Al-Khwarizmi Engineering Journal, Vol. 18, No. 4, December, (2022)
P. P. 1- 13

Al-Khwarizmi Engineering Journal

Comparative Study between Activated Carbon and Charcoal for the Development of Latent Fingerprints on Nonporous Surfaces

Hadeel Faroak Hameed* **Alaa K. Mohammed****
Dheaa S. Zageer***

,Department of Biochemical Engineering / Al-Khwarizmi College of Engineering/ University of Baghdad/ Iraq*
****Forensic DNA center for research and training- College of science/ University of Al-Nahrain/ Iraq*
*Email: hadeel.farook1205a@kecbu.uobaghdad.edu.iq
**Email: dr.alaa@kecbu.uobaghdad.edu.iq
**Email: dheaairoai72@gmail.com

(Received 20 July 2022; Accepted 7 September 2022)
https://doi.org/10.22153/kej.2022.09.001

Abstract

For criminal investigations, fingerprints remain the most reliable form of personal identification despite developments in other fields like DNA profiling. The objective of this work is to compare the performance of both commercial charcoal and activated carbon powder derived from the Alhagi plant to reveal latent fingerprints from different non-porous surfaces (cardboard, plain glass, aluminum foil sheet, China Dish, Plastic, and Switch). The effect of three variables on activated carbon production was investigated. These variables were the impregnation ratio (the weight ratio of KOH: dried raw material), the activation temperature, and the activation time. The effect factors were investigated using Central Composite Design (CCD) software. The optimum activation conditions were found as an impregnation ratio of 1:2.6, activated time of 160 min, and temperature of 630°C. The results of the comparison show that Alhagi active carbon powder (AAC) has a high ability to develop latent fingerprints on all surfaces except on plastic surfaces while the commercial charcoal failed to develop the latent fingerprint on both plastic and aluminum foil sheets surfaces. AAC was found to clearly show every feature of the latent fingerprints more than commercial charcoal for both males and females. Also, AAC has the ability to show latent fingerprints till 15 days while commercial charcoal has the ability to show latent fingerprints just till 7 days.

Keywords: *Fingerprint, Non-porous surface, Personal identification, CCD.*

1. Introduction

A fingerprint is an impression of the friction ridges found on the palmer side of the finger, often used for biometric identification in criminal investigations [1]. Before a baby is born, its fingerprint is already well developed in its mother's womb and unique fingerprints started to form [2]. Friction ridges are formed when a baby's environment is formed and the effect of pressure on its fingers as a result of the baby's touching [3]. On everyone's fingers and toes, there are faint lines that can be seen called friction ridges [4]. In criminal cases, this identity represents important physical evidence. Because every human being has a unique fingerprint pattern, these fingerprints provide almost perfect verification of the presence of a person at the crime scene [5]. Due to their dissimilar ridges and patterns, these fingerprints may easily be recognized. Water, amino acids, fatty acids, and minerals constitute fingermarks, which can be described as imprints of regions left on a friction ridge skin surface using various analytical methods [6].

For the development of latent fingerprints on diverse surfaces, several powders have been used.

Some fingerprint powders are dangerous and can lead to major health issues so it's important to find a greener option that is just as effective at detecting latent fingerprints on dry, non-porous surfaces [7]. As a result, various attempts have been made to create powders that are easily accessible, non-toxic, and inexpensive for developing latent fingerprints. Powdering is a technique that involves applying powder particles to natural residues deposited on a latent fingerprint. Friction between powder particles and natural residues causes adhesion [8]. For a long time, natural carbon elements including charcoal and active carbon have been a major component in traditional fingerprint formulations (mostly in grey and black powder)[9].

Charcoal is a lightweight black carbon residue produced by strongly heating wood (or other animals and plant material) to remove all water and volatile constituents[10]. Charcoal has been used since the earliest times for a large range of purposes due to its high surface including as a powder for the development of latent fingerprints [11] .

Activated carbons are widely used in numerous fields, such as water treatment processes, environmental protection, catalyst support, protection from toxic substances, solvent recovery, decolorizing, biomedical engineering and metal recovery [12].

This study represents two samples of powders commercial charcoal and active carbon prepared from the Alhagi plant (AAC) to develop latent fingerprints by these powders on non-porous surfaces such as (cardboard, plain glass, aluminum foil sheet, China Dish, Plastic, and Switch). The purpose of the current work is to compare which powder gives good and better results to develop latent fingerprints. Another purpose is to determine the characteristics of Alhagi activated carbon under different influential factors such as impregnation ratio, activation temperature, and activation time Furthermore, a comparative study was implemented including both males and females on the same surface (cardboard). The time for the latent fingerprint to remain on the surfaces is also diagnosed.

2. Materials and Methods

2.1 Materials

Alhagi plant was collected from some areas in Baghdad. Potassium hydroxide (KOH) was provided from (Himedia, India) as a chemical activation agent. Nitrogen was used as an inert gas in the carbonization step to prevent raw materials combustion. All the chemical reagents used in this study were analytical grade and were not purified further. The commercial charcoal was provided by the Acura brand (India).

2.2 Preparation activated carbon

The Alhagi plant was cut into small pieces and washed well with distilled water to remove any dirt from its surface. After then dried at 60 ^oC for 24 h and crushed to the required size (2 mm). The dried mass of Alhagi pieces was mixed and kneaded with potassium hydroxide solution. Using varying impregnation ratios and left overnight at room temperature. Then, the sample was filtered from the base residue, washed with distilled water several times, and dried at 100 ^oC for 2 h. The dried material was put in a steel box in the furnace under a purified nitrogen flow of 120 cm^3/min. After that, the sample is cooled to room temperature under the same nitrogen flow. The carbon powder was washed with hot distilled water at 60 ^oC until the pH value of the leachate become (6-7) to eliminate the residual base. The carbon powder produced from the carbonization step was dried at 60^oC for 24 h, pulverized, sieved to 44 microns (325-mesh screen), and put into a small container with a tight cover to prevent moisture from contacting the powder[13].

2.3 Sample characterization

A serval of characterization steps was carried out to find the best operating conditions for preparing activated carbon from the Alhagi plant using KOH solution as the activating agent. Scanning Electron Microscope (SEM) was used to investigate the surface shape and its topographical properties. The obtained images are three-dimensional which represent the surface shape accurately. Analysis of the elements that compose the precursors was carried out with an Energy Dispersive X-ray Spectrophotometer (EDS). SEM-EDS analysis was carried out by TESCAN, Vega III electron microscope (Czech Republic). Fourier Transform Infrared Spectroscopy (FTIR, IR Affinity-1 Shimadzu, Japan) was employed to determine the functional groups that exist in the composition of both the Alhagi plant and Alhagi activated carbon.

2.4 Design of experiments

One of the research objectives is to produce activated carbon from Alhagi and find the optimum production conditions. Generally, many factors affect the production of AAC by chemical activation, such as activation time, activation temperature, and impregnation ratio IR. The effects of these factors on the response (yield of AAC) were investigated using Central Composite Design (CCD). Their ranges were chosen to be 500-800 ºC for the activation temperature, 1:1-1: 3 for the impregnation ratio, and the range of the activation time was chosen to be 1-4 h. [14].

Central composite design (CCD) software is a commonly used statistical approach for optimizing processing parameters and determining regression model equations from the experimental results. It can also be used to investigate the interactions between the various parameters influencing the process response[15].

For the purpose of the experimental design, a significance level (denoted as α or alpha) of 0.05 value is always satisfied to be selected. If the p-value is less than 0.05 the parameter is statistically having a significant effect on the response. In contrast, if the p-value is higher than 0.05, there is no statistically significant association between the variables and the response[16].

The F-test, which is the ratio of the mean of the square of regression to the mean of the square of residuals, can be used to determine the significance of the model equation by comparing the F-test value to the tabulated F-values while taking into consideration the degrees of freedom associated with the regression and residual variances. The mathematical model is said to be well fitted to the experimental data if the calculated F-value is higher than the tabulated F-value. In addition, the high F-value of the studied parameters indicates that this parameter is significant[17].

The polynomial equation linking the response with the independent variables is suggested by software given in Eq. (1)

$$f(x) = a_0 + \sum_{i=1}^{N} bixi + \sum_{i=1}^{N} ciix2i + \sum_{ij(i<j)}^{N} cijxixj + \sum_{i=1}^{N} dix3i + \sum_{i=1}^{N} eix4i \quad \ldots (1)$$

Where N is the number of model inputs, $f(x)$is the response, xi is the set off model inputs, a_0 is the constant coefficients, bi and cii, are model coefficient, cij interactions coefficient, and i and j are 1,2,3.

3. Results and Discussion

3.1 Characterization of activated carbon

3.1.1 Scanning electron microscopy (SEM)

The scanning electron microscopy technique was carried out to observe the morphology of the surface of the precursor, Alhagi powder, and the prepared Alhagi activated carbon (AAC). Figure1b shows that the surface nature of (AAC) is porous and loose. As a result of activation, they have a large number of pores, are full of cavities, and are quite irregular. The reaction between carbon atoms and KOH, as well as the impact of high temperature on the activation process, result in different pore shapes as shown in Figure (1)

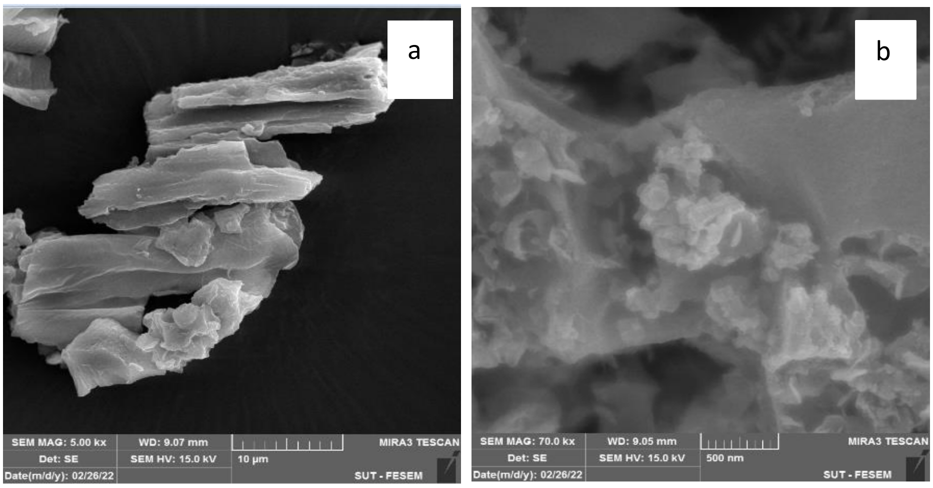
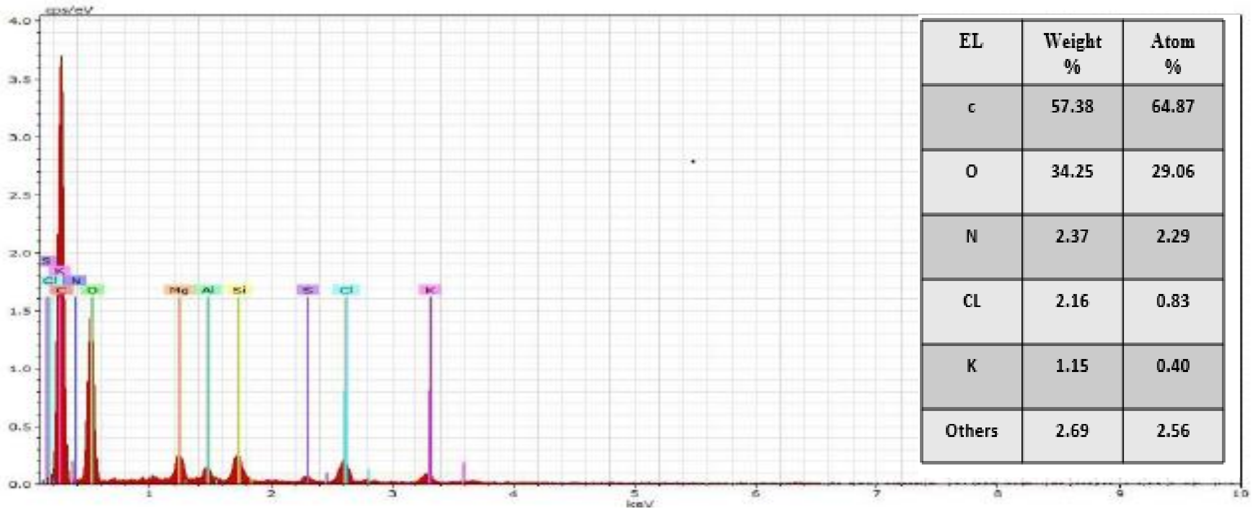


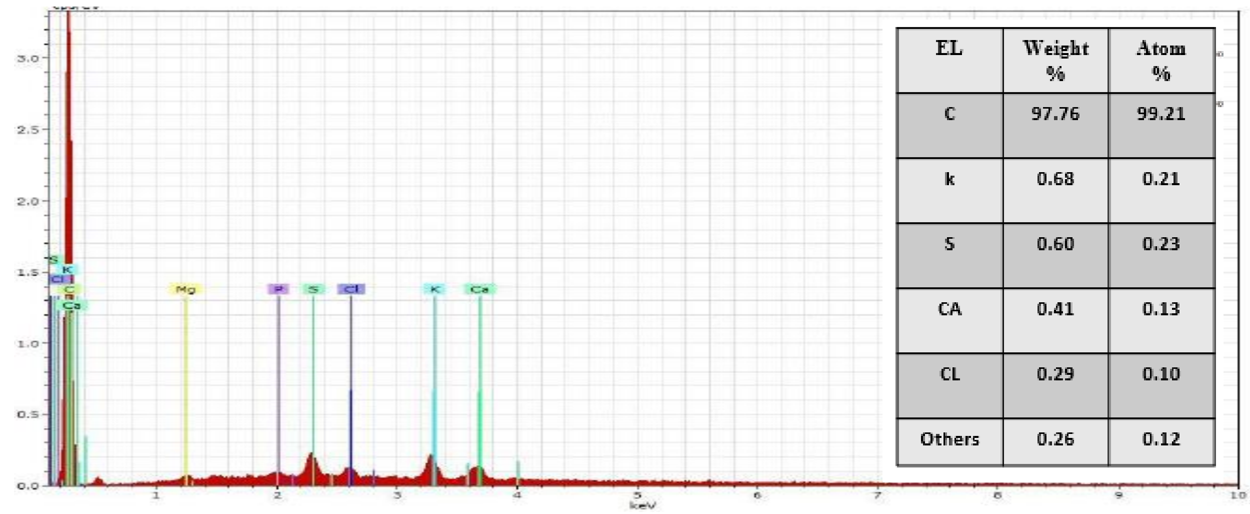
Fig. 1. SEM images of (a) Alhagi powder (b) Alhagi activated carbon (AAC).

Elemental compositions of raw material (Alhagi) and AAC were investigated by energy dispersive spectroscope (EDS). The results are shown in Figures (2) and (3) respectively. It is clear from these figures that the carbon percentage for active carbon produced from raw Alhagi plants is raised from 57.38% to 97.76%. Whereas all elements' compositions are reduced due to the carbonization process or evaporation.



EL	Weight %	Atom %
c	57.38	64.87
O	34.25	29.06
N	2.37	2.29
CL	2.16	0.83
K	1.15	0.40
Others	2.69	2.56

Fig. 2. EDS analysis of Alhagi.



EL	Weight %	Atom %
C	97.76	99.21
k	0.68	0.21
S	0.60	0.23
CA	0.41	0.13
CL	0.29	0.10
Others	0.26	0.12

Fig. 3. EDS analysis of AAC.

3.1.2 The FT-IR analysis of Alhagi powder and AAC

Figure (4) shows FTIR spectra for both Alhagi powder (ALH) and Alhagi activated carbon (AAC). The broad peak that appears around 3298.28 cm^{-1} in (ALH) is assigned to the hydroxyl group; this indicates the presence of moisture that disappears from (AAC) spectra due to its elimination by the activation process. The band at 2916.37 cm^{-1} in (ALH) is ascribed to alkane (C-H) stretching vibration, the fading of this peak from (ALH) spectra indicates hydrogen removal during the activation process. The bands at 1612.49 cm^{-1} and 1411.89 cm^{-1} that appeared in (ALH) and (AAC) spectra respectively are due to the skeletal C = C vibrations of organics. The peaks of 667.37 cm^{-1} and 709.80 cm^{-1} in the spectra of Alhagi and AC respectively are assigned to the bending vibration of carbon bonds (C≡C). The band at 1099.43 cm^{-1} in (ALH) has been assigned to (-C-O-C-) stretching. The bands at 1141.86 cm^{-1} in (AAC) have been assigned to (C–O) stretching and the bands at 1018.41 and 871.82 have been assigned to(C-H plane) and (C-H bend) stretching [18], [19].

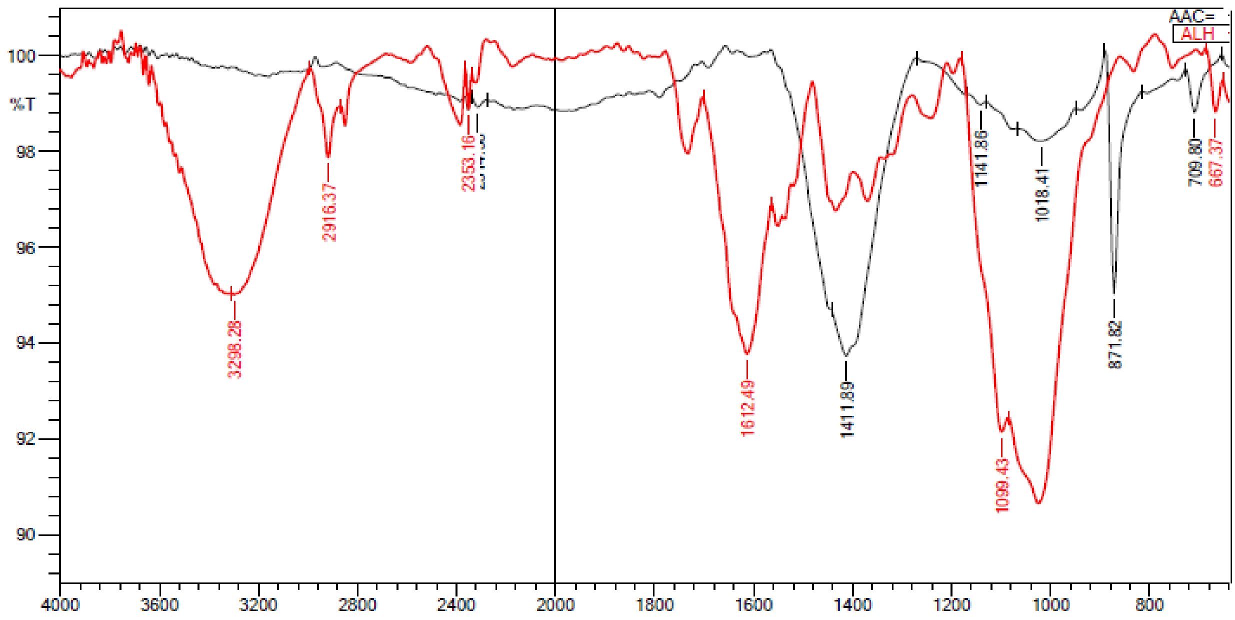


Fig. 4. FTIR spectra of Alhagi plant (ALH) and Alhagi activated carbon (AAC).

3.2 Yield of activated carbons.

The preparation conditions and results of Alhagi activated carbon are shown in Table (1). The values of the parameters in the table were selected according to the CCD program, while the yield was experimentally evaluated. The sample with an IR of 1:3, activation temperature of 650 °C, and 150-min activation time show a maximum yield of 86.14 %.

Table 1,
The predicted values of yield using CCD software.

RUNS	IR: A	TIME: B	TEMP: C	YIELD: R
1	2	2.5	650	80%
2	2.5	1.75	725	80.24%
3	2.5	1.75	575	79%
4	2	1	650	68.04%
5	1.5	3.25	725	54.66%
6	3	2.5	650	86.14%
7	2	4	650	74.36%
8	2.5	3.25	575	85%
9	1.5	1.75	725	62.3%
10	1.5	3.25	575	75.56%
11	1.5	1.75	575	64.44%
12	2	2.5	650	82.42%
13	2	2.5	500	71%
14	2	2.5	800	58.6%
15	1	2.5	650	52.46%
16	2.5	3.25	725	73.63%

3.3 Interactive effect of the impregnation ratio and activation time

The effect of the impregnation ratio and time interaction is demonstrated in Figure (5). The curves show that the yield of activated carbon tends to increase as the impregnation ratio rises till it reaches a value of about 2.6. Pore formation is influenced by the impregnation ratio. The intercalation of potassium metal into the carbon structure promotes pore formation. Thus, high impregnation ratio increases the amount of potassium metal that can be intercalated and promotes more pore formations. This results in an increase in the surface area and yield. On the other hand, the effect of the time parameter is clear. It can be seen from the contour curves that with the increase of the activation time, the yield increases gradually at the beginning and reaches optimum at an activation time of 2.66 h. Increasing the yield with the activation time is due to more carbon atoms at active sites reacting with the activation agent and forming a new pore structure and the activating reaction reaches a full stage. Then, the curve begins to take a stable shape because carbon atoms on the carbon skeleton are consumed and original micropores develop into micropores, resulting in a decrease in yield. This is consistent with the finding of Li et al., (2017) [20] who examined the influence of the same experimental parameters on the yield of activated carbon produced from gulfweed. So, theoretically, the optimized values of impregnation ratio and activation time obtained using CCD software are 2.6 and 2.66 h (160 min) respectively.

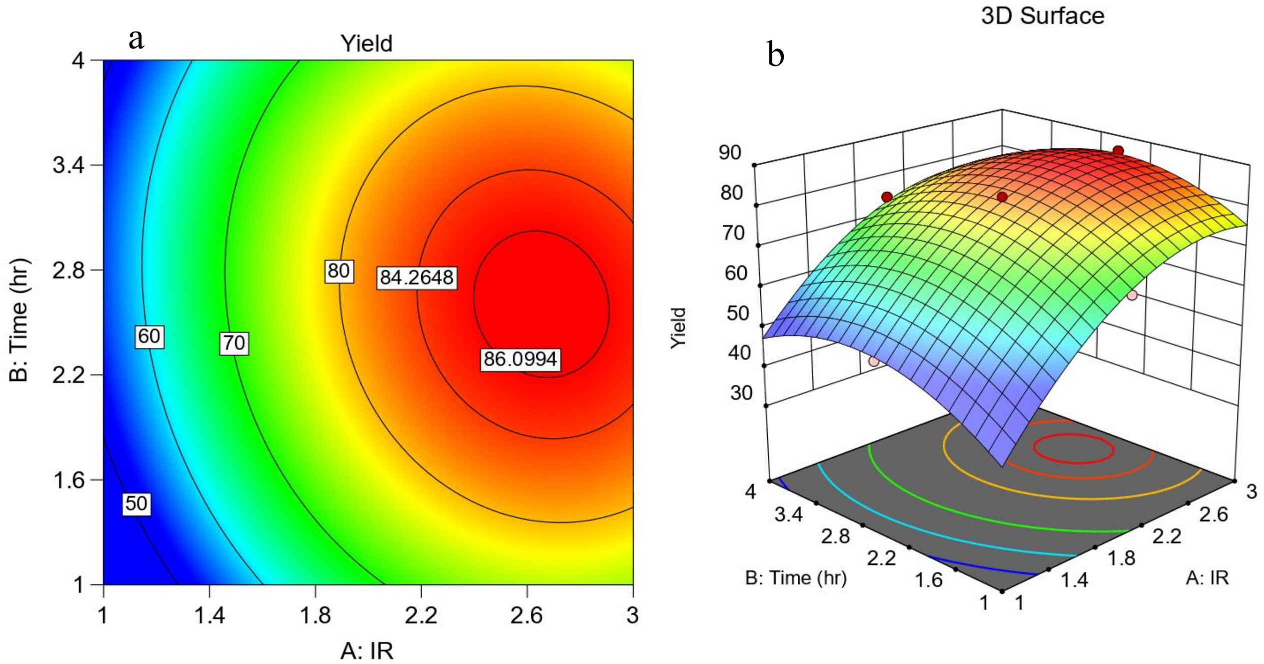


Fig. 5. The interaction between the impregnation ratio and time (a) contour (b) 3D surface.

3.4 Interactive Effect of the Impregnation Ratio and Activation Temperature

The interactive effect of the impregnation ratio and activation temperature is shown in Figure (6). From the contour plot in Figure (6), we notice that the optimum value of temperature is 630°C and the impregnation ratio is 2.6. Regarding the activation temperatures, it was perceived that as the temperature was increased from 500 to 620 °C, the yield of AAC increased till it reached an optimum value at nearly 630 °C. These results interpreted that as the activation temperature increased, the structure tended to become more porous due to KOH evaporation. After that, the percentage of yield starts to go lower because high activation temperatures caused pore explosion, resulting in reduced yield values [21].

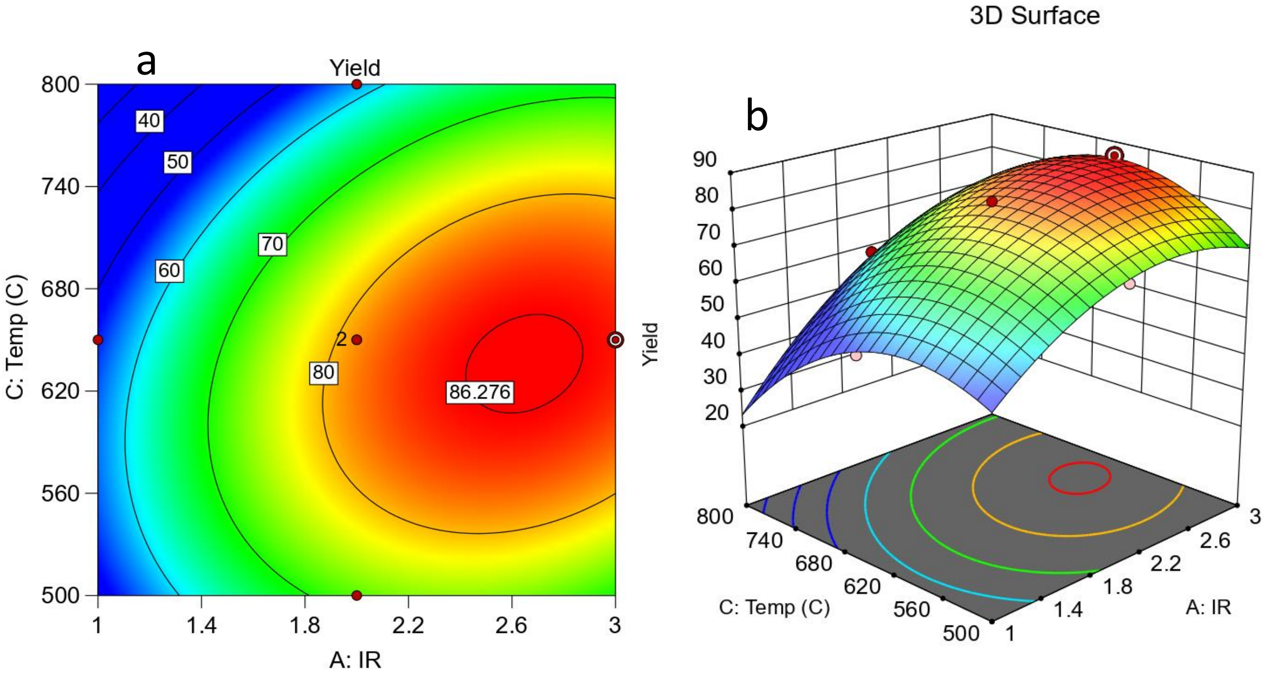


Fig. 6. The interaction between the impregnation ratio and temperature a) contour b) 3D surface.

3.5 Analysis of variance (ANOVA)

Statistical significance of the factors was established with Analysis of Variance (ANOVA). Impregnation ratio IR has been encoded as(A), time of activation (B), Temperature (C) and the yield (R). The experimental values obtained from the lab experiments were compared with the predicted results calculated by statistical design software. The value of coefficient R^2 is equal to 0.9696, indicating that the experimental data fits perfectly with the quadratic model. Figure (7) plots the predicted values versus experimental values, which is a good tool for studying the significance of the suggested model. As can be seen from the plot, all the data points are close to the line, indicating that the experimentally observed data fits well with the empirical model.

The model equation for yield (R%) is shown mathematically in Eq. (2) in terms of coded factors. The terms express the relationship between the independent variables and the dependent response of the system.

$$R\% = 81.32 + 8.02A + 0.97B - 3.62C - 0.5100AB + 1.61AC - 3.92BC - 2.98A^2 - 2.50\,B^2 - 4.10\,C^2 \quad \ldots(2)$$

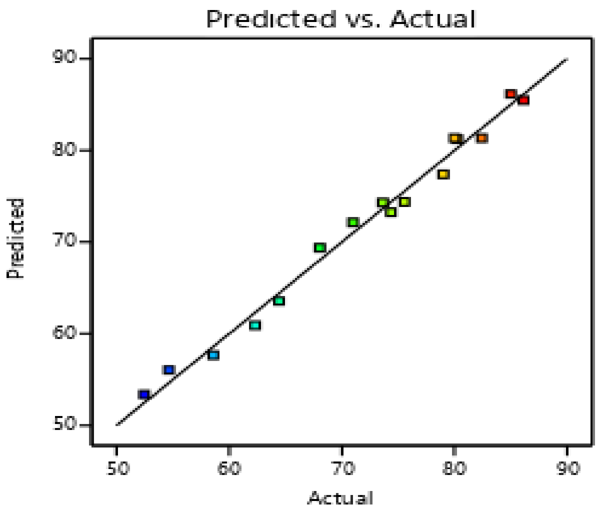


Fig. 7. The predicted values versus experimental values.

From Table (2) according to the lower P-value and a higher F-value, the most significant parameter is the impregnation ratio and activation temperature with the weak effect of time. It was also noted that the more effective interaction is between the temperature and time.

Table 2,
ANOVA for Quadratic model

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	1687.46	9	187.50	54.11	< 0.0001	significant
A-IR	1028.48	1	1028.48	296.79	< 0.0001	
B-Time	15.05	1	15.05	4.34	0.0822	
C-Temp	209.96	1	209.96	60.59	0.0002	
AB	2.08	1	2.08	0.6005	0.4678	
AC	20.87	1	20.87	6.02	0.0495	
BC	122.93	1	122.93	35.47	0.0010	
A^2	141.85	1	141.85	40.93	0.0007	
B^2	100.20	1	100.20	28.91	0.0017	
C^2	269.29	1	269.29	77.71	0.0001	
Residual	20.79	6	3.47			
Lack of Fit	17.86	5	3.57	1.22	0.5932	not significant
Pure Error	2.93	1	2.93			
Cor Total	1708.25	15				

3.6 Comparison between charcoal and Alhagi activated Carbon (AAC)on different surfaces

The commercial charcoal and Alhagi activated carbon (AAC) were used for developing latent fingerprints on several non-pours surfaces that can commonly be found at the crime scene (cardboard, plain glass, aluminum foil sheet, China Dish, Plastic and Switch.). The results show that the prepared AAC has a high ability to develop the latent fingerprints on all surfaces except on plastic while the commercial charcoal failed to develop the latent fingerprint on both plastic and aluminum foil sheet surfaces. This is due to the adhesion property of the AAC being greater than the charcoal, as a result of the activation and carbonation processes, which led to the development of the adhesion of the powder to the finger residue as shown in Figure (8).

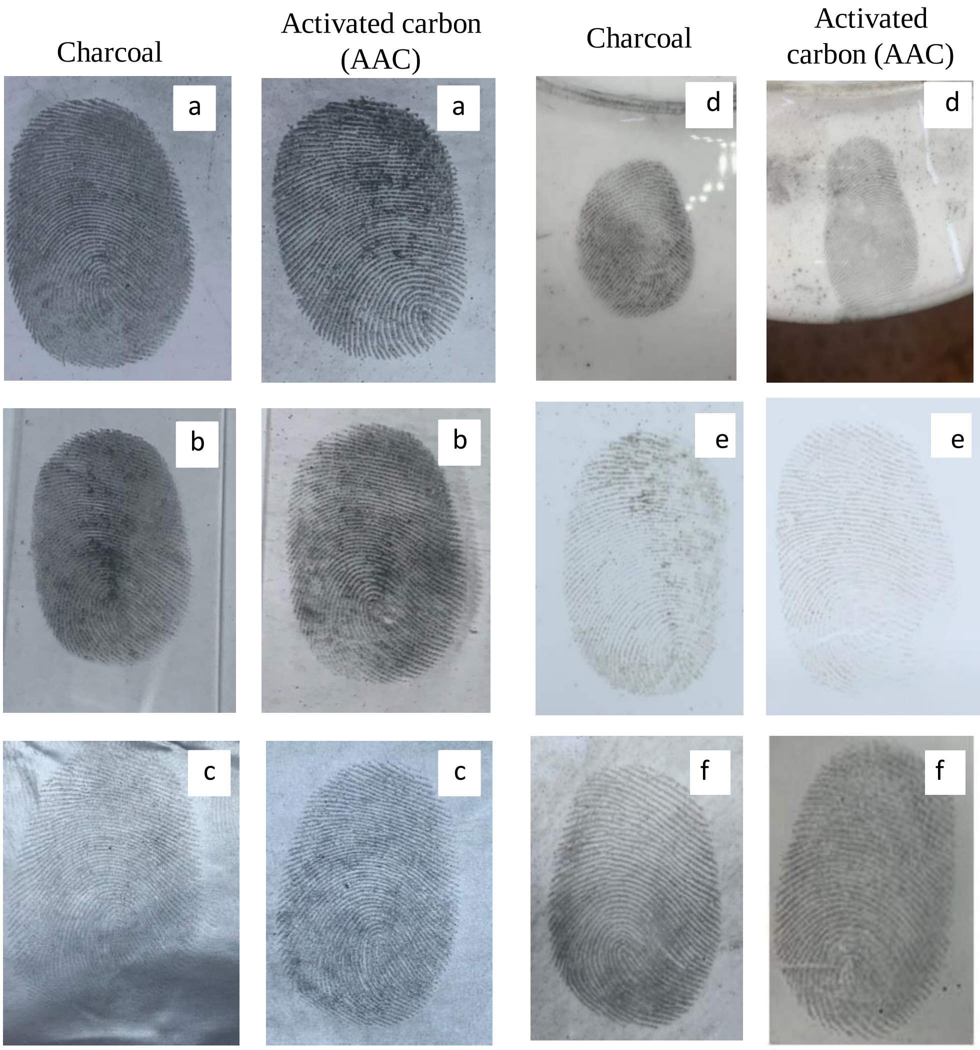


Fig. 8. Comparative visualizations of latent fingerprints between commercial charcoal and AAC on several nonporous surfaces(a) cardboard. (b) plain glass (c) aluminum foil sheet. (d) China Dish. (e) Plastic(f) Switch.

3.7 Comparison between charcoal and Alhagi activated Carbon for both male and female

The commercial charcoal and Alhagi activated carbon (AAC) were used to show their performance to develop latent fingerprints from ten volunteers for both males and females on the same surface (cardboard). The result of the comparison was shown in Figure (9). It was noticed that AAC gave clear prints and showed clearly all the minutiae of the latent fingerprints more than charcoal.

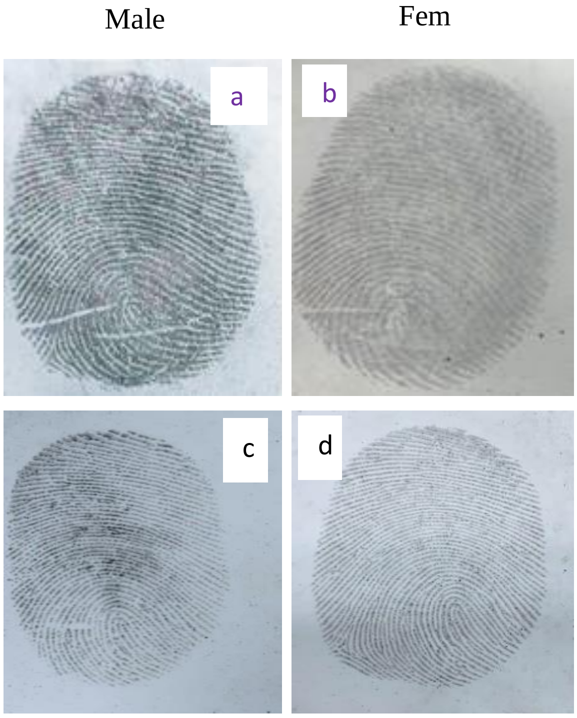


Fig. 9. Comparative visualization of latent fingerprints between commercial charcoal and AAC powders- (a) prepared powder (AAC) for males. (b) prepared powder (AAC) for females. (c) commercial charcoal for males. (d) commercial charcoal for females.

3.8 Fingerprints lifespan

The time for the latent fingerprint to remain on the surfaces was also diagnosed. Nonporous surface(cardboard) was selected for this purpose and all samples were taken from the same volunteer at the same lab conditions. The fingerprints were developed after 1,4,7,15, and 25 days. Figure (10) shows that the latent fingerprints present on the surface examined using AAC can be successfully developed even for long time of stay on the surface, but the quality is decreased as the print's lifespan increased. As shown in Figure (10), clear visible fingerprint was noticed till 15 days, but less contrast was noticed after 25 days. While the performance of commercial charcoal to show the latent fingerprint is lower where visible fingerprint was noticed till 7 days only.

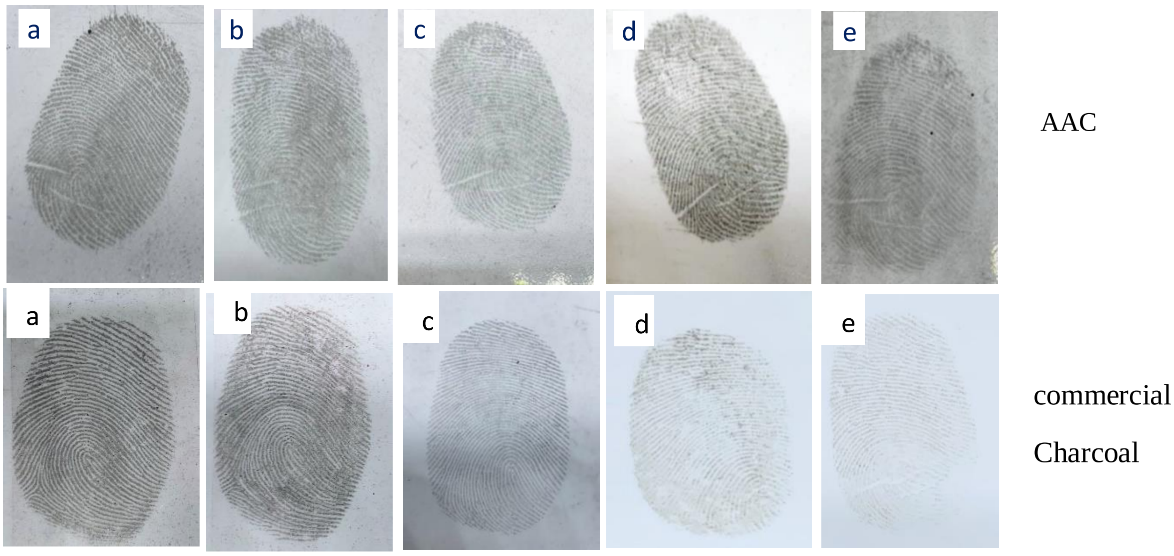


Fig. 10. Comparative visualizations of latent fingerprints for both powders on the nonporous surface(cardboard) at different lifespans. (a) after 1 day. (b) after 4 days. (c) After 7 days. (d) after 15 days. (e) after 25 days.

4. Conclusion

The Alhagi active carbon powder (AAC) derived from the Alhagi plant and commercial charcoal used to reveal latent fingerprints from different non-porous substrates. The (AAC) powder was compared with commercial charcoal and tested for several surfaces (cardboard, plain glass, aluminum foil sheet, China Dish, Plastic and Switch). Three parameters were examined that affect the production of AAC by chemical activation, such as activation time, activation temperature, and impregnation ratio IR. The yield of the produced activated carbon was chosen as a response. The effects of the experimental parameters were investigated using Central Composite Design (CCD) software. The optimum values of variables for Alhagi activated carbon were 1:2.6 as impregnation ratio, activation temperature of 630^{o}C and activation time of 160 min which give the highest yield of 86.14%. The value of coefficient R^2 is equal to 0.9696, indicating that the experimental data fits perfectly with the quadratic model. The final product was characterized by SEM, EDX and FTIR, analysis. The prepared AAC has a high ability to develop the latent fingerprints on all surfaces except on plastic while the commercial charcoal failed to develop the latent fingerprint on both plastic and aluminum foil sheet surfaces. In addition, it was noticed the prepared powder (AAC) show clearly all the minutiae of the latent fingerprints and gives good results in developing latent fingerprints for both males and females. Also, the time for the latent fingerprint to remain on the surfaces was diagnosed using two powders to visualization. It was found the prepared powder (AAC) has the ability to clearly develop the latent fingerprints until 15 days while the performance of commercial charcoal to show the latent fingerprint is lower where visible fingerprint was noticed till 7 days only.

Acknowledgement

we wish to thank the staff of the Biochemical Engineering Department at Al-Khwarizmi College of Engineering / University of Baghdad for the continued support they have given me throughout my M.Sc. studies. Also, we appreciate all the efforts introduced by the Criminal Evidence Investigation Directorate for the co-operation and assistance through this work.

5. References

[1] V. Chauhan, “Xournals Fingerprint Studies and Dactyloscopy Abstract : Xournals,” vol. 03, no. 01, 2020.

[2] S. Sehmi, “Dermatoglyphic patterns in type 2 diabetes mellitus,” Anat. J. Africa, vol. 7, no. 1, pp. 1162–1168, 2018, doi: 10.4314/aja.v7i1.169489.

[3] J. Lakshmi Prabha and R. Thenmozhi, “A short review on Dermatoglyphics,” J. Pharm. Sci. Res., vol. 6, no. 4, pp. 200–202, 2014.

[4] R. E. Ball, R. E. Ball, D. Ayers, and W. Virginia, “Prevalence of Pores in Latent Fingerprints Prevalence of Pores in Latent Fingerprints Department of Forensic & Investigative Science,” 2020.

[5] V. Saran, L. Kesharwani, and M. K. Mishra, “Comparative Study of Different Natural Products for the Development of Latent Fingerprints on Non Porous,” vol. 3, no. August 2016, pp. 9–12, 2015.

[6] A. R. Azman, N. A. Mahat, R. A. Wahab, W. A. Ahmad, M. A. M. Huri, and H. H. Hamzah, “Relevant visualization technologies for latent fingerprints on wet objects and its challenges: a review,” Egypt. J. Forensic Sci., vol. 9, no. 1, 2019, doi: 10.1186/s41935-019-0129-3.

[7] R. K. Garg, H. Kumari, and R. Kaur, “A new technique for visualization of latent fingerprints on various surfaces using powder from turmeric: A rhizomatous herbaceous plant (Curcuma longa),” Egypt. J. Forensic Sci., vol. 1, no. 1, pp. 53–57, 2011, doi: 10.1016/j.ejfs.2011.04.011.

[8] A. A. Madhavan, R. Qotainy, and R. Nair, “Synthesis of functionalized silver nanoparticles and its application as chemical sensor,” 2019 Adv. Sci. Eng. Technol. Int. Conf. ASET 2019, no. June, pp. 1–4, 2019, doi: 10.1109/ICASET.2019.8714300.

[9] R. Rohatgi and A. K. Kapoor, “New Visualizing Agents for Developing Latent Fingerprints on Various Porous and Non-Porous Surfaces Using Different Household Food Items,” Asian J. Sci. Appl. Technol., vol. 3, no. 2, pp. 33–38, 2014, [Online]. Available: www.trp.org.in.

[10] P. D. Ashtaputrey and S. D. Ashtaputrey, “Preparation and Characterization of Activated Charcoal derived from Wood Apple Fruit Shell,” J. Sci. Res., vol. 64, no. 01, pp. 236–240, 2020, doi: 10.37398/jsr.2020.640146.

[11] G. S. Sodhi and J. Kaur, “Powder method for

detecting latent fingerprints: A review," Forensic Sci. Int., vol. 120, no. 3, pp. 172–176, 2001, doi: 10.1016/S0379-0738(00)00465-5.

[12] S. D. Salman, "Adsorption of Heavy Metals from Aqueous Solution onto Sawdust Activated Carbon," vol. 15, no. 3, pp. 60–69, 2019.

[13] R. Krishnamoorthy, B. Govindan, F. Banat, V. Sagadevan, M. Purushothaman, and P. L. Show, "Date pits activated carbon for divalent lead ions removal," J. Biosci. Bioeng., vol. 128, no. 1, pp. 88–97, 2019, doi: 10.1016/j.jbiosc.2018.12.011.

[14] S. Maulina and M. Iriansyah, "Characteristics of activated carbon resulted from pyrolysis of the oil palm fronds powder," IOP Conf. Ser. Mater. Sci. Eng., vol. 309, no. 1, pp. 0–6, 2018, doi: 10.1088/1757-899X/309/1/012072.

[15] B. Sadhukhan, N. K. Mondal, and S. Chattoraj, "Optimisation using central composite design (CCD) and the desirability function for sorption of methylene blue from aqueous solution onto Lemna major," Karbala Int. J. Mod. Sci., vol. 2, no. 3, pp. 145–155, 2016, doi: 10.1016/j.kijoms.2016.03.005.

[16] A. E. Sarrai et al., "Using central composite experimental design to optimize the degradation of Tylosin from aqueous solution by Photo-Fenton reaction," Materials (Basel)., vol. 9, no. 6, 2016, doi: 10.3390/ma9060428.

[17] S. Chattoraj, B. Sadhukhan, and N. K. Mondal, "Predictability by Box-Behnken model for carbaryl adsorption by soils of Indian origin," J. Environ. Sci. Heal. - Part B Pestic. Food Contam. Agric. Wastes, vol. 48, no. 8, pp. 626–636, 2013, doi: 10.1080/03601234.2013.777283.

[18] T. Budinova et al., "Characterization and application of activated carbon produced by H3PO4 and water vapor activation," Fuel Process. Technol., vol. 87, no. 10, pp. 899–905, 2006, doi: 10.1016/j.fuproc.2006.06.005.

[19] S. Lecturer and S. Dawood, "Removal of Organic Micro Pollutants by Adsorption on Activated Carbon Prepared from Alhagi (Maurorun)," 2019.

[20] S. Li, K. Han, J. Li, M. Li, and C. Lu, "Preparation and characterization of super activated carbon produced from gulfweed by KOH activation," Microporous Mesoporous Mater., vol. 243, pp. 291–300, 2017, doi: 10.1016/j.micromeso.2017.02.052.

[21] M. Waleed Khalid and S. D. Salman, "Adsorption of Chromium Ions on Activated Carbon Produced from Cow Bones," Iraqi J. Chem. Pet. Eng., vol. 20, no. 2, pp. 23–32, 2019, doi: 10.31699/ijcpe.2019.2.4.

تحضير وتشخيص مسحوق للكشف عن البصمة الوراثية الكامنة لتطبيقات الادلة الجنائية

هديل فاروق حميد*   علاء كريم محمد**
ضياء شامخ زغير***
،قسم الهندسة الكيميائية الاحيائية/ كلية الهندسة الخوارزمي/ جامعة بغداد*
****كلية العلوم/ مركز الدنا العدلي/ جامعة النهرين*
*البريد الالكتروني: hadeel.farook1205a@kecbu.uobaghdad.edu.iq
**البريد الالكتروني: dr.alaa@kecbu.uobaghdad.edu.iq
***البريد الالكتروني dheaairoai72@gmail.com

الخلاصة

بالنسبة للتحقيقات الجنائية، تظل بصمات الأصابع هي الشكل الأكثر موثوقية لتحديد الهوية على الرغم من التطورات في مجالات أخرى مثل DNA. الهدف من الدراسة هي مقارنة اداء مسحوق الجاركول التجاري و الكاربون المنشط المحضر من نبات العاكول على عدة سطوح غير مسامية (ورق مقوى , قطعة من الزجاج , سطح الالمنيوم , صحن صيني المنشأ ,سطح بلاستيكي ,مفتاح اضاءة) . تم دراسة تأثير ثلاث عوامل على انتاج الكاربون النشط وهي نسبة التفعيل (وزن هيدروكسيد البوتاسيوم / وزن المادة) ودرجة الحرارة التفعيل وزمن التفعيل. تم تحليل النتائج بطريقة Central Composite Design (CCD). وجدت الظروف المثلى عند نسبة الغمر 2.6 :1 و زمن التفعيل 160 دقيقة و درجة حرارة التفعيل 630 درجة سليزية . بينت النتائج ان للكاربون النشط المحضر من نبات العاكول له القابلية على اظهار البصمات المخفية على كل السطوح عدا السطح البلاستيكي بينما فشل مسحوق الجاركول التجاري باظهار البصمات الكامنة على كل من السطح البلاستيكي وسطح الالمنيوم. كما ان لمسحوق الكاربون المنشط يظهر كافة خطوط البصمة المخفية لكلا الجنسيين (للذكور والاناث) أفضل من مسحوق الجاركول التجاري. لمسحوق الكاربون المنشط قابلية على اظهار البصمات الكامنة لفترات زمنية تصل الى 15 يوم بينما قابلية اظهار البصمات المخفية بالنسبة لمسحوق الجاركول التجاري وصلت الى 7 أيام فقط.