Mesopo. Environ. j Vol.3, No.2 :35-39, 2017
ISSN 2410-2598

Mesopotemia Environmental journal
journal homepage:www.bumej.com

The use of grinded white kidney beans to remove the congo-red dye from aqueous solutions by adsorption

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To Cite This Article:

Salman. J.M, Al-Muttarri.A .K, Abd-Hussian. N. A, Mustafa.S.A, The use of grinded white kidney beans to remove the congo-red dye from aqueous solutions by adsorption *Mesop. Environ. j*., 2017, Vol. 3, No.2, pp. 35-39.

Received Date: 5/1/2017 Accepted Date: 7/1/2017 Publishing Date: 1/3/2017

Abstract

The present study was conducted to evaluate the efficiency of white kidney beans as low cost adsorbent of the Congo red dye. The results show that the best contact time was 90 mints with removal efficiency (R%) 73%, the results also that there was a direct correlation between the increase in the adsorbent weight and the increase in R%, with R% up to 76.7 , while the initial dye concentration does not affect the adsorption process. From the results it been noticed that the adsorption of the congo red dye was the highest in the acidic medium with R% 73.3 and the lowest R% was observed in the alkali medium. The isotherm studies show that the freudlish isotherm fit well with experimental data rather than the Langmuir isotherm.

Introduction

There are many industries contain dyes , such as textiles, leather, and printing plastics, and 10-15% of the used dyes are lost in the environmental , many of these dyes have several effects on health

including, teratogenicity, carcinogenic and toxic effects, as well as, damaging the aquatic water bodies [1]. The main problem in removing colors from waste water which faced the stability of the azo-dyes to light and oxidative agents , therefore, traditional methods are not effective in removing these dyes. Many new methods are used to get-red of dyes from water, including flotation, filtration, and the most promising technique is adsorption[2]. Congo red is an example for the anionic dyes which released to water bodies from the textile industry and it also used in microscopic preparations, and this dye is hard to remove from water due to its high solubility in water [3]. Beans which also known as pluses, they are recognized by their seed-bearing pods, beans families can be classified in tow groups or classes, the first class is oil-seed and the second one is legumes, which include dry white kidney beans and dry red beans. Beans are cheap and tasteful source of fiber, proteins, micronutrient and carbohydrates[4]. Many studies has been done to remove the Congo red from aqueous solutions [3,5, 6,7]. This work is a modest effort to find a new and cheap materials that can be used for the water treatment and remove dyes.

Materials and Methods

Batch Studies

Stock solution of the congo red dye was prepared by dissolving the dye in D.W. to prepare a stock solution with concentration of 50 mg/L and volume of 1000 ml. The adsorbent was prepared by grinded the dry white kidney beans, and used without any activation[7,8].

In this study four parameters were tested to show their effects on the adsorption processes as follow :

The first parameter test was the time contact, five samples were prepared with concentration of 20mg/l and volume of 50 ml , 1.5gm of the adsorbent (white kidney beans) was added to each sample and then kept in the shaker for a series of time 30, 60, 90, 120, 150 mints respectively . The samples then transferred to the centrifuge to get-rid of the remaining adsorbent, after that the absorbance of resulting supernatant was measured by using the spectrophotometer. The second parameter was the weight of the adsorbent (white kidney beans), in this experiment five samples were prepared with the concentration of 20 mg/l and volume of 50 ml and the time was set at (90 mints), a series of adsorbent (0.5, 1, 1.5 , 2, 2.5 gm) was added to each sample respectively. The third parameter tested was the concentration of dye (cong red). In this experiment a series of samples was prepared with the concentration of 10, 20, 30, 40, 50 mg/l respectively, and volume of 50 ml and the time was set at (90 mints), 1.5gm of the adsorbent was added to each samples. The final and forth parameter tested in this work was the pH Value , three samples were prepared with the concentration of 50mg/l and volume of 50ml and time was set at (90 mints)and the weight of the added adsorbent was 1.5gm, the pH value was set for the samples as 3 (acidity medium), 7 (neutral medium) and 9 (alkali medium) respectively.

Isotherm studies

To qualify the adsorption capacity of white Kidney beans in relation to congo red dye the Langmuir linear equation is :

$qe=(abC_e)/(1+bC_e)$

and Freudlish linear equationis:

$qe=K_fC_e^{1/n}$

Where :

qe= quantity adsorbed at equilibrium in (mg/L).

C_e= Te=the equilibrium concentrationof adsorbate in (mg/L).

A and b = the Langmuir constants in (mg/L).

Kf and n= the Freudlish experimental constant, and they are indicators of the adsorption capacity and intensity respectively.

Results and Discussion

Before we go through with results of this research it must be note that in this research the materials that use in the adsorption (white kidney beans) was use without any activation (its only grinded and used), in order to make the results of the study doable from the point view ordinary worker that deals with colors and dyes in their jobs. The first experiment was carried out to determine the best contact time for adsorption , the table.1 show the contact time and the removal efficiency ,it's shown in this table that the best R% (Removal Efficiency) was in 30 mints, and then it reach saturation at 60 mints , then the adsorbent agglomerate and that could be the reason for the decrease in the R% with the increase in time , from the results, the adsorbent show a very fast time for adsorping the dye in comparison with adsorbent used in other study which take a long time to remove the dye as shown in the results of Khan *et al.*[9] , while our results were similar to the results found by [3] .

Table.1: The effect of time contact on the adsorption process

Time (mints)	R % (Removal Efficiency)
30	49
60	67.5
90	73
120	48.8
150	42.16

The second experiment was done to show the effects of the adsorbent weight on the adsorption process, the results show that there was a direct correlation between the increase in the adsorbent weight and the increase in R%, the highest R% noted was 76.7 with use of 2.5gm of the White kidney beans, and that can be due the increase in the surface area available for adsorption , and that was similar to the results of Smaranda *et al.*[3] and Salman *et al.* [8].

Table.2: the effect of adsorbent weight on the adsorption process

White kidney beans weight	R % (Removal Efficiency)
0.5	34.4
1	52.9
1.5	46.2
2	51.2
2.5	76.7

In the third experiment the effect of the initial dye concentration on the adsorption process was studied, the results show that in this particular study the initial dye concentration was not a deciding factor , as shown in Table 3, the highest R% is 50.2 was observed with high initial dye concentration 20 mg/L , and that can be explain by the fact that the increase in the dye concentration can deliver a greater driving force of dye molecules to reach the adsorption site faster, and hence low dye concentration means less dye iotas will reach the adsorption sites[10].

Table.3: The effect of initial dye concentration on the adsorption process

Congo red dye concentration mg/L	R % (Removal Efficiency)
5	7.4
10	6.8
15	34.6
20	50.2
25	48.3

In the fourth experiment a further step in determining the efficiency of the white kidney beans as adsorbent by increasing the initial dye concentration to 50 mg/L.Table 4 show the effects of the pH value on the adsorption process, as shown from the results the highest R% was observed in acidic

medium , and the lowest R% which was 37.4 was perceived in alkali medium, and that is similar to the results found by [11].

Table.4: The effect of pH value on the adsorption process

pH value	R % (Removal Efficiency)
3	73.3
7	41.2
9	37.4

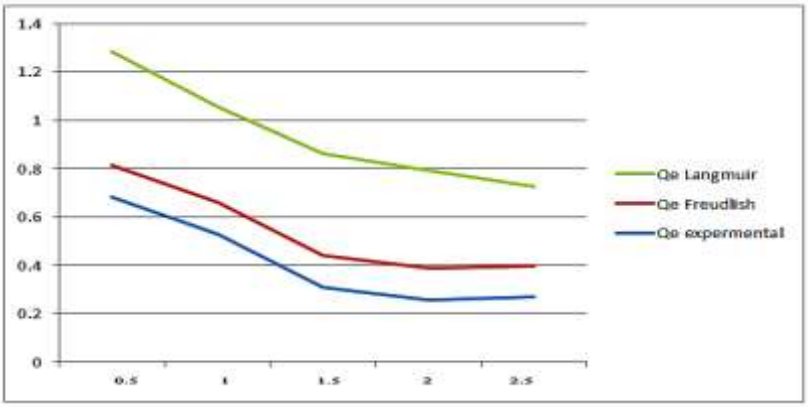
Characteristic, parameter and determination coefficient of experimental data for two isotherms are listed in Table 5

Table 5: Characteristics, parameter and coefficient of experimental data

Langmuir		Freundlich	
a	0.135	Kf	0.1287
b	4.47	1/n	0.5013

From the value of the correlation coefficient of the two models above, Freudlish isotherm fit well with the experimental data rather than Langmuir isotherm as show in Fig.1.

Fig.1: the isotherm models



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