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للبحوث والدراسات

مجلة علمية محكمة ومفهرسة

سلسلة العلوم الطبيعية والتطبيقية

تصدر في جامعة مؤتة

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الفهرس:

* ما ورد في هذا العدد يعبر عن آراء الكتاب أنفسهم ولا يعكس بالضرورة آراء هيئة التحرير أو سياسة جامعة مؤتة.

الهيئة الاستشارية الدولية

مؤتة للبحوث والدراسات

سلسلة العلوم الطبيعية والتطبيقية

مجلة علمية محكمة ومفهرسة تصدر عن عمادة البحث العلمي في جامعة مؤتة

كلمة المحرر

تصدر مجلة مؤتة للبحوث والدراسات في سلسلتها **العلوم الطبيعية والتطبيقية** منذ عام 1986، وهي مجلة علمية محكمة ومفهرسة، وتصدر بشكل منتظم وبواقع مجلد واحد في كل عام منذ تأسيسها، يحتوي المجلد على عددين، ويشرف على تحريرها هيئة من الأساتذة المتخصصين والأكاديميين في مختلف التخصصات العلمية والتطبيقية، ورقم تصنيفها الدولي(ISSN 1022-6812) . تقوم المجلة بنشر الأبحاث الأصيلة التي تسهم بنشر العلم والمعرفة في كافة تخصصات **العلوم الطبيعية والتطبيقية**. وتخضع الأبحاث المقدمة للنشر إلى معايير دقيقة تشمل التدقيق الفني والتحكيم العلمي من قبل محكمين اثنين للتحقق من صلاحية البحث للنشر.

وقد حظيت المجلة بسمعة رائدة محلياً وإقليمياً على مدار الثلاث عقود الماضية، فأصبحت مجلة معتمدة لغايات النقل والترقية للباحثين في كافة الجامعات الحكومية والخاصة في الأردن، بشكل خاص، والعالم العربي، بشكل عام، وهذا يبرر العدد الكبير والمتزايد من الأبحاث الذي يرد إلى المجلة من جامعات ومؤسسات ومراكز بحثية محلية وإقليمية ودولية، ولضمان جودة الأبحاث المنشورة في المجلة، فإنها تتبع معايير وضوابط وإجراءات تضمن جودة المنتج البحثي وتتضمن:

1. قواعد النشر
2. المواصفات الفنية
3. إجراءات النشر
4. أخلاقيات النشر

عميد البحث العلمي

رئيس التحرير

أ. د أسامه عيسى مهاوش

1. قواعد النشر.

انسجاماً مع الخطة الاستراتيجية لجامعة مؤتة ورؤيتها للوصول إلى تحقيق معايير التصنيفات العالمية للجامعات، وانطلاقاً من الخطة الاستراتيجية لعمادة البحث العلمي ورؤيتها التي تنص على: **(نحو عمادة حاضنة لبحث علمي متميز يرتقي بتصنيف الجامعة محلياً وإقليمياً وعالمياً)** ورسالتها التي تتضمن: **(تأمين بيئة قادرة على إنتاج بحوث علمية تسهم في تعزيز دور الجامعة في البحث والابتكار محلياً وإقليمياً وعالمياً)**. فقد ارتأت عمادة البحث العلمي تطوير مجلة مؤتة للبحوث والدراسات للوصول إلى قواعد البيانات العالمية، مثل: SCOPUS, ISI, PubMed والارتقاء بعامل التأثير (Impact Factor) للمجلة، لوصول الانتاج البحثي للمؤلفين إلى العالمية.

وبناء عليه، وعند تقديم أبحاثكم للنشر في المجلة، يراعى الآتي:

1. اعتماد نظام جمعية علماء النفس الأمريكية (APA)، للاطلاع على الدليل المختصر لطريقة التوثيق، ولمزيد من الأمثلة، يرجى زيارة الموقع التالي: http://www.apastyle.org/ وموقع المجلة على الرابط: https://ejournal.mutah.edu.jo
2. تكتب جميع المراجع العربية باللغة الإنجليزية في المتن وفي قائمة المراجع.
3. ترجمة كافة المراجع غير الإنجليزية (بما في ذلك المراجع العربية) إلى اللغة الإنجليزية، مع ضرورة ابقاء القائمة العربية موجودة.
4. اذا كان للمراجع العربية ترجمة إنجليزية معتمدة فيجب اعتماد ذلك، أما المراجع التي ليس لها ترجمة إنجليزية معتمدة (مثل: فقه السنه) فيتم عمل Transliteration أي كتابة المرجع بالأحرف الإنجليزية كتابة حرفية، (Fiqih Alsunah) .
5. إعادة ترتيب كافة المراجع (والتي يفترض أنها قد أصبحت باللغة الإنجليزية) حسب ترتيب الأحرف الإنجليزية (Alphabets) بما يتناسب مع نظام APA.
6. يجب الالتزام بالمواصفات الفنية لتحرير المخطوط المبينة على موقع المجلة، علماً بأن البحث يخضع للتدقيق الفني عند استلامه. وفي حال عدم الالتزام بهذه المواصفات الفنية يُعاد البحث.
7. يتم تسليم البحث والملفات المطلوبة والنماذج الخاصة بها الكترونياً على الموقع https://ejournal.mutah.edu.jo/ والمبينة في الجدول التالي.
8. عدم الالتزام بأي من النقاط السابقة يعفي المجلة من السير في إجراءات التحكيم

الرقم	اسم الملف	ملاحظات
.1	رسالة تغطية **Cover Letter**	توجه الى رئيس التحرير
.2	صفحة الغلاف **Title Page**	يكتب التالي باللغتين العربية والإنجليزية في صفحة الغلاف وحسب الترتيب التالي: 1. عنوان البحث 2. اسم الباحث (الباحثين) من ثلاثة مقاطع. 3. العنوان البريدي 4. الرتبة العلمية 5. البريد الإلكتروني 6. رقم الهاتف
.3	ملخص البحث **Abstract**	يكتب الملخص باللغتين العربية والإنجليزية بحيث لا يزيد الملخص عن (150) كلمة والكلمات المفتاحية **(keywords)** عن خمس كلمات.
.4	البحث **Research Document**	يجب أن تلتزم وثيقة البحث بالمتطلبات التالية: 1. عدم وجود اسم الباحث (الباحثين). 2. أن لا يحتوي البحث على أي معلومات تشير إلى الباحث (الباحثين). 3. أن يكون التوثيق للمراجع في المتن **(In-text Citation)** باللغة الإنجليزية. 4. اعتماد نظام جمعية علماء النفس الأمريكية **(APA)**. 5. الالتزام بالمواصفات الفنية لطباعة البحث. 6. تخضع البحوث للتدقيق الفني قبل السير في إجراءات التحكيم.
.5	قائمة المراجع **References**	يجب أن تلتزم قائمة المراجع بالمتطلبات التالية وترسل في نفس الملف: 1. تكتب المراجع (الواردة في البحث باللغة الإنجليزية) في القائمة النهائية مرتبة حسب الحروف الهجائية **(Alphabets)**. 2. إذا كان للمراجع العربية ترجمة إنجليزية معتمدة فيجب اعتماد ذلك، أما المراجع التي ليس لها ترجمة إنجليزية معتمدة (مثل: فقه السنة) فيتم عمل **Transliteration** أي كتابة المرجع بالأحرف الإنجليزية كتابة حرفية (**Fiqih Alsunah**). 3. إعادة ترتيب كافة المراجع (والتي يفترض أنها قد أصبحت باللغة الإنجليزية) حسب ترتيب الأحرف الإنجليزية **(Alphabets)** بما يتناسب مع نظام **APA**. 4. الإبقاء على قائمة المراجع العربية وإدراجها في نهاية الملف بعد المراجع المترجمة.
.6	التعهد Pledge	يلتزم الباحث بتعبئة التعهد

2. المواصفات الفنية.

يجب الالـــتزام بالمواصفات الفنيـــة لتحريـــر المخطوط والموجـــودة على الرابـــط: https://ejournal.mutah.edu.jo ، حيث يخضع البحث للتدقيق الفني عند استلامه، وفي حال عدم الالتزام بهذه المواصفات الفنية يُعاد البحث.

3. إجراءات النشر.

1. يُقدم البحث للنشر إلى عمادة البحث العلمي في جامعة مؤتة الكترونياً على موقع المجلة https://ejournal.mutah.edu.jo.
2. يوقع الباحث على تعهد النشر وفق نموذج خاص تعتمده المجلة.
3. يعرض البحث على هيئة تحرير المجلة، ويسجل في السجلات المعتمدة.
4. يخضع البحث المرسل إلى المجلة إلى التدقيق الفني والتحكيم الأولي من هيئة التحرير؛ لتقرير أهليته للتحكيم الخارجي، ويحق للهيئة أن تعتذر عن السير في إجراءات التحكيم الخارجي أو عن قبول البحث للنشر في أي مرحلة دون إبداء الأسباب.
5. يرسل البحث إلى محكمين اثنين على أن يقوم كلاً منهما بالرد في مدة أقصاها شهر، وفي حال عدم الرد ضمن الموعد المحدد يتم ارسال البحث إلى محكم آخر، وبناء عليه يكون قرار هيئة التحرير على النحو الآتي:

أ. يُقبل البحث للنشر في حالة ورود تقارير إيجابية من المحكمين الإثنين، وبعد أن يقوم الباحث بإجراء التعديلات المطلوبة، إن وجدت.

ب. في حال ورود تقارير سلبية من كلا المحكمين يرفض البحث.

ج. في حالة ورود رد سلبي من أحد المحكمين ورد إيجابي من المحكم الثاني يرسل البحث إلى محكم ثالث للبت في أمر صلاحيته للنشر.

6. إذا كان الباحث من جامعة ما فلا يجوز أن يُحكَّم البحث من قبل زميل يعمل في الجامعة نفسها.
7. يجب على الباحث بعد إبلاغه بإجراء التعديلات أن يقوم بذلك وفق ملاحظات المحكمين في مدة أقصاها أسبوعين من تاريخه، وفي حال عدم استجابة الباحث ضمن المدة المحددة يتم وقف إجراءات السير في نشر البحث.
8. إذا أفاد المحكم (مراجع التعديلات) أن الباحث لم يقم بالالتزام بإجراء التعديلات المطلوبة، يُعطى الباحث فرصة ثانية وأخيرة مدتها أسبوعين للقيام بالتعديلات المطلوبة، وإلاّ يرفض البحث ولا ينشر في المجلة.
9. تمنح رسالة القبول بعد إجراء التدقيق الفني المترتب على البحث بعد التعديل.
10. ترتب البحوث المقبولة في المجلة وفقا لسياسة المجلة.
11. ما ينشر في المجلة يعبر عن وجهة نظر الباحث ولا يعبر بالضرورة عن وجهة نظر جامعة مؤتة، أو هيئة التحرير، أو القائمين عليها.

4. أخلاقيات النشر.

تلتزم هيئة التحرير والمحكمون والباحثون بأخلاقيات النشر التالية:

أولاً: واجبات هيئة التحرير

1. العدالة والاستقلالية: يقوم المحررون بتقييم المخطوطات المقدمة للنَّشر على أساس الأهمية والأصالة وصحة الدراسة ووضوحها وأهميتها لنطاق المجلة، بغض النظر عن جنس المؤلفين أو جنسيتهم أو معتقدهم الديني بحيث يتمتع رئيس التحرير بسلطة كاملة على كامل المحتوى التحريري للمجلة وتوقيت نشره.
2. السرية: هيئة التحرير وموظفو التحرير مسؤولون عن سرية أية معلومات حول البحث المقدم وعدم إفشاء هذه المعلومات إلى أي شخص آخر غير المؤلف والمحكمين والهيئة الاستشارية كلٌ وفقاً لاختصاصه.
3. الإفصاح وتضارب المصالح: هيئة التحرير مسؤولة عن عدم استخدام معلومات غير منشورة موجودة في البحث المقدم لأغراض النشر دون موافقة خطية صريحة من المؤلفين، ويجب على عضو هيئة التحرير الإفصاح عن وجود أي تضارب في المصالح مع أي من المؤلفين. مثل علاقات تنافسية أو تعاونية أو علاقات أخرى مع أي من المؤلفين؛ بدلاً من ذلك، سوف يطلبون عضو خارجي للتعامل مع المخطوطة.
4. قرارات النشر: تحرص هيئة التحرير على أن تخضع جميع الابحاث المقدمة للتحكيم من قبل اثنين على الأقل من المحكمين الذين هم خبراء في مجال البحث. وتعتبر الهيئة مسؤولة عن تحديد أي من الابحاث المقدمة إلى المجلة التي سيتم نشرها، بعد التحقق من أهميتها للباحثين والقراء.

ثانياً: واجبات المحكمين.

1. المساهمة في صنع قرارات هيئة التحرير.
2. السرعة والدقة في الوقت: أي محكم يشعر بعدم قدرته على مراجعة البحث لأي سبب كان يجب عليه إخطار هيئة التحرير على الفور ورفض الدعوة للتحكيم بحيث يمكن الاتصال بالمحكمين البدلاء.
3. السرية: أي أبحاث وردت للمجلة للتحكيم والنشر هي وثائق سرية؛ لذا يجب ألا تظهر أو تناقش مع الآخرين إلا إذا أذن بها رئيس التحرير وينطبق هذا أيضا على المحكمين المدعوين الذين رفضوا الدعوة للتحكيم.
4. معايير الموضوعية: يجب مراجعة وتحكيم الأبحاث بموضوعية وأن تُصاغ الملاحظات بوضوح مع الحجج الداعمة، بحيث يمكن للمؤلفين استخدامها لتحسين أبحاثهم بعيداً عن النقد الشخصي للمؤلفين.

5. الإفصاح وتضارب المصالح: يجب على أي محكم مدعو للتحكيم أن يُخَطِّرَ هيئة التحرير على الفور بأن لديه تضارب في المصالح ناجم عن علاقات تنافسية أو تعاونية أو علاقات أخرى مع أي من المؤلفين بحيث يمكن الاتصال بالمحكمين البدلاء.
6. المحافظة على سرية المعلومات أو الأفكار المتميزة غير المنشورة والتي تم الكشف عنها في الأبحاث المقدمة للتحكيم وعدم استخدامها دون موافقة كتابية صريحة من المؤلفين وينطبق هذا أيضاً على المحكمين المدعوين الذين يرفضون دعوة التحكيم.

ثالثا: واجبات المؤلفين.

1. معايير إعداد البحث: يجب على المؤلفين الالتزام بالقواعد والإجراءات والمواصفات الفنية وأخلاقيات النشر الموجودة على موقع المجلة.
2. السرقة الأدبية: لا يجوز بأي حال من الأحوال الاعتداء على حق أي مؤلف آخر بأي صورة من الصور فالقيام بهذا العمل يعتبر سرقة أدبية ويتحمل من قام بهذا العمل كامل المسؤولية القانونية والأدبية عن ذلك.
3. الأصالة: يجب على المؤلفين التأكد من تقديم أعمال أصيلة تماما، وتوثيق أعمال أو كلمات الباحثين الآخرين التي تم الرجوع اليها في بحثهم. وينبغي أيضا الاستشهاد بالمنشورات المؤثرة في مجال البحث المقدم. فأخذ المعلومة دون توثيق المصدر بجميع أشكاله يُشكل سلوكاً غير أخلاقي للنشر ويأخذ أشكالاً عديدة، مثل اعتماد بحث على أنه للمؤلف نفسه، نسخ أو إعادة صياغة أجزاء كبيرة من بحث أخر (دون الإسناد).
4. عدم إرسال البحث إلى مجلات مختلفة وبشكل مُتزامن: يجب على المؤلف عدم إرسال أو نشر نفس البحث في أكثر من مجلة واحدة. وبالتالي، لا ينبغي للمؤلفين أن يُقدموا مخطوطة سبق نشرها في مجلة أُخرى وذلك لأن تقديم بحث بالتزامُن مع أكثر من مجلة واحدة هو سلوك غير أخلاقي وغير مقبول.
5. تأليف المخطوطة: يجب أن يتم إدراج الأشخاص الذين يستوفون معايير التأليف التالية كمؤلفين في البحث بحيث يكونوا قادرين على تحمل المسؤولية العامة عن المحتوى: (1) تقديم مساهمات كبيرة في تصميم أو تنفيذ أو الحصول على البيانات أو تحليل أو تفسير الدراسة؛ (2) المساهمة في صياغة وكتابة محتوى البحث أو مراجعته. (3) مراجعة النسخة النهائية من البحث والموافقة عليها وعلى تقديمها للنشر. إضافة إلى ذلك هناك أشخاص لا يستوفون معايير التأليف فيجب ألا يُدْرَجوا كمؤلفين، ولكن يجب ذكرهم في قسم "شكر وتقدير" بعد الحصول على إذن كتابي منهم.
6. الإفصاح وتضارب المصالح: يجب على المؤلفين الإبلاغ عن أي تضارُب في المصالح مع جهات لا تعلمها هيئة التحرير يمكن أن يكون له تأثير على البحث. ومن أمثلة التضارب المحتمل في المصالح التي ينبغي الإفصاح عنها مثل العلاقات الشخصية أو المهنية، والانتماءات، والمعرفة في الموضوع أو المواد التي نوقِشتْ في البحث.
7. المخاطر والمواد البشرية أو الحيوانية: إذا كان العمل ينطوي على استخدام مواد كيميائية أو إجراءات أو معدات لها أي مخاطر غير عادية، فيجب على المؤلفين تحديدها بوضوح في البحث. وكذلك إذا كان العمل ينطوي على استخدام أو إجراء تجارب على البشر أو الحيوانات في بحثهم، فيجب على المؤلفين التأكد من أن جميع الإجراءات تم تنفيذها وفقاً للقوانين والتعليمات ذات الصلة وأن المؤلفين قد حصلوا على موافقة مسبقة بهذا الخصوص. وكذلك ويجب مراعاة حقوق الخصوصية الخاصة بالمشاركين من البشر.
8. التعاون: يجب على المؤلفين التعاون بشكل كامل والاستجابة الفورية لطلبات المُحررين بشأن البيانات الأولية والتوضيحات وإثبات الموافقات الأخلاقية وموافقات المرضى وأذونات حقوق الطبع والنشر. وفي حالة اتخاذ قرار أولي بشأن إجراء التعديلات الضرورية على البحث، يجب على المؤلفين الاستجابة لملاحظات المحكمين بشكل منهجي ويقوموا بإجراء التعديلات المطلوبة وإعادة تقديمها إلى المجلة بحلول الموعد النهائي المحدد.
9. الأخطاء الأساسية في الأعمال المنشورة: عندما يكتشف المؤلفون أخطاء كبيرة أو عدم دقة في أعمالهم المنشورة، فإن عليهم الالتزام بإخطار محرري المجلة أو الناشر فوراً والتعاون معهم إما لتصحيح البحث أو سحبه.

رئيس هيئة تحرير مجلة مؤتة للبحوث والدراسات

الأستاذ الدكتور أسامه عيسى مهاوش

عميد البحث العلمي

جامعة مؤتة

الرمز البريدي (61710) مؤتة / الأردن

Tel: +962-3-2372380 Ext (6117)

Fax. +962-3-2370706

Email: darmutah@mutah.edu.jo

مؤتة للبحوث والدراسات

مجلة علمية محكّمة ومفهرسة تصدر عن

عمادة البحث العلمي

جامعة مؤتة

قسيمة اشتراك

أرجو قبول اشتراكي في مجلة مؤتة للبحوث والدراسات:

☐ سلسلة العلوم الإنسانية والاجتماعية ☐ سلسلة العلوم الطبيعية والتطبيقية

للمجلد رقم ( ) الاسم :..... العنوان : .....

التاريخ : / / 200 التوقيع :..... .....

طريقة الدفع : ☐ شيك ☐ حوّالة بنكية ☐ حوّالة بريدية

أ – داخل الأردن : للأفراد (9) دنانير أردنية.

للمؤسسات (11) ديناراً أردنياً.

ب – خارج الأردن (للأفراد والمؤسسات): (30) دولاراً أمريكياً.

ج– للطلبة: (5) دنانير سنوياً

د – تضاف أجرة البريد لهذه الأسعار.

تُملأ هذه القسيمة، وترسل مع قيمة الاشتراك إلى العنوان التالي:

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المحتويات

Geological Map of Suwaylih, 3154-II, National Resources Authority, Amman.

Semenov, A. (1987). NMR Hydroscope for water prospecting. Proceedings of a Seminar on Geotomography, Indian Geophysical Union, Hyderabad,: 66– 67.

Shawabkeh, K. (2001). Map sheet 3153 IV.- National Resources Authority, Amman.

Talozi, A. (2007). Water and Security in Jordan, Integrated Water Resources Management and Security in the Middle East, NATO Science for Peace and Security, C: Environmental Security, Dordrecht: Springer in Cooperation with the NATO Public Diplomacy Division,: 73- 98.

Weichmann, P., Lavely, E., &, M. Ritzwoller, (2000). Theory of Surface Nuclear Magnetic Resonance with Application To Geophysical Imaging Problem, Physical Review E, 62 (1) :1290-1312.

Wolfart, R., (1959). Geology and hydrology of the Irbid district (Hashemite Kingdom of Jordan). Bundesanstalt fuer Bodenforschung. Hanover.

Colorado, Environmental and Engineering Geophysical Society: 717- 736.

MacDonald, M. & Partners, (1963). Salt 1:25.000 C.W.A. Geologic Series Sheet 215/150. Jordan office for geological and engineering services, Amman.

Masri, M., (1963). Report on the geology of the Amman-Zarqa area, Central Water Authority, (Unpubl. Rep), Amman,: 1-74.

Moh'd B. & S. Muneinzel, (1998). The geology of Al Salt area, Map sheet No 3154III.- Bulletin No. 41, Amman,: 67.

NWMP, (1977). National Water Master Plan of Jordan. Hannover, Bundesanstalt für Geowissenschaften und Rohstoffe, GTZ, (8).

Pake, G. (1993). Nuclear magnetic resonance in bulk matter: Physics Today, (46): 46- 51.

Sahawneh, J., (2011). "Structural Control of Hydrology, Hydrogeology and Hydrochemistry

along the Eastern Escarpment of the Jordan Rift Valley, JORDAN", Universität Karlsruhe, :4, :136.

Salameh, E. (1996). Water quality degradation in Jordan (impact on environment, economy and future generations resources base). Fredrich Eberet Stiftung, R Soc Conservation Nature, Amman.

Sawarieh, A., & M. Barjous, (1993). National Mapping Project. Geological Mapping Division,

References:

Behroozmand, A., Teatini P., Pedersen J., Auken E., Tosatto O., and A. Christiansen, (2017). Anthropogenic wetlands due to over-irrigation of desert areas: a challenging hydrogeological investigation with extensive geophysical input from TEM and MRS measurements. Hydrol. Earth Syst. Sci., 21: 1527– 1545.

Flexer, A. (2009). "Regional setting", The Water of the Jordan Valley, 512.

Hadadin, N., (2015). Dams in Jordan Current and Future Perspective. Canadian Journal of Pure

and Applied Sciences, (9): 3279- 3290.

Hertrich, M., Braun, M., U.Yaramanci, (2005). Magnetic Resonance Soundings with separated transmitter

and receiver loops. Near Surface Geophysics (3): 141- 154

Legchenko, A., Baltassat, J-M., Beauce, A., & J. Bernard, (2002). Nuclear magnetic resonance as a geophysical tool for Hydrogeologists: Journal of Applied Geophysics (50): 21- 46.

Lieblich, D.A., Legchenko, A., Haeni, F.P., and A. Portselan, (1994). Surface nuclear magnetic resonance experiments to detect subsurface water at Haddam Meadows, Connecticut, in Bell, R.S., and Lepper, C.M., eds., Symposium on the Application of Geophysics to Engineering and Environmental Problems, Boston, Massachusetts, March 27-31, 1994, Proceedings: Englewood,

variation in the water content suggest that there is a change in lithology in the subsurface. Both these factors likely affect the recharge for the subsurface aquifers. The 2D model results for the water content indicate a highly-localized zone of high water content (an aquifer) at a depth of 40–60 m between station SNMR 1 and SNMR 2 (figure 6). This is likely a semi-confined aquifer. Higher and moderate water content located between station SNMR 1 and SNMR 2 where hydraulic conductivity is high. The recharge of this zone seems to be due to the vertical surface infiltration.

3. Conclusion

In spite of the topography and the cultural noise in the study area, the data from this study show that utilizing SNMR is an excellent method for estimating percentage of water content and hydraulic conductivity in the subsurface. The 2D model of the SNMR data shows the distribution and thickness of an aquifer at depth near the Wadi Shueib Dam. The results show horizontal and vertical variations of water content percentage and hydraulic conductivity which indicate a change in sediment type with depth and complex geology in the study area likely due to faulting along the Dead Sea transform system. The SNMR results can be used to estimate the recharge direction and help to construct hydrogeological models of Wadi Shueib Dam area.

located between station SNMR 1 and SNMR 2 at a depth of approximately 40-60 m.

This zone also has a hydraulic conductivity of more than 10^{-5} m/s (figure 6).

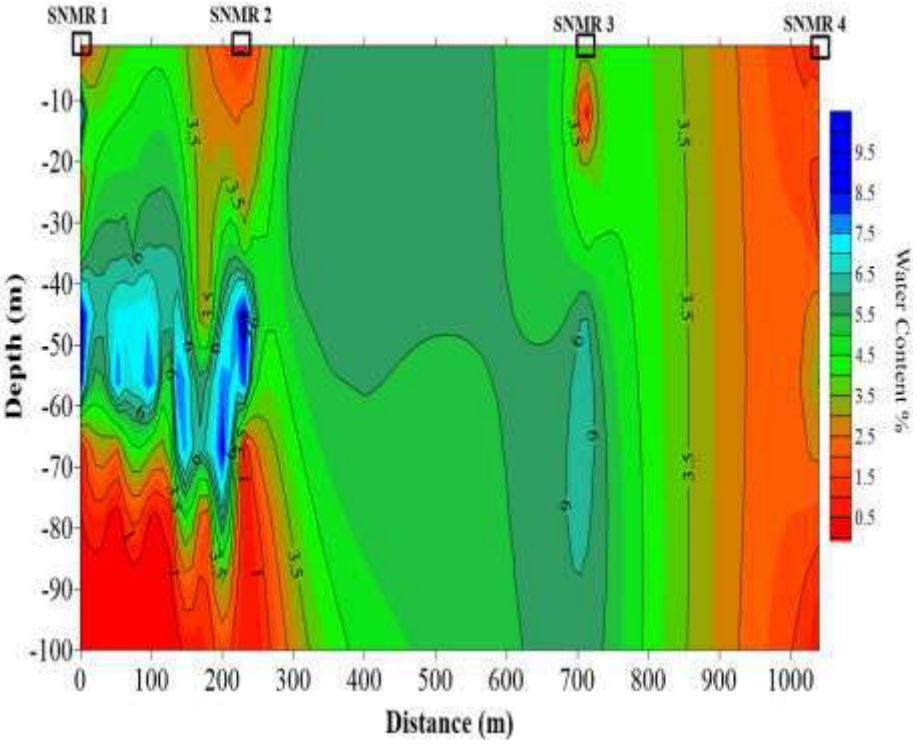

Figure (6) Water content distribution with depth.

The vertical and lateral hydraulic conductivity variations in the study area indicate a complex subsurface geological structures. The abrupt termination of the hydraulic conductivity between station SNMR 1 and SNMR 3 suggests that there is a fault at this location (figure 2b). This lateral

sand). And high hydraulic conductivity values (more than 10^{-4} m/s) represent high permeability materials (coarse sand or gravel). The high and moderate conductivity layers are located between station SNMR 1 and SNMR 2 very close to the dam.

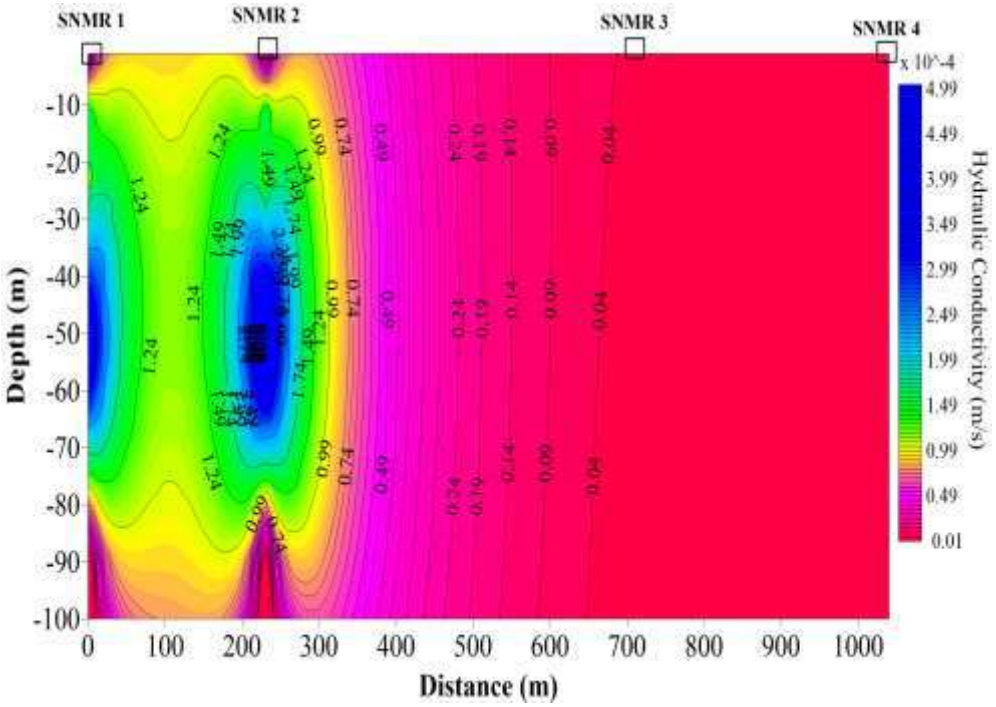

Figure (5) Hydraulic conductivity distribution with depth.

The distribution of the water content percentage with depth along the SNMR profile is shown in figure 6. Cooler colors (blues) show areas of relatively high water content, whereas warmer colors (reds) show areas of relatively low water content. The zone with the highest water content is

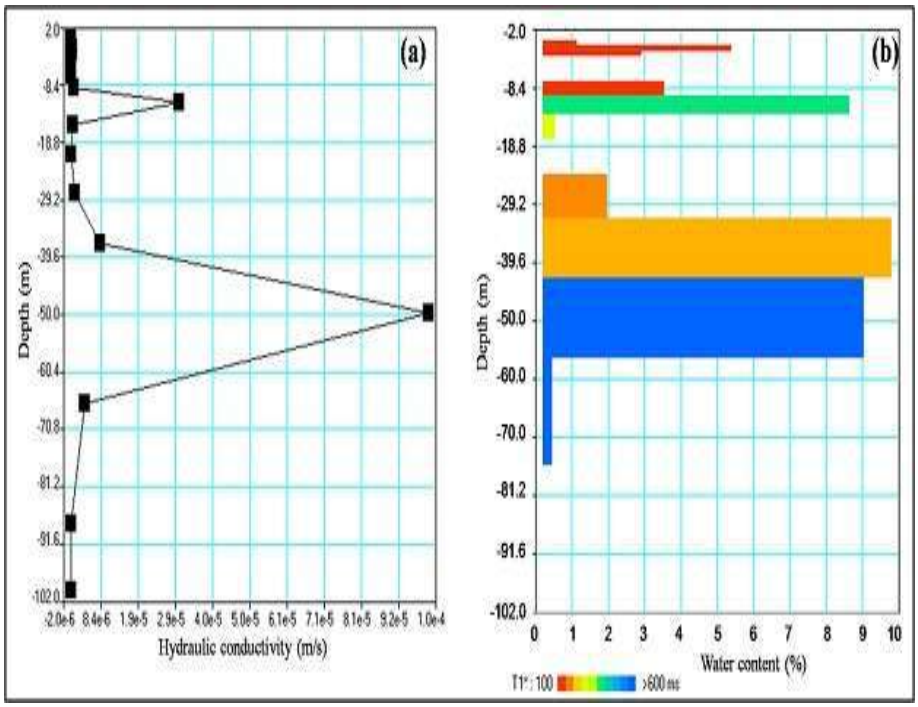

Figure (4: a) The distribution of hydraulic conductivity (m/s) with depth for station SNMR 1. b) Water content percentage versus depth and the decay time constant T_1^* of the signal (ms) versus depth.

Two cross sections were constructed from the data along a profile that connects the four SNMR stations (figure 5 and 6). A map of the variation in hydraulic conductivity and water content percentage to a maximum depth of 100 m along the cross section was made by contouring the data from each site.

Three hydraulic conductivity ranges are shown in the profile (figure 5). Low hydraulic conductivity values (less than 10^{-5} m/s) likely represent low permeability materials (clay and silt). The moderate hydraulic conductivity between 10^{-5} to 10^{-4} m/s represents moderate permeability materials (fine

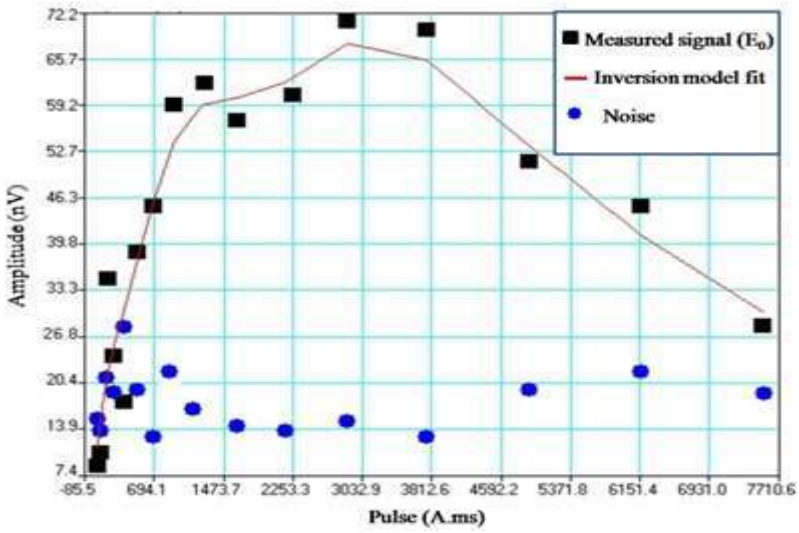

Figure (3) Maximum measured amplitude of the signal versus pulse moment for station SNMR 1.

2. Results

Data from the survey in the Wadi Shueib area indicate that SNMR is an effective method for mapping subsurface water storage. Figure 4 shows the variation of hydraulic conductivity (m/s) with depth for the SNMR Station 1. Also, show is the percentage of water content and the decay time constant (T_1^*) of the signal (ms) with depth. The latter measurement is used to determine the relative hydraulic conductivity of the sediments versus depth. Zones with high water content and high hydraulic conductivity are interpreted as aquifers, i.e. sediment with high permeability. Whereas zones with low water content and low hydraulic conductivity are interpreted as aquicludes or aquitards, i.e. sediment with low permeability.

1-The rock resistivity: conductive ground leads to less penetration and less depth.

2-The earth magnetic field: the higher the field amplitude the higher the signal amplitude and easier detection of the deep aquifer.

1. Field Survey and Processing

The SNMR survey was conducted in the Wadi Shueib Dam area at the end of autumn when the dam was almost empty of water. We utilized a NUMIS Plus instruments from IRIS instruments (France) with maximum 100 m depth of penetration deep. Data were collected along a 1-km-long transect at a total of six SNMR stations where the surficial materials are unconsolidated sediments, primarily sands and sandy clay. We used a 100 m per side square loop according to the limitations of the terrain. Excellent signal-to-noise conditions were recorded at four SNMR stations. At two stations, the measurements were distorted by noise from power lines and other types of cultural interference (figure 2b).

The E_0 (q) curves shows the value of maximum amplitude E_0 in nanoVolt for each E(t) curve versus the 16 excitation moments (q) in ampere per millisecond for station SNMR 1 (figure 3). The data collected in the area of the Wadi Shueib Dam were inverted using SAMOVAR v6.2 software to estimate water content of the subsurface sediment at different depths and the decay time of the magnetic resonance signal were utilized to determine the hydraulic conductivity.

where k is permeability; C_k is a permeability constant based on pumping tests; Φ is porosity; T_1^* is better than T_2^* for determining the permeability, but more acquisition time is required.

The transverse relaxation time constant (T_2^*) value varies from few milliseconds for clay bound water to a few hundred milliseconds in pore free water. The relaxation voltage measured at the loop just after the excitation current has been turned off is given by:

$$E_0 = \int_v 2\pi f_0 H_\perp f(r) M_0 f(r) \sin\left(\frac{\gamma}{2} H_\perp (r) q\right) dv$$

where E_0 is the initial amplitude of signal (nV), which depends on the number of protons and hence on the quantity of water, M_0 is the magnetic moment of the water molecules, f(r) water content, q pulse moment (I x Δt) Ampere per millisecond and H⊥(r) is the component of the excitation field perpendicular to the Earth's field.

In small pores (low permeability) rock many socks of water against grains that causes quick decrease of energy and then short time decay.

The inspection depth of SNMR depends on two major factors:

1- The pulse moment (current intensity).

2-The surface (outside) of the antenna: for circular antenna the inspection depth equal to the diameter of the antenna and equal to the side length of the square antenna.

The two other factors influence the depth of investigations is:

surface and is directly related to the number of protons thus to percent water content.

The Larmor frequency f_0 of the proton

$$f_0 = \gamma H_0/2\pi$$

where γ is the ratio of the protons magnetic moment to their angular momentum (γ= 0.2675 Hz/nT)

The equation that governs the amplitudes E_0 (q) of the nuclear magnetic resonance as a function of the pulse moment q is given by, Weichmann et al. (2000)

$$E(t,q) = E_0(q)\exp(-t/T_2^*)\ \sin)\ 2\pi f_0 t + \varphi_0$$

where T_2^* is the signal decay time constant (ms) which is linked to the average sizes of the pores of the rocks and is the shifted phase φ_0 between the arranging of excitation current and relaxation voltage measured in the loop and used for a qualitative estimation of the electrical resistivity of rocks.

The decay of magnetization vector after deflection drifting from equilibrium position is linked to the permeability through the average size and can be expressed by two times:

1- T_1^* the spin-lattice or longitudinal relaxation time linked to the component of the proton magnetic moment M_0 parallel to the Earth magnetic field (two pulse technique measurement).

2- T_2^* the spin-spin or transverse relaxation time constant related to the component of the proton magnetic moment M_0 perpendicular to the Earth magnetic field (one pulse technique measurement).

The permeability of a formation can be calculated based on the following relationship:

$$k = C_k(\Phi T_1^{*2})$$

Shallow alluvial groundwater aquifers located within the study area developed in Quaternary deposits formed along the lower reaches of the Wadi Shueib. The water quality of the shallow aquifers and springs in the study area becomes more degraded due to effluent which infiltrates and adds pollutant the groundwater.

Methodology

The petrophysical properties of aquifers are influenced by the water content and salinity, e.g. electrical conductivity and electric permittivity. Surface nuclear magnetic resonance (SNMR) is based on the principle of nuclear magnetic resonance (NMR), Hertrich et al (2005). The amplitudes of the NMR signal are directly related to the water content, while the decay times are linked to pore size and grain size and, therefore, to hydraulic conductivities

The method uses the macroscopic magnetism of a large number of atomic nuclei to obtain information about their physical and chemical environment, Pake et al. (1993), Lieblich et al. (1994), Legchenko et al. (2002), Hertrich et al. (2005). The SNMR method measures the magnetic field produced by the oscillation of water molecules (H protons) once they are excited by an electric current set up at the proper resonance frequency. In the SNMR method, three magnetic fields have to be considered. First, the Earth's magnetic field located inside the loop area has to be calculated. The frequency equals the precession frequency or Larmor frequency. Second, the current in the loop produces a magnetic field in the excitation field at a frequency equivalent to Larmor frequency. And thirdly, the relaxation field produced by protons excited by the excitation field. After the excitation current is shut off, the amplitude of the relaxation field is measured at the

Table (1) Stratigraphic units throughout the study area, Wolfart (1959), Masri (1963), MacDonald et al (1963).

Period		**Group**	**Formation**	**Lithology**
Quaternary			**Soil over bedrock**	
			Pleistocene Gravel	
Cretaceous	Upper	Balqa	Amman Silicified Limestone (ASL)	
			Wadi Umm Ghudran (WG)	Dolomatic marly limestone, marl, chert and chalk
	Middle	Ajloun	Wadi As Sir (WSL)	Dolomatic limestone, limestone, chert and marl
			Shueib (S)	Alternating nodular limestone with soft thiny bedded marl, Large ammonites are present
			Hummer (H)	Limestone, micrite and shelly wakestone
			Fuheis (F)	Dominantly marly and marly lime stone
			Naur (NL)	Alternating limestone and dolomite with soft marl
	Lower	Kurnub Sandstone (KS)	Kurnub Sandstone (KS)	Friable, massive, white-grey to light brown, coarse to medium grained quartozes, cross-bedded sandstone
Jurassic		Azab (AZ)		Dolomite, sandstone, limestone, silty mudstone

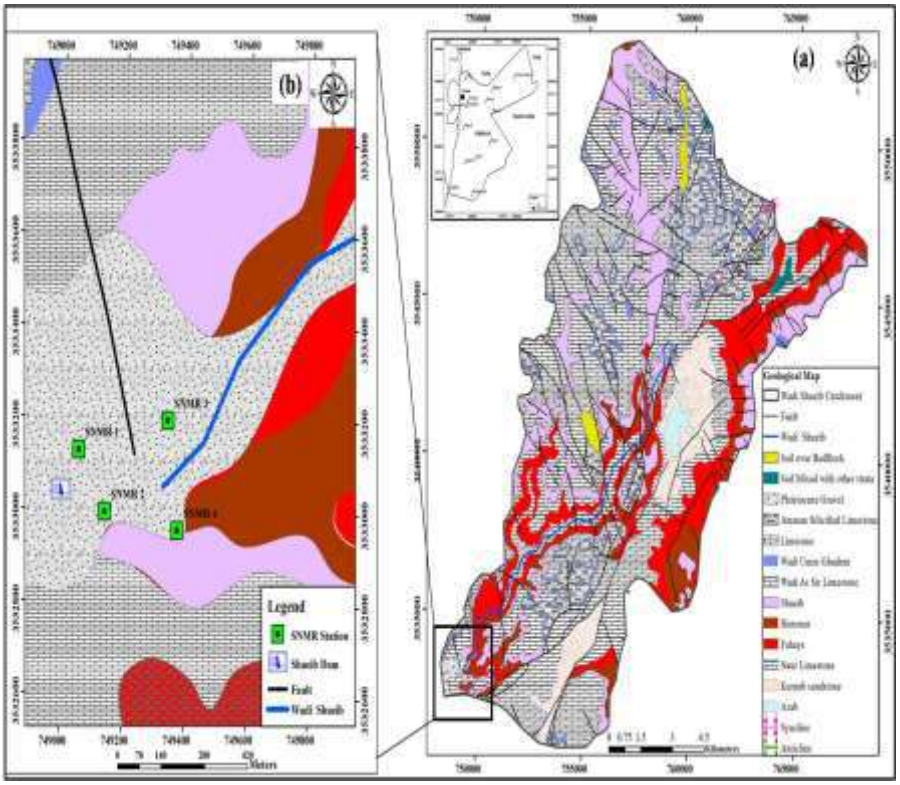

Figure (2) (a). Geological Map of the study area (modified after Shawabkeh, 2001; Moh'd & Muneizel, 1998; MacDonald & Partners, 1963; Sawarieh & Barjous, 1993). (b). Location map of SNMR stations.

The groundwater aquifers of Jordan are divided into three main complexes, Salameh (1996): 1) Deep sandstone aquifer complex within the Disi Group Aquifer (Paleozoic) and Kurnub and Zerka Group of Jurassic-Lower Cretaceous age, 2) the Upper Cretaceous aquifer complex, that consists of an alternating sequence of limestones, dolomites, marlstones and chert beds, and 3) the shallow complex aquifer. The intensive fault system and the anticline and syncline structures that cross the Shueib basin are the most important elements controlling the groundwater flow patterns. The dense NE- and NW-trending fault system allows hydraulic connections between the upper and lower aquifers, Flexer (2009).

The bedrock geology of the study region contains carbonates, chert, chalk, gravels, sandstones and evaporates which range in age from the Jurassic to Cretaceous (Table 1; figure 2). The Azab Group which is composed of dolomite, sandstone, limestone, silty mudstone is the oldest exposed strata in the study area. This group is unconformably overlain by the Lower Cretaceous Kurnub Sandstone Group that is comprised of different facies include conglomerates, coarse-grained sandstone, laminated siltstone, and shale, Sahawneh (2011). The depositional environment of the Kurnub Sandstone was dominantly fluvial with braided to meandering streams that flowed into a shallow marine setting, Sawariah and Barjous (1993). A thick sequence of limestone and marls of the Ajloun Group unconformably overlies the Kurnub Sandstone Group. It is subdivided into five formations; Na'ur Limestone, Fuheis, Hummar, Shueib, and Wadi As Sir Limestone. The Balqa Group cover represented by the Wadi Umm Ghudran Chalk can be found in the south of the study site. The Quaternary sediments in the study area are predominantly alluvium and lacustrine deposits.

The drainage extends from an elevation of 1200 m along the mountains to the east to elevations of > -170 m below sea level at the lower Jordan River Valley. The wadis (ephemeral streams) of the drainage are deeply incised as they cut through the eastern escarpment of the rift valley. This topography was created by fault motion along the Dead Sea Transform system that extends from the Gulf of Aqaba to the south, through the Dead Sea, and along the Jordan River Valley.

The main recharge for the Wadi Shueib basin is precipitation that falls over the eastern mountain ranges where the annual average precipitation is 700 mm/yr. The catchment area also receives return flow from springs, treated water from waste water treatment plants, and untreated waste water that is discharged from towns and villages along the drainage. In the highlands, the annual potential evaporation rates is approximately 2,000 mm/yr, while along the lower part of the study area, it reaches 2,600 mm/yr, Sahawneh (2011).

The Wadi Shueib Dam is situated on the eastern side of the Jordan River Valley about 18 km southwest of Al Salt city. The earth-filled dam began operation in 1969 with a capacity of 2.3 million m^3, although sediment infilling has lower this capacity over time, Hadadin (2015). The dam is recharged from surface water flow, springs, irrigation return flows, and effluent from two wastewater treatment plants. During the dry seasons, these flows are not large enough to recharge the dam. During extreme precipitation events, the dam has flooded. The water from the dam is predominantly used for irrigation and to recharge the groundwater in the Jordan River Valley.

Study Area:

Groundwater basins in Jordan are very scarce and vary in quantity and quality and are divided into 12 basins based on hydrogeological factors (figure 1), NWMP (1977). The Wadi Shueib basin is part of the "Side Wadis" groundwater basins, a series of small drainage basins the flow westward to the Jordan River. The Wadi Shueib basin has a catchment area of approximately 178 km^2 that flows into the Jordan River Valley north of the Dead Sea, Hadadin, (2015).

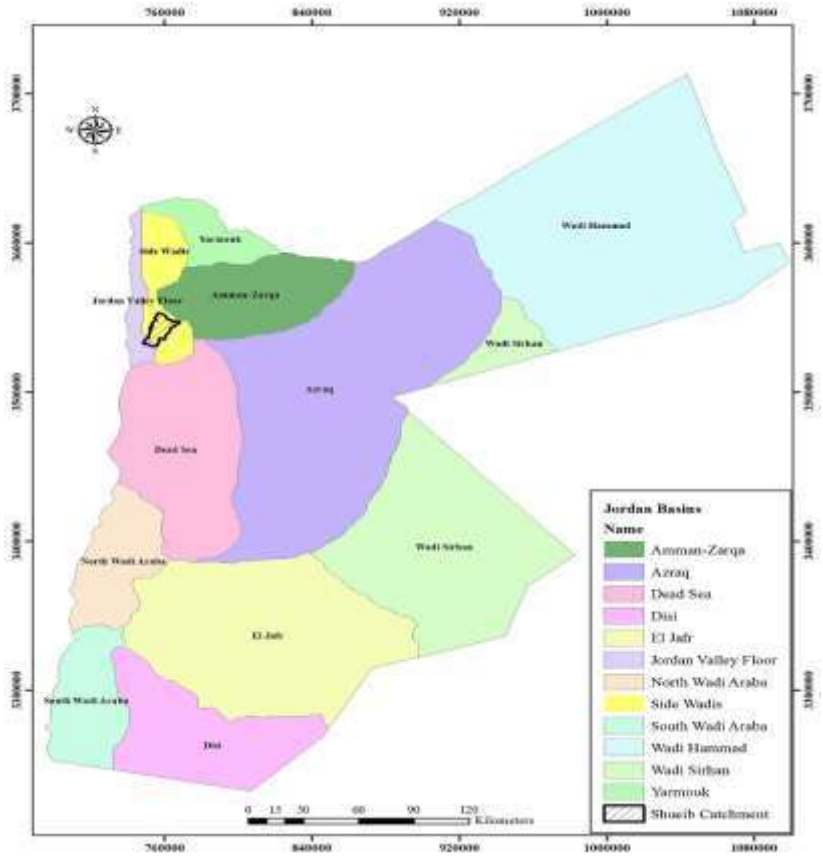

Figure (1) Groundwater basins in Jordan.

Introduction:

Jordan is located within an arid to semi-arid climatic zone based on the low mean annual precipitation and high evaporation rates. In terms of water resources, Jordan is considered one of the poorest countries in the world, Talozi (2007). Problems of groundwater exploitation in the region highlight concerns not only of the quantity of available water but also its quality.

The demand on groundwater due to farmland over-irrigation is a widespread occurrence with a large global impact on the available water resources, Behroozmand et al. (2017).

Quantification and qualification of groundwater and hydro-geological parameters of aquifers are necessary to manage and preserve groundwater resources. Surface nuclear magnetic resonance (SNMR), surface proton magnetic resonance sounding (MRS), and magnetic proton resonance (PMR) are emerging as geophysical techniques that permit direct, noninvasive hydrogeological investigation of subsurface water resources, Semenov (1987). The method not only detects the presence or absence of subsurface groundwater but also can be utilized to estimate groundwater properties including porosity, permeability, and hydraulic conductivity. SNMR is better than other conventional geophysical methods such as direct current electrical or time domain electromagnetic because they measure the resistivity of rocks which is only indirectly linked to the presence of groundwater.

An SNMR survey was carried out to investigate the shallow aquifers within the lower Wadi Shuieb located west of Amman and east of the Jordan River Valley. Little is known about the sedimentary sequence and groundwater near the Wadi Shuieb Dam which is located at the outlet of the Wadi Shuieb catchment. The purpose of the investigation was to better understand the hydrogeology and to determine physical properties such as permeability and hydraulic conductivity of the subsurface in this region.

استخدام التصوير بالرنين المغناطيسي النووي السطحي للمياه الجوفية والخواص الهيدروليكية في منطقة سد وادي شعيب، الأردن

عبدالرحمن أبو العدس

خلدون سعيد محمد قطيشات

ملخص

الرنين المغناطيسي النووي السطحي هو إحدى الطرق جيوفيزيائية غير تدميرية تستخدم لتحديد وجود المياه الجوفية وتحديد خصائص الخزان الجوفي من القياسات السطحية. تم جمع بيانات الرنين المغناطيسي النووي على طول مقطع عرضي بطول كيلومتر واحد بالقرب من سد وادي شعيب الواقع في وادي نهر الأردن السفلي. تظهر النماذج ثنائية الأبعاد لبيانات الرنين المغناطيسي النووي التباين الرأسي والجانبي في محتوى الماء والتوصيل الهيدروليكي حتى عمق 100 متر.

تظهر بيانات الرنين المغناطيسي النووي بالقرب من سد وادي شعيب طبقة مياه جوفية شبه محصورة ذات موصلية هيدروليكية عالية تقع على عمق 40–60 م. يشير عمق وموقع هذا الخزان الجوفي إلى إعادة التغذية من المياه السطحية إلى الشرق من سد وادي شعيب تظهر الخرائط انخفاض قيم الموصلية الهيدروليكية وانخفاض نسبة المحتوى المائي.

تشير التغيرات الجانبية في محتوى الماء والتوصيل الهيدروليكي إلى تغير نوع الرواسب والجيولوجيا تحت السطحية المعقدة التي قد تكون ناتجة عن خلل على طول فالق البحر الميت التحويلي.

الكلمات الدالة: الرنين النووي المغناطيسي للسطح، التوصيل الهيدروليكي، سد وادي شعيب، أحواض المياه الجوفية.

Use Surface Nuclear Magnetic Resonance Imaging for Groundwater and Hydraulic Properties at Wadi Shueib Dam Area, Jordan

Abdelrahman Abueladas*

Khaldoun Qtaishat**

Abstract

Surface nuclear magnetic resonance (SNMR) is a non-invasive, nondestructive geophysical method used to determine the presence of groundwater and to define aquifer properties from surface measurements. SNMR data were collected along a 1-km-long transect in the vicinity of the Wadi Shueib Dam located in the lower Jordan River Valley. 2-D modeling of the SNMR data shows vertical and lateral variation in the water content and hydraulic conductivity to a depth of 100 m.

SNMR data near the Wadi Shueib Dam shows a semi-confined aquifer with high hydraulic conductivity located at a depth of 40-60 m. The depth and location of the aquifer suggests recharge from surface water. Low hydraulic conductivity and low water content layers were mapped to the east of the Wadi Shueib Dam.

The lateral changes in water content and hydraulic conductivity indicate a change sediment type and complex subsurface geology that is possibly due to faulting along the Dead Sea Transform.

Keywords: Surface nuclear magnetic resonance, hydraulic conductivity, Wadi Shueib Dam, Groundwater basins

* **كلية الهندسة، قسم المساحة والجيوماتكس، جامعة البلقاء التطبيقية، الأردن.**

** **كلية الهندسة، قسم الهندسة المدنية، جامعة مؤتة، الأردن.**

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Watson, Roger, & Lea, Amanda. (1997). The caring dimensions inventory (CDI): content validity ,reliability and scaling. journal of advanced nursing, 25, 87-94.

Zamanzadeh, Vahid, Shohani, Masoumeh, & Palmeh, Tina. (2015). Nursing students' perception of instructors' caring behaviors in Tabriz University of Medical Sciences. Journal of caring sciences, 4(1), 55.

Zamanzadeh, Vahid, Valizadeh, Leila, Azimzadeh, Roghaieh, Aminaie, Nasim, & Yousefzadeh, Sedigeh. (2014). First and fourth-year student's perceptions about importance of nursing care behaviors: socialization toward caring. Journal of caring sciences, 3(2), 93.

Rudman, Ann, & Gusatavsson, Petter. (2012). Burnout during nursing education predicts lower occupational preparedness and future clinical performance: A longitudinal study. international journal for nursing studies 49, 988-1001.

Safadi, R., Saleh, M., Nassar, O., Amre, H.., & Froelicher, E. (2011). Nursing students' perceptions of nursing: a descriptive study of four cohorts. International Nursing Review, 7-8.

Salimi, Saleh, & Azimpour, Afsaneh. (2013). Determinants of Nurses' Caring Behaviors (DNCB): Preliminary Validation of a Scale. Journal of caring sciences, 2(4), 269.

Savvas, Karassavidis, (2017). Nursing Students' Perceptions of Caring: A Qualitative Approach. International Journal of Caring Sciences, 10(3), 1148-1157.

Sebold, Luciara Fabiane, Kempfer, Silvana Silveira, Radünz, Vera, Prado, Marta Lenise do, Tourinho, Francis Solange Vieira, & Girondi, Juliana Balbinot Reis. (2016). Care is... nursing student perceptions: A Heideggerian perspective. Escola Anna Nery, 20(2), 243-247.

Shalaby, Samah Anwar Mohamed, & AlDilh, Sara Mahdi Swaid. (2015). Exploring the Relationship between Perceived Stress and Academic Achievement among Critical Care Nursing Students. Athens Journal of Health, 2(4), 283-296.

Stopper, Mary Constance. (2012). Perceptions of caring and nursing by senior level baccalaureate nursing students from thailand and the united states as influenced by curriculum focus: A descriptive, comparative study. University of Kansas.

Watson, Roger, Ian, Deary, & lea, Amandah. (1999). A longitudinal study into the perceptions of caring and nursing among student nurses journal of advanced nursing, 29(5), 1228-1237.

Li, Yuh-Shiow, Yu, Wen-Pin, Yang, Bao-Huan, & Liu, Chin-Fang. (2016). A comparison of the caring behaviours of nursing students and registered nurses: implications for nursing education. Journal of clinical nursing, 25(21-22), 3317-3325.

Mackintosh, Carolyn. (2006). Caring: The socialisation of pre-registration student nurses: A longitudinal qualitative descriptive study. International Journal of Nursing Studies, 43(8), 953-962.

Manar, Nabolsi, Zumot, Arwa, Wardam, Lina, & Abu-Moghli, FaAthhieh. (2012). the experience of Jordanian nursing students in their clinical practice social and behavioral Sciences 46, 5849-5857.

Murphy, Fiona, Jones, Steve, Edwards, Mark, James, Jane, & Mayer, Alan. (2009). The impact of nurse education on the caring behaviours of nursing students. Nurse Education Today, 29(2), 254-264.

Nursalam, Nursalam, Wijaya, Andri, Bakar, Abu, & Efendi, Ferry. (2015). Indonesian Nursing Students in Caring Behavior. JNHC.

Papastavrou, Evridiki, Efstathiou, Georgios, & Charalambous, Andreas. (2011). Nurses' and patients' perceptions of caring behaviours: quantitative systematic review of comparative studies. Journal of advanced nursing, 67(6), 1191-1205.

Petrou, Alexandros, Sakellari, Evanthia, Psychogiou, Maria, Karassavidis, Savvas, Imbrahim, Selim, Savvidis, George, & Sapountzi-Krepia, Despina. (2017). Nursing students' perceptions of caring: A qualitative approach. International Journal of Caring Sciences, 10(3), 1148-1157.

Phillips, Jill, Cooper, Karen, Rosser, Elizabeth, Scammell, Janet, Heaslip, Vanessa, White, Sara, . . . Harding, Andrew. (2015). An exploration of the perceptions of caring held by students entering nursing programmes in the United Kingdom: A longitudinal qualitative study phase 1. Nurse education in practice, 15(6), 403-408.

References:

Alhadidi, M, & Ahmad, M. (2016). The Caring Dimension Inventory (CDI-29): Modified Arabic Version. International Archives of Nursing and Health Care, 2(2).

Baljani, Esfandiar., Azimi, Neda, & Hosseinloo, Abdollah. (2012). A survey on nurses' perception of the importance of caring behaviors and factors affecting its provision. Evidence based care, 2(1), 13-21.

Bucco, Theresa. (2015). The relationships between patients' perceptions of nurse caring behaviors, nurses' perceptions of nurse caring behaviors and patient satisfaction in the emergency department.

Grainger, Patricia, & Bolan, Christine. (2006). Perceptions of nursing as a career choice of students in the Baccalaureate nursing program. Nurse Education Today, 26, 38-44.

Grobbel, Claudia C, & Rowe, Linda. (2014). Exploring pre-nursing students' perceptions of caring and nursing: A phenomenological study. International Journal of Human Caring, 18(1), 8-16.

Jaradeen, Najah, Jaradat, Raed, Abosafi, Ahmad, & Tarawneh, Falah. (2012). Students satisfactions with nursing program Bahrain medical bulletin, 34(1), 1-6.

Jrasat, Mnal, Samawi, Osama, & Wilson, Calvin. (2005). beliefs, attitudes and perceived practice among newly enrolled students at the Jordanian ministry of health nursing colleges and Institutes Education for health 18(2), 145-156.

Kursun, Serife, & Arslan, Fatma Tas. (2012). Nursing students' perceptions of caring in Turkey. HealthMed, 6(9), 3145-3151.

Li, Yuh-Shiow, Yu, Wen-Pin, Yang, Bao-Huan, & Liu, Chin-Fang. (2018). Learning Styles and Caring Behaviors Among Students in Different Nursing Programs: Implications for Nursing Education.

Implication for Nursing Practice

Caring interventions should be carried out in order to help students build and enhance their caring behaviors that should be adapted to clinical situations. The findings of this study highlight the importance of placing caring at the essence of the nursing profession, a state of affairs that will surely draw the scholars' attention to the varied dimensions of caring. This goal could be achieved by re-emphasizing a holistic care approach, which is client-centered.

Conclusion and recommendations:

The results of this study showed students' perception of the caring dimensions is subject to change. Negatively or positively, it is not the same among students at different academic levels in the nursing program. Therefore, there is a dire need to keep evaluating every nursing program, so that we could figure out those areas which are most subject to change over the course of time. In doing so, we could detect (and therefore fix) missing aspects that should be provided to the clients.

It is also recommended that further research is badly needed to further consolidate caring competence as a fundamental value in nursing education and nursing students' motivation. For this, the academic and clinic personnel should pay immense consideration to caring behaviors when instructing nursing students.

Group 1 scored more than group 2 on 15 items of the questionnaire. The difference between both groups on these items were statistically significant. This finding is compatible with the findings of some previous studies (Grainger & Bolan, 2006; Mackintosh, 2006; Manar, Zumot, Wardam, & Abu-Moghli, 2012; Murphy, Jones, Edwards, James, & Mayer, 2009). This has been attributed in large part to the idyllic view of nursing among first-year students and to the negative effect of the educational process and professional socialization for fourth-year nursing students.

Implications:

Implication for nursing education

Given the general findings of the current research, it could be concluded that the information obtained on nursing students' perception of care and caring behaviors might enhance our knowledge (and thus understanding) of the phenomenon in this educational setting. Moreover, the information can be used by nursing educators to teach caring behaviors as a significant part of their curricula because caring outcomes in practice, research and theory are related to the teaching of a caring ideology.

Findings of this study suggest that psychosocial care become less important as students formally are engaged in training and professional socialization. This situation may imply that nursing teachers have to pay attention to this aspect when designing nursing curricula to be more responsive to the client psychosocial needs by teaching, assessing and evaluation students' caring behaviors.

Further investigation into nursing caring behaviors is encouraged, as a part of nursing program evaluation in different nursing faculties and different countries as caring is culture–sensitive and setting–specific practice.

First-year nursing students (compared with fourth-year nursing students) are more likely to offer themselves as they scored more on the items representing the domains of appropriate and inappropriate self-giving. Such engagement with their clients points to the conclusion that first-year nursing students need be informed on how to distinguish between professional relationship and social relationship when interacting with clients. However, it should be mentioned here that both groups' scores were generally low on both domains.

Fourth-year nursing students' low scoring on the majority of CDI items may predict early burnout, which could have serious consequences on educational success and retention in the profession (Watson et al., 1999) as well as on lower occupational preparedness and performance (Rudman & Gusatavsson, 2012). Such consequences were highly expected taking into account previous research findings. To illustrate, research conducted at the same setting has shown that students' satisfaction with nursing program was neutral, concisely one third of students lacked the sense of belonging to nursing (Jaradeen, Jaradat, Abosafi, & Tarawneh, 2012). A Jordanian study on the beliefs, attitudes, and perceived practice among newly enrolled students at the Jordanian Ministry of Health Nursing colleges and institutes has shown that students' desire to become a nurse accounted for only 31% of participants, while 69% of the participants began a nursing career because of other reasons. For example, whereas some reported that they chose nursing because of family economic pressures, others stressed that it was the only choice available to them for them at the time (Jrasat, Samawi, & Wilson, 2005).

communication skills and therapeutic relationships. Students at this stage are still novice as they had not spent much time of interactions with patients and other health workers. Lack of knowledge at the educational level and lack of experience at professional socialization level sometimes negatively affect students' perception of caring including the routine technical procedures, assignments, paper work. Unlike fourth-year students, first-year students often perform such tasks in exchange of sacrificing some psychosocial considerations. This finding is consistent with that of Watson et al. who have shown that nursing students lose some of their idealism about nursing and caring after they get engaged in nursing education (Watson, Ian, & lea, 1999). Likewise, Safadi et al. have contended that student perceptions change throughout the education process, thus stressing a theory – practice gap. They therefore suggested the need to revise nursing schools' curricula and universities' admission policies into the nursing schools in Jordan (Safadi, Saleh, Nassar, Amre, & Froelicher, 2011).

As for the domain of technical and professional care, fourth-year nursing students, compared to first year nursing students, turned to be more mindful. Yet, those students have shaped their professional and technical care at the expense of sacrificing psychosocial care. This may be in part be due to the negative effect of educational process itself, where students sometimes lose some ideals when they get engaged in it (Watson et al., 1999). We therefore recommend that technical and professional care of nursing be accompanied with psychosocial care development during formal instruction.

compared with fourth-year nursing students (3.56 ± 1.12), t (190) = 4.44, p = 0.001.

First-year nursing students had statistically higher significant scores in the inappropriate involvement or self-giving domain of caring (3.07 ± 1.00) compared with fourth-year nursing students (2.67 ± 1.06), t (190) = 2.69, p = 0.008.

Discussion:

Psychosocial domain:

This domain was represented by 12 items in the CDI. Group A in this domain showed more agreement than group B on all of the questionnaire items measuring this domain. This was evidenced by the statistically significant difference reported above by the independent t-test, a state of affairs that might be attributed to number of factors characteristic of the nursing program itself and/or the students themselves. The courses of the nursing program at this university were distributed progressively into four academic years, each of which divides into first, second and summer semesters. The courses administered to Group A (those who had finished their first year) were basically geared to build students' orientation of nursing as a humane profession. During formal instruction, students were expected to gain some fundamental nursing skills at nursing both laboratory training at the faculty and while practicing at hospitals (particularly at summer semester). During this period of formal instruction, the academic staff emphasize the importance of effective interaction and communication with the patient as an integral part of performing fundamental nursing. In simple words, they try communicate to their students the set of the rules for humanistic interaction, such as nursing ethics, patients' rights, basic

Item	Domain	level	Mean	SD.
Observing the effects of a medication on a patient	professional technical	first year	4.37	1.16
		fourth year	4.75	.49

As shown on table 2, the highest two mean score was reported for the items (Making a nursing record about the patient)and (Measuring the vital signs of a patient) for the fourth year nursing students , which reflect the perception of technical and professional aspect of care as the most important among those students and the emphasis of clinical supervision among those students in which documentation and measuring vital signs always within their daily tasks .assigned to them by their clinical supervisors .

Table 2 also shown that the first year nursing students mean scores was mostly higher than fourth year mean scores on the items of psychosocial domain , this is a part of emotional and social intelligence that did not improved by education process as the fourth year nursing students show more interest on the technical and professional competencies on the expense of psychosocial competencies as it is appear on the mean scores of the CDI items .

An independent-samples t-test was conducted to compare students' responses on the items related to each domain of caring (see Tables 3 and 4).

First-year nursing students had statistically higher significant scores in the psychosocial domain of caring (3.95 ± 0.77) compared with fourth-year nursing students (3.37 ± 0.95), t (190) = 4.60, p = 0.050.

Fourth-year nursing students had statistically higher significant scores in the professional and technical domain of caring (4.69 ± 0.25) compared with first-year nursing students (4.42 ± 1.31), t (190) = 2.05, p = 0.042.

First-year nursing students had statistically higher significant scores in the appropriate self-giving or altruism domain of caring (4.24 ± 0.99)

Item	Domain	level	Mean	SD.
Listening to a patient	psychosocial	first year	4.41	.81
		fourth year	3.63	1.64
Consulting with a doctor about the patient	professional technical	first year	4.58	.81
		fourth year	4.70	.55
Instructing a patient about an aspect of self-care	psychosocial	first year	3.96	1.33
		fourth yea	3.28	1.50
Sharing your personal problems with a patient	inappropriate involvement	first year	2.27	1.46
		fourth year	2.39	1.36
Keeping relatives informed about a patient	psychosocial	first year	3.62	1.38
		fourth year	2.83	1.20
Measuring the vital signs of a patient	professional technical	first year	4.06	1.31
		fourth year	4.84	.38
Putting the needs of a patient before your own	Appropriate self giving	first year	4.17	1.09
		fourth year	3.35	1.42
Being technically competent with a clinical procedure	professional technical	first year	3.93	1.29
		fourth year	4.76	.52
Involving a patient with his or her care	psychosocial	first year	3.96	1.25
		fourth year	3.29	1.46
Giving reassurance about a clinical procedures	psychosocial	first year	4.06	1.26
		fourth year	3.55	1.32
Providing privacy for a patient	psychosocial	first year	4.41	1.04
		fourth year	3.76	1.34
Being cheerful with a patient	Appropriate self-giving	first year	4.31	1.15
		fourth year	3.76	1.21

Item	Domain	level	Mean	SD.
activity of daily living		fourth year	3.48	1.30
Making a nursing record about the patient	professional technical	first year	4.24	1.17
		fourth year	4.79	.51
Feeling sorry for a patient	inappropriate involvement	first year	3.86	1.23
		fourth year	2.94	1.44
Getting to know the patient as a person	psychosocial	first year	4.41	.93
		fourth year	3.28	1.39
Explaining a clinical procedures to a patient	professional technical	first year	4.48	.77
		fourth year	4.39	.90
Being neatly dressed when working with a patient	professional technical	first year	4.37	1.19
		fourth year	4.50	.785
Sitting with a patient	psychosocial	first year	3.55	1.25
		fourth year	3.47	1.19
Exploring a patient life style	psychosocial	first year	3.27	1.26
		fourth year	3.41	1.25
Reporting a patient condition to a senior nurse	professional technical	first year	4.19	.95
		fourth year	4.70	.53
Being with a patient during clinical procedure	psychosocial	first year	3.79	1.24
		fourth year	3.14	1.32
Being honest with a patient	psychosocial	first year	4.17	1.29
		fourth year	3.30	1.53
Organizing the work of others for a patient	professional technical	first year	3.85	1.15
		fourth year	4.75	.60

The data was analyzed using version 17 of the Statistical Package for Social Sciences (SPSS). An independent sample t-test was performed to compare the mean scores of both groups' responses on the items of the CDI which represent four domains of caring: psychosocial domain, professional technical domain, appropriate self-giving or altruism domain, and inappropriate involvement or self-giving domain.

Results:

Table (1) Characteristics of first year (n=87) and fourth year (n=105) nursing students

Level	First -year students N (%)	Fourth -year students N (%)	Total N (%)
Male	20(23)	25(23.8)	45(23.4)
Female	67(77)	80(76.2)	147(76.6)

As presented in Table 1, 254 students who are the first and fourth year were the population of the study; only 192 of them responded positively, so the response rate was 76% (N = 192 out of 254). 87 students (45.3%) were first year students and 105 (54.7%) were fourth year students. Most study subjects were females (77%, n = 67) and (76.2%, n = 80) in the first and fourth year, respectively.

Caring Dimension Inventory(CDI) is a questionnaire with 25 items represent variety of nursing behaviors during interaction with client .as caring is composed of many dimensions the questionnaire include items representing four dimensions of caring ;professional technical dimension in which , psychosocial dimension, appropriate self-giving or altruism domain of caring, the inappropriate involvement or self-giving domain of caring.

Table (2) Caring Dimensions Inventory (CDI) Items

Item	Domain	level	Mean	SD.
Assisting patient with an	psychosocial	first year	3.79	1.38

were assembled by circling on one of the numbers: 1-2-3-4-5, where 1 denotes "strongly disagree" and 5 "strongly agree".

Timetable

The research was carried out from January-July, 2018, sketched into the following phases:

A. Preparatory phase
   1. Review of literature from Jan-Feb 2018
   2. Preparing the study questionnaire from Jan-Feb 2018
   3. Getting approvals from the different authority bodies-on March,2018

B. Data collection phase from March to April ,2018

C. Analysis and writing phase
   1. Tabulating and statistically analyzing the data from April-May , 2018
   2. Reporting and writing final research from June-September, 2018

Ethical considerations:

After getting the approval of the Institutional Review Board (IRB), we sought the permission of the committee of human scientific research at the Faculty of Nursing -Mutah University to conduct the study. Informed consent, a statement assuring anonymity, confidentiality, and the right to withdraw, were enclosed with the questionnaire upon administrating it to the respondents.

Procedure:

The students were approached as respondents after taking permission from faculty personnel to administer the questionnaire in class over one week. Cordially asked to answer the questionnaire items to the best of their knowledge and expertise, they were requested to drop them back into the researcher's mailbox at the Faculty of Nursing.

Statistical Analysis:

semester of their first year and 105 students were in their fourth year, i.e. completed eighth semesters in the program.

Instrumentation:

There are few instruments (already available in the published literature) that may be used to measure caring. One of which is the Caring Dimension Inventory (CDI), which is basically a questionnaire designed primarily to assess the perception of caring. This instrument, first developed by Watson in 1997 (Alhadidi & Ahmad, 2016), contains 25 items sub-sectioned into four dimensions: psychosocial dimensions of care, inappropriate involvement or self-giving dimensions of care, appropriate self-giving or altruism dimensions of care, and lastly technical and professional dimensions of care.

Used to gather data about nursing students' perceptions of these dimensions, the response to the inventory are ordered on a five-point Likert scale (strongly disagree - disagree - neutral - agree - strongly agree).

As the scale was originally in English, it was first translated into Arabic by the researchers. To double-check the accuracy of the translation, two bilingual nursing faculty members, who had not seen the original English version, were cordially asked to translate the questionnaire back into English. To ensure consistency in terms of form and accuracy in terms of meaning, the researchers and the two other bilingual nursing faculty members convened together to resolve variations and inconsistencies between the English and Arabic versions of the questionnaire.

Reliability and Validity:

The issues of content validity, reliability and scaling were discussed by the authors. Reliability or internal consistency of the items were measured by estimating Chrombach alpha. The value obtained for the 25 items of the CDI was 0.91, thus showing a high degree of internal consistency (Watson & Lea, 1997). The participant's responses to each item of questionnaire (e.g. "do you consider the following aspects of nursing practice to be caring?")

caring process on our nursing students is available. It is hoped that eliciting data about nursing students' perception of care (and relevant behaviors) would add to a better understanding of the caring phenomenon within both the educational and clinical settings. Moreover, study findings might be used as a benchmark for developing future curricula and reforming existing one towards a more inclusive caring ideology and research. With this in mind, the purpose of the current research is to explore differences in perception of caring dimensions between first- and fourth-year nursing students at Mutah University.

Research Questions:

This study was conducted to answer the following two intertwined research inquires:

1. Is there a difference in perception of caring dimensions between first- and fourth- year nursing students?
2. In which domain of caring is there a different perception between first-year and fourth-year nursing students?

Materials and Methods

Design:

In the present study, the design of the study was descriptively cross-sectional as we believed it fitting for exploring first- and fourth-year nursing student' perceptions of important nursing care behaviors.

Study Population:

The target population for this study was the baccalaureate nursing students from faculty of nursing at Mutah University - Jordan. All first- and fourth-year nursing students during the year of 2018 were individually asked to participate in this study. They were 254 students. However, 62 students (41 of the first-year students and 21 of the fourth-year students) did not give their consent to participate. With a positive response rate of 76%, the sample consisted of 192 students; 87 of whom completed the second

theories for the goal of theory-building, necessary for real practice today. As nursing students are potential nurses of the future, it is important to let them gain proper caring behaviors during nursing education. Caring outcomes in practice depend on teaching and learning processes (Kursun & Arslan, 2012). Recently, there has emerged an urgent need to identify, foster and support a caring disposition in student nurses worldwide. In a climate of intense international scrutiny of healthcare in general and of nursing in particular (Phillips et al., 2015), nurse educators strive to enhance professionalism in care provision in their students.

In this study, first- and fourth-year nursing students were selected as the target population because these students would represent perception of caring at the entering of and near completing nursing educational program (Zamanzadeh et al., 2014). Indeed, our theoretical assumption was that first- and fourth-year students would have different perceptions about what constitutes nurse caring behaviors.

Problem statement: Given the literature available to date on the subject matter, we can easily tell that there is some lack of correspondence in the nursing profession between what nursing students say (or probably believe) about caring and what they actually do as caring. Therefore, this study sets itself the goal to explore the perceptions of first- and fourth-year nursing students of caring behaviours (Crafford, 2014).

Significance of the study

Although studies on caring are abundant, there is still paucity of research on nursing students' perception of it (Kursun & Arslan, 2012). To illustrate, research has so far been focused on the changes in (1) students' perceptions of their own caring and (2) their perceptions of peers' changes while in a nursing program. However, little information about the impact of

other, they should convey to patients a feeling of being cared for (Zamanzadeh, Valizadeh, Azimzadeh, Aminaie, & Yousefzadeh, 2014) as an essential concept in student socialization (Savvas Karassavidis, 2017).

Since nursing is itself caring, it requires nursing students to learn how to become professional nurses in clinical settings. Therefore, nursing students should be regarded as clients in health facilities and should show the care and concern necessary to do the job in the most optimal fashion (Y.-S. Li, Yu, Yang, & Liu, 2018). Caring has therefore become an integral component of the curriculum which aims at developing the potentials of professional nurses. Medical and nursing students see their caring to have both emotional and practical magnitudes (Savvas Karassavidis, 2017). At the emotional level, they have to feel that they have compassion, commitment, competence, confidence and conscience towards their patients. At the practical level, they should show the appropriate communication, patience, courage and support kills of professional medical and nursing students. For this, nursing students are immersed in the teaching-learning process at both the theoretical and practical fronts in their academic experience as part of their professional preparation (Shalaby & AlDilh, 2015).

Having perceived the importance of caring in nursing teaching, students can learn professionalism (Zamanzadeh, Shohani, & Palmeh, 2015). Not only is there paucity of research which involves nursing students as respondents, but there is also lack of research involves respondents prior to being nursing students. (Grobbel & Rowe, 2014). In addition, most research available to date has focused on understanding and validating caring

Background:

Being the essence of professional nursing practice (Alhadidi & Ahmad, 2016; Baljani, Azimi, & Hosseinloo, 2012; Y. S. Li, Yu, Yang, & Liu, 2016; Nursalam, Wijaya, Bakar, & Efendi, 2015), caring is sometimes defined as 'the process by which the nurse becomes responsive to another person as a unique individual, perceives the other's feeling, and sets that person apart from the ordinary'. It includes knowledge, skills and attitude (Y. S. Li et al., 2016), and is therefore the 'art' of nursing. Because caring behaviors are a distinct feature of nursing (Bucco, 2015; Papastavrou, Efstathiou, & Charalambous, 2011; Stopper, 2012), they might be affected by the perceptions of nurses and patients (Salimi & Azimpour, 2013)

However, caring is difficult to define (Sebold et al., 2016) probably because it is not unique to nursing (Petrou et al., 2017). Being fundamental to our understanding of human nature, the concept of caring denotes a primary mode of being in the world that is significant in our relationships with others as well as with ourselves. As a universally acknowledged concept, caring lies at the very center of the scope of nursing (Petrou et al., 2017) However, nursing care has been changing in the course of time; it has gone through specific stages in the development of knowledge corpus.

Evolving in the discipline of nursing as a science on its own right, caring has become a main concept in nursing education, crystallized in a caring science-centered curriculum, the aim of which is to orient nursing students on how to be able provide health care services as professional nurses. The orientation is two-fold. On the one hand, they should be able to create an atmosphere that supports the patients' sense of well-being. On the

إدراك أبعاد الرعاية بين طلاب التمريض في السنة الأولى والسنة الرابعة في جامعة مؤتة – الأردن

فلاح زعل الطراونة
عبدالله الخمايسة

ملخص

الخلفية الأدبية: أصبحت الرعاية جزءًا لا يتجزأ من المنهج الذي يهدف إلى تطوير إمكانات الممرضات المحترفات. لذا هدفت هذه الدراسة الى استكشاف الاختلافات في إدراك أبعاد الرعاية بين طلاب التمريض في السنة الأولى والرابعة في جامعة مؤتة.

الطريقة: تم استخدام تصميم وصفي مقطعي بين 254 طالبًا في السنة الأولى والرابعة من كلية التمريض في جامعة مؤتة – الأردن

النتائج: حقق طلاب التمريض في السنة الأولى درجات أعلى إحصائيًا في مجال الرعاية النفسية والاجتماعية (3.95 ± 0.77) مقارنة بطلاب التمريض في السنة الرابعة (3.37 ± 0.95)، t (190) = 4.60، p = 0.050. حقق طلاب التمريض في السنة الرابعة درجات إحصائية أعلى بكثير في المجال المهني والتقني للرعاية (4.69 ± 0.25) مقارنة بطلاب التمريض في السنة الأولى (4.42 ± 1.31)، t (190) = 2.05، p = 0.042.

الاستنتاجات: ان إدراك أبعاد الرعاية قابل للتغيير، حيث انه يختلف بين الطلاب على اختلاف المستويات الأكاديمية في برنامج التمريض، وهناك حاجة لتقييم هذه البرامج لتحديد مجالات التغيير للرعاية المدركة من هؤلاء الطلاب وكذلك تحديد بعض مناطق الرعاية المفقودة المقدمة للمرضى.

الكلمات الدالة: ابعاد الرعاية؛ الأدراك؛ طلاب التمريض؛ الأردن

Perception of Caring Dimensions Between First Year Nursing Students and Fourth Year Nursing Students at Mut'ah University-Jordan

Falah Zaal Altarawneh *

Abdullah Khamaiseh

Abstract

Backgrounds: Caring has become an integral component of the curriculum that aims at developing the potentials of professional nurses. With this in mind, the purpose of the current research is to explore differences in perception of caring dimensions between first- and fourth-year nursing students at Mutah University.

Methods: A descriptive cross-sectional design was conducted. Data were collected from 254 students who are in the first and fourth year in the faculty of nursing at Mutah University - Jordan.

Results: First year nursing students had statistically significantly higher scores in the psychosocial domain of caring (3.95 ± 0.77) compared with fourth year nursing students (3.37 ± 0.95), $t(190) = 4.60$, $p = 0.050$. Fourth year nursing students had statistically significantly higher scores in the professional and technical domain of caring (4.69 ± 0.25) compared with first year nursing students (4.42 ± 1.31), $t(190) = 2.05$, $p = 0.042$.

Conclusions: Perception of caring dimensions is subject to change, it is not the same among students at different academic levels in the nursing program, and there is a need to evaluate every nursing program to pinpoint the areas of change in student's perception of caring in order to find out missing areas of care provided to the clients.

KeyWords: Caring Dimensions; Perceptions; Nursing Students; Jordan

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* **كلية التمريض، جامعة مؤتة، الأردن.**

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Zama, D., Meraihi, Z., Tebibel, S., Benayssa, W., Benayache, F., Benayache, S. & Vlietinck, A., (2007). Chlorpyrifos-induced oxidative stress and tissue damage in the liver, kidney, brain and fetus in pregnant rats: The protective role of the butanolic extract of Paronychia argentea L. Indian Journal of Pharmacology, 39, 145–150.

urinary risk factors of calcium oxalate urolithiasis during experimental hyperoxaluria. Pharmacological Research, 43: 89–93.

Sinha, M. & Tagore, R. (2010). Effect of acid-hydrolyzation of fruits juice of apple (Malus domestica), moushmi (Citrus medica) and amla (Emblica officinalis) on solubility of urinary stones. Asian Journal of Chemistry, 22: 4840-4846.

Sinha, M., Dev, A., Prasad, A., Ghosh, M. & Tagore, R. (2011). Experimental study of solubility of urinary stones in juice of Chikku (Achras zapota) fruit. Journal of Chemical and Pharmaceutical Research, 3: 231-237.

Sowers, M., Jannuasch, M., Wood, C., Pope, S. & Lalhance, L. (1998). Prevalence of renal stones in a population-based study with dietary calcium, oxalate, and medication exposures. American Journal of Epidemiology, 147: 914-920.

Varalakshmi, P., Shamila, Y. & Latha, E., (1990). Effect of Crataeva nurvala in experimental urolithiasis. Journal of Ethnopharmacology, 28: 313– 321.

Veronika, B. & Khan, S. R., 2009. Herbal medicines in the management of urolithiasis: alternative or complementary? Planta Medica, 75: 1095–1103.

Yamaguchi, S., Wiessner, J., Hasegawa, A., Hung, L., Mandel, G. & Mandel, N. (2005). Study of a rat model for calcium oxalate crystal formation without severe renal damage in selected conditions. International Journal of Urology, 12: 290–298.

Yasir, F. & Waqar, M. (2011). Effect of indigenous plant extracts on calcium oxalate crystallization having a role in urolithiasis. Urological Research, 39: 345–350.

Yasui, T., Fujita, K., Sato, M., Sugimoto, M., Iguchi, M., Nomura, S. & Kohri, K., (1999). The effect of takusha, a kampo medicine, on renal stone formation and osteopontin expression in a rat urolithiasis model. Urological Research, 27: 194–199.

with allopathic and ayurvedic medicines. Urology and Nephrology Open Access Journal, 7: 69-74.

Kulaksizoglu, S., SoWkerim, M., Cevik, C., (2008). In vitro effect of lemon and orange juices on calcium oxalate crystallization. International Urology Nephrology, 40: 589–594.

Laroubi, A., Touhami, M., Farouk, L., Zrara, I. R. A., Benharref, A. & Chait, A., (2007). Prophylaxis effect of Trigonella foenum graecum L. seeds on renal stone formation in rats. Phytotherapy Research, 2007, 21, 921–925.

Leusmann, D., Niggemann, H., Roth, S. & Von Ahlen, H., (1995). Recurrence rates and severity of urinary calculi. Scandinavian Journal of Urology and Nephrology, l29: 279-283.

Lieske, J., Deganello, S. & Toback, F. (1999). Cell-crystal interactions and kidney stone formation. Nephron, 81: 8-17.

McHarg, T., Rodgers, A. & Charlton, K., (2003). Influence of cranberry juice on the urinary risk factors for calcium oxalate kidney stone formation. British Journal of Urology International, 92: 765–768.

Nuhu, A. (2014). Bioactive micronutrients in coffee: recent analytical approaches for characterization and quantification. ISRN Nutr. 2014: 384230.doi:10.1155/2014/384230

Odvina, C. (2006). Comparative valus of orange juice versus lemonade in reducing stone-forming risk. Clinical Journal of the American Society of Nephrology, 1: 1269–1274.

Parmar, M. (2004). Kidney stones. British Medical Journal, 328: 1420-1424.

Seltzer, M.., Low, R., McDonald, M., Shami, G. & Stoller, M. (1996). Dietary manipulation with lemonade to treat hypocitraturic caclium nephrolithiasis. Journal of Urology, 156: 907–909.

Selvam, R., Kalaiselvi, P., Govindaraj, A., Bala, M. V. & Kumar, A. (2001). Effect of Aerva lanata leaf extract and vediuppu chunnam on the

Curhan, G., Willett, W., Rimm, E., Spiegelmann, D. & Stampfer, M. (1996). Prospective study of beverage use and the risk of kidney stones. American Journal of Epidemiologyl, 143: 240 –247.

Alelign, B. & Petros, B. (2018). Kidney stone disease: An update on current concepts. Advances in Urology, 2018: Article ID 3068365, 12 pages, doi.org/10.1155/2018/3068365

Trinchieri, A. (2008). Epidemiology of urolithiasis: an update. Clinical Cases in Mineral and Bone Metabolism, 5: 101-106.

Freitas, A., Schor, N. & Boim, M. (2002). The effect of Phyllanthus niruri on urinary inhibitors of calcium oxalate crystallization and other factors associated with renal Stone formation. British Journal of Urology International, 89: 829–834.

Gohel, M. & Wong, S. (2006). Chinese herbal medicines and their efficacy in treating renal stones. Urological Research, 34: 365–372.

Goldfarb, D. & Asplin, J.(2001). Effect of grapefruit juice on urinary lithogenicity. Journal of Urology, 166: 263–267.

Grases, F., Ramis, M., Costa-Bauzá, A. & March, J. (1995). Effect of Herniaria hirsuta and Agropyron repens on calcium oxalate urolithiasis risk in rats. Journal of Ethnopharmacology, 45: 211–214.

Joshi, V. & Joshi, M. (2003). Influence of inhibition of citric acid and lemon juice to the growth of calcium hydrogen phosphate dihydrate urinary crystals. Indian Journal of Pure and Applied Physics, 41: 183-192.

Kessler, T., Jansen, B. & Hesse, A., 2002. Effect of balckcurrant-, cranberry- and plum juice consumption on risk factors associated with kidney stone formation. European Journal of Clinical Nutrition, 56: 1020–1023.

Khan, S. & Kok, D. (2004). Modulators of urinary stone formation. Frontiers in Bioscience, 9: 1450-1482.

Khan, F., Haider, M. , Singh, M., Sharma, P., Kumar, T. & Neda,. (2019). A comprehensive review on kidney stones, its diagnosis and treatment

References:

Afifi, F., Al-Khalidi, B. and Khalil, E., (2005). Studies on the in vivo hypoglycemic activities of two medicinal plants used in the treatment of diabetes in Jordanian traditional medicine following intranasal administration. Journal of Ethnopharmacology, 100: 314–318.

Al-Bakri, A. & Affifi, F. (2007). Evaluation of antimicrobial activity of selected plant extracts by rapid XTT colorimetry and bacterial enumeration. Journal of Microbiological Methods, 2007, 68, 19–25.

Araújo Viel, T., Diogo Domingos, C., da Silva Monteiro, A. P., Riggio Lima-Landman, M. T., Lapa, A. & Souccar, C., (1999). Evaluation of the antiurolithiatic activity of the extract of Costus spiralis Roscoe in rats. Journal of Ethnopharmacology, 66: 193–198.

Atmani, F., Slimani, Y., Mimouni, M. and Hacht, B., (2003). Prophylaxis of calcium oxalate stones by Herniaria hirsuta on experimentally induced nephrolithiasis in rats. British Journal of Urology International, 92: 137–140.

Atmani, F., Slimani, Y., Mimouni, M., Aziz, M., Hacht, B. & Ziyyat, A., (2004). Effect of aqueous extract from Herniaria hirsuta L. on experimentally nephrolithiasic rats. Journal of Ethnopharmacology, 95: 87–93.

Barros, M., Schor, N. & Boim, M. (2003). Effects of an aqueous extract from Phyllantus niruri on calcium oxalate crystallization in vitro. Urological Research, 30: 374–379.

Carmona, M., Llorach, R., Obon, C. & Rivera, D (2005). "Zahraa", a Unani multicomponent herbal tea widely consumed in Syria: components of drug mixtrues and alleged medicinal properties. Journal of Ethnopharmacology 102: 344–350.

It is known that control urine sample contains mixture of COD and COM crystals (Figure 3). Incorporation of Prosopis farcta extract has shown a significant effect by changing the morphology of crystals from COM form to COD form that change the ratio in the direction to get less COM that has high affinity for cell membrane damage affecting the epithelial cells than COD and finally leads to kidney stone formation (Yamaguchi et al., 2005).

Conclusion

The aqueous ethyl acetate extract fraction of of Prosopis farcta proved an excellent inhibitory activity on calcium oxalate crystallization in vitro and therefore might be beneficial in dissolving urinary stones that might be attributed to its high polyphenolic contents including saponins, flavonoids, tannins and other polyphenolic compounds. However, further in vivo studies using animal models of urolithiasis is needed to evaluate the potential antiurolithic activity of this fraction. As the observed activity of the plant extract might be due to other phytochemicals present in it, further characterization and isolation of the major active compounds from the potent fractions are required.

Acknowledgment

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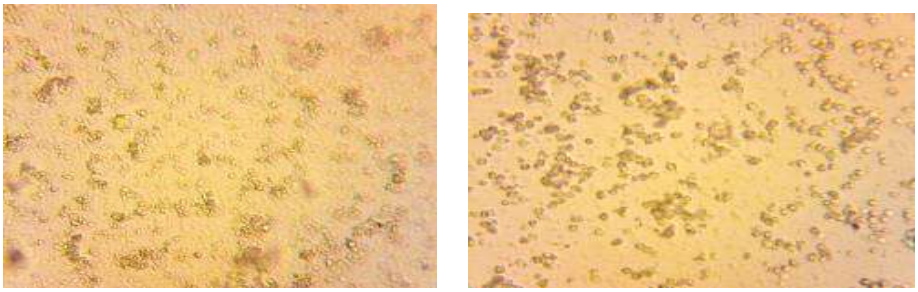
control the crystallization process using some substances in order to modify the products that affect kidney stone formation (Veronika and Khan, 2009). Based on many reports regarding the surgical interventions applied for the treatment of kidney stones such as shock wave lithotripsy, nephrolithotomy and ureteroscopy, they all lead to complications and several recurrences was also reported after having such interventions (Khan et al., 2019). However, many other treatment protocols have also been recommended which were proven to be effective adding to being non-invasive and not posing complications compared to surgical procedures (Khan et al., 2019). Among the recommended treatment alternatives for kidney stones, changing the diet habits by leaning on more fresh vegetables and fruits along with using some medicaments such as thiazide diuretics, potassium citrate and allopurinol depening on the type of calcium salt present in the formed kidney stone. Interestingly, many of the recommended treatment alternatives of kidney stones were based on traditional herbal medicine using several plants which proved to be very effective both as preventive and treatment against kidney stone formation (Khan et al., 2019). This finding inspired the research conducted in this study based on the use of Prosopis farcta extract to interfere with the crystallization process of calcium oxalate in the human urine that has shown a considerable effect on the calcium oxalate crystal size and number.

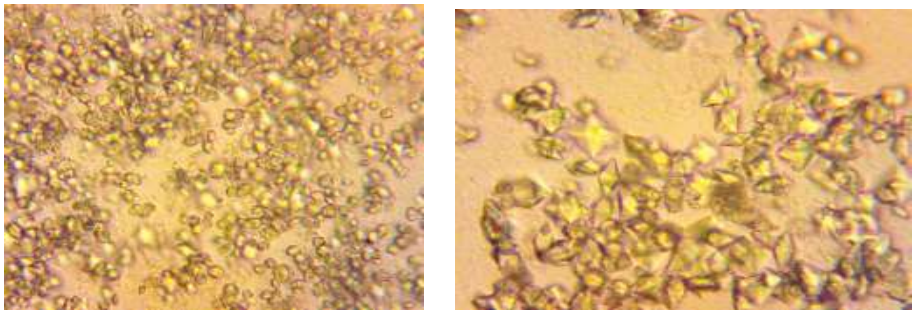
Table (2) In vitro antioxidant (DPPH) assay results

Fraction of Propspois farcta seeds and control and standard	**IC_{50} (mg/ml)**
Acetone	5.86
Methanol	12.73
Ethyl acetate	45.62
Isopropanol	190.61
Oxalate	No inhibition
Cystone	297.33

(a) Ethyl acetate (b) Acetone



(c) Isopropanol (d) Methanol



(e) Oxalate (control) (f) Cystone (standard)

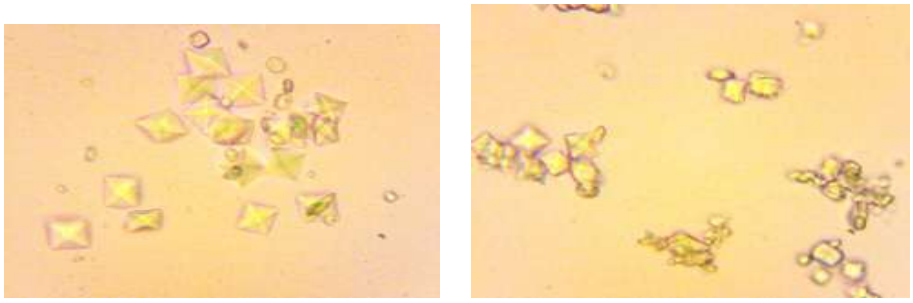


Figure (4) Light microscopy of calcium oxalate crystals induced in vitro with different concentrations of (a) ethyl acetate, (b) acetone, (c) isopropanol, (d) methanol fractions, (e) control and (f) standard drug at 400×, respectively.

It is well-established scientific fact that kidney stone formation process is a result of crystallization that happens in supersaturated urine (Barros et al., 2003), so to treat and forbid of urolithiasis, is necessary to change and

reduced the size and shape of COM crystals compared to the other fractions and cystone as a standard drug under the same magnification power. This notion reflects the influence of the natural products in ethyl acetate fraction that inhibited COM crystal growth, which according to the phytochemical screening results might be attributed to saponins and polyphenolics such as flavonoids and tannins featuring potent antioxidant activities. Further confirmation to the effect of different fractions of Prosopis farcta roots methanol extract was obtained through the study of calcium ion concentration after adding different fractions to be tested individually by using spectrophotometer using calcium kit and flame photometer. The results (Table 1) unraveled that ethyl acetate fraction induced the highest concentration of calcium 470 ppm ion indicating its potent effect on dissolution of calcium oxalate monohydrate crystals comparable to those of cystone 360 ppm as standard which was also supported by results of the microscopic study.

The in vitro antioxidant (DPPH) study of different fractions, oxalate and cystone (Table 2) displayed that acetone was the most potent antioxidant (IC_{50} of 5.86 mg/ml) and however ethyl acetate fraction revealed an intermediate antioxidant activity (IC_{50} of 45.62 mg/ml), it showed the most potent activity in the microscopic and dissolution experiments.

Table (1) Concentration of calcium ion in each fraction and cystone produced from dissolution of calcium oxalate measured by flame photometer and spectrophotometer.

fraction	**Concentration Ca^{+2} (ppm)** flame	**Concentration Ca^{+2}(ppm) spectroscopy**
Acetone	360.397± 2.854	368.643±0.158
Methanol	317.554± 4.943	317.628±0.084
Ethyl acetate	469.975±1.427	469.418±0.114
Isopropanol	346.391±1.427	346.244±0.173
Oxalate	246.699±2.854	241.629±0.179
Cystone	360.397±2.854	364.595±0.147

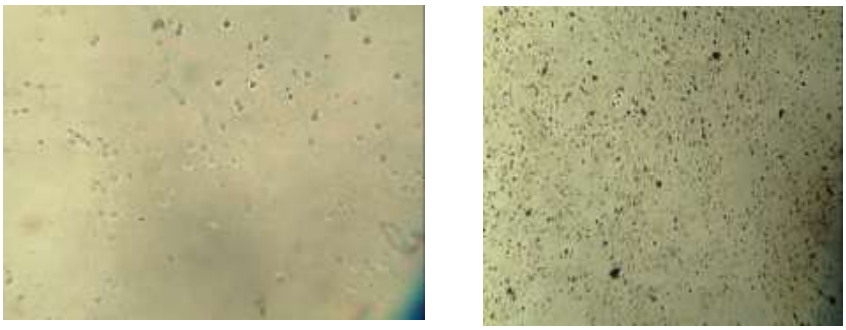
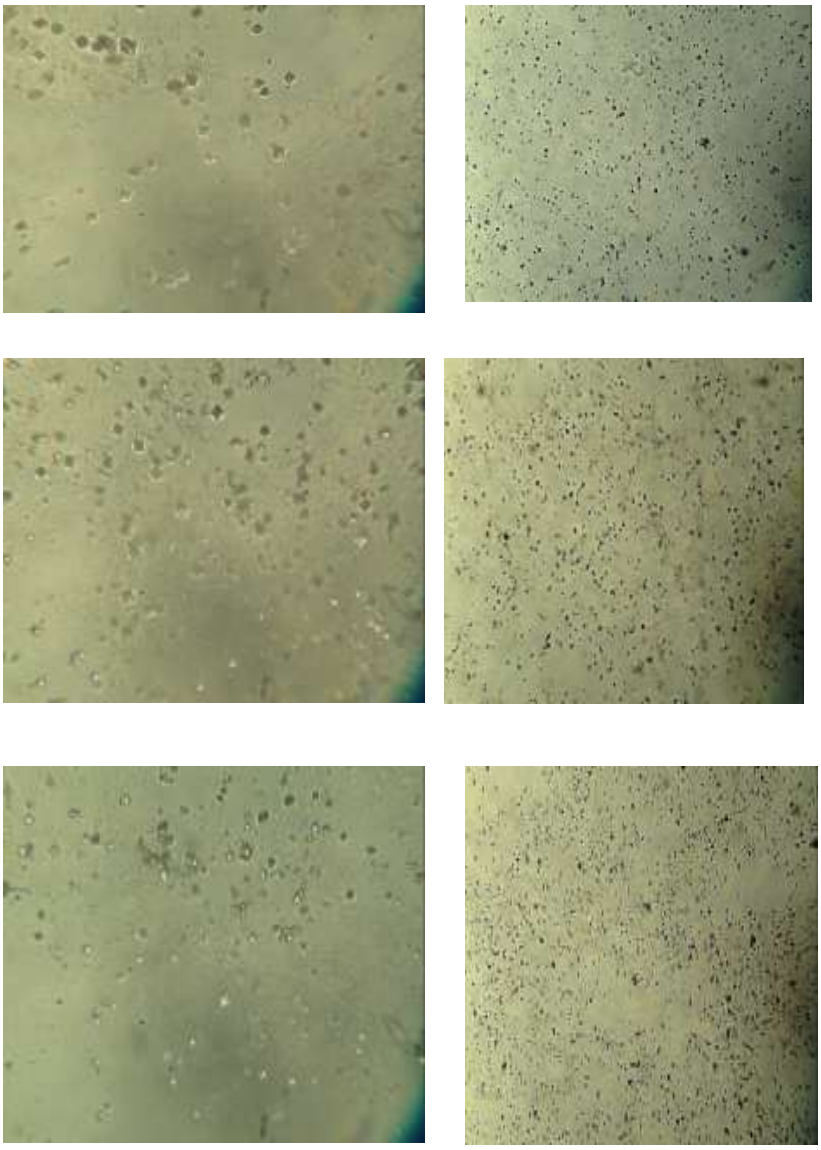


Figure (3) Light microscopy of calcium oxalate crystals induced in vitro in the presence of different concentration of Prosopis farcta aqueous solution extract, (f) 32.0 mg/mL, (g) 64.0 mg/mL, (h) 80.0 mg/mL and (i) 100.0 mg/mL at 40× and 10×, respectively.

The last results obtained from the crude aqueous extract of Prosopis farcta encouraged us to study the subsequent fractions, namely; ethyl acetate, acetone, isopropanol and methanol residual extract of Prosopis farcta.

Phytochemical screening of the different fractions of the total methanol extract prepared from Prosopis farcta roots revealed that however all the fractions possessed carbohydrates among their contents, only isopropanol didn't give positive results for tannins, phenols and flavonoids tests. Interestingly, ethyl acetate fraction displayed the highest and the most persistent froth indicating its relative high content of saponins compared to other fractions. Prosopis farcta ethyl acetate fraction was significantly more effective in inhibiting the nucleation and aggregation of COM crystals at 1 mg/ml solution than cystone. Moreover, the extract induced more formation of COD crystals, with a significant reduction in the number and size of COM crystals. Microscopic results (Figure 1a) indicated that the crystals in the control oxalate had the hexagonal shape related to COM whereas COM crystals lost their crystalline nature and they were converted to octahedral shape after using the different fractions, as indicated by the dispersed, lesser, very smaller octahedral shape COD particles compared with control in 40× magnification. By comparing different fractions of methanol extract of Prosopis farcta roots, it was found that ethyl acetate fraction (Figure 4)

40× 10×



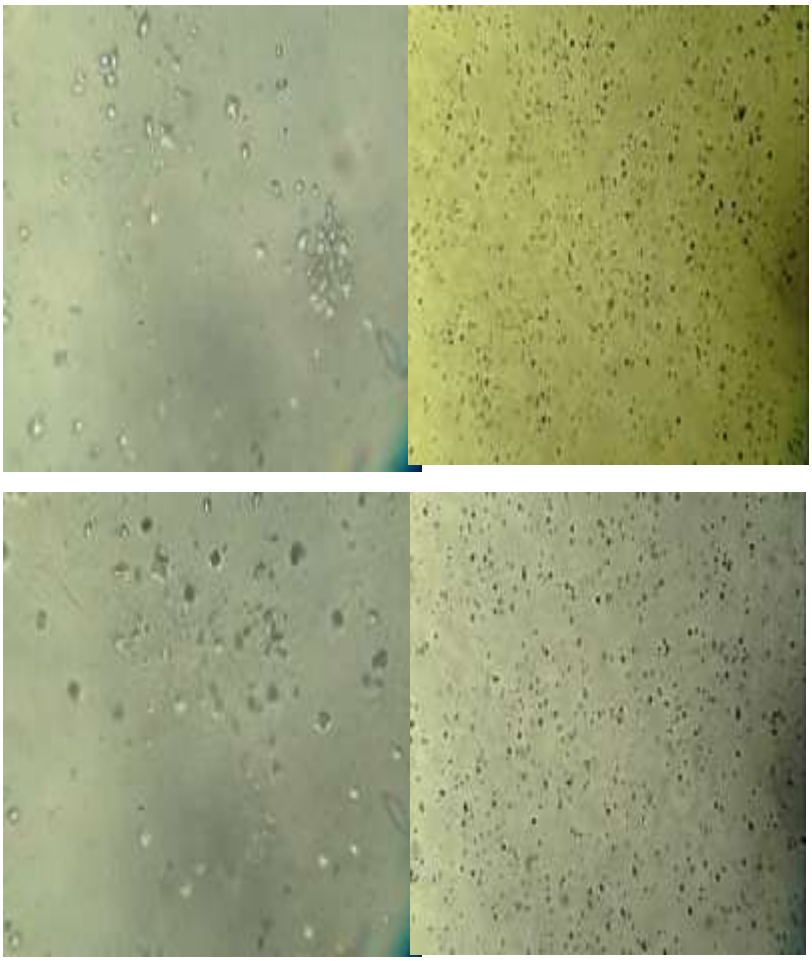
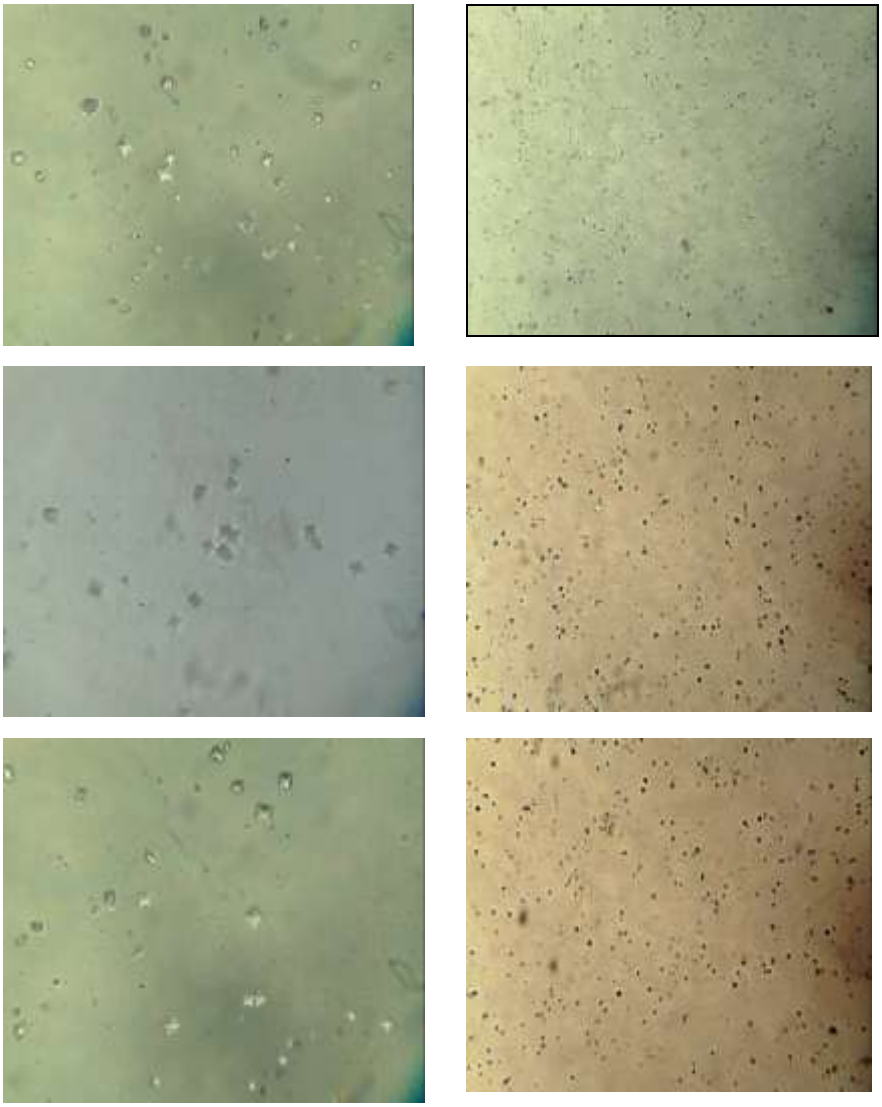


Figure (3) Light microscopy of calcium oxalate crystals induced in vitro, in (a) in the absence of different concentration of Prosopis farcta crude aqueous solution extract (-ve control), (b) 1.0 mg/mL, (c) 4.0 mg/mL, (d) 8.0 mg/mL and (e) 16.0 mg/mL at 40× and 10×, respectively.

40× 10×



Another important finding which can be observed is that crystals of calcium oxalate dihydrate (COD) is produced rather than calcium oxalate monohydrate (COM) by adding more crude extract (Figure 3).

Statistical analysis (ANOVA single factor) for calcium concentration comparison between UV spectroscopy and flame photometry for each fraction derived from the crude extract as in table 1

ANOVA: Single Factor						
UMMARY						
Groups	*Count*		*Sum*	*Average*	*Variance*	
Column 1	6	2108.157	351.3595	5523.294	Column 1	
Column 2	6	2101.413	350.2355	5269.345	Column 2	
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	3.790128	1	3.790128	0.000702	0.979378	4.964603
Within Groups	53963.1998	10	5396.32			
Total	53966.98993	11				
	F calc < F crit			Good correlation between the methods		
	0.000702 < 4.964603					
			P-value			
			0.979378			

The results showed that no significant difference between methods (good correlation between the methods).

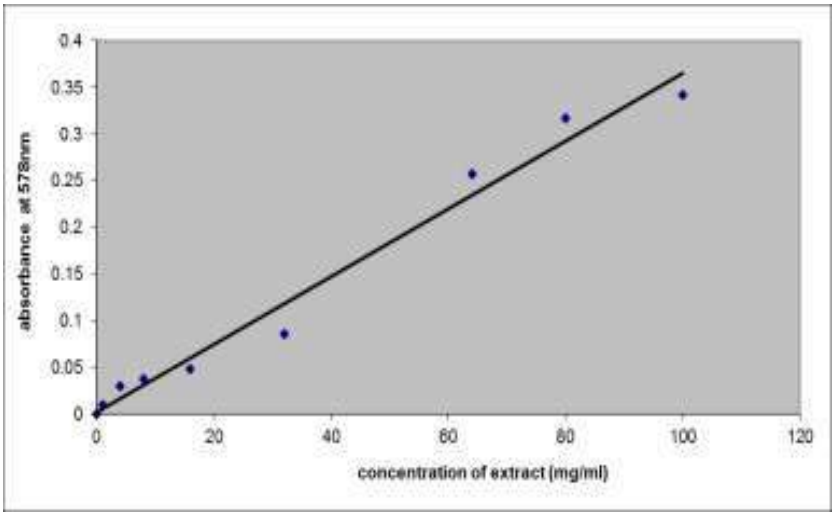


Figure (1) Effect of increasing concentrations of Prosopis farcta crude extract on calcium oxalate crystallization measured absorbance at 578 nm.

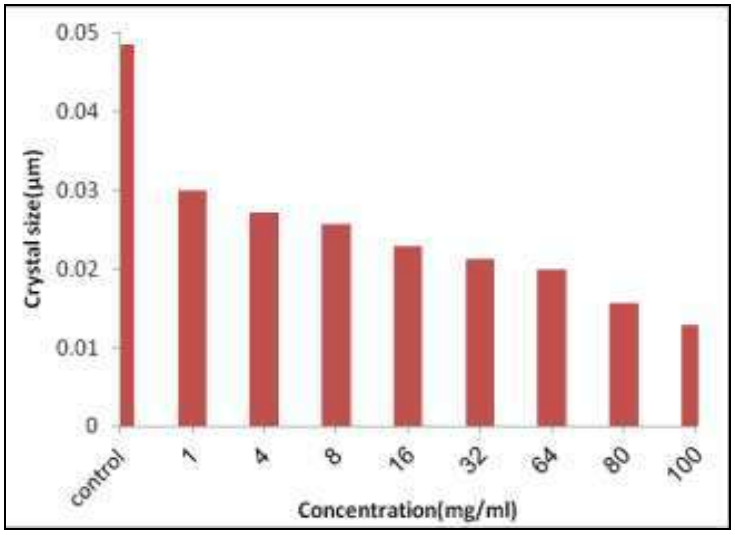


Figure (2) The effect of increasing concentration of Prosopis farcta crude extract on COM crystal size.

"Abs control" is the absorbance of the control reaction (containing all reagents except the tested compound) and "Abs sample" is the absorbance of the tested compound with all other reagents. Extract concentration providing 50% inhibition (IC_{50}) was determined from a graph plotting percentage inhibition against extract concentration. Trolox® [(±)-6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid] (final concentration 0 to 1.5 µg/ml) was used as a standard antioxidant drug for the construction of the calibration curve, and the DPPH radical-scavenging activities were expressed as mg Trolox® equivalents per gram of plant extract (Barros et al., 2003).

Results

Phytochemical screening of the total aqueous extract of Prosopis farcta revealed the presence of saponins, flavonoids, tannins and polyphenolics in addition to considerable amount of carbohydrates.

In this study, it was found that the tested extract reduced the crystallization process in a concentration dependent manner (Figure 1, R2 = 0.9802). The increasing concentration not only decreased the number of crystals but interestingly the size of crystals as well got reduced, so the absorbance increases with increased concentration of the extract.

The main result that can be taken from this study as the concentration of extract of Prosopis farcta increased the crystallization process inhibited; it was found also that with increasing the concentration of extract the size of COM crystals decreased as in Figure 2.

microscope 151 and equipped with KRUSS optronic camera (Hamburg, Germany).

The percentage of the dissolution (inhibition) produced by the herb extracts was calculated using the following formula:

$$\% \text{ Dissolution} = \frac{(\text{Absorbance of control} - \text{Absorbance of sample})}{(\text{Absorbance of control})} \times 100$$

The description of calcium oxalate crystals with respect to hydration, size and shape, i.e. calcium oxalate monohydrate (COM) and calcium oxalate dihydrate (COD) was recorded. The concentration of soluble calcium in the samples was measured by using two methods as follows for each fraction: (a) Flame Photometric determination: A serial dilution of a standard 100 mg/dl stock solution of calcium carbonate in deionized water was measured by using Flame Photometer JENWAY Models PFP7 (Staffordshire, UK) used to draw a calibration curve. The unknown concentrations of calcium ions in the test solutions were detected using the determined calibration curve equation and correlation coefficient (Figure 3). (b) Spectrophotometric determination of calcium ion: calcium ions in the sample reacts with arsenazo III forming a colored complex that can be measured by UV/VIS double beam Spectrophotometer SCOTech SPUV-26 (Dingelstadt, Germany) at 650 nm using a Kit (Calcium-Arsenazo Biosystems).

Antioxidant activity of plant extracts using DPPH radical scavenging assay

The DPPH (2,2-Diphenyl-1-picrylhydrazyl) radical assay was carried out spectrophotometrically as previously described in literature (Tepe et al., 2005). Of various concentrations of the extracts were added to 5 mL of 0.004% methanol solution of DPPH. After incubating the samples for 30 min at room temperature, the absorbance was determined against methanol at 517 nm. All determinations were done in triplicate. Inhibition of free radical scavenging activity was calculated using the following equation:

$$\text{Inhibition (\%)} = 100 \times (\text{Abs control} - \text{Abs sample})/\text{Abs control}$$

Testing for tannins and phenols

Ferric chloride test

To a 3 ml aliquot of the total extract and its subsequent fractions, 3 ml of 5% (w/v) ferric chloride solution was added. The resulting blue-black color indicates the presence of tannins and phenols.

Lead acetate test

To a 3 ml aliquot of the total extract and its subsequent fractions, 3 ml of 1% (w/v) lead acetate solution was added. The formed precipitate was filtered, dried and weighed where it was taken as an indication about the presence of tannins and phenols.

Crystallization assay in urine

Human urine samples were obtained, collected and kept in a refrigerator at 4 ºC from a 30-year old healthy person in polypropylene bottles refrigerated immediately after collection. Urine sample was centrifuged at 5000 rpm for 8 min and the supernatant was decanted in clean test tube. Urine sample firstly was tested with crude aqueous extract by using 2ml urine sample in each test tube and then to add to each test tube a 50 µl of each concentration of the aqueous crude extract solution (1.0, 4.0, 8.0, 16.0, 32.0, 64.0, 80.0 and 100.0 mg/ml), 50 µl of 0.1 M sodium oxalate and 50 µl of 0.1 M $CaCl_2$ to be added to each test tube. One test tube used as negative control (oxalate) containing only 2 ml urine sample, 50 µl of 0.1 M sodium oxalate and 50 µl of 0.1 M $CaCl_2$ in test tube.

Five solutions each of 100 mg/ml (w/v) concentrations were prepared from standard drug (cystone), three different fractions, namely; ethyl acetate, acetone, isopropanol and the residual methanol. To 2 ml of urine sample, 50 µl from each fraction solution prepared added then 50 µl of 0.1 M sodium oxalate and 50 µl of 0.1 M $CaCl_2$ were added to each in different test tube. The experiment was conducted in triplicate. All samples were then incubated at 37ºC for 2 hours with shaking and the solution optical density (OD) was determined at 578 nm (Nuhu, 2014). A 10 µl aliquot of the filtrate from each sample was applied on a slide and examined under KRUSS

a brown residue. The methanol extract was then subjected to liquid-liquid fractionation against different solvents of increasing polarities, namely; ethyl acetate, acetone and isopropanol. Each fraction was then dried under vacuum. Ultimately, each fraction was used to prepared 1 mg/ml solution in distilled water and the prepared solutions were filtered through a 0.45 µm filter to be used for the study of its effect on kidney stones. Phytochemical screening of the plant extract and subsequent fractions Testing for carbohydrate

Molisch's test

To a 2 ml portion of the total extract and its subsequent fractions, 2-3 drops of α-naphthol solution in alcohol was added, shaken for 2 min and 1 ml of concentrated sulphuric acid was added slowly on the sides of the test tube. A deep violet color at the junction of two layers indicates the presence of carbohydrates.

Testing for flavonoids

NaOH test

A portion of the total extract and its subsequent fractions was separately treated with few drops of sodium hydroxide solution. Formation of intense yellow color, which becomes colorless on addition of dilute acid, indicates the presence of flavonoids.

Testing for saponins

Froth test

An aliquot of 30 mg from each tested fraction was dissolved in 2 ml distilled water by sonication then was vigorously shaken for 5 min each in graduated test tube. The solution is then allowed to stand for 15 min and the persistent froth height was then measured and taken as qualitative and quantitative indicator of the saponin content for each tested fraction.

Materials and Methods

General experimental procedures

Retsch Laboratory Mill model 5657 (Haan, Germany) was used to grind Prosopis farcta beans. Thermo Electro Corporation forma orbital shaker equipped with HEPA Filter (Massachusetts, USA) was used to prepare the total methanol extract that was thereafter fractionated using Soxhlet apparatus. UV/VIS double beam Spectrophotometer SPUV-26 (Staffordshire, UK) was used to measure the absorbance of the samples. Flame Photometer Models PFP7 (JENWAY,UK) was used to determine the concentration of calcium ion. Krüss microscope connected to a Krüss optronic camera (Hamburg, Germany) was used to investigate the size and shape of calcium oxalate crystals.

Plant material

Prosopis farcta plant was collected from a garden in Jordan in December, 2018 cleaned and dried at 45ºC overnight then it was powdered. The plant was authenticated by Prof. Dr. Saleh Al-Qur'an at Department of Botany, Faculty of Science, Mut'ah University and a voucher specimen coded PF-201312 was kept at Department of Pharmaceutical Chemistry, Faculty of Pharmacy, Mut'ah University.

Preparation of plant extract and subsequent fractions

Preparation of crude plant extract and subsequent fractions

A 100 g of dried ground roots was soaked for 24 hours in 500 mL distilled water, then it dried using rotary evaporator to get crude extract. The crude extract was resuspended in distilled water and filtered through a 0.45 mM filter and used to prepare solutions at different concentrations (1.0, 4.0, 8.0, 16.0, 32.0, 64.0, 80.0 and 100.0 mg/mL) in distilled water that used to test the effect of crude extract on the kidney stone.

Another 100 g of clean ground roots were refluxed using 400 ml hexane for 24 h to be defatted, then the hexane extract was decanted. Afterwards, 400 ml of methanol were added to the mark and refluxed for 24 h, then the methanol extract was filtered and dried using rotary evaporator to finally get

the solubility of urinary stones (Sinha et al., 2011; Yasir and Waqar, 2011; Sinha et al., 2010; Odvina, 2006).

Till now, there is no effective treatment for kidney stone without surgical and/or physiotherapeutic intervention whereas shock wave lithotripsy of renal and proximal ureteral stones appeared to increase the risk of hypertension and diabetes on long-term follow-up, also with high recurrence rate about 50% after 10 years (Lieske et al., 1999; Leusmann et al.,, 1995). These findings encouraged and strengthened the importance of searching for new treatment alternatives of kidney stones.

A number of vegetable drugs has been used in many parts of the world for the treatment of urolithiasis (Laroubi et al., 2007; Atmani et al., 2004; McHarg et al., 2003; Araújo Viel et al., 1999; Grases et al., 1995). Prosopis farcta (PA) is a plant belonging to family Fabaceae, popularly known as Arabic tea. Medicinal uses of the aerial parts are indicated in Algerian popular medicine as diuretic and for the treatment of the renal diseases, especially as antiurolithiasis (Zama et al., 2007), hypoglycemic activity (Afifi et al., 2005; Carmona et al., 2005) and antimicrobial activity (Al-Bakri and Afifi, 2007). In Portugal, Prosopis farcta is used as analgesic, in stomach ulcer, anorexia and flatulence (Yasui et al., 1999).

Herbal medicine rapidly spread through the world like Europe, United States, China and Hong Kong (Gohel and Wong, 2006; Yasui et al., 1999). Many medicinal plants showed effective antiurolithic activity such as Phyllanthus niruri, Aerra lanata, Crataeva nurvala, Herniaria hirsuta and indigenous plant (Kulaksizoglu et al., 2008; Atmani et al., 2003; Freitas et al., 2002; Selvam et al., 2001; Varalakshmi et al., 1990).

In this study, we will investigate the medicinal effect of Prosopis farcta in the treatment of kidney stones as alternative to surgically or ultrasound treatment of kidney stone, so to characterize the effect of Prosopis farcta on kidney stone we will study the in vitro effect of an aqueous extract of Prosopis farcta on calcium oxalate crystallization.

Introduction:

Nowadays, urinary stones (aka urolithiasis) become one of the main diseases that affects 10-12% of population in developed countries (Sowers et al., 1998). The incidence of urolithiasis has increased over last years while the age of onset is decreasing (Trinchieri, 2008; Alelign and Petros, 2018). Most of kidney stones are chemically composed of calcium salts, uric acid, cystine and/or struvite (MgNH4PO4) in the western hemisphere. Most kidney stones contain calcium oxalate (Trinchieri, 2008; Alelign and Petros, 2018) and the formation of urinary calculi involves a CaOx crystallization process that includes nucleation, growth and the aggregation of crystals (Khan and Kok, 2004). About 75-85% of urinary stones are made of calcium oxalate or calcium phosphate but may be admixed in the same stone. Calcium phosphate in kidney stones is usually present as Hydroxyapatite [$Ca_5(PO_4)_3OH$] or, less commonly Brushite ($CaHPO_4.XH_2O$) (Joshi and Joshi, 2003). Urinary stones exist in different morphology colloid or crystalloid such as calcium oxalate, calcium phosphate, calcium carbonate, magnesium-ammonium phosphate, uric acid and cysteine. Recent studies showed that low calcium and higher oxalate diets such as beets, beans, blueberries, celery, grapes, chocolate, strawberries, spinach, rhubarb, tea, nuts, bran, almonds and peanuts, promote calcium oxalate precipitation about 15 times above normal levels, so it is advisable to avoid excessive intake of diets rich in oxalate (Parmar, 2004; Kessler et al., 2002; Goldfarb and Asplin, 2001; Seltzer et al., 1996; Curhan et al., 1996). In addition, it was found that citrate-rich diets may also be used as a preventive measure combatting kidney stone formation because it is not only increases the urinary pH, but also increases the urinary citrate level which inhibits crystal growth and nucleation due to lowering urine super-saturation via complexation of calcium (Odvina, 2006). Hence, higher intake of fresh natural citrus fruit juices especially lemon, orange, blackcurrant and cranberry may reduce the risk of urinary stone formation. This effect is attributed to the protective effect of citric acid (citrate) against kidney stone formation (Odvina, 2006) while acid-hydrolyzation of natural fruits such as Juice of Apple, Moushmi, Samras, Amla and Chikku increases

العلاج بالأعشاب لحصى البول باستخدام المستخلص المائي الكلي ومن خلال مجتزئات مستخلص الميثانول لنبات الينبوت الذي يزرع في الأردن

موسى خميس المغاربة
طايل عبدالغني الحجران
شريف سعيد عباده

ملخص

تعتبر عملية البلورة هي الخطوة المحددة في تكوين حصى البول لذلك هذه الدراسة شخصت أثر مستخلص جذور نبات الينبوت في الماء على تكون بلورات أوكزالات الكالسيوم بداية ثم مجزئات مستخلص الميثانول والتي تضم (خلات الإيثيل، أيزوبروبانول، الأسيتون وباقي الميثانول).

كثير من العوامل مثل الحجم وعدد ونوع بلورات أوكزالات الكالسيوم وتركيزها تم تضمينها كمؤشرات لعملية ترسب البلورات .أشارت النتائج إلى وجود فعالية ملحوظة للمستخلص المائي وكذلك المجزئات وخصوصا خلات الايثيل تجاه عملية تكون البلورة والحد منها مع زيادة التركيز والجرعة من حيث تقليل الحجم للبلورة.

عدد بلورات أوكزالات الكالسيوم أحادية الماء والتي تحطم الخلايا تقل تدريجيا وكليا عند تركيز عالي من المستخلص بالإعتماد على الجرعة .وأشارت النتائج أيضا بأن مستخلص جذور نبات الينبوت له تأثير مضاد على تكون حصى البول وله القدرة على تقليل حجم البلورة وأيضا بحفز تكون بلورة أوكزالات الكالسيوم ثنائية الماء بدلا من بلورات أوكزالات الكالسيوم أحادية الماء.

إن عملية تحول بلورات أوكزالات الكالسيوم لإنتاج بلورات ثنائية الماء بدلاً من أحادية الماء وتقليل حجم البلورة وزيادة تركيز الكالسيوم بالإضافة لتأثيره كمدر للبول للمستخلص والتي تلعب دور مهم في عملية التحكم بعملية تكون الحصى.

الكلمات الدالة: الحصى البولي؛ أوكزالات الكالسيوم؛ الينبوت ؛ حصوات المسالك البولية.

Herbal Treatment for Urinary Stones Using Crude Aqueous Extract and Fractionated Methanol Extract of Prosopis Farcta Cultivated in Jordan

Mousa K. Magharbeh*
Tayel A. Al-Hujran
Sherif S. Ebada

Abstract

Crystallization process is the rate limiting step in urolithiasis. Therefore, the present study chemically investigated the aqueous extract of Prosopis farcta and its effect on crystallization of calcium oxalate salts. Many factors such as the size, number, type of calcium oxalate crystals and calcium concentration were included as markers for the crystallization process. Results showed that the crude aqueous extract and the fractions especially ethyl acetate fraction significantly inhibit calcium oxalate crystallization in a dose-dependent pattern by reducing the crystal size. The number of calcium oxalate monohydrate (COM) crystals that damages epithelial cells gradually decreased and completely disappeared at higher concentrations of extract in a dose-dependent fashion. The results confirmed that Prosopis farcta extract has antiurolithic activity and has the ability to reduce crystal size as well as to activate the formation of calcium oxalate dihydrate (COD) crystals rather than calcium oxalate monohydrate (COM).

The shifting of crystallization process toward COD rather than COM and reducing the crystal size, calcium ion concentration, in addition to the diuretic action of the extract play an important role in controlling urolithiasis.

Keywords: Urolithiasis; Calcium oxalate; Prosopis farcta; Urinary stone.

* **كلية الصيدلة، قسم الكيمياء الصيدلانية، جامعة مؤتة.**

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Özacar, M., & Sengýl, I.. (2004). Two-Stage Batch Sorber Design Using Second-Order Kinetic Model for the Sorption of Metal Complex Dyes onto Pine Sawdust. Biochemical Engineering Journal, 21, 39–45.

Patel, M. (2017). Evaluation of Mass Transfer Rate in Column of Small Lilsx Particles. MSc. Thesis, Cleveland State University, Cleveland, Ohio, United States.

Porkodi, K., & Kumar, K (2007). Equilibrium, Kinetics and Mechanism Modeling and Simulation of Basic and Acid Dyes Sorption onto Jute Fiber Carbon: Eosin Yellow, Malachite Green and Crystal Violet Single Component Systems. Journal of Hazardous Materials, 143, 311–327.

Qiu, H., Lv, L., Pan, B., Zhang, Q., Zhang, W., & Zhang, Q. (2009). Critical Review in Adsorption Kinetic Models. Journal of Zhejiang University Science A, 10(5),716-724.

Rokanuzzaman, M. (2015). Design Method For Layered Bed Adsorber For Separation of Co_2 And N_2 from Natural Gas Using Zeolite13x, Carbon Molecular Sieve and Activated Carbon. MSc. Thesis, University of Regina, Regina, Saskatchewan, Canada.

Seepe, L. (2015). The Use of Cassava Waste in the Removal of Cobalt, Chromium and Vanadium Metal Ions from Synthetic Effluents. MSc. Thesis, University of Witwatersrand, Johannesburg, South Africa.

Ullah, H., Nafees, M., Iqbal, F., Awan, M., Shah, A., & Waseem, A. (2017). Adsorption Kinetics of Malachite Green and Methylene Blue from Aqueous Solutions Using Surfactant-modified Organoclays. Acta Chim. Slov., 64, 449−460.

Guo, H., Stüben, D., Berner, Z. & Kramar, U. (2007). Adsorption of Arsenic Species from Water Using Activated Siderite-Hematite Column Filters. Journal of Hazardous Materials, 151, 628-635.

Gupta, V., Srivastava, S. & Tyagi, R. (2000). Design Parameters for the Treatment of Phenolic Wastes by Carbon Columns (Obtained from Fertilizer Waste Material). Water Res., 34 (5), 1543-1550.

Ho, Y., & McKay, G. (1998). A Two-Stage Batch Sorption Optimized Design for Dye Removal to Minimize Contact Time. Trans IChemE, 76 (B), 313-318.

Ko, D., Lee, V.., Porter, J. & McKay G. (1999). Correlation-Based Approach to the Optimization of Fixed Bed Sorption Units. Industrial & Engineering Chemistry Research, 38, 4868–4877.

Ko, D., Lee, V. K., Porter, J. F., & McKay G. (2002). Improved Design and Optimization Models for the Fixed Bed Adsorption of Acid Dye and Zinc Ions from Effluents. Journal of Chemical Technology and Biotechnology, 77, 1289–1295.

Kwok, K. & McKay, G. (2010). Novel Batch Reactor Design for the Adsorption of Arsenate on Chitosan. Chem Technol Biotechnol, 85, 1561–1568.

Levenspiel, O. (1999). Chemical Reaction Engineering (3rd ed.), New York, USA: John Wiley & Sons.

McKay, G. (1981). Design Models for Adsorption Systems in Wastewater Treatment. J. Cham. Tech. Biotechnol. 31, 717-731.

McKay, G. & Bino, M. (1990). Simplified optimization procedure for fixed bed adsorption systems. Water, Air, Soil Pollution, 51, 33-41.

McKay, G., Otterburn, M. S., & Aga, J. A. (1985). Fuller's Earth and Fired Clay as Adsorbents for Dyestuffs: Equilibrium and Rate Studies. Water, Air, and Soil Pollution, 24, 307-322.

Munagapati, V. & Kim, D. (2017). Equilibrium Isotherms, Kinetics, and Thermodynamics Studies for Congo Red Adsorption Using Calcium Alginate Beads Impregnated with Nano-Goethite. Ecotoxicology and Environmental Safety, 141, 226–234.

References:

Al-Degs, Y., Khraisheh, M. Allen, S. & Ahmad, M. (2009). Adsorption Characteristics of Reactive Dyes in Columns of Activated Carbon. Journal of Hazardous Materials, 165, 944–949.

Al Shabanat, M., Al-Mufarij, R. & Al-Senani G. (2016). Study on Adsorption of Malachite Green by Date Palm Fiber. Oriental Journal of Chemistry, 32(6), 3139-3144.

Amin, M., Alazba, A. & Shafiq M. (2015). Adsorptive Removal of Reactive Black 5 from Wastewater Using Bentonite Clay: Isotherms, Kinetics and Thermodynamics. Sustainability, 7, 15302-15318.

Anderson P. (1986). The Modelling and Design of an Activated Carbon Adsorber for the Recovery of Organic Components from a Cellulose-Plant Effluent. MSc. Thesis, University of Witwatersrand, Johannesburg, South Africa.

Babu, B. & Gupta S. (2006). Modeling and Simulation of Fixed Bed Adsorption Column: Effect of Velocity Variation. i-manager's Journal on Future Engineering and Technology, 1(1), 60-66.

Cortés-Martínez, R., Solache-Ríos, M., Martínez-Miranda, V., & Alfaro-Cuevas, R. (2009). Removal of Cadmium by Natural and Surfactant-Modified Mexican Zeolitic Rocks in Fixed Bed Columns. Water Air Soil Pollution, 196, 199–210.

Doğan; M., Alkan; M., & Onganer Y. (2000). Adsorption of Methylene Blue on Perlite from Aqueous Solutions. Water, Air, and Soil Pollution, 120, 229–248.

El Qada, E. (2019). Adsorption of Malachite Green by Jordanian Diatomite Ores: Equilibrium Study. JJECI, 2(3):92-99.

El Qada, E. (2020). Kinetic behavior of the Adsorption of Malachite Green using Jordanian Diatomite as adsorbent. JJECI, In Press.

El Qada, E., Allen, S. & Walker, G. (2006). Adsorption of Basic Dyes onto Activated Carbon Using Microcolumns. Industrial & Engineering Chemistry Research, 45, 6044–6049.

Faust, S. & Aly, O. (1998). Chemistry of Water Treatment (2nd ed.). Michigan, USA: Ann Arbor Press, INC.

The results of the characteristics of MTZ of MG adsorption revealed that diluted initial MG concentration and slower flow rate of MG solution are favourable condition for MG-diatomite system.

The Empty Bed Residence Time (EBRT) model was successfully applied. The obtained results of the EBRT approach showed the significant effects of the flow rate of MG solution and the depth of diatomite bed on the adsorption efficiency. Increasing the depth of diatomite bed and decreasing flow rate of MG solution enhanced the adsorption column performance and increased volume throughput.

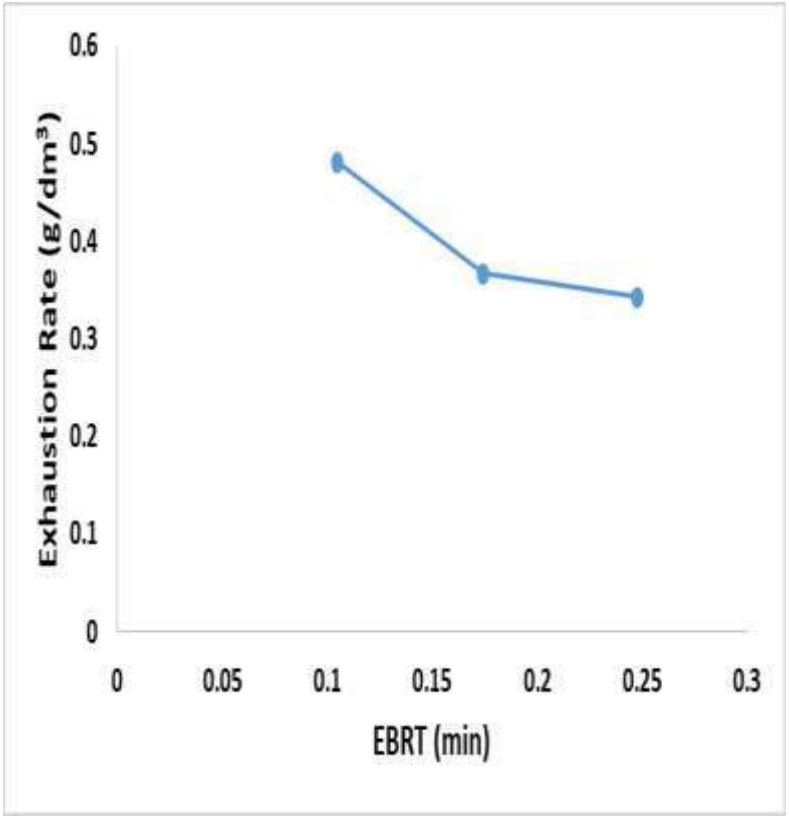

Figure (7) EBRT plot for the adsorption of MG onto diatomite.
Effect of bed height

5. Conclusion:

The proposed batch adsorber design method succeeded in predicting the performance of the batch adsorber to treat different volumes of MG solutions for different percentage removal of MG and for any initial MG concentration. The amount of diatomite required to treat same volume of MG solution was increased at higher initial concentration of MG solution. Fixing the percentage removal of MG and initial MG concentration and increasing the volume of MG solution to be treated required higher dosages of diatomite.

Thus, longer EBRT and smaller dosage of diatomite is needed per unit volume of MG solution treated. This lowers the operating cost and allow larger column to be used. Conversely, if the diatomite exhaustion rate is high, the EBRT will be smaller and a high dosage of diatomite is needed which requires higher operating costs. Therefore, a small column will be used to reduce the construction cost.

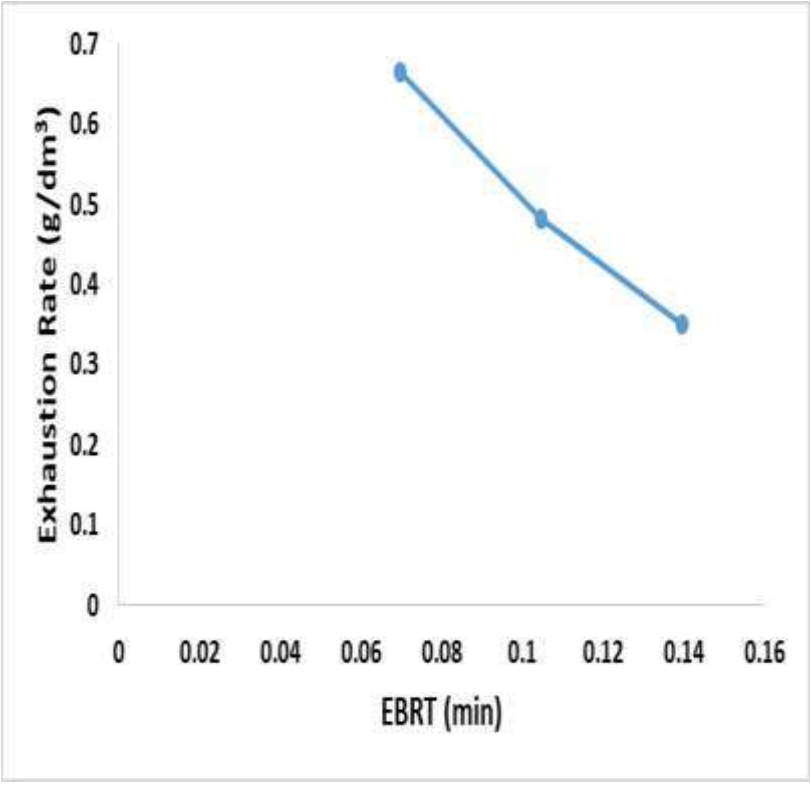

Figure (6) EBRT plot for the adsorption of MG onto diatomite. Effect of flow rate

It is clear from Table 3 that increasing the bed depth from 0.9 to 2.13 (cm) increases EBRT from 0.1047 to 0.2476 (min) and decreases the adsorbent exhaustion rate (0.48-0.34 (g/dm^3)). On the contrary, increasing flow rate resulted in a decrease of EBRT and an increase in the adsorbent exhaustion rate. Ko et al. (2002) reported that the increase in EBRT with a fixed flow rate will require the bed volume to be larger which allows more solution to be treated and reduce adsorbent exhaustion rate. Decreasing flow rate will allow more contact time between adsorbate solution and adsorbent bed.

Table (3) EBRT and adsorbent exhaustion rate for the adsorption of MG onto diatomite as a function of flow rate and mass of diatomite

variable Flow Rate (m1/min)	Bed Depth (cm)	Bed volume (cm3)	Vb (dm3)	Tb (hr)	EBRT (min)	Ads orbent Exhaustion Rate (g/dm3)
3	0.9000	0.4190	0.5700	3.1600	0.1396	0.3500
4*	0.9000	0.4190	0.4160	1.7366	0.1047	0.4807
6	0.9000	0.4190	0.3010	0.8416	0.0698	0.6644
Mass (g)						
0.200*	0.9000	0.4190	0.4160	1.7366	0.1047	0.4807
0.300	1.5000	0.6975	0.8179	3.4060	0.1743	0.3669
0.400	2.1300	0.9904	1.1667	4.8600	0.2476	0.3430
*standard experimental conditions						

Figure (6) and Figure (7) show the operating line for the adsoprtion of MG onto diatomite at different bed hights and MG solution flow rates, respectively. The aysmptoes of the operating time can be used to determine the minimum residence time and the minimum diatomite exhaustion rate (Ko et al., 1999).

Based on the above discussion, lowering the adsorbent exhaustion rate will increase the volume of MG solution to be treated at breakthrough point.

mass flow rate of MG. Thus, a higher MG concentration on diatomite surface is expected and this is indicated by q_{column} values which was increased from 166.2-385.1 (mg/g) as the initial MG concentration increased from 50-150 (ppm).

Table 2 reveals the effect of flow rate on the MTZ characteristics. It is obvious from the table that increasing the flow rate from 3-6 (ml/min) has decreased the treated volume ($V_{0.9}$) from 1.26-0.859 (dm^3). This indicates the high effect of the flow rate on the adsorption efficiency. MTZ life time has increased from 2.38-7 (hrs) by decreasing the flow rate from 6-3 (ml/min). Increasing the flow rate decreased the contact within the column and increase L_{MTZ}. RMTZ has decreased from 6.24-2.13 (cm/min) by decreasing flow rate from 6-3 (ml/min). The amount of MG adsorbed has increased from 267-293 (mg/g) as the flow rate decreased from 6-3 (ml/min). This is mainly due to the increase in contact time within the column.

Table (2) Effect of flow rate on the MTZ characteristics

Flow rate (m1/min)	L (cm)	V_x (dm^3)	V_b (dm^3)	C_x (ppm)	C_b (ppm)	t_x (hr)	t_b (min)	l_{MTZ} (cm)	RMTZ (cm/min010^3	Qads (mg)	Qcolumn (mg/g)
3	0.9	1.26	0.570	89.71	4.78	7.00	189.6	0.49	2.13	58.60	293.0
4	0.9	1.04	0.416	90.00	4.99	4.33	104.2	0.54	3.46	53.00	264.9
5	0.9	0.859	0.301	94.45	5.60	2.38	50.50	0.58	6.24	49.50	247.5

EBRT and adsorbent exhaustion rate were also determined for the adsorption of MG onto diatomite as a function of MG solution flow rate and mass of Diatomite. According to Ko et al. (2002), four parameters determine EBRT and the adsorbent exhaustion rate, namely, flow rate of adsorbate solution, bed volume, mass of adsorbent and volume of adsorbate solution treated at breakthrough.

Table (3) lists the EBRT and adsorbent exhaustion rate for the adsorption of MG onto diatomite as a function of flow rate and mass of diatomite.

Continuous adsorption (fixed-bed column) data were used to study the effect of the experimental parameters on the design aspects of a fixed-bed adsorber. The breakthrough and exhaustion points were defined as phenomena when the effluent concentration is 5% and 90% of influent concentration, respectively.

The values of V_x ($V_{0.9}$), V_b ($V_{0.05}$), C_x ($C_{0.9}$), C_b ($C_{0.05}$), t_x ($t_{0.9}$) and t_b ($t_{0.05}$) were collected from the experimental data and used to calculate the MTZ characteristics such as t_x, L_{MTZ}, RMTZ and column adsorption capacity (q_{column}) for MG adsorption onto diatomite. In addition, the total amount of MG adsorbed (q_{ads}) was calculated by multiplying q_{column} by the adsorbent mass. Table 1 summarizes the effect of initial MG concentration on MTZ characteristics.

Table (1) Variation in the characteristics of the MTZ with initial MG concentration

C_o (ppm)	L (cm)	V_x (dm^3)	V_b (dm^3)	C_x (ppm)	C_b (ppm)	t_x (hr)	tb (min)	L_{MTZ} (cm)	RMTZ (cm/min)10^3	q_{ads} (mg)	q_{column} (mg/g)
50	0.9	1.410	0.619	44.50	2.47	5.87	154.7	0.50	2.53	33.24	166.2
100	0.9	1.040	0.416	90.00	4.99	4.33	104.2	0..54	3,46	53.00	264.9
150	0.9	0.884	0321	134.7	7.84	3.68	80.20	0.57	4.05	71.62	385.1

It is clear from Table 1 that the treated volume $V_{0.9}$ was increased from 0.884-1.41 (dm^3) as the initial dye concentration decreased from 150-50 ppm. Longer bed life time (t_x) was recognized by decreasing the initial MG concentration. 5.87 hrs was obtained for the initial dye concentration of 50 ppm, while 3.68 hrs was obtained at 150 ppm. Thus, it can be inferred that diatomite is efficient for treating solution of lower MG concentration, while concentrated MG solution required high amount of diatomite. L_{MTZ} was slightly increased by the increase in the initial dye concentration. This means that MTZ was more effective at lower MG concentration. The data shows that L_{MTZ} is shorter than the original bed depth (0.5, 0.54 and 0.57 cm against 0.9cm, the bed depth length). This might indicate high adsorption kinetics for MG in column operation. RMTZ has increased from 2.53-4.05 $*10^{-3}$ (cm/min) as the initial MG concentration increased from 50-150 (ppm). Increasing initial MG concentration may result in an increase in the

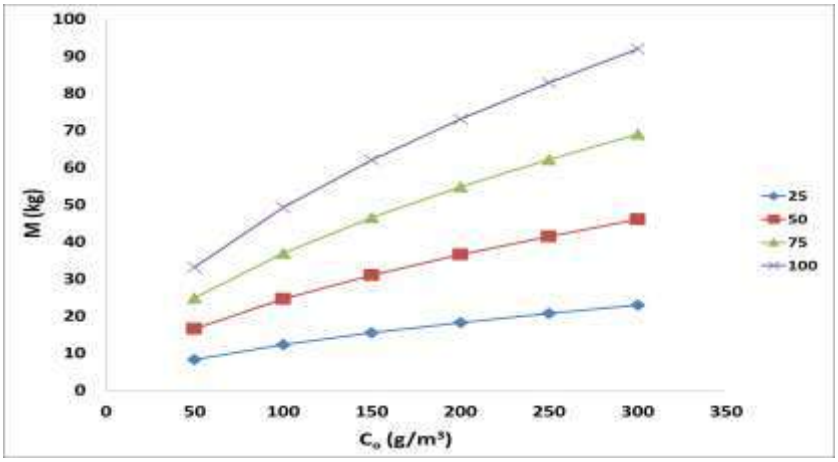

Figure (4): Adsorbent mass (M) against initial MG concentration for 90% colour removal at various volume of effluent (V) treated, pH = 7, particle size = 500-710 µm. Volume in m^3.

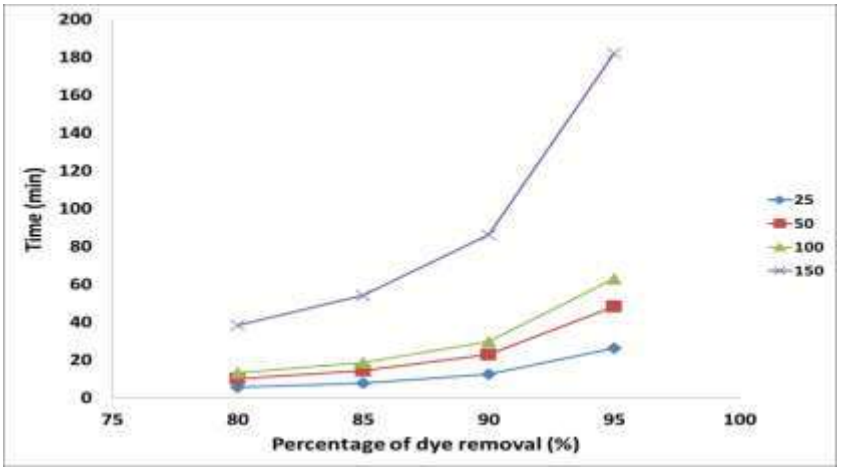

Figure (5): Design time required to reduce the colour concentration by 80- 95% at various initial dye concentration. pH = 7, diatomite size = 500- 710 µm. Concentration in g/m^3.

4.2 Fixed-Bed Adsorber:

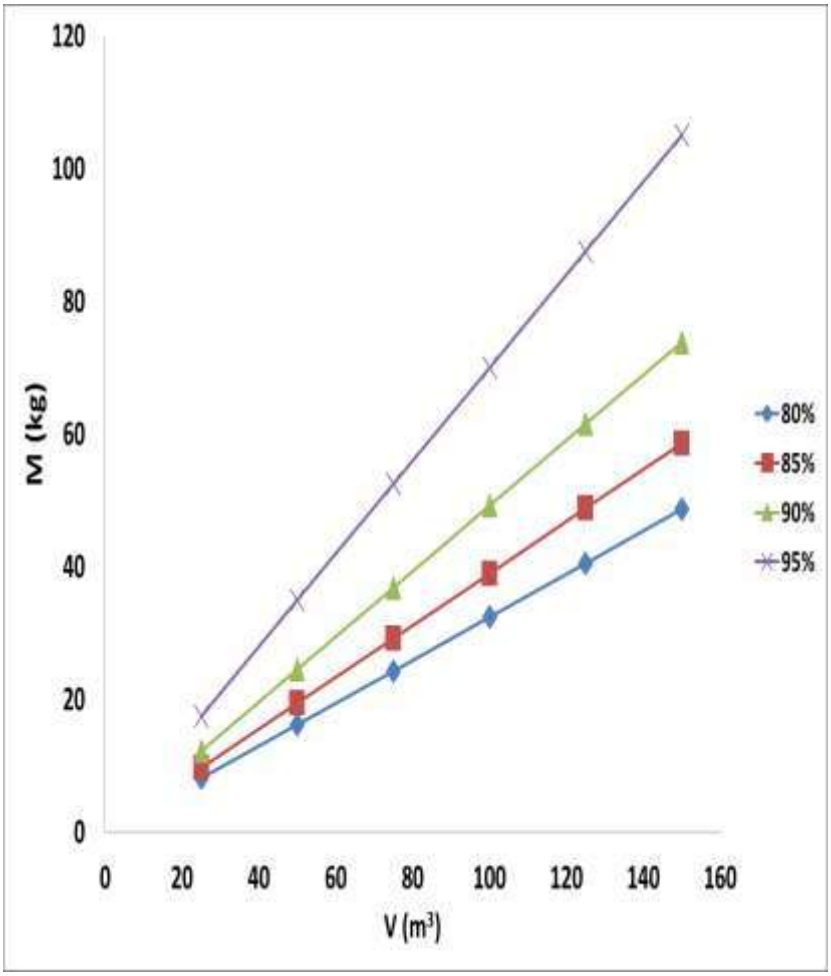

Figure (3): Adsorbent mass (M) against volume of effluent (V) treated for various percentage of dye removal at initial concentration =100 g/m^3, pH = 7, particle size = 500-710 µm.

and 52.54 kg for 80%, 85%, 90% and 95% dye removal, respectively. Increasing the treated volume of MG solution served to increase the required amount of diatomite for a fixed percentage of MG removal. This agrees with the results reported in the literature (McKay et al., 1985; Porkodi & Kumar, 2007; Doğan et al., 2000).

Equation 2 can also be used to calculate the amount of diatomite required to remove 90% of dye from aqueous solution for any initial dye concentration for a fixed volume. Figure 4 illustrates the required amount of diatomite to reduce the color content by 90% from various volumes of effluents at different initial MG concentrations. The required amounts of diatomite to reduce the color concentration by 90% from aqueous solution of volume $25m^3$ and initial MG concentration of 50 g/m^3 is 8.29 kg. Also, it is noticeable from Figure 4 that by increasing the initial MG concentration from 50 to 300 g/m^3, the amounts of diatomite required to reduce the color content by 90% increases from 24.88 to 68.99 kg when 75 m^3 of dye solution is to be treated. A similar trend has been reported by Kwok and McKay (2010). The authors designed a batch adsorber for the adsorption of arsenate onto Chitosan. The authors found that larger amount of chitosan is required to treat a higher concentration of arsenate solution.

Figure (5) displays the required time to reduce the colour concentration by 80-95% at various initial dye concentrations. The results showed that as the initial dye concentration increases, more time is needed to reach the specified percentage of dye removal. This agrees with the earlier findings of the effect of concentration on the adsorption process (El Qada, 2020). In the case of low initial MG concentration, less MG molecules are present in the adsorber and this means less competition between MG molecules for available adsorption sites. Thus, the reduction in the colour concentration will be faster.

3.2 Procedure

Equilibrium and kinetic adsorption experiments are well presented in El Qada (2019) and El Qada (2020). In order to confirm the applicability of diatomite for dye recovery, breakthrough curves were determined for different initial dye concentrations (50-150 ppm), bed heights (0.9-2.13 cm) and flow rates (3-6 ml/min). A small scale column tests were conducted. Adsorption column is constructed using columns of 15cm length with internal diameter of 0.77 cm. Dye solution with specific concentration was prepared and was fed to the sample tank of 4 dm^3. The concentration of dye solution was checked before the commencement of each experiment. Diatomite was soaked in deionised water before it was transferred to the column. In order to prevent adsorbent leakage or attrition, glass wool was added above and under the diatomite bed. Before the adsorption test commenced, the complete system was checked by circulating water for one hour. The solution was then pumped using small pump, connected with Teflon tubes from the sample tank to the top of the column at the designated flow rate (down flow pattern). Samples were taken from a sample point (at the bottom of the column) at regular time interval and the concentrations of the dye in the effluent were measured using Varian Cary-50 UV/VIS spectrophotometer (USA). The experiment was terminated when the concentration of the effluent was equal to the concentration of influent.

4. Results and Discussion

4.1 Batch Adsorber

Equilibrium and kinetic data were exploited in the design aspects of batch adsorber for the removal of MG dye from aqueous solutions using diatomite ores. More information about equilibrium and kinetic data is presented elsewhere (El Qada, 2019; El Qada, 2020). Figure 3 depicts a series of design plots derived from Equation 2 for the adsorption of MG onto diatomite for different volumes of MG solution. It is based on the assumption that the initial MG concentration is100 g/m^3. From Figure 3 the required amount of diatomite to reduce the color content by 80%-95% at various volumes of effluents can be estimated. For example, if 75 m^3 of MG solution at pH = 7 and adsorbent particle size of diatomite = 500-710 µm is to be treated, the required masses of diatomite are 24.34, 29.28, 36.92

where $C_{0.9}$ and $C_{0.05}$ represent the concentration (mg/dm^3) at 90% and 5% of exhaustion respectively. M is the adsorbent mass (g) and $V_{0.9}$, and $V_{0.05}$ have the same meaning as described earlier.

The Empty Bed Residence Time (EBRT) is another design procedure used to optimize system variables (Cortés-Martínez et al., 2009; McKay& Bino, 1990). The empty bed residence time and the adsorbent exhaustion rate are usually correlated to determine the capital and operating cost of the fixed-bed adsorption column (McKay& Bino, 1990). Ko et al. (1999) reported that EBRT can be used to determine the optimum adsorbent usage in the fixed-bed column and Guo et al. (2007) stated that EBRT is a critical parameter that has a substantially effect on the adsorption process when the contact time between adsorbate and adsorbent is a key factor.

EBRT can be defined as the required time for the liquid to fill an empty column. EBRT is related to the liquid flow rate and column volume through the following relation:

$$EBRT\,(\text{min}) = \frac{\text{Bed Volume}}{\text{Volumetric flow rate}} \qquad (16)$$

The adsorbent exhaustion rate is the weight of adsorbent used in the adsorption column per volume of the liquid treated at breakthrough:

$$\text{Adsorbent Exhaustion Rate}(g/dm^3) = \frac{\text{Mass of adsorbent used}}{\text{Volume of liquid treated at breakthrough}} \qquad (17)$$

A single operating line can be constructed from a plot of adsorbent exhaustion rate versus EBRT to determine the optimum combination of the two design parameters.

3. Materials and Methods

3.1 Materials

Basic malachite green dye ($C_{23}H_{25}N_2Cl$) was chosen as principal adsorbate. The adsorbent used in this work is diatomite obtained from Natural Resources Authority, Amman, Jordan. More information about them is reported elsewhere (El Qada, 2019).

2009). The length of the MTZ (L_{MTZ}) can be calculated by the following equation (Gupta et al., 2000; Seepe, 2015):

$$L_{MTZ} = \frac{L.\left(t_x - t_b\right)}{t_x} \tag{12}$$

where L_{MTZ} is the length of MTZ (cm), L is the length of the entire adsorbent bed (cm), t_b is the time it takes for the adsorbent bed to reach breakthrough point (hr), t_x is the time it takes for the adsorbent bed to reach complete exhaustion.

The total time (t_x) required for the mass transfer zone to establish itself, move down the length of the column of adsorbent and out of the bed, may be calculated by:

$$t_x = \frac{V_x}{F} \tag{13}$$

where F is the volumetric flow rate ($dm^3\ min^{-1}$), V_x is the influent volume at exhaustion point, corresponding to C_x (dm^3).

Another important factor of fixed bed adsorber design is the rate of movement of the mass transfer zone (RMTZ) (Patel, 2017). According to Al-Degs et al. (2009), the adsorption extent is highly affect RMTZ, which indicates the rate at which the adsorbent will be exhausted and can be calculated from:

$$RMTZ(cm/\min) = \frac{L_{MTZ}F}{V_{0.9} - V_{0.05}} \tag{14}$$

where F is the volumetric flow rates of inlet dye solution (cm^3/min), $V_{0.9}$ is the treated volume corresponding to $C_{0.9}$ (L) and $V_{0.05}$ is the treated volume corresponding to $C_{0.05}$ (L).

Column capacity (mg/g) can be estimated from the following equation:

$$q_{column} = \frac{\int_{V0.05}^{V_{0.9}} \left(C_{0.9} - C_{0.05}\right) dV}{m} \tag{15}$$

Figure (2) Mole balance on system volume.

Since earlier findings of kinetic study approved the possibility of the adsorption process to be represented by a second-order reaction (El Qada, 2020), then equation (8) can be written as:

$$\frac{-dC_A}{dt} = -r_A = kC_A^2 \tag{9}$$

Since the time needed to reach equilibrium is a significant factor for a batch adsorber, then equation (9) can be rewritten as:

$$-\frac{dC_A}{kC_A^2} = dt \tag{10}$$

Integrate from C_{A0} to C_{At} and from 0 to t, gives:

$$t = \frac{1}{k}\left(\frac{1}{C_A} - \frac{1}{C_{Ao}}\right) \tag{11}$$

where t is the time needed to reduce the MG concentration in a batch adsorber from an initial value, C_{A0} (g/m^3), to some specified value, C_{At} (g/m^3) and k is the rate constant ($m^3/g.min$). Thus equation (11) was used as a design equation to calculate the time required to achieve a reduction in colour concentration by different percentages.

2.2 Designing of Fixed-Bed Adsorber

An important design component of the fixed bed adsorber is the length of the mass transfer zone (MTZ) (Patel, 2017). Within MTZ, complete removal of adsorbate occurs (Faust & Aly, 1998). Minimizing the length of the MTZ increases the capacity of adsorption bed (Patel, 2017). Several variables affect the length of MTZ, among them, mass of adsorbent, initial concentration of adsorbate solution and solution flow rate (Al-Degs et al.,

Kinetic data can also be utilized in the design aspect of batch adsorber. The general mole balance equation on a system volume shown in Figure 2 can be written as (Levenspiel, 1999):

In + Generation – Out = Accumulation

$$F_{Ao} + G_A - F_A = \frac{dN_A}{dt} \tag{3}$$

And

$$G_A\left(\frac{moles}{time}\right) = r_A.V \tag{4}$$

where F_{Ao} is the molar feed rate (mole/min); F_A is the molar output rate (mole/min); r_A is the rate of adsorption (mole/min.m^3); N_A is the number of mole of component A (mole) and V is the volume of adsorber (m^3). For batch adsorber, $F_{Ao} = F_A = 0$. Thus, mole balance on species A is:

$$\frac{dN_A}{dt} = \int^V r_A dV \tag{5}$$

If the adsorber is perfectly mixed, that is, the rate of adsorption is constant throughout the adsorber, then r_A can be taken out of the integral:

$$\frac{dN_A}{dt} = r_A V \tag{6}$$

If the volume is constant, then V can be taken inside the differential and the mole balance in term of concentration can be written as:

$$\frac{1}{V}\frac{dN_A}{dt} = \frac{d\left(\frac{N_A}{V}\right)}{dt} = \frac{dC_A}{dt} = r_A \tag{7}$$

Applying equation (7) on the adsorption process where MG concentration is reduced from C_{A0} to C_{At}, gives:

$$\frac{-dC_A}{dt} = -r_A \tag{8}$$

equates the MG removed from the effluent to that adsorbed on diatomite can be formulated as:

$$V(C_o - C_1) = M(q_1 - q_o) = Mq_1 \qquad (1)$$

At equilibrium, $C_1 \rightarrow C_e$ *and* $q_1 \rightarrow q_e$. Since earlier findings of equilibrium studies confirmed that Freundlich isotherm gave the best fit to the experimental data for the adsorption of MG onto diatomite (El Qada, 2019), Freundlich isotherm equation was used for batch adsorber design. Rearrange equation 1 and substitute Freundlich equation for q_1:

$$\frac{M}{V} = \frac{C_o - C_1}{q_1} = \frac{C_o - C_e}{q_e} = \frac{C_o - C_e}{k_f C_e^{\frac{1}{n}}} \qquad (2)$$

where k_f is the Freundlich constant (mg/g.(mg/dm^3)$^{1/n}$) and is the heterogeneity factor. Equation (2) was used to calculate the required amount of diatomite to treat different volumes of MG solutions for the required percentage removal of MG from aqueous solution and for any initial MG concentration.

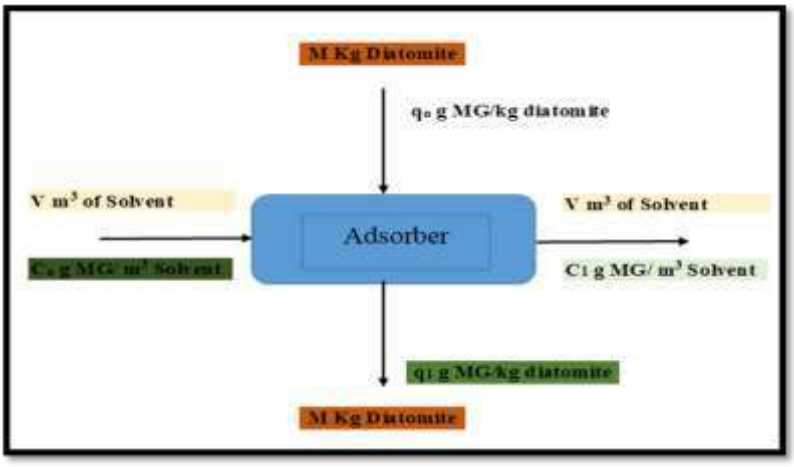

Figure (1) Single-stage adsorber for MG-diatomite system.

dynamic behavior of adsorption column is obviously an important issue for the optimal design of an industrial adsorption system (Cortés-Martínezet al., 2009).

This work is directed towards the design of adsorption system for the removal of malachite green (MG) dye from wastewater by using diatomite ores. Batch (equilibrium, kinetics) and continuous (column) data were utilized. Design is based on estimating the required amount of diatomite to reduce the initial dye concentration by a fixed percentage at various volumes of effluents. It also predicts the amount of diatomite required to remove certain amount of MG from aqueous solution for any initial dye concentration and for a fixed volume. Kinetics data were employed to calculate the time required to achieve a reduction in MG concentration by different percentages. In order to determine the minimum residence time and the minimum adsorbent exhaustion rate, the Empty Bed Residence Time (EBRT) optimization procedure has been applied to the experimental data.

Theoretical Background

2.1 Designing of Batch Adsorber

Fitting the equilibrium data to most suitable isotherm model is a vital step to the design of an adsorption system (Al Shabanat et al., 2016). Therefore, adsorption isotherms were utilized to design a single-stage batch adsorber based on the best fit isotherm model. The procedure outlined by Doğan et al. (2000) was adopted.

The main aim of the design was to predict the required amount of diatomite ores to treat different volumes of MG solutions for the desired percentage removal of MG and for any initial MG concentration.

A schematic diagram shown in Figure 1 was designed for different volumes of MG solution. Consider an effluent containing V (m^3) of MG solution with initial concentration C_o (g/m^3), which is to be reduced to C_1 (g/m^3) during the adsorption process. In the treatment stage, M (kg) of diatomite is added and the amount of MG adsorbed on diatomite changes from q_o (g/kg) to q_1 (g/kg). At time t = 0, q_o = 0. The mass balance that

1. Introduction:

Adsorption is recognized as low-cost and energy-efficient technique to decolourize industrial effluents contaminated with dyes (Özacar & Sengýl, 2004; Rokanuzzaman, 2015; Munagapati & Kim, 2017). Adsorption is a separation process in which a solid adsorbent can concentrate specific substances from a fluid phase onto its surface (McKay, 1981; Ullah et al., 2017). Adsorption processes are usually carried out in adsorbers operating either in batch mode or in continuous mode. McKay (1981) lists five ways of contacting solid adsorbent with the fluid phase: batch-type contact, fixed-bed, fluidized-bed, pulsed-bed and steady-state moving bed type contact. Intensive researches has been conducted for the design of the adsorption systems. The design of adsorption system is of great concern since it controls the quality of the treated effluents (Ullah et al., 2017). Most of batch adsorber designs have focused on reducing adsorbent cost by minimizing the mass of adsorbent when expensive adsorbents are used. But in the case of cheap adsorbents, minimizing the contact time was of interest (Özacar & Sengýl, 2004; Ho & McKay, 1998). Ho and McKay (1998) pointed out that minimizing the contact time between the adsorbent and the fluid phase will result in processing more batches of contaminated effluents per day, and enable smaller size of adsorber to be used, which in turn reduce the plant capital cost.

Equilibrium, kinetics and column studies are usually conducted for the design of an adsorption system in batch and continuous modes. Numerous investigators have outlined the benefit of these studies in the design of the adsorption system (Anderson, 1986; McKay et al., 1985; Porkodi & Kumar, 2007; Al Shabanat et al., 2016; Babu & Gupta, 2006; Al-Degs et al., 2009; Qiu et al., 2009; Amin et al., 2015). According to Anderson (1986), the knowledge of the equilibrium and kinetics of the process is important for the proper design of any unit operation. However, despite the valuable information offered by equilibrium and kinetic studies, earlier studies reported that batch adsorption systems cannot provide designers with accurate scale-up data required when designing effluent treatment systems operating in continuous mode (Cortés-Martínezet al., 2009; El Qada et al., 2006; Gupta et al., 2000). Thus, modelling and accurate simulation of the

تصميم جهاز الامتزاز لإزالة صبغة الملكيت الخضراء

بواسطة الدياتوميت الخام

عماد نهاد القدع

ملخص

تهدف هذه الدراسة لتصميم جهاز الامتزاز ذو الوجبة والمرحلة الواحدة وجهاز الامتزاز ذو الطبقة المثبتة والمستخدم لإزالة صبغة الملكيت الخضراء بواسطة الدياتوميت الخام بنسب مختلفة من كتلة الممتز/ الحجم المعالج من محلول الصبغة وباستخدام نموذج فروندليخ الرياضي. تم ايضا دراسة تأثير ظروف تشغيل عمود الامتزاز مثل معدل التدفق والتركيز الاولي للصبغة على خصائص MTZ وتم تطبيق النموذج الرياضي EBRT على النتائج لتحسين ظروف التشغيل لنظام الامتزاز. أظهرت النتائج ان معالجة تركيز أكبر من محلول صبغة الملكيت الخضراء يتطلب كمية أكثر من الدياتوميت. زادت الكمية المطلوبة من الدياتوميت بنسبة 64% عند زيادة تركيز الصبغة من 50 الى 300 غم/متر مكعب. كما وأظهرت الدراسة مدى تأثير ظروف التشغيل على كفاءة ازالة صبغة الملكيت الخضراء من المحلول. زيادة كمية الممتز وانخفاض معدل التدفق والتركيز الأولي للصبغة زادت من كفاءة عامود الامتزاز.

الكلمات الدالة: الامتزاز، الامتزاز الدفعي، EBRT ، صبغة الملكيت الخضراء، الدياتومايت.

Adsorber Design for Malachite Green Adsorption by Diatomite Ores

Emad El Qada*

Abstract

This work has been undertaken to cover design aspects of a single-stage batch adsorber and fixed-bed adsorber for the removal of malachite green (MG) dye using diatomite ores. The single stage batch adsorber was designed for different adsorbent mass/treated effluent volume ratios using the Freundlich isotherm. The effects of column operating conditions such as flow rate and initial dye concentration on the characteristics MTZ were investigated. Furthermore, the Empty Bed Residence Time (EBRT) has been applied to the experimental data to optimize the operating conditions of the adsorption system. It was found that a higher amount of diatomite is required to treat a higher concentration of MG solution. Approximately, the required amount of diatomite was increased by 64% when the initial concentration of MG solution increased from 50 to 300 g/m^3. Results of column studies reflected the significance of the experimental parameters on the efficient removal of MG from aqueous solution. Increasing bed depth and decreasing flow rate and initial MG concentration enhance the efficiency of the adsorption column.

Keywords: Adsorption, batch adsorber, EBRT, malachite green dye, diatomite

* **كلية الهندسة، جامعة مؤتة، الأردن.**

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pediatric surgery children in South India. International Journal of World Research, 1(XI),25-34.

Royal College of Nursing. (2015). Children and young people in day surgery. Retrieved from https://www.rcn.org.uk/__data/assets/pdf_file/0009/78507/004_464.pdf

Royal College of Anaesthetists. (2010). Guidance on the provision of paediatric anaesthesia services. Retrieved from: www.rcoa.ac.uk/documentstore/guidance-the-provision-of-paediatric-anaesthesia-services.

Royal Medical Services Directorate (2018). Annual Statistical Report of Royal Medical Services. Planning and Information Directorate, Jordan.

Sadeghi, A., Tabari, A. , Mahdavi, A., Salarian, S. & Razavi, S. (2017). Impact of parental presence during induction of anesthesia on anxiety level among pediatric patients and their parents: a randomized clinical trial. Neuropsychiatric disease and treatment, 12, 3237.

Sampaio, C., Silva, R., Romano, R. & Comino, L. (2012). Adaption Mechanisms (coping of the companions of children submitted to outpatient surgery. Journal of Nursing Revista De Enfermagem UFPE, 6(8), 1880-1886.

Doi:10.5205/reuol.2931-23598-1-LE.0608201219

Scrimin, S., Haynes, M., Alto, G., Bornstein, M.& Axia, G. (2009). Anxiety and stress in mothers and fathers in the 24 hours after their child's surgery. Child: Care, Health and Development, 35(2), 227-233. doi:10.1111/j.1365-2214.2008.00920.x

Hamilton, G., Corlett, J. & Dowling, M. (2014). Adult-trained perioperative nurses' practice of family-centered care. British Journal of Nursing, 23(9), 477-482.

Kushnir, J., Djerassi, R., Sofer, T. & Kushnir, T. (2015). Threat perception, anxiety and noncompliance with preoperative fasting instructions among mothers of children attending elective same day surgery. Journal of Pediatric Surgery, 50(5), 869-874. doi:10.1016/j.jpedsurg.2014.08.018

Lazarus, R. & Folkman, S. (1984). Stress, appraisal, and coping. New York: Springer.

Litke, J., Pikulska, A. & Wegner, T. (2012). Management of perioperative stress in children and parents. Part I—The preoperative period..Anaesthesiology Intensive Therapy, 44(3), 165-169.

Miklósi, M., Szabó, M., Martos, T., Galambosi, E. & Forintos, D. P. (2013). Cognitive Emotion regulation strategies moderate the effect of parenting self-efficacy beliefs on parents' anxiety following their child's surgery. Journal of Pediatric Psychology, jss174.

Nayak, M., Sharada, G. & Geroge, A. (2012). Socio-cultural perspectives on Health and Illness. Nitte University Journal of Health Science, 2(3), 61-67.

Omran, S. & Obeidat, R. (2015). Palliative care nursing in Jordan. Journal of Palliative Care & Medicine S, 4, S4-005.

O'Shea, M., Cummins, A., & Kelleher, A. (2010). Setting up pre-admission visits for children undergoing day surgery: a practice development initiative.The Journal of Perioperative Practice, 20(6), 203.

Osuoji, R. , Coker, A.., William, O. & Ajai, O. (2012). Assessment of parental distress and psychiatric morbidity before elective surgery in a Lagos teaching hospital. East and Central African Journal Of Surgery, 17(1), 22-28.

Pagé, M. G., Campbell, F., Isaac, L., Stinson, J. & Katz, J. (2013). Parental risk factors for the development of pediatric acute and chronic postsurgical pain: A longitudinal study. Journal of Pain Research, 6727-741. doi:10.2147/JPR.S51055

Pai, M, MCh, V., Prabhu, P. & Sundeep, P. (2014). Effectiveness of hospital-based intervention on parenting stress among mothers of

Chieng, Y., Chan, W., Liam, J., Klainin-Yobas, P., Wang, W. & He, H. (2013). Exploring influencing factors of postoperative pain in school-age children undergoing elective surgery. Journal for Specialists in Pediatric Nursing, 18(3), 243-252. doi:10.1111/jspn.12030

Chorney, J. & Kain, Z. (2010). Family-centered pediatric perioperative care. The Journal of the American Society of Anesthesiologists, 112(3), 751-755.

Department of Statistics (2020) Population Clock. Available at: http://dosweb.dos.gov.jo/ (accessed 8 February 2020). (In Arabic)

Department of Statistics (2016) Population & Housing Census 2015. Available at: http://census.dos.gov.jo/ (accessed 8 February 2020). (In Arabic)

Draskovic, B., Simin, J. & Kvrgic, I. (2015). Psychological aspects of pediatric anesthesia. Medical Review, 68(1/2), 29-34. doi:10.2298/MPNS1502029D

Fincher, W., Shaw, J. & Ramelet, A. (2012). The effectiveness of a standardized preoperative preparation in reducing child and parent anxiety: a single-blind randomized controlled trial. Journal of Clinical Nursing, 21 (7/8), 946-955.

doi:10.1111/j.1365-2702.2011.03973.x

Fortier, M., Del Rosario, A., Martin, S. & Kain, Z. (2010). Perioperative anxiety in children. Pediatric Anesthesia, 20(4), 318-322. doi:10.1111/j.1460-9592.2010.03263.x

Frisch, A. , Johnson, A., Timmons, S., & Weatherford, C. (2010). Nurse practitioner role in preparing families for pediatric outpatient surgery. Pediatric Nursing, 36(1), 41.

Ghabeli, F., Moheb, N. & Hosseini Nasab, S. D. (2014). Effect of toys and preoperative visit on reducing children's anxiety and their parents before surgery and satisfaction with the treatment process. Journal of Caring Sciences, 3(1), 21-28. doi:10.5681/jcs.2014.003

Charana, A., Tripsianis, G., Matziou, V., Vaos, G., Iatrou, C., & Chloropoulou, P. (2018). Preoperative anxiety in Greek children and their parents when presenting for routine surgery. Anesthesiology research and practice, 2018.

References:

Abdullatif, Q. & Spielberger, C. (2011). First Report on the Arabic State Trait Anxiety Inventory (STAI): Methodological, Cultural, and Linguistic Considerations. Psychology Journal, 8(2), 50-60.

Ahmed, M. , Farrell, M., Parrish, K.., & Karla, A.. (2011). Preoperative anxiety in children risk factors and non-pharmacological management. Middle East Journal of Anesthesiology, 21(2), 153-164.

Akdağ, M., Baysal, Z., Atlı, A., Samancı, B., & Topçu, İ. (2014). A multi-centric prospective study: Anxiety and associated factors among parents of children undergoing mild surgery in ENT. Journal of Clinical & Experimental Investigations, 5(2), 206-210. doi:10.5799/ahinjs.01.2014.02.0390

Akinci, S., Köse, E., Ocal, T. & Aypar, U. (2008). The effects of maternal presence during anesthesia induction on the mother's anxiety and changes in children's behavior. The Turkish Journal of Pediatrics, 50(6), 566-571.

Andersson, L., Johansson, I., & Österberg, S. A. (2012). Parents' experiences of their child's first anaesthetic in day surgery. British Journal of Nursing,21(20), 1204-1210.

Bahammam, M. (2016). Validity and reliability of an Arabic version of the state-trait anxiety inventory in a Saudi dental setting. Saudi medical journal, 37(6), 668.

Bellani, M. L. (2008). Psychological aspects in day-case surgery. International Journal of Surgery (London, England), 6 Suppl 1S44-S46. doi:10.1016/j.ijsu.2008.12.019

Berghmans, J., Weber, F., van Akoleyen, C., Utens, E., Adriaenssens, P., Klein, J. & Himpe, D. (2012). Audiovisual aid viewing immediately before pediatric induction moderates the accompanying parents' anxiety. Paediatric Anaesthesia, 22(4), 386-392. doi:10.1111/j.1460-9592.2011.03767.x

Cagiran, E., Sergin, D., Deniz, M., Tanattı, B., Emiroglu, N. & Alper, I. (2014). Effects of sociodemographic factors and maternal anxiety on preoperative anxiety in children. The Journal of International Medical Research, 42(2), 572-580. doi:10.1177/0300060513503758

Results of the current study emphasize the need for nurses to approach the child as well as his parent's holistically. The holistic nursing implies that the entire patient experience should be considered and that both physical and psychological aspects of care should be addressed. In pediatric nursing, the child and his parents is inseparable unit, requiring nurses to expand their caring activates to involve parents who are usually ignored.

Further prospective and interventional studies with larger random samples are required to be conducted in other regions and other health sectors in Jordan. Also, conducting qualitative research to explore the lived experience of parents' anxiety pre and post operatively in a pediatric same day surgery is recommended.

from holy Quran and Sunna to protect their children from evil can alleviate parents' anxiety. As such, the cultural and religious beliefs may have an effect on the parental experience and may play a role in alleviating the intensity of anxiety (Nayak, Sharada & Geroge, 2012).

This study sampled a small number of parents and was conducted in one setting which may interfere with the external validity and limit generalization of the current study findings. The internal validity might be also threatened as a result of selection bias related to convenience sampling. Nevertheless, the findings of this study are comparable to other studies on parental anxiety in pediatric surgery.

Conclusion and Recommendations:

A high percentage of parents exhibited clinically significant anxiety before their child's surgery. There was a significant decline in the state anxiety after surgery. Parental perioperative anxiety appears to be a cross-cultural phenomenon. The need for strategies to deal with parents' state anxiety is essential as well as Policies that allow both parents to be present across the pediatric surgical continuum is recommended.

Perioperative nurses can play a vital role in parents' preparation for their child's surgery. Nurses have the most frequent contact with both children and their parents. Thus nurses are in an ideal position to deal with parent's fear and anxiety in pediatric surgery. Parents' adherence with protocols both pre and postoperatively is vital. It is essential to target the nurses' efforts toward providing the appropriate education in the right way and at the right time so it would be communicated effectively in such stressful situations (Fincher, Shaw & Ramelet, 2012; Ghabeli, Moheb & Hosseini Nasab, 2013).

Emotional support is beneficial in enhancing security and feeling of control. So, to reduce parents struggle, the nurses have to relate therapeutically with the parents and show a sincere attention and empathy toward them. Such emotional support is crucial in enhancing the parents coping abilities which is important in relieving their anxieties.

Akinci et al., (2008). The significant decline in the level of anxiety after surgery in this study indicates that many pre-operative concerns may be diminished after the child's recovery from anesthesia. In contrast, Scrimin and his colleagues (2009) found that the majority of parents exhibited normal levels of anxiety at 24 hours after surgery. However, in their study, more than 25% of parents showed a clinically significant level of anxiety one day post-surgery (Scrimin et al., 2009).

The type of pediatric surgery, the parents' susceptibility to experience trait anxiety, as well as the parental gender were found to be factors that impact the parents' post-operative state anxiety (Scrimin et al., 2009; Ahmed et al.,2011). Similarly, the results of the current study found that the anxiety levels were higher in mothers than in fathers both before and after surgery. A possible explanation for this result may be related to that social roles are culturally determined; fathers are expected to be strong. So, being anxious might be interpreted as a feminine or demonstrate a weakness for men. Additionally, mothers are usually the primary care giver and because of potentially high levels of emotional attachment to their children, they may experience more difficulty coping with any potential suffering that may occur to their children during perioperative period.

Cultural Perspectives:

Cultural beliefs and practices have an effect on how parents deal with encounters with health care delivery systems. Some beliefs and practices might be beneficial and should be encouraged by the health care team while others may be harmful and should be discouraged. Nurses and other healthcare providers need to become culturally competent in the provision of culturally sensitive care (Nayak, Sharada & Geroge, 2012).

Jordanian Muslim parents have a religious affiliation toward Islam, which usually has a protective effect upon them at the difficult moments, such as pediatric surgery. The existential Islamic beliefs, such as belief in God's power, wisdom and mercy, in addition to belief in fate may moderate the experience of parents in such stressful situations. Additionally, some practices, such as parents' prayer for their children's health and using verses

Discussion:

Pediatric same day surgery is stressful situation for both children and their parents. Anxiety is a normal human response under stress situations. High levels of pre-operative parental anxiety associated with children's surgery could have a negative effect on overall healthcare outcomes. The incidence rate of 74% for state anxiety preoperatively among Jordanian parents in this study is similar to other studies (Fortier et al., 2010; Osuoji et al., 2012). The high level of parental anxiety in the current study may have been related to that parents appraise surgery as a stressful experience with a potential threat to their child's health. According to stress appraisal and coping theory (Lazarus & Folkman, 1984), threat appraisal, which is characterized by anxiety and fear take place when there is a possible damage or harm that has not occurred yet. In the current study, the appraisal of threat before surgery was aroused as parents anticipated complications after surgery. Some might even think about the death as a possible outcome of surgery.

Previous studies have concluded that lack of sufficient information was a major source of parent pre-operative anxiety (Akdag et al., 2014; Andersson et al., 2012). At the Queen Rania Pediatric Hospital, lack of information related to the surgical procedure, the anesthesia and outcomes of the surgery is not uncommon. This is because surgical environment at the facility was characterized by a rapid pace and technological focus that the parents were unfamiliar with, which essentially may also explain the high level of anxiety the parents experienced in the same day surgery wards. In other words, the unknown is also anxiety provoking.

Previous study has found that parents prefer to receive the education program one week or one day before their child's surgery (O'Shea, Cummins & Kelleher, 2010). Since parents are usually more anxious on the day of surgery, it is not advisable to provide them with educational information on the day of surgery.

The results of the current study showed that the level of anxiety declined after surgery with 48% of parents have experienced state anxiety after surgery. This result is supported by previous research conducted by

Variables	Mean	Standard Deviation
Parents age	32.6	6.7
Children age	5.1	2.2
Variables	Frequency	Percent %
Parents Gender		
Male	18	39
Female	28	61
Children gender		
Male	29	63
female	17	37
Parents Educational Level		
Primary	2	4.3
Secondary	20	43.5
University	23	50
Postgraduate	1	2.2

Parental State Anxiety Levels:

Parent's pre-operative state anxiety scores ranged from 26-65 with a mean scores (SD) were 42.6 ± 9.5. Post-operatively, scores ranged from 20-60 with a mean scores (SD) were 37.4 ±10.7. Statistically there was a significant decline in the parents' levels of state anxiety pre and post operatively t (46) = 3.93, p=0.005. A cutoff point of 39-40 has been determined to indicate clinically significant state anxiety.

Scores above 39-40 indicated clinically significant state anxiety. About 74% of parents scored ≥ 39-40 on this scale preoperatively .also, about 48 % of parents scored ≥ 39-40 on this scale postoperatively.

Mothers experienced significantly higher levels of state anxiety compared with fathers (82% vs. 61%), (57% vs. 33%) pre and post-operative scores respectively.

The Arabic version of this scale has generally revealed satisfactory reliability coefficients and validity; The Correlation coefficient was 0.85 and the Cronbach's alpha was 0.89 (Michael, 2003). In the current study, the Cronbach's alpha of STAI-state anxiety was 0.85.

Several steps have been carried out to guarantee the protection of participants. The approvals of the ethical Committees at Princess Muna College of Nursing, Mutah University and the Royal Medical Services have been obtained. The purpose of the study and data collection process has been explained to the directors and head of the surgical department at Queen Rania Pediatric Hospital to facilitate data collection. In addition, a signed consent form has been obtained from all participants.

The statistical package for social science (SPSS) software, version 19.0, is used for data analysis. Descriptive statistics have been used to describe the sample characteristics and the pre- and post-operative level of parents' state anxiety. Paired t-test is used to compare differences between the pre and post-operative levels of parents' state anxiety. A p-value of 0.05 or less is considered as statistically significant.

Results:

Participants' characteristics

Forty six parents participated in this study, 61 % (n=28) were females. The mean age (SD) of participants were 32.6 (6.7). The age of participants ranged from 21-50 years. Fifty percent of them had a university degree. The majority of children who underwent surgery were male 63% (n=29), the age of children ranged from 1-12 years with mean age (SD) of 5.1(2.2). The children underwent various types of same day surgeries including Ear Nose Throat (ENT), ophthalmic, dental, orthopedic, genitourinary, and other surgical conditions. The characteristics of the participants are shown in Table 1.

Table (1) Socio-Demographic Characteristics of Study Participants

same day surgery were performed at the Queen Rania Pediatric Hospital/ Royal Medical Services.

A convenience sample of 46 Jordanian parents of children who were scheduled for same day pediatric surgery under general anesthesia at Queen Rania Pediatric Hospital have been recruited to participate in this study.

The researcher visited the same day surgery ward in the selected hospital to recruit participants. The researcher made the initial contact with each participant after their child admission to the same day ward. Participants who were selected to participate were asked to sign the informed consent. After that, the researcher asked parents to complete the Arabic version of the STAI state anxiety subscale before and after their child's same day surgery. The tool was explained for the parents prior to their child's surgery. Both parents were invited by the researcher to participate and each one was asked to answer the questionnaire separately. The parents' anxiety level was measured again one hour after the child's surgery. The sample size has been determined by a priori power analysis at a significance level of 0.05, and power of 0.90 (paired t-test).

The data have been collected using the 20 items state anxiety subscale of the State Trait Anxiety Inventory for Adults (STAI) (Abdullatif & Spielberger, 2011), which is a self-report questionnaire used to measure the intensity of state and trait anxiety. State and Trait Anxiety is assessed by two subscales: state anxiety (20 items) and trait anxiety (20 items). For the purpose of this study, only state anxiety subscale has been administered for the participants. Responses to the items are evaluated by a 4-point Likert scale, ranging from a score of 1 ("not at all") to a score of 4 ("very much so"). Higher scores indicate higher levels of anxiety. A cutoff point of 39-40 has been determined to indicate clinically significant state anxiety. The Arabic version of STAI was reported to be a valid and reliable scale. In 2016, Bahammam tested the internal consistency reliability, concurrent criterion validity and discriminant validity by recruiting 387 Saudi people. Results showed high internal consistency reliability with Cronbach's alpha was 0.989. and adequate concurrent and discriminant validity. Also, factor analysis indicate the unidimensionality of the scale.

(Chorney & Kain, 2010). Addressing parents' anxiety is a critical aspect of family centered nursing care.

Essentially, the existing literature indicates that parental anxiety related to pediatric same day surgery is a major concern worldwide. In addition to studies of parental anxiety related to pediatric surgery that were conducted in the United States, studies have been conducted in other countries with different cultural perspectives, including Greece (Charana, et al., 2018); Nigeria (Osuoji, et al., 2012); Portugal (Sampaio, Silva, Romano & Comino, 2012; Sweden (Andersson, et al., 2012); Turkey (Akdag, et al., 2014); and Iran (Sadeghi, et al., 2017) which reflect the perspectives of many cultures.

Jordan is one of Arab countries. It has a population of about 10.58 million (Department of Statistics DOS, 2020). About 92% of Jordanians are Muslims (DOS, 2016). Wellness and illness beliefs of Jordanians are wildly influenced by religion of Islam. Islamic beliefs, such as belief in God's power and religious practices such as prayers and reading verses of holy Quran are used to help Jordanian peoples to alleviate and cope with illnesses and stressful situations (Omran & Obeidat, 2015).

However, there is scarcity of literature regarding the nature of pre- and post-operative parental state anxiety in a pediatric same day surgery among Jordanian parents, a gap this study aims to address. Therefore, the aim of this study was to describe pre- and post-operative state anxiety for Jordanian parents when their children undergo same day surgery. This study will add to the body of literature by extending the research to a sample Jordanian of parents, reflecting potential cultural variations in the Middle East.

Research questions: (a) what are the levels of state anxiety pre and post same day surgery among Jordanian parents; and (b) do Jordanian parents differ in their state anxiety levels?

Methods:

This descriptive study has been conducted at the Queen Rania Pediatric Hospital/ Royal Medical Services in Amman, Jordan which provides care for children since birth and until 14 years old. According to the Royal Medical Services (RMS) Annual Statistical Report (2018), a total of 6080

hinders provision of family centered care (Hamilton, Corlett & Dowling, 2014).

On the other hand, perioperative parental stress and anxiety may also negatively impact the child and healthcare outcomes. Ahmad and his associates (2011) suggested that parents' behavior before surgery is a major predictor of their child's behavior before and after surgery. In addition, parental anxiety is a major predictor of a high level of anxiety in children (Akdag et al., 2014)

Significantly, researchers have explored a number of factors contributing to perioperative parental stress and anxiety. Researchers found that uncertainty about the medical condition and its related treatment, uncertainty about the ability to provide nursing care at home, and worries about post-operative complications are among factors contributing to parental anxiety and stress (Akdag et al.,2014;). Additionally, the feelings of stress and anxiety among parents are further exacerbated by worry about pain management, potential post-operative complications and the ability of the parents to care for their child during physical recovery at home after surgery (Akdag et al., 2014; Scrimin et al., 2009).

Demographic factors, such as gender, socioeconomic status, educational level as well as the social support may also play a role in parental reactions to their child having surgery (Akdag et al., 2014; Scrimin et al., 2009). Furthermore, locus of control, beliefs about self-efficacy, cognitive emotional regulation and type of surgery are also significantly related to parental stress and anxiety (Miklósis et al., 2013; Scrimin et al., 2009).

Pediatric nurses play an essential role in pre-operative preparation of both parents and their children, especially in alleviating anxiety by offering pre-operative education (Berghmans, et al., 2012; Frisch, et al., 2010). Such educational programs have a significant impact on parents by decreasing their state anxiety associated with surgery and enhancing their positive coping skills (Andersson et al., 2012; Frisch, et al., 2010). The importance of family-centered perioperative nursing care cannot be overemphasized

Introduction:

Parents play a pivotal role in supporting their children scheduled for pediatric surgery (Andersson, Johansson & Osterberg, 2012; Draskovic, Simin & Kyrgic, 2015; Royal College of Nursing, 2015). Forthcoming pediatric surgery can be stressful for children and their parents (Frisch, Johnson, Timmons & Weatherford, 2010; Osuoji, Coker, William, & Ajai, 2012; Pai, MCh, Prabhu & Sundeep, 2014). Parental stress is defined as a subject feeling of being troubled, anxious, worried, and overwhelmed with the prospect of their child having surgery (Hug, et al., 2005).

Many studies have reported that most parents exhibited high levels of anxiety and stress during their children surgery (Akdag, Baysal, Ath, Samanci & Topcu, 2014; Pai, et al., 2014). The ability of anxious parents to provide supportive emotional care for their children anticipating surgery may be impeded (Andersson, et al., 2015; Draskovic, et al., 2015).

Same day surgery is a common practice in pediatric surgery. Since children usually present uncomplicated conditions with no associated significant systemic illnesses, they are considered ideal candidates for such type of surgery (Royal College of Anesthetists, 2010). In addition to its economic benefits, the same day surgery minimizes the psychological disturbances and anxiety associated with hospitalization and reduces the risk of hospital acquired infections in children (Litke, et al., 2012).

The anxiety and stress experienced by parents during perioperative care mean that the ability of the parents to provide supportive emotional care for their children anticipating surgery may be impeded (Andersson et al., 2015; Draskovic et al., 2015).

Perioperative parental stress and anxiety have been linked to lack of adherence to pre-operative instructions (Kushnir et al., 2015), being inadequately prepared for surgery (Litke, Pikulska, & Wegner,2012), may have an effect on pre-operative pediatric anxiety (Cagiran et al., 2014), complicate the process of the child's anesthesia induction (Ahmed, Farrell, Karla & Parrish, 2011), and result in inadequate management of post-operative pain (Chieng et al., 2013; Pagé et al., 2013). Furthermore, nurses have reported that dealing with anxious parents is a challenge, which

تقييم حالة القلق لدى أهالـــي الأطفال الأردنيين الذين يخضعون للجراحات اليومية

هالا محمود عبيدات
دعاء عبدالله دويرج
آلاء احمد عبابنة

ملخص

مقدمة: الجراحات اليومية للأطفال أصبحت أكثر انتشارا، آلاف الاطفال يخضعون لمثل هذه العمليات على الصعيد العالمي. حاله القلق والتوتر لدى الأهالي أثناء الجراحات اليومية مرتبطة بعدم التزام الأهالي بتعليمات ما قبل وبعد العملية بإضافة إلى عدم كفاية معالجة الألم من قبل الآباء.

هدف الدراسة: وصف حالة القلق قبل وبعد العملية لدى اهالي الاطفال الذين يخضعون لجراحات يومية في عمان الأردن.

منهج البحث: تم اجراء هذه الدراسة الوصفية باستخدام عينة ملائمة مكونه من 46 شخص من اهالي الاطفال. تم قياس حالة القلق لدى الاهالي من خلال مقياس تقييم حالة وسمة القلق قبل وبعد ساعة من العملية. تم استخدام الاحصاءات الوصفية والإحصائي (ت) في تحليل النتائج.

النتائج: اظهرت النتائج ان 74% من الاهالي اظهروا ارتفاع بحالة القلق قبل العملية مقارنه ب 48% ما بعد العملية. من الناحية الاحصائية كان هناك علاقه ذات دلاله إحصائية بانخفاض حالات القلق بعد العملية مقارنة ب قيل العملية ت (46)= 3.93، القيمة الاحتمالية= 0.005. كما أظهرت النتائج ايضـــا أن الأمهات تعرضن لمســـتويات أعلى من القـــلق مقارنة مع الآبـــاء (61% -82%) (33%-57%) قبل وبعد العملية على التوالي.

الاستنتاج: غالبية الآباء في هذه الدراسة شعروا بحالة من القلق بنسبة عالية قبل العملية لكن حالة القلق لديهم انخفضت بشكل ملحوظ بعد العملية. هناك حاجة ماسة لاستراتيجيات عن كيفية تعامل الأهالي مع حالة القلق قبل وبعد العملية. ومن الواضح بان ممرضات العمليات يلعبن دور مهم في تحضير الاهالي وقت العملية الجراحية لأطفالهم.

الكلمات الدالة: حالة القلق، الجراحات اليومية، جراحة الأطفال، الأردن.

State Anxiety in Jordanian Parents of Children Undergoing Same Day Surgery

Hala Mahmoud Obeidat *
Doa'a Abdullah Dwairej**
Alaa Ahmad Ababneh

Abstract

Introduction: Same day pediatric surgery is becoming more prevalent, with thousands of children undergoing such surgery globally. Perioperative parental stress and anxiety have been associated with lack of adherence in pre- and post-operative instructions, including inadequate pain management by parents.

Aim: To describe pre- and post-operative parental state anxiety in a pediatric same day surgery in a military hospital in Amman, Jordan.

Method: This descriptive study has been conducted with a convenience sample of 46 parents. Parental levels of state anxiety have been measured using the State Trait Anxiety Inventory (STAI-S) prior to and one hour following their child's surgery. Descriptive statistics have been used for data analysis.

Results: Seventy four percent of the parents have shown clinically significant state anxiety before surgery compared with forty eight percent postsurgery. Statistically, there was a significant decline in the parents' levels of state anxiety pre and post operatively t (46) = 3.93, p=0.005. Mothers experienced significantly higher levels of state anxiety compared with fathers (82% vs. 61%), (57% vs. 33%) pre and post-operative scores respectively.

Conclusion: The majority of parents have approached their child' same day surgery with a high level of state anxiety, which decreased significantly after surgery. The need for strategies to deal with parents' state anxiety is essential. Perioperative nurses can play a vital role in parents' preparation for their child's surgery.

KeyWords: State anxiety, same day surgery, pediatric surgery, Jordan

* **كلية التمريض، كلية الأميرة منى للتمريض، جامعة مؤتة، الأردن.**
** **كلية الأميرة عائشة بنت الحسين للتمريض والعلوم الصحية، جامعة الحسين بن طلال، الأردن.**
*** **كلية التمريض، كلية الأميرة منى للتمريض، جامعة مؤتة، الأردن.**
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Mu'tah Lil-Buhuth wad-Dirasat
Deanship of Scientific Research
Mu'tah University, Mu'tah (61710),
Karak, Jordan.
Tel: . +962-3-2372380 Ext. 6117
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Mu'tah Lil-Buhuth wad-Dirasat
Natural and Applied Sciences Series
Mu'tah University, Mu'tah (61710),
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