام جهاز TDS meter نوع OEM.

الفحوصات المختبرية:

لإجراء الفحوصات المختبرية أخذت النماذج في قناني البلاستيكية نظيفة حيث قيس أيون الكبريتات باستخدام جهاز Turbidity meter واما العسرة الكلية فقد تم تسحيحها مع Na_2EDTA، كما تم قياس ايون الكلوريد بتسحيحه مع نترات الفضة. اما النترات فتم قياسها باستخدام جهاز SpectroPhotometer. وفيما يخص الفحوصات البايولوجية فتم تقدير العدد الكلي للبكتيريا وبكتيريا القولون بطريقة النشر على الأطباق حسب (Cappuccino and Welsh, 2018).

يوضح الجدول (1) محددات التوصيلية الكهربائية وكمية الاملاح الذائبة الكلية لأغراض الري حسب مختبر الملوحة الأمريكي، اما الجدول (2) فيوضح المحددات العراقية للمياه المستخدمة لأغراض الري (Saghir, 2017).

الجدول (1) محددات مختبر الملوحة الأمريكي لمياه الري حسب محتواها من التوصيلية الكهربائية وكمية الاملاح الذائبة الكلية (Al-Sanjary,2001).

صنف الماء	التوصيلية الكهربائية (مايكروسيمنز/سم)	كمية الأملاح الذائبة الكلية (ملغم/لتر)	مدى ملائمة المياه للري
قليل الملوحة C_1	250-100	160-0	الماء ملائم لأغلب النباتات ولمعظم الترب مع احتمال قليل جدا لنشوء ملوحة التربة
متوسط C_2 الملوحة	750-250	480-160	الماء ملائم للنباتات جيدة التحمل للأملاح في حالة وجود غسل متوسط للتربة

عالي الملوحة C_3	2250-750	1440-480	الماء ملائم للنباتات متحملة الملوحة وعلى الترب جيدة البزل مع ضرورة وجود نظام بزل وغسل جيد للتربة
عالي الملوحة C_4 جداً	5000-2250	3200-1440	الماء ملائم للنباتات المتحملة جدا للملوحة على التربة النفإذية جيدة البزل مع وجود غسل شديد للأملاح

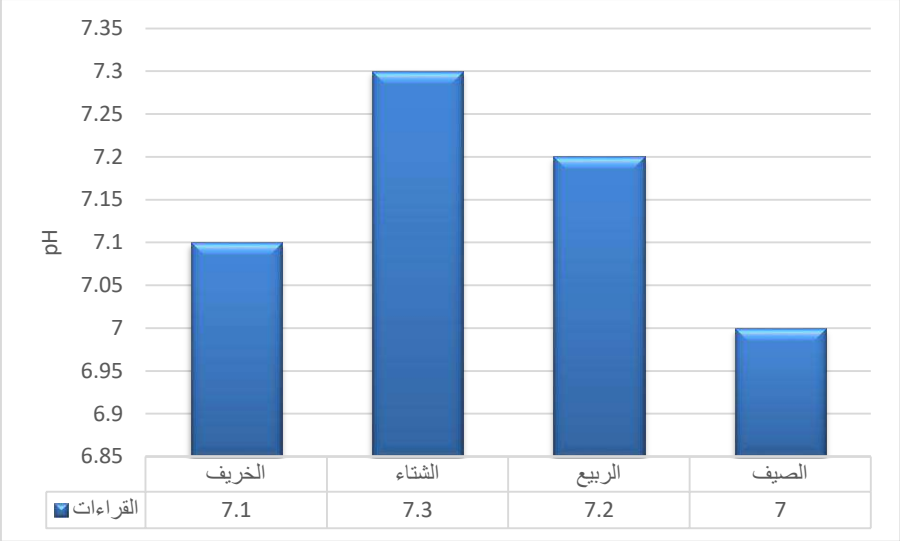
الجدول (2) يوضح محددات المياه العراقية المستخدمة لأغراض الري (Saghir, 2017)

المتغير	المحدد العراقي
pH	8.5-6.5
(T.H) العسرة الكلية (ملغم/لتر)	(اقل من 1000) منخفضة (3000-1000) متوسطة (أكثر من 3000) مرتفعة
الكبريتات (ملغم/لتر)	اقل من 400
الكلوريد (ملغم/لتر)	اقل من 200
النترات (ملغم/ لتر)	اقل من 50

النتائج والمناقشة

الدالة الحامضية pH

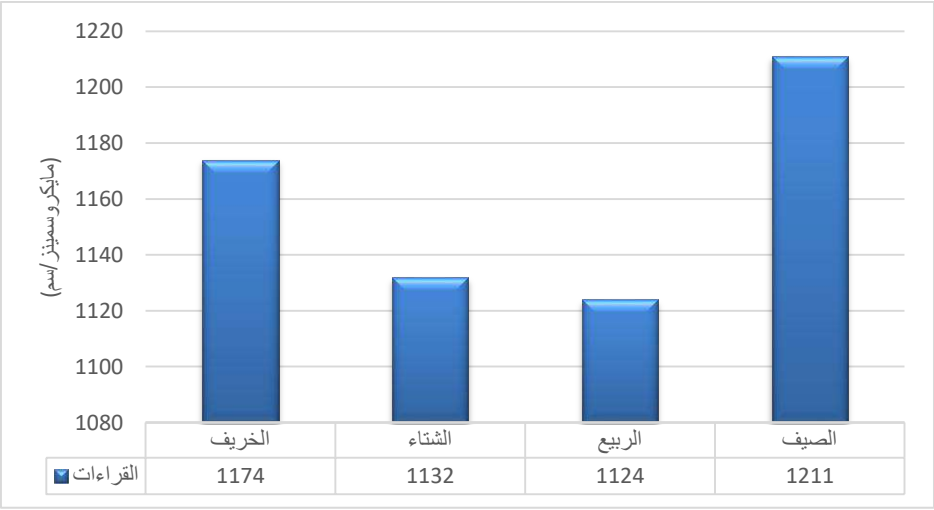
سجلت الدراسة الحالية نتائج متقاربة خلال فصول السنة في تراكيز الpH تراوحت بين(7 -7.3)، مما يتوافق مع المعايير العراقية لمياه الري التي تحدد مدى pH بين(6.5-8.5) النتائج تشير إلى استقرار قيم pH ومطابقة المعايير البيئية، يعزى ذلك الى أن الفضلات التي تحملها المياه لا تؤثر على قيمة pH.. وهذا ما أكدته الدراسات البيئية حيث أظهرت دراسة (Shehab, 2017) حول تأثير المطروحات على مياه النهر، و استنتجت(Shihab, 2021) في دراستها عن بعض الخصائص الفيزيائية والكيميائية والإحيائية لمياه نهر دجلة ضمن مدينة الموصل، أن قيم الـ pH كانت ضمن الحدود المسموح بها اذ تراوحت بين (6.5-8.5). اما ما توصلت اليه (Alkhabouri, 2023) خلال دراستها لفضلات مياه المنازل في محطات الرفع داخل مدينة الموصل، فان قيم الـ pH تراوحت ما بين (6.91-7.9)،



الشكل (2) قيم pH في منطقة الدراسة خلال افصل السنة

التوصيلية الكهربائية **Electrical Conductivity (EC)**

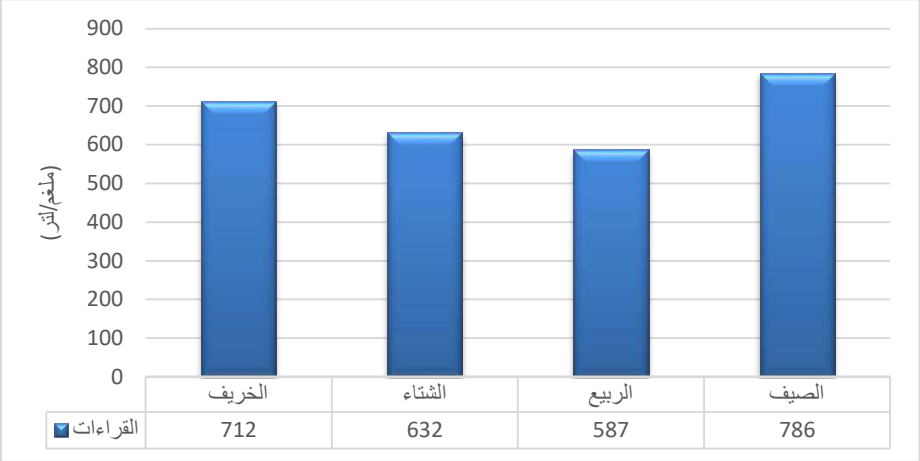
سجلت نتائج الدراسة الحالية أقل قيمة الـ EC في فصل الربيع في شهر نيسان 2024 وبلغت (1124) مايكروسمينز/سم بينما كانت أعلى قيمة في فصل الصيف في شهر تموز 2024 وبلغت (1211) مايكروسمينز/سم، كما موضح في شكل (3)، ارتفاع قيم التوصيلية الكهربائية يعود إلى طبيعة الفضلات التي تحتوي على أنواع مختلفة من الأملاح، حيث تؤثر كمية وتنوع الأملاح في مياه المجاري والفضلات على قيم الـ EC (Alkhabouri, 2023)، من ناحية أخرى يؤدي تخفيف مياه الفضلات بسبب الأمطار إلى انخفاض هذه القيم (Al-Taee, 2022).



الشكل (3) قيم EC في منطقة الدراسة خلال افصل السنة

المواد الصلبة الذائبة الكلية **Total Dissolved Solid (TDS)**

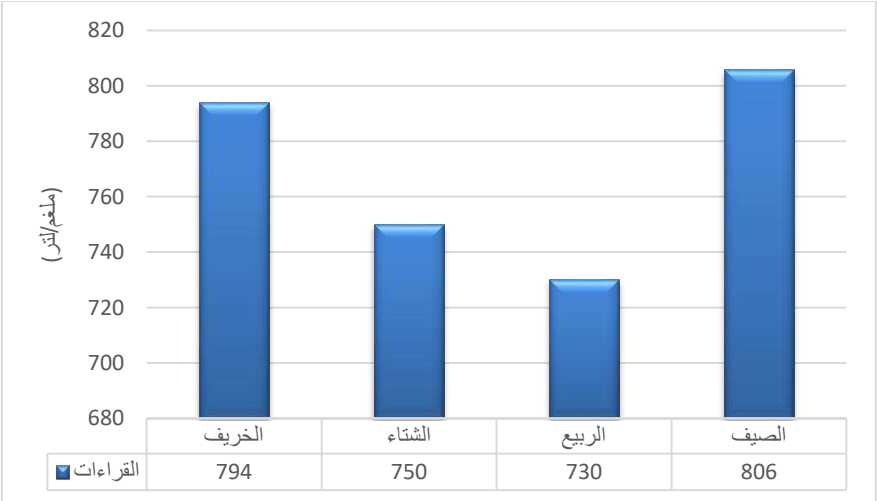
اظهرت الدراسة الحالية اقل تركيز للـ TDS في شهر نيسان(فصل الربيع) 2024 اذ بلغ (587) ملغم/لتر، اما أعلى تركيز فقد كان في شهر تموز(فصل الصيف)2024 وبلغ (786)ملغم/لتر كما موضح في (الشكل 4). تعتمد تراكيز الـ TDS على قيمة التوصيلية الكهربائية، اذ تتناسب معها بشكل طردي (Bhat *et al.*, 2018).



الشكل (4) قيم TDS في منطقة الدراسة خلال افصل السنة

العسرة الكلية **Total Hardness (T.H)**

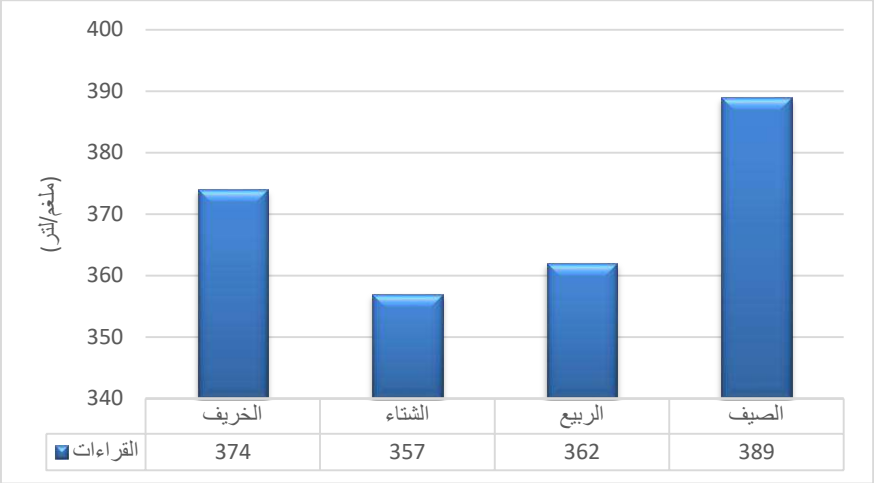
أظهرت نتائج الدراسة الحالية بعدم وجود فرق كبير في تراكيز الـ T.H بين فصول السنة حيث سجل أعلى تركيز في فصل الصيف في شهر تموز 2024 وبلغ (806) ملغم/لتر، بينما كان أقل تركيز في فصل الربيع في شهر نيسان 2024 وبلغ (730) ملغم/لتر كما موضح في (الشكل 5)، إن سبب الارتفاع والانخفاض في تراكيز الـ T.H يعود لاحتواء مياه الفضلات المنزلية على املاح غير النقية والغنية بأملاح الكالسيوم والمغنيسيوم (Al-Mashhadany, 2023).



الشكل (5) قيم T.H في منطقة الدراسة خلال افصل السنة

أيونات الكبريتات **Sulphate Ions (SO_4^{-2})**

سجلت نتائج الدراسة الحالية أقل قيمة للكبريتات في فصل الربيع في شهر كانون الاول 2024 وبلغت (357) ملغم/لتر بينما كانت أعلى قيمة في فصل الصيف في شهر تموز 2024 وبلغت (389) ملغم/لتر، كما موضح في (الشكل 6)، إن تراكيز الـ SO_4^{-2} خلال مدة الدراسة الحالية كانت ضمن الحدود المسموح بها للري، والتي حددت تركيز الـ SO_4^{-2} بـ (400) ملغم/لتر كما موضح في (الجدول 2). وتمثل الكبريتات عاملا مؤكسدا قويا، لأنها تؤكسد المركبات العضوية المعرضة للأكسدة (Venkatesharaju *et al.*, 2010).

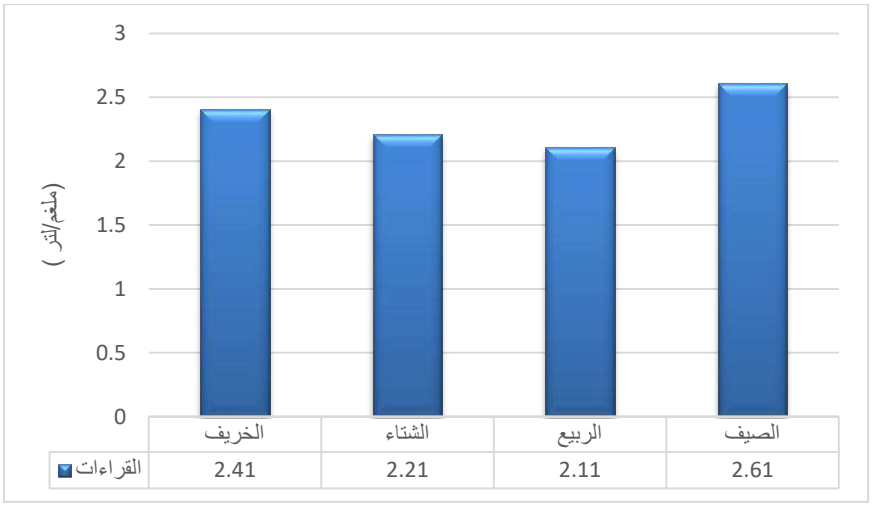


الشكل (6) قيم SO_4^{-2} في منطقة الدراسة خلال افصل السنة

أيونات الأورثوفوسفات **Phosphates Ions (PO_4^{-3})**

سجلت الدراسة الحالية نتائج متقاربة خلال فصول السنة في تراكيز الـ PO_4^{-3} اذ تراوحت تراكيزها ما بين (2.11–2.61) ملغم/لتر كما موضح في (الشكل 7).

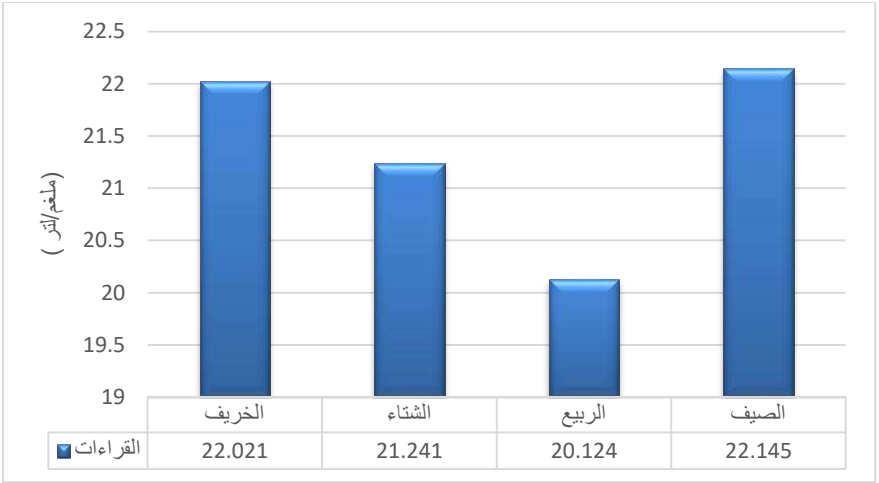
ثبتت المحددات العراقية تراكيز الـ PO_4^{-3} بـ (3) ملغم/لتر كحد أقصى ، كانت نتائج تركيز الـ PO_4^{-3} ضمن الحدود المسموح بها للري خلال فترة الدراسة الحالية ، إن السبب في أرتفاع تراكيز أيونات الـ PO_4^{-3} يعود لطبيعة الفضلات المدنية فضلاً عن كميات وأنواع المنظفات الحاوية على الفوسفات (Al-Mashhadany,2023).



الشكل (7) قيم PO_4^{-3} في منطقة الدراسة خلال افصل السنة

أيونات النترات **Nitrate Ions (NO_3^-)**

اظهرت نتائج الدراسة الحالية أن تراكيز الـ NO_3^- تراوحت ما بين (20.124–22.145) ملغم/لتر كما موضح في (الشكل 8)، وهي ضمن المواصفات المسموحة للمياه الري والتي حددت تركيز الـ NO_3^- بـ (50) ملغم/لتر كما موضح في (الجدول 2). أن هذا الاختلاف في تراكيز أيونات الـ NO_3^- يعود إلى الأفعال الأيضية للإنسان والأمونيا الناتجة عنها، بالإضافة لوصول المبيدات الزراعية فضلاً عن المطروحات فضلات الحيوانات الى مياه الصرف الصحي (Al-Taee, 2022).

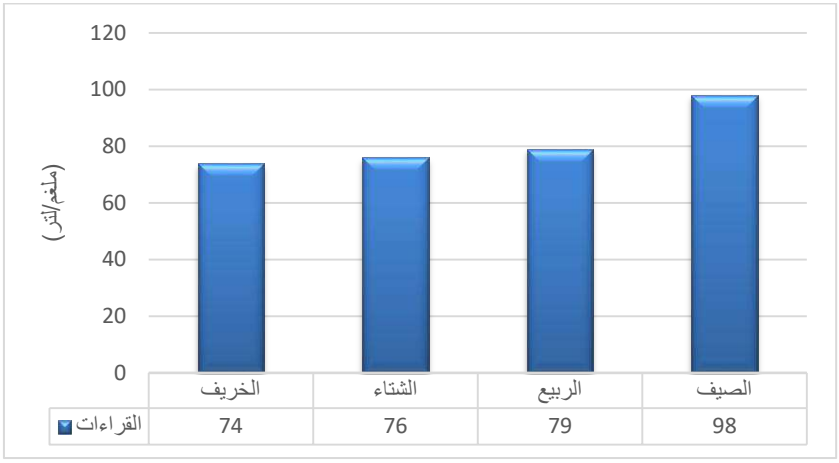


الشكل (8) قيم NO_3^- في منطقة الدراسة خلال افصل السنة

أيون الكلوريد **Chloride Ion (Cl^-)**

سجلت نتائج الدراسة الحالية بوجود فرق في تراكيز الـ Cl^- حيث بلغ مداها ما بين (74–98) ملغم/لتر كما موضح في

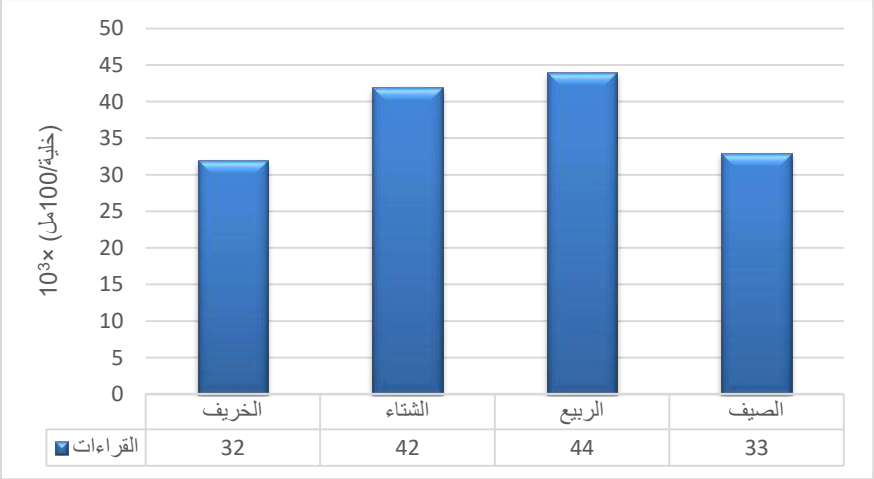
(الشكل 9)، وكانت النتائج ضمن الحدود المسموح بها للري حسب المحددات العراقية للري كما موضح في (الجدول 2). أن السبب في وجود أيون الـ Cl^- قد يعود للفضلات السائلة التي تكون غنية بأيون الـ Cl^- (Danhalilu *et al.*, 2018).



الشكل (9) قيم Cl^- في منطقة الدراسة خلال افصل السنة

العدد الكلي للبكتيريا **Total Bacteria Count (T.B.C)**

سجلت الدراسة الحالية أدنى عدد لـ T.B.C في شهر تشرين الثاني 2023 وبلغ (10^3*32) خلية/100مل، بينما سجلت أعلى عدد في شهر نيسان 2024 وبلغ (10^3*44) خلية/100مل كما موضح في (الشكل 10). يعود سبب ارتفاع العدد الكلي للبكتيريا الى زيادة كمية المواد العضوية الموجودة في مياه الفضلات(Al-Saffawi, 2018) .



الشكل (10) قيمT.B.C في منطقة الدراسة خلال افصل السنة

العدد الكلي لبكتيريا القولون **Total Coliform Count (T.C.C)**

سجلت الدراسة الحالية أقل عدد لـ T.B.C في شهر تموز 2024 وبلغ (10^3*16) خلية/100مل، بينما سجلت أعلى عدد في شهر نيسان 2024 وبلغ (10^3*22) خلية/100مل كما موضح في (الشكل 11). يشير أرتفاع أعداد الـ

T.C.C الى تلوث المياه بالفضلات المنزلية خصوصاً نتيجة تصريف خزانات التعفين الى شبكة التصريف العامة (Al-Saffawi, 2018).

الشكل (11) قيمT.C.C في منطقة الدراسة خلال افصل السنة

الاستنتاجات

صُنفت نوعية المياه المدروسة من مياه عسرة إلى مياه عسرة جداً حسب تصنيف العسرة.

ارتفاع قيم التوصيلية الكهربائية (EC) وتراكيز المواد الصلبة الذائبة الكلية (TDS) خلال فصلي الصيف والخريف بسبب ارتفاع درجات الحرارة في منطقة الدراسة خلال هذين الفصلين إذ ان ارتفاع درجات الحرارة تزيد من عملية تبخر المياه مما يؤدي الى تراكم الاملاح في المياه.

إنَّ قيم الدالة الحامضية (pH) كانت ضمن المدى الطبيعي خلال مدة الدراسة فهي تقع ضمن المدى (6.5-8.5).

بينت نتائج الدراسة بعدم وجود تغاير كبير في قيم الايونات المدروسة (الكبريتات، النترات، الأورثوفوسفات ، الكلوريد) خلال مدة الدراسة.

نستنتج من النتائج لبعض الخواص الفيزوكيمائية المدروسة إن مياه الوادي صالحة لاستخدام لأغراض الري و كذلك يمكن عمل محطة معالجة أولية او ثانوية لمياه الوادي لاستخدامها لأغراض أخرى.

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إستخدام تطبيق نظم المعلومات الجغرافية والتحليل المتعدد المعايير لتحديد أفضل الأماكن لطمر النفايات الصلبة في قضاء تلعفر

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الملخص

تلعب إدارة النفايات الصلبة دوراً محورياً في تعزيز الصحة العامة والحفاظ على البيئة من خلال الحد من المخاطر البيئية والآثار الاجتماعية السلبية. وفي ظل تزايد كميات النفايات الناتجة عن الأنشطة البشرية، تبرز الحاجة إلى إختيار مواقع مناسبة لطمر النفايات بصورة علمية ومستدامة.

تهدف هذه الدراسة إلى تحديد المواقع المثلى لطمر النفايات الصلبة في قضاء تلعفر بالاعتماد على تقنيات نظم المعلومات الجغرافية (GIS) وأسلوب اتخاذ القرار متعدد المعايير (MCDM)، باستخدام طريقة التحليل الهرمي (AHP) لتحديد الأوزان النسبية للعوامل المؤثرة. شمل التحليل ستة عوامل رئيسية: الغطاء الأرضي، شبكة الطرق، نوع التربة، الانحدار، الارتفاع واتجاه الرياح. وقد تم جمع البيانات المكانية وتحليلها داخل بيئة GIS، ومن ثم دمج الطبقات من خلال أسلوب الدمج الوزني لإنتاج خرائط الملاءمة.

أظهرت النتائج وجود مناطق ذات ملاءمة عالية لإنشاء مواقع الطمر، تتركز بشكل خاص في الجزء الجنوبي الغربي من قضاء تلعفر، والتي تتصف بانخفاض الكثافة السكانية واعتدال الانحدار وبعدها عن المناطق السكنية، إضافةً إلى قربها من الطرق الرئيسة، مما يجعلها مناسبة من الناحية البيئية واللوجستية.

توصلت الدراسة إلى أن دمج تقنيات GIS مع منهجيات MCDM يمثل أداة فعالة تدعم اتخاذ قرارات مستدامة في مجال إدارة النفايات. وتوصي بأهمية الرصد البيئي المستمر كوسائل داعمة للتخطيط طويل الأمد، بما يضمن المرونة والتكيف مع التغيرات المستقبلية ويُسهم في الحد من الأثر البيئي الناتج عن مواقع الطمر الغير الملائمة.

الكلمات المفتاحية: *النفايات الصلبة, نظم المعلومات الجغرافية, تحليل متعدد المعايير , مواقع الطمر.*

Using the GIS application and multi-criteria analysis to determine to optimal site for solid waste landfill in Tal Afar district

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Abstract

Solid waste management plays a vital role in enhancing public health and protecting the environment by minimizing ecological hazards and social impacts. This study aims to determine optimal landfill sites in the Tal Afar district using Geographic Information Systems (GIS) and Multi-Criteria Decision Making (MCDM) techniques. Six key factors were analyzed: land cover, road network, soil type, slope, elevation, and wind direction. Each factor was weighted using the Analytic Hierarchy Process (AHP), and spatial analysis was performed using a weighted overlay in a GIS environment. The resulting suitability maps identified highly appropriate areas for landfill development, primarily located in the southwestern part of the Tal Afar district, characterized by low population density, moderate slope, and road accessibility. The study concludes that integrating GIS and MCDM provides a reliable framework for sustainable site selection. It also recommends ongoing environmental monitoring and long-term waste management planning.

Keywords: *Solid waste, Geographic information systems, Multi-criteria analysis, Landfill sites.*

المقدمـة

تعدُّ النفايات الصلبة من المواد الضارة التي يتم التخلص منها لعدم جدواها، إلا أن إدارتها تمثل تحدياً متزايداً في العديد من البلدان نتيجةً لسوء التعامل معها. ولتحقيق بيئة مستدامة وصحية، أصبح من الضروري تبنّي أساليب معالجة آمنة تضمن حماية الصحة وتحافظ على البيئة. ومن بين الأساليب الفعالة في هذا المجال، تُوظَّف تقنيات نظم المعلومات الجغرافية (GIS) والاستشعارعن بُعد في تحديد المواقع المثلى لإنشاء الخرائط المكانية الخاصة بإدارة النفايات (Oyebode O. J., 2024).

يُعَدُّ الطمر الصحي من أكثر الطرق شيوعًا للتخلص من النفايات الصلبة، حيث تُوزَّع النفايات في طبقات رقيقة، ثم تحدل في مساحات صغيرة وتُغطى في النهاية بطبقة من التربة، مما يسهم في تقليل تأثيرها البيئي والحد من الانبعاثات الضارة. وعلى الرغم من تنوع الأساليب المتبعة في معالجة النفايات، فإن الطمر الصحي يظل خياراً مفضلًا في العديد من المناطق، خاصة عند ارتباطه مع نظم المعلومات الجغرافية (GIS). إذ تتيح هذه النظم تكوين قاعدة بيانات مكانية متكاملة تُستخدم في تحليل الخصائص البيئية والمكانية للمواقع المقترحة، بما يسهّل عملية اتخاذ القرار ويعزز من فعالية إدارة النفايات الصلبة بشكل علمي ومدروس (Hazarika R. et al., 2020).

وفي هذا الإطار، يُعد اختيار مواقع مكبات النفايات من أبرز تطبيقات التحليل المكاني التي تعتمد على تقنيات التحليل متعدد المعايير (MCDM)، لما توفره من أدوات تساعد في تقييم المواقع بناءً على مجموعة من العوامل البيئية والاجتماعية والاقتصادية. ومع ذلك، لم تعد المكباتّ حلاً نهائيًا للتخلص من النفايات، بل أصبحت جزءً من منظومة متكاملة تهدف إلى تحويل النفايات إلى موارد ذات قيمة بيئية واقتصادية (Maqsoom A. et al., 2022). وقد تطورت مفاهيم إدارة النفايات بشكل ملحوظ خلال السنوات الأخيرة، فلم تعد تقتصر على أساليب تقليدية كالحرق أو الطمر، بل توسعت لتشمل استراتيجيات مستدامة مثل إعادة التدوير واستخلاص الطاقة والاستفادة من المخلفات بطرق مبتكرة (Musa, A. et al., 2021).

فيما يلي مجموعة من الدراسات القائمة على ذلك :

أجرت دراسة (Faisal RM et al ., 2018), تحليلًا لاختيار موقع مناسب لطمر النفايات الصلبة في مدينة الموصل، حيث تم في إطارها تقدير كميات النفايات المتولدة في المدينة، بالإضافة إلى استعراض طرق معالجتها. وقد بيّنت نتائج الدراسة أن استخدام التحليل القائم على المعايير المعتمدة ساعد بشكل فعّال في تقييم المواقع المقترحة للطمر، مما أسهم في دعم اتخاذ القرار بشأن الموقع الأنسب من الناحية البيئية والفنية.

أجرت دراسة (Alkaradaghi et al ., 2021), أظهرت إحدى الدراسات في محافظة السليمانية تقييماً كمياً لإنتاج النفايات الصلبة، وركّزت على التحديات التي تواجه إدارتها، خاصة في ظل الارتفاع المتوقع لمعدلات التوليد المستقبلي. وبينت نتائج الدراسة أنه بحلول عام 2040 قد يبلغ معدل إنتاج الفرد اليومي من النفايات نحو 1.32 كغم، ليصل إجمالي الإنتاج اليومي إلى حوالي 10,445 طناً . وتُبرز هذه الأرقام الحاجة إلى تخطيط بعيد المدى لمواقع طمر النفايات، من خلال اختيار مواقع تتسم بالاستدامة البيئية والقدرة الاستيعابية، بما يضمن تقليل الأثر البيئي وتخفيف الضغط على البنى التحتية الحالية.

بينما، ناقشت دراسة (Al-Ansari N et al., 2019), إستخدام نموذج MCDM لتحليل مواقع الطمر في محافظة بابل، حيث أظهرت النتائج إن مواقع التخلص من النفايات الحالية لا تتوافق مع المعايير البيئية، مما يشكل خطراً على المجتمع.

على جانب آخر، ركزت دراسة (Ahmed MF et al., 2020), على نمذجة جودة المياه الجوفية في قضاء الشيخان بهدف إنشاء الطبقات الفرعية للمنطقة. استخدمت الدراسة أسلوب التحليل الهرمي (AHP) مع برنامج ArcGIS، حيث تم دمج الأوزان الملائمة مع خرائط الملائمة لتقييم جودة المياه بشكل شامل. أثبتت النتائج أن نسبة كبيرة من المياه غير صالحة للشرب، مما يستدعي اتخاذ إجراءات عاجلة لمعالجتها وضمان سلامتها للحفاظ على الصحة العامة.

المنهجية

بالاعتماد على بيانات موثوقة جُمعت من مصادر متعددة، تم تناول عدد من القضايا المترابطة ضمن إطار منهجي دقيق، مما أتاح إنتاج خرائط تفصيلية تغطي منطقة الدراسة بدقة. وفي هذا السياق، تم تطبيق أسلوب التحليل متعدد المعايير (MCDM) بهدف تحديد المواقع الأكثر ملاءمة لإنشاء مكبات النفايات الصلبة.

جرى كذلك توظيف تقنيات التحليل المكاني لإنتاج خريطة نهائية توضح المواقع المقترحة للطمر، وذلك ضمن الحدود الإدارية لقضاء تلعفر. وقد استند التحليل إلى منهجية التحليل الهرمي (AHP) كأحد أساليب MCDM، مع دمج عدد من العوامل المكانية والبيئية ذات التأثير المباشر في عملية الاختيار. وأسفر هذا النهج عن إنتاج خرائط لملاءمة المواقع، أسهمت بدورها في دعم اتخاذ القرار بشأن الموقع الأمثل، مع مراعاة المعايير البيئية ومتطلبات التخطيط العمراني.

(Multi- criteria decision making MCDM)

يُعَد التحليل متعدد المعايير (MCDM) أداة تحليلية فعّالة تُستخدم لتقييم وتحديد أنسب المواقع لطمر النفايات، لما يتمتع به من قدرة على التعامل مع معايير معقدة ومتشعبة تشمل الجوانب البيئية والاجتماعية والاقتصادية في آنٍ واحد. وتكتسب

هذه المنهجية قوة إضافية عند ربطها بنظم المعلومات الجغرافية (GIS)، إذ يُوفر هذا التكامل وسيلة دقيقة لمعالجة وتحليل البيانات المكانية بطريقة منهجية تسهم في دعم عملية اتخاذ القرار.

يساعد الجمع بين MCDM وGIS في تطوير نموذج متكامل يراعي مختلف العوامل المؤثرة، مما يؤدي إلى تقليص الآثار السلبية المحتملة على البيئة، ويُعزز من فعالية السياسات التخطيطية الرامية إلى تحقيق تنمية مستدامة. ومن خلال هذا النهج التكاملي، يمكن الوصول إلى نتائج دقيقة وموثوقة تدعم اختيار مواقع مدروسة بعناية، تتوافق مع الأطر التنظيمية والمعايير البيئية، وتُسهم في تحسين كفاءة إدارة النفايات على المدى البعيد.

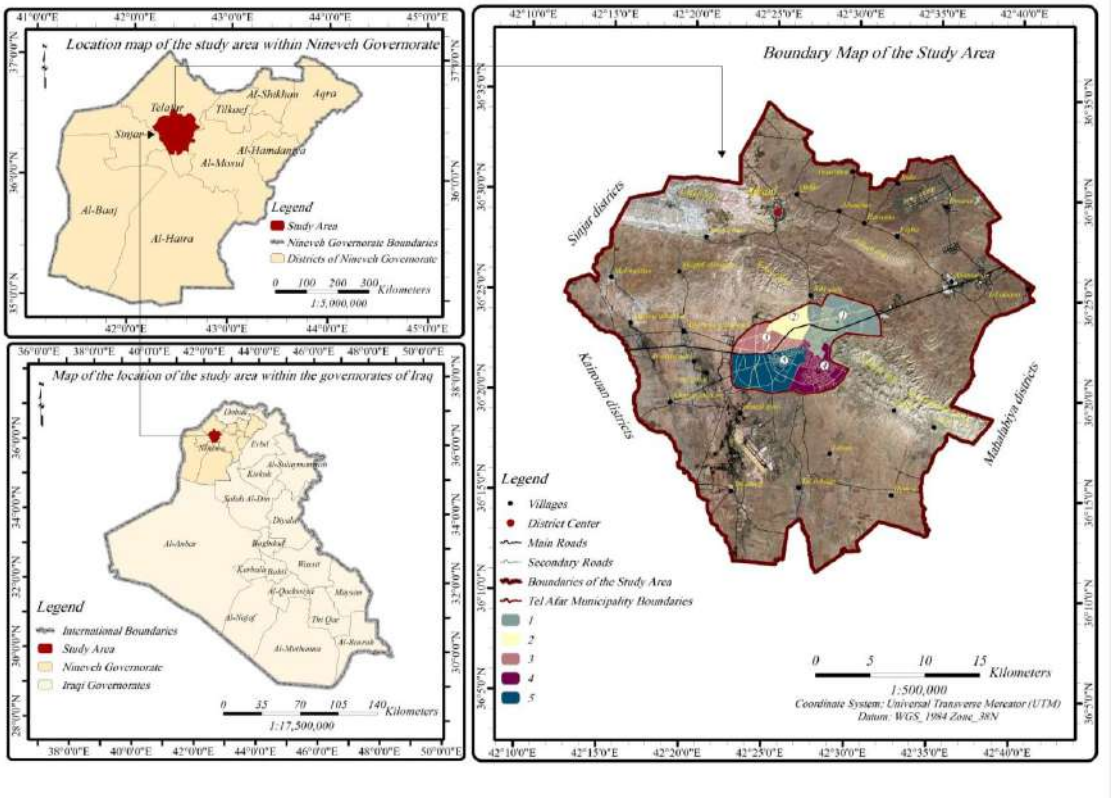
يُسهم هذا الأسلوب في تطوير نموذج قرار متكامل يُراعي مختلف الأبعاد البيئية والاجتماعية والاقتصادية، بما يُحقق توازناً فعّالاً بين المتطلبات المتنافسة. كما يُعالج الفجوات في إدارة النفايات من خلال تقديم نموذج شامل يستند إلى مبادئ الاستدامة، ويُعزز اختيار مواقع المكبات بما يضمن الاستخدام الأمثل للأراضي، ويُسهم في اتخاذ قرارات مدروسة تُراعي الاعتبارات البيئية والاجتماعية بشكل متكامل. (Faisal RM, et al: 2024).

منطقة الدراسة

تقع منطقة الدراسة ضمن حدود قضاء تلعفر، التي تتمركز في الجزء الغربي من محافظة نينوى، وتعد واحدة من أهم المناطق الحيوية في شمال العراق. تمتد منطقة الدراسة بين خطي عرض 36° 10' 51.4722" شمالاً و36° 34' 55.8146" شمالاً، وخطي طول 42° 11' 50.3832" شرقاً و42° 41' 23.7579" شرقاً، مما يمنحها موقعًا جغرافيًا استراتيجيًا يربط بين شمال وغرب العراق.

تبلغ المساحة الكلية للمنطقة حوالي 1062.73 كم²، مقسمة إلى 42 قطاع، تشمل الأقضية الواقعة ضمن حدود بلدية مدينة تلعفر. تتميز هذا المنطقة التابعة لقضاء تلعفر بتنوع تضاريسها، حيث تتراوح بين السهول المنبسطة والتلال المنخفضة، ما يساهم في تنوع الغطاء النباتي وأنماط الاستخدامات الأرضية فيها.

يقدر إجمالي عدد سكان مدينة تلعفر بحوالي 217,000 نسمة، وفقًا لآخر التقديرات، حيث يتوزعون على خمسة قطاعات سكنية رئيسية، تعكس تركيبة سكانية متنوعة من حيث العادات والثقافات، مما يعزز من الأهمية الاجتماعية والاقتصادية للمنطقة كما موضح في الشكل (1) .



الشكل (1) خارطة موقع منطقة الدراسة لقضاء تلعفر

النتائج والمناقشة

استناداً إلى معايير إدارة النفايات، ينبغي مراعاة مجموعة من الشروط المعتمدة لضمان التخلص الفعّال من النفايات. وبناءً على حجم البيانات المتاحة، يتطلب الأمر الالتزام بإجراءات محددة تضمن إدارة متكاملة لمجموعة من المتغيرات المرتبطة بدرجات وأوزان مختلفة، تعكس أهمية كل متغير في عملية التقييم واتخاذ القرار. كما موضح في الجدول رقم (1).

الجدول (1) المتغيرات المعتمدة لتحديد الموقع الامثل لطمر النفايات التابعة لقضاء تلعفر

N	Variables	Sub– Variables	Points	Area_km2	Percent (%)	Weights
1	Slope	0% – 2%	10	147.11	13.84	10.77%
		2% – 7%	9	564.52	53.12	
		7% – 12%	6	244.89	23.04	
		12% – 18%	3	70.46	6.63	
		18% >	Restricted	35.74	3.36	
2	Soil	Brown Soils Deep Phase	10	336.87	31.70	12.67%
		Reddish Brown soils, deep phases	9	540.86	50.89	
		Lithosolic Soils in Sand Stone & Gypsum	7	185.00	17.41	
3	Land cover /Land use	Barren land (Exposed Soil, Exposed Rocks &The Foots of the Mountains Hills is Barren)	10	263.17	24.76	19.01%
		Grass land	8	173.49	16.32	
		Crops land, Cultivated Crops	7	585.88	55.13	
		Orchards	3	2.73	0.26	
		Urban and Rural Settlement Land, Paved Roads& Sediments of valleys Land	Restricted	37.45	3.52	
4	Elevation	< 400m	10	551.80	51.92	5.81%
		400m – 450m	9	238.32	22.43	
		450m – 500m	8	184.54	17.36	
		500 – 550	6	62.07	5.84	
		550m>	3	26.00	2.45	
5	Road network	0m – 300m	Restricted	220.34	20.73	10.14%
		300m – 1000m	10	360.60	33.93	
		1000m – 2000m	8	220.36	20.73	
		2000m – 3000m	6	114.09	10.74	
		3000m – 4000m	4	61.60	5.80	
		4000m>	2	85.75	8.07	
6	Residential areas	0m – 2000m	Restricted	172.70	16.25	21.54%
		2000m – 3000m	10	53.47	5.03	

		3000m – 4000m	9	59.24	5.57	
		4000m – 5000m	8	65.35	6.15	
		5000m – 6000m	7	71.55	6.73	
		6000m – 7500m	6	119.05	11.20	
		7500>	4	200.61	18.88	
7	Groundwater Level	>70m	10	747.99	70.38	6.12%
		60m–70m	9	133.34	12.55	
		50m–60m	8	124.94	11.76	
		<50m	4	41.66	3.92	
8	Wind Effect	Very High	3	291.16	27.40	13.94%
		High	5	100.15	9.42	
		Moderate	7	165.64	15.59	
		Low	8	392.24	36.91	
		Very Low	10	113.56	10.69	
9	villages	0m–1000m	Restricted	43.18	4.06	0%
		>1000m	Unrestricted	1019.55	95.94	
10	Electrical Power Lines	0m–100m	Restricted	18.76	1.77	0%
		>100m	Unrestricted	1043.97	98.23	
11	Streams network	0m–350m	Restricted	127.05	88.05	0%
		>350m	Unrestricted	935.68	11.95	
12	Airport & Military Base	0m–500m	Restricted	46.00	4.33	0%
		>500m	Unrestricted	1016.73	95.67	
13	Wells	0m–250m	Restricted	7.88	0.74	0%
		>250m	Unrestricted	1054.85	99.26	

المناطق السكنية: تعد مواقع التخلص من النفايات مصدراً مهماً في إنماء المناطق السكنية، إذ تؤثر على رصانة حياة السكان، لكن قربها من الإنبعاثات السكنية، قد تعمل على إفراط المخاطر الصحية ويسعى التخطيط السكني إلى إكمال بيئة متوازنة مستقرة ، مع سهولة الوصول إلى الخدمات الأساسية وتنقسم حسب الكثافة إلى ضعيفة ، معتدلة، مرتفعة، أو موحدة ، ويتطلب كل منها برامج تخطيط محددة لتحسين كفاءة إستخدام المساحات ، مع الحفاظ على الجوانب البيئية

والاقتصادية, (Ren X et al., 2023). ينفرد هذا الإقتراح المشترك في إزدهار بيئات سكنية تدعم جودة الحياة وتعزز الإستدامة التنموية ، حيث بلغ التأثير بنسبة 21.54% كما تؤشر البيانات الواردة في الجدول رقم (1) والخريطة رقم (2).

" الأراضي وغطاء الأرض : لهاعوامل مؤكدة لتعيين المواقع الملائمة للقضاء على النفايات،.تقوم الأنشطة البشرية مثلاً الغابات المزالة والإمتداد الحضري المبعثر إلى تغييرات هائلة في إستخدام الأراضي وغطائها ,(Tela, A et al., 2024). تلعب التقنيات المتقدمة مثل الاستشعار عن بُعد ونظم المعلومات الجغرافية (GIS) أهمية حيوية في استقرارية التغيرات، مما يدعم صناع القرار على إعتماد إستراتيجيات مستمرة. ، حيث بلغ التأثير 19.01% كما توضح البيانات المسجلة في الجدول رقم (1) والخريطة رقم (3).

" إتجاه الرياح : يعد عاملًا ذو أهمية لدى الأرصاد الجوية والبيئية المصممة، حيث يعمل على تأثير أنماط الطقس، في اختيار موقع الطمر ، أيضاً له دورًا قوياً في إنتشار الملوثات المحمولة في الجو بينما يساهم هطول الأمطار في إحداث الغازات (Osra F A et al., 2020). ويسهم هذا المثيل قسماً من التأثير البيئي الشامل، حيث تم تسجيل تأثير بنسبة 13.94% كما هو موضح في الجدول رقم (1) والخريطة رقم (2).

" التربة: تعد التربة من العوامل المهمة في إبعاد تدفق المياه إلى المدافن النافعة، وهذا يخفض من خطر فعل الرشح وإتساخ المياه الجوفية. قد يقود تكوينها إلى دوراً هاماً في إدارة النفايات وحماية البيئة (Khor Sandi H et al., 2019). تساعد التربة بنسبة فعلية في نسبة المطامر الصحية من خلال كسبها كعائق حماية. لذلك يتخذ بالإعتبار إختيار التربة بشكل دقيق هدفاً رئيسياً للمحافظة على أمان المطامر وتقليل من أثار تغير حالة المناخ، مع تأثير مسجل بنسبة 12.67% كما هو موضح في الجدول رقم (1) والخريطة رقم (2).

"المنحدر: يشير إلى ميلان الأرض، وله دور حاسم في الكثير من العوامل الطبيعية، مثل إقتناء التربة بالرطوبة، والتعرية، مما يلاحق بشكل مباشر على ثباتية المناظر الطبيعية وواقع الأنظمة البيئية. كما يعقب الإنحدار على المناخات المحلية .

ويعد فهم وإدارة الإنحدار تقنية مهمة للوقاية من إنهيار التربة ، وعلى الأخص المناطق المتأثرة بالتنشيط البشري مثل التعدين , يساعد ايضاً في الحفاظ على السلامة الهيكلية (Armando's AM et al., 2023), وقد يوفر الإنحدار حوالي 10.77% من إلحاح تأهيل المدافن, كما هو موضح في الجدول رقم (1) والخريطة رقم (2).

"شبكة الطرق :هي إدارة الأساس المدعوم الذي يربط بين المناطق المتنوعة وبين الحواجز، مما يسهل حركة العابرين والسلع. تتكون من أنواع متنوعة من الطرق منها السريعة والريفية حيث تفيد كل منها إستخدامات النقل الخاصة. قد تعد قدرة البلوغ إلى الطرق من العمليات الرئيسية في إختيار مواقع المطامر الصحية، حيث يؤثر بعد الطرق وحالتها على كفاءة الحمل وتكاليف التحميل ، مما يزيد من التكاليف اللوجستية ويقلل من قوة المنطقة. وفقًا لـ (Mallick J., 2021)، تشكل شبكات الطرق حوالي 10.14% من اعتبارات المطامر الصحية، مما يلفت دورها في تخطيط إدارة النفايات وإتمام صيانة مفيدة للطرق إلى مواقع المدافن يقود الوصول ويخفض من التكلفة ويحمي من الآثار البيئية الرديئة، كما هو موضح في الجدول رقم (1) والخريطة رقم (3).

" مستوى المياه الجوفية : يشير إلى القعر الذي تنشأ فيه المياه أسفل سطح الأرض بين الطبقات المائية. يتغير هذا الحجم نتيجة لعوامل طبيعية مثل هطول الأمطار ، فضلاً عن الأجتهاد البشري مثل إستخراج المياه الكثيرة وإعتماد الأراضي. يعتبر هذا المستوى مجهوداً رئيسياً على هيئة غزارة الموارد المائية في المنطقة.

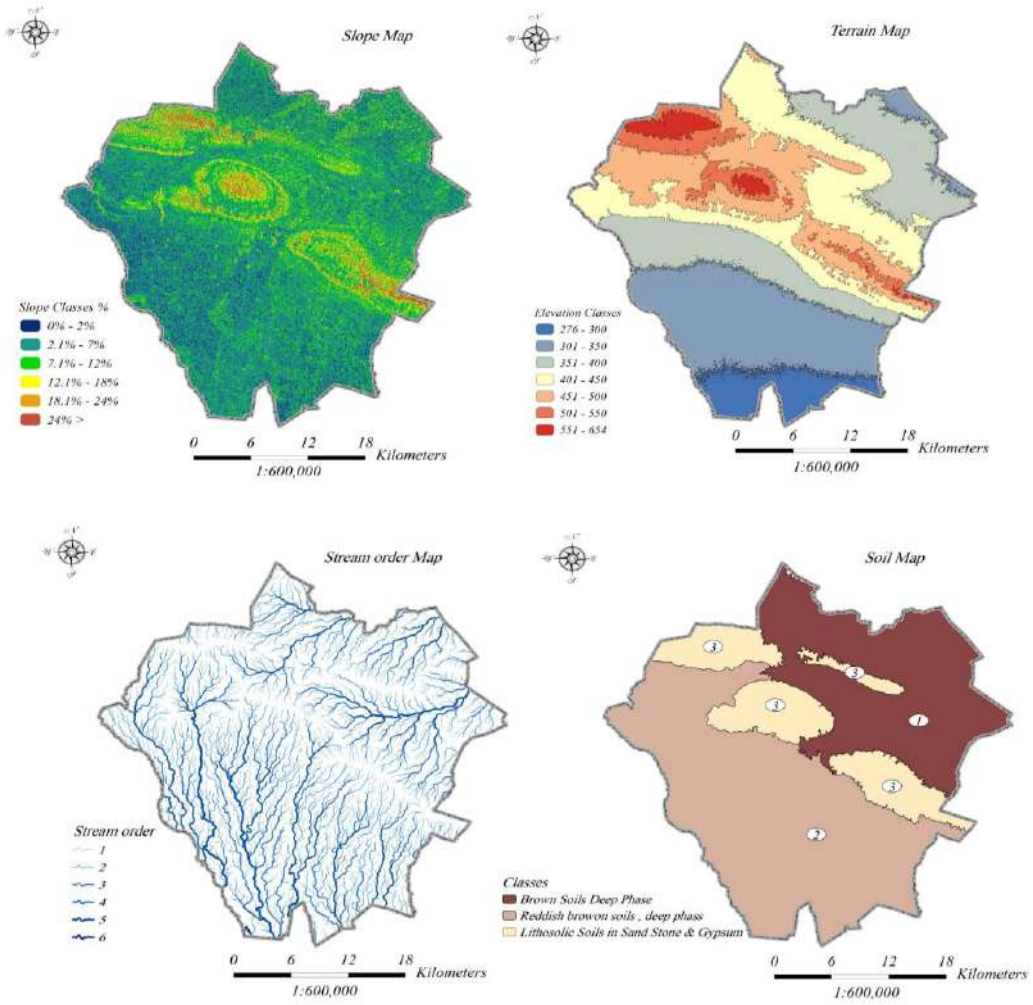
وان إنعدام المياه الجوفية يمكن أن تقود إلى مخاوف بيئية بشكل عام ، حيث تمتد الملوثات بين الطبقات المائية، مما يؤثر على مياه الشرب والنظم البيئية. لذلك، تلعب المراقبة والإدارة السليمة أمرين مهمين للقضاء على التلوث.

وفقًا لـ (Ali SA et al., 2021)، وقد شكلت مقاييس مستوى المياه الجوفية حوالي 6.12% من تعين التأثير البيئي كما هو موضح في الجدول رقم (1) والخريطة رقم (3) ، مما يسهم دورها في إدارة الموارد المستدامة،

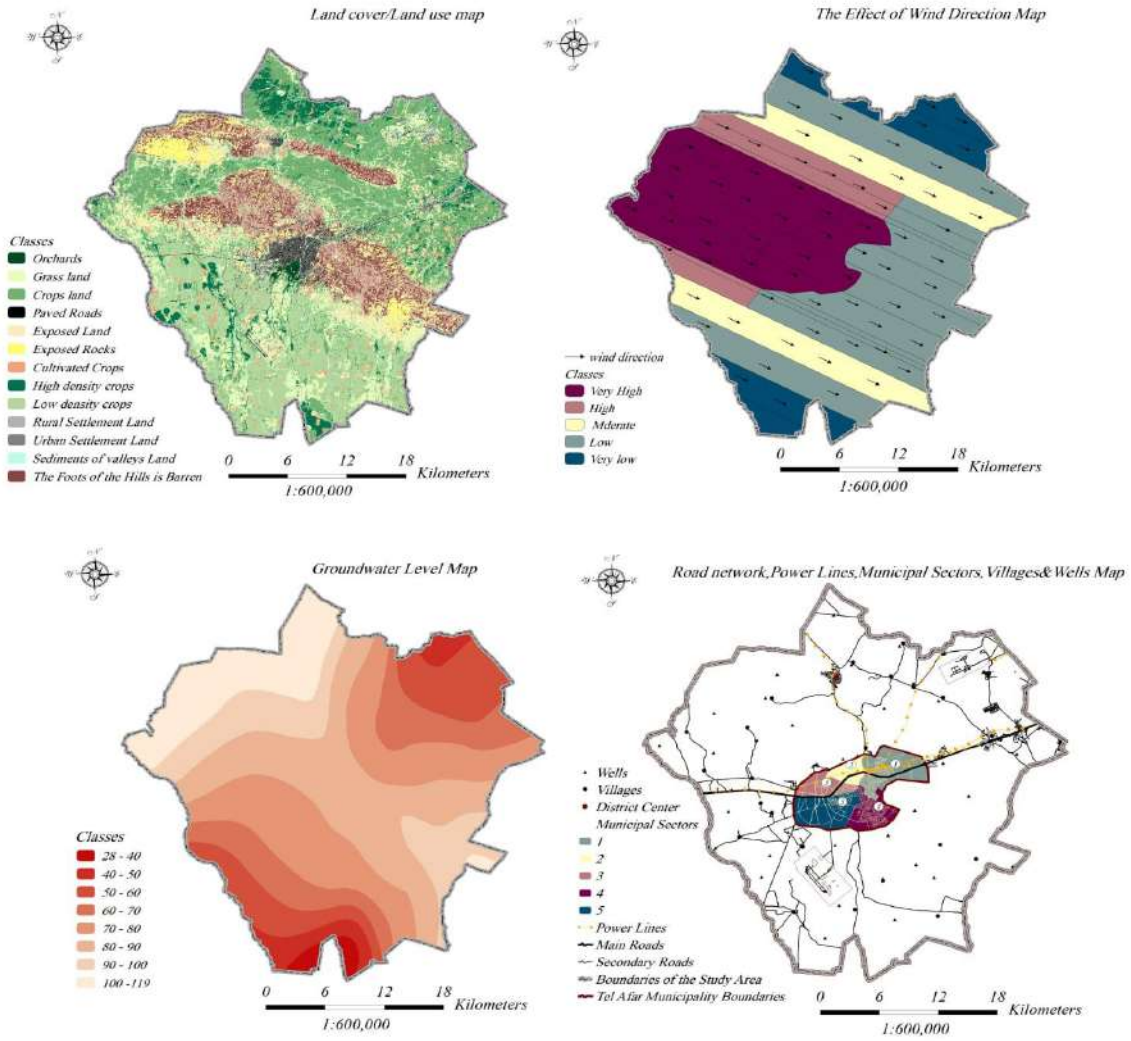
" الارتفاع : يشير إلى إنتصاب الموقع عن مستوى سطح البحر، وهو يعد من العوامل البارزة في تعين موقع الطمر. يمكن أن تواجه المواقع ذات الإنتصابات المرتفعة إلى تحديات مثل إفراط التأثير البيئي،مشكلة إدارة النفايات، وزيادة مستويات إيرادات البنية التحتية. من المتباين تفضل المواقع ذات الإنتصابات القليلة, نظرًا لإستقرارها وسهولة الوصول إليها. اما بالنسبة لإدارة النفايات في الارتفاعات العالية قد تكون أكثر تشديداً ،وفقاً لـ (Abushammala MFM et al., 2022). تساعد العوامل المرتبطة باللإرتفاع في قلة كفاءة إدارة النفايات بنسبة 5.81%، ، مما يوضح أهمية إختيار المواقع الملائمة للمدافن.

تعد خمسة من المتغيرات ضمن القرى عوامل مستقرة لا تشكل عناصر جذب رئيسية وهي:

(village ,Electrical Power Lines, Streams network, Airport & Military Base, Wells)، وكما موضح في الجدول رقم (1), لكنها تُسهم في تحديد الحدود التي ينبغي عدم تجاوزها، مما يُعزز من إمكانية قبولها ضمن الترتيب العام للمواقع .



الشكل (2) توضح خريطة الشكل المتغيرات المدروسة ضمن منطقة طمر النفايات التابعة لقضاء تلعفر



الشكل (3) توضح خريطة المتغيرات المدروسة ضمن منطقة طمر النفايات التابعة لقضاء تلعفر

يوضح الجدول (2) قيم معامل الاتساق للمتغيرات المدروسة في منطقة طمر النفايات

	s	Residential Areas	Landcover/Land use	Wind Direction	Soil	Slope	Roads network	Groundwater level	Elevation	Relative Importance
1	Residential Areas	1	1	2	2	2	2	3	4	21.54%
2	Landcover/Land use	1	1	2	2	2	2	2	3	19.01%
3	Wind Direction	1/2	1/2	1	1	2	2	2	2	13.94%
4	Soil	1/2	1/2	1	1	1	2	2	2	12.67%
5	Slope	1/2	1/2	1/2	1	1	1	2	2	10.77%
6	Roads network	1/2	1/2	1/2	1/2	1	1	2	2	10.14%
7	Groundwater level	1/3	1/2	1/2	1/2	1/2	1/2	1	1	6.12%
8	Elevation	1/4	1/3	1/2	1/2	1/2	1/2	1	1	5.81%

يعد معامل الإتساق (CR) عنصرًا أساسياً في عملية التحليل الهرمي (AHP)، حيث يُستخدم لتقييم مدى اتساق المقارنات الزوجية في عملية صنع القرار. كما يساعد في تحديد مدى موثوقية ومنطقية الأحكام التي يصدرها صناع القرار، مما يسهم في ضمان دقة وموضوعية النتائج.

يتم حساب معامل الإتساق (CR) باستخدام الصيغة التالية:

CR = frac {CI}/{RI}

في حين يتم حساب مؤشر الإتساق(CI) على النحو التالي:

CI = frac {λ_max} / {n − 1}

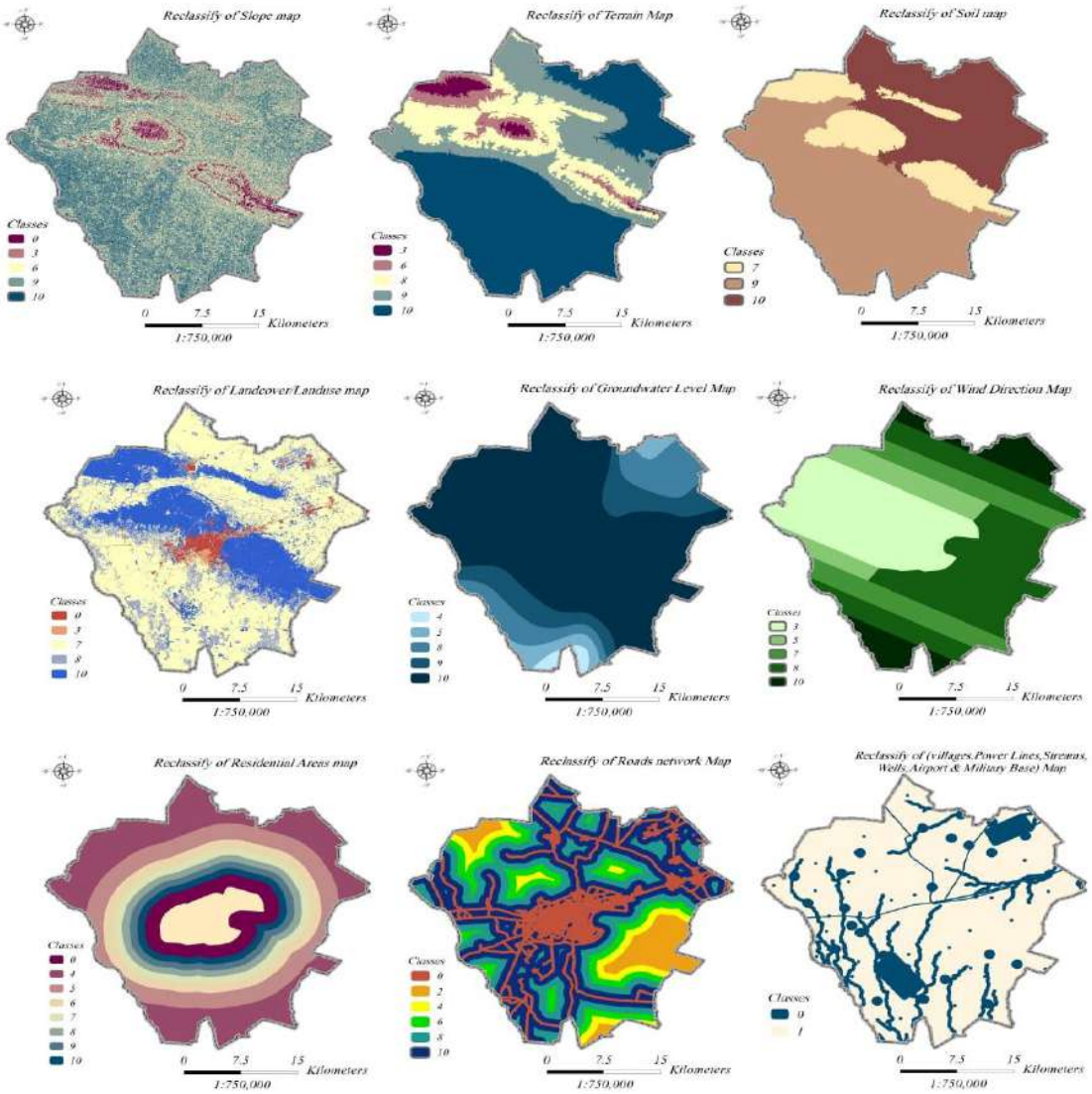
{λ _max} هي القيمة الذاتية الأساسية لمصفوفة المقارنة

{n_1} هو عدد المعايير او البدائل التي تتم معالجتها

{RI} مؤشر العشوائية : هو قيمة معيارية تعتمد على عدد المعايير، تُستخدم في تحليل AHP لمقارنة مؤشر الاتساق المحسوب مع الاتساق المتوقع عشوائياً، بهدف تقييم مدى منطقية المقارنات الزوجية.

اي ان

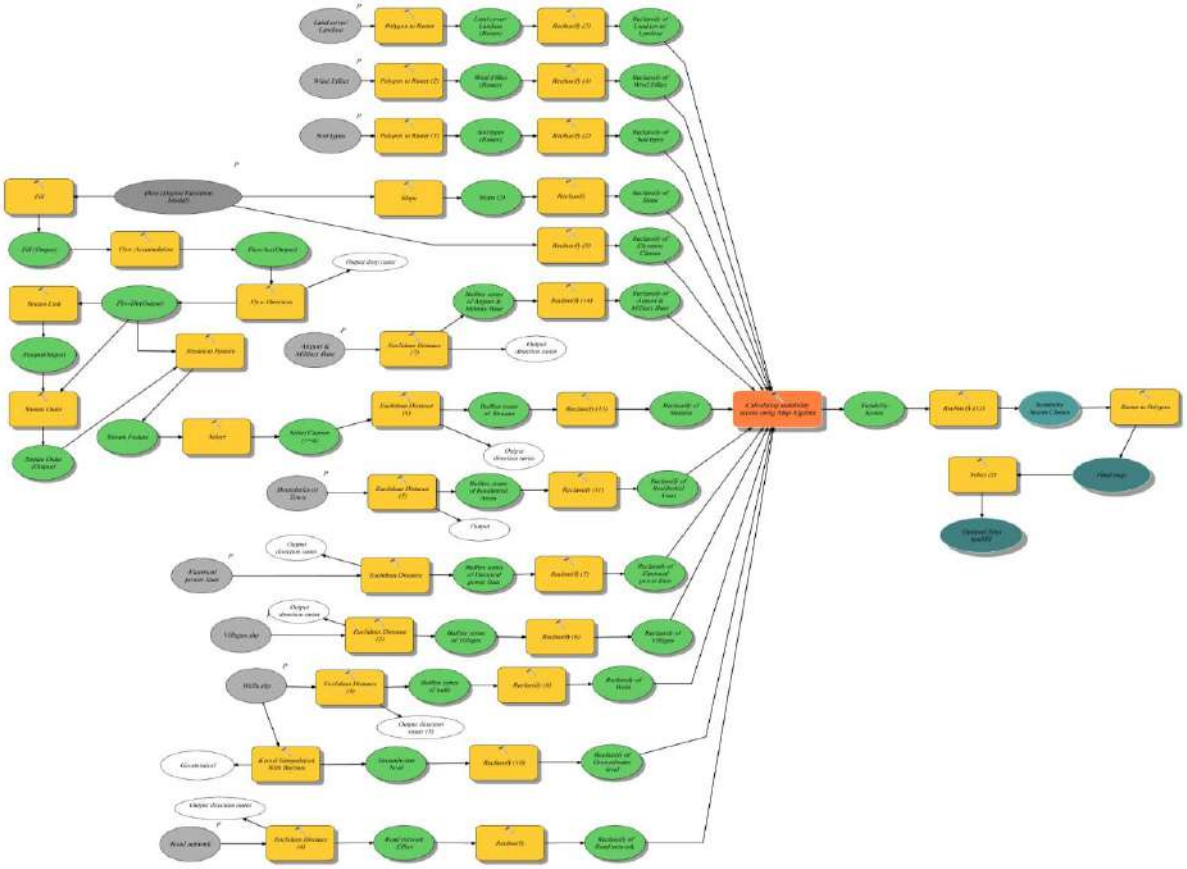
$CR < 0.1$



الشكل (4) خريطة إعادة تصنيف البيانات حسب المعايير المحددة والتابعة لقضاء تلعفر

بناء الموديل

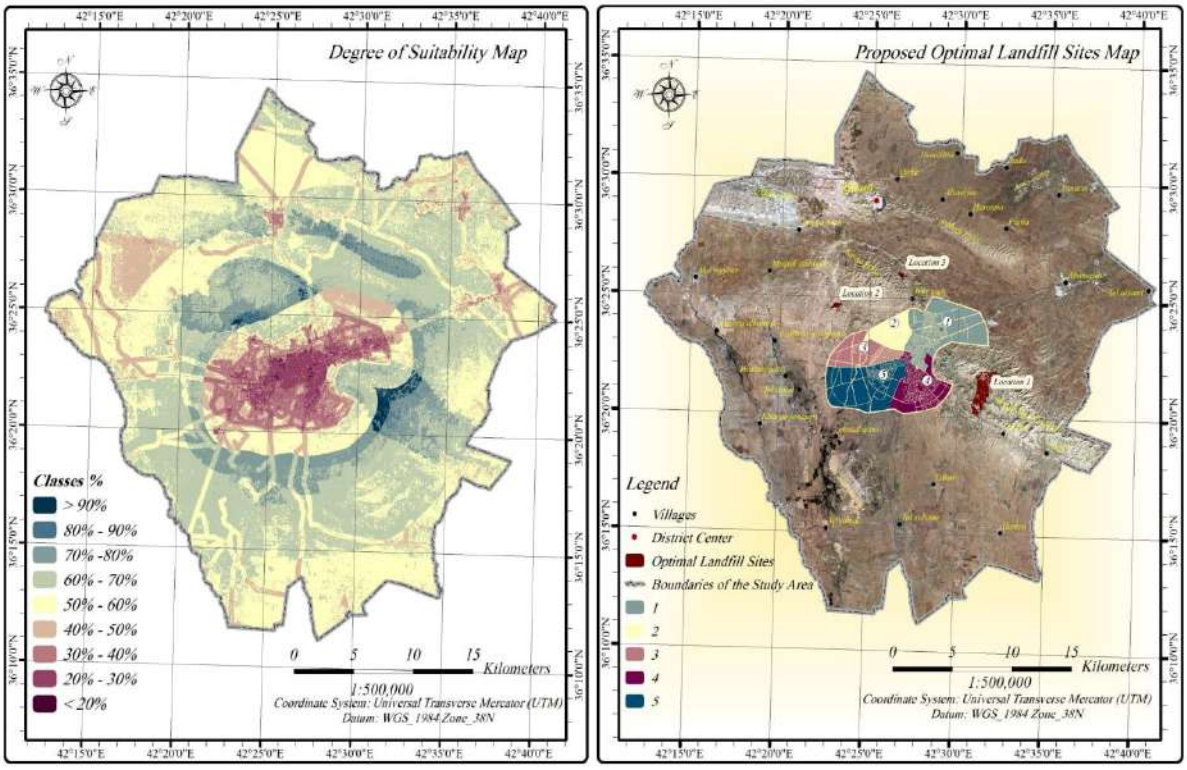
بناء النموذج وسيلة مهمةً لإجراء المعالجة المكانية لتوليد الخرائط تلقائياً. كما أنه آلية مهمةٌ لتوضيح تسلسل العمليات المستعملة في الدراسة. وقد يمكن تقسيم خطوات البناء النموذجي إلى ثلاثة مراحل، تشمل المرحلة الأولى إعداد الخرائط الأساسية، والتي شملت طبقات الغطاء الأرضي وخريطة التربة ونموذج الارتفاع الرقمي (DEM) الذي أنشئت منه خريطة المنحدر والتضاريس ومسارات النقل وشبكة الطاقة الكهربائية والمناطق السكنية وخريطة اتجاه الرياح ومنسوب المياه الجوفية. ومن هذه الخرائط ، أنشئت المتغيرات الرئيسية في تحديد موقع مكب النفايات. أما المرحلة الثانية، فقد شملت إعادة تصنيف فئات الخرائط بإستخدام أداة إعادة التصنيف الإقليدية والمسافة، وذلك وفقاً لطبيعة البيانات من حيث كونها متصلة أو منفصلة. أما الخطوة الثالثة والأخيرة، فكانت تطبيق أداة جبر الخرائط على المتغيرات المرجحة وفقًا لإوزانها النسبية، مما أدى إلى استنباط خريطة ملاءمة لتحديد أفضل مواقع الطمر في المنطقة، كما موضح في الشكل (5).



الشكل (5) بناء الموديل

يوضح الشكل خطوات بناء الموديل لتحليل وتقييم منطقة طمر النفايات باستخدام المتغيرات البيئية والجغرافية المدروسة لقضاء تلعفر

في المرحلة الأخيرة، تم الاعتماد على خريطة درجات الملاءمة لتحديد الموقع النهائي لمكب النفايات. صُممت هذه الخريطة باستخدام نظم المعلومات الجغرافية (GIS) بهدف تحليل واختيار الموقع الأمثل، وذلك من خلال دمج مجموعة متنوعة من البيانات البيئية والهندسية، مثل الغطاء الأرضي و التضاريس وشبكة الطرق واتجاه الرياح ونوعية التربة. يهدف هذا النهج إلى دعم عملية اتخاذ القرار بشكل منهجي، مما يضمن اختيار موقع مستدام بيئيًا واقتصاديًا، مع تقليل التأثيرات السلبية على البيئة والمجتمع وتحقيق أعلى مستويات الكفاءة والملاءمة.



الشكل (6) خريطة درجة الملائمة لقضاء تلعفر

الجدول (3) متغيرات المواقع المحتملة

يُعرض في الجدول الخصائص البيئية والهندسية للمواقع المحتملة لمكب النفايات، لتقييم ملاءمة كل موقع بناءً على المعايير المحددة

Location	Area_m2	longitude	latitude
1	2838877.50	42.52354	36 35324
2	262321.26	42.38533	36. 41095
3	143834.04	42.445522	36 43362

يساهم تحليل نسب المساحة وتحديد مواقع النفايات الصلبة باستخدام الإحداثيات الجغرافية في تحسين التخطيط والإدارة المستدامة للمواقع، مما يقلل التأثير البيئي ويعزز كفاءة عمليات الطمر الصحي وفقًا للمعايير الجغرافية والبيئية. عند تقييم مواقع الطمر، يتم تصنيف المساحة الكلية إلى نسب محددة لتقييم كفاءة الإدارة. تم تحديد الإحداثيات باستخدام خطوط الطول والعرض لتحسين دقة التحليل الجغرافي من خلال تخصيص المساحات المناسبة، كما هو موضح في الجدول رقم (3).

الإستنتاجات

في هذا البحث، تم تحديد الموقع الأمثل لإنشاء مكب النفايات في قضاء تلعفر باستخدام نظم المعلومات الجغرافية (GIS) وتقنيات تحليل اتخاذ القرار متعدد المعايير (MCDM) بهدف تطوير بدائل فعّالة لإدارة النفايات الصلبة. اعتمدت الدراسة على GIS في تحليل ورسم الخرائط المكانية والطبوغرافية، بالإضافة إلى خرائط شبكة الطرق ونوعية التربة، حيث تم دمج هذه المعلومات لاستخراج الخرائط الأساسية التي تُساهم في اختيار الموقع الأمثل للمكب.

كما شملت الدراسة استخدام خرائط درجات الملاءمة (Suitability Maps) لتقييم المواقع بناءً على مجموعة من المعايير البيئية والجغرافية والاجتماعية، بهدف تحديد الموقع النهائي المناسب لدفن النفايات.

أظهرت نتائج التحليل أن المساحات المخصصة لكل مرحلة من البحث جاءت كما يلي:

المرحلة الأولى: بمساحة 2838877.50 م².

المرحلة الثانية: بمساحة 262321.26 م².

المرحلة الثالثة: بمساحة 143834.04 م².

أظهرت النتائج وجود تباين واضح في المساحات الناتجة عن اختلاف توزيع المواقع الجغرافية استناداً إلى إحداثيات الطول والعرض، مما يعكس تأثير الموقع المكاني في تحديد مدى ملاءمته لتخطيط منشآت إدارة النفايات الصلبة. وتُعد هذه

الفروقات spatial variations عاملاً حاسماً في دعم اتخاذ قرارات مدروسة، تهدف إلى تحسين كفاءة التوزيع المكاني لمرافق النفايات وتقليل التكاليف التشغيلية والحد من الآثار البيئية السلبية. وكما موضح في الجدول رقم (3) والخريطة رقم (6).

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البحوث باللغة الإنكليزية

Arabic Section

Activated Carbon Prepared From Various Plant Sources: A Review

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Abstract

Plant resources are receiving increasing attention worldwide as a kind of renewable resources with low cost and widely available, the preparation of activated carbon from these materials at low cost from various natural raw materials has become a necessity now and in the future. This review discussed different methods for obtaining activated carbon from different plant materials using different activation methods and activation agents (chemical and physical). The results of the review showed that the types of activated carbon obtained have large surface area and greater adsorption capacity. The use of low-cost and widely available raw materials for the production of activated carbon is the main objective of this study such as (corn cob, rice straw, peanut shell, oil stones, and ficus leaves). It was found that chemical activation can develop both microporosity and surface area. The best raw material used is peanut shell, which can then be used in the field of environmental pollution (dyes, pesticides, heavy metal ions, phenolic compounds and other organic and inorganic pollutants). It was found that the adsorption process using activated carbon is a method that can be applied to remove various pollutants.

Keywords: *Activated carbon, Carbonization, Activation, Environmental pollutants, Adsorption.*

الكاربون المنشط المحضر من مصادر نباتية مختلفة: مراجعة

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الملخص

تحظى الموارد النباتية باهتمام متزايد في جميع انحاء العالم لإنها نوع من الموارد المتجددة منخفضة التكلفة ومتوفرة بشكل كبير, وتحضير الكاربون المنشط من هذه المواد بتكلفة منخفضة من مختلف المواد الخام الطبيعية اصبح ضرورة الآن وفي المستقبل. ناقشت هذه المراجعة طرقًا مختلفة للحصول على الكاربون المنشط من مواد نباتية مختلفة باستخدام طرق تنشيط وعوامل تنشيط (كيميائية وفيزيائية) مختلفة. وأظهرت نتائج المراجعة أن أنواع الكاربون المنشط التي تم الحصول عليها ذو مساحة سطح كبيرة وقدرة امتزاز أكبر. إن استخدام المواد الخام منخفضة التكلفة والمتوفرة على نطاق واسع لإنتاج الكاربون المنشط هو الهدف الرئيسي

لهذه الدراسة مثل (كوز الذرة، قش الأرز، قشر الفول السوداني، أحجار الزيت، أوراق اللبخ) ووجد أن التنشيط الكيميائي يمكن أن يطور كل من المسامية الدقيقة والمساحة السطحية وافضل مادة اولية مستخدمة هي قشر الفول السوداني، والذي يمكن استخدامه بعد ذلك في مجال التلوث البيئي (الأصباغ والمبيدات الحشرية وأيونات المعادن الثقيلة والمركبات الفينولية وغيرها من الملوثات العضوية وغير العضوية). وقد وجد أن عملية الامتزاز باستخدام الكاربون المنشط هي طريقة يمكن تطبيقها لإزالة الملوثات المختلفة.

الكلمات المفتاحية: *الكاربون المنشط، الكربنة، التنشيط، الملوثات البيئية، الامتزاز.*

Introduction

Activated carbon (AC) is a group of porous carbons that are physically or chemically activated to prepare materials with a large pore size and a large internal surface area. For this reason, it is used to treat various pollutants as it is an excellent absorbent (Salman *et al.*, 2022). Activated carbon can be found in many forms: granular, powdered, and fibrous(Ahmad & Azam, 2019). Activated carbon was initially used in ancient Egypt, where the Egyptians used it for water purification and medical purposes (Tadda *et al.*, 2016). The specifications of the resulting activated carbon in terms of the large surface area, which may reach a value of 3000 m^2/g, and the high degree of surface interaction are the main reason for the ability of activated carbon to remove organic and inorganic pollutants, whether liquid or gaseous (Acevedo *et al.*, 2020). AC is also known as a carbon substance characterized by an amorphous structure, which consists mainly of carbon elements. Because of its electronic configuration ($1s^2$, $2s^2$, $2p^2$) carbon has unique bonding capabilities with other elements as well as with itself. The three most likely bonds are cubic diamond, hexagonal graphite, and fullerene (C60).

Activated carbon is classified as graphite carbon due to its low density and porous structure. The presence of heterogeneous atoms for example nitrogen, oxygen, hydrogen, sulfur, and phosphorus on its surface to estimated its chemical characteristics, as these atoms and delocalized electrons form good functional groups during activation of AC, which classifies it as acidic or basic (Shafeeyan *et al.*, 2010).

These functional groups affect the rate of adsorption, as activated carbon has two forms. The first type, H, is naturally characterized by positive charges and has a hydrophobic nature. The second type, L, is acidic, negatively charged, and hydrophilic (Yahya *et al.*, 2018). Adsorption properties of AC encourage researchers to use it in many fields. This is due to its simple design, easy operation, high selectivity towards certain materials, and its ability to completely eliminate pollutants even in the case of dilute solutions. It has led to increased strive to find permanent and preventive alternatives to protect and preserve the environment. Biomass residue resulting from food, wood, and other resources such as agricultural waste has increased interest in this field, and the manufacture of activated carbon from natural material waste can enhance economic returns and reduce pollution (Boopathy *et al.*, 2013).

In this review, many different methods for preparing activated carbon using various natural plant materials with low cost were discussed to produce activated carbon using carbonation methods, activation methods and different activation agents and to clarify the possibility of using them in removing different types of pollutants as we have a variety of applications such as purifying drinking water, purifying air and gas, treating wastewater and the medical field by taking advantage of this waste as well as reducing spending on waste recycling processes to reduce environmental pollution in order to achieve the sustainable development goals that all researchers from around the world seek to achieve.

Literature Review

There are many plant materials used and methods used in preparing activated carbon which are:

Sujitha & Ravindhranath, 2016 used barks of ficus racemose to prepare activated carbon (particle size = 75μ_m) by carbonization in an electric furnace. It was used to remove coomassie brilliant ($C_{43}H_{44}N_3NaO_7S_2$) blue dye with molecular weight (825.97g/mol) with 100% effectiveness, pH = 2-4, it have a big surface area, and good adsorption capacity. Md Arshad *et al.,* 2016 prepared activated carbon from oil palm empty fruit bunch (EFB) by tearing these fibers, then dried it in an oven and treated with H_3PO_4. Then carbonization and activation were carried out at temperature (100°C) for three hours, and a product with surface area (142 m^2/g) was obtained. And use catalyst support while Ooi *et al.,* 2017 were able to prepare it by treating it with concentrated H_2SO_4 in ratio [1:1.5] at temperature (400)°C for 60 minutes, then activating it with CO_2, N_2 gases, then heating it to 900°C under CO_2, N_2 for an hour, then cooling it to room temperature. Use this product as an effective absorbent to remove urea.

Kan *et al.,* 2017 were able to use waste tea to prepare activated carbon by treating it with H_3PO_4 at ratio [1:1.5] temperature (450°C) for a time of one hour. It was found that surface area of product was (880m^2/g). And it was used to remove qxytetracycline. Tharaneedhar *et al.,* 2017 were able to produce activated carbon from cornob via microwave-assisted pyrolysis, and the adsorption capacity was (82.8mg/g) for methylene blue dye from its aqueous solution.

Ahsaine *et al.,* 2018 prepared activated carbon from almond shell based on chemical activation with KOH at a ratio of [1:2]. It was noted that the product had a high adsorption capacity for methylene blue dye and crystal violet on the Zr_3O/activated compound, and its kinetic models were studied. Misran *et al.,* 2018 prepared activated carbon from banana stem waste by chemical activation with H_3PO_4 acid. A removal efficiency of more than 99% was observed at room temperature over a period of 90 minutes. The weight was 0.2g and used to absorb methylene blue dye. Kar *et al. in* 2019 prepared AC from the wood of acacia auriculeaformis using the chemical activation method and by changing the chemical agent (NaCl, NaOH, H_3PO_4). The physicochemical analysis indicated that the prepared activated carbon samples worked efficiently (6.60%, 26.25%, 41.81%) and the ash content low (6.60, 14.90, 5%) and iodine values ranged between (380.71-190.35mg/g). Which indicates the good quality of the prepared activated carbon boehm's test was used to detect the functional groups of the prepared samples. It was found that the best prepared model was the one with H_3PO_4 because of its good surface area and good pore size compared to those found in the literature. And use as an absorbent material to treat liquid waste.

Khellouf *et al.,* 2019 prepared activated carbon from the cyores cones plant by chemical activation with H_3PO_4 acid in two steps, including activation, carbonization, and an impregnation ratio of [1:1] for 5 hours, and carbonation at (873 K) for 4 hours. The product was selected by batch adsorption of methylene blue dye from its aqueous solutions. With an efficiency reaching 97.29%, It has proven its efficiency in treating polluted water coming from the textile industry.

Khadhri *et al.,* 2019 were able to prepare AC from date palm petiole by chemical activation with NaOH at a ratio of [1:2] in two steps, the first being carbonization at temperature (600)°C for two hours, the second step, activated at temperature (600)°C for two hours. The surface area of the prepared activated carbon was estimated at approximately (655m^2/g) and was used to adsorb indigo carmine with good efficiency. Wang *et al.,* 2020 used waste tangerine seed to prepare activated carbon by chemical activation with H_3PO_4 at a ratio of [1:2.5] at an activation temperature of 600°C for 4 hours in an inert atmosphere. The results showed that the surface area of the prepared carbon amounted to (660 m^2/g).) and used in adsorption of carbamate from the water plant.

Queiroz *et al.,* 2020 studied the possibility of producing activated carbon from tailings acai seed through chemical activation with KOH at a ratio of [1:5] and in two steps. The first step includes carbonization at temperature (600)°C for one hr., and at (850)°C for one hour in a nitrogen atmosphere. The results showed that the surface area amounted (2774 m^2/g), and the prepared activated carbon was characterized by high adsorption properties, which enabled it to be used in the adsorption of Fe(II), Lead(II), and Mg(II) from contaminated water.

Najmi *et al.*, 2020 prepared activated carbon from glycyrrhiza glabra residue through chemical activation using $ZnCl_2$ in a ratio of [1:2] at the optimum carbonation temperature, and the impregnation rate reached (959.22 m^2/g) and studied the possibility of using the product in adsorption nitrate, phosphates from contaminated water. Abate *et al.*, 2020 were able to prepare activated carbon from catha edulis stem by carbonizing it in an electric furnace for two hours at (400°C) in the absence of air. After that, chemical activation was carried out with NaOH at a ratio of [1:5] for an hour, and some measurements were made and the analysis showed the approximate estimate is that the resulting adsorbent contains a very high percentage of carbon (83.65%) and its surface area was estimated at (1735 m^2/g). The efficiency of its adsorption of malachite green dye from its aqueous solution (98.8%) was studied.

Guo *et al.*, 2020 prepared activated carbon from waste sugarcane bagasse through physical activation in the presence of air. The process was carried out in two steps: the first was carbonization at temperature (750°C) for an hour in a nitrogen atmosphere, and the second step was physical activation at temperature (850°C) for two hours with flow CO_2 and air. The results explained that surface area of model (622 m^2/g) that used for CO_2 adsorption.

Ahmad *et al*., 2021 prepared activated carbon from agricultural waste by chemical activation with K_2CO_3 and with the help of microwave. The produced activated carbon was characterized using (SEM and FTIR). The results showed that the adsorption capacity of carbon produced from tobacco stems was (517.5 mg/g) yield was (80.99%), and total pore volume corresponded to (2557 m^2/g) and (1.647 cm^3/g) respectively, with a microwave power of (700 W) and an irradiation time (30 min).

Budianto *et al.*, 2021 were able to manufacture activated carbon from empty palm oil bunvhes waste through multiple activation processes: physical and chemical. Carbonization was performed at (400°C) for 4 hrs. with flow of nitrogen gas. Physical activation was performed by heating for an hour at temperature (700°C), it was found that the best concentration of H_3PO_4 was 13%, which produced high-quality activated carbon with the following specifications: moisture content 3%, ash content 3.92%, surface area(272.9 m^2/g), iodine number (945.47mg/g), and volatile matter 3.92%. Genli *et al.*, 2021 prepared carbon from chickpea stall using $ZnCl_2$. Some factors were studied, for example impregnation rate, time and temperature. Iodine number was determined (734mg/g) under conditions of impregnation time (24 hrs.). The temperature was (400°C) and time (45 min). It was characterized by SEM images of chickpea stalk, hydrochar and AC are given in Figure (1), and FTIR measurements shows in Figure (2). The surface area of the AC was (572 m^2/g), and the methylene blue number was obtained as (105 mg/g).

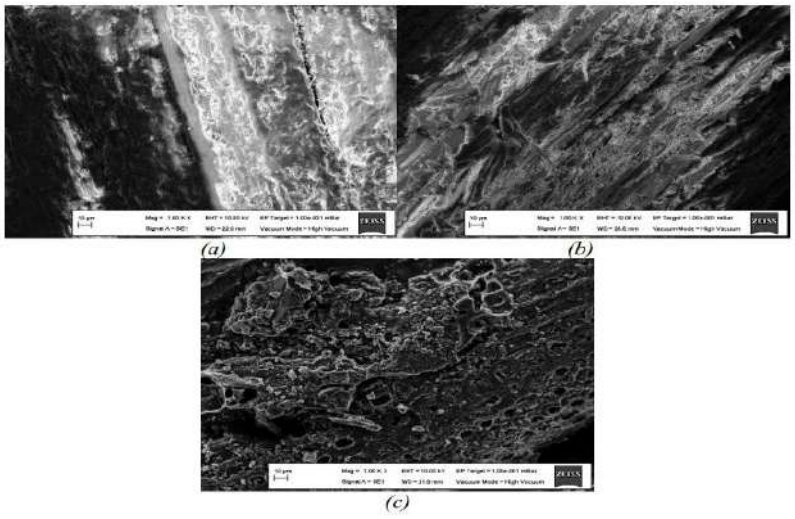

Figure 1: SEM images (a)Chickpea Stalk (b) Hydrochar (c) AC

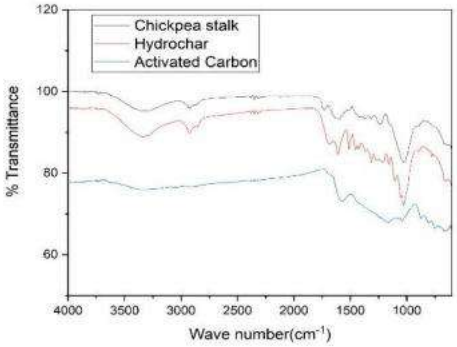

Figure 2: Results of FTIR analysis

Campos *et al.*, 2021 were able to prepare carbon from coffee parchment and spent coffee by means of Co-Calcination with $CaCO_3$. Their absorbing efficiency in organic compounds was compared, and its productivity was 9.0%. SEM measurements confirmed that this preparation method improved the pore structure compared to the raw materials. The efficiency of coffee parchment in adsorption of carboxylic acids was comparable to activated carbon prepared from spent coffee, which in turn was higher in adsorption efficiency than commercial activated carbon. Bilal *et al.*, 2021 prepared activated carbon from capparis decidua by activation at a temperature ranging between (700-500)^{o}C. The heat treatment caused a significant change in shape and chemical composition of carbon, and it had a high adsorption capacity for lead (II) estimated at 719.42 mg/g. The interaction of lead with activated carbon was of a physical nature.

Kaminska *et al.*, 2021 studied the possibility of producing activated carbon from sunflower husks, Coffee Grounds, and Orange Peels using KOH followed by a carbonization process at (800°C) in a N_2 atmosphere. The prepared carbon materials were characterized by a surface area ranging from (1566–1366 m^2/g), a pore volume ranging (0.694–0.584 cm^3/g). Diagnostic techniques (XRD, SEM, XRF, XPS) were demonstrated the prepared materials have an amorphous structure, have an irregular surface shape, and a high degree of purity with small amounts of inorganic materials. Therefore, they were used as catalysts for multiple industrial processes.

Neme *et al.*, 2022 were able to prepare activated carbon from castor seed hull through chemical activation with H_3PO_4 at different impregnation rates (0.8-0.2), then it was heat treated at 900, 700, and 600°C for different times (120, 90, 60 minutes). The effect of the impregnation rate was studied. With H_3PO_4, activation time, and activation time on the production of activated carbon, it was found that the activated carbon yield increased with an increase in the percentage of impregnation with H_3PO_4 and reached a maximum of 78.86% with an impregnation rate of 0.8, an activation temperature of 700°C and an activation time of 60 minutes. The maximum surface area was obtained (785.38 m^2/g).

Madani *et al.*, 2022 from stipa tenacissima prepared activated carbon by chemical activation using H_3PO_4. The effect of activation temperature and impregnation rate on the structural and chemical surface properties of the prepared activated carbon was studied. The indicating results that temperatures activation (500,450)°C are the most suitable for producing activated carbon with an advanced porous structure. It was found that its surface area is (1503 m^2/g) and pore size is (0.59 cm^3/g). The best ratio of phosphoric acid is [1:2]. The optimal adsorption capacity for this prepared activated carbon is (110 mg/g) for the drug atenol to be removed from its aqueous solution compared to the presented commercial activated carbon from darco company.

Worldlight *et al.*, 2023 prepared activated carbon from groundnut shells (arachis hypoheae) by chemical activation using different ratios of H_3PO_4 [1:1 , 1:2 , 2:1]. Then carbonization was performed at temperatures of 400, 500, and 600 ^{o}C. Obtaining adsorption efficiency of prepared carbon (11.57mg/g) for Tartrazine from its aqueous solutions. It was also shown from the results that the adsorption technology using activated carbon on a large scale can be effective and less expensive to remove Tartrazine from wastewater.

Castaneda-Olivera *et al.*, 2023 were able to prepare activated carbon from prun persica and persea americana by exposing these materials to a temperature (800°C) for 30 min, then crushing and sifting them (800μ_m) to obtained particle homogeneity the coal was then treated with (1mL) phosphoric acid per gram of raw material at a temperature less than 500°C, then the it is purified with water and using specification ASTMC136-01, then the grain size, porosity, moisture content, and organic matter content of the prepared activated carbon samples are evaluated and used to remove arsenic with an efficiency rate of 95.37%, 96.94%. Lead removal was 95.52% and 97.19% due to its high porosity. This demonstrates the effectiveness of the prepared activated carbon in water treatment applications.

Liang *et al.*, 2024 studied plant-derived activated carbon for double-layer electrolytic capacitors. Plant-derived raw materials for active carbon are classified into four distinct groups: forest, agricultural residues, fruit peels, aquatic biomass, and plant particles. They described recent advances in the use of plant materials as raw materials for active carbon production, and the use of catalytic graphite techniques to enhance their electrochemical performance in double-layer electrolytic capacitors, and identified potential application prospects in double-layer electrolytic capacitors and future research directions for plant-derived active carbon.

Mandal *et al.*, 2024 were able to prepare activated carbon from agricultural waste materials (peanut shells (PSPA), betel nut fiber (AFPA)) and used phosphoric acid (H_3PO_4) at two different concentrations (20% and 40%) to prepare activated carbon. The results showed that all the prepared AC samples had high surface area ranging from (580-780) m^2/g and porosity by Brunauer–Emmett–Teller (BET) was measured as shown in the Table (1). The surface area of AC prepared from peanut shells was higher than that prepared from betel nut fiber. Prepared activated carbon samples were used for adsorption of amoxicillin, pharmaceuticals paracetamol and aspirin from their aqueous solution where (90%) of paracetamol was adsorbed within (5 min) of contact.

Table 1: Porosity of AC and Specific surface by BET analyses

Adsorbent	Specific surface area ($m^2.g^{-1}$)	Total pore volume($cc.g^{-1}$)	Average pore diameter(nm)
PSPA-20	689	0.56	3.27
PSPA-40	778	0.55	2.85
AFPA-20	586	0.36	2.47
AFPA-40	653	0.52	3.21

Preparation of Activated Carbon

Activated carbon can generally be prepared from various plant sources, and these materials are rich in carbon. Carbonation processes (pyrolysis) and physical and chemical activation processes have been clearly used to produce activated carbon from plant sources, as activation agents increase the versatility of activated carbon in large range applications, for example acids, alkalis, metals, gases rich in oxygen (Yahya *et al.*, 2015).

Carbonization

Carbonization means thermal decomposition and the removal of non-carbon species from raw materials (Shaheen *et al.*, 2019). It can be defined as a process that leads to a decrease in the material's content of volatile compounds to prepare coal, which is characterized by its high carbon content, by breaking the mutual bonds in the raw material. There are many factors that have a direct impact on this process, such as heating rate and temperature (Wang *et al.*, 2020).

Here, grade of the raw material is raised from 300^{o}C to 800^{o}C, and thus three types of products can be obtained: a solid carbonized material, a liquid material, and a gaseous material with non-condensable specifications. For example CO, CO_2 , CH_4 or H_2 (Alonso *et al.*, 2012). The carbonization process can be divided into four stages depending on temperature, Survival time, and speed of heating during carbonization for each stage, the components of the raw material (plants) are subject to reactions for example crosslinking, dehydration, fragmentation, rearrangement, depolymerization, repolymerization, condensation, carbonation (Quan *et al.*, 2016). The slow carbonization process is carried out in conditions that include low heating equipment and a longer residence time, which leads to the production of products with compliant compositions show in Table (2).

Table 2: Carbonation methods: types, conditions and products (Qambrani *et al.*, 2017)

Types	Conditions		Products		
	Temp. (^{o}C)	Re. time	Carb (%wt)	L (%wt)	G (%wt)
Slow	300-700	Hrs. or days	35	30	35
Intermediate	~500	10-20	20	50	30
Fast	850-1250	0.5-10	12	75	13
Flash	1050-1300	<0.5	20	50	30

Re. time: residue time, Carb: Carbonized, L: Liquid, G: Gas

Slow carbonization is one of the most widely used methods for obtaining activated carbon because it generates the largest amount of carbonized materials. For example, new methods can be used that use microwaves to generate hot spots in carbon molecules, which represents a promising way to obtain activated carbon. However, the carbon product obtained under (poor or zero) oxygen conditions has a lower surface effectiveness compared to activated carbon, to predict product properties and yield it is necessary to understand the effect of oxygen on the pyrolysis process of the raw material because of its great and beneficial effect on this process, as its presence leads to improving the quality of surface area, and increasing the total pore size of material (Zhang *et al.*, 2016, Shen *et al.*, 2017).

There is another classification of the carbonization process, which includes classifying it into four ranges of temperature: The first range (25-150)^{o}C physical adsorption occurs about 12% of absorbed water with simple change in order, the second range (150-240) ^{o}C dehydration of OH^{-}, H^{+} on the molecular scale, the third range (400-240) ^{o}C leads to thermal rupture of glycosidic bond and the C–O, C=C bonds, the fourth stage (greater than 700)^{o}C At these temperatures a structure similar to graphite with irregular layers is obtained (Chen *et al.*, 2020).

Activation

The basic properties of the carbon are determined during carburization and the next activation step must be designed to complement the carburization step. Due to the formation and condensation of hydrocarbons on the surface, carbon will have low porosity and surface area (Masoumi & Dalai, 2020). The activation agent has a major role in developing the carbon's pores on a wide and large scale through corrosion of its internal surfaces and leads to changing the shapes of the atoms on the surface to surface functional groups without reducing the mechanical strength (Dong *et al.*, 2018). The process is carried out in two ways: physical or chemical activation to prepare activated carbon, and in some cases sometimes the two methods can be combined.

Physical Activation

Physical activation, or what is called molecular gasification, takes place at high temperatures ranging from (1100-800)^{o}C using oxidizing materials for example steam(Zhang *et al.*, 2011), CO_2(Zhu *et al.*, 2012), air(Ould-Idriss *et al.*, 2011), or a mixture of them. Cl^-, sulfur vapors and ammonia are rarely used. The gasification process of carbonized material occurs through the use of steam, CO_2, and oxygen through endothermic reactions, as shown in the following equations:

i Steam

$$C + H_2O \rightarrow H_2 + CO$$
$$CO + H_2O \rightarrow H_2 + CO_2$$
$$C + 2H_2 \rightarrow CH_4$$

ii Carbon dioxide

$$C + CO_2 \rightarrow 2CO$$

iii Oxygen

$$C + O_2 \rightarrow CO_2$$
$$2C + O_2 \rightarrow 2CO$$

To obtain products with desirable properties in terms of pore development, which plays a major role in the pore size distributions and activity level of carbon, this is done by manipulating the activation process, such as changing the temperature and rate of flows of steam and carbon dioxide (Ouyang *et al.*, 2020). Table (3) shows the characteristics of some carbons produced by physical activation, Figure (3) shows the physical activation process.

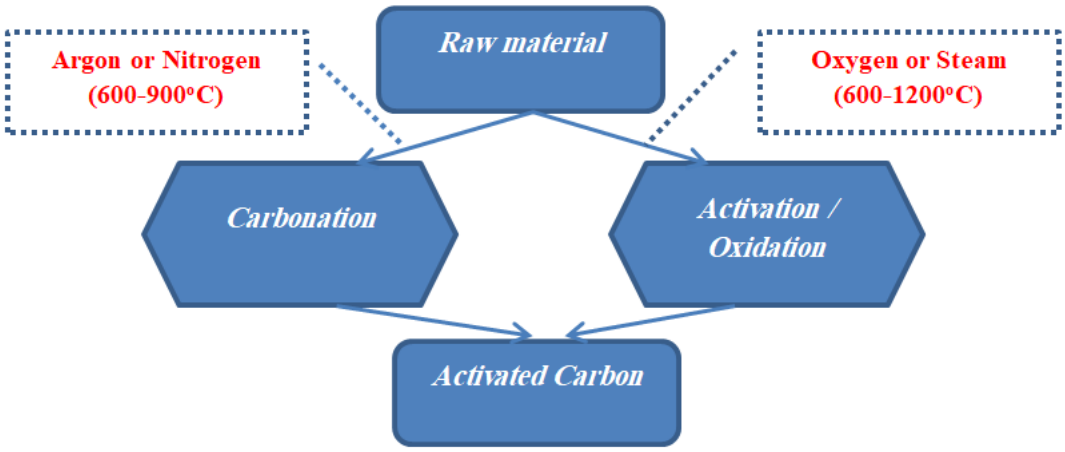

Figure 3: Physical activation process (Ganjoo *et al.*, 2023)

Table 3: Characterization of AC prepared by physical activation

Raw materials	Agent	S_{BET}(m^2/g)	Reference
Oil palm shell	CO_2	905	(Herawan *et al.*, 2013)
Cocoa shell	CO_2	558.25	(Ahmad *et al.*, 2013)
Oil palm empty fruit bunch	Steam	718	(Kadir *et al.*, 2014)
Rubber wood sawdust	CO_2	465	(Mazlan *et al.*, 2016)
Waste tea	Steam	995	(Zhou *et al.*, 2018)
Coconut shell	CO_2/Steam	610	(Chandana *et al.*, 2019)
Rice straw	Steam	243	(Yang *et al.*, 2020)

Chemical Activation

There are a series of steps required before activation to achieve a sufficient and rapid production process. The raw material is washed with deionized water to ensure that it is free of dust and other impurities, then drying it at temperature ranging (65-105)^{o}C, then grinding it to reduce the particle size (Surugau *et al.*,2019).

The process of chemical activation is carried out in three steps: pumping, mixing, and permeation of the solution a dried chemical is used that is characterized by its ability to stimulate the decomposition of materials and increase its speed through pyrolysis to prevent the formation of volatile materials before the activation process. The activation factors used include: phosphoric acid, sodium hydroxide, sodium chloride, zinc chloride, and in some cases the raw material is carbonized in one step, then these materials are added, the treated coal is then heated in a nitrogen atmosphere. The requirements of temperature for chemical activation process between (800-400)^{o}C, which is Lower than average temperature for physical activation process (Xin-hui *et al.*, 2011). The activation process can be used in two sequential steps: the first is to treat the primary plant material with the activation factor, followed by heat treatment according to conditions listed in Table (4) (Hoseinzadeh-Hesas *et al.*, 2013).

Table 4: The models of chemical activation process

conventional One-step		Convention al Two-step	Microwave
Temp. or power	(400-1200) ^{o}C	(400-800) ^{o}C	(300-1000) w
Heating & time	(1-3) hrs.	(400-1200) ^{o}C	5-30 min
Yield %	(30-50)%	(30-40)%	(> 40)%
Corrosion	H	H	L
Efficiency	L	H	H
Flow process	Continuous	Batch	Batch

The Figure(4) shows the process of chemical activation (Ganjoo *et al.*, 2023).

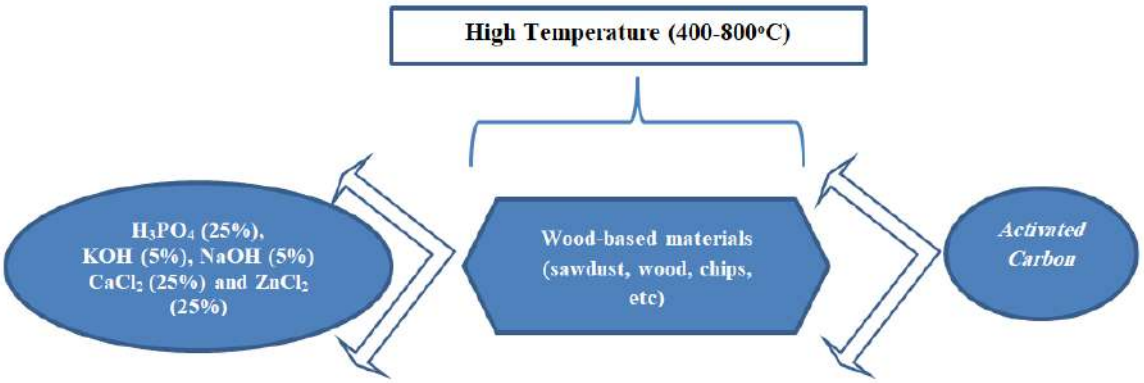

Figure 4: Chemical activation process

Table (5) shows the characterization of some carbon's prepared by chemical activation process.

Table 5: Characterization of activated carbons prepared by chemical activation

Raw materials	Agent	S_{BET}(mg/g)	Reference
Oil palm shell	$ZnCl_2$	1254	(Hoseinzadeh Hesas *et al.*, 2013)
Cocoa shells	H_3PO_4	1077	(Pereira *et al.*, 2014)
Rubber seed shell	KOH	620	(Pagketanang *et al.*, 2015)
Kenaf stem	H_3PO_4	1154	(Meryemoglu *et al.*, 2016)
Coconut shell	KOH	265	(Purnomo *et al.*, 2018)
Coconut spathe	KOH	1705	(Prashanthakumar *et al.*, 2018)
Rice husk	NaOH	2786	(Zhang *et al.*, 2020)

Activated Carbon Applications

Its use is not limited to a specific aspect of the industry and daily life, but rather expands to include many fields because of its large surface area, high adsorption capacity, surface effectiveness, and microporous structure. Activated carbon is used in the treatment of drinking water and industrial water, and its main applications include removing odor, color, and other unwanted (inorganic, organic) impurities. in liquid phase applications approximately 80% of total activated carbon (granular and powdered) is consumed. while granular activated carbon is optimal choice in gas phase applications (Nawaz *et al.*, 2019).

Use of activated carbon to remove dyes

As a result of the harmful and carcinogenic effects on living organisms due to contamination of wastewater with dyes issued by the textile, printing, dyeing, cosmetics and paper industries, the disposal of these colored liquid wastes is a major environmental challenge, and in order to get rid of dyes and other pollutants, the absorption of activated carbon is very successful (Ahmad *et al.*, 2011). There are many examples of removing dye from polluted water using activated carbon, as shown in Table (6).

Table 6 : Previous studies on activated carbon prepared from different plant materials used to remove dyes

Raw materials	Method	Activation factor	Dyes	Adsorption capacity (mg/g)	Ref.
Castile nutshells	Chemical	H_3PO_4	Methylene blue	169.5	(Bell-Hutle *et al.*, 2010)
Oak cups pulp	Chemical	$ZnCl_2$ H_3PO_4	Basic Red18 Acid Red111 Methylene blue	181.82 40.48 384.60	(Timur *et al.*, 2010)
Pecan nut shells	Chemical	Calcium solution	Acid blue25	48	(Hernandez -Montoya *et*

		H_3PO_4			*al.*, 2011)
Posidonia oceanica(L) dead leaves	Chemical	$ZnCl_2$	Methylene blue	285.7	(Dural *et al.*, 2011)
Pineapple waste biomass	Chemical	$ZnCl_2$	Methylene blue	288.34	(Mahamad *et al.*, 2015)
Cocoa shell	Physiochemical	$ZnCl_2/FeCl_3$	Reative Violet 5 RV-5	-----	(Sellaoui *et al.*, 2017)
Coconut shell	Hydrothermal Carbonization& Chemical	NaOH	Methylene	200.01	(Islam *et al.*, 2017)
Peanut shell	Chemical	$FeCl_3/MgCl_2$	Malachite green(catioic)	4031.96	(Guo *et al.*,2020)

Using activated carbon to remove pesticides

There are many materials used for the chemical preparation of pesticides and these products aim to prevent damage caused by pests. Such as herbicides, insecticides, fungicides, algaecides, antimicrobials, miticides, rodenticides, and viricides (Foo *et al.*, 2010). This organic material is used based on its chemical and physical properties and method of application to kill target pests. The most commonly used pesticides in agriculture are organophosphorus pesticides (OPs) and are considered the main cause of cancer. The continuous and excessive use of pesticides leads to an impact on the environment and health due to their continuous nature (Chavoshani *et al.*, 2020). Chemical, physical processes were used to remove pesticides from contaminated water. Adsorption is the most widely used method. There are many examples of using activated carbon produced from various plant sources to remove pesticides, as shown in Table (7).

Table 7 : Previous studies on activated carbon prepared from different plant materials used to remove pesticides

Raw materials	Method	Activation factor	Pesticides	Adsorption capacity (mg/g)	Ref.
Corn cobs	Physical	Steam	Bromopropylate	0.189	(Ioannidou *et al.*, 2010)
Oil palm shell	Chemical	NaOH	4-Choroguaiacol	454.45	(Hamad *et al.*, 2010)
Oil palm frond	Chemical	KOH	2,4-dichlorophenoxyacetic acid	352.89	(Sulaiman *et al.*, 2011)
Coconut frond	Chemical	H_3PO_4	Carbofuran	80	(Njoku *et al.*, 2014)
Rice straw	Chemical	KOH	Carbofuran	296.52	(Chang *et al.*, 2014)
Apricot kernel	Physical	Hot air	Prothiofos	145.8 ± 2.4	(Abdelhameed *et al.*, 2020)
Waste tangerine seed	Chemical	H_3PO_4	Carbamate	----	(Wang *et al.*, 2020)
Diospyros kaki fruit	Chemical	$ZnCl_2$	Atrazine herbicide ATZ	194.20	(Salomon *et al.*, 2021)

Using activated carbon to remove heavy metals

The most important serious environmental problem is the contamination of water with heavy metals. The reason for this is due to their toxicity, accumulation, bio-magnification in the food chain, and their persistence for a long period, even at relatively low concentrations (Wojanarovits *et al.*, 2010). Among the most dangerous metals that are commonly found in wastewater as a result of many industries are cadmium, chromium, and lead. And using activated carbon to remove these metals through adsorption is considered one of the most successful ways to achieve environmental standards, and Table (8) includes some of these plant materials used in preparing activated carbon.

Table 8 : Previous studies on activated carbon prepared from different plant materials used to remove heavy metals

Raw materials	Method	Activation factor	Heavy metal	Adsorption Capacity (mg/g)	Ref.
Cotton stalk	Chemical	H_3PO_4	Pb(II)	119	(Li *et al.*, 2010)
Peanut shell	Chemical	KOH	Cr(VI)	16.26	(AL-Othman *et al.*, 2012)
Corn style	Chemical	----	Ce(III)	180.2	(Varsihini *et al.*, 2014)
Olive fruit stones	Chemical	H_3PO_4	Cd	24.83	(Obregon-Valencia & Sun-Kou, 2014)
Grapefruit peels	Hydrothermal Carbonization	KOH	Cu(II)	48.22	(Semercioz *et al.*, 2017)
Pistachio wood	Chemical	NH_4NO_3	Hg	190.2	(Sajjadi *et al.*, 2018)
Limonia acidissima shell	Chemical	H_3PO_4	Fe(II)	48.13	(Das *et al.*, 2020)
Conconut shell	Physical	Cr_2O_3	Cr(VI)	45.2	(Wang *et al.*, 2020)

Using activated carbon to remove phenolic compounds

The most common pollutants found in variety liquid wastes from disinfectant, plastics and gasoline industries are phenol and its derivatives (Timur *et al.*, 2010). Phenol is considered one of the toxic pollutant compounds listed by the Environmental Protection Agency, so it must be removed from wastewater. By referring to the literature, we find several studies in this field, including shown in Table (9).

Table 9 : Previous studies on activated carbon prepared from different plant materials used to remove phenolic compounds

Raw materials	Method	Activating factor	Pollutant	Adsorption capacity (mg/g)	Ref.
Castile nutshell	Chemical	H_3PO_4	Phenol	53.2	(Bell-Hutle *et al.*,

					2010)
Oak cups pulp	Chemical	H_3PO_4 $ZnCl_2$	Phenol	75.19	(Timur *et al.*, 2010)
Almond shell	Physical	HNO_3 CO_2	Phenol P-nitrophenol	76-139 154-224	(Mourao *et al.*, 2011)
Avocado kernel seeds Presa americana	Chemical	K_2CO_3	Phenol	0.215-0.134	(Dejene *et al.*, 2016)
Olive-pit **Date-pit**	Physical	-----	Phenol	4.39 39.37	(Gilani *et al.*, 2019)
Oil stoens	Chemical	$ZnCl_2$	Phenol	635	(Saleem *et al.*, 2019)
Ficus Leaf(ACF)	Chemical	H_2SO_4	P-nitrophenol	0.6738	(Mahdi *et al.*, 2022)
Acacia mangium wood	Chemical	H_3PO_4	Phenol	53.8	(Alam *et al.*, 2023)

Using activated carbon to remove organic and inorganic pollutants

Organic & inorganic compounds such as vanadium, NO^{-3}, fluorides, and SO_4^{-2} are considered toxic substances when present in drinking water. Many countries, such as India and China, suffer from a major problem due to the presence of fluoride in drinking water in high concentrations. Therefore, there was a need to use activated carbon to remove these pollutants (Hernandez-Montoya *et al.*, 2011). If the concentration is higher than 1.5mg/L, it may cause bone fluorosis in children. It has been shown through previous studies that there is a strong relationship between the fluoride ion and the ions of multivalent metals such as Zn^{+3}, AL^{+3}, it may interact with some divalent ions Ca^{+2} (Alagumuthu & Rajan, 2010). While recent studies have indicated that it is possible to remove fluoride from water using carbon prepared from egg shell wastes, pecan nut shells. The results showed that the presence of calcium chemical groups on the surface of the prepared activated carbon played an important role in the fluoride removal process (Hernandez-Montoya *et al.*, 2012).

Use of activated carbon in gas purification

Activated carbon is often used to purify gas, where hydrogen gas, sewage gas, carbon dioxide, hydrogen sulphide, siloxanes and other things are removed from the air using activated carbon compressed in certain filters, which are often placed in the middle of the filter and the purification process takes place in either one or two steps of filtration. These gases are absorbed and fixed in large layers of activated carbon due to their ability to quickly decompose into solid materials, thus completing the air purification process (Ganjoo *et al.*, 2023).

Using activated carbon in medical fields

World Health Organization has listed activated carbon produced from various materials as one of the effective medicines in treating cases of poisoning and overdose resulting from taking medications, except for cases of poisoning with cyanide, lithium, and iron. Taking into account the consumption of activated carbon under health care, it is also used in teeth whitening (Ganjoo *et al.*, 2023).

Conclusion

The wide applications for the production of activated carbon have led to a large demand for it in various industrial applications. For this reason, research has increased to find alternatives to replace commercial activated carbon, which is known for its high cost. In this review, it has been proven that natural plant materials can be used to produce activated carbon and its use in removing different types of pollutants by taking advantage of this waste. It is also possible to reduce spending on waste management and improve the country's economy. Many processes have been used to activate carbon, chemical activation has proven successful compared to physical in terms of activation temperature, cost lower, short processing time, big surface area, high porosity, and higher carbon efficiency. This makes it an excellent adsorbent for many diverse pollutants, such as its use. In removing dyes, pesticides, heavy metals, and highly toxic phenolic compounds, and removing various organic and inorganic pollutants, in addition to using it in gas purification and various medical preparations. The most important thing for the adsorption process is choosing the appropriate starting material for its effective role in controlling the porous structure of the prepared carbon.

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MEASURING NITRATE CONCENTRATIONS IN A NUMBER OF VEGETABLES SOLD IN MOSUL MARKETS

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Abstract

Animal nutrition plays a crucial role in livestock productivity and health. This makes them susceptible to poisoning when animals eat quantities of food that contain high levels of nitrates because of excessive use or misuse of nitrogen fertilizers. This leads to the accumulation of nitrates in plants, in addition to polluting surface and groundwater and creating environmental risks. The research aimed to detect the percentage of nitrates in vegetables that are given to animal breeders in the markets of the city of Mosul, and to find the vegetables that have the largest percentage of nitrates. Nitrates were read using the instrument green test in vegetables (Tomato, onions, cucumbers, chard and eggplant) as I showed that the highest percentage of nitrates is located in the chard, which reached 3662.77mg/kg and the least in onions is 30mg/kg Which was measured within 10 months. Nitrate concentrations in the measured samples of tomatoes, onions, and cucumbers were normal when compared with the values recorded by the World Health Organization. We found concentration of nitrates in onions was stable Compared with other measured vegetables. The results showed an increase in nitrate concentration levels above the permissible limit set by the World Health Organization, in chard and eggplant 3662.77mg/kg and 854.3mg/kg. respectively. From the above, it is clear that nitrates are dangerous in vegetables sold in Mosul markets and used to feed indoor animals. It also gives an indication of the danger to human health when consuming them. Which causes diseases such as colon cancer or death.

Keywords: vegetables, Nitrates, animals, nitrites, poisoning.

قياس تراكيز النترات في عدد من الخضراوات المباعة في أسواق الموصل

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الخلاصة

تلعب التغذية الحيوانية دوراً حاسماً في إنتاجية الثروة الحيوانية وصحتها. مما يجعلها عرضة للتسمم عندما تتناول الحيوانات كميات من الطعام الذي يحتوي على نسبة عالية من النترات بسبب الاستخدام المفرط أو سوء استخدام الأسمدة النيتروجينية. ويؤدي ذلك إلى تراكم النترات في النباتات، بالإضافة إلى تلويث المياه السطحية والجوفية وخلق مخاطر بيئية. هدف البحث إلى الكشف

عن نسبة النترات في الخضار التي لا تباع وتعطى لمربي الحيوانات في أسواق مدينة الموصل، ,والكشف عن الخضار التي تحتوي على النسبة العالية من النترات. تمت قراءة النترات باستخدام جهاز Greentest في الخضروات (الطماطم والبصل والخيار والسلق والباذنجان) حيث تبين أن أعلى نسبة نترات موجودة في السلق والتي بلغت 3662.77 ملغم/كغم وأقلها في البصل 30 ملغم/كغم. كلغ والتي تم قياسها خلال 10 اشهر. وكانت تراكيز النترات في العينات المقاسة من الطماطم والبصل والخيار طبيعية بالمقارنة مع القيم المسجلة لدى منظمة الصحة العالمية. وقد وجدنا أن تركيز النترات في البصل كان مستقراً مقارنة ببقية الخضروات المقاسة. أظهرت النتائج ارتفاع تركيز النترات عن الحد المسموح به من منظمة الصحة العالمية في السلق والباذنجان 3662.77 ملجم/كجم و854.3 ملجم/كجم. على التوالى. مما سبق يتبين خطورة مادة النترات في الخضار التي تباع في أسواق الموصل وتستخدم لتغذية الحيوانات الداخلية. كما أنها تعطي إشارة إلى مدى خطورة تناولها على صحة الإنسان. مما يسبب أمراض مثل سرطان القولون أو الوفاة.

الكلمات المفتاحية: الخضروات، النترات، الحيوانات، النتريت، التسمم.

INTRODUCTION

Today, the role of nitrogen fertilizers in agriculture is increasing due to the increased demand for growth, performance and quality of products to achieve more productivity, and this leads to excessive use or misuse of nitrogen fertilizers. This leads to the accumulation of nitrates in plants, in addition to polluting surface and groundwater and creating environmental risks. Accumulation of nitrates in plants causes various diseases in humans as well as animals, such as methemoglobinemia as well as cancer of the digestive system in humans, through the ability of nitrates to interact with amino acids in the body of living organisms and convert them into nitrosamines that cause cancer. (Noorafkan *et al.*, 2008; Raghimi *et al.*, 2008; Pirsaheb *et al.*, 2012) This is done by eating particularly leafy vegetables such as lettuce and spinach leaves, which contain high concentrations of nitrates. The accumulation of nitrates and nitrites is harmful, based on research and studies, and the reason is that the effect of chemical fertilizers accumulated in the soil and which accumulate in agricultural products is not immediately detected (Serpell., 2012).

Nitrates enter irrigation water in various ways through soil contaminated with high concentrations of nitrate fertilizers, and from it to foods, especially vegetables, through contaminated water, as well as fruits, dairy products, and grains, through which nitrates and nitrites enter the human body.

Nitrite poisoning occurs when eating feed that contains high concentrations of nitrates like silage or eating large quantities of feed vegetables provided by the breeder to the animal after collecting them from markets selling agricultural products and then converting nitrate to nitrite by the action of rumen normal flora (Cockburn *et al.*, 2013; Al-Saffawi., 2020; AN *et al.*, 2023; Khalil *et al.*, 2023). It is one of the foods that spoil easily if its sale or marketing is delayed. Animals are also fed with fresh green fodder from the fields in spring and fall, especially those that sprout after the first rain. One of these plants is Portulaca oleracea (Simões *et al.*, 2018), which is dangerous to animals and causes confusing symptoms for breeders, especially in cows, as it gives a form similar to milk fever but does not respond to calcium (Brender., 2020). Here is a distinctive sign, which is a loud heart sound compared to a weak heartbeat milk fever condition. Nitrate concentration of 0.5% is considered hazard and severe toxicity appeared if the amount of nitrate is more than 1% (Puschner., 2000). When the normal flora fails to reduce nitrite by converting it to ammonia the potential to as well as reduced capacity to detoxify Methemoglobinemia (MetHb) back to haemoglobin (Hb) due to the important clinical signs of poisoning by nitrites are cyanotic, bloat, diarrhoea, loss of appetite,

drowsiness, weakness of the limbs, tachypnea and tachycardia and recumbence followed by death within days (Thornton and Abrahams.,1983; Simões *et al.*, 2018; Al-Quwaie *et al.*, 2023). Humans cause the accumulation of nitrates in plants, as well as polluting surface water and then penetrating groundwater, causing environmental risks (AbuElHassan *et al.*, 2022; hazim sabry., 2022; Al-Hussein *et al.*, 2023). Accumulation of nitrates in plants causes various diseases in humans, such as gastrointestinal cancer in adults and causes methemoglobinemia in adults and children (Dezfouli and Abdollahi 2009; Afali and Elahi., 2014; Al-Bhar and Al-Saffawi., 2021). Therefore, the research focused on detecting types of vegetables that contain high concentrations of nitrates to protect the consumer by protecting animals that feed on feed tazken mainly from local markets, where large amounts are disposed of, causing poisoning of animals and thus transferring these high concentrations. Via milk and meat to humans.

MATERIALS AND METHODS

Samples of vegetables (Tomato, onions, cucumbers, chard and eggplant) were collected, and their total number reached 750 Of every type of vegetable sample was distributed among 150 each type of vegetables from the markets of the city of Mosul for the period from 10/1/2022 to 31/7/2023 after randomly collecting a sample. It was measured after purchase using the green test. Zhejiang, China device.

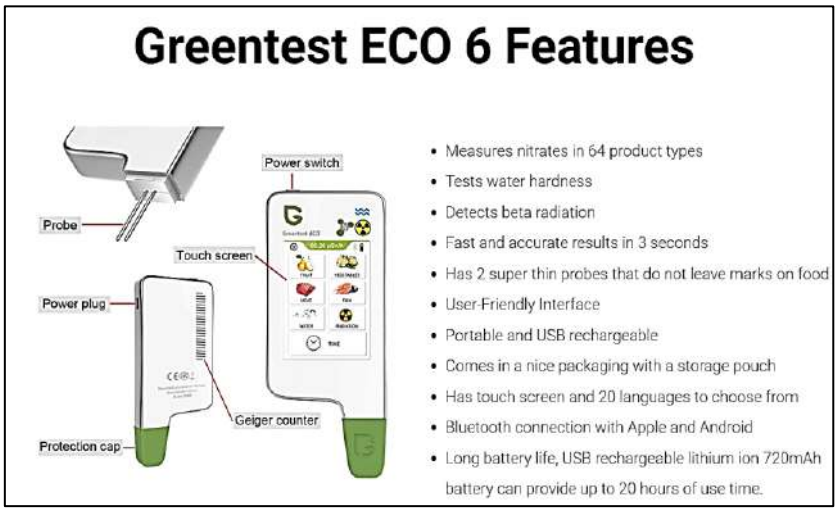

Figure 1. The figure above represents the device (Greentest) and its specifications used to conduct the research

RESULTS

Table 1. shows the values measured with the green test device in milligrams/kg for each of the vegetables (tomatoes, cucumbers, and Swiss chard), where the highest value in chard was 3662.77 mg/kg and the lowest in tomatoes was 51 mg/kg.

N		Tomato	Onions	Cucumbers	Eggplant	Chard
1	Number of samples	150	150	150	150	150
2	Min	30	30	30	150	100
3	Max	140	30	320	1030	7600

4	Sum	7650	4500	17110	128145	549416
5	Mean	51	30	114.067	854.3	*3662.77
6	Std.error	2.0067	0	5.7635	18.7238	164.862
7	Variance	604.027	0	4982.7	52587	4.07692E06
8	Stand. dev	24.577	0	70.5882	229.319	2019.14
9	Median	50	30	95	910	4100

*The highest- measured value of nitrate concentration appears in chard.

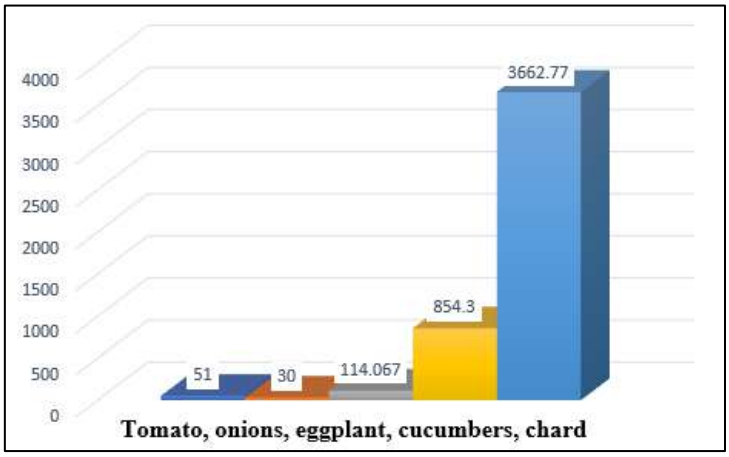

Figure 1. shows the average values of nitrate concentration in the measured vegetables

Table 2. shows the values measured with the green test device in milligrams/kg for tomatoes over ten months. The highest value of nitrate concentration in tomato plants was 63 mg/kg, and the lowest in tomatoes was 34 mg/kg.

N	Months	10	11	12	1	2	3	4	5	6	7
1.	Number of samples	15	15	15	15	15	15	15	15	15	15
2.	Sum	880	670	950	910	730	950	840	640	570	510
3.	Mean	59	45	*63	61	49	*63	56	43	38	34

*The highest- value of nitrate concentration that measured in tomatoes appears within ten months.

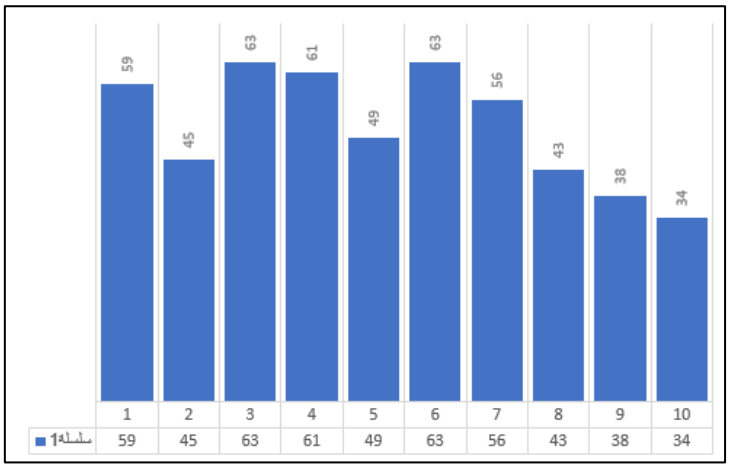

Figure 2. shows the nitrate values that measured in tomatoes, milligrams/kg, during ten months

Table 3. shows the values measured with the green test device in mg/kg for Onions over ten months, where we show Consistency in values of nitrate concentration in the Onion was 450 mg/kg,

N	Months	10	11	12	1	2	3	4	5	6	7
1	Number of samples	15	15	15	15	15	15	15	15	15	15
2	Sum	450	450	450	450	450	450	450	450	450	450
3	Mean	30	30	30	30	30	30	30	30	30	30

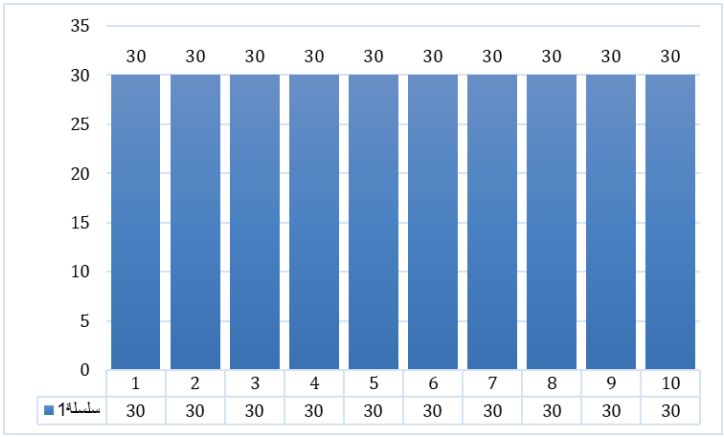

Figure 3. shows the nitrate values that measured in cucumbers (mg/kg) over ten months.

Table 4. shows the values measured with the green test device in mg/kg for cucumbers over ten months, where the highest value of nitrate concentration in the cucumber plant was 290 mg/kg, and the lowest in tomatoes was 68 mg/kg.

N	Months	10	11	12	1	2	3	4	5	6	7

1.	Number of samples	15	15	15	15	15	15	15	15	15	15
2.	Sum	4356	1610	1040	1680	2050	2220	2090	1560	1020	1850
3.	Mean	290*	107	69	112	137	148	139	104	68	123

*The highest- measured value of nitrate concentration in cucumber appears within ten months.

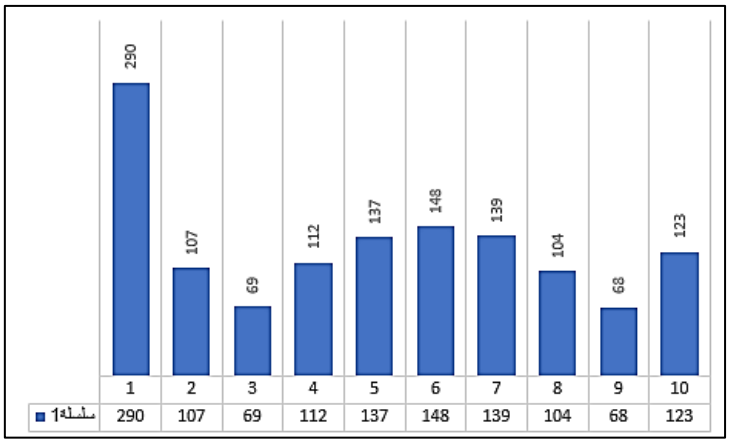

Figure 4. shows the nitrate values measured in cucumbers (mg/kg) over ten months.

Table 5. shows the values measured with the Greentest device in milligrams/kg for chard over ten months. The highest value of nitrate concentration in Swiss chard plants was 4967 mg/kg, and the lowest in chard was 290 mg/kg.

N	Months	10	11	12	1	2	3	4	5	6	7
1	Number of samples	15	15	15	15	15	15	15	15	15	15
2	Sum	4356	8839	56300	68700	64421	74500	72700	74200	68800	56600
3	Mean	290	589	3753	4580	4295	*4967	4847	4947	4587	3773

*The highest- measured value of nitrate concentration in chard appears within ten months.

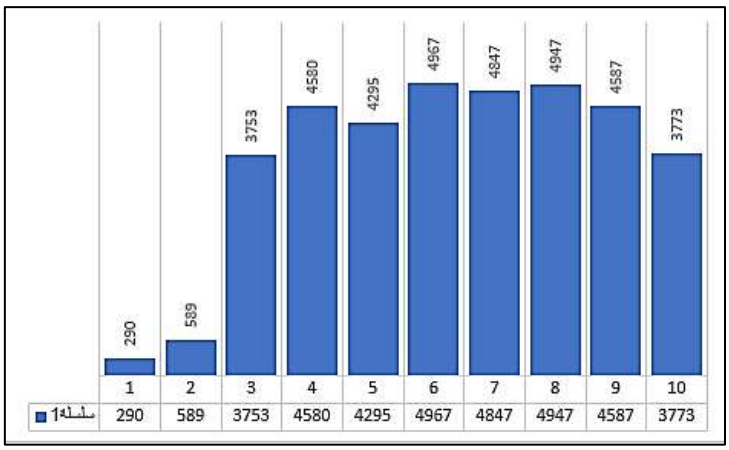

Figure 5. shows the nitrate values measured in chard, mg/kg, over four months

Table 6. shows the values measured with the Greentest device in milligrams/kg for eggplant over ten months. The highest value of nitrate concentration in Swiss chard plants was 1008 mg/kg, and the lowest in eggplant was 277 mg/kg.

N	Months	10	11	12	1	2	3	4	5	6	7
1	Number of samples	15	15	15	15	15	15	15	15	15	15
2	Sum	13500	14410	14855	15120	14550	13950	13600	13500	10500	4160
3	Mean	900	961	990	*1008	970	930	907	900	700	277

*The highest- measured value of nitrate concentration in eggplant appears within ten months.

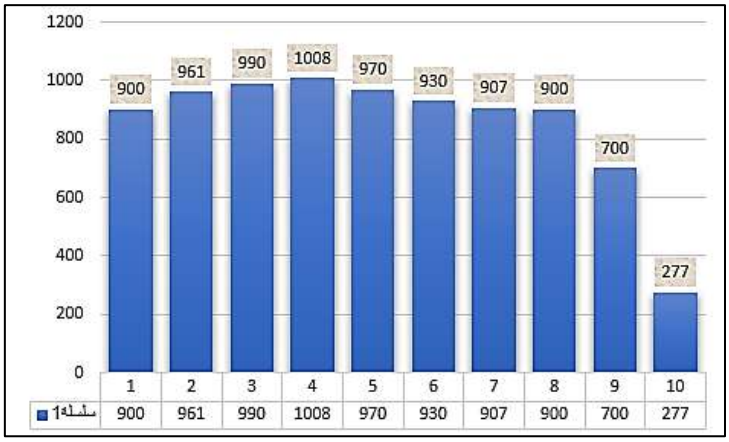

Figure 6. shows the nitrate values measured in chard, mg/kg, over four months

DISCUSSION

The study showed that the values of nitrates in tomato, onion, and cucumber vegetables fall within the normal values with the values shown in the World Health Organization bulletin: 300 mg/kg, 80 mg/kg, and 150 mg/kg, respectively (WHO.2009), but in chard and eggplant, they exceed the recommended normal values, which are 2000 mg/kg, 300 mg/kg, reaching 3662.77 mg/kg and 854.3 mg/kg. Respectively, this is consistent with (Nowrouz et al., 2012; Salehzadeh *et al.*, 2020; AbuElHassan *et al.*, 2022). The permissible limit of nitrate in the daily diet is 3.3 mg/kg body weight per day for nitrite in livestock (Cockburn *et al.*, 2013). From the above, it is clear that the concentrations in some vegetables are very high and can cause diseases in field animals as well as in humans, where the permissible concentrations of nitrates in humans' food daily diet are between 0-07 mg/kg of body weight per day (Al-Hamdani., 2021; Cockburn *et al.*, 2013). These results give danger signals from the presence of high levels of nitrate concentrations in some vegetables sold in Mosul markets.

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Detection of Shiga toxins and its inhibition in *Escherichia.coli* O157:H7 Strain isolated from water in Mosul city

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Abstract

The current study was conducted with the aim of isolating and diagnosing the strain *Escherichia coli* O157:H7 from water in the city of Mosul, and studying the possibility of inhibiting its toxin Shiga toxin (STX) using different materials and compounds. for this purpose 55 water samples was collected (30 Tigris River water, 25 sewage water).

Isolation and diagnosis results showed that 29 isolates of *E.coli* O157:H7 strain were obtained using the selective medium Sorbitol MacConkey Agar (SMAC) , distributed over river water (50%) and sewage water (56%). The molecular technique (PCR) polymerase chain reaction was used by adopting the 16srRNA gene to confirm the diagnosis of cultured isolates, the same technique was also used to investigate the genes encoding both types of shiga toxin, and it was found that the prevalence of the stx2 gene encoding the shiga toxin Stx2 is higher compared to the stx1 gene encoding the shiga toxin Stx1.

The inhibitory effect on the shiga toxins of the *E.coli*O157:H7 strain was studied using a group of materials represented by alcoholic plant extracts of mint leaves, pomegranate peels, and natural materials, namely honey, gum arabic, and propolis, in addition to using some essential oils, namely cinnamon oil, watercress seed oil, and gum arabic oil. The inhibitory materials used showed a high inhibitory ability against the growth of the selected isolates.

The possibility of inhibiting shiga toxins was investigated at the molecular level by investigating the possibility of inhibiting gene expression for the stx1 and stx2 genes, and Quantitative Real Time PCR technology was used for this purpose. The results showed that the alcoholic pomegranate peel extract was able to inhibit gene expression. for the stx1 and stx2 genes by approximately half, with values ranging between 0.35 for the first gene and 0.41 for the second gene, compared to the gene expression of the untreated control samples, while the rest of the studied materials did not affect the inhibition of gene expression.

The cytotoxicity of the studied shiga toxins was detected on a cell line (normal lymphocytes) for the first time locally using the MTT cytotoxicity assay method. The method succeeded in showing the cytotoxicity of the shiga toxins and confirming the ability of the alcoholic pomegranate peel extract to inhibit the shiga toxins of the studied isolates compared to the control sample without treatment.

Keywords: *E.coli*O157:H7, Shiga toxin, Sorbitol MacConkey Agar, MTT cytotoxicity assay

الكشف عن سموم الشايكا وتثبيطها في سلالة ***Escherichia.coli*** **O157:H7** المعزولة من مياه مدينة الموصل

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الخلاصة

أجريت الدراسة الحالية بهدف عزل وتشخيص سلالة *E.coli* O157:H7 من مياه مدينة الموصل، ودراسة إمكانية تثبيط سموم الشايكا Shiga toxin (STX) باستخدام مواد ومركبات مختلفة. ولهذا الغرض، تم جمع 55 عينة مائية (30 عينة من مياه نهر دجلة، و25 عينة من مياه الصرف الصحي). أظهرت نتائج العزل والتشخيص أنه تم الحصول على 29 عزلة من سلالة *E.coli* O157:H7 باستخدام الوسط الانتقائي Sorbitol MacConkey Agar (SMAC)، موزعة على مياه النهر (50%) ومياه الصرف الصحي (56%). تم استخدام تقنية تفاعل البلمرة المتسلسل (PCR) باعتماد الجين *16SrRNA* لتأكيد تشخيص العزلات المزروعة، كما استُخدمت التقنية نفسها لدراسة الجينات المُشفرة لكلا نوعي سم الشايكا، وتبين أن معدل انتشار جين *stx2* المُشفر لسم الشايكا STX2 أعلى مقارنةً بجين *stx1* المُشفر لسم الشايكا STX1.

دُرست الفعالية التثبيطية لسلالة *E.coli* O157:H7 على سموم الشايكا باستخدام مجموعة من المواد، تمثلت في مستخلصات نباتية كحولية من أوراق النعناع وقشور الرمان، ومواد طبيعية، وهي العسل والصمغ العربي والعكبر، بالإضافة إلى استخدام بعض الزيوت العطرية، وهي زيت القرفة وزيت بذور الجرجير وزيت الصمغ العربي. وقد أظهرت المواد المثبطة المستخدمة قدرة عالية على تثبيط نمو العزلات المختارة. تم البحث في إمكانية تثبيط سموم الشايكا على المستوى الجزيئي من خلال دراسة إمكانية تثبيط التعبير الجيني لجينيّ *stx1* و*stx2*، واستُخدمت تقنية تفاعل البلمرة المتسلسل الكمي(Quantitative Real Time PCR) لهذا الغرض. أظهرت النتائج أن مستخلص قشر الرمان الكحولي كان قادرًا على تثبيط التعبير الجيني لكل من *stx1* و*stx2* بمقدار النصف تقريبًا، بقيم تتراوح بين 0.35 للجين الأول و0.41 للجين الثاني، مقارنةً بالتعبير الجيني لعينات السيطرة غير المعاملة، بينما لم تؤثر بقية المواد المدروسة على تثبيط التعبير الجيني.

تم الكشف عن السمية الخلوية لسموم الشايكا المدروسة على خط خلوي (خلايا اللمفاوية طبيعية) لأول مرة محليًا باستخدام طريقة اختبار السمية الخلوية MTT. نجحت الطريقة في إظهار السمية الخلوية لسموم الشايكا وتأكيد قدرة مستخلص قشر الرمان الكحولي على تثبيط سموم الشايكا للعزلات المدروسة مقارنةً بعينة السيطرة غيرالمعاملة.

الكلمات المفتاحية: السلالة O157:H7 ، سموم الشايكا ، وسط سوربيتول ماكونكي أكار ، اختبار سمية الخلايا MTT.

Introduction:

Water pollution intended for human use is one of the most dangerous cases of pollution because of its direct relationship to the public health of human societies. About 80% of diseases are linked to unsafe use of water, and more than a third of deaths in developing countries are caused by water pollution. (Nega *et al*., 2021).

Intestinal bacteria constitute one of the most important causes of water-borne diseases. Perhaps the most prominent and widespread of these bacteria is *E.coli*. This bacteria plays the primary role in the issue of bacterial contamination of water, whether for its pathogenic role or as one of the approved indicators of fecal contamination. *E. coli* O157: H7 is important strain, which is a serotype belonging to the bacterial type *E. coli* from the enterohemorrhagic *E. coli* group (EHEC). The most important characteristic of this bacterium distinguishes it from Other types of *E.coli* its inability to sorbitol sugar. The pathogenicity of this strain is due to its possession of virulence factors, the most important of which is its ability to produce Shiga toxin (STX), which is the main factor responsible for bloody diarrhea (HC) and hemolytic uremic syndrome (HUS). It was found that there is more than one type of STX toxin, and the most important types are STX1 and STX2 (Van Bree *et al*., 2018).

Many immunological and molecular methods are used to diagnose these toxins, in addition to biological methods based on laboratory animals. Live cell lines may be used to detect and determine the effect of these toxins, including the use of the MT assay (3-(4,5-Dimethylthiazol-2-yl). -2,5-Diphenyltetrazolium Bromide) based on tetrazolium dye that measures cytotoxicity or the degree of cell inhibition (Mustafa, 2022).

Inhibiting bacterial toxins is one of the most important goals of anti-virulence drugs because the majority of pathogenic bacteria cause disease by producing toxins that have a high effect on the cells of the host's body, and the effectiveness of targeting them with these anti-virulence agents represents a tremendous progress in the field of treatments after the emergence of highly toxic bacterial strains and resistant to many drugs (Krueger and Brown, 2019). Many substances and compounds are mainly used for anti-virulence treatments, including plant extracts, because these extracts contain various chemical and metabolic compounds that have antibacterial activity, such as resins, gums, flavonoids, etc., and the effectiveness of these compounds has been proven on many disease-causing bacterial species (Chew *et al*., 2018). Plant Essential Oils (EOs) are also used for the same purpose, which are composed of volatile substances of an oily nature and consist of a mixture of aldehydes, hydrocarbons, terpenes, and phenols (Qasim *et al*., 2021). Natural materials such as honey, propolis, and Arabic gum are also included in many research studies that deal with their use in killing and inhibiting microorganisms and as therapeutic alternatives, especially against bacteria that are resistant to drugs. (Rivera *et al*., 2021 ; Bains *et al*., 2020)

In view of the epidemiological and health importance of the bacterial strain *E. coli* O157:H7 and the lack of extensive local studies on Shiga toxins, which are the most important factors of its virulence, the study aimed to investigate molecularly the production of these toxins in the strain *E. coli* O157:H7 isolated from river and sewage water, and studying the possibility of inhibiting these toxins using a plant extracts, plant essential oils, and natural materials.

Materials and Methods:

Water samples

55 water samples were collected (30 Tigris River water, 25 sewage water) from different areas of Mosul city.

Isolation and Identification

Isolation was carried out using MacConkey agar medium (HIMEDIA\ India) by inoculating this medium with the last dilutions of water from river water and sewage water samples, after performing the decimal water dilutions, plates of MacConkey agar medium inoculated with the aforementioned samples were incubated at a temperature of 37 °C for 24 hours. The pink colonies were subjected to preliminary tests to isolate *E. coli* bacteria, represented by microscopic examination with Gram stain and biochemical tests (IMVC), and they were cultured on Eosin Methylene Blue (EMB) medium (HIMEDIA\India), and the colonies that had a metallic sheen were observed (Atlas and Synder, 2006). *E. coli* isolates and its strain O157:H7 were grown on Sorbitol MacConkey agar(SMAC) medium (HIMEDIA\India) which is selective for the *E. coli* O157:H7 strain, as this strain is distinguished from the rest of the *E. coli* strains by its inability to fermente Sorbitol sugar, so transparent colonies appeared. The inoculated plates were incubated at 37 °C for 24 hours, and the results were recorded compared to the standard strain *E. coli* O157:H7 38884 Supplied by Media Medical Center / Erbil / Iraq. The culture diagnosis of all *E. coli* O157:H7 isolates was confirmed using molecular diagnosis using conventional polymerase chain reaction technology to diagnose the *16SrRNA* gene of the strain. The genomic DNA of the isolates was extracted using a special extraction kit (Presto™ Mini DNA Bacteria Kit Geneaid. USA). The purity and concentration of the extracted DNA were measured using a BioDrop spectrophotometer (Cambridge\ England), the primer supplied by the company (macrogen \Korea) F:

(CCCCCTGGACGAAGACTGAC), R: (ACCGCTGCAACAAAGGATA) . was used, and the amplification steps for the PCR reaction were performed by using the following thermal steps. Table(1)

Table (1) Thermal program PCR

Phase	Tm (°C)	Time	No. of cycles
Initial denaturation	95	min5	1
Denaturation	95	Min1	35
Annealing	63	Min1	
Extension	72	Min1	
Final extension	72	Min7	1

The testing steps were completed by electrophoresis on an agarose gel, and the results were photographed and recorded (Qamar *et al.,* 2017; Sasagawa, 2020).

Detection of *stx1* and *stx2* genes using PC

Ten isolates were selected for each source (river water and sewage water) were identified using molecular methods. DNA extracted as mentioned above and measuring the purity and concentration of the DNA, and primers Supplied by Macrogen\Korea.

Genes	**Primers Sequence**	**size (bp)**
SLTI-F	ACA CTG GAT GAT CTC AGT GG	614
SLTI-R	CTG AAT CCC CCT CCA TTA TG	
SLT2-F	CCA TGA CACA CGG ACA GCA GTT	779
SLT2-R	CCT GTC AAC TGA GCA CTT TG	

The amplification steps of the PCR test were performed by the following thermal steps.Table (2).

Table (2) Thermal program PCR

Steps	*STX*1			*STX*2		
	˚C	m:s	Cycle	˚C	m:s	Cycle
Initial Denaturation	94	10:00	1	95	5:00	1
Denaturation	94	00:45	35	95	00:45	35
Annealing	58.9	00:45	35	58	00:45	35
Extension	72	11:00	35	72	00:45	35
Final extension	72	5:00	1	72	7:00	1

STX1 and STX2 toxin inhibition tests:

All plant extracts used in the current study were prepared in the form of an alcoholic extract, according to the method (Al-saidy *et al*., 2013). While the concentrations of plant essential oils were prepared using the solvent Dimethyl Sulfoxide (DMSO) and based on. (Hassanshahian *et al*., 2020). As for natural materials, the aqueous extract of mountain honey and its concentrations were prepared based on (Wasihun and Kasa, 2016). Aqueous and alcoholic extracts of Arabic gum were

prepared using distilled water and 70% ethyl alcohol, according to the method (Bains *et al.*, 2020). While the alcoholic extract of propolis was prepared based on (Kubiliene *et al*., 2015) the minimum inhibitory concentration (MIC) and the minimum inhibitory concentration (SMIC) for the tested inhibitory substances were determined by the Microdilution method using a 96-well plate based on(Hassan *et al*., 2020;Sato *et al.*,2018).

The effect of the studied inhibitors on the gene expression of the *stx1* and *stx2* genes.

One of the strains that had been confirmed to possess the two types of genes encoding shiga toxins was chosen, this strain was treated with minimum inhibitory concentrations (SMIC) of studied inhibitors, and then: RNA extraction from bacterial cells was performed using the Quick RNA Bacterial MininprepTM Kit. The concentration and purity of the extracted RNA samples were measured using a Nanodrop device, and the results were recorded. Usually, the ratio of 1.8-2 is considered acceptable and indicates the purity of the RNA (Sanders, 2016)Then gene expression measurement was performed using Quantitative Real Time PCR technology: This test was conducted on previously extracted RNA samples to determine the gene expression of the *Stx1* and *Stx2* genes encoding Shiga toxin in the presence and absence of the materials using for inhibition. This reaction included several steps, which are: -

The first step: converting RNA to cDNA: I by using the Prime ScriptTM RT reagent kit to convert

RNA samples to cDNA as a first step to perform the quantitative real-time polymerase reaction. The

Master Mix reaction buffer was prepared according to the attached instructions, as follows:

The ingredients were mixed well with a micropipette, then the tubes were incubated in the thermocycler for 47 minutes at 37°C. During this period, all the RNA would be converted into cDNA.

The second step: Conducting the instantaneous polymerase reaction test: To perform this step, the following was prepared:

1- Preparing the storage buffer for the primers: To complete the instantaneous polymerase reaction, primers (forward and reverse) were used for each of the target genes stx2 and stx1 and the reference gene, which is *16SrRNA* primers were prepared by dissolving the forward and reverse primers in 250 µl of sterile distilled water and shaking well. Then they were diluted by taking 10 µl of each primer (separately) and diluting it in 90 µl of sterile distilled water.

2- Conduct the reaction: To perform this step, I used the kit (TransStart R Green qPCR

After mixing the reaction components, 42 tubes were prepared, 14 of which were for the target gene stx1, 14 of which were for the gene stx2, and 14 for the reference gene *16SrRNA* for the purpose of comparison. The tubes were inserted into the Real Time PCR device, where the reaction conditions used were:

After the end of the reaction, which took an hour and a half, a curve was obtained showing the number of cycles and the percentage of fluorescence that reflects the gene expression of the gene. The preliminary results of the reaction were also obtained and entered into special calculations to determine the relative gene expression. The delta-delta (ΔΔCT) Ct method is the simplest method. As it is a direct comparison of Ct values between the target gene and the reference gene, the values were compared between control samples for the target gene and the reference gene and between samples treated for both genes as well, and the results were recorded in tabular form.

1- Bacterial suspension was prepared (compare with McFarland tube No.1.), also pomegranate peel extract was prepared at a SMIC concentration (8.33 mg/cm3).

2- To tubes containing 0.5 cm3 of Mueller-Hinton MHB broth medium, 0.5 cm3 of pomegranate peel extract was added, and 10 microliters of the bacterial suspension were added to it. The tubes were shaken and incubated at 37 °C for 24 hours.

***Lymphocyte isolation and method MTT.**

1- 100 microliters of lymphocyte culture at a concentration of (16×10^5 cells/ml) was placed in each well of the plate and incubated in 5% CO_2 for 24 hours. and then100 microliters from the tubes of Step No. (2) above , were added to the plate holes. positive control and negative control was prepared , and the plate was incubated in 5% CO_2 for 24 hours.

2- 10 microliters of the previously prepared MTT dye was added to all the wells, and a yellow color was observed in the wells. They were incubated in the dark at 37°C for 4 hours in CO_2.

3- 100 microliters of SDS-HCL (Sodium Dodecyl Sulfate) was added to each well and incubated at 37°C for 4 hours in CO2 ,and by mixed each sample with a pipette violet color was observed in the wells . The absorbance was read at 595 nm .

The percentage of cells number of cells was calculated as following :

The Number of cells % = average absorbance of samples OD / average absorbance of control OD × 100. (Vinken and Rogiers, 2015; Talukder *et al*., 2012).

Result and Discussion:

Isolation and diagnosis:-

In this study, 55 different water samples were collected, and 50 isolates of *E.coli* bacteria were isolated and identified based on preliminary diagnosis (microscopic using Gram stain and culture based on MacConkey agar and EMB medium) Eosin methylene blue, which yielded pink-colored colonies fermenting the sugar lactose. On MacConkey medium, while when grown on EMB medium, it gives colonies characterized by the green metallic sheen phenomenon (APHA, 2022; Al-Dawmy and Yousif, 2013), Figure (1). Isolates were distributed during the initial diagnosis into (25) river water and (25) sewage water. Using the selective medium (SMAC) Sorbitol MacConkey Agar for the strain *E. coli* O157:H7, 29 isolates were identified, as they are distinguished from the rest of the strains of *E. coli* by their inability to ferment the sugar Sorbitol within 71 hours. Therefore, their colonies appear pale compared to the rest of the types of *E. coli*. that appear pink (Yadav *et al*., 2018; Al-Taie, 2020) ,which confirms the sensitivity of this medium in diagnosing the strain, and many other studies have confirmed this result (Avila *et al*., 2021) O157:H7). figure (2). Table (5)

Table (5) Number of *E.coli* isolates and its strain O157:H7 isolated from water samples.

Type strain / NO.	River water	Swage water	Total
NO. Samples	**30**	**25**	**55**
E.coli	**(%83)25**	**)25100(%**	**(%90.90)50**
***E.coli* O157:H7**	**(%50) 15**	**(%56)14**	**(%52.72)29**

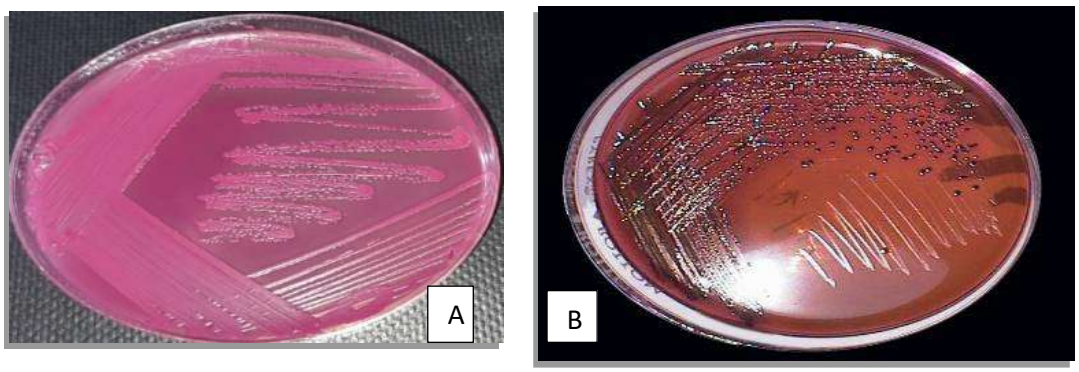

Figure (1) **A**: *E.coli* colonies in MacConkey medium **B**: Eosin methylene blue EMB medium

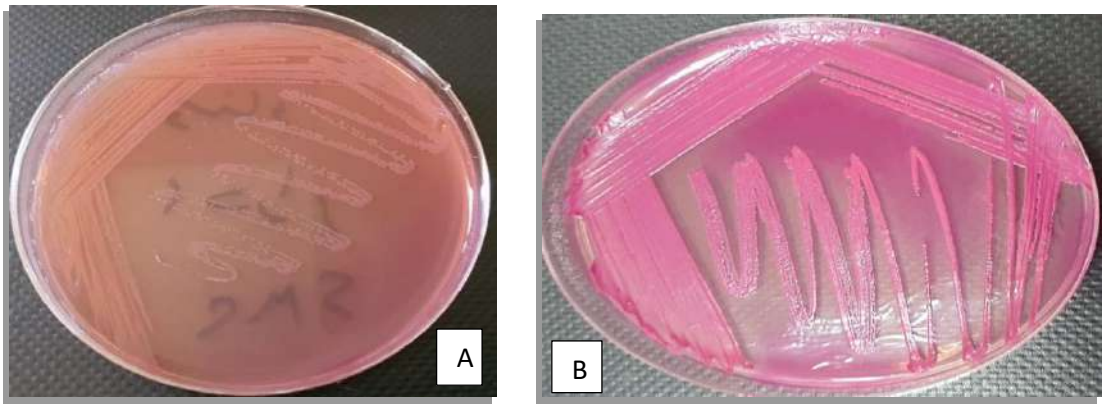

Figure (2) A: Colonies of strain *E.coli* O157:H7 on Serbitol-MacConkey Agar medium B: Colonies of the rest of the strains of *E.coli* bacteria on this medium

In the current study, this strain was isolated from river water and sewage water at a rate of (50%) and (56%) . This indicates the importance and risk of this strain and the possibility of it being transmitted through contaminated water and causing infections through consumption of contaminated water. Especially since this strain has the ability to live in a wide temperature and pH range, thus it has become a waterborne pathogen that poses a serious threat to health around the world (Avila *et al*.,2021). In a previous study, it was isolated from drinking water in Nineveh Governorate, with a high isolation rate of (47.7%). (Al-Oqadyi and Al-Oqadyi, 2019).

Molecular methods, including the PCR test used in the current study to detect the *16SrRNA* of the *E.coli* O157:H7 strain and using specific primers, Figure (3), are highly efficient, and this method is considered one of the most important modern methods of diagnosis that is used in many fields, the most important of which is detection. About pathogens. The most important feature of this technology is the accuracy and speed of diagnosis compared to traditional tests. One study found that two strains of serotype O157 out of 81 strains were non-motile when diagnosed phenotypically and serologically, but PCR revealed that they possessed the gene encoding the flagellar antigen (Shah, 2019). The diagnostic method based on the *16SrRNA* gene and by means of PCR technology is more accurate, faster and simpler, as it allows the distinction between the *E.coli* O157:H7 strain and other types of *E.coli*, as ribosomal genetic diagnosis is more than 90% accurate compared to With other diagnostic tests. The *16SrRNA* gene contains hyper variable regions that are important in distinguishing between different species more accurately. The *16SrRNA* gene contains about 1600 base pairs, and includes nine heterologous regions V1-V9, with the V2 and V8 regions responsible for maintaining the structural stability of the ribosomal gene *16SrRNA* (Bukin *et al*., 2019; Shaebth, 2018).

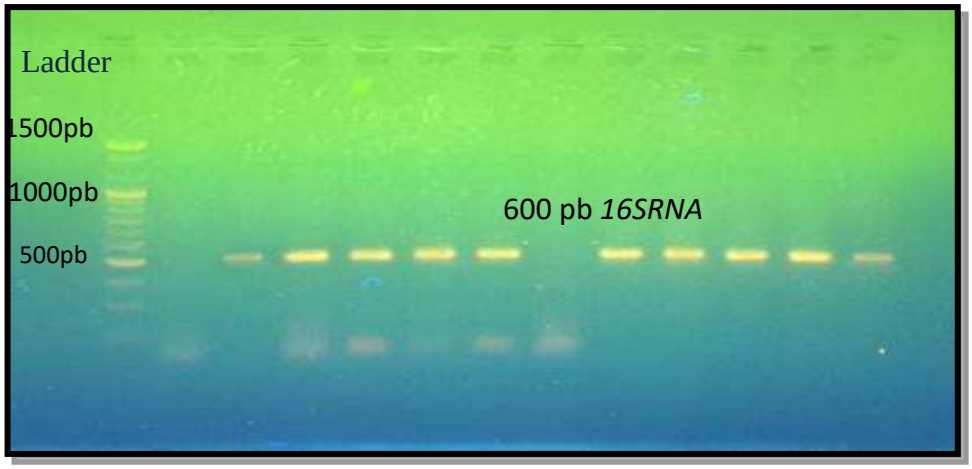

Figure (3) Results of *16SrRNA* gene for diagnosis of *E.coli* O157:H7 strain

Detection of the *sxt1* and *sxt2* genes encoding the shiga toxin

In this study, the stx2 and stx1 genes were detected, which encode the shiga toxin, which is essential in the virulence of *E. coli* O157: H7 bacteria, using the traditional PCR technique and primers for these two genes. Table (6) shows the number and percentage of strains that carry the *stx1* and *stx2* genes. In the strains studied, 20 isolates identified for this strain were tested, distributed into 10 strains for each isolate source. It is noted from the results that is a variation in the spread and distribution of both types of genes in the strains under study, which also reflects a variation in the virulence of these strains, and that this variation is consistent with the results of other local and foreign studies (Abdul-Hussein *et al.*, 2018; Mohsen, 2022). (Loconsole, 2020)

Table (6) Number and percentage of strains carrying the *stx1* and *stx2* genes in the studied strains

Type Sample	Type gene			
	stx1		*stx2*	
	+	-	+	-
River water	(%10)1	(%90)9	(%30)3	(%70)7
Swage water	(%10)1	(%90)9	(%30)3	(%70)7
Total(%)	(%10)2	(%90)18	(%30)6	(%70)14

STX2 toxin has greater diversity compared to STX1, which led to the emergence of many types of STX2 toxin (Wang *et al.*, 2014). Because of the importance of STX2 toxin in bacterial pathogenesis, and to differentiate the strains that produce it into different types from other strains that produce both types of toxin, STX1 remains cell-bound and is stored in the periplasmic zone while STX2 is released from bacterial cells and is therefore usually detected at a higher titer (Chui *et al*., 2018). The results also showed that the strains under study that carried both genes *stx2* and *stx1* were one isolate for each source of isolation, as in the Figure (4). These are consistent with many studies (Joensen *et al.*, 2014; Abdulrazzaq *et al*., 2021). The results also showed that the strains under study that carried both genes stx2 and stx1 were one isolate for each source of isolation, as in the Figure (5). These are consistent with many studies (Joensen *et al*., 2014; Abdulrazzaq *et al*., 2021).

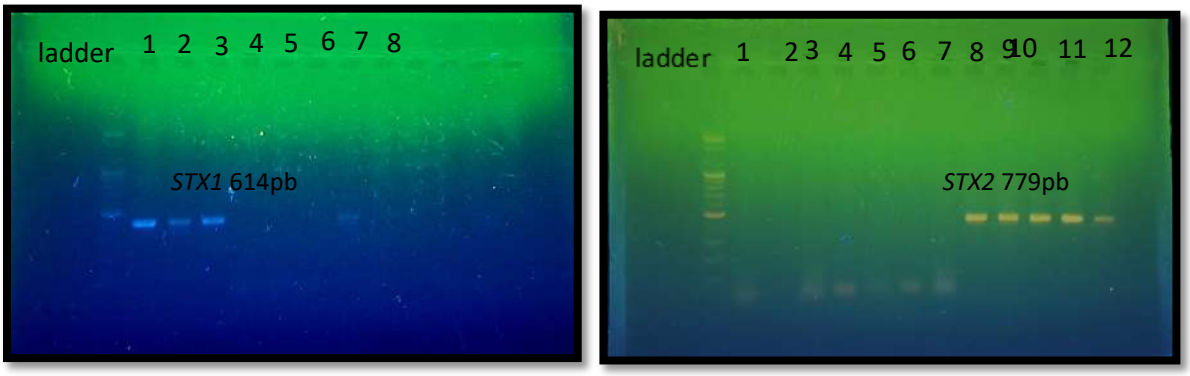

Figure (4) A: the bands of the stx1 gene, B :the bands of the stx2

Inhibition of shiga toxin in the studied *E.coli* O157:H7 strains

The minimum inhibitory concentration (MIC) and the sub-minimum inhibitory concentration (Sub-MIC) were determined for the inhibitory substances used, which were alcoholic plant extracts of mint leaves, pomegranate peels, and natural materials, namely honey, gum arabic, and propolis, in addition to the use of some vegetable oils, namely cinnamon oil and seed oil. Watercress and gum arabic oil were tested for their effectiveness against 2 selected strains of *E.coli* O157:H7, which contain both the *stx1* and *stx2* genes, in addition to the standard isolate. The results shown in Table (7) showed that all the materials used had an inhibitory ability. On the strains under study, including the standard isolate, this effect varied according to the type of inhibitory substance and the source of the *E.coli* O157:H7 strain.

Regarding plant alcoholic extracts, the results showed that the alcoholic extract of mint leaves was the most effective, as it was able to inhibit strains at concentrations of 6.25 - 12.5 mg/cm^3, compared to the alcoholic extract of pomegranate peels, whose effect ranged within concentrations of 15.62 - 62.5 mg/cm^3 on the strains studied, which... It reflects the difference and diversity of their content of compounds and aggregates, and these results support what was mentioned in the study (Tafrihi *et al.*, 2021) that the mint plant contains many active substances such as alkaloids, phenols, and other compounds such as Carvone, Riboflavin, Cumaric acid, and others, which give the plant therapeutic and antioxidant properties. And for bacteria, in another study it was proven that both the aqueous and alcoholic extract of grape seeds and the alcoholic extract of mint led to the inhibition of enterotoxin production in strains of *S.aureus* by 100%. (Kazim, 2022).

It is noted from the results of the inhibition of natural substances that mountain honey had the best inhibitory effect compared to extracts of Arabic gum and propolis, as the inhibitory effect of mountain honey ranged within concentrations of 3.125 - 25 mg/cm^3 in the strains under study, as laboratory studies indicate that honey has microbial activity against many types of bacteria, including Gram-positive and negative bacteria. The reason is that honey contains inhibitors due to the presence of oxidative-reductase enzymes, phenolic acids, etc., in addition to the osmotic effect of honey resulting from sugary components, which 2h causes the breakdown of cell walls and low water stress, in addition to the low acidity that ranges from (4-3.6) and the high viscosity of honey, which It prevents bacteria from penetrating and forming colonies on wound surfaces (Kazim, 2022), as well as containing many active aggregates.

As for the effect of plant essential oils studied on the strains, the three oils, cinnamon oil, watercress seed oil, and gum arabic oil, had a similar inhibitory effect, ranging from a concentration of 3.125 - 6.12 mg/cm^3. This reflects the diversity and difference in their content of active compounds and groups. With regard to vegetable oils of both types (volatile and essential), their mechanism of action against bacteria occurs through affecting the cell wall and membrane. Because they are lipophilic, they affect the quantity and structure of unsaturated fatty acids in cell

membranes, which works to Killing cells due to a difference in the process of entry and exit of molecules and ions, and thus the cells explode or shrink and lose their vitality (Yu *et al.*, 2020).

Table (7) The minimum and sub-minimum inhibitory concentration (mg/cm^3) for the various inhibitory substances used against the *E.coli* O157:H7 strain under study.

Inhibitory substances	Standard isolate		River water		Swage water	
	MIC	SMIC	MIC	SMIC	MIC	SMIC
Alcoholic extract of mint leaves	6.25	3.125	6.25	3.125	6.25	3.125
Alcoholic extract of pomegranate peels	15.62	7.812	31.25	15.625	31.25	15.625
Honey	6.125	3.125	3.125	1.562	6.125	3.125
Water extract gum Arabic	50	25	50	25	50	25
Alcoholic extract of propolis	125	62.5	125	62.5	62.5	31.25
cinnamon oil	3.125	1.562	6.25	3.125	3.125	1.562
Seed oil	6.125	3.125	6.125	3.125	3.125	1.562
gum Arabic oil	6.125	3.125	6.125	3.125	6.125	1.562

Inhibition of gene expression of *stx2* and *stx1* genes in the studied *E.coli* O157:H7 strain.

The possibility of inhibiting the shiga toxin was detected at the molecular level by detecting the possibility of inhibiting the gene expression of the *stx1* and *stx2* genes. Real-time quantitative polymerase reaction technology was used for this purpose and an isolate was chosen that possessed the two types of toxin representative of the rest of the strains. The ability of the studied inhibitors to inhibit gene expression was tested at the SMIC concentration. The RNA of the selected isolate was extracted before and after treating it with the inhibitory substances and the purity of the extracted RNA samples ranged between 1.8-2.1. This means that the extracted samples are pure and free of protein and contaminants, as the purity required to conduct molecular experiments ranges from 1.8-2 (Sanders, 2016).

The results of the quantitative real-time polymerase chain reaction technique for measuring gene expression, shown in Table (8), showed that only the alcoholic extract of pomegranate peels was able to inhibit the gene expression of the stx2 and stx1 genes by approximately half, with values ranging between 0.35 for the first gene and 0.41 for the second gene, compared to the gene expression of the non-control samples. Treatment, which reflects the possession of this alcoholic extract on active compounds affecting gene expression, such as the secondary amine, alkene, and methyl, which are very effective groups that may have interfered with the process of genetic expression of the gene, whether at the level of turning off the gene operator or at the level of cloning. The process of inhibiting the production of toxins, including enterotoxin, can take place through inhibiting their gene expression, which can occur at several levels, starting with inhibiting the production of regulatory proteins and their function. It may also take place at the level of inhibiting the production of cloning factors and their association with the gene operator, as the region of the operator that is located Upstream promotor region is the main region that affects the

genetic expression of the gene, and therefore other substances interfere with this region. It is one of the important steps to suppress gene expression, and the process of toxin inhibition may then take place by inhibiting the production and assembly of the toxin or even the process of maturation of the toxin after translation by modification (Garland *et al.*, 2017), as the active chemical groups and compounds in plant extracts are characterized by properties, including their ability On chelating, oxidation and reduction, it is associated with regulatory proteins and enzymes that contribute to the process of reproduction and translation. Knabner and Amelung (2014). The results shown in Table (4) also indicated that the natural materials (honey, propolis, and gum arabic) increased the gene expression of the *stx1* and *stx2* genes alike, at much higher values than the control sample without treatment.

Table (8) Effect of the studied inhibitory substances on the gene expression of the *stx2* and *stx1* genes.

Inhibitory substances	**Reference gene** *16SrRNA*	***stx1***	**ΔCT**	**ΔΔCT**	**FOLD Change**	***stx2***	**ΔCT**	**ΔΔCT**	**FOLD Change**
Alcoholic pomegranate peels	**18.3**	**43.7**	**25.4**	**1.5**	**0.35**	**44.8**	**26.5**	**-0.5**	**0.41**
Alcoholic mint leaves	**19.5**	**38.4**	**18.9**	**-5**	**32**	**39.5**	**20**	**-7**	**128**
Honey	**15.7**	**32.3**	**16.6**	**-7.3**	**157.58**	**33.4**	**17.7**	**-9.3**	**630.34**
Water gum Arabic	**19.3**	**33.2**	**13.9**	**-10**	**1024**	**34.3**	**15**	**-12**	**4096**
Alcoholic propolis	**14.6**	**33.8**	**19.2**	**-4.7**	**25.99**	**34.9**	**20.3**	**-6.7**	**103.96**
cinnamon oil	**17.1**	**33.5**	**16.4**	**-7.5**	**181.01**	**34.6**	**17.5**	**-9.5**	**724.07**
Seed oil	**18.6**	**37.5**	**18.9**	**-5**	**32**	**38.6**	**20**	**-7**	**128**
gum Arabic oil	**18.6**	**35.6**	**17**	**-6.9**	**119.42**	**36.7**	**18.1**	**-8.9**	**477.7**
Control	**11.6**	**35.5**	**23.9**	**0**	**1**	**38.6**	**27**	**0**	**1**

Also, the oils used (cinnamon oil, watercress seed oil, and arabic gum oil), despite their inhibitory effect on the strain, increased the gene expression of both types of shiga toxin at very high values compared to the control. It has been shown in a number of studies that it is possible to increase the encoding of the shiga toxin by the influence of some substances, as it was found that there is a close connection between the encoding of the toxin and multiple drug resistance. A study (Crane *et al*, 2021) also indicated that antibiotics such as Ciprofloxacin and non-steroidal antibiotics such as Fluoxetine and Paroxetine increase the encoding of the toxin. The STX2 toxin in *E.coli* O157:H7 bacteria is approximately 1.4 fold greater compared to control samples and at concentrations that ranged between 40-50 micrograms per cm3, in addition to the study (Sarmiento *et al.*, 2020) confirmed that some types of antibiotics such as ampicillin Ciprodar, methperim, ceftazidine, and Quinolones stimulate the production of SXT2 toxin in the bacteria themselves, which increases the risk of developing hemoglobin syndrome.

Some modern alternative methods to antibiotics rely on inhibiting the phenomenon of quorum sensing (QS) or inhibiting virulence factors individually using natural products and plant extracts by

extracting and purifying the active compounds in them and using them as alternative treatments (Rahman, 2018). The development of anti-virulence agents helps in treating many diseases caused by bacteria, in addition to reducing the selection pressure on them as a result of the frequent and indiscriminate use of antibiotics, which reduces their resistance to these antibiotics and drugs over time. The results of the current study differed from many studies on the benefits of plant extracts containing phenolic groups, especially the orthophenol compound, which has the ability to inhibit the encoding of many genes responsible for the various regulatory proteins controlling the process of reproduction and translation (Kong *et al.,* 2018), as the compounds have proven. Polyphenols extracted from various plants, especially those containing hexahydroxybisphenol and caloyl groups, have a high ability to interfere with the process of making toxin A and inhibit its production (Shimamura *et al.,* 2016). It has also been found that many plant compounds have the ability to render bacterial toxins inactive. By competing for attachment to the target part of the host cell (Upadhyay *et al.,* 2015).

Evaluation of the inhibition of Shiga toxin using a lymphocyte toxicity test:

A lymphocyte toxicity test was used to confirm the inhibitory effect of alcoholic pomegranate peel extract on the types of toxin STX1 and STX2 in the two selected strains of *E.coli* O157:H7 bacteria under study and isolated from water sources, in addition to the standard isolation. Lymphocytes extracted from blood were used in this test, according to paragraph of the materials and methods of work, such as a cell line, the MTT dye was also used to detect the vitality of the tested cells, as this dye contains terazole, a yellow color that turns into violet formazan when treated with living cells only. The absorbance of the colored solution can be determined by measuring the absorbance on A wavelength between 500 and 600 nanometers, using a spectrophotometer, as the degree of light absorption depends on the concentration of formazan accumulated inside the cell and on the cell surface. The higher the concentration of formazan, the greater the violet color and the greater the transmittance. The MTT test is used to measure the cytotoxicity or degree of cell inhibition of active pharmaceutical agents and toxic substances. This test is usually performed in the dark, because the test reagent is sensitive to light. (Vinken and Rogiers, 2015; Nazarpour *et al*., 2012).

The results showed the ability of alcoholic pomegranate peel extract at (SMIC) concentration to inhibit the production of shiga toxin, through the change in the color of the tetrazol dye to violet in the test plate wells treated with the extract, and the white lymphocyte cells remained alive and were not affected by shiga toxin compared to the wells that were not treated with the extract, which appeared yellow color indicates the death of white cells due to the effect of shiga toxin produced by the studied strains.

The absorbance results with the ELISA reader device at the wavelength of 595 nm showed that the negative control sample (C2) after obtaining the average for the duplicates was 0.136 nm, as the pits were purple in color. As for the positive control (C3), which is the standard strain that does not contain shiga toxins treated at the sub-minimum concentration. The alcoholic pomegranate peels also appeared in a purple color, indicating that the cells remained alive (lymphocytes), thus turning the yellow-colored terazole into a purple-colored formazan. As for the two strains treated with the subminimum inhibitory concentration of alcoholic pomegranate peels, the absorbance of the river water strain was similar in absorbance to the positive control sample of 0.101 nm by 0.104, while the sewage strain was similar in absorbance to the standard strain that does not contain toxins, 0.079, as in Figure (5).

STX1 has shown cytotoxic activity in various mammalian cells such as HeLa cells, mouse embryonic fibroblasts (MEFs), and Caco-2 cells (human primary intestinal fibroblast line). This toxin has been shown to induce DNA damage. In human endothelial cells, it is involved in cell cycle arrest, DNA repair, and apoptosis (Talukder *et al*., 2012). Another study also showed the cytotoxic effect of STX1 on two types of cells isolated from human colorectal cancer and the cancer

cell line (NCM425). Ability of probiotics to inhibit STX1 toxin and cytotoxicity test using MTT tetrazolium test showed that STX1 has a cytotoxic effect on cells and cell lines (Mustafa, 2022)

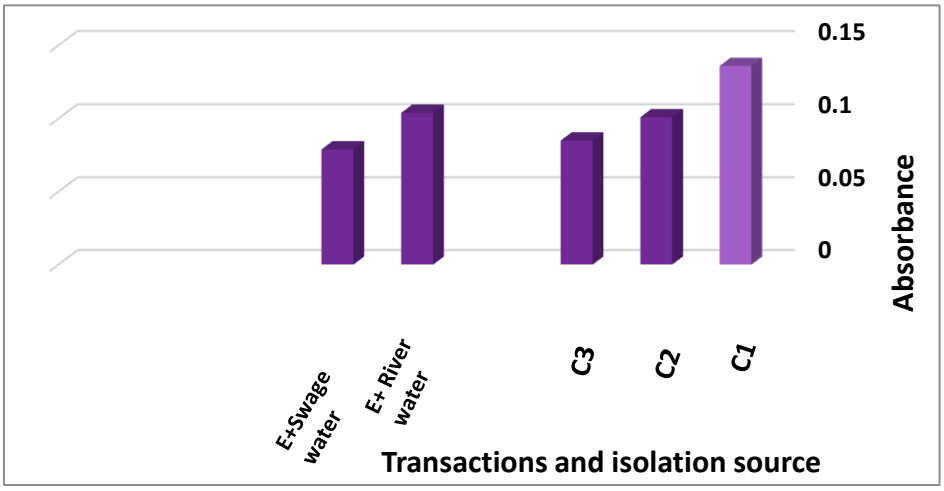

Figure (5) The effect of alcoholic pomegranate peel extract on the inhibition of shiga toxins STX1 and STX2 in terms of the toxic effect on lymphocytes, C1 negative control lymphocytes only, C2 negative control alcoholic pomegranate peel extract and lymphocytes, C3 positive intermediate extract, standard strain

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Environmental Assessment and Treatment of Kirkuk Well Water Using Activated Charcoal and Walnut Shells

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ABSTRACT

This study aimed to assess the quality of groundwater used for garden irrigation in Kirkuk Governorate. The study conducted a comprehensive field survey and chemical analysis of water from twelve wells distributed across the governorate. The analyses focused on several key chemical indicators that affect the suitability of water for irrigation purposes, such as sulfate (SO_4^{2-}), chloride (Cl^-), and total hardness.

The results showed that the water extracted from all wells fell within acceptable limits according to approved irrigation water standards, indicating its general feasibility for use in this field. However, some wells recorded relatively high concentrations of certain chemical elements, particularly sulfate, chloride, and hardness, which could negatively impact soil and plants in the long term if not treated or diluted. To reduce the concentrations of these elements and improve water quality, an environmental treatment approach was adopted using chemical adsorption techniques. This approach utilized low-cost, highly effective adsorption materials: walnut shells (a natural organic material rich in active groups such as hydroxyl and carboxyl) and activated carbon (known for its high porosity and large surface area).

Activated charcoal and walnut shells were used for environmental remediation on the water samples under study under controlled experimental conditions. The results showed a significant decrease in the concentration of the target elements, confirming the effectiveness of adsorption processes in removing pollutants from groundwater and effectively improving its quality.

This study highlights the importance of adopting sustainable environmental solutions for water treatment, particularly those that rely on municipal solid waste such as walnut shells or locally available materials, which combine economic efficiency with environmental effectiveness.

Keywords: Environment , Walnut shells , Charcoal , Well water.

التقييم البيئي ومعالجة مياه آبار كركوك باستخدام الفحم النشط وقشور الجوز

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الملخص

في هذه الدراسة تم إجراء مسح وتحليل ميداني لمياه (12) بئراً تقع في مدينة كركوك وتستخدم لري الحدائق ، وقد أثبتت الدراسة أن مياه جميع الآبار في مواقع الدراسة مناسبة الري ، ولكن أظهرت بعض نتائج تلك الآبار زيادة في قيم النتائج مثل (SO_4)و (Cl^-) والعسرة الكلية ، في هذا البحث تم اقتراح طريقتين لمعالجة نماذج الآبار قيد الدراسة باستخدام قشور الجوز والفحم المنشط لتقليل نسبة التراكيز ومقارنة النتائج قبل وبعد المعالجة ، حيث أظهرت النتائج انخفاضًا في تراكيز الملوثات لهذ العينات من خلال عملية الامتزاز الكيميائي للعينات.

الكلمات المفتاحية : البيئة ، قشور الجوز ، الفحم المنشط ، مياه الآبار.

Introduction

One of the primary sources of water used to irrigate crops is well water, particularly in situations where surface water is limited or nonexistent (Konstantina and Hrissi,2017). It is not surprising that towns and cities grow up around these water sources, as anthropogenic activities exacerbate geogenic variables that affect water quality, which poses a serious risk to human health and agricultural methods. Whether it is found above ground or below, water is the most significant and essential natural resource for maintaining life on Earth as well as for the sustainable growth of socioeconomic sectors like irrigation and industry. The hydro-geo-ecological cycle and several other metabolic, physiological, and ecological processes that occur in living things depend on water. Due to immoral human activities in the planet's hydrosphere, geosphere, and biosphere, there is a global discrepancy in water availability, putting the lives of a billion people and a variety of natural ecosystems at danger (Mekonnen and Hoekstra,2016 and Falkenmark, etal.,2019). Additionally, the geographical effects of drought, floods, low water quality, abstraction, unpredictable rainfall, etc. on a large population have made the water deficit a worldwide problem (Boers, etal., 2017, Ellison, etal., 2017 and Jain, etal., 2013). The largest source of water for both rural and urban populations, mostly in the world's arid and semiarid regions, is groundwater aquifers (Rao, etal., 2020), Global attention is drawn to the shortage of groundwater during dry seasons and the perceived risk posed by anthropogenic activities such as excessive groundwater extraction for industrial, drinking, and irrigation uses (Mekonnen, etal., 2015 and Adimalla, etal., 2020). Therefore, improper usage of groundwater has an adverse impact on the quantity and general quality of water (Ray and Elango,2019), Additionally, Anthropogenic activities and geogenic pollutants found in rocks and soils can affect groundwater resources (Saha and Mukherjee, 2018), Inadequate management has further upset the global water cycle, which is likely aggravating groundwater pollution and climate change (Abbott, etal., 2019). The chemistry and features of groundwater systems at each place are distinct and influenced by various factors, including surface water, recharge, precipitation, and climatic variations. Water quality is greatly influenced by subterranean factors, as well as the geochemical and lithological composition of the underlying rock (Magesh and Chandrasekar, 2013).

In general, well water contains varying levels of dissolved salts. Examining the quality of groundwater is essential to comprehending the potential problems associated with using it for agricultural irrigation since it is influenced by the salts and rocks in the subsurface crust that pass through it (Ijumulana, etal., 2022).

To assess the suitability of twelve well waters for agricultural use, water samples were collected and analyzed using precise analytical techniques in accordance with international standards approved by the World Health Organization (WHO) and others. The analyses included measuring a range of key physical and chemical properties, such as acidity (pH), electrical conductivity (EC), and the concentration of major ions such as calcium, magnesium, sodium, chloride, and sulfate. These analyses aimed to determine the suitability of this water for irrigating various crops and to propose appropriate treatment procedures for wells whose results showed levels of contaminants or properties that were not compatible with recognized agricultural standards.

In our study, activated charcoal was used because it represents an effective and cheap method for removing many salts, suspended materials and turbidity, in addition to its availability in the market.

Walnut shells from municipal solid waste are also used to treat water, which is considered an environmentally sustainable method.

Chemicals and devices used in the study

Chemical Compounds : All chemicals used in this study were of analytical grade with a purity of (99.9)% and were purchased from fluka and merck.

Devices used :.

PH meter (PW-9418 , pH-meter – Hanna), It is considered a specialized water diagnostics company, examining all types of water in the environment, including surface and groundwater pH, industrial wastewater, and sewage water, etc.

Flame photometer (Pyunicom), It is one of the accurate and preferred methods, especially for concentrations that are less than (10 ppm). This method is suitable for measuring the concentration of sodium and potassium in surface water samples, drinking water samples, and domestic and industrial wastewater.

Field Electrical Conduction Device (Hanna), The ability of water to conduct electricity is known as conductivity. In other words, conductivity depends on the concentrations of ions present in the solution. Conductivity is measured in the laboratory using electronic methods.

Turbidity meter, The effect of turbidity on the passage of light and blocking it from aquatic organisms is one of the most important effects in the ecosystem. Its effect on plant growth is through reducing the penetration of light that is used in the process of photosynthesis and through the adhesion of suspended materials to plants.

Sensitive balance (Sartorius -Germany), Electrical oven (GallenKamp, England).

Experimental part :

Samples were collected from twelve irrigation wells, as shown in Figure (1), with depths ranging from 55 to 100 meters, established by Kirkuk Municipality. Samples were stored in volumetric glass containers according to the study protocol. Laboratory analyses were conducted to evaluate

relevant indicators and parameters, according to international standard methods for water analysis (Afah, etal., 1976).

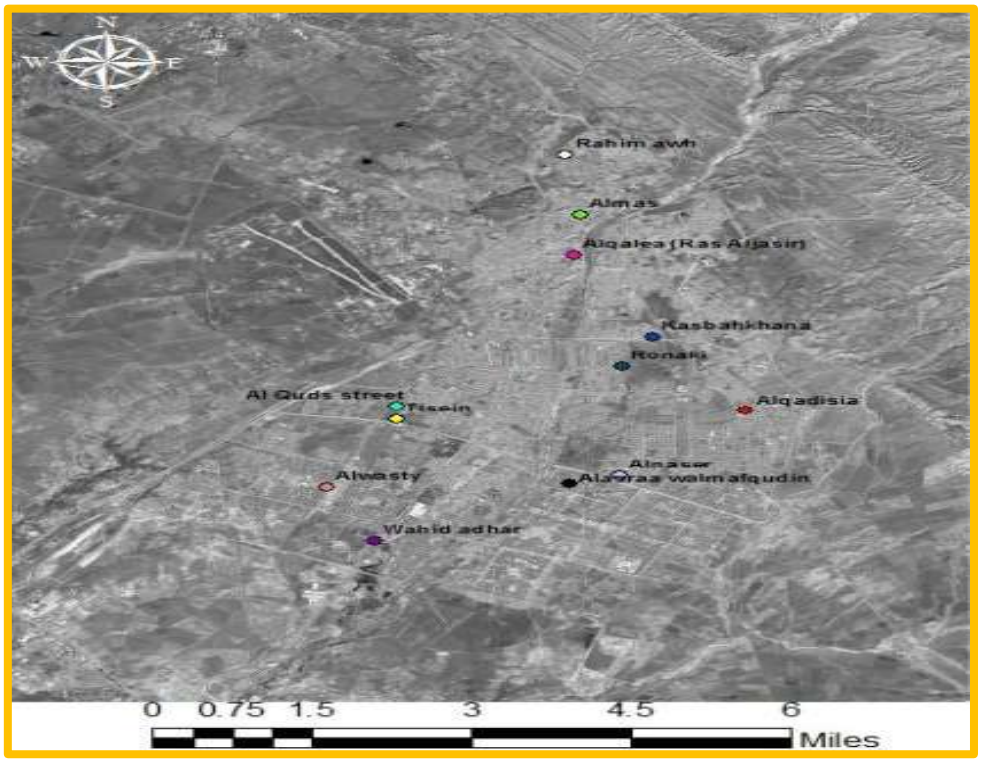

Figure (1):A map showing the study area in the city of Kirkuk

Chemical measurements :

Chemical measurements were carried out to analyze the elements present in water models using the following analytical methods :

1- **The simple (conventional) analytical method:** the titration process by forming complexation titration was used to estimate the concentrations of ions (Mg^{+2} , Ca^{+2} , SO_2^{-2}) this was done by using a solution of ethylene diamine tetra acetic acid (EDTA) at a concentration of 0.001µ and the precipitation precipitation titration was used to determine the chloride (Cl^-) ion using a silver nitrate solution ($AgNO_3$) at a concentration of 0.001µ using potassium dichromate as a guide (Gary, 2004).

2- **Methods of automated analysis:** the method of Flam photometer was used for the determination of sodium and potassium ions, using a mixture of standard solutions of sodium chloride and potassium chloride with concentrations ranging from 80-25 ppm, respectively. The electrical conductivity of water was measured using a field conductivity meter made by the same company above. The results were expressed in microsiemens/cm (µs) cm^{-1}. Chloride was measured by titration using silver nitrate and potassium chromate indicator. Calcium was measured by titrating a certain volume of sample water with EDTA and using Murexid dye as an indicator. Sulfates were measured using the turbidity method, where the measurement is done using a spectrophotometer, and the results were expressed in mg/l.

Table No. (1) shows the well numbers, names, geographical locations, and the type of soil from which the samples were collected.

Table No. (1) Shows the Numbers and Names of the Wells, their Geographical Coordinates

Well number	Region	Soil type	North latitude (N)	East longitude (E)
1	Tisein	Clay soil	35° 25` 49,254``	44° 21` 37,906``
2	Al Quds street	Clay soil	35° 26` 31,207``	44° 22` 37,228``
3	Almas	Clay soil	35° 28` 53,381``	44° 23` 26,991``
4	Rahim awh	Clay alluvial soil	35° 29` 48,083``	44° 23` 18,101``
5	Alqalea (Ras Aljasir)	Clay soil	35° 28` 17,264``	44° 23` 22,898``
6	Kasbahkhana	Clay coarse soil	35° 27` 30,997``	44° 24` 11,241``
7	Ronaki	Coarse soil	35° 26` 37,331``	44° 23` 53,588``
8	Alnasr	Mixed soil	35° 24` 59,097``	44° 23` 52,658``
9	Alqadisia	Clay soil	35° 26` 10,369``	44° 21` 37,316``
10	Wahid adhar	Dry clay soil	35° 23` 59,162``	44° 21` 25,683``
11	Alasraa walmafqudin	Clay soil	35° 24` 51,700``	44° 23` 22,458``
12	Alwasty	Clay soil	35° 24` 47,175``	44° 20` 56,408``

processing methods

There are numerous well-known and contemporary techniques that can be applied to treat groundwater and render it fit for human consumption. These techniques aim to sterilize and purify well water, making it an excellent source for drinking. The kind of pollutants in the groundwater and the cost of treatment will determine which of these approaches is selected (Towert, 2009).

Adsorption is a physical process widely used in water treatment. It is based on the principle that contaminants move from water to the surface of a solid material known as an adsorbent, without any chemical reaction occurring between them. This method uses materials with large, porous surfaces, such as activated carbon and walnut shells, as these pores allow for the capture of the largest possible amount of contaminants. When contaminated water passes through a layer of this material, the contaminants are captured and retained, resulting in cleaner, purer water (Douha and Yasser, 2024).

Here’s a simple graphical explanation on how activated carbon works.

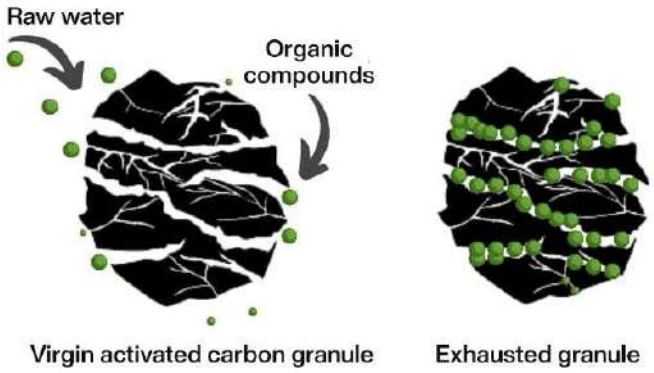

Figure (2) represents the mechanism of pollutant treatment

Results and Discussion

Water quality and composition are influenced by physical and chemical properties, water volume, flow rate, and human activities. Geochemical processes, driven by interactions between water and surrounding rocks, play a key role. These interactions depend on rock composition, temperature, pressure, and dissolved substances like ions and heavy metals. As a result, water properties such as pH, electrical conductivity, and chemical content are shaped, affecting its suitability for human, agricultural, and industrial use, (Korany and Abd Rabou, 1995).

The acidity function (PH) of the samples was measured, as well as the electrical conductivity, before treatment, where it was found that the acidity function PH>8 , that is, the solutions are alkaline, and the ions (Cl^- , SO_4^{-2} , Na^+ , K^+ , Ca^{+2} , Mg^{+2}) were estimated before the treatment process, as it was found that these concentrations were high in all samples.

Based on the proposed system for assessing irrigation water quality in relation to the specific problems that directly affect plant growth and create unsuitable growing conditions, the analysis of water from these wells indicates that it can be classified as irrigation water with either a rising salinity issue or a severe salinity problem, (Korshid, 1998).

Water samples were classified based on electrical conductivity (EC) values into two main groups for irrigation purposes: the first is water with medium salinity, and the second is water with high salinity, according to the approved standards shown in Tables (2) and (3).

Water quality can also be classified according to the Scofield classification and the American Salinity Laboratory for Irrigation according to electrical conductivity, as we see in Table (4).

Table No. (2) Chemical measurements of well water with high salinity

Well No	Mg^{+2} mg/l	Ca^{+2} mg/l	K^+ mg/l	Na^+ mg/l	SO_4^{-2} mg/l	Cl^- mg/l	EC µs/cm	PH	T.H
1	134	227	7.1	74	602	81	1850	8.1	728
2	114	221	3.1	62	459	63	1460	7.8	645
3	120	224	3.8	78	587	71	1760	8.2	737
4	138	229	3.9	80	622	87	1910	7.6	749
5	140	231	3.8	84	637	89	2150	7.7	599
6	116	215	3.8	65	536	67	1590	8.1	666
7	113	213	3.5	59	450	60	1480	7.6	640
8	118	219	3.6	71	554	69	1680	7.5	694

Table No. (3) Chemical measurements of well water with medium salinity

Well No	Mg^{+2} mg/l	Ca^{+2} mg/l	K^+ mg/l	Na^+ mg/l	SO_4^{-2} mg/l	Cl^- mg/l	EC µs/cm	PH	T.H
1	82	151	2.1	43	360	44	685	8.1	422
2	63	159	2.3	39	392	52	680	7.8	480
3	76	142	1.4	32	288	40	564	7.9	410
4	98	160	2.4	48	478	57	748	7.6	503

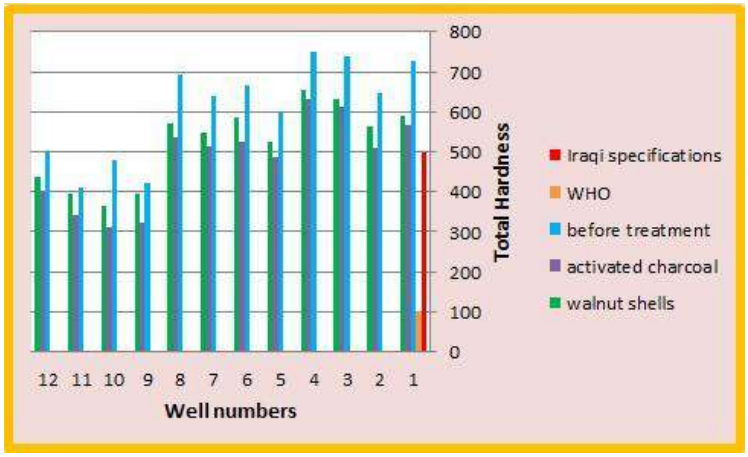

Figure (3) Total Hardness before and after treatment for the two methods

The study's findings make it feasible to observe how some of these wells' highly salinized water directly affects the irrigation system's quality. These wells' water has salinity values that are higher than what is considered globally allowed when compared to international criteria for salinity (Taleea, 1976).

Table No. (4) represents the Scofield classification and the American Salinity Laboratory for irrigation, according to the electrical conductivity

electrical conductivity (µs/cm)	Irrigation water class	Irrigation water type
<250	Low salinity	excellent
750-250	average salinity	good
2000-750	High salinity	allowed
>2000	Very salinity	unsuitable

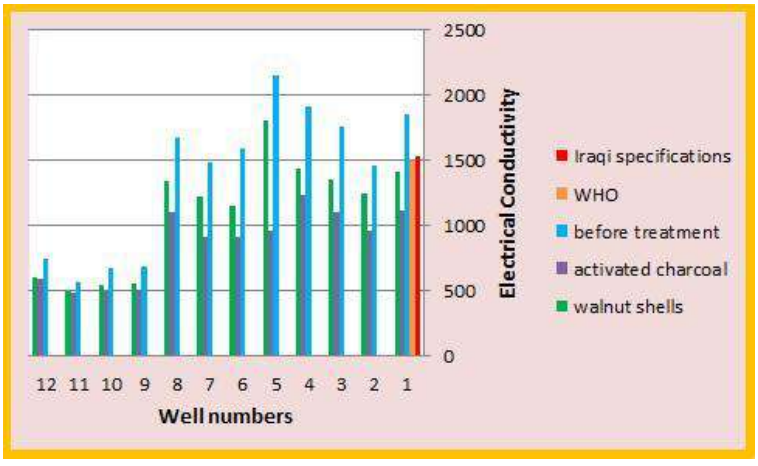

Figure (4) Electrical Conductivity before and after treatment for the two methods

Regarding the suitability of well water for domestic and drinking purposes, Table No. (5), (Angham, etal., 2021), shows that the total hardness of all these wells, as well as the values of some measured chemical indicators like sulfate, calcium, magnesium, and the value of sulfate, exceeded the internationally permissible limit for drinking water specifications. These international standards were established by the International Health Organization (Water Safety plan Manual WHO). The

results can also be compared with Table (5). As a result, these wells are unfit for household or drinking purposes.

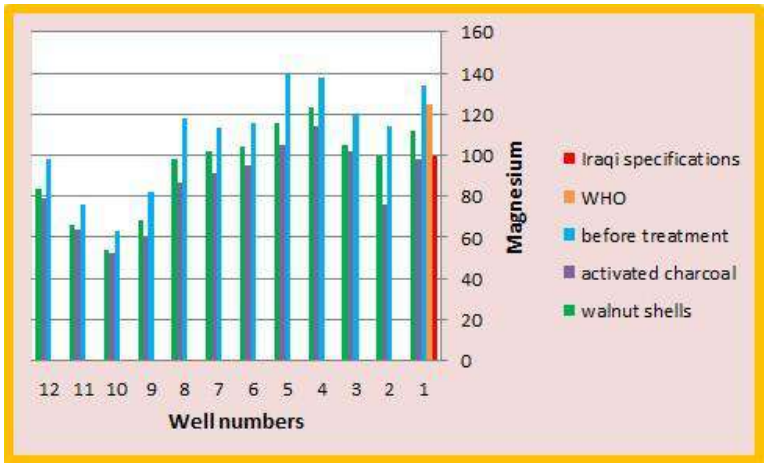

Figure (5) Magnesium before and after treatment for the two methods

Table No. (5) WHO global standards for drinking water

The highest limit allowed	Permissible limits	Chemical indicators
9.2-6.5	8.5-7.0	PH
200	75	Ca^{+2}
650	200	Cl
400	200	SO_4^{-2}
150	50	Mg^{+2}
500	100	T.H

Post-treatment chemical measurements

The electrical conductivity of these models after the treatment process is much lower than their conductivity before treatment due to the decrease in ion concentrations after the adsorption process on activated charcoal. The same chemical measurements were repeated for the well water samples under study after conducting the treatment process using activated charcoal as an adsorption media for ions.

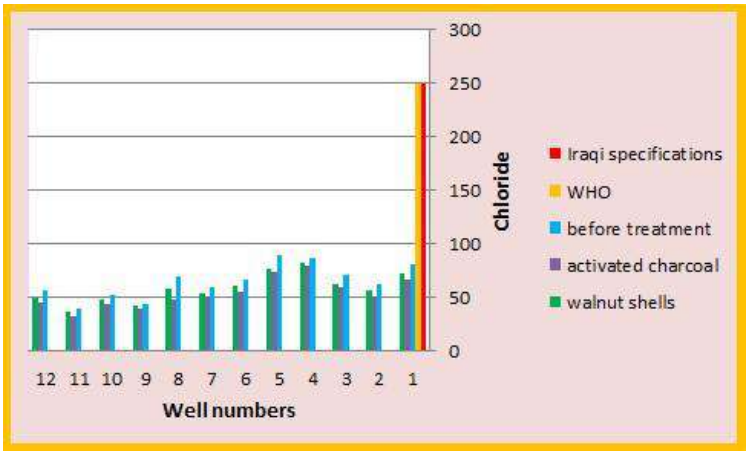

Figure (6) Chloride before and after treatment for the two methods

Additionally, after treating well water samples with walnut shells a sustainable green treatment method—a decrease in electrical conductivity and ions was noted. This is because walnut shells were used again to treat water samples without causing environmental pollution from the use of chemicals that harm the environment. Tables (6) and (7) display the chemical measurements following the treatment process using walnut shells and activated charcoal.

The comparison between the two treatments showed that the activated charcoal treatment was relatively more effective. However, the performance of the walnut shell treatment could be improved by applying specific acid concentrations to enhance pore formation on its surface, thereby increasing its adsorption capacity for pollutants, (Yakout and Sharaf El-Deen, 2012).

Table (6) Chemical measurements after the activated charcoal treatment process

Well No	Mg^{+2} mg/l	Ca^{+2} mg/l	K^{+} mg/l	Na^{+} mg/l	SO_4^{-2} mg/l	Cl^{-} mg/l	EC µs/cm	PH	T.H
1	98	171	3.6	44	502	67	1120	7.5	566
2	76	155	2.4	41	388	51	962	7.3	510
3	102	185	2.2	49	477	60	1099	7.4	614
4	114	160	2.5	52	512	79	1234	7.5	630
5	105	159	1.9	50	494	74	963	7.4	488
6	95	147	2.3	46	464	56	912	7.3	524
7	91	162	1.8	39	376	51	908	7.4	512
8	87	167	2.6	52	402	48	1105	7.2	537
9	60	136	1.6	32	294	39	514	7.4	322
10	52	139	1.5	30	310	44	502	7.3	311
11	64	129	1.1	24	225	32	480	7.4	340
12	79	134	1.6	34	344	46	588	7.3	398

Table (7) Chemical measurements after the processing of walnut shells

Well No	Mg^{+2} mg/l	Ca^{+2} mg/l	K^{+} mg/l	Na^{+} mg/l	SO_4^{-2} mg/l	Cl^{-} mg/l	EC µs/cm	PH	T.H
1	112	190	4.8	62	649	72	1408	7.7	590
2	100	184	2.7	50	422	57	1246	7.5	562
3	105	210	3.0	64	522	62	1350	7.7	631
4	123	182	3.4	67	560	83	1438	7.6	653
5	116	201	2.9	73	554	77	1806	7.6	524
6	104	196	2.9	58	498	61	1155	7.5	586
7	102	187	2.6	42	397	54	1218	7.4	547
8	98	189	3.2	58	486	58	1344	7.3	572
9	68	140	1.7	46	312	42	561	7.5	394
10	54	145	1.8	33	345	48	542	7.3	365
11	66	134	1.1	30	267	37	494	7.5	397
12	84	151	2.0	44	405	50	601	7.4	436

Conclusions

According to the study's findings, the water in the study area's wells has a high level of hardness because it exceeds the allowable limit and has higher than average concentrations of calcium, magnesium, sulfate, and chloride before treatment. These findings provide proof that the water in the study area's wells is unfit for drinking and household use. The well water in this region has been divided into two categories for agricultural purposes: medium salinity irrigation water, which is appropriate for crops that can withstand salinity in moderation, and relatively high salinity irrigation water, which is limited to crops that can withstand such ratios.

Following the adsorption process using activated charcoal and walnut shells, the straightforward treatment method demonstrated that it is possible to improve the quality of the water entering domestic and agricultural uses, with some ion concentrations falling within internationally permissible limits. Activated charcoal is more effective than walnut shells when comparing the two therapy modalities.

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Investment Green Internet of Things for Sustainable and Eco-Friendly Smart Cities: Prospects and Future Challenges

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Abstract

The study explores the integration of the Green Internet of Things (IoT) into the development of sustainable and eco-friendly smart cities. It highlights the challenges posed by urbanization, such as pollution, congestion, and resource inefficiencies, and emphasizes the transformative role of IoT in creating innovative urban systems. Green IoT facilitates energy conservation, waste management, air quality monitoring, and efficient transportation through innovative applications and technologies. Key focus areas include leveraging renewable energy sources, optimizing resource utilization, and implementing eco-friendly technologies to reduce greenhouse gas emissions and promote sustainable practices. Despite its potential, challenges such as data management, security concerns, and the energy consumption of IoT devices persist, necessitating the development of advanced solutions. Case studies, including those in Singapore and Barcelona, illustrate the successful implementation of green strategies and technologies in urban environments. The paper concludes by emphasizing future research directions, including improving interoperability, managing electronic waste, and developing energy-efficient Internet of Things (IoT) frameworks to achieve smarter and greener cities. This research examines how the Green Internet of Things (IoT) can make our cities cleaner, smarter, and more sustainable. It explores how smart technologies can enhance everyday aspects such as energy use, waste management, and transportation. The goal is to develop greener cities that are more beneficial for both people and the planet.

Keywords: Green IOT, Smart Cities, Eco-Friendly.

الاستثمار في انترنيت الأشياء الأخضر من أجل مدن ذكية مستدامة وصديقة للبيئة: الآفاق والتحديات المستقبلية

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الملخص

تستكشف هذه الدراسة دمج انترنيت الاشياء الاخضر (Green IoT) في تطوير المدن الذكية المستدامة والصديقة للبيئة. وتسلط الضوء على التحديات التي تفرضها عملية التحضر، مثل التلوث، والازدحام، وعدم كفاءة استخدام الموارد، مع التأكيد على الدور التحويلي الذي يمكن أن يؤديه إنترنت الأشياء في إنشاء أنظمة حضرية مبتكرة.

يساهم الإنترنت الأخضر للأشياء في الحفاظ على الطاقة، وإدارة النفايات، ومراقبة جودة الهواء، وتحسين كفاءة وسائل النقل من خلال تطبيقات وتقنيات مبتكرة. وتشمل مجالات التركيز الأساسية الاستفادة من مصادر الطاقة المتجددة، وتحسين استخدام الموارد، وتطبيق تقنيات صديقة للبيئة بهدف تقليل انبعاثات الغازات الدفيئة وتعزيز الممارسات المستدامة. ورغم الإمكانات الكبيرة لهذه التقنيات، إلا أن هناك تحديات مستمرة مثل إدارة البيانات، ومخاوف الأمن السيبراني، واستهلاك الطاقة من قبل أجهزة إنترنت الأشياء، مما يستدعي تطوير حلول متقدمة.

تُبرز الدراسات التطبيقية، مثل تلك التي أُجريت في سنغافورة وبرشلونة، التنفيذ الناجح للاستراتيجيات والتقنيات الخضراء في البيئات الحضرية. وتختتم الورقة بالتأكيد على اتجاهات البحث المستقبلية، بما في ذلك تحسين التوافق بين الأنظمة، وإدارة النفايات الإلكترونية، وتطوير أطر عمل لإنترنت الأشياء ذات كفاءة عالية في استهلاك الطاقة، لتحقيق مدن أكثر ذكاءً واستدامة. بشكل عام، تفحص هذه الدراسة كيف يمكن للإنترنيت الأشياء الأخضر أن يجعل مدننا أنظف، وأكثر ذكاءً، وأكثر استدامة، من خلال تعزيز الاستخدام الذكي للطاقة، وإدارة النفايات، وتحسين النقل، بهدف تطوير مدن خضراء أكثر فائدة للإنسان والبيئة معًا.

Introduction

The increasing traffic and population growth in cities has become a significant issue that causes diseases, pollution, and other major environmental concerns. To overcome these problems, IoT-based smart cities are proposed. The world's population is growing primarily due to improved living conditions and the widespread use of modern medications. With a population of over 11 million, there are 25 major cities worldwide, see Figure 1(Yang *et al.*, 2021). This figure shows how future internet technologies and smart computing support smart city development. It highlights real-time data processing and decision-making, and 1.5 million people relocate to cities daily. The Internet of Things (IoT) is expected to contribute to developing smart cities, ultimately leading to a more intelligent world. The Internet of Things (IoT) plays a significant role in enhancing smart cities and affecting in different ways with its numerous applications for strengthening public transformation, reducing

traffic congestion, creating cost-effective municipal services, keeping citizens safe and healthier, reducing energy consumption, improving monitoring systems, and reducing pollution, as shown in Figure 2(Almalki *et al*., 2023). Smart cities leverage the fact that many people use smartphones, creating a specialized network infrastructure equipped with various sensors and intelligent systems to collect and process information. However, the existing Internet of Things (IoT) in smart cities suffers from security challenges, increased traffic, high energy consumption, and a large number of IoT devices. Consequently, some critical issues related to IoT-based networks must be addressed to develop sustainable smart cities (Ketu and Mishra, 2022).

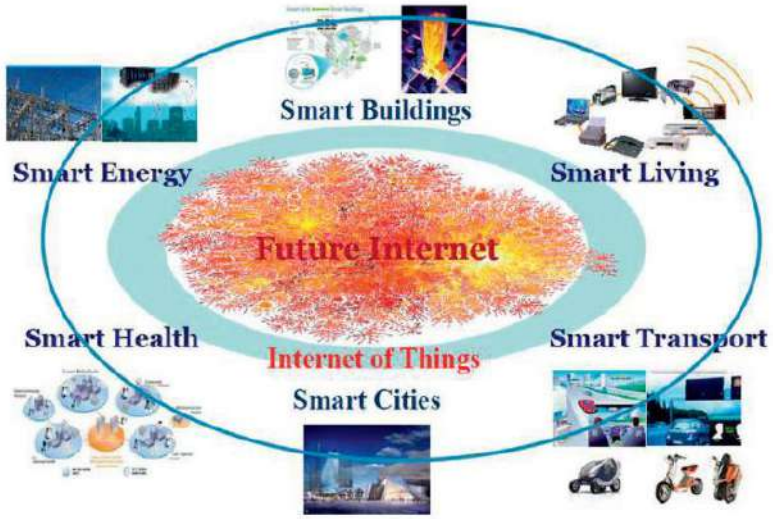

Figure 1: Future Internet and smart computing.

In this respect, this essay discusses and presents the findings of different green concepts and potential future directions. First, various green IoT-supported smart city applications and platforms are explored. Next, green technologies, IoT platforms, and approaches supported by various green communication paradigms are explored. After explaining the various future direct applications, smart cities, and their supporting technologies, including IoT platforms and approaches, we have discussed several green directions for established smart cities and provided recommendations for future research. In summary, several future directions of green IoT are explored, including the interaction between the developed smart city and the transformed green smart city in IoT-WMSNs for green IoT-supported smart city solutions. Existing and promising approaches for green smart cities are also presented (Rani *et al*., 2022).

1.1. Background and Rationale

Green IoT is rapidly growing and offering benefits to the world. Factors such as the low cost of devices and hardware, increased software usage, and the emergence of new business models drive this phenomenon. Green IoT focuses on controlling energy resources, waste management, air pollution, transportation, and water quality. It covers hardware, software, communication protocols, and security for eco-friendly smart cities. However, research is needed to effectively manage Green IoT in smart cities and enhance energy efficiency, software, and security protocols (Albreem et al., 2022; Ahmetoglu *et al*., 2022).

In the Industry 4.0 era, smart cities built on the Internet of Things (IoT) are experiencing rapid growth. Connected healthcare services for smart cities exemplify this paradigm shift. The feasibility of smart smart-related towns and services is demonstrated. There is global pressure to develop sustainable cities on an international scale. These cities require continuous systems, services, and applications to optimize the utilization of their infrastructure. With over 70% of the population

expected to live in urban areas by 2050, improving the rural-urban lifestyle is essential, with a focus on sustainability. Cities will utilize fewer resources and operate more efficiently in the IoT era, while maintaining a reasonable quality of life for residents (Ren et al., 2023; Mahtta *et al*., 2022).

1.2. Scope and Importance

Cities globally are tackling environmental issues caused by excessive greenhouse gas emissions. The effects of global warming and climate change are affecting urban populations. Smart cities are being proposed as a solution for efficient energy management and reducing carbon footprints. The Internet of Things (IoT) is crucial to future smart cities, aiding automated decision-making. However, little attention has been given to green technologies in the research on smart cities. It is essential to prioritize green technologies in future smart cities. Green IoT, the intersection of IoT and green technologies, can lead to eco-friendly and sustainable practices, offering benefits in terms

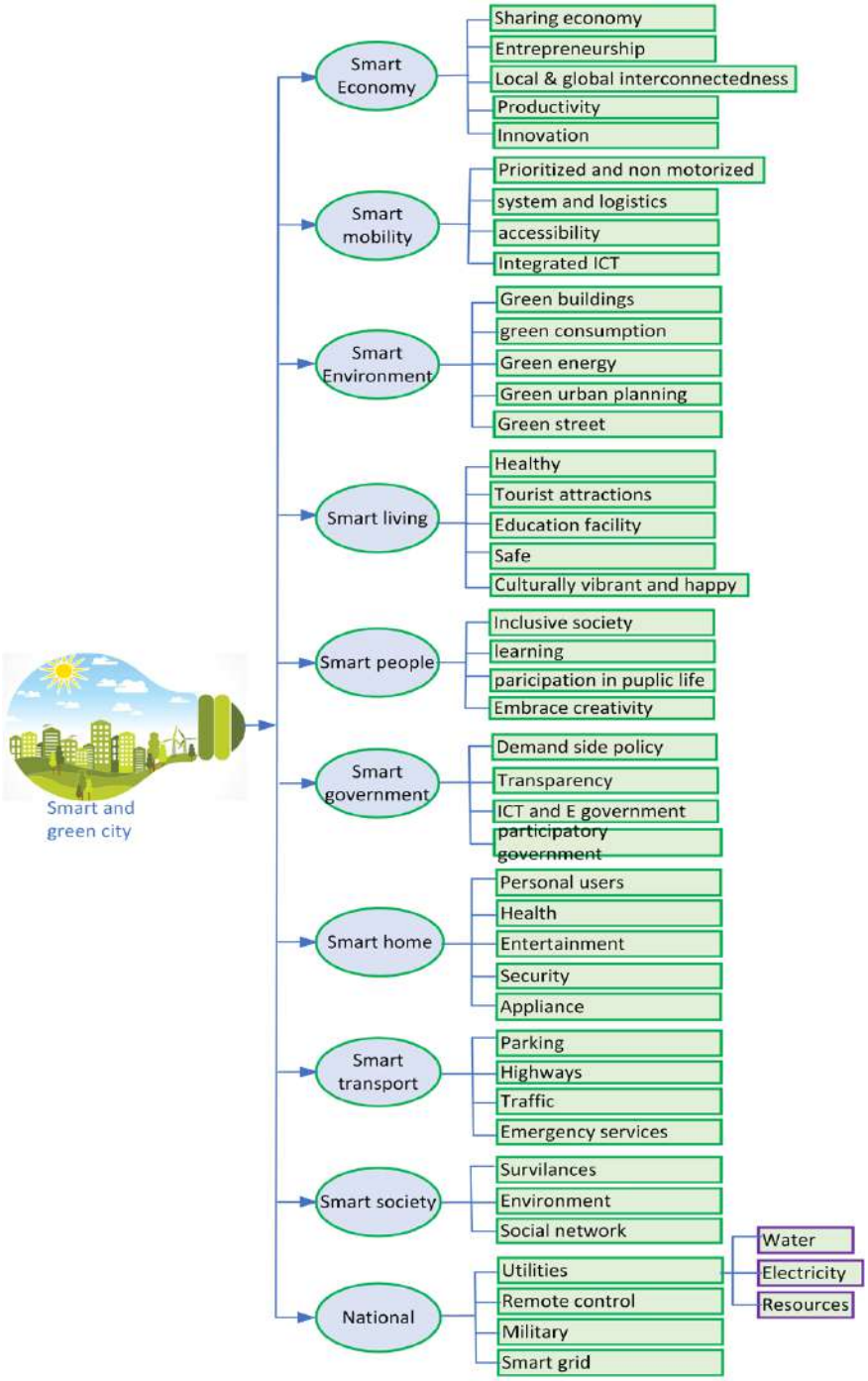

Figure 2: Smart city applications

of power consumption and reduced electromagnetic field exposure. This opens up opportunities for green IoT in various aspects of life, such as sensor devices, networking, data transmission techniques, transportation, health cloud, smart factories, underwater sensor networks, and security and privacy. Green IoT can be implemented at different levels to promote economic development (Kim *et al*., 2021) (Chen *et al*., 2022).

Figure 2 presents key smart city applications such as energy management, transportation, and waste control. It shows how IoT improves city sustainability and services.

1.3. Big Data Management

Managing the massive volumes of data generated by IoT devices requires a combination of efficient storage architectures and advanced processing techniques. One key strategy is integrating sharded blockchain systems, which allows parallel and distributed data storage, enhancing scalability and performance in innovative building environments (Zheng *et al*., 2024). Additionally, hybrid data management systems that combine edge, fog, and cloud computing are critical in minimizing latency and optimizing resource use, especially in logistics and supply chain applications (Zrelli and Rejeb, 2024). To tackle database-specific challenges, solutions such as dynamic indexing, real-time filtering, and data deduplication have been proposed to handle IoT data's high volume and velocity (Fazil, 2024). IoT frameworks integrated with big data analytics enable proactive decision-making and automation in industrial management contexts, reducing processing overhead. Finally, systematic data lifecycle strategies—including selective retention, compression, and archiving—are crucial to maintain performance and cost-efficiency in industrial IoT platforms (Mu *et al*., 2024).

IoT devices are rapidly increasing, with projections reaching over 30 billion by 2030, significantly impacting global energy consumption. Green IoT mitigates this by using low-power technologies like edge computing and energy harvesting. These methods can reduce device energy use by up to 35%, supporting sustainability and scalability in smart environments (Zheng *et al*., 2024).

Integrating Green IoT technologies into urban planning requires comprehensive policy frameworks that promote sustainability, data governance, and wise infrastructure investment. Governments play a crucial role by setting regulatory standards, incentivizing eco-friendly innovation, and funding research in low-energy IoT applications (Pliatsios *et al*., 2023). Urban policies must also address interoperability, data privacy, and e-waste management to ensure long-term viability. For instance, Singapore's innovative city model demonstrates how public policy and digital governance can accelerate green technology deployment in transportation and energy systems (Quah and Tan, 2022). Collaborative efforts between policymakers, academia, and industry are vital for transforming cities into sustainable, innovative ecosystems.

2. Green IoT in Smart Cities

IoT for smart cities is a new sensor network level that monitors, manages, and controls the smart city environment. The constant expansion of smart city applications has increased energy consumption and electromagnetic pollution. The increasing number of smart city applications and actuator devices can lead to a higher energy consumption rate and increased CO2 emissions. The concept of Green IoT has garnered considerable attention for reducing the hazardous impact of smart cities. Green IoT offers a novel approach to creating cost-effective, eco-friendly smart cities (Aliero *et al*., 2021).

Green IoT reduces the energy consumption of devices in smart cities, creating a sustainable and eco-friendly environment. It enables cities to adapt to demand, reduce energy consumption, and minimize environmental impact. Traditional IoT focuses on user experience, while Green IoT prioritizes energy reduction and environmental impact. Developing easy-to-implement Green IoT

solutions using common machine-learning approaches is a critical challenge in smart cities. Individuals can program Green IoT applications using existing resources. Traditional IoT systems focus primarily on functionality and connectivity but often overlook energy efficiency, leading to high power consumption and increased environmental impact. In contrast, Green IoT integrates energy-saving protocols, efficient data transmission, and eco-friendly design principles, resulting in significantly lower carbon footprints (Almalki *et al*., 2023). Studies show that Green IoT can reduce energy usage by up to 40% in innovative city applications compared to conventional IoT models (Roy et al., 2023). Moreover, Green IoT emphasizes device longevity, responsible e-waste handling, and sustainable urban integration. This makes it a more effective and sustainable option for future smart city development.

2.1. Environmental Benefits

Smart cities utilize IoT technologies to address living, social, and economic challenges. They monitor resources like electricity, energy, water, and air. These cities are environmentally friendly and sustainable. Energy-efficient IoT sensors collect data from various areas, reducing travel time and emissions. Smart cities also use recycled waste for environmental solutions (Oberascher *et al*., 2022).

Implementing powerful technologies drastically improves smart cities' environmentally friendly and sustainable urban living and surroundings through waste management, renewable energy, and reduced carbon emissions. Another way to reduce electricity usage is through renewable energy assets, often resulting in lower electricity consumption. Utilizing these energy sources in smart cities can make them earthquake-resistant and environmentally friendly. Encouraging smart cities in this way can support many other emergency or goodwill intentions, folks to apply renewable power sources at their home level or in different uses to produce non-electric units, e.g., bio-gas (for cooking, lighting, heating, etc.), bio-fertilizer, a mixture of petrol or diesel used in machinery at industries, etc. Monitor and track pollution or environmental stress and inform the people using a mobile application or information screen (such as LED screen in bus stations, railway stations, and other public places or alert by siren in case of emergency) about the view of safe places (Almalki *et al*., 2023) (Blasi *et al*., 2022).

2.2. Challenges and Limitations of Eco-Friendly and Sustainable Smart Cities

Although several benefits of Green IoT have been discussed, various challenges need to be addressed in smart cities to implement IoT for a sustainable environment; Figure 3 illustrates the rapid growth of connected devices expected by 2025. It emphasizes the challenges of handling large data volumes and energy use. The total number of active device connections globally—a large statistic used in communications—is projected for 2025 and used by large data. One of the main challenges is that many smart objects and intelligent devices can produce a significant volume of data. To manage large volumes of data, machine learning techniques can effectively approach big data. Various data analytic solutions can be adopted, including filtering, random sampling, smoothing, dimensionality reduction, clustering, etc. Another challenge is ensuring the quality of big data, which can be contaminated by random, partial, and other types of noise. Several open research issues are associated with false positive and false negative decisions, data outliers, and novelty (Benhamaid *et al*., 2021).

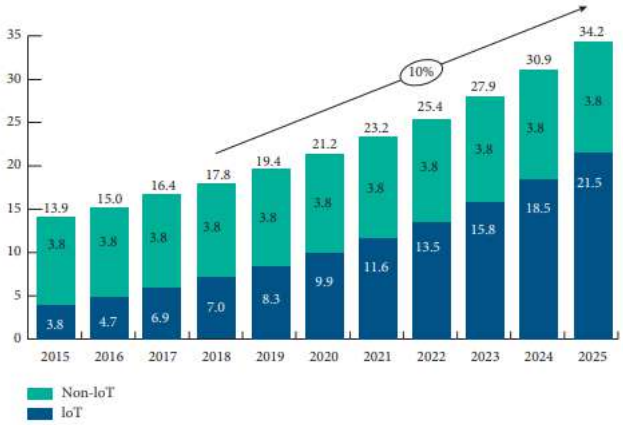

Figure 3: Total number of active device (IoT and Non-IoT) connections worldwide

The possibility of using IoT as a hit-and-sleep solution is explored to address the primary challenges associated with power consumption in wireless IoT. Other challenges, such as the lifespan of batteries and the disposal of these devices when they become non-operational, can also be explored. Security and privacy challenges are related to unauthorized access to data, devices, and services. Several solutions have been adopted, including firewalls, encryption, and VPNs, to address the challenges associated with security. A good policy is to keep the content close to the user, provided that e-waste is managed correctly so that the device and network elements can be reconditioned, rehabilitated, or recycled, ensuring open research. It is essential to raise awareness among the population about the proper management of e-waste. E-waste is a serious and growing problem, and addressing it has become increasingly urgent. Governments and businesses are working to implement the policies and standards necessary to sustainably and responsibly manage these devices. Many users must toss their devices haphazardly into the waste bin (Razip *et al*., 2022) (Farjana *et al*., 2023).

Effective implementation of Green IoT technologies requires addressing interoperability challenges among heterogeneous systems, which hinder seamless data exchange and integration. One major concern is the vulnerability of IoT ecosystems to cybersecurity threats, including unauthorized access and data breaches, especially in cloud-based environments (Pliatsios *et al.,* 2023). Moreover, many low-power IoT devices face energy efficiency limitations due to battery constraints and suboptimal communication protocols (Aliero *et al*., 2021). Researchers propose adopting semantic standards, decentralized architectures, and secure, lightweight encryption models to mitigate these issues. These strategies balance performance with sustainability, ensuring resilient and scalable smart city deployments.

2.2.1 Technology Concerns

Smart cities often fall short of their goal of being efficient and sustainable. They fail to implement good infrastructure, energy efficiency, and resource allocation. This limits the sustainability of urban society and neglects the importance of resource sustainability. Additionally, the technological capabilities of smart cities are often not fully realized, particularly in handling large amounts of data (Aurigi *et al*., 2021).

2.2.2Interoperability

There is a growing interest in eco-friendly smart cities. Information technologies play a crucial role in solving urban challenges. However, interoperability among smart city solutions remains a concern. This relates to the ability of systems to exchange and use data. Government interference and limited participation are also obstacles. To improve citizens' quality of life and achieve

inclusive prosperity, the president should focus on the unique features of these places to enhance economic growth (Pliatsios *et al*., 2023).

3. Related works

In 2022, S. Krishnapriya et al. highlighted the significance of IoT-based systems in creating smart cities that are efficient in resource management and contribute to improved quality of life for residents through enhanced environmental monitoring, waste management, lighting efficiency, pollution control, and traffic management (Sudhakaran *et al*., 2022).

Abhay et al., in 2023, emphasized the importance of transitioning towards Green IoT for eco-friendly and sustainable smart cities. They highlighted traditional IoT technologies' challenges, such as power consumption, pollution, and e-waste generation, and stressed the need for environmentally friendly smart city applications (Chaturvedi *et al*., 2023).

Siddhartha Roy et al., in 2023, delved into the concept of green Internet of Things (IoT) for eco-friendly and sustainable smart cities and discussed how IoT technologies can be leveraged to enable sustainable practices in various urban aspects such as energy management, waste management, transportation, and urban planning, also discusses the significance of addressing issues like pollution, traffic congestion, energy consumption, public safety, resource management, and cost-effectiveness through the implementation of Green IoT strategies. These strategies aim to enhance quality of life, ensure environmental sustainability, and make cities smarter and more eco-friendly (Roy *et al*., 2023).

Sangram and Milind, in 2023, used RFID and IoT technologies to implement smart solid waste collection systems in Pune, aiming to make the city eco-friendly and smart and develop sustainable, innovative technology to achieve 100% household collections and transportation and treatment of waste so that to minimize waste to send landfill side (Patil and Gidde, 2023).

Naik et al., in 2023, discussed the significant impact of Internet of Things (IoT) devices and applications in today's information society and also highlighted how IoT enables the automation of research and development processes through the use of cutting-edge technologies like smart sensors, smartphone-based instruments, and seamless networking (Bhaskar *et al*., 2023).

Nesma Abd El-mawla et al., in 2023, suggested that by embracing eco-friendly IoT solutions, smart cities can not only address current environmental challenges like e-waste management, climate change adaptation, water crises, and natural disaster management but also pave the way for a more sustainable and interconnected urban future (El-Mawla and Badawy, 2023).

Rahaman and Azharuddin, in 2024, explored the integration of green IoT technologies in urban infrastructure for sustainable development. It identifies key challenges, including technological integration, data management, privacy concerns, and high implementation costs. The benefits include improved resource efficiency, enhanced public services, and economic growth. The study concludes that despite existing challenges, the long-term advantages make green smart cities a promising direction for urban innovation (Rahaman and Azharuddin, 2024).

Siddhartha Roy discussed techniques in 2024, including AI-driven smart buildings, renewable energy models, IoT deployment for sustainability, predictive analytics for infrastructure, and optimizing transport mobility in smart cities using green computing technology (Roy, 2024).

Aman et al. proposed a Green Internet Architecture (GIA) to integrate IoT technologies with eco-friendly practices in smart cities. The system utilizes ecological sensors, cloud computing, and Blockchain to reduce energy consumption and carbon emissions. This approach promotes sustainable resource management and long-term urban viability (Aman *et al*., 2024).

Adaramola et al. discussed integrating Green IoT with environmental sustainability to enhance resource management in smart cities. They highlighted using real-time data and interconnected sensors to optimize energy, water, and waste systems. The study also emphasized the role of Green Fintech in promoting sustainable investments and reducing environmental impact (Adaramola *et al*., 2024).

4. Energy Management in Smart Cities

Smart cities must be eco-friendly and use power efficiently due to the increasing use of electrical gadgets. Energy generation is crucial for meeting power requirements, and utilizing limitless energy sources can help mitigate power waste. While coal, oil, wind, water, and solar cells are used for power generation, they also release greenhouse gases that are not eco-friendly. Smart communities are now focusing on harnessing inexpensive power with minimal environmental impact. Green power technologies aim to harness renewable resources to keep pace with modern advancements. These communities promote sustainable energy preservation by effectively harnessing renewable power. Utilizing renewable energy for homes will contribute to the sustainability of green cities (Humayun *et al*., 2022) (Ismail *et al*., 2025).

Energy management differentiates between energy needs and budgets, utilizing available resources and minimizing consumption. Effective management satisfies eco-friendly energy needs with renewable resources and minimal greenhouse gas emissions. Green cities integrate renewable resources and adaptable load infiltration for optimal production. Urban "smart energy" management is key in mitigating climate change (Razmjoo *et al*., 2022).

4.1. Renewable Energy Sources

A sustainable city relies on clean, renewable energy sources, which reduce costs and minimize pollution. Renewable energy is also efficient for low-power devices and has a positive environmental impact. Solar, wind, and other sources, such as RF, are used. Sunlight is particularly promising for modern networks (Ezhiljenekkha and MarsalineBeno, 2020).

Smart cities must prioritize environmental considerations during their development. Carbon emissions, transportation, water, and energy management are crucial for sustainable development. Waste, air, water quality, and CO2 reduction are also important. To combat urban pollution, cities should adopt multifaceted approaches that generate renewable energy. Energy revival plays a key role in supporting eco-friendly monitoring. This is achieved through renewable techniques and energy-harvesting tools (Javed *et al*., 2021).

4.2. Proposed Quantum IoT Architecture for Smart Cities

Figure 4 illustrates a new conceptual framework for an energy-based quantum IoT network architecture. This figure proposes a layered quantum IoT architecture for smart cities. Each layer manages different tasks to improve energy efficiency and sustainability. The design has four layers, each assigned specific tasks within the network. These layers are essential for facilitating sustainable operations in smart cities (Mishra and Singh, 2023).

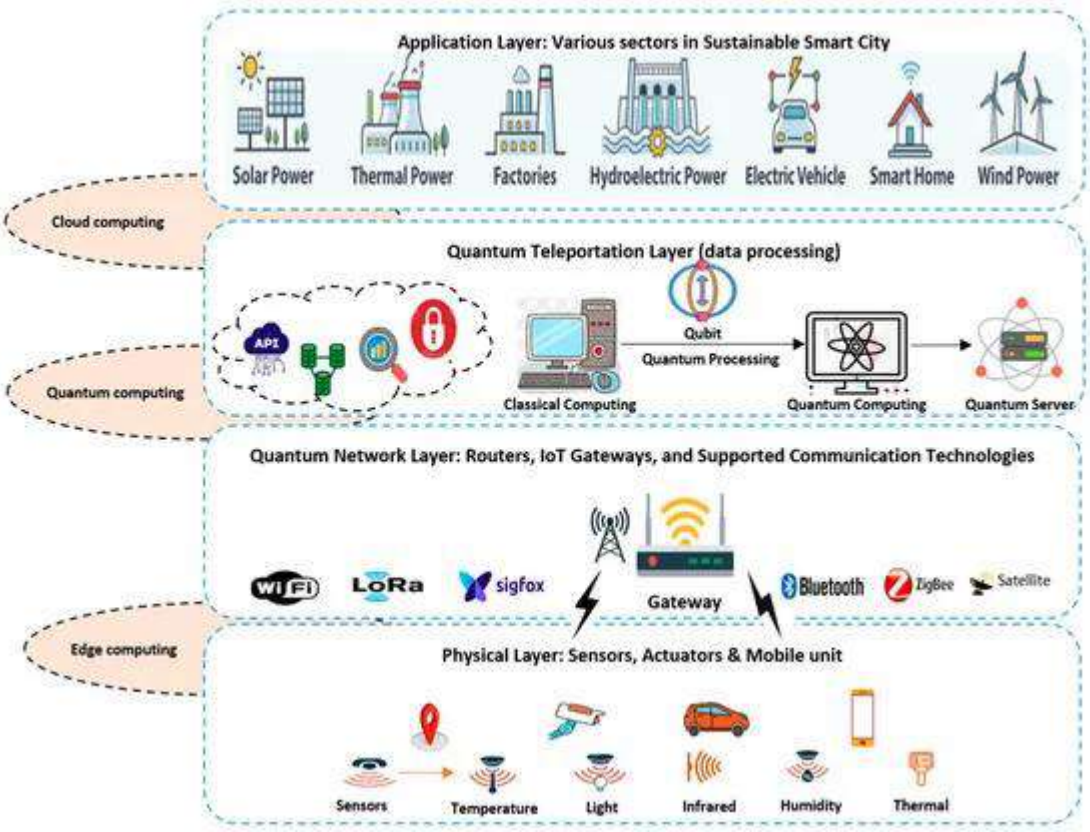

Figure 4: An energy-based quantum Internet of Things (IoT) network architecture designed to create sustainable smart cities.

5. Transportation Systems in Smart Cities

Transportation infrastructure is a significant problem in smart cities. To support the increasing demand for public transportation, smart cities will implement more public-private collaboration in public transportation, bike-sharing, and electric scooter services, among others. There are various aspects of the public transportation system, some of which are as follows (Kuo *et al*., 2023):

1. Smart Management of Mass Transit System: The integrated management of the Intelligent Transportation system in a metropolitan city has proven efficient for making essential operational decisions through the smooth interaction of sensor data, inaccessible traffic control systems, and mass transit systems. With the increasing residential and working density in the core areas of metropolitan cities, the effort to improve transportation systems has led to a significant rise. Data from smartphones and social media servers is also used to manage mass transit systems. In a metropolitan city, travel times have varied significantly (Gohar and Nencioni, 2021).

2. Smart Parking Applications: The implementation of smart parking applications is widespread in a few big cities. The various available parking options can directly help reduce traffic congestion in megacities. Many projects should focus on a variety of big-data approaches that suggest where the parking avenues are still less crowded. For instance, a new airport in Montevideo has parking directed by field sensors. It displays guides in personal homes and analysts, revealing free parking spots in blue (Vaslavskaya *et al*., 2023).

3. Smart Traffic Management: Smart city foundations will establish intelligent signals around major public intersections. Traffic lights would be prepared to accept the initial contingent of vehicles entering to speed up traffic. If returning foreign ministers are not required by a junction, three vehicles will be notified after some time. Smart facility organizations should include individual

infrastructure vehicles among their top devices. System mediators allow sites such as airports and traffic districts to check when the light is green for them to go (Gonzalez *et al.*, 2020).

5.1. Public Transportation Infrastructure

The growth of cities promotes the use of individual vehicles for transportation, increasing the number of cars and motorcycles in urban areas. Developing public transportation infrastructure is crucial for sustainable mobility in smart cities. Cities like Curitiba, Bogotá, San Francisco, and Paris reduced car usage by improving conditions for walking or using non-motorized transportation and deploying BRT systems. Prioritizing public transportation infrastructure doesn't negate the need for compact, mixed-use, and multifunctional urban areas. Traffic accidents cause 1.35 million deaths annually, with pedestrians and cyclists being the majority. Livable streets are urgently needed to reduce traffic problems and decrease car dependency. Bikeable cities like Copenhagen and Malmö offer low-cost, comfortable cycling infrastructure. Car-sharing and bike-sharing programs also decrease car dependency (Cugurullo *et al.*, 2020).

5.2. Smart Traffic Management

Efficient traffic management is crucial for any smart city. Various strategies and technologies have been developed, such as parking information systems, vehicle-to-infrastructure communication, and reservation-based parking management. Let's discuss top traffic management strategies for transportation optimization in big cities or smart cities. Result: 190 characters (Lee and Chiu, 2020).

Automated Traffic Light Signal System (ATLSS): Researchers propose enhancing traffic management by leveraging real-time traffic density and vehicle-to-vehicle or vehicle-to-infrastructure communication. ATLSS adjusts light duration based on vehicle count at intersections, reducing congestion in urban centers (Zeadally *et al*., 2020).

Smart parking informs people about parking availability and costs, reducing traffic and crises in big cities and tourist areas. It utilizes applications and smartphones to manage urban parking spots and provide availability on terminals and smartphones. These parking spaces can be promoted near commercial zones or event venues. Many parking managers and government authorities use electronic parking meters to collect and send parking space information to servers (Canli and Toklu, 2022).

6. Waste Management and Recycling in Smart Cities

Municipal waste is a priority in urban waste management. Smart cities use different disposal strategies. Solid waste management applies TCFM-EWM principles. Recycling is essential for a clean environment. A legal framework, innovative strategy, and optimized processes contribute to creating clean cities.

Smart cities implement control measures for waste management and recycling. However, these measures are not comprehensive due to the complexities involved. This analysis examines various approaches and the necessity for technological advancements in waste management and recycling. This includes legislation and schemes to reduce automotive waste, evaluations for construction projects, and a landscaping system designed to improve recycling. Sorting materials before recycling has been proven to reduce pollution. We also analyze special facilities for handling hazardous waste and assessing compliance with recycling (Lange, 2021).

7. Water Management and Conservation in Smart Cities

Desalination is a global topic in water management. ECM adoption can convert wastewater into emission-free energy, resulting in cost savings. Current desalination technologies have limitations, so future research should focus on waste heat recovery. "Green" materials are necessary to mitigate

the toxicity associated with specific desalination techniques. This chapter highlights eco-friendly methods to convert city waste into energy with zero emissions. The ECD cycle treats organic waste and produces biogas for power generation, reducing reliance on non-renewable energy sources. Using biogas also cuts logistics costs for waste treatment. Additionally, treated water can be reused, reducing freshwater usage. This progress will make the eco-friendly Smart City a notable technological milestone (Diaz-Secades *et al*., 2023).

8. Urban Planning and Design for Sustainability

When planning and designing for urban sustainability, there are techniques to adopt, such as integrating Service Oriented Architecture (SOA) into the Smart city network for easy integration and updating of sensor systems. Mixed-use zoning stimulates non-motorized transportation and social interaction. Incorporating parks and green spaces within urban areas improves oxygen levels and enhances urban livability (Mishra and Sarkar, 2022).

Sustainable cities integrate economy, environment, and community with replicable management. This creates a harmonious urban area that fulfills ecological, productive, and social aspects. Social urban planning constructs a sense of place, interaction, and cooperation. It addresses multi-function cities, business activity, land use, and partnerships (Quijano *et al*., 2022).

8.1. Mixed-Use Zoning

Mixed-use zoning has gained interest as it creates better urban spaces for living, working, and recreation. It stimulates urbanization and sustainable growth. It can help address diverse needs and prevent the underutilization of land. Mixed-use zoning is becoming increasingly influential in smart cities, contributing to improved environmental quality and reduced harmful emissions. Smart cities integrate technology and the Internet of Things (IoT) with mixed-use zones, encompassing residential, retail, and office areas. This offers unified development, efficiency, and diverse resources. Ultimately, mixed-use zoning can lead to happiness and common goals (Grace *et al*., 2023).

8.2. Green Spaces and Parks

Urban spaces are often covered with concrete, which can harm human lives. Green spaces and parks offer numerous benefits, including air purification, noise reduction, and wildlife habitat. They are crucial for maintaining ecological balance and sustainability. Green belts and parks also help absorb CO2, preserving the environment (Liu and Russo, 2021).

A green belt with park facilities serves as a space for sports, recreation, education, tourism, and aesthetics. It is important for the environment and quality of life in residential areas. Urban parks modify microclimates and provide comfort during temperature increases and air pollution. Makassar boasts large parks and city forests, complete with amenities such as jogging tracks, sports arenas, and gardens. These areas have also developed other public facilities (Rosso *et al*., 2022).

9. Case Studies of Eco-Friendly Smart Cities

This paper presents, analyzes, and discusses the complexity of smart city concepts and eco-smart city tendencies in a generic sense. Other studies have confirmed the importance of advanced technologies in building a truly smart city. Still, they have also emphasized the critical role of residents' involvement, openness, good governance, and other issues. Furthermore, numerous researchers worldwide have repeatedly demonstrated that an "ordinary" smart city can often provide higher comfort, quality, and safety than a city solely focusing on green or eco-considerations. This supports the thesis that energy-saving does not necessarily have to be strictly associated with new technologies, but rather with new ecological manners and lifestyles likely to become permanent features of contemporary cities.

With these strong interpretations in mind, this paper presents and analyzes dozens of case studies and reviews solutions aimed at eco-friendly and sustainable urban tech park, spa, or resort design. These studies originate from some of the most polluted cities in the world, including Bengaluru in India and Chongqing in China, as well as Scandinavian cities such as Oulu and Oslo, which serve as models for modern, ecologically oriented urban policies. However, in the bottom-line section, two highly technological Metropolitans are discussed: the Esch-sur−Alzette Metropolitan Area in Luxembourg, which focuses on upgrading and repurposing former heavy industry locations, and the Punggol Digital District in Singapore, which showcases the design and construction techniques of a truly modern eco-friendly urban area at the district level (Liow and Sam, 2023) (Quah and Tan, 2022).

9.1. Singapore

Singapore is considered the world's first eco-friendly smart city. It is a state and a city in the western Pacific. It is located at a crossroads of the world's major transportation routes. Singapore boasts numerous blocks, breathtaking green spaces, rich natural surroundings, and vibrant dining and shopping districts. The Ministry of the Environment and Water Resources (MEWR) works to create a livable and sustainable environment, ensuring a steady supply of clean water to the people of Singapore. Singapore has proposed eco-friendly initiatives, including regulating environmental auditing, enhancing performance in nature parks, and promoting ecological restoration. Singapore has a smart approach to transportation. The Singapore government has introduced policies to invest substantially in improving and updating public transportation infrastructure, encouraging reduced road usage. The momentum behind electric vehicles is beginning to gain traction. Singapore encourages its citizens to drive fuel-efficient or electric hybrid vehicles. Singapore is mostly a state composed of citizens who value the cultural traditions of their ethnicities (Arya, 2023).

9.2. Barcelona

Following an urban development plan in 1859, Barcelona implemented a system to protect its natural resources, consisting of interconnected parks. This approach facilitated urban expansion with square blocks, providing better solar exposure and mid-to-high residential densities to reduce sprawling pollution caused by commuter traffic. The city built water channels to overcome the water shortages and dramatically reduced leakages and consumption thanks to public policies and local water companies. The Eixample is a good example of excellent urban growth since then (Lopez-Morell *et al*., 2024).

Between 1858 and 1929, the population of the city had quintupled to 1 million, and the octogenarian city walls had been successfully replaced by the not-so-newly incorporated Eixample, a 7.5 km2 enlarged city grid and the conspicuous proof that Cerdà's planners had put a lot of intellectual resources into creating a new city outside the walls. However, Eixample took fifty years to complete when the first sporadic buildings were built along the northern side of the Gran Via, accompanied by a few properties along its southern limits (Smith and Smith, 2023).

Tiled street names refer to the pre-expansion agricultural fields each new wealthy urbanized resident had bought for not-so-uninteresting profit. Cerdà's new radial city was developed in various phases with corresponding architectural styles, allowing citizens to choose Eixample neighborhoods with a particular architectural identity. Cerdà thought the streets would look identical regardless of the buildings, but local architectural design made all the difference (Schenk, 2023).

Urban life flourished for the citizens of the Eixample. Car traffic was limited, and to address the issue of the new Eixample's water shortage, exits were constructed from the city to the Besòs and Llobregat streams, each equipped with a filtration plant (Rodriguez-Rey, 2022).

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Evaluation of some bioremediation applications of Tannase enzyme purified from ascomycete fungus *Helvella bachu*

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Abstract

With the aim of reducing or stopping the threats to ecosystems, the current study was designed to investigate the ability of the tannase enzyme purified from the local isolate of ascomycete fungus *Helvella bachu* in reducing the most dangerous toxin aflatoxin B1, using high-performance liquid chromatography technique, aflatoxin B1concentration was reduced to 3.4 ng/ml. Tannase enzyme analyzed the aflatoxin into two compounds in terms of the appearance of two peaks at a retention time 2.08 minutes and 4.59 minutes, with a residual area percentage 13.8 and 86.6% respectively, compared to standard aflatoxin, which appeared with one peak at a retention time 4.79 minutes. The concentration of aflatoxin decreased to 1.2 ng/ml using the crude enzyme compared to aflatoxin before treatment 1.32 µg/ml at the same retention times for the purified enzyme with a difference in the remaining area 45.8 and 54.2% respectively. Moreover tannase enzyme analyzed the aflatoxin into two new compounds . The ability of tannase enzyme to remove a number of industrial dyes was also evaluated in a period of time ranging from (6-48) hours, the results showed that the enzyme was able to remove 100% of the dyes: Reactive Yellow, Indigo Carmina, and Orange G. but with varying percentages of the other dyes used after 48 hours of enzyme treatment.

The aim of this study was investigate the ability of the purified tannase enzyme from the ascomycete fungus *Helvella bachu* to treat aflatoxin B1 and number of industrial dyes.

Keywords: Tannase enzyme**,** Aflatoxin B1, industrial dyes, *Helvella bachu* **.**

تقييم بعض تطبيقات المعالجة الحيوية لإنزيم التانيز Tannase المنقى من الفطر الكيسي *Helvella bachu*

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الملخص

بهدف التقليل أو إيقاف التهديدات التي تتعرض لها الأنظمة البيئية صممت الدراسة الحالية للتحري عن قدرة انزيم التانيز المنقى من العزلة المحلية للفطر الكيسي *Helvella bachu* في إختزال سم الأفلاتوكسين B1 الأشد خطورة باستخدام تقنية كروماتوكرافيا السائل عالي الاداء حيث قل تركيزه ليبلغ 3.4 نانوغرام/ مل , كما قام الانزيم بتحليل الافلاتوكسين الى مركبين بدلالة ظهور قمتين عند زمن احتجاز 2.08 دقيقة و 4.59 دقيقة وبنسبة مساحة متبقية 13.8و86.6% على التوالي بالمقارنة مع الافلاتوكسين القياسي والذي ظهر بقمة واحدة عند زمن احتجاز 4.79 دقيقة . في حين إنخفض تركيز الافلاتوكسين الى 1.2 نانوغرام / مل باستخدام الإنزيم الخام مقارنة بالأفلاتوكسين قبل المعاملة 1.32 مايكروغرام / مل عند نفس ازمان الاحتجاز للإنزيم المنقى مع الاختلاف في المساحة المتبقية 45.8 و54.2% على التوالي وتمكن من تجزئة السم الى مركبين جديدين . كما تم تقييم قدرة الانزيم على ازالة عدد من الاصباغ الصناعية في مدة زمنية تراوحت بين (6–48) ساعة اذ تمكن إنزيم التانيز من إزالة 100 % لكل من الصبغات Reactive yellow و Indigo Carmina وOrange G ونسب متفاوتة للصبغات الأخرى المستخدمة بعد 48 ساعة على المعاملة بالإنزيم.

الكلمات المفتاحية : إنزيم التانيز, الأفلاتوكسين B1, الاصباغ الصناعية,*Hevella bachu* .

Introduction

Environmental pollution has been and is still increasing at a rapid and alarming pace due to the increase in human activities resulting from the population explosion, unsafe agricultural practices, unplanned urbanization, deforestation, rapid industrialization and unwise use of energy reservoirs and other human activities, not to mention the huge increase in toxic wastes that are thrown into the environment every day indiscriminately due to industrial activity and human dominance over the natural resources of the earth, all of which imposed on us the fact that the consumption of chemicals has become an inevitable matter at present time(Vaksmaa, *et al*.,2023). Among pollutants that present environmental and health risks due to their toxicity that worry environmentalists include: chemical fertilizers, heavy metals, types of plastic, pesticides, herbicides, industrial dyes, and hydrocarbon compounds such as oil and its derivatives(Abdel-Shafy and Mansour, 2016) , that prompted specialists and researchers in this field to follow safe methods away from chemicals and apply them in various industrial fields, the most important of which are enzymes purified from natural sources such as bacteria, algae, yeasts and fungi. The tannase enzyme came at the forefront of these enzymes, which gained the attention of many researchers.

Tannas enzyme which also know Tannin acyl hydrolase (E.C 3.1.1.20) is an important extracellular fungal enzyme in biotechnology. It can be produced from different microbial bio sources. Tannase has many advantages, such as its ease of production by submerged cultures or solid-state fermentation using low-cost agricultural waste, its tolerance to a wide range of temperatures and pH, and its high ability to hydrolyze toxic tannins and convert them into simpler and less harmful compounds glucose and gallic acid. Therefore, it has been widely used globally in industrial and food applications such as clarifying beverages and removing bitter taste, improving feed quality, increasing the nutritional value of bean powder, as well as removing multiple phenolic compounds from wastewater (Albuquerque, *et al*., 2020), in addition to environmentally friendly industrial applications, bioremediation, and medical fields. It is worth noting that the use of enzymes extracted from fungi represents one of the technical developments in bioremediation to reduce the time of bioremediation and simplify the process further. Fungal biomass can also be used directly on pollutants (Shome, 2020).

Bioremediation is promising, innovative, environmentally friendly and technology for controlling polluted environments. It is successful ,an attractive cleaning technology for removing many toxic wastes from polluted environments by degrading or detoxifying various hazardous physical and chemical wastes from the environment through the biological activities of microorganisms at low cost and without secondary pollution. Fungi play important roles in biological treatment

(bioremediation) of pollutants, especially permanent organic pollutants, such as pharmaceuticals ,dyes, leather tanning waste, coal, personal care products, polycyclic aromatic compounds (diesel and kerosene) and industrial wastewater. So, fungi take all these type pollutants as substrates and decompose them effectively to get nitrogen , carbon or energy which they need for their metabolism (Tomer *et al*., 2021). Due to the importance of the topic, this study was designed to investigate the ability of the purified tannase enzyme from the ascomycete fungus *Helvella bachu* to treat aflatoxin B1 and number of industrial dyes.

Materials and methods

1.Test organism

The research experiments were done using the ascomycete *Helvella bachu*, which was morphologically and molecularly characterized by (Al-Rawi & Abdul-Hadi, 2022).
The fungus fruiting bodies figure (1) were obtained from Al- Nimrud area, which is located 30 km south of Mosul city, Iraq. *H.bachu* fruiting bodies were transport to the laboratory and then washed several times with tap water until clean. The culture cabinet was prepared by sterilizing it with 70% ethanol. *H.bachu* fruiting bodies were cut from different parts, stem, cap, and heart of it, using a sterile scalpel into small pieces. The pieces were sterilized by immersed in 70% ethyl alcohol for 3 minutes, after which they were transferred using sterile forceps with alcohol to a volumetric beaker containing sterile distilled water (D.W) for 5 minutes to remove trail of alcohol. Then the fruiting body pieces were loaded onto sterile filter papers, type Whatman No. 1, and left them to completely dry. The different fruiting body pieces were cultured in sterile Petri dishes which were containing Potato Dextrose Agar (PDA) culture medium. The inoculated dishes were incubated after covering them with foil paper in the incubator at a temperature of 28 ± 2º C for 5-10 days until dense, pure fungal hyphae were obtained during this period (Rana, 2016).

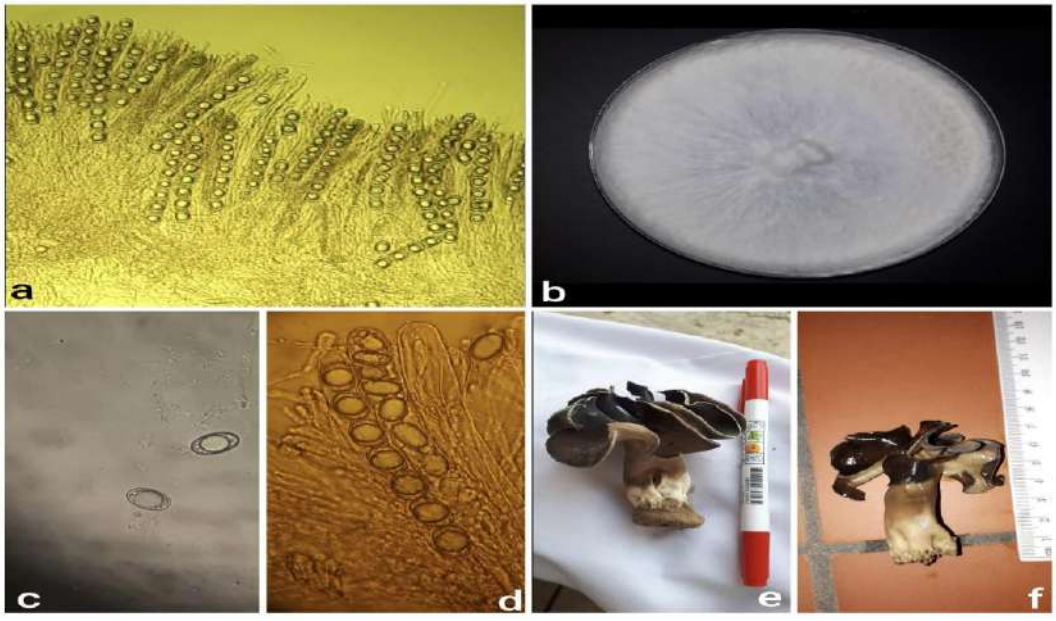


Figure 1: Morphological and microscopic diagnosis of the selected local fungal isolate, a: asci and paraphysis at 40X magnification, b: fungal colony on culture medium, c-d: cyst spores under the light microscope after staining with lactophenol. e-f: fruiting body.

2. Purified tannase enzyme

Tannase enzyme was purified to homogeneity by the following steps: precipitation with ammonium sulfate, dialysis, DEAE-Cellulose ion exchange chromatography, the last purification step in which

the enzyme was purified to homogeneity was devoted using Sephadex-G150 gel (Al-rawi & Abdul-Hadi,2022).

3. Potato Dextrose Agar (PDA) culture medium

To prepare the culture medium , dissolving 39 g of PDA powder in 1 L of distilled water , mixing well until complete dissolution, adjusting the pH to 5.6. The prepared medium was sterilized by autoclaving at 121 °C and 1 atmosphere pressure for 15 minutes. 250 mg/liter of the antibiotic (Chlormphenecol) which was sterilized with a membrane filter with a diameter of 0.45 microns, this antibiotic added to the culture medium after sterilization and cooling in the laboratory temperature ,to avoid contamination with the bacteria . The medium had been distributed in sterile plastic (Petri dishes) at a rate of 15 ml per dish, these dishes were kept in the refrigerator, until used for isolating and culturing fungal isolates (1998, Atlas).

4. Tannase enzyme production medium

To produce tannase enzyme, the modified Czapeck–Dox medium described by Sena (2014) was used. The medium was prepared by dissolving the following components in one liter of sterile distilled water (g/liter). Sucrose 2, KCl 0.5, $MgSO_4.7H_2O$ 0.5, $FeSO_4.7H2O$ 0.01, K_2HPO_4 0.1, Tannic acid 10, pH adjusted to 6, the medium was distributed into 250 ml glass flasks at a rate of 50 ml per flask, the flasks were sterilized with an autoclave at a temperature of 121 °C and a pressure of 1 atmosphere for 15 minutes, while Tannic acid was sterilized with a membrane filter with a diameter of 0.45 microns and then added to the sterile medium cooled at room temperature. The medium was inoculated with five discs of young fungal colony per flask, the flasks were incubated in a shaking incubator at a shaking speed of 150 rpm for 5 days, the medium was used in the experiments of the culture conditions.

5. Bioremediation Applications

5.1 Reduction of Aflatoxin B1

To demonstrate the ability of the crude and purified tannase enzyme from the fungal isolate *H. bachu* to reduce the toxicity and concentration of commercially purified aflatoxin from the fungal isolate *Aspergillus* sp., sterile test tubes were used and 1 ml of the purified and crude enzyme were placed in each tube separately. Each tube was added 0.2 ml of aflatoxin at a concentration of 8 µg/ml so that each tube contained a final concentration of 1.33 µg/ml with manual mixing. The tubes were placed in a shaking incubator at a shaking speed of 150 rpm and a temperature of 15ºC for 72 hours incubation. The tubes were removed from the shaking incubator after the incubation period was over, their components were poured into a separating funnel and twice the volume of the organic solvent chloroform was added to each tube with careful shaking. The addition process was repeated three times and two layers were observed to form. The upper layer was concentrated by rotary evaporator to obtain a dry powder. The obtained powder was stored in opaque glass bottles in the refrigerator at 4 °C. Later, the characterization was carried out by injecting 20 µl of the reaction mixture into a high-performance liquid chromatography column, the column type used was C18 with dimensions of 250×2.4 cm, the mobile phase was Acetonitrile: Water (70:30) at a flow rate of 1 ml/min (Alberts, *et al*., 2009).

5.2 Industrial dyes removal

The environmental damage caused by the use of industrial dyes is certainly countless, to preserve the environment, a practical experiment was planned to remove the color of many industrial dyes used in tissue factories using tannase enzyme. The experiment was carried out using many industrial dyes including : (Reactive black- Reactive yellow- Reactive green- Aniline Blue-

Bromophenol Blue- Congo Red - Phenol Red- Orange G - Bromocresol Purple- Indigo Carmine) which were added at a concentration of (100) mg/L to the tannase enzyme production medium in 250 ml conical flasks at a rate of 50 ml for each flask, the pH of the different culture media was adjusted to 6. Inoculated with fungal colony discs, the flasks were incubated in a shaking incubator at a shaking speed of 150 rpm at a temperature of 28±2 °C. After the incubation period, the contents of the flasks were filtered using Whatman No.1 filter papers fixed on a Buechner funnel. 1 ml of the filtrate of each dye was taken in each test tube separately and the same amount of sodium acetate buffer with a concentration of 0.2 M and pH 5.5 and 8 units/ml of the enzyme filtrate was added to each tube with good mixing. The tubes were incubated for different incubation periods of 48, 42, 36, 30, 24, 18, 12, 6 hours. The mixture was centrifuged at a speed of 5000 rpm for 5 minutes. The absorbance was measured by a spectrophotometer at the wavelength of each dye by taking 1 ml of each dye. The percentage of dye removal was estimated according to the following equation: (Ado, *et al*., 2019).

D% = [(Aini - Afin) / Aini] x100

Where: D = Decolourization

Aini = Initial absorbance

Afin = Final absorbance

Results and Discussion

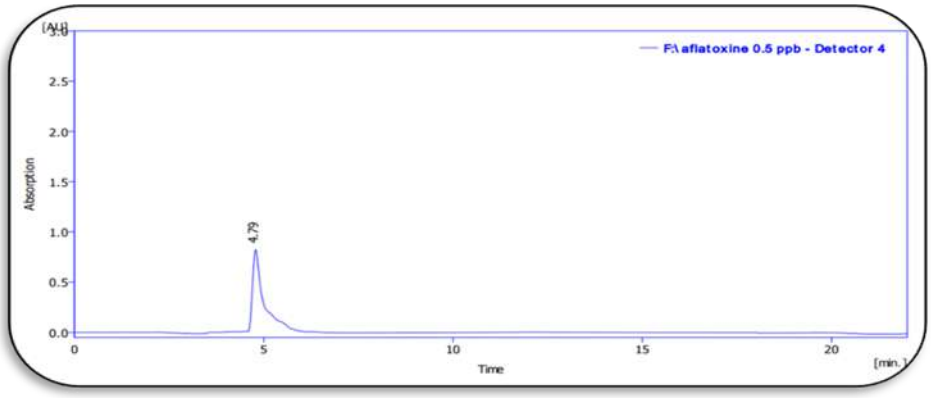
1. Bioremediation Applications

1.1 Reduction of Aflatoxin B1

A lot of research and efforts have been devoted to removing or reducing the toxicity of aflatoxin. Enzymes extracted from fungi have wide applications and play a positive role in the analysis of pollutants related to human aspects. The most extensive application was their use in reducing the most polluting toxin for agricultural products and foods, aflatoxin type B1, which colonizes grains of various types. Aflatoxin was treated with the extracted and purified tannase enzyme from the local isolate of the fungus *H. bachu* for 72 hours separately. The results of the analysis by high-performance liquid chromatography, under the conditions designated for the detection of aflatoxin, when treating aflatoxin with the purified enzyme (Figure 2B) showed a clear reduction of aflatoxin, as its concentration decreased to 3.4 ng/ml. It also analyzed the aflatoxin into two compounds, indicating the appearance of two peaks at a retention time of 2.08 min and 4.59 min with a residual area percentage of 13.8 and 86.6%, respectively, compared to the standard aflatoxin with a single peak at a retention time of 4.79 min. The crude enzyme was able to effectively and efficiently reduce the aflatoxin B1 until its concentration decreased to 1.2 ng/ml at the same retention times as the purified enzyme, with a difference in the residual area of 45.8 and 54.2%, respectively. It was also able to fragment the aflatoxin B1 into two new compounds, as shown in Figure (C2).

From the above results, it is clear that the crude enzyme outperformed the purified enzyme in effect. It is believed that the effectiveness of the crude enzyme is due to its containing other proteins and some impurities that work synergistically with the enzyme to reduce the toxicity of aflatoxin B1 and decrease its concentration. In fact, both of them (the crude and the purified) worked to split the aflatoxin into two compounds: Aflatoxin epoxide and Dihydrodiol, and later to break down the cyclic compound Difuran by splitting the double bond, thus turning it into a less toxic compound. The reason may also be attributed to the generation of free radicals that interact with each other and thus work to break down the aflatoxin and form non-toxic binary polymer compounds (Alberts, 2006). Thus, fungal enzymes, especially tannase enzyme, appear as one of the ideal solutions to get rid of aflatoxin toxicity. Some studies are still being conducted at the University of Modern Technology in Finland with the aim of benefiting from fungal enzymes in reducing toxins of various types. In a study presented by the researcher Yehia (2014), it was confirmed that the destruction of aflatoxin B1 by the manganese peroxidase enzyme purified from the edible white rot

fungus *Pleurotus ostreatus* achieved a clear progress, as it reached 90% after 48 hours of incubation and with an enzyme activity of 1.5 units / ml, as shown in the results of high-performance liquid chromatography. The results obtained by the researchers Branà (2020) indicated the possibility of destroying aflatoxin B1 by the enzymes laccase and Mn-peroxidase purified from the fungal isolate *Pleurotus eryngii*, as the percentage of inhibition reached 90% after 72 hours of treatment with enzymes and at a pH of 8 and a temperature of 25 ºC. The researcher Muslim (2015) has been proven the effectiveness of the purified tannase enzyme from the bacterial isolate *Citrobacter freundii* in reducing the toxicity of Zearalenone produced from the fungus isolate *F. graminearum* at different concentrations ranging from 200 to 700 µg/ml, as the enzyme was able to reduce the toxicity up to a concentration of 500 µg/ml, while treating the toxin with the tannase enzyme had no ability to reduce the toxin at higher concentrations.



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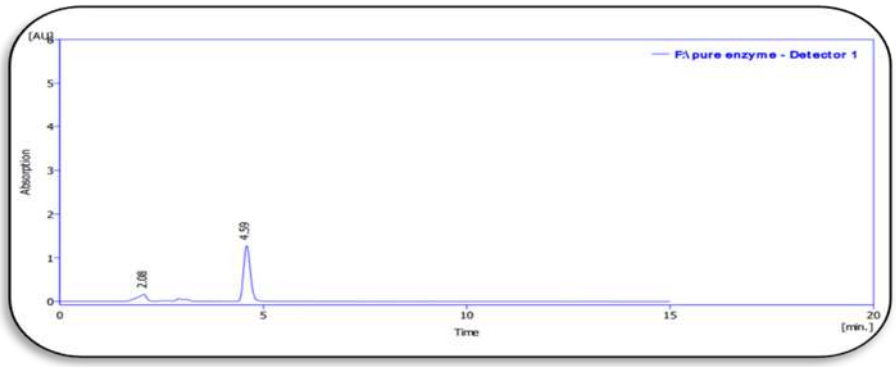

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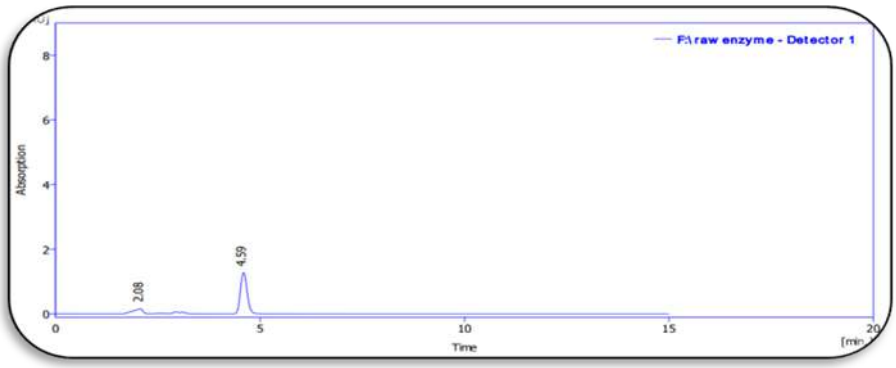

C

Figure 2: curves and peaks of the degradation products of aflatoxin B1 using HPLC technique, where A: control sample, B: purified enzyme from *Helvella bachu*, C: crude enzyme

1. 2 Removal of industrial dyes

Water pollution takes different forms, dyes are among the most important pollutants of water resources. This is likely due to their wide use in various industries (food, textile, printing, oil, etc. and countless other fields). Therefore, the process of removing dyes from polluted water before disposing of it is extremely important. Because water is the basis of life, this problem, which represents a real crisis, requires the use of efforts to reduce it and treat it at the lowest cost. Despite the diversity of physical and chemical methods for treating water pollution with industrial dyes, biological methods are the most efficient, and perhaps the most important of them is the use of fungal enzymes.

In order to solve this problem, a laboratory experiment was conducted to investigate the ability of the purified tannase enzyme from the *H. bachu* fungus isolate to remove several types of dyes in a period of time ranging from (6-48) hours with a 6-hour interval between each period. By carefully examining the results recorded in Table (1), it becomes clear that the tannase enzyme provides an alternative strategy to treat the problem of environmental pollution by industrial dyes, as the enzyme was able, after 24 hours of treatment, to completely remove the Orang G dye (100)%, and the percentage of dye removal for all types used increased with increasing time for enzyme treatment, with differences between them. The enzyme was also able to remove the color of each of the dyes (Reactive yellow and Indigo carmina) by 100%, respectively, after 48 hours of treatment. It was also able to remove 96.2% of the Reactive black dye. The lowest percentage of dye removal was for Congo red dye, reaching 38.3% after 48 hours. The ability of the tannase enzyme to remove artificial dyes can be explained by the high potential of the enzyme to adsorb dyes after dismantling the complex bonds that make up their structure. Among the research that enriches the study and is similar to the experimental conditions is the research published by Abd-elmotey (2022) in which the tannase enzyme extracted from the fungal isolate *Aspergillus niger* SWP33 and *P.griseoroseum* T11 by solid-state fermentation was able to remove Reactive blue 19 and Red 24 dyes after 6 hours of incubation.

Table 1 Removal of industrial dyes using biomass of local isolate of *Helvella bachu*

(%) Percentage of removal of industrial dyes									The dye used
Time (hour)								Absorption	
48	42	36	30	24	18	12	6		
84.3	80.5	76.2	58.2	48.1	36.6	22.7	17.3	585	Aniline Blue
73.8	63.2	55.9	48.5	42.8	36.1	30.3	22.3	427	Bromophenol Blue
38.3	33.5	28.6	26.9	22.7	18.5	13.5	4.7	487	Congo Red
88.5	77.2	68.9	52.6	45.5	38.5	25.3	17.5	497	Phenol Red
100	100	100	100	100	67.0	54.4	37.6	475	Orange G
96.2	94.8	90.0	85.8	73.6	71.7	64.8	38.5	600	Reactive black
100	99.3	95.0	88.3	80.4	76.5	62.4	42.7	600	Reactive Yellow
56.4	48.3	44.8	37.7	26.8	18.0	13.5	7.3	460	Neolan yellow
89.5	83.5	77.9	63.5	58.2	43.6	37.6	28.2	588	Bromocresol Purple
100	97.4	92.5	86.3	83.1	66.0	55.3	32.5	609	Indigo Carmine

Conclusions

Tannase enzyme purified from the local isolate of ascomycete fungus *Helvella bachu* demonstrated an effective ability to bioremediation the most dangerous toxin aflatoxin B1. The crude enzyme was more effective than the purified enzyme in effectively reduce the aflatoxin B1 that its concentration decreased to 1.2 ng/ml at the same retention times as the purified enzyme. It was also able to fragment the aflatoxin B1 into two new compounds less toxic. After 24 hours of treatment, the enzyme was able to completely remove a number of synthetic dyes. The percentage of dye removal for all types used increased with increasing enzyme treatment time, although there were differences between them. The enzyme was also able to completely remove the color of each of the dyes Reactive Yellow, Indigo Carmina, and Orange G, and varying percentages of the other dyes used after 48 hours of enzyme treatment. Under the experimental conditions of the current research, tannase enzyme has been proven to be highly efficient in treating aflatoxin B1 and synthetic dyes, which are considered among the most dangerous sources of environmental pollution.

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Environmental Assessment of Selected Groundwater Wells InAbu Ghraib District, West of Baghdad, for The Year 2023

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ABSTRACT

Water security is a basic human need, and its impact on the ecosystem is a major issue worldwide, especially groundwater in areas lacking surface water. Therefore, the aim of this study was to identify the chemical and physical properties of groundwater and its various possible uses in the Abu Ghraib area. Eight groundwater samples were collected and analyzed for physical and chemical parameters (pH, total dissolved solids, electrical conductivity, sodium, potassium, calcium, magnesium, sulfur, chlorine, and hydrogen). The pH was found to be neutral to slightly alkaline, and the water was slightly saline according to the values of total dissolved solids and excess minerals according to the European Commission's electrical conductivity. The groundwater samples in the area were found to be unsuitable for drinking and various industrial purposes, and all water samples were suitable for construction. The water was also found to be suitable for livestock. The concentrations of total solids and electrical conductivity were found to be high, making it unsuitable for irrigation. The suitability of groundwater for agricultural purposes was found.
Keywords: Physicochemical properties,groundwater quality,, Abu Ghraib,uses of groundwater.

التقييم البيئي لآبار المياه الجوفية المختارة في قضاء أبو غريب، غرب بغداد، لعام 2023

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الملخص

الأمن المائي هو حاجة إنسانية أساسية، والنظام البيئي هو قضية رئيسية في جميع أنحاء العالم، وخاصة المياه الجوفية في المناطق التي تفتقر إلى المياه السطحية، لذلك فإن الهدف من الدراسة هو معرفة الخصائص الكيميائية والفيزيائية للمياه الجوفية واستخداماتها المختلفة الممكنة في منطقة أبو غريب، تم جمع 8 عينات من المياه الجوفية وتحليلها لمكونات المعايير الفيزيائية والكيميائية (الرقم الهيدروجيني، المواد الصلبة الذائبة، التوصيل الكهربائي، الصوديوم، البوتاسيوم، الكالسيوم، المغنيسيوم، الكبريت،

الكلور، الهيدروجين)، وجد أن الرقم الهيدروجيني متعادل إلى قلوي قليلاً، والمياه قليلة الملوحة وفقًا لقيم المواد الصلبة الذائبة والمعادن الزائدة وفقًا للمفوضية الأوروبية للتوصيل الكهربائي. وقد وجد أن عينات المياه الجوفية في المنطقة غير مناسبة لأغراض الشرب و الصناعات المختلفة وجميع عينات المياه مناسبة للبناء.كما وجد أن المياه مناسبة للماشية. كما تبين أن تركيزات المواد الصلبة الكلية والتوصيل الكهربائي عالية وبالتالي فهي غير مناسبة لعملية الري، وجد أن ملاءمة استخدام المياه الجوفية للأغراض الزراعية.

INTRODUCTION

Currently, groundwater is considered one of the major and important natural resources due to the increasing demand for water with limited surface water supply and decreasing rainfall. It has become very important to obtain large quantities of good quality groundwater (Mahmoud and Al-Shamma'a, 2023), Hydrogeological studies are an important task in areas where groundwater is the only source of water, which is used for various purposes, especially in agriculture (Al-Khafaji *et al.*, 2021) or As a result of using modern methods to extract groundwater, which is considered an important economic resource. (Al-Salh, 2016),. As a result, groundwater is an important and viable alternative resource in these environments (Li *et al.,* 2018) Iraq is one of the Middle Eastern countries suffering from severe water shortages (Alkhafaji, 2018). Due to the world's growing population, we need to extract vast quantities of groundwater for various human purposes. This leads to water depletion and a decline in groundwater levels due to depletion of recharge (Zahid et al., 2008; Bouderbala et al., 2014). Therefore, both natural and human processes affect groundwater pollution (Aravinthasamy et al., 2020). Water quality testing is crucial because both natural and anthropogenic influences can contaminate aquatic resources (Ase et al., 2022). Water quality depends on the intensity of chemical weathering, the direction of groundwater flow, and the interaction between rocks and water during recharge periods, all of which depend on geological features that influence groundwater chemistry. The presence of salinity in water resources is an important factor, especially in arid and semi-arid regions with groundwater (Zarei et al., 2013). Groundwater with high salt concentrations was found in wells in many areas that were abandoned (Cotecchia and Polemio 1999). It is difficult to predict the location and quality of groundwater in such environments, so the source of salts in these wells must be known over geological time (Lee, 2010). The quality of salt ions is due to their natural source or various human activities (Panno et al., 1994). The Abu Ghraib area is considered one of the areas that lack surface water and is an agricultural area, so groundwater was relied upon for its various uses. Therefore, many studies were conducted that included the study area, including the study conducted by the researcher (Hussein, 2015) on the water of some wells in the study area, where a high percentage of dissolved solids and a low level of minerals was found. Another study conducted by (Abbas, 2021) on soil moisture in the study area, and it was found that increased moisture leads to significant damage to the growth of vegetable crops, as they are exposed to diseases and pests**.** of the study was to determine the physical properties of acidity, electrical conductivity, and total dissolved solids, as well as to study the chemical properties of various key elements, including calcium, magnesium, sodium, potassium, sulfates, chlorides, bicarbonates, nitrates, and phosphates. Therefore, water samples were taken from some wells spread across the region in different locations, with the aim of studying them, identifying their properties, and the extent to which they can be used for various purposes.

Description of the Study Area

The Abu Ghraib area is part of the Mesopotamian alluvial plain, where the lower part consists of Holocene sediments, mainly forming part of the Euphrates River floodplain, with a narrow strip containing sediments from the Dahleh River to the east (Mohammed et al., 2014; Ali, 2023). Abu Ghraib covers an area of approximately 90,293 hectares. It is located approximately 20 km west of Baghdad, between latitudes 33º06' and 33º50' north and longitudes 43º50' and 44º25' east. The

elevation of the plain ranges from 45 m above sea level in the northwest to 42 m above sea level (Saleem et al., 2014),

The irrigation system mainly uses the water of the Euphrates and the Tigris rivers on a large scale for irrigation purposes in the project area. Currently, due to water scarcity, Groundwater is used to fill the shortage for irrigation purposes. The climate of the study area is hot and dry subtropical, with long rainless summers from May to October, and a relatively short, cold winter from December to February. The average annual rainfall is 126.6 mm and the average annual temperature is 22.5 degrees Celsius. The study area lies under a subtropical desert (Papadakis., 1966;in Ali, 2023). The soil temperature is high (Baillie, 2001) and the soil moisture is Toric or Aridic (dry climate) (NEDECO, 1978). **as shown in Figure 1.**

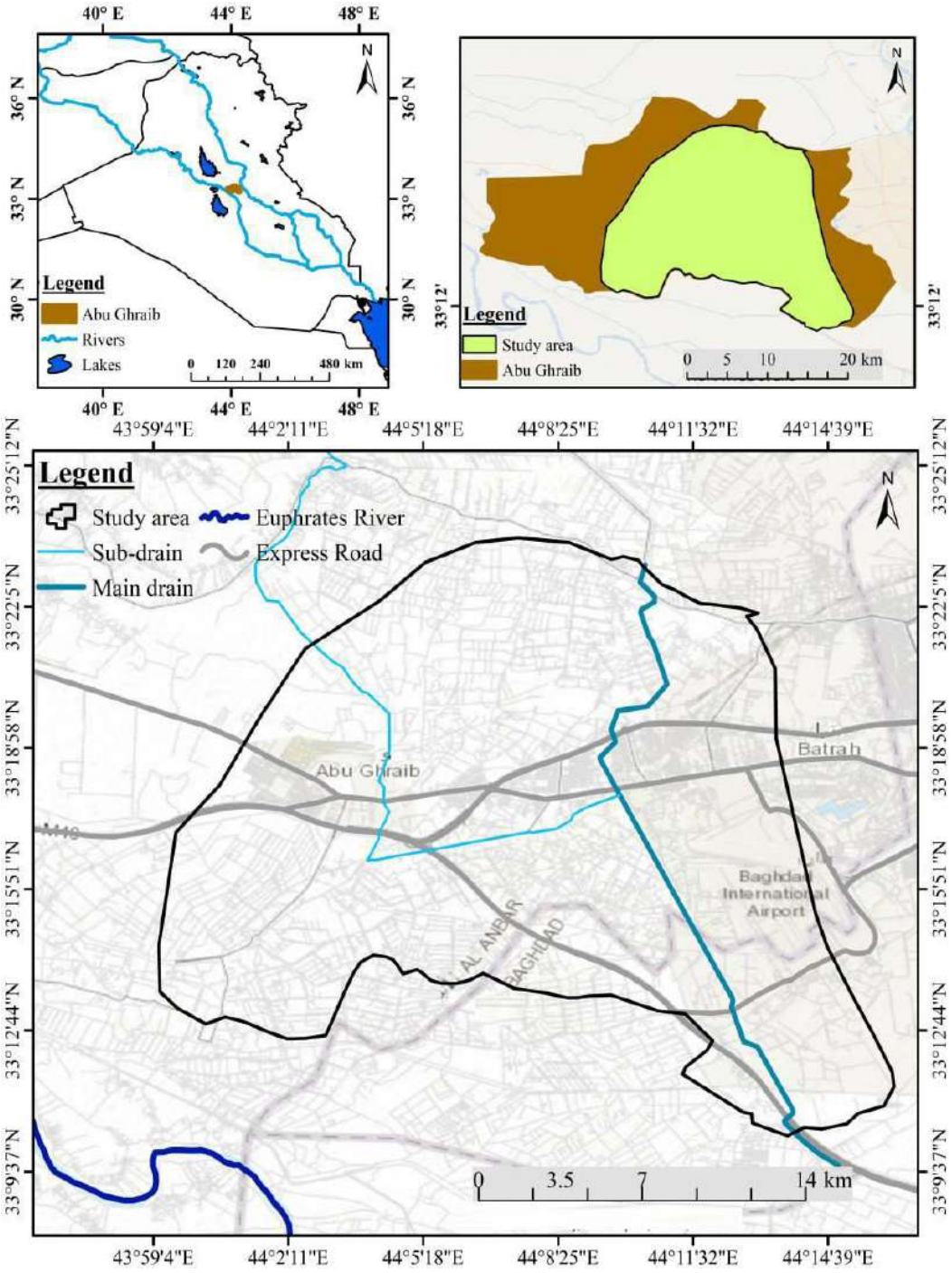

Fig.1. The location of the Abu Ghraib district in relation to the districts of Baghdad city

GEOLOGICAL formation

The geology of the study area will be studied through of Structural and tectonic setting and deposits. It is well known that tectonic movements occur on a regional scale and over large areas. Since a tectonic study of an area such as this is not feasible, we will study the tectonics of Iraq, particularly the tectonics of the alluvial plain, to study the tectonics in the study area. The study area forms part of this area The study area is tectonically located in the unstable shelf zone of the Mesopotamian region, or the Tigris sub-region, which is part of the Tigris sub-belt. Subsurface structures are present in the area; they may not have reached the bottom of the sedimentary layer, but may lie deep within the basement rocks. Few studies indicate ongoing tectonic activity. According to Abdullah (1982), the tectonic nature of the alluvial plain is quite clear. This nature is reflected in the ability of marshes and swamps to persist for long periods without extinction. Had it not been for the continuous downward movement, these marshes would have been filled and buried by the sediments of the Tigris and Euphrates rivers (Abdullah, 2006).
The soil of the study area is rich in calcareous silt materials and is a permeable soil. Despite the establishment of an irrigation and drainage system but the soil salinity is a problem until now. The topography of the area is often flat, although the topography of the area is medium, formed due to the extensive history of irrigation (Buringh, 1960) in the area.

MATERIALS AND METHODS

Eight wells were selected in the study area at different distances to cover the research area, where water samples were collected on 3/5/2023. Water samples were taken using one-liter plastic bottles. These bottles have been sterilized before use and washed. The bottles were washed several times with well water before samples were taken. It was tightly closed and placed at 25 degrees Celsius until analyzes were conducted in the laboratory. Analyses were conducted on samples from the study area in the laboratories of the General Corporation for Groundwater, where the physical properties (hydrogen, electrical conductivity, dissolved solids) and chemical properties included the ions of the mager elements.. It included (Ca^{2+}, K^{+}, Na^{+}, Mg^{2+}, SO_4^{2-} .HCO_3^{-} and Cl^{-}) Field data were collected using a Garmin eTrex 20 GPS device, Fig. 2 and Table 1 show the locations of the study samples in order to Coordinates of each well.

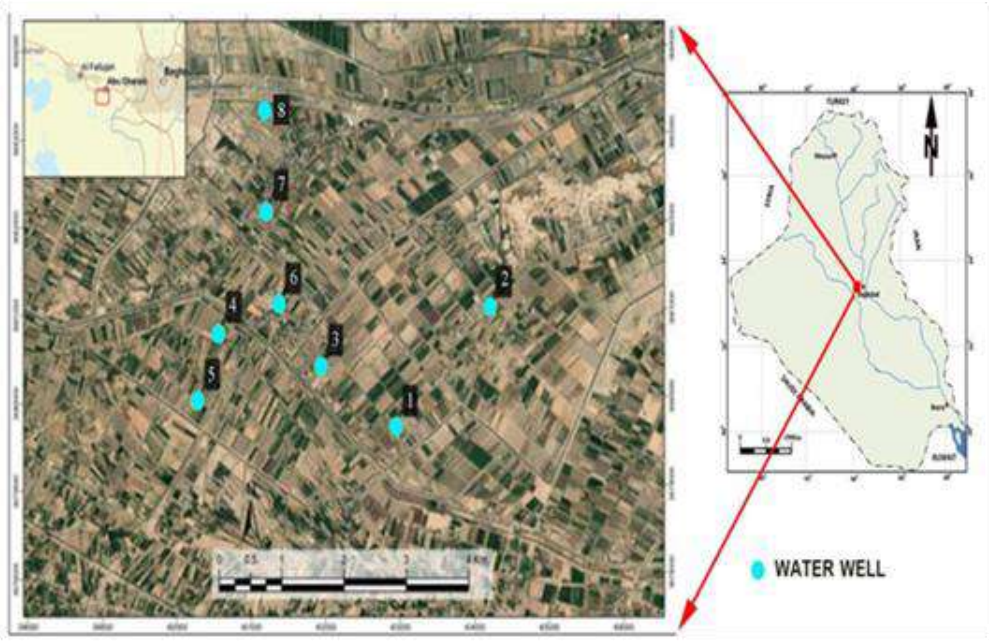

Fig. 2. Locations of the wells in the study area**.**

Table 1. The coordinates of wells in the study area.

	N	E	Coordinates	Well No
	33°15'06.8"N	43°57'30.3"E	33.251884,43.958417	1
	33°15'50.8"N	43°58'18.8"E	33.264115,43.971885	2
	33°15'28.7"N	43°56'51.0"E	33.257971,43.947495	3
	33°15'40.8"N	43°55'58.1"E	33.261339,43.932803	4
	33°15'16.1"N	43°55'47.0"E	33.254483,43.929734	5
	33°15'16.1"N	43°55'47.0"E	33.254483,43.929734	6
	33°15'52.0"N	43°56'29.4"E	33.264454, 43.941492	7
	33°16'25.9"N	43°56'22.9"E	33.273867,43.939696	8

ACCURACY

The symbel U defined as the degree is the degree which the exact value is similar to the actual value that was measured. In order to verify the results, this is done by calculating the absolute error that may be caused by the method of work or intervention during the analyses. The method described by (Appelo and Postm, 2004). Uncertainty can be calculated as in the following equation in units of epm.

U={r sum cations - r sum anions / r sum cations + r sum anions} ×100

When (U ≥ 5%), the results can be accepted for interpretation, but if (5% ≥ U ≥ 10%), the results are acceptable with risk if the value is (U% > 10%). The hydrochemical interpretation of the results cannot be relied upon in this case if (5<U15), the results are accepted with risk. The accuracy of the water analysis results was as shown in Table 2 .

Table 2. Showing the accuracy of the water analysis results for the study area.

Sample	U%	Notes
1	3	Accepted
2	4	Accepted
3	9	Acceptable with risk
4	6	Acceptable with risk
5	-9	Accepted
6	25	Accept results with risk
7	9	Acceptable with risk
8	-18	Unaccepted

Results

Physical properties

The pH is considered a very important measure as it affects the quality of water.. Many factors may be affected by water pH including bioavailability and the importance of evaluating drinking water (WHO., 2007) The groundwater in this area was neutral to slightly alkaline, with recorded pH values ranging from 7 to 8.1, with an average value. 7.5 As in Table 2. The pH values were within the permissible limits (6.5-8.5) set by the World Health Organization and Iraqi quality standard (IQS) (2009) in all sites.

Total Dissolved Solids: They are the minerals of salt, metals, calcium, other organic as well as inorganic composition in water (Altoviski, 1962). The maximum TDS values were recorded in well number 7 (3389 mg/L) and, the minimum value was recorded in wel 8(983mg/L) with mean value of 18403 as in Table 3. By comparing the TDS values with studies (Altoviski, 1962; Drever, 1997; Tood, 2007) they were concluded that the water in the type is often Slightly water mineralization (Boyd, 2000).Table 4.

Table 3. Physical properties of the samples of the study area

No. of well	Physical properties		
Code	pH	**Ec(uS\cm)**	**TDS.(mg/l)**
1	7.1	1008	1310
2	7.3	11003	1546
3	7.1	998	2129
4	7.8	11400	1094
5	7.6	11252	2827
6	8	11508	3389
7	7.9	11500	1445
8	7.5	11362	983
Average	7-8	998 - 11508	983 – 3389
Mean	7.5	8753.5	1840.3

Table 4. Classification of water salinity according to the TDS (ppm) (Drever, 1997; Tood, 2007 Altoviski ,1962).

Altoviski (1962)	**Drever (1997)**	**Tood (2007)**	**Water class**	**Samples of study**
0-1000	<1000	10-1000	Fresh water	Well no. 8
1000-3000	1000-2000	----------	Slightly water	Wells no 1,2,3,4,5,7
3000-10000	2000-20000	1000-10000	Slightly-Brackish water	Well no. 6
10000-100000	----------	10000-100000	Brackish water	
----------	20000-35000	----------	Saline water	
>100000	>35000	>100000	Brine water	

Electrical conductivity (EC): The EC is an indirect measurement of salinity, which is established by the total concentration of ions in water (APhA, 1998). It depends on the temperature as well (Hem, 1985). The relationship between TDS and EC is dependent on the type and nature of cations and anions dissolved in water (Thirumalini and Joseph, 2009). In water of the study area, EC ranges from 998 to 3150 µs/cm with mean 1878.5µs/cm, as in Table 3. The relationship between electrical conductivity and mineralization Located within Excessively Mineralized Water Except number 4, Table 5.

Table 5. Relation between EC and

EC (µS\cm)	**Mineralization**	**The Study area**
<100	Very weakly mineralized water(granite terrains)	
100-200	Weakly mineralized water	
200-400	Slightly mineralized water (limestone terrains)	
400-600	Moderately mineralized water	
600-1000	Highly mineralized water	
>1000	Excessively mineralized water	All samples Except number 3

Chemical Properties

The chemical properties in the present study include the Major Ions such as Major Cations (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}), Major Anions (Cl^{-}, SO_4^{-2}, and HCO_3^{-}) .
Mean and range values of chemical analysis of Well water of the study area are presented in Table 5 while Major Ions: are showing Ions values Some of the metals such as calcium, magnesium, potassium and sodium are essential to sustaining life and must be present for normal body functions (Al-Jaberi *et al.*, 2016). The abundance of the major ions is as follow Na+ > Ca2+> Mg2> K+ and SO42- > CL-> HCO-. Most of samples had higher values of Na, Ca, Mg, CL, and SO4 which were beyond the acceptable limits of (WHO, 2011).

Table 6. Represents chemical properties of the samples of the study area.

NO- OF	Ca^{+2} Ppm	Ca^{+2} Epm	Mg^{+2} ppm	Mg^{+2} Epm	Na^{+} ppm	Na^{+} Epm	K^{+} ppm	K^{+} Epm	Cl^{-} ppm	Cl^{-} Epm	SO_4^{-2} ppm	SO_4^{-2} Epm	HCO_3^{-} ppm	HCO_3^{-} (Epm)
1	141	7.05	101	8.28	148	6.43	7	0.18	264	7.44	573	11.94	76	i.25
2	182	9.10	69	5.66	245	10.65	12	0.31	299	8,42	589	12.27	150	2.46
3	209	10.45	19	16.31	272	11.83	14	0.36	513	14.45	722	15.04	200	3.28
4	131	6.55	89	7.30	112	4.87	5	0.13	209	5.89	474	9.88	74	1.21
5	299	14.95	131	10.74	449	9.52	18	0.64	634	17.86	812	16.92	484	7.93
6	599	29.95	231	18.93	453	19.70	39	0.75	722	20.34	1024	21.33	330	5.41
7	137	6.85	72	5.90	274	11.91	6	o.15	211	5.94	560	11.67	185	3.03
8	76	3.80	73	5.98	91	3.96	3	0.08	182	5.13	446	9.29	112	1.84
Mim. and Max. values	76 – 599	3.80-29.95	69 – 231	5.66 – 18.93	91 – 453	3.96 - 19.70	3 -30	o.o8-0.77	182-722	5.13 – 20.34	446 - 1024	9.29 – 21.33	74 - 484	1.21 -7.93
Mean	221.7	11.08	120.6	9.88	255.5	9.82	11.8	0.30	379.2	10.68	650	13.54	201.3	3.30

Calcium (Ca^{2+}): It is consder one of the most widespread alkaline earth elements, and is considered one of the essential elements for plants and animals. The highest concentration of calcium ion in the water of the study area was 599 mg/L in well (6), while the lowest concentration of calcium was 76 mg/L in well (8), as in Table 6. The average was 221.7 mg/L. Most values of the study area within the global value of drinking water in Table 7,, according to international standards (WHO, 2011).

Table 7. Permissible values limits for parameters and comparing with study area (WHO, 2011).

Parameters'	Desirable-permissible limits (WHO 2011)	Sample number of the Study area
pH	6.5-8.5	All samples
TDS	1000	8
EC	500-1500	1,3
Na	200-600	1,2,3,5,6,7
K	10-12	1,4,7,8

Ca	75-200	1,2,4,7,8
Mg	50-100	2,3,4,7,8
CL	250-500	1,2,4,7,8
SO_4	200-250	No samples
HCO_3	200-500	All samples

Magnesium (Mg^{2+}):The main source of magnesium ion in surface waters is the result of erosion of dolomite rocks, and human activities such as industrial waste and sewage (Davis and Dewiest, 1966; Todd, 1970). The highest concentration of magnesium ion in the water of the study area was 251 mg/L in well (6), while the lowest concentration of magnesium ion was 69 mg/L in well (2), with an average value of 120.6, as in Table 6. There are some examples of the highest concentration of global drinking water values found in Table 7.

Sodium (Na^{+}):Sodium is a highly soluble chemical component that occurs naturally in water (Hem, 1991). The highest concentration of sodium in the water of the study area was 453 mg/L in well (6), while the lowest concentration was 91 mg/L in well (8), with an average value of 255.5 as in Table 7.

Potassium (K^{+}):Potassium is an essential nutrient for humans. It is a soluble cation that makes water have a salty taste. It rarely occurs in high concentrations in natural waters due to the high stability of potassium-bearing aluminosilicate minerals (Hem, 1989). The highest concentration of potassium ions in the water of the study area was 30 mg/L in well (6), while the lowest concentration of potassium was 3 mg. /l in well (8), Some value are within the global scale in Table 7.

Chloride (Cl^{1-}): It is a widespread component of all rock types (Braide *et al.,* 2004) The decomposition of evaporated minerals such as halite (NaCl) is the main source of chloride ions in water (Todd, 1970). The highest concentration of chloride in the water of the study area was 722 mg/L in well (6), while the lowest concentration of chloride was 182 mg/L in well (8), with an average value of 397.2 n Table 6. Most values of the study area within the global value of drinking water in Table 7 according to international standards (WHO, 2011).

Sulphate (SO_4^{2-}): High sulfate values may be the result of dissolution of sediments or sulfate-bearing minerals such as gypsum ($CaSO_4.2H_2O$) and anhydrite ($CaSO_4$), rainfall, and fertilizers (Hamdan, 2012).
The water of the study area is characterized by an abundance of sulfates. The highest concentration of sulfate was 1024 mg/L in well (6), while the lowest concentration of sulfate was 446 mg/L in well (8), with an average value of 650 . We note that the concentrations in the study area are higher than what is shown in Table 7.

Bicarbonate (HCO_3-): The primary source of bicarbonate ion in groundwater is the dissolution of limestone rocks in water that containing dissolved carbon dioxide from dissolved carbon and the presence of hydrogen ions resulting from the dissolution of carbonic acid. The highest concentration of bicarbonate ion in the water of the study area was 484 mg/L in well (5), while the lowest concentration of bicarbonate ion was 74 mg/L in well (24), with an average value of 201.3, as Table 6 shows. All of the samples fall within the permissible limits..as Table 8.

USABILITY OF GROUNDWATER IN THE STUDY AREA

Groundwater is using for several purposhes which depends on the type of water and its content of anions and cations that change it from one type to another. Therefore, it is necessary to evaluate the water according to the local and world standard specifications to determine the suitability of water

to the different uses like domestic, agricultural and industrial (Todd, 1970). In order to assess their suitability for different utilities the water constituents are compared with standard water qualities. Standard is the concentration of constituent that does not result in significant risks (negative impact) to the health of the consumer over the lifetime of consumption (Qannam., 2003).

usability of Groundwater for Drinking Purpose

Drinking water standards are generally based on two main criteria, first, the presence of undesirable tastes, odor and color, second, the presence of substances with harmful physiological properties (health effects) (WHO, 2011) The use of water for drinking depends on the ionic concentration of water, dissolved solids (TDS) and other components. Groundwater is considered very important because it can be used for drinking in some arid and semi-arid areas. The results of the study area were compared with international standards. It is not fit for human drinking as in Table 8 (WHO, 2007; IQS, 2009).

Table 8. Standard specifications for drinking water (WHO, 2007; IQS, 2009)

No. of parameter	Component	IQS (2009)	WHO (2007)	Range values of samples
1	Ca^{+2}	150	75	76-599
2	Mg^{+2}	100	125	69–251
3	Na^{+}	200	200	91–453
4	K^{+}	-	12	3 – 30
5	CL^{-}	350	250	182 – 722
6	SO_4^{-2}	400	250	446 – 1024
7	TDS ppm	1000	1000	983 – 3389
8	pH	6.5-8.5	6.5-8.5	7 – 8

usability of Groundwater for Industrial purpose:

The uses of groundwater for industrial purposes require water that has several characteristics in terms of quality, because any error in determining its composition as it will reflect negatively on the quality of production for a particular industry (Hem, 1986) Formulating some standard specifications for the type of water used in various industries (Crist and Lowry, 1972). These standards represent the recommended upper limits before adding any additional ingredients. Table 9 represents the uses of water quality for industrial purposes according to standard specifications according to (Hem, 1986) According to this classification, all water samples are not suitable for all types of industries as in Table 9.

Table 9. Standard specifications for Industrial purpose water **(Hem, 1986).**

Indestory type		Ca ppm	Mg Ppm	Cl ppm	HCO_3 Ppm	SO_4 ppm	TDS Ppm	pH
Petroleum products		75	30	300	-	-	1000	6 -9
Cement Industry		-	-	250	-	250	600	6.5–8.5
Wood Chemical		100	50	500	250	100	1000	6.5–8
Leathers Industry		-	-	250	-	250	-	6–8
Soft drinks bottling		100	-	500	-	500	-	-
Fruit Icing		-	-	250	-	250	500	6.5–8.5
Synthetic rubber		80	36	-	-	-	-	6.5 – 8.5
Chemical pulp & papers	Unbleached	20	12	200	-	-	-	6 -10
	Bleached	20	12	200	-	-	-	6 10

usability of Groundwater for building

The ratings were used to evaluate the suitability of water samples for construction purposes. Limited proposal from Al-Tufiski Company for building uses Table 10. It is clear from the results of Table 10 that all groundwater samples in the study area are suitable except HCO_3^- is Unsuitable for construction

.

Table 10. Limited suggestion for the building uses, by Altoviski (1962).

Cations	**Concentration µg/L**	**suitability**	**Anions (ppm)**	**Concentration µg/L**	**Water of the Study**
Na^+	1160	Suitable	Cl^-	2187	Suitable
Ca^{++}	437	Suitable	SO_4^{-2}	1460	Suitable
Mg^{++}	271	Suitable	HCO_3^-	150	Unsuitable

usability of Groundwater for Livestock

Using the proposed standard (Altoviski., 1962; WHO, 2011) which is based on ions and cation to total hardness and dissolved solids, and according to these standards, when comparing the average concentrations of the element with what is in Table 11, it was found that the water which suitable for drinking livestock at a very good rate. By comparing the average concentrations of dissolved solids with what shown in Table 12, it was found that the water is suitable for livestock and horses.

Table 11. Standards suggested by Altoviski (1962) for livestock uses in ppm.

Elements Ppm	**Very good water**	**Good**	**Recommended Uses water acceptable**	**Can be use**	**Upper limit**	**Wet season (ppm)**	**Dry season (ppm)**
Na^+	800	1500	2000	2500	4000	76- 858	98 – 888
Ca^{+2}	350	700	800	900	1000	81-533	100 – 545
Mg^{+2}	150	350	500	600	700	84 - 178	105 – 196
Cl^-	900	2000	3000	4000	6000	99 - 1335	112 – 1350
SO_4^{-2}	1000	2500	3000	4000	6000	886 - 1634	900 – 1654
T.D.S	3000	5000	7000	10000	15000	1506 - 3940	1603 – 4045
TH	1500	3200	4000	4700	54000	1940 - 1399	1200 – 3300

Table 12. Standard specifications for animal drinking according to the classification of 29 (WHO, 2011).

ppm TDS	**Animal type**	**Rang of values of samples (ppm)**
2860	Livestock	983 - 3389
6435	Horses	
7150	Milk cattle	
10000	Meat cattle	
12900	Sheep	

Usability of Groundwater for Irrigation Purposes:

The chemical and physical properties of water used for irrigation are similar to the types of water used in agriculture in that it contains dissolved solids, sodium, and toxic ions. The Agricultural

Nutrition Organization classification FAO (1997).was adopted to evaluate groundwater samples in the region. The study area and its acceptance of the irrigation schedule 13. We note that the TDS percentage is very high and is not suitable for irrigation, and the EC values are also high and not suitable for irrigation as well.

Table 13. Water type accepted for Irrigation according to FAO (1997).

E.c µS/cm	TDS Regarding ppm	Characterizes
100-250	Less than 200	Water little salinity and suitable irrigate
250-750	200-500	Moderately salinity and need filtration
750-2250	500-1500	High salinity and cant use near
2250-5000	1500-3000	Very high and not suitable irrigate and need to desalination soil
More than 5000	More than 3000	Not a actionable irrigate

usability of Groundwater for agricultural purposes:

TDS plays an influential role in groundwater if it reaches plant roots, which reduces their productivity and increases the soil's ability to filter (Levy and Kearney, 1999). If the concentration of Na% increases, it reduces soil permeability. If the exchange rate between sodium and calcium ions increases, the high concentration of bicarbonate may lead to the precipitation of calcium and magnesium, and thus to an increase in their proportion in calcium, which leads to a decrease in soil porosity (Heim, 1986). The percentage of sodium (Na%) is calculated from the following equation (Hamil and Bill, 1986) with a value of epm.

$$Na\% = \frac{Na + K}{Ca + Mg + Na + K} * 100 \qquad (1)$$

If Na% exceeds 60%, the water is considered poor quality. Comparing the values in the study area, we find that all values are less than 60%, and therefore the water is considered good, as shown in Table 13. Sodium absorption ratio (SAR): It is considered an important criterion for determining the suitability of water for agriculture because it is a measure of the risk of alkalis/sodium (Subramani et al., 2005). Richards (1954) defined the sodium absorption ratio (SAR) of water as follows .

$$SAR = Na / \sqrt{(Ca + Mg)/2} \qquad (2)$$

Where concentration are reported in (meq/l).
Concentrations are recorded in milliequivalents per liter. The specific absorption rate (SAR) measures the tendency of irrigation water to undergo exchange reactions in the soil. A high SAR value indicates the risk of sodium being replaced by absorbed calcium and magnesium, ultimately damaging the soil structure (Heim, 1985). Water is classified into four categories based on the SAR values in Table 14. Comparing the SAR results for the study area in Table 14 with Table 15 reveals that all well water was of excellent quality .

Table 14. Values of (SAR, Na %) for water samples in study area

Samples no.	SAR	Na%
1	1.64	30.1%
2	2.77	42.6%
3	2.28	31.3%
4	1.30	26.5%
5	3.85	43.7%
6	2.81	29.5%
7	3.33	48,5%
8	1.26	27.2%

When comparing the results of the SAR in Table 14 for the samples of the study area with the values in Table 15, as result that the SAR values in the entire study area fall under < 10, and therefore it all under the first category S1, that, the water quality is excellent.

Table 15. Alkalinity hazard classes of water (Subramani *et al*., 2005).

SAR	Alkalinity hazard	Water class	Representing samples
< 10	S1	Excellent	All ground water Samples
10- 18	S2	Good	W8 in dry season
18-26	S3	Doubtful	-------
> 26	S4	Unsuitable	-------

When comparing the results of the study with what is found in Table 16, it is found that samples (1, 2, 3 and 5) show that the water quality is Doubtful, and samples (3and7) that the water quality is unsuitable, and that samples (4, 8) show that the quality of the water is permissible.

Table 16. Classification of irrigation waters according to (Don, 1995).

EC uS\cm	TDS ppm	SAR	Na%	pH	Water Quality
250	175	3	20	6.5	Excellent
250-750	175-525	3-5	20-40	6.5-6.8	Good
750-2000	525-1400	5-10	40-60	6.8-7.0	Permissible
2000-3000	1400-2100	10-15	60-80	7-8	Doubtful
>3000	>2100	>15	>80	>8	Unsuitable

DISCUSSION OF RESULTS

The results were obtained from various analyzes of the water of the study area, where it was found that the pH values were neutral to slightly alkaline, falling within international standards, The dissolved solids values in most samples were found to be at lower concentrations when compared to the international standard values.. Its source may be due to Agricultural runoff/pesticide and sewage discharge. Or from natural sources such as weathering of rocks. The electrical conductivity values, when compared with an international standard, were found to be excessively mineral water, with the exception of the value of well No. (3). As for the validity values of the results obtained, they are from Table 3, We find that there are some values that fall within the acceptable values, and there are Some values fall within acceptable risks.

It was found that some calcium ion concentrations in some samples are so high that they exceed the values of international specifications for drinking water (WHO, 2007). The reason may be due to an

increase in the ion exchange process between calcium and sodium ions. It is possible that this increase is the result of groundwater mixing with wastewater in some urban areas in the study area. When these materials are oxidized, large amounts of carbon dioxide are released, leading to an increase in calcium ions (WHO, 2007). As for the magnesium ion concentration, it was found that there are some examples of a higher concentration than the global values for drinking water found in Table 7. The reason may be due to the ion exchange process and the effect of the evaporation process, or it is originally present from natural sources from the melting of dolomite rocks. The most valuable sodium ion is present in the global values of drinking water. Its natural source is concentrated in sedimentary rocks containing evaporate minerals such as halite (Banat and Howari, 2002), in addition to human activities that have a significant impact on sodium levels in surface and groundwater (Hem, 1989) and human activities affect sodium concentration. This is due to the extensive use of salts by households in addition to irrigation water (WHO, 2006). When comparing the presence of potassium ions in the water of the study area to international standards for drinking purposes, some of the water contains high concentrations of potassium ions in excess of the permissible limit. The reason is either from a natural source or due to the presence of wastewater, irrigation water discharges, and the use of fertilizers (Daly, 1994). The increase may also be due to the dissolution of sodium bicarbonate in the soil as a result of irrigation operations. Most of the chloride ion value is higher than what is shown in Table 6. The reason for its high levels may be due to pollution resulting from industrial wastewater, sewage outlets, irrigation drains, fertilizers, and water treatment with chloride, which has an effect in increasing the concentration of chloride ions in the water (WHO, 1996). Or sulfate ions, All the values of the study models are higher than what is shown in Table 6. The reason may be due to either their natural confiscation or to the release of sulfate ions by water as a result of their washing from the upper layers of the soil and their transfer to groundwater. Also, the falling rain contains sulfate ions. Its concentration in groundwater in the gypsum layer was found to be 1360 ppm. Its concentration in natural waters is less than 200 parts per million (Richards, 1954). The concentration of bicarbonates was found to be within the global resource values, and its source was either natural or anthropogenic. The pH of water indicates the presence of dissolved carbon dioxide, and the presence of carbonic acid is an indicator. When the pH is below 4.5, bicarbonates are present, and between 4.5 and 8.2, carbonates are present. When the pH exceeds 8.2, the water is charged with carbon dioxide, which dissolves carbonate minerals (Davis and DeWest, 1966). Regarding the various uses of the water in the study area, it was found to be unsuitable for drinking and industrial purposes. However, its use in construction, cattle and horse grazing, and agriculture was deemed appropriate, based on a comparison of its concentrations with local and international standards. Finally, the water was found to be unsuitable for irrigation due to its high total dissolved salts concentrations and electrical conductivity values, which are too high compared to international standards, and should be disposed of in the soil.

CONCLUSIONS

The study concludes that water quality depends on its physical properties, including pH, which ranges from neutral to slightly alkaline. The water is highly saline and mineralized, according to the electrical conductivity values. The chemical properties reveal that the source of the elemental ions is either natural or anthropogenic. The water is unsuitable for drinking and industrial purposes, but is also unsuitable for construction, livestock drinking, and irrigation. Some wells in the study area are of questionable safety, and some are unsuitable for irrigation. Compared to international standards, the water is suitable for agriculture, and the water quality is good, based on the values of the electrical conductivity (EC), total dissolved solids (TDS), specific absorption ratio (SAR), sodium (Na%), chloride (Cl-), and sulfur dioxide (SO4).

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