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ADSORPTION OF CHLORIDE ION FROM POLLUTED WATER USING POMEGRANATE PEELS POWDER AND TEA LEAVES

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Abstract: The aim of this research paper is to minimize chloride ion concentration in water using natural materials such as pomegranate peels powder and tea leaves as adsorbent materials. The water samples that tested in this study were collected from one of Baghdad's public swimming pools. Influence of contact time and temperature on removal efficiency was investigated. The results showed that after 60 minutes of contact time the chloride ion's concentration was decreased from (873.3 mg/L) as initial concentration to (213 mg/L) and (234.3 mg/L) when using pomegranate peels powder or tea leaves respectively. In addition, results showed that increasing solution temperature would improve adsorption capability of adsorbent material that used in this study, increasing solution temperature to (100 ^{o}C) reduces chloride ion concentration from (873.3 mg/L) as initial concentration to (206 mg/L) and (220.1 mg/L) using pomegranate peels powder or tea leaves respectively. Comparing the effect of contact time and temperature on adsorption process showed that temperature had rapid effect for both adsorbent tested material, while pomegranate peels powder was more effective than tea leaves in chloride ion's concentration reduction

Keywords: *Water Treatment, Chloride Ion, Pomegranate Peels Powder, Tea leaves, Adsorption.*

أمتزاز آيون الكلوريد من المياه الملوثة باستخدام مسحوق قشور الرمان وأوراق الشاي

الخلاصة: الهدف من هذه الدراسة هو تقليل تركيز أيون الكلوريد في الماء باستخدام مواد طبيعية مثل مسحوق قشور الرمان وأوراق الشاي كمواد ماصة. تم جمع عينات المياه التي تم اختبارها في هذه الدراسة من أحد حمامات السباحة العامة في بغداد. وقد تم التحقيق في تأثير وقت التماس ودرجة الحرارة على كفاءة الامتزاز. أظهرت النتائج أنه بعد 60 دقيقة من زمن التلامس انخفض تركيز أيون الكلوريد من (873.3 مجم / لتر) كتركيز أولي إلى (213 مجم / لتر) و (234.3 ملغم / لتر) عند استخدام مسحوق قشور الرمان أو أوراق الشاي على التوالي. بالإضافة إلى ذلك ، أظهرت النتائج أن زيادة درجة حرارة المحلول من شأنه تحسين قدرة الامتصاص للمواد الماصة المستخدمة في هذه الدراسة ، كما أن زيادة درجة حرارة المحلول إلى (100 درجة مئوية) تقلل تركيز أيون الكلوريد من (873.3 مجم / لتر) كتركيز أولي إلى (206 مجم / لتر).) و (220.1 ملغم / لتر) باستخدام مسحوق قشور الرمان أو أوراق الشاي على التوالي. أظهرت مقارنة تأثير زمن التماس ودرجة الحرارة على عملية الامتصاص أن درجة الحرارة لها تأثير سريع لكل من المواد الممتزة المختبرة ، في حين أن مسحوق قشور الرمان كان أكثر فعالية من أوراق الشاي في تقليل تركيز أيون الكلوريد.

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1. Introduction

Water occupies greater than 70 % of earth surface, its chemical formula is (H_2O); which indicate that it consist of one oxygen and two hydrogen atoms joined by a molecular bond.

Water exists as liquid at rivers, lake, oceans and seas, however it also exists in solid or vapor state in nature [1]. Water effluent from agricultural, restaurant, manufacturing and toilets sources may harmful or toxic compounds, such as nitrates, lead, mercury etc, therefore treating may considered as necessary step before reuse it or even discharges it to any water body. Water used for drinking or swimming should be free from harmful or toxic matters [2]. One of the most corporate and low-cost ways to purify water is to add substances that let the harmful bits to be removed easily. When chlorine gas is added to wastewater, the chlorination kills the bacteria and portion of the suspended solids can be removed by simple filters.

The chloride ion is negatively charged (Cl^-). Its salts such as potassium chloride are mostly very soluble in water. It is an essential electrolyte in body liquids for keeping acid/base balance. A Chlorine atom is smaller than Chloride ion, 99 and 167 pm, correspondingly. The ion is colorless and soluble in most cases. Some chloride salts, such as lead (II) ion chloride and silver chloride are very soluble in water [3].

Adsorption is one of polluted water treatment methods using adhesion of molecules, atoms and ions from polluted water on a surface of adsorbent material, produces a film of the adsorbate on the surface of the adsorbent, so it is consider as a physical phenomenon occurs on the surface of the adsorbent. In a bulk substance, other atoms of the material fill all the bonding requirements using ionic, covalent, or metallic bonds. Regardless that the atoms on the surface are not surrounded totally by other adsorbent material atoms, they can still attract a specific adsorbate, adsorption classified as weak van der Waals forces (characteristic of covalent bonding) [4] [5].

Ahmed El Nemr in (2007) tested Pomegranate husk as an adsorbent material to remove toxic chromium from wastewater, the study was conducted to determine the adsorption capability of the pomegranate husk. Effects of initial concentration, pH, contact time, and sorbent concentration have been considered at room temperature. The results show that adsorption capacity was increased as the pH decreased, with optimal conditions occurs when pH value was one. The process may consider fast, where it reaches equilibrium condition within three hours. The results showed complete removal of 25 milligram of chromium ion on 5 g of pomegranate husk dose, while maximum adsorption capacity was 10.59 mg/g [6].

Shartooh. et al in (2013) used Pomegranate Peels as sorbent material to reduce heavy metal ions concentration in Industrial wastewater. Dried small pieces and powder of peels were used. Zinc, chromium, and nickel removal efficiency were tested under specific conditions of temperature, contact time and pH. The results show that zinc, chromium and nickel ions removing were significant. Powder peels had the best capability comparing with dried peels in removing zinc, chromium and nickel ions [7].

Hassan and Ali in (2014) determined Ciprofloxacin removal from synthetic solution onto Tea Leaves and Pomegranate Peels. Ciprofloxacin is an antibiotic medicine

transported to the environment with wastewater, results in infection of the ear, skin and tissue infections and bone. Adsorption capability of Ciprofloxacin was investigated under the influence of specific parameters such as temperature, initial concentration, adsorbent dosage, contact time, and pH. The results presented that the adsorption equilibrium occurs after 180 and 150 min for both Tea Leaves and Pomegranate Peels correspondingly [8].

Bindra Shrestha et al in (2012) studied the removal of Lead (II) and Zinc (II) ions using tea leaves to adsorb them from their aqueous solution. The maximum adsorption capability of the tea leaves was found to be around (120.8 mg/g) for Pb^{+2} and (79.76 mg/g) for Zn^{+2} [9]. Wei-Lung Chou, et.al, in (2010) investigated the removal of gallium ions from aqueous solution. Waste of tea leaves as a low cost adsorbent was used, specific operation parameters effects, such as adsorbent dose, initial concentration, and temperature were traced. Freundlich isotherm model was used to describe the adsorption process of gallium ions (Ga^{+3}) onto waste of tea leaves, the model provides correlation coefficients more than 0.99. The study showed that tea leaves waste is an effective, eco friendly adsorbent material for gallium ions removal from aqueous solutions [10].
In the present study, the pomegranate peels powder and tea leaves were used to minimize chloride ion from waste water.

2. Experimental Method

2.1 Equipment and Chemical Materials

Equipments and chemical materials used were includes: glass cylinder, watch glass, funnel, beaker, clamp, stand, digital balance, dropper, burette, washing bottles, water sample, potassium dichromate solution, silver nitrate solution, and distilled water to dissolve and mitigation.

2.2 Adsorption Method

Adsorption method was used to decrease chloride ion concentration in water sample until reach an acceptable range by using (10 gm) of pomegranate peels powder or tea leaves for each time as adsorbent materials at standard temperature as shown in Fig (1) and (2) respectively. The adsorbent material and the solution were mixed by using manual stirrer. This method repeated two times depending on two factors that were time (from 0 - 60 mints) and temperature (from 20-100 ˚C) to see which one is more effective than other in decreasing chloride ion in water sample.

Figure (1) Pomegranate peels powder and Adsorption Process.

Figure (2) Tea Leaves and Adsorption Process.

3. Calculation Method and Experimental setup.

Mohr method (Method of silver nitrate) was used to calculate the concentration of chloride ion in water before and after adsorption depending on silver nitrate titration and potassium dichromate as a guide in the center neutral or weak base. At first, silver nitrate react with chloride ion to produce silver chlorides, which is a white precipitate as shown in the below reaction:

$$AgNO_3 + NaCl \rightarrow AgCl\ (White\ precipitate) + NaNO_3 \quad (1)$$

After the reaction deposited all chlorides, then silver nitrate begins react with potassium dichromate to produce silver chromate, which is a red-colored precipitate, and this is refer to the end of the calibration points as shown in the below reaction:

$$2AgNO_3 + K_2CrO_4 \rightarrow Ag_2CrO_4\ (Red\ precipitate) + 2KNO_3 \quad (2)$$

Fig.3 below shows the titration results from reactions described in equations (1) and (2) mentioned previously.

Figure (3) Titration results 1. White precipitation (AgCl), 2. Red precipitation (Ag_2CrO_4).

The titration method procedures are:

i. Pour volume of (50 ml) of water sample in beaker.
ii. Add 3-5 drops of reagent yellow potassium dichromate solution to the sample turn it to yellow color.
iii. Titrate with silver nitrate solution to get a white precipitate of silver chloride consists ends interaction and stops at the first point mixed turned into a red dusty.
iv. Take the size of silver nitrate before and after titration to know the volume of silver nitrate consumed to form a precipitate of silver chloride and applies the size in the following equation:

$$[Cl^-] = \frac{v*N*eq.wt.}{V} * 1000 \quad (3)$$

Where:

$[Cl^-]$: The concentration of chloride (mg/l)

v: The volume of silver nitrate (ml)

N: normality of silver nitrate = 0.1 Cl^- (mg/l)

eq.wt. = 35.450 g/eq.

V: sample volume = 50 ml

4. Results.

The results of the chloride ion's concentration in the water sample before and after adsorption using pomegranate peels powder and tea leaves as an adsorbent material are showed in the following:

4.1. Effect of Contact Time.

The concentration of chloride ion was calculated before adsorption using equation (3) as shown below:

$$[Cl^-]=\frac{12.3*0.1*35.5}{50}*1000$$

$$[Cl^-]= 873.3 \text{ mg/L}$$

After adsorption, the concentration of chloride ion decreased until reached less than 250 mg/l which is Iraqi standard of max permissible chloride concentration for drinking water. The results are plotted in figures (4) and (5) for pomegranate peels powder and tea leaves, respectively. They represented the concentration of chloride ion in water sample at constant temperature (25 ˚C) and different contact time ranges from (0-60 min).

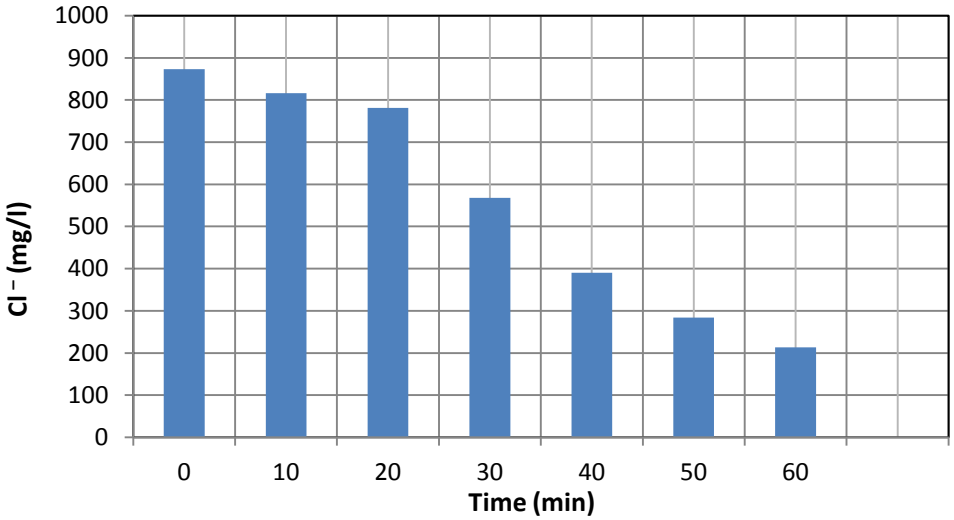

Figure 4. Effect of contact time on chloride ion concentration using pomegranate peels powder

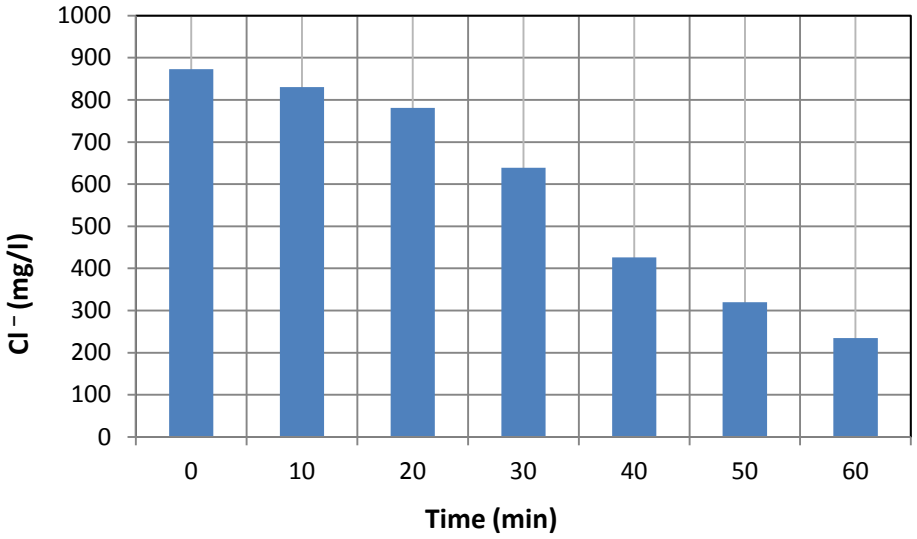

Figure 5. Effect of contact time on chloride ion concentration using tea leaves

4.2. Effect of Temperature.

The concentration of chloride ion was calculated before adsorption depending on equation (3), it has the same value that calculated before (873.3 mg/L).

After adsorption, the concentration of chloride ion decreased until reached less than 250 mg/l which is Iraqi standard of max permissible chloride concentration for drinking water. Figures (6) and (7) shows the results that represented the concentration of chloride ion in water sample at constant contact time (10 min) and different sample temperature ranges from (20-100 ˚C).

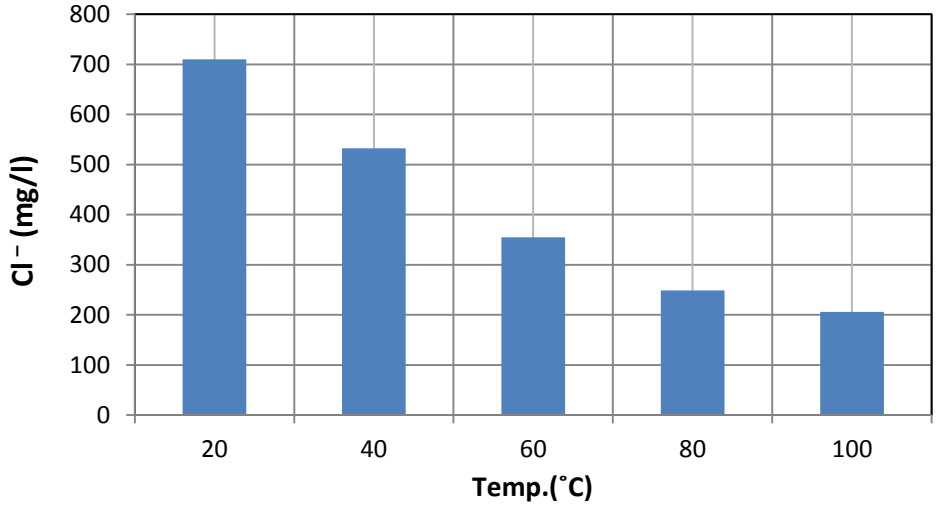

Figure 6. Effect of water temperature on chloride ion concentration using pomegranate peels powder

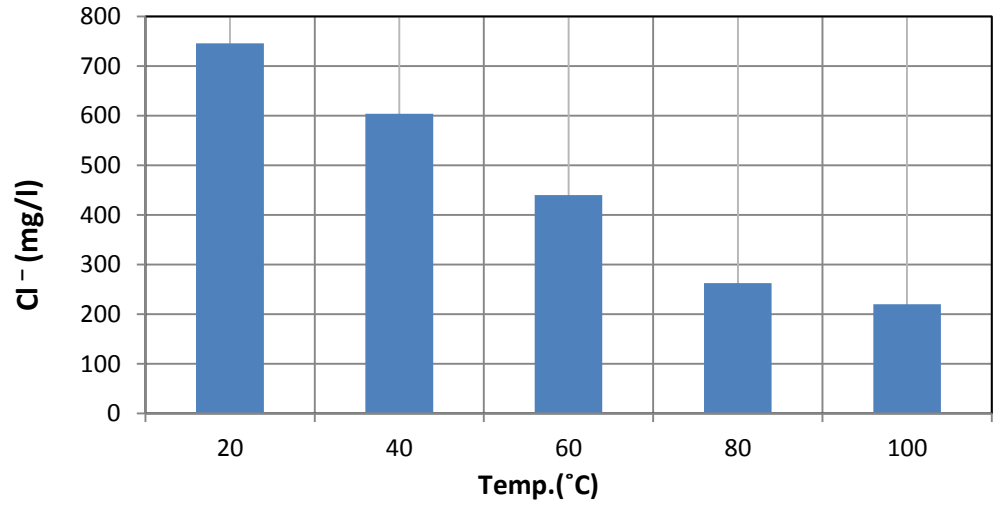

Figure .7 Effect of water temperature on chloride ion concentration using tea leaves.

5. Conclusions

From the previous tests and results in this paper, the following conclusions can be come out:

The results showed that using pomegranate peels powder or tea leaves as adsorbent materials can successfully decrease chloride ion concentration till it reaches 250 mg/l which is Iraqi standard of max permissible chloride concentration for drinking water, deciding which material will be used then depend on its availability.

Water temperature increasing was faster and more effective than contact time in chloride ion decreasing process and this due to fact that increasing of solution temperature will enhance chloride ion release as chloride gas to the air.

The results indicated that using pomegranate peels powder was more effective than tea leaves in decreasing chloride ion in water.

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