Cu (II) ADSORPTION WITH ACTIVATED CARBON OBTAINED FROM SEA URCHIN PREPARED BY ULTRASOUND-ASSISTED METHOD

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ABSTRACT

In this study, activated carbon has been obtained by using sea urchin as an adsorbent substance, which is abundant, cheap, and natural in nature, as an alternative to active carbon used in heavy metal removal. Using the Ultrasound-assisted support, 1:1, 2:1, 3:1 (H_3PO_4/sea urchin) carbonization process was carried out by subjecting H_3PO_4 as the sea urchin activating agent. The BET surface area of the activated carbon obtained was characterized by total pore volume, ash content, and SEM analysis. Cu (II) removal in aqueous solutions were investigated with activated carbons. Experimental studies have been conducted to determine the effects of pH, contact time (min), adsorbent concentration (g/L), temperature, and initial metal concentration parameters affecting adsorption. The adsorption capacity of the activated carbon obtained from the sea urchin at 25 °C was calculated as 643 mg/g. Optimum conditions from the results were determined as pH 2.0, contact time 80 minutes, initial adsorbent concentration 10 mg/L, and temperature 25 °C. According to the results of the study, it has been concluded that the activated carbon obtained from the sea urchin can be an alternative adsorbent to other activated carbons in heavy metal removal.

Keywords: Ultrasound-assisted, Copper (II), Sea urchin, Activated carbon, Adsorption

ULTRASES YÖNTEMİ İLE HAZIRLANAN DENİZ KESTANESİNDEN ELDE EDİLEN AKTİF KARBON İLE Cu (II) ADSORPSİYONU

ÖZET

Bu çalışmada, ağır metal gideriminde kullanılan aktif karbonlara farklı seçenek olarak doğada bol, ucuz ve doğal olarak bulunan adsorbent bir madde olarak deniz kestanesi kullanılarak aktif karbon elde edilmiştir. Ultrason desteği kullanılarak deniz kestanesi aktifleştirme maddesi olarak H_3PO_4 'ün kullanıldığı karbonizasyona tabi tutularak 1:1, 2:1, 3:1 (H_3PO_4 /deniz kestanesi) karbonizasyon işlemi gerçekleştirilmiştir. Elde edilen aktif karbonun BET yüzey alanı, toplam gözenek hacmi, kül içeriği ve SEM analizleriyle karakterize edilmiştir. Aktif karbonlar ile sulu çözeltilerdeki Cu (II) giderimi araştırılmıştır. Adsorpsiyonu etkileyen pH, temas süresi (dk), adsorbent konsantrasyonu (g/L), sıcaklık ve başlangıç metal konsantrasyonu parametrelerinin etkilerini belirlemek için deneysel çalışmalar yapılmıştır. Deniz kestanesinden elde edilen aktif karbonun 25 °C'de Cu (II) adsorplama kapasitesi 643 mg/g olarak hesaplanmıştır. Elde edilen sonuçlardan optimum koşullar pH 2.0, temas süresi 80 dakika, başlangıç adsorbent madde konsantrasyonu 10 mg/L ve sıcaklık 25 °C olarak belirlenmiştir. Çalışmanın sonuçlarına göre, deniz kestanesinden elde edilen aktif karbonun ağır metal gideriminde diğer aktif karbonlara alternatif bir adsorbent olabileceği sonucu elde edilmiştir.

Anahtar kelimeler: Ultrason destekli, Bakır (II), Deniz kestanesi, Aktif karbon, Adsorpsiyon

1. INTRODUCTION

Today, the mixing of poisonous heavy metal ions from industrial wastes into water constitutes the most important environmental problem for many life types [1]. These heavy metal ions are taken into the human body directly from water and indirectly through nutrients [2]. It has been stated in scientific studies that heavy metal ions accumulating in the body significantly affect multiple organs and systems. In addition, it has been determined that humans cause the most forgetfulness or damage to the central nervous system, the composition of higher blood levels, the lungs, kidneys, liver, and other organs [3], [4].

The rapid development of the industry in recent years has led to the increase and accumulation of Cu (II) in the environment. Cu (II) is used in electricity, construction, transportation, industrial machinery, industrial production such as paint, jewelry, coins [5]. Physical, chemical, and physicochemical processes are applied in removing heavy metals from wastewater [6]. Different

NÖHÜ Müh. Bilim. Derg. / NOHU J. Eng. Sci. 9(2): 770-780

B. Gezer

methods such as chemical precipitation, solvent extraction, vacuum evaporation, membrane technologies, adsorption, ion exchange are used in waters containing heavy metal pollution [7], [8]. Among these methods, adsorption is the oldest and most well-known, more useful and economical method, as well as a well-established method. The economy of this method is related to the cost of the adsorbent [9], [10]. While adsorption techniques are an efficient and attractive method for removing biodegradable pollutants (such as dyes, heavy metals, pesticides), they are also very popular with the use of natural adsorbents [11].

The adsorption method on activated carbon has gained importance in removing heavy metals from dirty metals. Activated carbon, produced from carbon-based materials, has a large internal surface area and pore structure of different diameters; therefore it has a high capacity to adsorb organic and inorganic substances in gas and liquid phases. However, due to the high cost of activated carbon production, research has focused on alternative raw materials and production methods. Natural adsorbents are particularly useful for developing countries, as they are renewable, can be grown everywhere, contribute to environmental protection, and are economical [12]. Studies have revealed that activated carbon is more efficient and useful than zeolites, metal oxides, ion exchange resins, and biosorbents in removing heavy metals from the aqueous solution [13], [14]. Usually activated carbons, banana peel [15], kindling pine shavings [16], apricot kernel shell [17], pumpkin kernel shell [18], waste tea [19], nutshell [20], corncob [21], olive waste is obtained from various biomass such as [22]. Of this biomass, activated carbon is produced mostly by physical and chemical activation methods [23].

Recently, the ultrasound-assisted process (US) has come to the fore in order to rise of the adsorbent surface [24], [25]. Cavitation the ultrasound process, which operates according to the principle, provides the adsorption surface activation thanks to the OH radicals and pyrolysis effect formed as a result of the explosion of bubbles formed in water under high temperature and pressure, and as a result, the adsorption pressure. As a result the effectiveness of ultrasound is made more active by particle surface with the effect of radical production and mechanical energy caused by the cavitation bubble formed in water, and a large surface area is obtained. The diffusion of molecules adsorbed through the pore due to the mechanical force caused by ultrasound is provided faster through the pore [24]-[26]. According to the studies, if the adsorption process is carried out in ultrasound supported systems, it is seen that both the higher adsorption efficiency is achieved and the adsorption process reaches equilibrium in a shorter time [27], [28], [29].

In this study, sea urchin, which is sea waste, both carbonization, and activated carbon was obtained using the activation/carbonization process and the capacity of the activated carbon to adsorb copper (II) from aqueous solutions was investigated. Cu (II) adsorption on activated carbons prepared by the carbonization process in N_2 atmosphere by absorbing phosphoric acid to sea urchin with the help of ultrasound. In the adsorption of Cu (II); The effects of parameters such as pH, contact time, adsorbent dose, concentration temperature, and metal concentration were investigated in the adsorption experiments. The results obtained were applied to the Langmuir and Freundlich isotherms.

2. MATERIAL AND METHOD

2.1. Material

The sea urchin used in the study was obtained from a firm located in the province of Izmir (Figure 1). Various chemicals were used in the experimental stages of the study. The H_3PO_4 chemical used for the carbonization of sea urchin in the experiment. HCI and NaOH chemicals (Merck, 0.99%) were used to adjust the pH values of the solution.

Figure 1. Sea urchin samples

Cu (II) ADSORPTİON WİTH ACTİVATED CARBON OBTAİNED FROM SEA URCHİN PREPARED BY ULTRASOUND-ASSİSTED METHOD

2.2. Preparation of Experimental Samples

The sea urchin was used as the main ingredient. Samples were cleaned by brush washing in tap water. Afterward, it was washed three times in pure water and removed from impurities and dried in a 110 °C oven for 4 hours. Samples were pulverized in the cleaned ball mill. The powders were brought to the standard powder size with a 100μm sieve.

2.3. Activated Carbon Production from Sea Urchins with Ultrasound-Assisted

40 kHz fixed frequency to increase the adsorption capacity ultrasound-assisted device was used. The adsorbent's modification process was achieved by dispersing it with low-frequency ultrasound cutting forces in each experiment phase used to obtain activated carbon in sea urchins. 3 different impregnation (wetting) processes were applied: sea urchin, 1:1, 2:1, 3:1 (H_3PO_4 / sea urchin) by mass. After 24 hours impregnation, the samples were dried in the oven at room temperature, then at 120 °C from time to time with mixing. Carbonization was applied to the completely dried samples for two hours at a heating rate of 10 °C/min, with the temperature of the oven being 600 °C. After the carbonization step, the samples were washed with pure water until the pH range was 4-5 and dried at 110 °C in the oven (Figure 2).

Figure 2. Carbonized sea urchin powders

2.4. Characterization Studies

The specific surface areas of the activated carbon sample obtained were carried out with the uantachrome Corporation, Autosorb-6 model surface area determiner available in the laboratory of the Middle East Technical University. In order to determine the surface morphology and pore structure of activated carbon, for example, SEM images were taken using the JEOL/JSM-6510 LV electron microscope in the Research Laboratory of the Middle East University.

2.5. Analysis Ash Determination and Carbon Content

Before determining the ash content of the activated carbon sample obtained, 2.5 hours in an oven at 100 ºC in sample porcelain, it was brought to constant weighing, and moisture content was determined. The sample, whose moisture content was determined, was weighed 2 grams and burned for 2.5 hours in porcelain crucibles brought to constant weight at 550 ºC until reaching fixed weight. The residual amount at the end of the combustion was weighed and the amount of ash (in %) contained in the activated carbon sample was calculated with the help of Equation 1 [30]. The ash content calculated with this equation gives the ash content, for example, on the dry foundation.

$$Ash\% = \left(\frac{100}{m_1}\right)\left(\frac{100}{100-N}\right) \tag{1}$$

In this equation, m_1: The initial weight of the activated carbon sample (g), m_2: Ash weight (g), and N:% moisture.

The suspension prepared by adding 50 ml of distilled water and 10 ml of skin HCl on 2 grams of activated carbon samples were boiled under reflux for 20 minutes. Mix filter paper after boiling process filtered with. In order to completely remove chlorine ions, the filtrate was washed with 0.15 N AgNO₃ solution until it did not precipitate. After washing, the sample was kept at 550 ºC for 20 hours and dried. The mass remaining on the filter paper was brought to constant weight at 110 ºC and its weight was determined. Later, the sample was burned at 550 ºC in a porcelain crucible, which was brought to weigh, and the amount of ash was determined [31] The carbon content of the activated carbon sample subjected to these processes that It was calculated with the help of Equation 2.

$$carbon\% = \left(\frac{m_1 - m_2}{m_0}\right) 100 \tag{2}$$

where, m_0: for example, the initial weight (g), m_1: For example, the weight (g) after drying at 110 ºC, and the amount (g) remaining after combustion at m_2: 550 ºC.

3. RESULTS AND DISCUSSION

3.1. Analysis Results of Sea Urchin

Preliminary analysis results to characterize the sea urchin are given in Table 1. When Table 1 is investigated, it is seen that the sea urchin we use in our study is appropriate for the production of activated carbon with its low ash content (3.6%), high volatile matter (31.7%) and fixed carbon (87.4%) content. In the literature, it is stated that vegetable wastes containing volatile content 20-67%, fixed carbon content 17-70% and ash content 3-5% are used as raw materials in activated carbon production [32], [33].

Table 1. Sea urchin analysis results

Analyzes made	Results
Particle size	0.75 mm
Determination of moisture content	8.3%
Determination of ash content	3.6%
Determination of volatile matter	31.7%
Fixed carbon	87.4%
Determination of lignin	9.5%

The carbonization efficiency depends largely on the organic groups that form in the sea urchin, breaking down into smaller molecules during carbonization. As the carbonization time and temperature increase, it is possible to separate some of the non-carbon elements (H, N, O, and S) and volatile molecules and a product with a high carbon content remain [34]. The high ash content of products obtained as a result of carbonization at very high temperatures is seen as a disadvantage for the industrial use of the activated carbon obtained. Increasing the ash content with the carbonization temperature indicates that an extreme thermal degradation of the sea urchin occurs with the temperature. On the other hand, it is stated that the amount of acid that cannot be removed from the environment as a result of carbonization increases the ash content of activated carbon [35].

3.2. The Effect of Chemical Activation Rate

Activator doses is an important parameter in chemical activation. The effect of this parameter on the production of activated carbon obtained from sea urchins; The weight ratio (impregnation rate) of H₃PO₄/activated carbon was changed between 1:1, 2:1 and 3:1, and was examined in chemically activated samples at 25 °C for 24 hours. The properties of the carbonized products obtained by carbonization of the products obtained in each condition are given in Table 2.

Significant increases in BET surface area and total pore volumes were determined due to the increase in chemical activator dose. At high impregnation rates, it has been determined that macro and mesopores turn into micropores with the effect of H₃PO₄, and therefore significant increases occur in BET surface areas and total pore volumes. It was determined that microporous activated carbons were obtained by activation, especially on the impregnation rate. Similar findings have been reported in studies on obtaining activated carbon by chemical activation of the grape stem [36] and vine branch [37] with H₃PO₄. The high impregnation rate also confirms that it has an important effect on obtaining activated carbon-containing carbon (Table 2). It is stated that the commonly used active carbon has a surface area of 500-1500 m²/g, the total pore volume is 0.3 cm³/g and the carbon content varies between 85-95% [38]. Compared with the commercial activated carbons, it can be said that the active carbons with commercial activated carbon properties can be obtained with the chemical activation of the sea urchin H₃PO₄ at the rates of impregnation 3:1 and above (Table 2).

NÖHÜ Müh. Bilim. Derg. / NOHU J. Eng. Sci. 9(2): 770-780

Cu (II) ADSORPTİON WİTH ACTİVATED CARBON OBTAİNED FROM SEA URCHİN PREPARED BY ULTRASOUND-ASSİSTED METHOD

Table 2. The effect of the impregnation rate on the acquisition of activated carbon
(impregnation time: 24 hours; impregnation temperature: 25ºC; carbonization temperature: 550 ° C; carbonization time: 20 hours)

H_3PO_4/activated carbon	Yield (%)	BET-surface area (m^2/g)	Total pore volume (cm^3/g)	Por diameter (nm)	C (%)
1:1	48.23	1147.63	0.7402	1.9731	80.27
2:1	39.84	1381.74	0.9044	1.8247	83.39
3:1	37.15	1528.95	1.0873	1.8012	87.4

3.3. Analysis of SEM (scanning electron microscope) Images

The activated carbon samples obtained were subjected to SEM analysis to determine the surface morphology. In Figure 3, SEM images of sea urchin and activated carbon samples obtained by chemical activation are given. As can be seen from the images, the raw sea urchin surface, which has not been subjected to any treatment, is quite smooth, has no cracks, and has a very low pore structure, while chemical activation shows cracks and pores on its surface. Especially due to the increase in the impregnation rate, although the number of pores on the surface increases, the formation of sewers has started. At high impregnation rates, open channels of deep inhomogeneous open channels appear on the surfaces of activated carbon samples. This suggests that activation occurs superficially. In samples obtained by impregnation carried out at 25 °C, the surface area is observed to increase due to superficial sewage and porosities. Therefore, it can be said that the impregnation conditions should be optimized under suitable conditions in order to obtain homogeneous and larger surface area activated carbons [39].
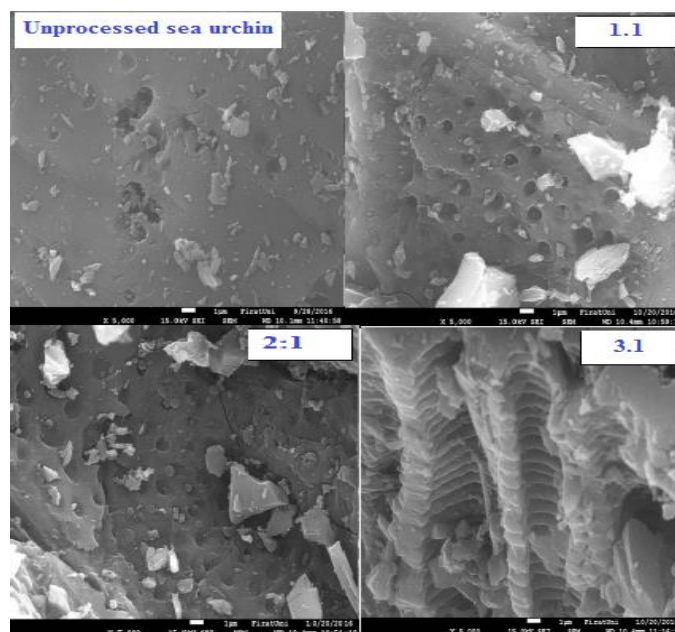
Figure 3. SEM images of unprocessed sea urchin and activated carbon samples obtained by chemical activation

3.4. Effect of Contact Time on Adsorption of Cu (II)

Contact time is one of the important parameters to be determined in the adsorption process. To determine the equilibration time for removal of Cu (II) ion with sea urchin activated carbon, 100 mg/L metal concentration, and 10 g/L adsorbent concentration were taken at room temperature. As can be seen in Figure 4, the contact time study was carried out for up to 320 minutes to see where the adsorption stabilized. As a result, adsorption reached equilibrium in 120 minutes. The greater the initial

NÖHÜ Müh. Bilim. Derg. / NOHU J. Eng. Sci. 9(2): 770-780

B. Gezer

concentration, the steeper the slope of the refraction curve, and the smaller the refraction time. These results show that the change in concentration gradient affects the saturation rate and refraction time, or the diffusion process is concentration-dependent [40].
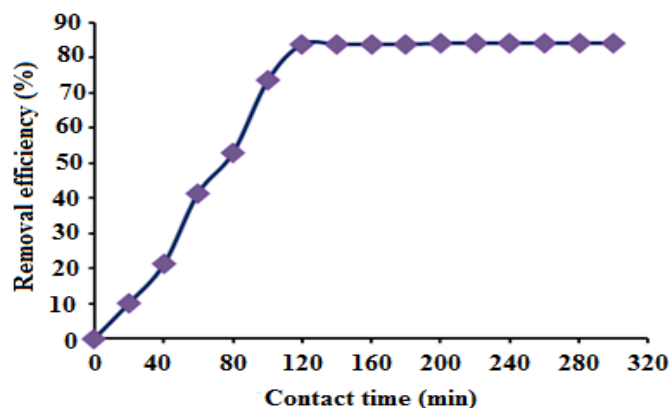

Figure 4. Effect of contact time of sea urchin on activated carbon with Cu (II) removal (C_o = 100 mg/L, T = 25 °C, Adsorbent concentration = 10 g/L)

3.5. The Effect of pH on Cu (II) Removal

pH affects the surface mechanism of the adsorbent and therefore the binding points of the pollutant and the adsorbent [41]. The initial pH value is 2.0 in the adsorption of Cu (II) ions with activated carbon obtained from the sea urchin; 3.0; 4.0; Changed to 5.0 and 6.0. The change of Cu (II) removal efficiency over time with different pH values is given in Figure 4. As seen in Figure 5, there is an inverse ratio between Cu (II) removal and pH, and as the pH value decreases, the amount of adsorbed copper increased. While 100 mg / L copper (II) ion at pH = 2 is removed by 77.52% with 5 g/L sea urchin, this ratio has decreased to 11.32% at pH = 5. Negative charged Cu 2+ forms at low pH values are now electrostatically bound to the positively charged adsorbent surface due to the density of hydrogen ions in the environment, and this event usually occurs at low temperatures. Since the effect of the pH parameter on adsorption is examined at 250 °C, no chemical interaction can be mentioned between metal particles and adsorbent particles at this temperature [42]. It was determined that pHzpc values of the activated carbon samples obtained varied between 4.81 and 5.68. Acidic groups were determined to be predominant in surface functional groups that were determined due to Boehm titration. These values falling in the slightly acidic region are due to the predominance of the acidic groups on the surface of the activated carbon obtained [43]. The values obtained are also in line with those reported in the literature [44].
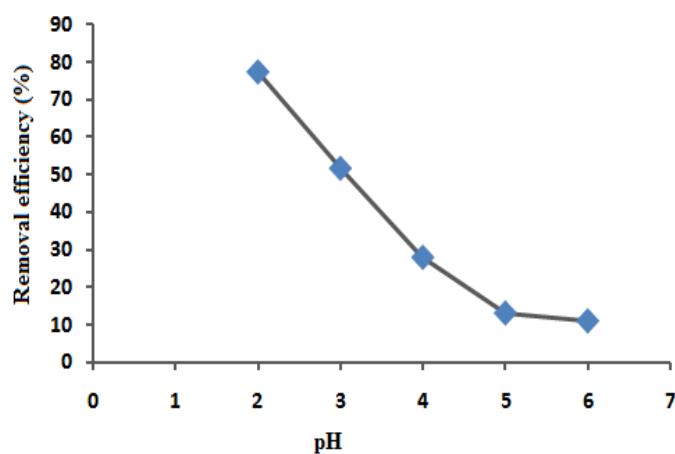

Figure 5. The effect of pH on Cu (II) removal with activated sea urchin (C_o = 100 mg/L, T = 25 °C, Adsorbent concentration = 10 g/L)

Cu (II) ADSORPTİON WİTH ACTİVATED CARBON OBTAİNED FROM SEA URCHİN PREPARED BY ULTRASOUND-ASSİSTED METHOD

3.6. Effect of Adsorbent Amount on Cu (II) Removal

The effect of adsorbent concentration was investigated by taking the amount of adsorbent 2.0, 4.0, 6.0, 8 and 10 g/L in the removal of copper (II) with activated carbon obtained from sea urchin. As seen in Figure 6, it is determined that the copper (II) ion at the concentration of 100 mg / L is removed by 30% with 2 g/L actif carbon, while the ion (copper) ion at the same concentration with the concentration of 10 g /L is 88.64%. As the amount of adsorbent increased, the adsorbent and Cu (II) substance that caused more removal efficiency increased in the column and the slope of the refraction curve decreased, indicating that an expanded mass transfer region was formed. Due to the increase in the adsorption surface, higher adsorption capacity has been observed by creating more binding sites for adsorption in more adsorbent amount [45]. Similar results by different researchers has been reported [46], [47].
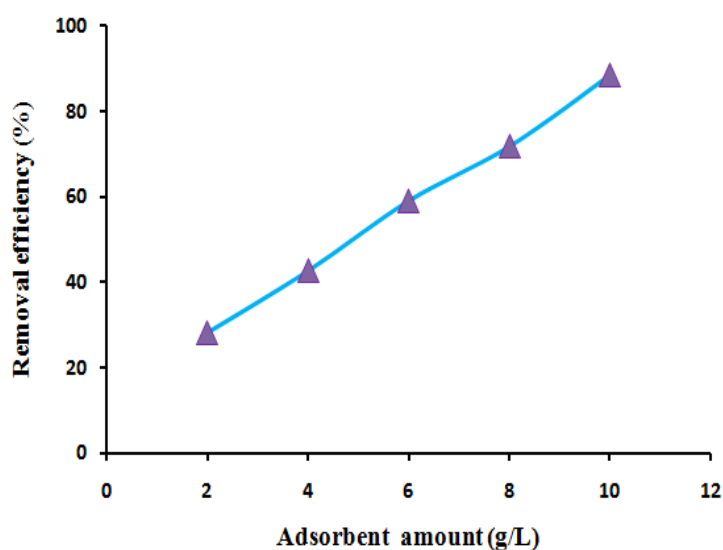

Figure 6. Effect of adsorbent concentration on copper (II) removal with sea urchin activated carbon (C_o = 100 mg/L, T = 25 °C, Adsorbent concentration = 10 g/L)

Since adsorption is a surface phenomenon, the magnitude of adsorption is proportional to the specific surface area. It is the properties that are desired to be in a particle structure with the adsorbent's large surface area, pore-volume, and a certain pore distribution [48]. Since increasing the adsorbent concentration will increase the surface area, the amount of metal adsorbed in the unit adsorbent mass increases. In contrast, the number of metal ions adsorbed in the adsorbent mass decreases. The metal ion concentration adsorbed in the unit adsorbent mass in the adsorption of 100 mg/L copper (II) ion with 2 g/L adsorbent is 10 mg.met/g adsorbent. While 10g/L adsorbent is used, this value decreases to 8.4 mg/g.

3.7. Effect of Initial Metal Concentration and the Temperature on Cu (II) Removal

The effect of initial metal ion concentration and temperature on the adsorption of copper (II) ion with sea urchin activated carbon was investigated. At 25 °C, 30 °C, 35 °C, 40 °C and 45 °C temperatures, the amount of adsorbent was reduced, and experiments were carried out by taking the initial metal concentrations as 20, 40, 60, 80 and 100 mg/L. In Table 3, removal efficiencies of copper (II) ion with different concentrations at different temperatures is given. As seen in the table, the increase in temperature causes the adhesion efficiency of the metal to increase. While 70 mg/L copper (II) ion 89.32% was removed at 25 C, 98.15% removal was achieved at 45 °C.

It is said that with increasing temperature, the number of binding regions on the adsorbent increases and more regions becomes active [49]. In a study, it was observed that the adsorption capacity increased by 60% with the increase of temperature from 25 °C to 40 °C in the removal of Cr^{6+} ions with activated carbon [50]. With increasing temperature, the kinetic energy of the solvent increases. Therefore, it was supported by a similar study in which an increase in adsorption capacity was observed. In the removal of granulated activated carbon and trinitrotoluene in a fixed-bed adsorption column, temperatures in the range of 10 °C - 60 °C were tried and it was observed that the adsorption capacity of granular activated carbon increased with increasing temperature [51]. The adsorption capacity is expected to be increased by increasing the starting material concentration because the high concentration difference provides a high driving force for the adsorption process [52].

Table 3. Elimination efficiency of copper (II) ion with different concentrations at distinct temperatures (pH = 2.0, X = 2 g/L)

Temperature (°C)	Copper (II) removal efficiency (%)				
	20 mg/L	40 mg/L	60 mg/L	80 mg/L	100 mg/L
25	89.32	80.54	63.03	59.32	48.74
30	91.06	84.96	67.75	62.54	57.49
35	95.28	88.29	71.28	66.55	59.08
40	97.87	90.06	79.71	73.42	65.19
45	98.15	91.23	85.34	76.03	70.21

3.8. Adsorption Isotherm Studies

Langmuir Isotherm explains better whether it is physical or chemical adsorption in the active adsorption areas on solid surfaces compared to other isotherms. In Langmuir isotherm; adsorption increases linearly with adsorbate initial concentration. The adsorption rate is directly proportional to the adsorbate concentration and the empty adsorption areas on the surface [53].

The simplest theoretical model for adsorption is the Langmuir model. It is expressed as equality below,

$$q = \frac{x}{m} = \frac{a.K.C_e}{1+K.C_e} \tag{3}$$

Where is q = x/m: The amount of adsorbed substance per unit adsorber weight in equilibrium (mg/g adsorbent), a: The amount of adsorbed substance (mg/g) per unit weight of the adsorber to form a complete single layer on the surface, K: Adsorption constant related to adsorption net enthalpy and C_e: Soluble concentration (mg / L) remaining in solution without adsorption in equilibrium.

Freundlich model adsorption on heterogeneous surfaces It is applied. It is expressed by the formula below.

$$q = \frac{x}{m} = K_f C_e^{(1/n)} \tag{4}$$

Where is K_f: Adsorption capacity, n: Adsorption intensity.

Freundlich and Langmuir adsorption models were used in the mathematical description of sea urchin activated carbon and copper (II) adsorption and isotherm constants were calculated It is given in Table 4. As can be seen from Table 4, under the most suitable adsorption conditions, the sea urchin activated carbon and the adsorption isotherms obtained in the removal of copper (II) (pH = 2.0, 20 mg/L adsorbent amount) results at all temperatures Langmuir and Freundlich's isotherm appears to be compatible with both.

Table 4. Constants obtained from Langmuir and Freundlich isotherm for copper (II) ion at different temperatures

Temperature (°C)	Langmuir isotherm			Freundlich Izotermi		
	q (mg/g)	C_e (mg/L)	R^2	K_f	n	R^2
25	7.33	0.5102	0.9672	0.9576	0.9846	0.9132
30	7.65	0.5324	0.9891	1.5382	1.4847	0.9207
35	7.74	0.6667	0.9981	1.8473	1.6116	0.9961
40	8.04	0.8161	0.9985	2.3759	1.9052	0.9979
45	7.93	0.9977	0.9984	2.8632	2.8305	0.9873

While the K_f value is 0.9576 at 25 °C, it increases to 2.3759 by increasing at 40 °C. The increase in K_f value with temperature indicates that the rate of adsorption increases with increasing temperature. A value of 1/n between 0.1 and 1.0 means that adsorption is favorable [39]. On the other hand, for 298, 303, 308, 313 and 318 K temperatures, adsorption Gibbs free energy according to Equation 5; Found as 1.666, 1.587, 1.037, 0.528 and 6.088x10-3 kJ/molK [54]. It shows that the free energy enthalpy value is very small, positive, and decreases with temperature increase. This indicates that adsorption occurs better at high temperatures and is endothermic shows.

$$\Delta G = -RT \ln C_e \tag{5}$$

Cu (II) ADSORPTİON WİTH ACTİVATED CARBON OBTAİNED FROM SEA URCHİN PREPARED BY ULTRASOUND-ASSİSTED METHOD

4. RESULTS

As a result of the study, sea urchins were subjected to the carbonization process with chemical processes with phosphoric acid. It was observed that high efficiency occurred in Cu (II) removal. In copper (II) removal, it was observed that as the adsorbent dose increased. The highest removal was obtained at pH = 2.0. It was also seen that copper (II) removal decreased with increasing initial metal concentration. It was concluded that the amount of samples obtained was higher for both temperatures in ultrasound-assisted conditions, thereby increasing the synthesis efficiency of ultrasound waves. The results obtained were compatible with both Langmuir and Freundlich adsorption isotherms. However, Langmuir fit more to the adsorption isotherm. The impregnation rate is also an important parameter in increasing porosity in chemical activation. In order to see the effect of the impregnation ratio on the obtained activated carbons, the properties of the activated carbons obtained in the impregnation ratios of 1:1, 2:1, and 3/1 were compared. It has been determined that the surface properties increase with the increase of the impregnation rate. The highest surface area has been determined as a 3/1 impregnation rate and 1528.95 m^2/g. It seems very advantageous to convert these agricultural residues with lignocellulosic structure, which have very low economic value, into active carbon by the proposed method. As a result; It can be considered from the obtained results that sea urchin can be an appropriate adsorbent in the removal of copper with copper (II).

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