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In Vitro Study of the Elimination of Fexofenadine Drug Poisoning by activated charcoal impregnated with potassium permanganate

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Abstract :

The current study aimed to estimate the ability of activated charcoal powder impregnated with 1% of ($KMnO_4$) to adsorbing the overdoses of fexofenadine drug via improve its surface properties. The powder activated charcoal was impregnated with 1% $KMnO_4$ to improving its surface properties. Two important factors was investigated in this study, the effects of pH of the solution and the effect of contact time. The concentration of fexofenadine drug after elimination was monitored by UV-Vis spectroscopy. The activated charcoal was kept in contact with the fexofenadine solution at pH of 2, 4, 7 and 10, and time of 15, 30, 45 and 60 minutes. The adsorption data show a high increase in the adsorption capacity of the activated charcoal in comparison to the normal charcoal. Where the adsorption of fexofenadine with the activated charcoal was twice or three times of the adsorption of fexofenadine with a commercial charcoal. The results showed that the adsorption at low pH where was up to 75% at pH of 2. On the other hand, the optimal time of contact between the activated charcoal and fexofenadine was 30 min.

Keywords: Fexofenadine, Activated charcoal, Adsorption, potassium permanganate.

دراسة مختبرية للتخلص من التسمم بدواء الفيكسوفينادين بواسطة الفحم المنشط ببرمنغنات البوتاسيوم

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مستخلص:

تهدف الدراسة الحالية الى دراسة قدرة مسحوق الفحم المنشط المشرب ببرمنغنات البوتاسيوم (KMnO4) على امتصاص الجرعات الزائدة السامة من دواء الفكسوفينادين عن طريق تحسين الخصائص السطحية للفحم. تم إشراب مسحوق الفحم المنشط بنسبة 1٪ مع برمنغنات البوتاسيوم لتحسين خصائصه السطحية. تمت دراسة عاملين مهمين في هذه الدراسة ، تأثيرات الأس الهيدروجيني للمحلول ووقت معاملات التفاعل باستخدام التحليل الطيفي للأشعة المرئية وفوق البنفسجية. ضل الفحم المنشط ملامسًا لمحلول فيكسوفينادين باستخدام محاليل أس هيدروجيني مختلفة (2 ، 4 ، 7 و 10) ، والوقت (15 ، 30 ، 45 ، 60 دقيقة). بشكل عام ، اظهرت بيانات الامتصاص زيادة كبيرة في قدرة امتصاص الفحم المنشط مقارنة بالفحم العادي. حيث كان امتزاز الفكسوفينادين بالفحم المنشط مرتين أو ثلاث مرات اكثر من امتصاص الفكسوفينادين بالفحم التجاري. أظهرت النتائج أن الامتصاص عند درجة حموضة منخفضة يكون اكثر بحوالي 75٪ عند درجة الاس الهيدروجيني 2. بينما ، كان الوقت الأمثل للتلامس بين الفحم المنشط والفيكسوفينادين 30 دقيقة.

الكلمات المفتاحية: فيكسوفينادين ، الفحم المنشط ، الامتزاز ، برمنجنات البوتاسيوم.

1. Introduction

Activated carbon (AC) has been extensively used in various applications, including gas (methane, carbone dioxide and H_2) adsorption [1–4]. Activated carbons are promising materials because of their simple methods of preparation, mechanical stability, and high thermal. The most attractive property of AC, that determines its performance in most applications, is its textural properties [2], [5]. The activated charcoal showed improved adsorption ability as the surface area improved.

It is traditionally prepared via either chemical or physical methods of activation. The physical method includes gasifying a carbon precursor with gases such as steam or air as an oxidizing agent at a high temperature (800-1100 °C).[2], [6], [7] The chemical method involves activating the carbon precursor thermally using KOH, NaOH, or ZnCl as an activating agent under inert conditions[2], [8]. Activated charcoal is used as an adsorbent to remove contaminants from liquid effluent.[9], [10]. However, preparation of AC is usually expensive and required high energy consumption, so finding a simple and less expensive activation method is highly demanded [11]namely, sawdust, the flowering plant Paeonia lactiflora and seaweed (Sargassum fusiforme. Chemical activation of charcoal is a simple and direct method for improving its adsorption ability.[2], [5]

Fexofenadine is a type of antihistamine that does not induce drowsiness. They are drugs used to treat allergic rhinitis, influenza, and other allergies [12], [13]. Fexofenadine is a type of antihistamine that does not induce drowsiness. They are drugs used to treat allergic rhinitis, influenza, and other allergies [12]. Activated carbon was used to adsorbed paracetamol from aqueous solutions and to remove amoxicillin from pharmaceutical effluents due to its toxicity effect onto algae and other organisms[7]. Activated carbon that was activated with KOH was used to adsorb chlorpheniramine and ibuprofen from deionized water and spiked hospital wastewater[14]. Granulated active carbon was used to remove organic micropollutants, including fexofenadine, lamotrigine, cetirizine, and carbamazepine from water treatment plants[15–17]Biology lab, and Physics lab based on the frequency

used by students. The aluminium (Al.

This study aims to activate commercial charcoal using $KMnO_4$ as an activating agent to improve the adsorption capacity of the activated carbon. The activated carbon was used to adsorb of fexofenadine drug from an aqueous solution and compared with the adsorption capacity of the commercial charcoal.

2. Experimental part

2.1. Materials:

The Activated charcoal and chemicals were obtained from Sigma-Aldrich. The fexofenadine drug (120 mg tablet) was purchased from the local market and produced by Micro Labs Limited Company. AC was dried to constant weight at 105 ˚C for 24 h after washing many times with distilled water.

2.2. Apparatus:

The spectrum of samples was recorded using a double beam Uv-Vis spectrophotometer (PG Instrument T80). The pH of the solution was managed pH meter (Philips PW-9409)., the maximum absorbance wavelength (λ_{max}), at which the concentration for the aqueous solution of fexofenadine measured, was identified and determined to be 225 nm.

2.3. Activation of charcoal:

The impregnation of charcoal (AC) was carried out and stirred under a neutral condition with 1% of $KMnO_4$ solution over (4 h). Then, the filtration was used to separate and obtain the AC, repeatedly washed with distilled water, and placed in the oven at 105˚C for 4 h to dry.

2.4. Adsorption Studies:

Exact 120 mg of the sold fexofenadine drug was dissolved in a distillated water in a 1 L volumetric flask. Then the volume of the mixture was adjusted up to 1 L with distilled water to obtain the fexofenadine standard solution (120 µg mL^{-1}). Then, the Whatman filter paper was used to filtrate the solution.

The effect of pH on fexofenadine adsorption was studied. 1 gm of activated charcoal was added to four containers, each containing 50 mL of standard fexofenadine solution (120 µg mL^{-1}) at pH ranges of 2, 4, 7, and 10. The mixtures then stirred for 60 minutes at 25 °C. Subsequently the residual fexofenadine concentration in the solution was measured using UV-Vis spectrophotometer at λ=225.

For the time study, the experiment was repeated at different periods of time of 15, 30, 45, and 60 minutes, using a drug concentration of 120 µg/ml. Subsequently the residual fexofenadine concentration in the solution was measured using Uv-Vis spectrophotometer at λ=225. The quantity of the adsorbed fexofenadine was calculated by applying the following equation:

$$q_e = \frac{(\mathrm{Ci} - \mathrm{Ce})\, V}{m}$$

Where q_e is the maximum adsorption amount of the fexofenadine in µg / gm removed by the activated charcoal, Ce is the residual concentration of the fexofenadine (µg mL^{-1}) in the solution at the equilibrium, Ci is the primary concentration (µg mL^{-1}) of the fexofenadine solution, V is the volume of the fexofenadine solution in milliliter and m is the mass AC in grams.

3. Results and Discussion

3.1. Effect of pH

The adsorption of fexofenadine (**Fex**) with normal and activated charcoal was investigated at pH 2, 4, 7 and 10 while the other condition constant. The adsorption of Fex. using normal charcoal is shown in Figure 1. The highest value of Fex. adsorption was found at pH 2 (34 %), which decrease continuously to about 13 % at pH of 10 (figure.1).

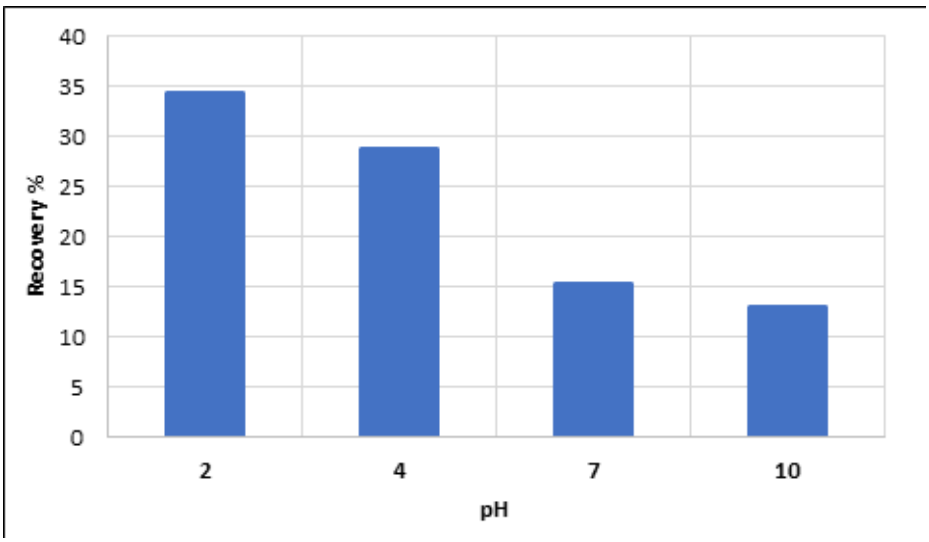

Figure :1 Effect of pH on adsorption of fexofenadine at 298 K (normal charcoal 1 g/ 50 ml of aqueous solution, time 60 min and initial fexofenadine concentration 120 µg mL^{-1})

On the other hand, the Fex. absorption rate using activated charcoal was 75% at pH 2, then decreased continuously with increasing pH to reach the minimum adsorption of Fex. 22 % at pH 10 (Figure 2).

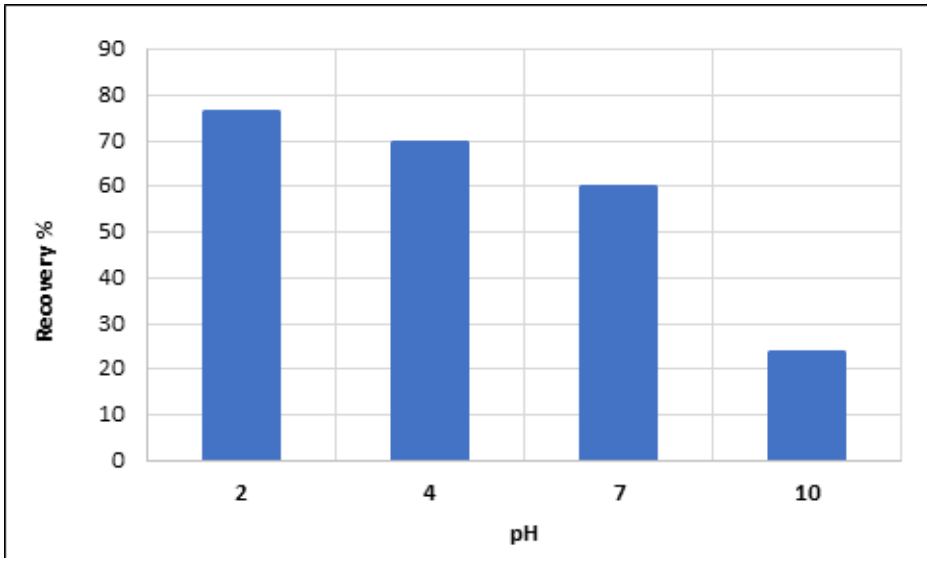

Figure : 2 Effect of pH on adsorption of fexofenadine at 298 K (Activated charcoal 1 g/ 50 ml of aqueous solution, time 60 min and initial fexofenadine concentration 120 µg mL^{-1}

In both cases of adsorption with commercial and activated charcoal, the effect of increasing pH leads to a decrease in the recovery of Fex. and highly noticeable when the solution is alkaline. The reduction in recovery as the pH increases has been previously reported, which also found that as the pH increases the adsorption of some pharmaceutical drugs decrease [18–20]. The changes in pH affected the protonation of the carboxylic group and the substituted ring nitrogen. Increasing the pH leads to deprotonating the function group onto the surface charcoal and simultaneously deprotonating the fex at pH > pKa [21]. Thus, at high pH, the fex dominant by the anionic function group and the charcoal surface became negative, which resulted in a reduction in adsorption ability due to electrostatic repulsion between the similarly charged fex (deprotonated function group) and the negatively charged charcoal .[18–20] The surface area of commercial charcoal obtained from Sigma Aldrich is between 600 to 800 m^2/ g[22] the comparison between the adsorption of commercial charcoal and activated charcoal shows the re-

covery of Fex. using activated charcoal (AC) was twice the recovery of Fex. using normal charcoal (NC) at pH of 2, 4, and 10, while the recovery with AC reaches four times the recovery with NC at pH 7. These results clearly show that the activation of charcoal with $KMnO_4$ may improve the surface area of charcoal, meaning it increases its adsorption ability[10], [17].

Table -1 The effect of pH recovery percentage of Fex. with normal and activated charcoal

pH	Recovery % of Fex. with Normal charcoal	Recovery % of Fex. with Activated charcoal
2	34.4	76.3
4	28.7	69.5
7	15.3	60.0
10	12.9	23.7

3.2. Effect of contact time

The effect of time between the AC and the fexofenadine (Fex) solution was studied. The aqueous solution of Fex. was mixed with the charcoal for 15, 30, 45 and 60 minutes. The recovery percentage of Fex. Using the normal charcoal is shown in Figure 3. The recovery percentage of Fex., using the normal charcoal is shown in Figure 3. The recovery percentage shows no change when the contact time increases from 15 to 30 min., then the recovery percentage sharply increases when time increases to 45 min. [23].

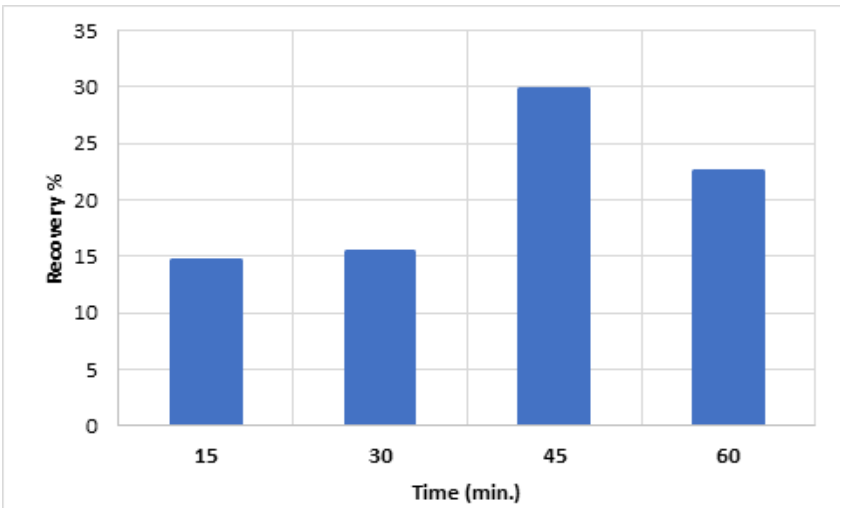

Figure : 3 Effect of contact time on adsorption of fexofenadine at 298 K (Normal charcoal 1 g/ 50 ml of aqueous solution, initial fexofenadine concentration 120 mg/l)

The recovery of Fex. using charcoal activated $KMnO_4$ are shown in Figure 4. The recovery of Fex show a significant increase from 40 % at the contact time of 15 min. to 55 % at the contact time of 30, then slightly decreased to 45 % at the contact time of 45 min. and continue stable even when increasing the time to 60 min.

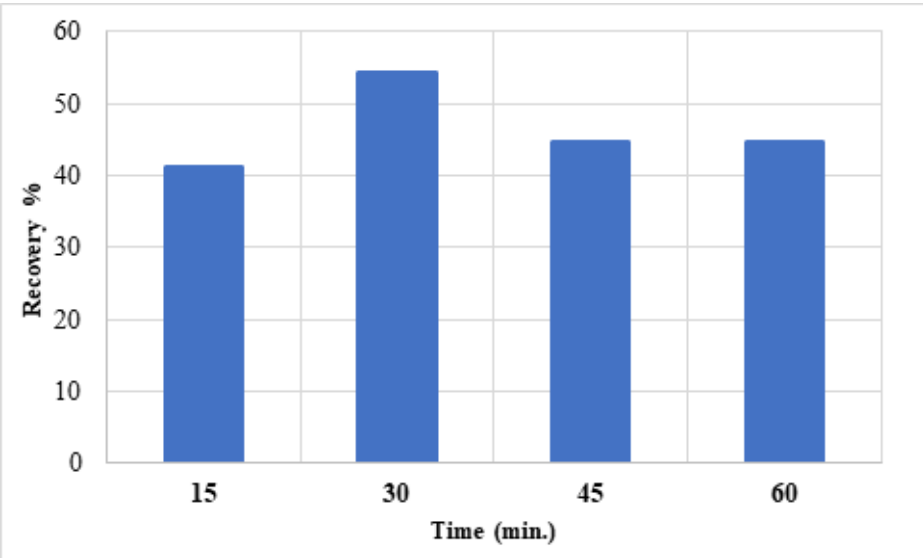

Figure -4 Effect of contact time on adsorption of fexofenadine (qe) at 298 K (Activated charcoal 1 g/ 50 ml of aqueous solution, initial fexofenadine concentration 120 mg/l)

The improvement in the adsorption ability of activated charcoal was measured by comparing its adsorption of fexofenadine (Fex) to that of normal charcoal. The recovery percentage of Fex. with activated charcoal was three times the recovery percentage of Fex. with normal charcoal as shown in Figure 2. These results emphasise that the activation with $KMnO_4$ improves the adsorption of charcoal and increase its surface area.[24], [25]

Table 2- The effect of contact time on the recovery percentage of Fex. with normal and activated charcoal

Time (min.)	Recovery % of Fex. with Normal charcoal	Recovery % of Fex. with Activated charcoal
15	14.7	41.1
30	15.5	54.2
45	29.9	44.7
60	22.6	44.7

4. Conclusion

$KMnO_4$ was successfully used for charcoal activation. Activation of charcoal by impregnation it with $KMnO_4$, without harsh activation conditions, improves the adsorption of the charcoal. It was observed that the adsorption at low pH (pH= 2)was up to 75%.

On the other side, the optimal time of contact between the activated charcoal and fexofenadine was 30 min. The adsorption data show a significant increase in the adsorption ability of the activated charcoal in comparison to the normal charcoal. The adsorption of fexofenadine with the activated charcoal was twice or three times the adsorption of fexofenadine with commercial charcoal. These results confirm this simple and easy activation step is very effective for improving the adsorption of charcoal.

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