The Possibility of Using the kiwi Peels as an Adsorbent for Removing Nitrate from Water

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Abstract

In this study, the possibility of using kiwi peels as natural adsorbents for reducing nitrate concentration in water was considered. Various periods of time (30, 60, 90,120,150,180) minutes were done to detect the best contact time with initial nitrate concentration C_o=50ppm, amount of adsorbent =1.0 gm. The results revealed that the equilibrium state of adsorption is approached after a contact time of 180 min and removal efficiency (R%=37.78). The effect of amount of adsorbent on nitrate adsorption, was studied by adding various amounts of adsorbent, (1, 1.5, 2, 2.5,3 gm.) with initial nitrate concentration (50 mg/l) and contact time of (3 hours). The results revealed that there was a relationship between the increase in the adsorbent amount (gram) and the increase in removal efficiency and that is due to the increase in the surface area available for adsorption process. Three initial concentrations of nitrate solution were examined (50, 75 and 100 mg/l) with amount of adsorbent of (1.0 gm.) and contact time of (3 hours). It is noticed that the adsorption rate increases with increasing the initial concentration. Also it is found that the best removal efficiency of nitrate occurs at initial concentrations of 100 mg/l.

Keywords: Adsorption, Adsorbent, Nitrate removal.

الخلاصة

في هذه الدراسة، تم النظر في إمكانية استخدام قشور الكيوي كمضافات طبيعية للحد من تركيز النترات في الماء. تم اعتماد فترات زمنية مختلفة (30، 60، 90،120،150،180) دقيقة للكشف عن أفضل وقت تماس مع تركيز أولي للنترات C_o=50ppm ومقدار المادة المازة = 1.0 غرام (جم). وأظهرت النتائج أن حالة التوازن للامتزاز تتم بعد وقت تماس مقداره 180 دقيقة مصحوب بكفاءة إزالة مقدارها (R%=37.78) . تم دراسة تأثير كمية المادة المازة على امتزاز النترات بإضافة كميات مختلفة من المادة المازة (1، 1.5، 2، 2.5، 3 جم) مع تركيز النترات الأولي (50 ملغم / لتر) وباستخدام وقت تماس (3 ساعات). وأظهرت النتائج وجود علاقة بين الزيادة في كمية الامتزاز (غرام) والزيادة في كفاءة الإزالة، ويرجع ذلك إلى الزيادة في المساحة السطحية المتاحة لعملية الامتزاز. تم فحص ثلاثة تركيزات أولية من محلول النترات (50، 75 و 100 ملغم / لتر) مع كمية من المادة المازة (1.0 جم) ووقت تماس (3 ساعات). ومن الملاحظ أن معدل الامتزاز يزداد مع زيادة التركيز الأولي. كما وجد أن أفضل كفاءة إزالة للنترات تحدث عند تركيز أولي مقدارة 100 ملغم / لتر.

الكلمات المفتاحية: الامتزاز، المادة المازة، إزالة النترات .

1. Introduction

Nitrate can be regarded as one of the pollutants having greatest importance in water supply systems. It is also a fundamental component increasing the algal population. For infants, nitrate often causes *methaemoglobinemia*, which is commonly known as “blue baby syndrome” (Taghizadeh, and Vahdati, 2015). Recent studies have demonstrated that increasing nitrate amount in drinking water would cause a variety of cancers in human beings. Due to serious health problems associating nitrate in drinking water, the Environmental Protection Agency (US EPA) has declared the maximum nitrogen concentration in water to be 10 milligrams per liter (Dehestaniathar and Rezaee , 2014). Nitrate is a plant component found naturally in vegetables at different levels depending

on the applied fertilizer amount and other growing situations. The announcements of the World Health Organization state that most adults takes 20-70 milligrams of nitrate-nitrogen per day and most of their sources are extracted from foods like beets, lettuce, celery, and spinach. Eating foods containing nitrate as part of a balanced diet, the harmful effect of nitrate is thought to be not harmful (Dehghani *et.al.*, 2015). Nitrate shows high solubility in water and it is found in the soil at a minimum rate, which is in turn makes it the most major constituent in groundwater during pollution formation of nitrate (Gaikwad and Warade, 2014).

The increasing use of nitrogen fertilizers in agriculture sector which caused the contamination by nitrate. In addition there are many factors such as sewage, urban and agricultural runoffs, untreated wastewater disposal, industrial wastewater, septic system leachate, waste disposal site leachate, agricultural fertilizer, and nitrogen compounds added to the air through industry and cars also give rise to the pollutants in water (Dehestaniathar and Rezaee , 2014). Different methods were adopted for removing nitrate. These methods are represented by reverse osmosis, biological de-nitrification chemical reduction, ion exchange, and electro dialysis. In this case, adsorption appears to be an inexpensive and represents the effective alternative for removing ions from water. Clays have been broadly adopted as adsorbents for controlling pollution because of their non-toxicity, high uptake ability, and large potential for ion exchange (Morghi *et.al.*, 2015).

Adsorption is a process, in which separation is accomplished between organic and inorganic particles existing in solution on the interface between a solid and liquid. It is also can be used for such processing the diversity of raw materials, cationic polymer-modified granular activated carbon rice husk, ion exchange resin, modified rice husk, bamboo powder activated, boiler slag and activated carbon powder, and invasive species biomass converted into activated carbon activated with hydrochloric acid. The adsorption process becomes more promising throughout using natural adsorbents, which are produced from biomass because they are renewable, having low cost, available, and in many situations their disposal may become an environmental problem (Schwantes *et.al.*, 2015).

Maximum removal of nitrate of activated carbon obtained from rice husk was 93.5 (mg/gr), and for the sludge obtained from paper industry was 79.5 (mg/gr). The result of tests for both adsorbents suggest a direct relationship between the level of adsorption run by Zncl2 used to activate adsorbents and the level of adsorbent (Dehestaniathar and Rezaee ,2014). The amount of NO_3 ions, which is adsorbed by chitin increases rapidly to approach in few minutes the equilibrium threshold. Generally, the results state that chitin adsorbent can successfully be adopted to remove NO_3 ions from aqueous solutions (El Ouardi *et.al.*, 2015).

It was demonstrated that 92% removal of nitrates takes place at an initial concentration of 80 mg NO_3/l solution. The maximum removal occurred during a flow of 1ml/min in a laboratory Ion Exchanger. Comparing with the activated carbon, the natural Zeolite-stilbite was found more efficient in removing nitrate (Gaikwad and Warade, 2014).

New Clay was considered as a very good adsorbent for NO_3, compared with other alternative materials, which are more costly adsorbents, thus New Clay can be used as a highly efficient adsorbent for separating nitrate from waste or drinking water (Morghi *et. al.*, 2015).

The effectiveness of adsorption offered by bamboo powder charcoal (BPC) was greater than that offered by commercial activated carbon CAC; regardless of nitrate-nitrogen concentration in the range of 0–10 mg/l. Results showed that the effectiveness of temperature dependency during the adsorption of BPC was weaker than that of CAC. This fact leads to that BPC can be a considerable option for the treatment by adsorption of nitrate-nitrogen-contaminated surface and underground water (Patil *et.al.,* 2013).

Experimental data show that FeO, Fe2 (SO4)3, and FeSO4 impregnated activated carbons were more effective than virgin almond activated carbon in nitrate removal. The maximum nitrate removal was 70% and 10-15% of modified activated carbons and virgin activated carbon, respectively. The increase in modified activated carbon dosages increased the removal of nitrate (Dehestaniathar and Rezaee , 2014).

Materials that are often used for producing activated carbon are of great importance in adsorption capability of the activated carbon. Activated carbon, which is produced from chip agricultural waste such as walnut, pistachio, and almond shells can be employed for increasing the quality of water. Active carbon produced from pistachio shell shows better result in removing nitrate compared to almond and walnut shells (Taghizadeh, and Vahdati, 2015).

The removal efficiency of nitrate by chaff is a promising technique and it was directly proportional to the amount of chaff, temperature, and contact time but inversely to the pH (Dehghani *et.al.*, 2015).

In this study, available and cheap plant residues are exploited to reduce the concentration of nitrates in water. The used residues are kiwi peels, which have shown good results in nitrate removal.

2. Material and methods

2.1. Preparation of Adsorbent

The adsorbent in this study was the kiwi peel, it was prepared by sinking of the kiwi peels in H_3PO_4 (10%) for one hour and then the peels were dried by using the oven at (80 C^o), then the kiwi peel were grinded by manual mill.

2.2. A Stock solution preparation

Nitrate stock solutions were prepared by dissolving a certain amount of potassium nitrate salt in distilled water. The ranges of concentration for the prepared nitrate ions solution varied between (50-100) mg/l. These concentrations were similar to nitrate concentration in some water sources found at different ground levels (Shahmoradi *et.al.*, 2015).

2.3. Experimental procedure

Adsorption experiments were accomplished by using a batch technique at ambient temperature. The experiments were performed in 250 ml conical flasks through mixing a pre-assigned amount of adsorbent with 100 ml solution of nitrate. All samples were filtered using a filter paper before the analysis and the resultants were placed in the centrifuge for 10 minutes at 400 rpm .The nitrate concentrations were found by using a spectrophotometric method (spectrophotometer type Optima,(SPECTRO SC 90 V. 50/60Hz), λ_{max} = 543 nm). Batch experiments, first one was to find the best contact time in the adsorption of the kiwi peels, the experiment was done by using six samples with a concentration of (50 mg/l), Volume 100 ml, and the adsorbent amount added was 1.0 gm., the test was performed for series of time (30, 60, 90, 120, 150 and 180 mints) respectively in the shaker then the samples were filtered and transferred to centrifuge to separate the remaining adsorbent from the solution, then samples concentration were determine by using the spectrophotometer. A second experiment was to estimate the

optimum amount of the adsorbent for nitrate removal. Five samples were used with concentration of 50 mg/l, the sample volume was 100 ml, the time was set to 3 hours in shaker, a series of amount of adsorbent weight (1, 1.5, 2, 2.5 and 3.0 gm.) were used. A third experiment was done to find the influence of the initial nitrate concentration on the adsorption process. Three samples were prepared with volume 100ml, initial nitrate concentrations was (50, 75, 100 mg/L) respectively. Experiment time was set 3 hours in shaker and the adsorbent amount added was 1.0 gm.

The nitrate removal efficiency percentage was calculated using the following equation:

$$R\% = \frac{Ci-Ce}{Ci} * 100\% \text{..... (1)}$$

Where:

R%: The nitrate removal percentage.

Ci: The initial concentration of nitrate (mg/L).

Ce: The nitrate concentration after adsorption had taken place over a period of time **t** expressed as (mg/L).

3. Results and discussion

Figure.1 shows the variation of nitrate removal efficiency (R %) with various times (30, 60, 90,120,150,180) minutes, initial nitrate concentration C_o=50g/l, and amount of adsorbent =1.0 gm. The experimental results point that the adsorption equilibrium state is approached after a contact time of 180 min and with removal efficiency of (R%=37.78).

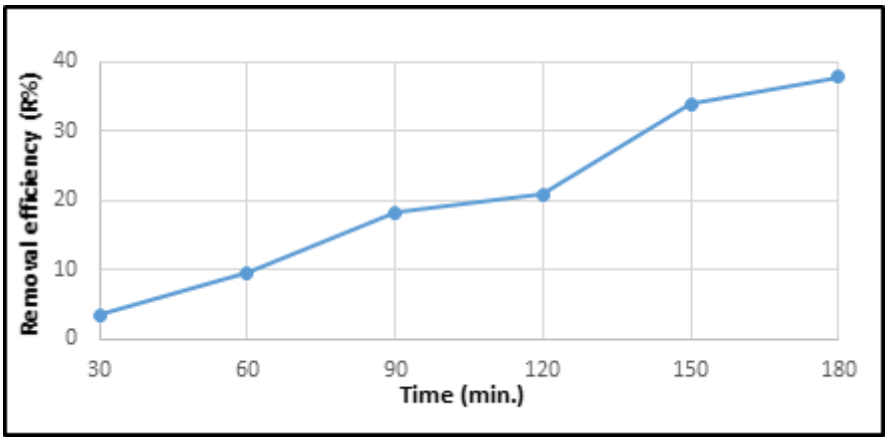

Figure (1): nitrates removal efficiency with time (initial nitrate concentration C_o=50mg/l, amount of adsorbent =1.0 gm.)

The effect of amount of adsorbent on nitrate adsorption, were studying by adding various amounts of adsorbent, (1, 1.5, 2, 2.5,3 gm.) with an initial nitrate concentration (50 mg/l) and contact time of (3 hours) (Figure. 2). The results revealed that there was a direct relationship between the increase in the adsorbent amount (gram) and the increase in removal efficiency and that is due to the increase in the surface area available for adsorption process (Morghi *et.al.*, 2015).

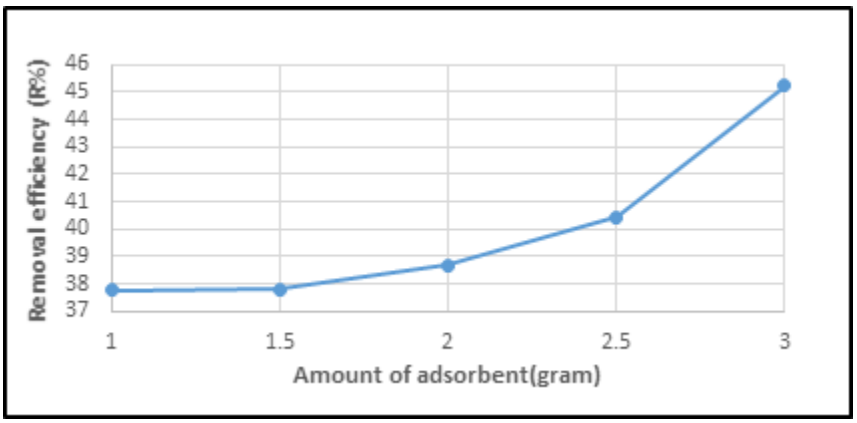

Figure (2): nitrates removal efficiency with different amount of adsorbent, C_o=50 mg/l, contact time=3 hr.

The initial nitrate concentration effect on adsorption process was considered (Figure. 3). Three initial concentrations of a nitrate solution were examined (50, 75 and 100 mg/l) with amount of adsorbent of (1.0 gm.) and contact time of (3 hr.). It is noticed that the rate of adsorption at equilibrium increases with the initial concentration increase (Dehestaniathar and Rezaee , 2014). Also, it was found that the best removal efficiency of nitrate occurred at initial concentrations of 100 mg/l.

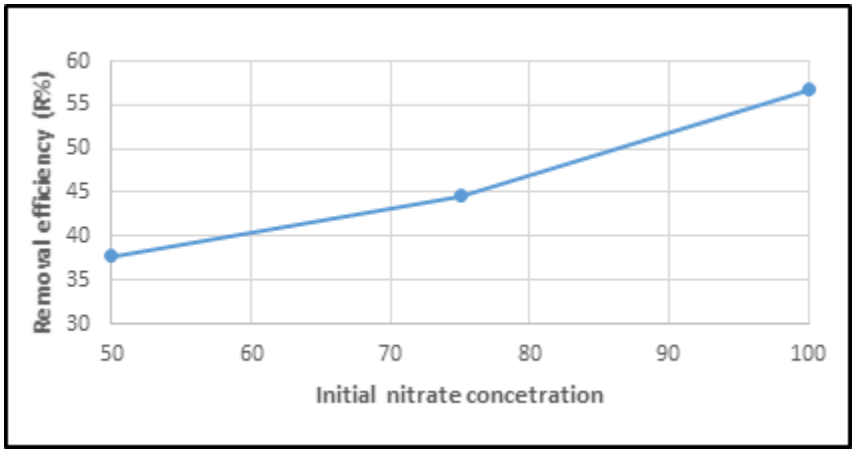

Figure (3): nitrates removal efficiency with initial nitrate concentration amount of adsorbent= 1gm., contact time=3 hr.

4. Conclusions

The experimental results revealed that there was a coherent relationship between the increase in the adsorbent amount and the increase in removal efficiency. This is because of the increase in the surface area available for adsorption process. In addition, it is concluded that the rate of adsorption increases with the initial concentration increase.

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