CI&CEQ
Chemical Industry & Chemical Engineering Quarterly

Available online at
Association of the Chemical Engineers of Serbia *AChE*
www.ache.org.rs/CICEQ

Chem. Ind. Chem. Eng. Q. 32 (1) 15–24 (2026) CI&CEQ

SEMAA IBRAHEEM KHALEEL

University of Mosul, College of Petroleum and Mining Engineering, Department of Petroleum and Refining Engineering, Mosul, Iraq

SCIENTIFIC PAPER

UDC 662.734:66:54:634.54

SYNTHESIS AND CHARACTERIZATION OF ACTIVATED CARBON PRODUCED FROM HAZELNUT- PEELS BY CHEMICAL ACTIVATION

Highlights

- The objective is to study the effect of the composite depressant additive (CDA).
- Assumptions were made regarding the mechanism of paraffin crystal formation.
- The developed composite additive exhibits high depressant activity.

Abstract

Activated carbon was prepared in this research from hazelnut (Corylus avellana) peels with some additives, which included polymeric waste (polymethyl methacrylate, PMMA), and the raw material was ground to facilitate handling and different amounts of sodium hydroxide were added to it and the ratio peels:NaOH was 1:0.5-1:2.5. The peels were also treated with polymeric waste materials at ratios of 5-25% and a basic ratio of 1:2 at a temperature of 550 °C as it is considered an environmental pollutant and then part of it was disposed of by preparing a material with great economic feasibility. Then, the adsorption properties of the prepared samples (methylene dye), iodine number, density, humidity, and yield were evaluated and compared with the British and Russian commercial models, and SEM, and FT-IR techniques were used to characterize the prepared activated samples. The results showed that activated carbon samples prepared from hazelnut peels were characterized by a high iodine number (895 mg/g), methylene blue dye adsorption capacity (98.4 mg/g), and yield (15.0%). As for the samples prepared from hazelnut peels with PMMA, an increase was observed in the iodine values (1015 mg/g) and the adsorption capacity for methylene blue dye reached (148 mg/g) and yield also increased. This indicates that the addition process was a positive step in improving the specifications and productivity of activated carbon. As for the density and ash, humidity values, they were within the permissible limits for all the prepared activated carbon samples, and thus they greatly exceeded the specifications of commercial carbon samples.

Keywords: Carbonation, polymeric waste, polymethyl methacrylate, methylene blue dye, physical properties.

INTRODUCTION

Activated carbon can be defined as a carbon material that has high porosity as well as a large surface area between particles, which is ready for chemical reactions or adsorption [1,2]. The pore size distribution of activated carbon and its adsorption properties depend on the chemical composition and physical properties of the primary material as well as the process conditions and methods used for activation [3]. The composition of matter is one of the factors that distinguish one from the other. Whereas cellulose, lignin, and materials that contain large percentages of lignin, such as cherry pits and grape seeds, develop activated carbon with a predominance of large pores, while other raw materials that contain large percentages of cellulose, such as almond shells and apricot stones, produce activated carbon with a highly porous structure mostly [4,5].

Activated carbon is used in various media, such as liquid and gaseous, either in powder or granular form. It is applied in liquids by treating water by removing compounds

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Correspondence: S.I. Khaleel, University of Mosul, College of Petroleum and Mining Engineering, Department of Petroleum and Refining Engineering, Mosul, Iraq;
Email:semaaibraheem@uomosul.edu.iq
Paper received 7 August, 2024
Paper revised: 25 January, 2025
Paper accepted: 6 March, 2025
https://doi.org/10.2298/CICEQ240807005K

that affect taste, smell, and color. It can also be used to purify proteins or separate metal compounds such as gold and silver [1]. Activated carbon is mainly prepared in two ways: chemical activation and physical activation. It is manufactured in two basic stages: the first includes carbonization of the raw material and the second includes activated coal. The first method includes carbonizing the raw material and then activating it at a high temperature in the presence of steam or carbon dioxide, while the second method includes carbonating the raw material that was previously impregnated using a chemical agent such as potassium hydroxide [6], zinc chloride [7], and phosphoric acid [8]. Activated carbon is prepared from many resources that depend on plants as a raw material.

Kumar and Jena [9] prepared activated carbon from fox nut (Euryale ferox) shells by chemical activation with H_3PO_4 in a nitrogen atmosphere. The effect of both temperature and impregnation ratio was studied and found that the best activation temperature was 700 ºC with an impregnation ratio of 1.5 and a time of activation of one hour. It was also found that the surface area of the prepared activated carbon was 2636 m^2/g and contained many active groups. Jamion and Hashim [10] prepared activated carbon from tamarind seeds Tamarindus indica and activated it using phosphoric acid in a ratio of 1:1 at a temperature of 500 °C for 4 hours. The BET surface area analysis gave a value of 594 m^2/g. The Field emission scanning electron microscopy (FESEM) analysis showed that the development and formation of pores were mostly in a circular and oval pattern and the highest adsorption capacity for methylene blue (MB) dye was equal to 103 mg/g).

Ramalingam *et al.* [11] prepared activated carbon from dead (Eucalyptus tereticornis) and neem (Azadirachta indica) leaves by washing, drying, grinding, and mixing them in equal proportions and placing them in an oven at a high temperature of up to 750 °C for 6 hours. The carbon powders were then characterized. The results obtained using scanning electron microscopy (SEM), Energy dispersive X-ray analysis (EDAX), and X-ray diffraction (XRD) analyses showed that the prepared carbon has good properties that enable it to be used in medical fields. Viena *et al.* [12] prepared activated carbon from banana peels using different activation agents like H_2SO_4, KOH, and $ZnCl_2$ for three hours. The resulting activated carbon had a low moisture content and better ability to absorb iodine and was used as an adsorbent to remove gases emitted from motorcycles.

Mistar *et al.* [13] were able to produce activated carbon from the plant Bambusa vulgaris striata through a chemical activation process using KOH [1:3] and an activation temperature of 800 °C for an hour. The porosity and advanced surface chemistry were examined using BET, SEM, and Fourier transform Infrared spectrum (FTIR) analyses. The BET results were 980 m^2/g , and the SEM images showed an advanced development of high porosity. Using FTIR technology, it was found that its surface contains different functional groups. Abudaia [14] was able to prepare activated carbon from rice hulls and corncobs as an available and inexpensive material to study the absorption of dimethoate from its aqueous solution. It was prepared by chemical activation with KOH and obtained a high yield, so it can be used in wide application fields. It was concluded that it is possible to use agricultural residue with low cost, such as rice husk and corncob adsorbent materials to remove water pollutants due to their high ability to absorb various pollutants. Ramutshatsha-Makhwedzha *et al.* [15] were able to manufacture an activated carbon derived from orange and lemon peels using H_3PO_4. Characterization was performed on OLAPC and the material was used to remove methyl orange and MB dyes from wastewater. The method was successfully applicable to real wastewater samples with a satisfactory percentage of methyl orange and MB removal of 99%. Islam *et al.* [16] prepared activated carbon from jute sticks by chemical activation using H_3PO_4, $ZnCl_2$, and H_2SO_4 to study the effect of activation factors and carbonization temperatures in a range of 300–350 °C. The properties of prepared samples were studied by iodine absorption and FTIR spectroscopy.

Gomaa *et al.* [17] prepared activated carbon from olive seed residue by chemical treatment with KOH (1:1), then dried at a temperature of 150 °C for 60 minutes, where 100 g of the material was activated at 250, 350, 450, and 550 ºC for 15, 20, 25, and 30 minutes at 1, 3, 1.6, and 1.9 bars in the presence of nitrogen at a flow rate of 50 cm3/min. The results indicated that the surface area of the prepared activated carbon had a significant effect, which amounted to 1092 m^2/g at an uttermost rotation of 1100 mg/g, a temperature of 450 °C, and an activation time of 25 minutes.

Sarici *et al.* [18] were able to prepare activated carbon from hazelnut shells using potassium carbonate for activation at different ratios of 1:1, 1:2, and 1:3 and carried out a carbonization process under nitrogen gas pressure and characterized the prepared activated carbon using X-ray, FT-IR, and SEM techniques after drying the sample. The BET value was equal to 644 m^2/g while the absorption numbers of iodine and MB dye were equal to 489 mg/g and 1974 mg/L, respectively. They also conducted a thermodynamic and kinetic study.

Altintig *et al.* [19] prepared activated carbon from hazelnut shells using H_3PO_4 as an activating agent. And coated with silver ions to prepare nanoparticles and mixed them in different ratios (1:0.5 or 1:1) using the chemical reduction method. It was found that the prepared activated carbon has a high adsorption capacity through the BET value equal to 1208 m^2/g. The results showed that the prepared model contains 66.01% carbon with an efficiency rate of 36.22%. The prepared activated carbon was distinguished by its use in drinking water applications.

Abo Hay Allah and Alshamsi [20] prepared activated carbon from Pontederia rassipe leaves and used it to remove Malachite Green, Congo Red dyes. The prepared materials were studied using diagnostic techniques including FT-IR, XRD, SEM, EDX, and TEM. Raman results showed that the optimum efficiency for removing both dyes was achieved at 98.9% for Congo Red dye and 99.2% for Malachite Green dye.

Olam [21] was able to carbonize waste coffee and duckweed together and separately at 800 °C and N_2 (flow rate of 100 ml/min) in a tubular reactor for 90 minutes and the results showed that it is an effective adsorbent for removing Crystal Violet dye from wastewater with a removal rate of 83%. He was also able to prepare activated carbon by carbonizing gelidium corneum at a temperature of 800 °C for 90 minutes. The prepared activated carbon was characterized using SEM, EDX, FT-IR, XRD, and UV, and it was found a suitable adsorbent for removing dyes from their aqueous solutions [22]. He prepared activated carbon by carbonizing Lemna minor and hazelnut shell at a temperature of 800 °C in the presence of N_2 (100 mL/min) for 90 minutes. The prepared activated carbon was examined using spectroscopic methods, which showed that the resulting carbon is a good adsorbent for removing Crystal Violet dye, as the adsorption capacity reached about 88 mg/g while and the removal capacity was 88% [23].

Khaleel *et. al* [24] prepared activated carbon from pomegranate peels alone and treated it with polymeric additives (Novolak resin) and asphalt by carbonization and activation at a temperature of 550 ± 25 °C using potassium hydroxide in different proportions. It was found that the best proportion was 1:2.5. The prepared activated carbon samples were excellent adsorbents for removing Bromocresol Green and Bromocresol Purple dyes from their aqueous solutions.

In this research, activated carbon was prepared from Corylus avellana peels with some additives from polymeric wastes, which are environmental pollutants, using the method of carbonization and activation by NaOH. The prepared samples had very excellent adsorption properties compared to the British and Russian commercial models.

EXPERIMENTAL

Materials

In this research, hazelnut peel residues (plant waste), polymethyl methacrylate (PMMA, polymer waste) NaOH with 99% purity (Fluka), HCl with 98% purity, iodine, starch, sodium thiosulfate with 95% purity (Fluka), potassium iodide with 99% purity, and MB dye with 97% purity (B.D.H.).

Instrumentation

A UV-9200 spectrophotometer (Biotechnology Engineering, UK) was used to make a calibration curve for MB dye at λ_{max} = 665 nm. The surface morphology of the materials was characterized using scanning electron microscopy (India). A Fourier transform infrared (FT-IR) absorption spectrophotometer) was from Bruker-Optics (German).

Preparation of Activated Carbon

Activated carbon was prepared by performing several steps as follows:

Preparation of the raw material: The raw material was taken from *C. avellana* peels in its natural, dry form, then ground and made into a fine powder to react with the carbonated material completely and to obtain good results.

Primary carbonization process: 10 g of the powdered material was mixed with various weight proportions of *C. avellana* peels:NaOH (1:0.5, 1:1, 1:1.5, 1:2, or 1:2.5). In a stainless steel crucible, the mixture was homogenized well by adding 5–10 ml of water, then heated to a temperature of 450 °C with continuous stirring for 3 hours until the release of gases stopped.

Final carbonization and activation process: After completing the initial carbonization of the *C. avellana* peels, the temperature was raised to (550 °C) for 2.5 hours to complete the process of carbonization, activation of prepared carbon samples, after which the models were left to cool to laboratory temperature.

Purification of activated carbon: The prepared activated carbon was washed with water repeatedly until samples that did not contain sodium hydroxide and metallic components were obtained. Then, it was washed with a 10% hydrochloric acid solution with thermal sublimation for an hour to remove ions and then washed many times with water until it ensured free from traces of acid. The resulting carbon samples were dried at 120 °C for 24 hours, crushed well, and kept in a dryer isolated from air and moisture.

Preparation of carbon from a mixture of *C. avellana* peels and PMMA: PMMA sheets were cut into small pieces and placed in a ceramic crucible covered with aluminum foil. Then, the lid was heated in an oven at 350 °C for 3 hours, taken out, left to cool to the laboratory temperature, and crushed into a fine powder using a mortar. Certain amounts of carbonated *C. avellana* peels were taken as primary carbonation, and thermally crushed polymeric waste was added in ratios of 5, 10, 15, 20, and 25% and the steps above were repeated, using a fixed *C. avellana* peels:NaOH ratio of 1:2 as the best one to prepare activated carbon from *C. avellana* peels.

Measurements for determining the effectiveness

To determine the effectiveness of the activated carbon that was prepared, several measurements were performed on it, as shown below:

1. **Measurement of the iodine number of activated carbon [25]:** It is one of the well-known and common methods for giving information about the internal surface area of carbon that is activated. It is expressed as the number of milligrams of iodine, adsorbed from the solution (1 g) from carbon. It includes the following:

- 1 g of carbon was placed in a 250 mL conical flask.
- 100 mL of a 5% HCl solution was transferred using a pipette to the conical flask.
- The conical flask was heated until it boiled for 0.5 h, then left to cool at the temperature of the laboratory.
- 100 ml of 0.1N iodine solution was placed in the conical flask using a pipette.
- The conical flask was shaken on an electric shaking device for a period of half a minute, and the contents of the conical flask were then filtered. Approximately 20-25 mL of the filtrate was discarded at the beginning of the filtering process, then the remainder was collected in a clean conical flask.
- 50 mL of the filtrate obtained from the previous step

was placed in a 250 mL conical flask and flushed with a standard 0.1N sodium thiosulphate solution until the color of the solution became pale yellow. Then, 1 mL of the starch indicator was added and the clarification was completed until the blue color of the starch indicator no longer appeared. The volume of thiosulfate used was calculated, and the iodine number (*IN*) was also computed through this equation:

$$IN = WIO/WAC \cdot CF \qquad (1)$$

where *WIO* is the weight of iodine adsorbed in milligrams, *WAC* is the weight of activated carbon prepared, and *CF* is the correcting factor.

2. Measurement of the adsorption capacity of prepared carbon samples to MB **dye:** The external surface area of the activated carbon was measured by taking 0.1g of dry activated carbon and placing it in a 250 mL conical flask. A certain amount (20 ppm) of MB dye was added, then the flask was placed in an electric shaking device for 24 h until became colorless, also another amount of the dye solution was added, thus increasing the unadsorbed dye. After that, the solution was centrifuged, and the absorbance of the clear solution was measured at λ_{max} = 665 nm The standard curve was prepared by taking different concentrations of the dye solution, ranging from 5 to 25 ppm with an increase of 5 ppm, and measuring the absorbance of the solution at the same wavelength mentioned above, then the relationship between concentration and absorbency was drawn [26].

3. Calculation of the humidity percentage: This method involved exposing the activated carbon to the laboratory temperature for 24 h, then drying it at 140 °C for 2 h. After cooling and weighing it accurately, the humidity percentage was calculated [27].

4. Ash content measurement: The ash content was measured by placing 1 g of the prepared carbon in a ceramic crucible in an oven at 1000 °C for an hour, leaving it to cool, and weighing it. The ash content was then calculated for each sample [28].

5. Density measurement of activated carbon: A certain weight of activated carbon was placed in a 5 mL volumetric flask, carefully compacted until the carbon occupied the entire volume of the bottle, and weighed using an accurate balance. Density was calculated by Eq. (2) [29]:

$$Density\ g/cm^3 = Mass/Volume \qquad (2)$$

6. Calculation of the yield of activated carbon: The yield was calculated from the weights of the raw, carbonated, and activated materials using Eq. (3) [30]:

$$yield = w_c/w_o \times 100 \qquad (3)$$

where w_c is the final dry product weight (g) and w_o is the dry raw weight (g).

RESULTS AND DISCUSSION

Activated carbon is considered porous. Its chemical structure suffers from a crystalline defect, leading to the appearance of pores that are energetically or effectively unstable. It is produced from raw materials with a high carbon content, such as bituminous materials and wood rich in lignin, using thermal carbonization processes that remove hydrogen and leave it rich in carbon. The resulting carbon is then activated thermally in an atmosphere of argon, nitrogen, or steam at high temperatures.

Due to the advantages that activated carbon possesses, it has been used in various fields, such as removing dyes, treating pollution, and reducing its damage. In addition to the availability of primary raw materials, researchers were encouraged to prepare them in a variety of ways. It was produced from plant sources, especially those in which lignin is abundant, i.e. nut shells, hardwoods, etc. In this research, one of the types of nut shells, i.e., *C. avellana* peels, which is unique in its extreme hardness and high lignin content was used for preparing carbon by mixing them dry with sodium hydroxide to remove hydrogen in the form of water and dispose of it thermally. That is, the carbonization process in this case is a fusion melting process followed by a process of loss of water and other gases, resulting in a black mass that is washed and activated with mineral acids.

Sodium hydroxide is considered an influential factor in the activation process, as it works to develop the fine porous structure in producing activated carbon by chemical treatment. In addition, hydroxide ions necrotize the structure of the raw material and thus lead to the development of the porous structure of the produced carbon. Table 1 shows the specifications of the activated carbon samples that were prepared.

It shows that chemical activation using an increased percentage of NaOH leads to increased adsorption of iodine from its solution to the extent of a 1:2 ratio, after which the adsorption value of iodine begins to decrease. Namely, an increase in OH leads to the destruction of part of the pores and a hiatus formed on the surface of the prepared carbon using a ratio of 1:2.5 due to the role of sodium hydroxide in expanding the internal pores. Therefore, the iodine number value increases regularly with the increase of the base added to the original sample.

An increase in the concentration of MB dye adsorbed using the positive portion of sodium hydroxide was also observed, which increased the capacity of the pores and organized them. Comparing it with the commercial models designed by B.D.H. and Russ showed that the amount of iodine absorbed by the prepared activated carbon was much better than both commercial samples. The humidity content values ranged between 7.5% and 9.8%, showing the extent to which the prepared samples could be used in the water vapor adsorption process. Namely, it was found that some prepared carbon samples could absorb water vapor. The ash content was within the permissible limits

Table 1. Specifications of prepared activated carbon from *C. avellana* peels by modified carbonation and chemical treatment.

AC	*C. avellana*:NaOH ratio	IN (mg/g)	MB (mg/g)	Humidity (%)	Ash (%)	Density (g/cm^3)	Yield (%)
AC_0	1:0	412.390	23.721	9.152	3.117	0.401	20.021
AC_1	1:0.5	670.300	64.534	9.835	3.100	0.380	18.572
AC_2	1:1	689.502	70.951	10.029	3.010	0.367	17.514
AC_3	1:1.5	757.280	76.860	11.108	2.958	0.291	16.230
AC_4	1:2	894.521	98.425	12.061	2.100	0.287	14.973
AC_5	1:2.5	789.672	78.002	7.528	3.975	0.293	9.021
CBDH	-----	908.000	90.000	0.800	3.200	0.345	-----
CRuss	-----	61.000	34.800	0.620	1.500	0.325	-----

AC_0 = activated carbon prepared from *C. avellana* peels without any additives.
CBDH [31] = British commercial granular activated carbon.
CRuss [31] = Russian commercial granular activated carbon.
MB = Adsorption capacity of MB.

due to the thermal sublimation process with HCl, which removed the bulk of the metal components. As for the density values, their values were low, being good evidence that the prepared activated carbon had high porosity and thus a high ability to adsorb small molecules. The yield decreased with the increase of the NaOH percentage added to the carbon due to an increase in the percentage of loss in the carbon content of the original material. From Table 1, it is clear that the best sample is AC_4 because of its high effectiveness for adsorbing iodine and methylene dye and its low density. Therefore, activated carbon, which is free of carcinogenic nitrogen and sulfate compounds, can be used in the medical field to absorb gases from the stomach and intestines.

To improve the specifications of the carbon prepared from *C. avellana* peels, the original material was treated by PMMA using a fixed ratio of the base [1:2]. Table 2 shows the specifications of the activated carbon samples prepared from a mixture of *C. avellana* peels with the polymer. The use of polymer as an additive to *C. avellana* peels improved the adsorption properties of activated carbon in terms of iodine value, which increased and reached 1015.02 mg/g. The adsorption capacity of MB dye also increased and reached 148 mg/g. The best model was AC_{10}, which gave the highest value of iodine value that exceeded those of the activated carbon prepared from hazelnut peels alone and a commercial activated carbon. In addition, the values of density and humidity were acceptable. Therefore, it was concluded that the addition process was a positive step in improving the specifications and productivity of activated carbon.

Thermogravimetric analysis of the activated carbon prepared from *C. avellana* was performed as shown in Figure 1, whereas Figures 2-5 illustrate various relationships.

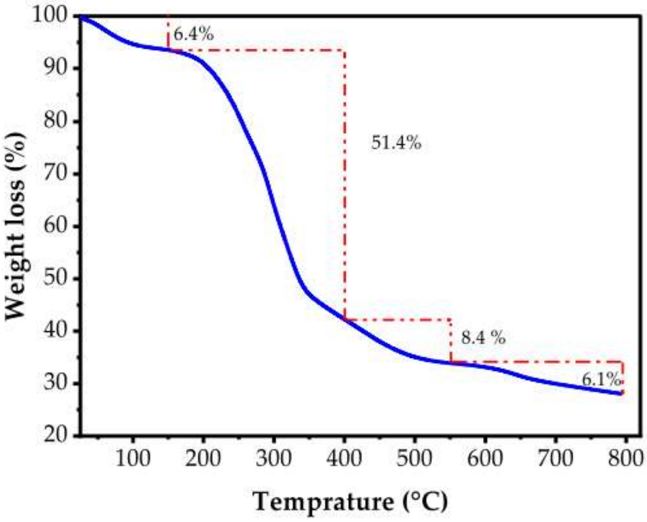


Figure 1. Thermogravimetric analysis of C. avellana peels.

Table 2. Specifications of activated carbon prepared from a mixture of (*C. avellana* peels with PMMA) using [1:2] [raw material: NaOH].

AC	Polymer (%)	IN (mg/g)	MB (mg/g)	Humidity (%)	Ash (%)	Density (g/cm^3)	Yield (%)
AC_6	5	904.217	105.000	12.000	1.975	0.270	15.751
AC_7	10	953.000	117.028	11.831	1.961	0.261	17.090
AC_8	15	997.215	125.000	11.957	1.952	0.246	20.807
AC_9	20	1000.700	137.115	12.280	1.871	0.184	23.465
AC_{10}	25	1015.021	148.000	13.500	1.330	0.103	30.970
CBDH	-----	908.000	90.000	0.800	3.200	0.345	-----
CRuss	-----	61.500	34.800	0.620	1.500	0.325	-----

AC_0 = activated carbon prepared from *C. avellana* peels without any additives.

CBDH [31] = British commercial granular activated carbon.

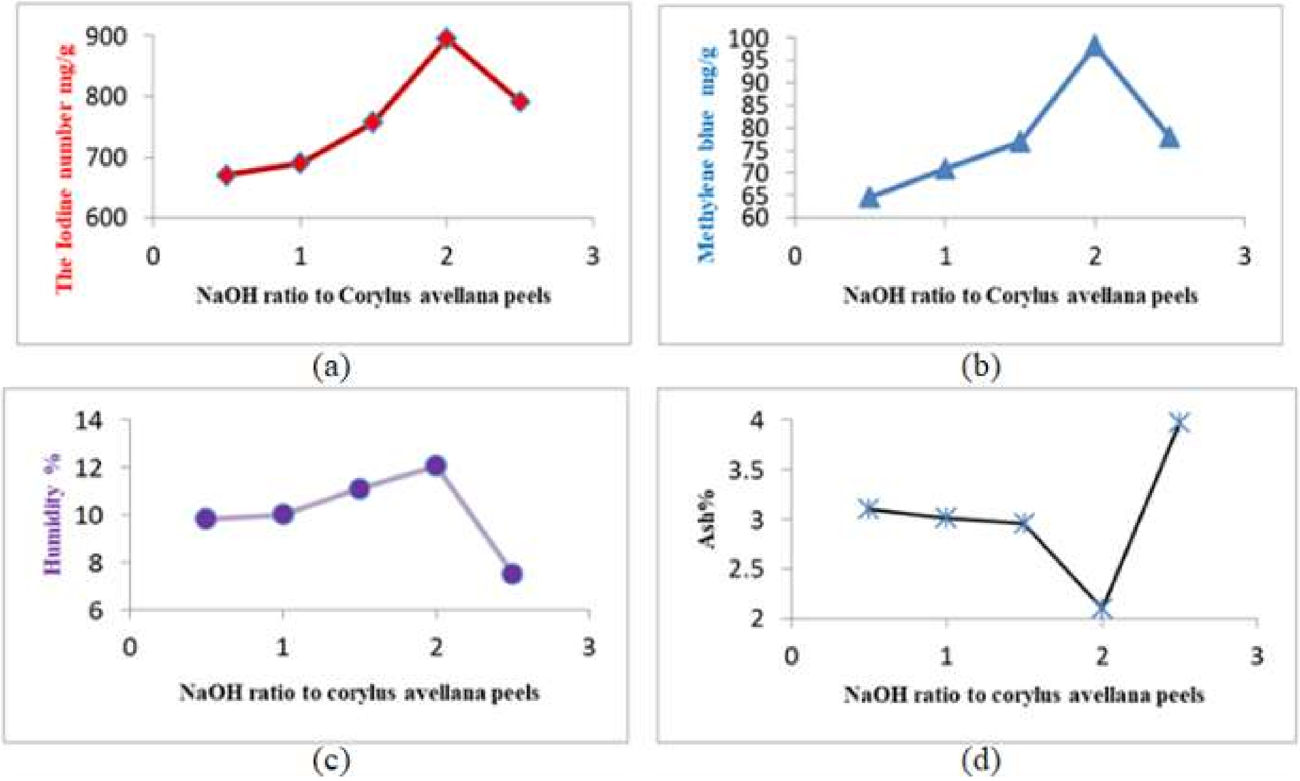
CRuss [31] = Russian commercial granular activated carbon.

MB = Adsorption capacity of MB.

Activated carbon characterization

SEM: This technique was implemented to evaluate the prepared activated carbon samples. Figure 6 shows the changes in the shape of the samples in terms of size and pore formation. It was noted that the process of adding the PMMA polymer led to the production of different types of pores and cavities on the surface.

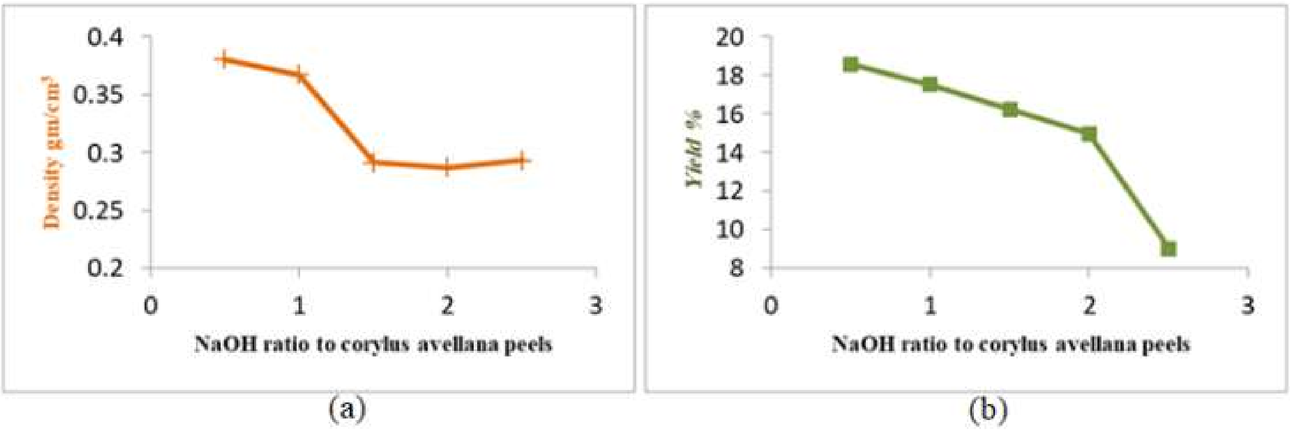
FT-IR: The FT-IR spectra of the raw material before carbonization and the material after carbonization and activation are shown in Figure 7 and 8, respectively. The FT-IR spectrum of the raw material before carbonization shows many bands indicated in Table 3, which shows the frequency of each band and the type of bond before carbonization. On the other hand, in the case of the material after carbonization and activation, some of the bundles disappeared and new ones appeared in its FT-IR spectrum, as shown in Table 4.



(a) (b)

(c) (d)

Figure 2. Relationship of the added NaOH ratio and (a) IN, (b) MB, (c) humidity content, and (d) ash content in activated carbon.



(a) (b)

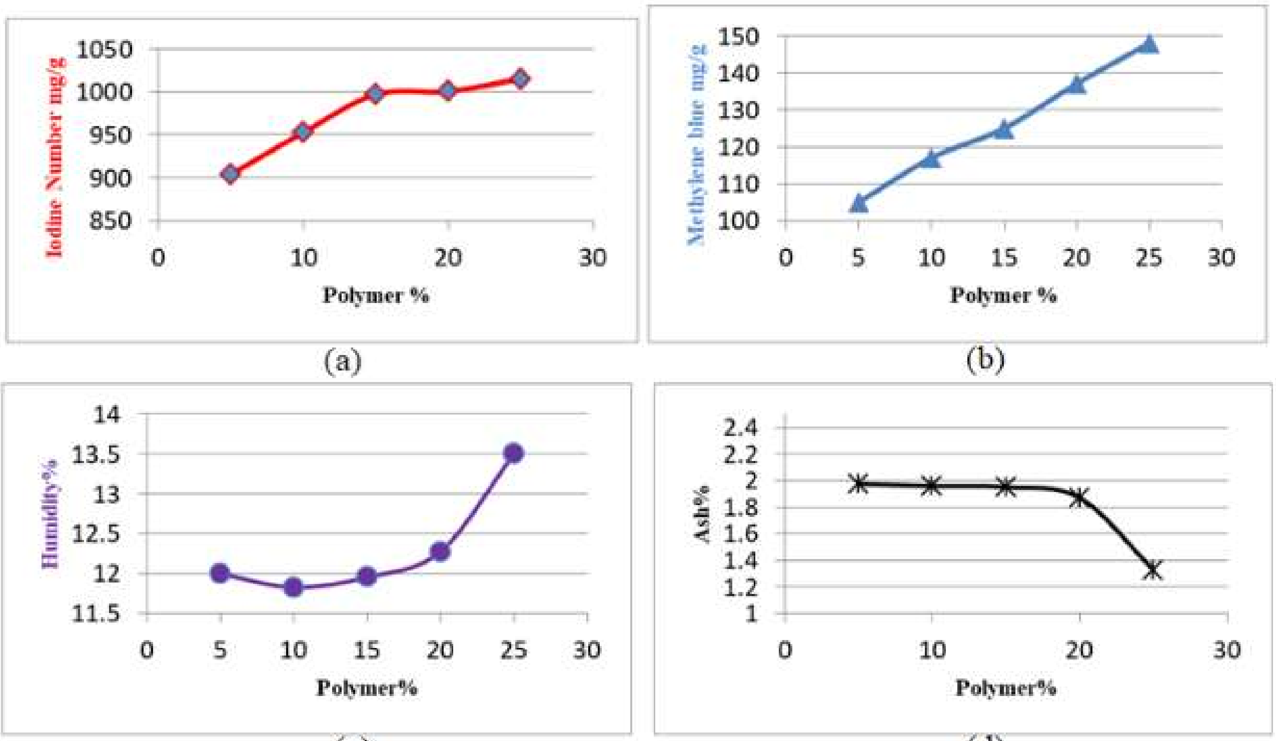
Figure 3. Relationship of the added NaOH ratio and (a) Density and (b) yield in activated carbon.

Table 3. FT-IR spectrum bands for the raw material before carbonization.

Type of bond	Frequency(cm^{-1})
Stretch (O -H)	3308
Stretch (C -H) Aliphatic	2852, 2921
(C= O)Ketone	1731
(C= N)	1605
Stretch (C- C)	1512
Bending (CH_3)	1370
Stretch (C -O)	1139
Stretch (C -N)	1021

Table 4. FT-IR spectrum bands of the material after carbonization and activation.

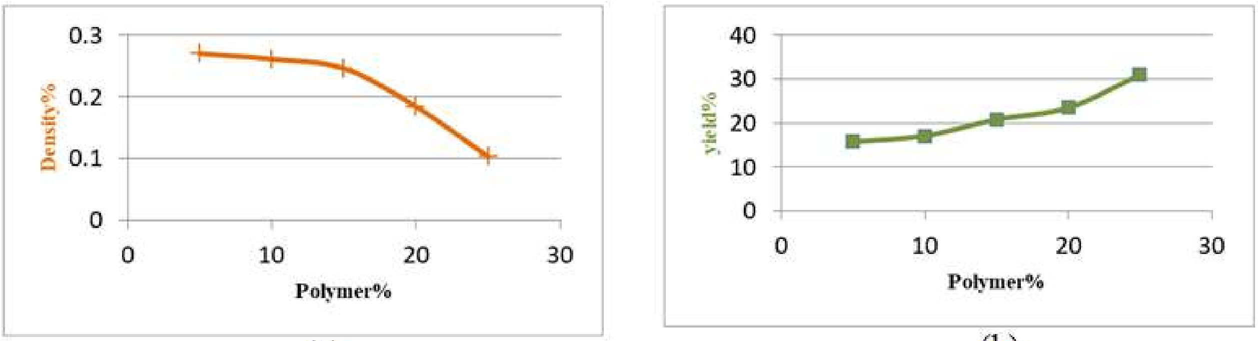
Type of bond	Frequency(cm^{-1})
Stretch (O -H)	3265
Stretch (C- C)	1574
Stretch (N= N)	1416
Stretch (C -N)	1074
Stretch (C -H)	873



(a) (b)

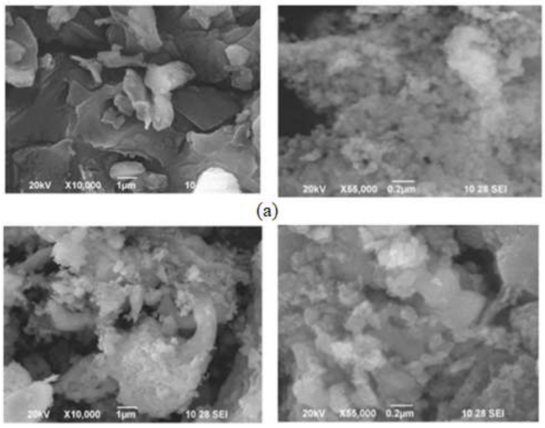
(c) (d)

Figure 4. The ratio between the organic glass polymer and (a) IN, (b) MB, (c) humidity content, and (d) ash content, of activated carbon.



(a) (b)

Figure 5. The ratio between the organic glass polymer and (a) Density and (b) yield of activated carbon.



(a)

(b)

Figure 6. SEM images of activated carbons prepared from (a) C. avellan peels and (b) C. avellana peels and PMMA.

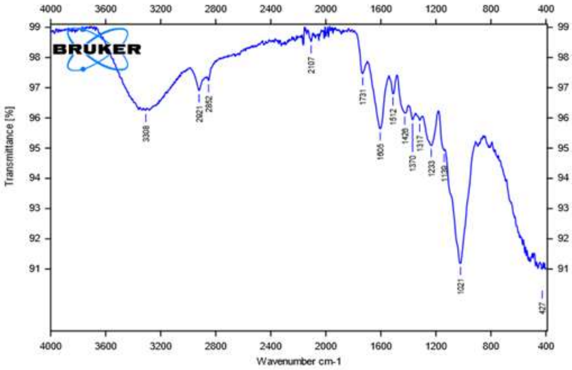


Figure 7. The FT-IR spectrum of the raw material before carbonization.

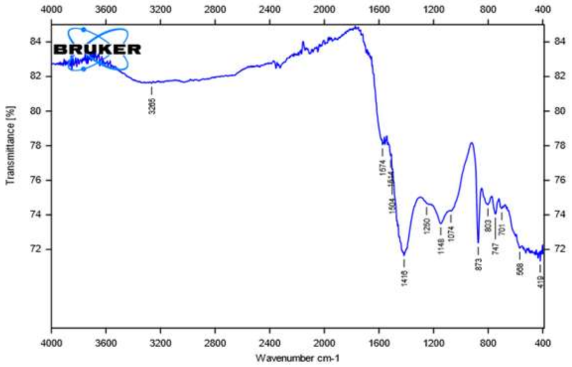


Figure 8. The FT-IR spectrum of the material after carbonization and activation.

CONCLUSION

As a result of the present research, *C. avellan* peels and polymer waste are excellent raw materials for preparing activated carbon. The activated carbon yield when using polymer waste increased by 25% compared to the use of *C. avellana* peels due to an increase in carbon mass. All the prepared activated carbon samples showed high adsorption capacity for MB dye, high iodine value, and high yield, while the density, humidity, and ash values were within the permissible limits, thus exceeding the specifications of commercial activated carbon. *C. avellana* peels charcoal is a promising raw material for producing activated carbon for various industrial purposes.

Future research recommendations include preparing activated carbon from hazelnut peels using different carbonization and activation agents and selecting other adsorbent materials that are available and inexpensive, by utilizing agricultural residues that pollute the environment.

Acknowledgments

I extend my thanks and appreciation to the University of Mosul and to the College of Science – Central Laboratory for the facilities provided to complete this research.

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SEMAA IBRAHEEM KHALEEL

Department of Petroleum and Refining Engineering, College of Petroleum and Mining Engineering, University of Mosul, Mosul, Iraq

NAUČNI RAD

SINTEZA I KARAKTERIZACIJA AKTIVNOG UGLJA DOBIJENOG OD LJUSKI LEŠNIKA HEMIJSKOM AKTIVACIJOM

Aktivni ugalj je u ovom istraživanju pripremljen od ljuski lešnika (Corilus avellana) sa nekim aditivima, kao što je polimerni otpad (polimetil metakrilat, PMMA). Samlevenoj sirovini su dodavane određene količine natrijum-hidroksida, tako da je odnos ljuska:NaOH bio u opsegu od 1:0,5 do 1:2,5. Ljuske su, takođe, tretirane polimernim otpadnim materijalima (5-25%) pri osnovnom odnosu ljuska:NaOH 1:2 na 550 °C. Zatim su procenjena svojstva pripremljenih uzoraka u pogledu adsorpcije metilenske boje, jodnog broja, gustine, vlažnosti i prinosa i upoređeni sa britanskim i ruskim komercijalnim modelima. Za karakterizaciju pripremljenih aktiviranih uzoraka korišćene su SEM i FT-IR tehnike. Rezultati su pokazali da se uzorci aktivnog uglja pripremljeni od ljuske lešnika karakterišu visokim jodnim brojem (894.521 mg/g), kapacitetom adsorpcije metilenskog plavog (98,425 mg/g) i prinosom (14.973%). Što se tiče uzoraka pripremljenih od ljuske lešnika sa PMMA, primećeno je povećanje vrednosti jodnog broja (1015.021 mg/g), kapaciteta adsorpcije metilenskog plavog (148 mg/g) i prinosa. Ovo ukazuje da je proces dodavanja bio pozitivan korak u poboljšanju svojstava i prinos aktivnog uglja. Što se tiče gustine, pepela i vlažnosti, ova svojstva su bila u granicama dozvoljenih za sve pripremljene uzorke aktivnog uglja i umnogome premašila svojstva komercijalnih uzoraka ugljenika.

Ključne reči: karbonacija, polimerni otpad, polimetil-metakrilat, metilensko plavo, fizička svojstva.