مجـــلة روافـــد المعرفة

تصدر عن كليتي الآداب والعلوم

جامعة الزيتونة

العدد السادس

ديسمبر 2022

مجلة روافـد المعرفة

ترسل البحوث وجميع المراسلات المتعلقة بالمجلة إلى العنوان التالي:

كلية العلـوم، جامعة الزيتونة، ترهونة

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شروط وتعليمات النشر

1- أن يكون البحث أصيلاً ومبتكراً ولم يسبق نشره في أي جهة أخرى، وتتوفر فيه شروط البحث العلمي المعتمدة على الأصول العلمية والمنهجية المتعارف عليها في كتابة البحوث الاكاديمية.
2- أن يكون البحث مكتوباً بلغة سليمة، ومراعياً لقواعد الضبط ودقة الرسوم والاشكال – إن وجدت – ومطبوعاً ببنط (14) وبخط (Simplified Arabic)، وألا تزيد صفحات البحث عن (35) صفحة متضمنة الهوامش والمراجع.
3- في بحوث العلوم الإنسانية - المكتوبة باللغة العربية - تدرج الهوامش بأرقام متسلسلة في نهاية البحث.
4- يُفضل أن تكون الجداول والاشكال مدرجة في أماكنها الصحيحة، وأن تشمل العناوين والبيانات الإيضاحية الضرورية، ويراعى ألا تتجاوز أبعاد الاشكال والجداول حجم حيز الكتابة في صفحة Microsoft Word.
5- أن يكون البحث ملتزماً بدقة التوثيق، وحسن استخدام المصادر والمراجع، وأن تثبت مصادر ومراجع البحث في نهاية البحث.
6- تحتفظ المجلة بحقها في اخراج البحث وإبراز عناوينه بما يتناسب واسلوبها في النشر.
7- ترحب المجلة بنشر البحوث المكتوبة باللغة الأجنبية ويفضل أن يرفق البحث بملخص باللغة العربية (لا يتجاوز 200 كلمة).
8- ترحب المجلة بنشر ما يصلها من ملخصات الرسائل الجامعية التي تمت مناقشتها وإجازتها، على أن يكون الملخص من إعداد صاحب الرسالة نفسه.
9- تُرسل نسخة من البحث مطبوعة على ورق بحجم (A4) إلى مقر المجلة، ونسخة إلكترونية إلى إيميل المجلة: rwafedalmarefa@gmail.com، على أن يدون على صفحة الغلاف: اسم الباحث، لقبه العلمي، مكان عمله، تخصصه، رقم هاتفه وبريده الإلكتروني.
10- يخطر الباحث بقرار صلاحية بحثه للنشر من عدمها خلال مدة ثلاثة أشهر من تاريخ استلام البحث.
11- في حالة ورود ملاحظات وتعديلات على البحث من المحكم، ترسل تلك الملاحظات إلى الباحث لإجراء التعديلات اللازمة بموجبها، على أن تعاد للمجلة خلال مدة أقصاها شهر واحد.
12- الأبحاث التي لم تتم الموافقة على نشرها لا تعاد إلى الباحثين.
13- تؤول جميع حقوق النشر للمجلة.
14- دفع رسوم التحكيم العلمي والمراجعة اللغوية والنشر، إن وجدت.

البحوث المنشورة في هذه المجلة تعبر عن رأي أصحابها ولا تعبر بالضرورة عن رأي المجلة أو الجامعة.

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الحمد لله وحده والصلاة والسلام على من لا نبي بعده وعلى آله وصحبه أجمعين، وبعد،،

يعد النشر العلمي من الضروريات الأساسية لدعم وتفعيل البحث العلمي في شتى الميادين حيث يوفر للباحثين فرصة عظيمة لتقييم بحوثهم عن طريق التحكيم العلمي الذي تخضع له البحوث العلمية كشرط أساسي لإجازة نشرها، كما يُمَكِّنْ النشر العلمي الباحثين من عرض نتائج بحوثهم أملا في الوصول إلى من يتبنى هذه البحوث والنتائج لتوظيفها في خدمة المجتمع، فأرقى المجتمعات هي التي تبني نهضتها على العلم والمعرفة.

وفي سبيل الارتقاء بالبحث العلمي ودعمه يسرنا نحن أسرة **مجلة روافد المعرفة** أن نضع بين أيدي القراء **العدد السادس** للمجلة والذي يزخر بالعديد من الأبحاث الرصينة في المجالات العلمية المختلفة، وتمت مراجعة هذه البحوث وتنقيحها بالاستعانة بكوكبة من المختصين كلاً حسب مجاله لإخراجها بالصورة النهائية التي نأمل أن تنال رضا القراء بمختلف مشاربهم، كما تفتح مجلة روافد المعرفة المجال أمام كل الكفاءات والطاقات العلمية الواعدة **وترحب بجميع المهتمين والباحثين** لنشر خلاصة جهدهم.

والحمد لله في بدءٍ ومُخْتتمِ

هيئة التحرير

المحتويات

Comparative study of efficiency biosorbents materials (almond, olive, and eucalyptus leaves) in removing of lead from laboratory aqueous solutions

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Abstract

The almond, olive and eucalyptus leaves were investigated as a low-cost biosorbents in removing lead ions from laboratory aqueous solutions. The adsorption experiments were conducted at different lead concentrations, and different biosorbent masses. The pH was adjusted to approximately 4.0, and contact time was 90 min. The obtained filtrates were analyzed for Pb^{+2} content using a Flame Atomic Absorption Spectroscopy (AAS - 220 FS). The results showed similar behavior in respect of the amount of lead adsorbed (q), which were increased with increasing lead concentrations (from approximately 2.0 – 790.0 mg/g), and it decreased with increasing bioadsorbents masses (from approximately 196.0 – 9.8 mg/g). In contrast, the removal percentage was relatively high and fluctuated between 67.4 – 99.6% for all biosorbents used in this study. The study deduced that the biosorbents exhibited high efficiency and sustainability for removing Pb^{2+} from aqueous solution.

الملخص

أجريت هذه الدراسة لمقارنة كفاءة أوراق اللوز، والزيتون، والكينا كمواد مازة حيوية رخيصة الثمن في إزالة أيونات الرصاص (Pb^{+2}) من المحاليل المائية القياسية. وقد أجريت تجارب الامتزاز باستخدام تراكيز مختلفة من أيونات الرصاص (Pb^{+2}) وكميات مختلفة من المادة الماز، في حين تم تثبيت قيم pH بحدود 4.0 لفترة زمنية مدتها 90 دقيقة تقريبًا. وبعد حدوث عملية الامتزاز تم تحليل الراشح المتحصل عليه باستخدام مطياف الامتصاص الذري اللهبي (AAS – 220 FS). واظهرت النتائج المتحصل عليها سلوك متشابه بالنسبة لكمية أيونات الرصاص الممتزة (q) للمواد المازة الثلاثة حيث زادت الكمية الممتزة من 2.0 – 790.0 ملجم/جم تقريبًا بزيادة تركيز أيونات الرصاص. وأن الكمية الممتزة من أيونات الرصاص قلت بزيادة كتلة المواد المازة من 9.8 – 196.0 ملجم/جم تقريبًا. وفي المقابل بينت النتائج أن النسبة المئوية لكمية المادة الممتزة كامن مرتفعة وتراوحت ما بين 67.4 – 99.6 % لكل المواد المازة المستخدمة في هذه الدراسة. وخلصت الدراسة إلى أن المواد المازة الحيوية أظهرت سلوك متقارب وكفاءة ومقدرة عالية على إزالة أيونات الرصاص (Pb^{+2}) من المحاليل المائية.

Key words: Biosorbents, lead, adsorption, removal percentage and AAS spectroscopy.

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1. Introduction:

The presence of heavy metals in the environment is of major concern because of their toxicity, bio-accumulating tendency, threat to human life and the environment [1]. It is a well known fact that heavy metals can damage nerves, liver, and bones and could also block functional groups of essential enzymes [2, 3]. Heavy metal contamination exists in aqueous waste streams of many industries such as metal purification, metal finishing, chemical manufacturing, mining operations, smelting, battery manufacturing, and electroplating [4 - 6]. As a result of industrial activities and technological development, the amount of heavy metal ions discharged into streams and rivers by industrial and municipal wastewater have been increasing incessantly [7].

Certain heavy metals such as iron, copper, zinc and manganese are required by humans for normal biological functioning. However, heavy metals such as mercury, lead, cadmium are toxic to organisms. Most of the health disorders are linked with specific tendency of heavy metals to bioaccumulate in living tissues and their disruptive integration into normal biochemical processes [4]. Lead poisoning in human body can cause severe damage to kidney, nervous system, reproductive system, liver, and brain and may result in sickness or death. Severe exposure to lead has been associated with sterility, abortion, still birth and neonatal deaths, anemia, coma, mental retardation, and seizures [8, 9].

Most heavy metals are cations, carrying a positive charge, such as lead and cadmium. Soil particles tend to have a variety of charged sites on their surfaces, some of which are positive and some others are negative. The negative charges of these soil particles tend to attract and bind the positively charged metal cations, preventing them from becoming soluble and dissolve in water. The soluble form of metals is more dangerous because it is easily transported, hence more readily available to plants and animals [10].

Many attempts were made to remove a heavy metal from standard and waste water aqueous solution. Activated carbon was used and it displays high adsorption capacity; but the high cost presents a major drawback for practical applications, especially in the field of industrial effluent treatment where activated carbons may play a very useful role. Efforts have been made to develop low cost adsorbents for the removal of heavy metals from aqueous solutions. A number of natural and synthetic adsorbents like agricultural waste's carbon [11 - 13], clay [14], neem leaves [15], cooked tea dust [16], zeolites [17], teak leaves activated carbon [18], cashew nut shell activated carbon [19], fly ash [20] etc have been studied by various researchers for the removal of heavy metals. In this work we will investigate the ability of using almond, olive, and eucalyptus leaves as low cost biosorbents in removing lead from standard aqueous solutions, due to abundant availability of these leaves.

2 – Materials and Methods

2.1 - Standard Solution

The Pb^{+2} standard solution was prepared from Pb $(CH_3COO)_2.3H_2O$ salt without further purification. About 18.31 g of Pb $(CH_3COO)_2$ was weighed and dissolved to obtain standard solution of Pb^{+2} 10000 mg/L, and further working solutions of different concentrations were prepared as and when required.

2.2 - Collection and Preparation the Biosorbents

The biosorbents were collected from private farm in Tarhuna using polyethelene bags and washed with distilled water several times to remove dirt particles and dried for three hours in an oven at 150 ºC and then allowed to cool at room temperature, subsequently they were crushed and then finally sieved into particle size of 0.5 mm. The sieved adsorbents were stored in an air-tight container. No other chemical modification was taken place [21].

2.3 – Analytical Procedure

- Effect of initial lead ion concentration

The experiments were carried out by taking five conical flasks of 150 ml. In each flask, 25 ml of 200, 400, 800, 1600, and 3200 mg/L of Pb^{2+} were mixed with 0.5 g of biosorbents, and 25 ml of buffer solution that has pH = 4.0 to adjust the pH of the experiment's environment to approximately 4.0, and each flask was sealed tightly. The mixtures were shaken on a reciprocating shaker at shaking speed of 155 rpm at room temperature in triplicate. After 90 min, the mixture was filtered through filter paper of ϕ 110 nm (ALTAY). The obtained filtrates were analyzed for Pb^{+2} content using an Flame Atomic Absorption (AAS - 220 FS).

- Effects of biosorbents mass on adsorption of lead ions

Five conical flasks of 150 ml were taken. In each flask, 25 ml of 800 mg/L of Pb^{2+} were mixed with 0.1, 0.5, 1.0, 1.5, and 2.0 g of biosorbents, and with 25 ml of buffer solution that has pH = 4.0 to adjust the pH of the experiments environment to approximately 4.0, and each flask was sealed tightly. The mixtures were shaken on a reciprocating shaker at shaking speed of 155 rpm at room temperature in triplicate. After 90 min, the mixture was filtered through filter paper of ϕ 110 nm (ALTAY). The obtained filtrates were analyzed for Pb^{+2} content using a Flame Atomic Absorption spectroscopy (AAS - 220 FS).

2.4 - *Pb^{+2} Adsorption Capacity*

The concentration of Pb^{+2} adsorbed onto the surface of biosorbents used in this study was calculated by the following equation:

$$q_{(mg/g)} = \frac{(C_o - C_f) \times V_{(L)})}{w_{(g)}}$$

Where, q is the amount of Pb^{+2} adsorbed on used biosorbents (mg/g), C_o is the initial Pb^{+2} concentration in the solution before adsorption (mg/L), C_f is the final concentration of Pb^{+2} in the solution after adsorption (mg/L), V is the volume of the Pb^{+2} solution (L) and w is the weight of the bisorbent. Adsorption system was quantified by calculating the adsorption percentage (E%) as defined by the following equation:

$$(E\ \%) = \frac{(C_o - C_f)}{C_o} \times 100$$

3 - Results and Discussion

3.1 – Effect initial lead ion concentration on lead adsorption

The obtained results in the Table 1, and in Fig. 3.1showed effects of variation in lead ion concentrations on the amount of lead adsorbed on almond, olive, and eucalyptus leaves. Also, they showed the lead removal percentage (Pb%).

It can be observed that the three bioadsorbents materials showed similar abilities of adsorbing lead ions on their

surfaces. Fig. 3.1a illustrates that the amount of lead ions adsorbed (q) was low at lower lead ions concentrations (about 2.0 mg/g at 100 ppm). The adsorbed amount of lead ions then increased with increasing the initial lead concentration up to maximum value (about 796.3 mg/g at 1600 ppm).

These observations are in agreement with the literatures for removing Cu^{2+} and Pb^{2+} using oil palm shell [22], and for removing Cd^{2+} using seaweed *H.valentiae* [23]. These studies have found that the amount of ions adsorbed per unit adsorbent weight increase as the lead ion increases. They attributed these observations into the fact that, at higher initial concentration a driving force was created to overcome mass transfer resistance that enabled the adsorbate ions to move sufficiently close to the sorbent to be adsorbed onto its binding sites. The sorbents used in this study displayed powerful ability in removing lead ions from aqueous solutions in compared with oil palm shell. As the amount of lead ions adsorbed on eucalyptus leaves reached 17.8 mg/g at 200 ppm, whereas it does not exceed 2.0 mg/g on oil palm shell at the same concentration.

In contrast, lead removal percentage (removal efficiency) (Fig. 3.1b) did not exhibit regular trend with increasing lead ion concentrations, with exception of eucalyptus leaves. This may due to low biosorbents amount (0.5 g) relative to initial lead ion concentration, which fluctuated between 100 – 1600 ppm, or due to appearance small particles of biosorbents in filtrated solutions after experiment (despite were filtered twice), which may lead to varying in Pb^{2+} concentrations from solution to another.

Table 1: Effect of initial lead ions concentration on the adsorption of lead on 0.5 g of biosorbents (pH = 4.0 and contact time of 90 min).

Pb^{2+} conc. mg/L	almond leaves		olive leaves		eucalyptus leaves	
	q (mg/g)	Removal (%)	q (mg/g)	Removal (%)	q (mg/g)	Removal (%)
100.0	1.9	95.7	1.8	88.2	1.8	89.5
200.0	16.8	84.1	16.7	83.4	17.8	89.2
400.0	32.9	82.3	34.7	86.8	37.4	93.6
800.0	69.3	86.6	66.5	83.1	77.3	96.6
1600.0	780.0	97.5	783.5	97.9	796.3	99.5

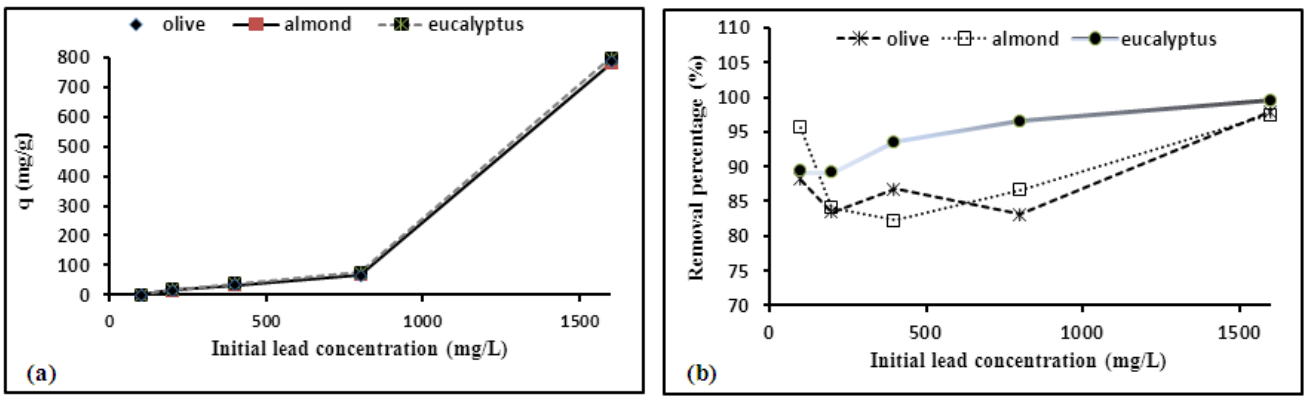

Fig. 3.1: Effect initial lead ion concentration on the amount of lead adsorbed (a); and on the removal percentage of lead (b).

3.2 – Effect of biosorbents mass on adsorption of lead ions

The obtained results in the Table 3.2 and in Fig. 3.2 showed effects of variation in sorbents masses on the amount of lead adsorbed on almond, olive, and eucalyptus leaves. Also, they showed the lead removal percentage (Pb%).

Again, the sorbents showed similarity in adsorbing lead ions on their surfaces. At constant concentration of lead ions (400 ppm), the amount of lead ions adsorbed decreases with increasing sorbents mass. It was observed that, the amount adsorbed on eucalyptus leaves, for example, decreased from 196 mg/g to approximately 10 mg/g as sorbent mass increased from 0.1 – 2.0 g. These results are in agreement with previous studies, which conducted using different biosorbent masses such as seaweed *H.valentiae* [23], and *Parthenium* (*P. hysterophorus* L.) weed [24]. This was attributed to that lowering lead ions to binding sites ratio at high mass of sorbent ($\frac{\text{lead ions}}{\text{binding sites}}$), where the ions are distributed onto larger amount of biomass binding sites [22, 25 and 26].

Table 2: Effect of biosorbents mass on adsorption of lead at constant lead ion concentration of 400 mg/L (pH = 4 and contact time of 90 min).

Biosorbent mass (g)	almond leaves		olive leaves		eucalyptus leaves	
	q (mg/g)	Removal (%)	q (mg/g)	Removal (%)	q (mg/g)	Removal (%)
0.10	187.5	93.8	134.9	67.4	196.3	98.1
0.50	35	87.5	32.7	81.8	39.3	98.2
1.00	19.3	96.6	16.9	8.84	19.8	99.3
1.50	11.8	88.7	11.9	89.4	13.2	99.6
2.00	9.4	94.3	9.6	96.6	9.8	98.1

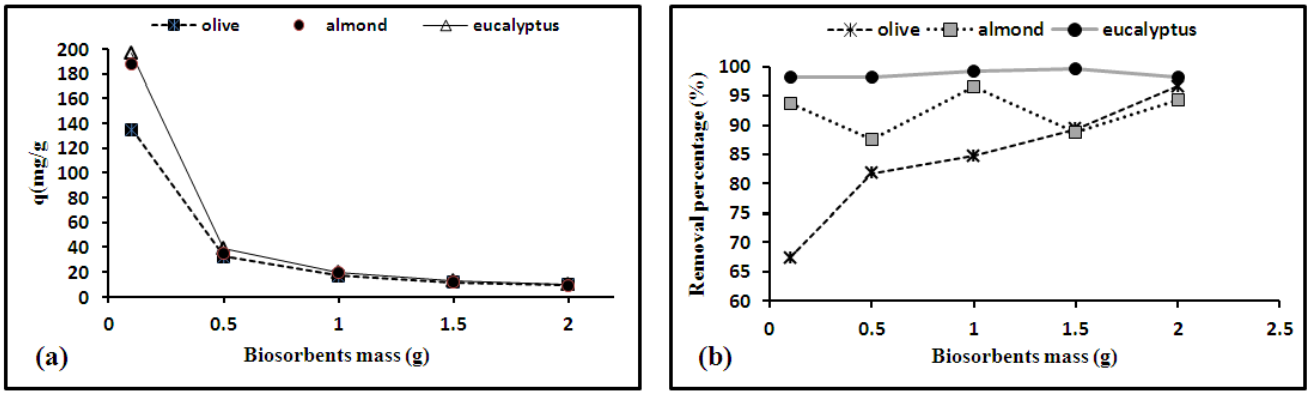

Fig. 3.2: Effect of biosorbents mass the adsorbed amount of lead (a); and on the removal percentage of lead (b).

In respect of effects of biosorbents mass on the removal percentage of lead ions (%), the biosorbent materials used in this study exhibited slight variations. The removal percentage of lead ions on olive leaves increased as the sorbent mass increase, it is fluctuated between 67.4% for 0.1 g of olive leaves mass to 96.6% for 2.0 g of olive leaves mass. This is in agreement with previous literatures [22, 25 and 26]. This was attributed

to the availability of more empty binding sites in large masses in compared with lower masses, which has less binding sites to adsorb the same amount of lead ions. On the other hand, the eucalyptus leaves showed elevated lead ions removal percentage. It was approximately 98.0%, but it does not influence by biosorbent mass. Finally, the lead ions removal percentage on almond leaves was also high, and also does not influence by biosorbent mass. This may be because of the adsorptive nature of these biosorbents.

4- Conclusion

In general, it can be concluded that the almond, olive, and eucalyptus leaves showed high efficiency for removing lead ions on their surfaces in compared with other biosorbents materials such as seaweed *H.valentiae*, *Parthenium* (*P. hysterophorus* L.) weed, Rice husks, maize cobs and sawdust.

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