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Basic Decomposition For Sunflower Seed Peels And Study Of Carbonation Products And Their Effect On The Specifications Of The Prepared Carbon

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Abstract
To investigate the optimal conditions for the basic decomposition of sunflower seed peels to produce a high-quality carbon precursor, and characterize the physical and chemical properties of the carbon precursor obtained from the decomposition process, one type of nut shell sunflower seed peels was adopted which is characterized by extreme hardness and high lignin content to prepare an activated carbon. The quantity of iodine adsorbed by the experimental material surpassed that of the commercial model, especially at a 1:1 ratio. The experimental material achieved an iodine number of 907 and a methylene blue dye adsorption of 91- indicating superior performance and higher density. Additionally, increasing the proportion of the carbonated material from 0.5 to 2 significantly enhanced the number and property of internal pores, leading to improved adsorption properties. The experimental activated carbon exhibited superior performance compared to commercial models, particularly in terms of iodine number and methylene blue dye adsorption. While the increased KOH ratio led to a decrease in density, it also resulted in a highly effective activated carbon with neutral pH and low density. This suggests that the carbonization process effectively disrupted the original structure of the sunflower seed peels, creating a highly porous material.This study demonstrates that sunflower seed peels, combined with enhanced chemical processing, can produce highly efficient activated carbon. The results indicate significant potential for environmental and industrial applications. However, strategies to reduce moisture content and costs should be explored to maximize the benefits.
Keywords: *Activated carbon, Methylene blue, Sunflower seed peels, Surface area.*

INTRODUCTION:

Activated carbon, sometimes known as activated charcoal, is an adsorbent that used extensively in the pharmaceutical and food industries, purification of the water, pollution control, gas and air purification (exhaust control for motor vehicles and cigarette filters), and separation, purification, decolorization, and deodorization of vegetable oils and fats. Its high surface area and high micropore size are some of its key laboratory uses [1]. The ability of activated carbon to purified water and remove the pollutions materials that could be obtain by the adsorption process sets it apart from regular carbon. The activated carbon had several adjectives for example it is a solid product, black-colored powder, porous, and usually be without flavor or odor. In [2] it created using a unique porous method to create tiny granules or fine powder with a high surface area that increases its chemical capacity to absorb undesirable or hazardous gasses. Activated carbon finds application as an organic and non-polar substance absorbent, as well as in the purification and treatment of gases [3]. The subject of production of activated carbon, which was dependent on the feed stock's source, was the subject of numerous reports. The activated carbon was produced using waste materials found in the area, [4] including the powdered peach seeds, coconut shells,[5] scrap tires[6], dates [7], tamarind seeds [8], sawdust [9], walnut peel, polyethylene terephthalate residues[10], cow bones [11], in addition to the side-products which obtained from the sulfur purification and extraction procedure from the Mishraq field, which has a sulfur content of about 92% by weight [12]. It also included consumed lubricating oils [13] and the branches of trees like pomegranate [14]. The temperature at which the produced carbon is activated—between 800 and 1000 ≲C—in an environment containing nitrogen, carbon dioxide, or water vapor varies on the duration of the activation process [15, 22]. The larger the pores, the longer the activation period. Due to its high cost in the market, numerous researchers looked for less expensive yet equally potent substitutes [16–23]. In our investigation, activated carbon was made using powdered sunflower seeds. Not only may a lot of trash be utilized to prepare activated carbon, but it also helps get rid of waste from the environment. In addition to having a high carbon content, activated carbon is inexpensive, and ash is one of the most significant ingredients. The preparing an activated carbon often will be less pure the more of it there is; the accumulated ashes could be eliminated through treating it with different potent mineral acids [17].

1. Materials and Method:

1.1. Preparing the Raw Material

To achieve optimal outcomes, sunflower seeds need to be dried, followed by a fine grinding process that turns them into a powder, maximizing their contact with the carbonated ingredient [18].

1.2. Initial carbonization process:

To begin the carbonization process, 12g of powdered sunflower seeds peels were combined with various weight fraction of potassium hydroxide (1:0.5,1:1,1:1.5,1:2) (wt:wt) (sunflower seed peels powder: KOH) in anti-rust vessel crafted from steel. The resulting mixture was well homogenized before being heated to 380 ^{o}C for a duration of 100 minutes.

1.3. Final Carbonization Process:

The response vessel eliminated from the heating source, and the activated carbon was underwent to purifying process, after that the measurement was calculated when the temperature is raised to 550 ^{o}C, with continues stirring for (3hor) to remove all the gases[19]

1.4. Purification of the Prepared Activated Carbon

To get rid of any mineral residues and potassium hydroxide, the produced activated carbon was repeatedly rinsed with distillation water. Until it is verified that the activated carbon is free of the base material, this washing procedure is repeated using distilled water. Ions were eliminated from the resultant carbon by treating it with 50 milliliters of 15% hydrochloric acid. Then, in order to get rid of any leftover acid, it was repeatedly cleaned with distilled water. Following an airtight seal and 125 °C drying process, the product was ground finely in a ceramic mortar[20].

1.5. Efficiency of the Prepared Activated Carbon:

a. The measurement of the surface area for prepared compound.

Methylene blue (MB) methods had been used to determine the carbon activity. This is a typical procedure where 0.1 g of activated carbon is weighed and mixt with 100 ml of (MB) dye is injected in (20 ppm conc.), all at laboratory temperature. After adding another (50 ml) of the dye solution and continuing to do so until the dye's color is stabilizes in the solution, filtered, and the absorption was measured at a wavelength (660 nm) by taking methylene blue at various concentrations (5, 10, 15, 20, 25 ppm). At what wavelength (660), the solution's absorbance.

b. Measuring of the internal surface area of activated carbon.

The surface area of activated charcoal was estimated using the iodine number (In) adsorption method. Iodine is adsorbable from its aqueous solution in order to do this. The iodine number (I.N.) is determined by using the equation which mentioned below and it expressed as the iodine absorbed in (mg) from the solution by (1g) of activated carbon.

I.N. is equivalent to $X / M * D$.

X represents the iodine weight in milligrams absorbed by activated carbon.

M: the model's weight in activated carbon.

D: Adjusting Factor

1.6. Physical measurements of preparing activated charcoal:

a. Ash Measurement:

The amount of ash present in the prepared activated charcoal was determined by placing (1g) of the preparing compound in a ceramic crucible, heating it to 1000 °C for an hour, and cooling it in a glass desiccator to room temperature. The sample's residual weight was then used to calculate the percentage of ash remaining.
b. Determining the acidic functioning of activated carbon:
An activated carbon (1g) had been mixt with (10 milliliters) of distilled water, agitated for thirty minutes, then filtered, and the PH of the mixture measured.
c. Measurement moisture content:
The produced activated carbon is weighed after being chilled and exposed to the lab environment for 24 hours, then dried for two hours at 130 °C. The percentage of moisture content was calculate through finding the difference between the two weights.
d. Density Measurement of Activated Carbon:
To eliminate the pores between the molecules, add a certain amount of activated carbon to a five milliliters flask. Carefully and gently tamp the material so that the activated carbon fills the flask, making sure the molecules are level at the flask's mark. Weigh the carbon then compute its density using the equation:
Mass / volume equals density (g/cm^3).
A solid, black, porous material with no taste or odor is called activated carbon. It may be separated from regular carbon by its adsorption process, which eliminates pollutants and purifies water[21].

RESULTS:
Table Analysis:
The table 1 compares the characteristic of activated carbon prepared through enhanced carbonation and chemist processing using potassium hydroxide (KOH) with varying weight ratios to sunflower seed peels. The relationship between the base concentration and the properties of the activated carbon is evident from the values presented:
Density:
The density decreases significantly as the KOH ratio increases.
It drops from 0.10 g/cm^3 in S(1) (1:0.5) to 0.04 g/cm^3 in S(3) (1:1.5), then slightly rises to 0.05 g/cm^3 in S(4) (1:2).
This indicates that higher KOH levels result in more pore formation, reducing the material's density.
Humidity:
Humidity increases with higher KOH ratios, rising from 6.1% in S(1) to 11.8% in S(4).
This suggests greater water retention within the porous structure formed during the reaction.
Ash Content:
Ash content is minimal (<1%), reflecting the effectiveness of purification using hydrochloric acid and distilled water.
Methylene Blue Index:
This index reflects the activated carbon's ability to adsorb organic dyes.
Adsorption capacity improved as the KOH ratio increased, with the index rising from 32.5 mg/g in S(1) to 217.0 mg/g in S(4), highlighting enhanced adsorption properties with more base.
Iodine Number:
This indicates the surface area of activated carbon, increasing from 965 mg/g in S(1) to 1141 mg/g in S(4).
The increase reflects the development of a larger and more active pore network.
Comparison with Commercial Carbon (BDH):
The BDH commercial activated carbon shows higher density (0.325 g/cm^3) but lower adsorption efficiency (iodine number = 907 mg/g).
This highlights the superior performance of the carbon prepared in this study.
Table 1: Characteristics of the Activated Carbon Produced via Enhanced Carbonation and Chemical Processing

Sample	sunflower seed : KOH	Iod. No. mg/gm	Methylene Blue mg/gm	Ash %	Humd. (%)	Dens. gm/cm^3
S(1)	1:0.5	965.0	32.5	0.46	6.1	0.10
S(2)	1:1	967.0	61.0	0.3	7.6	0.06
S(3)	1:1.5	1081.0	79.0	0.4	9.6	0.04
S(4)	1:2	1141.0	217.0	0.98	11.8	0.05
Carbon for British Drug Houses (BDH)		------ 907	91	3.2 0.8		0.325

The figure 1 represents the relationship between the KOH to sunflower seed peels ratio and the concentration of adsorbed methylene blue (mg/g) by the prepared activated carbon.

Gradual Increase:

The graph shows that the concentration of adsorbed methylene blue increases gradually as the KOH-to-peels ratio rises.

Initially, between ratios of 0.5:1 and 1:1, the increase in adsorption is limited but noticeable.

Accelerated Adsorption at Higher Ratios:

At higher ratios (1.5:1 and 2:1), there is a significant rise in adsorption, indicating the formation of a larger and more effective porous network with increasing KOH.

This highlights the role of KOH in enhancing the carbon structure and expanding the pore network, boosting adsorption capacity.

Highest Value:

The highest methylene blue adsorption value (around 217 mg/g) was recorded at a 2:1 KOH-to-peels ratio. This suggests that the higher KOH ratio results in more substantial improvements in the active surface area.

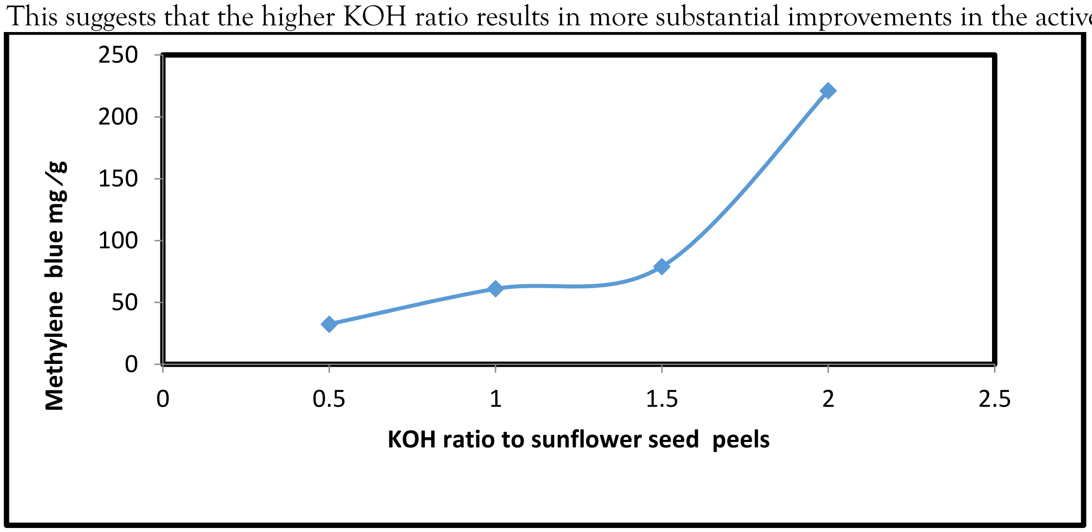

Figure 1: Comparing between the addition of KOH and Methylene blue

The figure 2 illustrates the relationship between the KOH-to-sunflower seed peel ratio and the iodine number (mg/g), which indicates the surface area of the activated carbon.

Initial Phase (0.5:1 to 1:1):
At low KOH ratios, the iodine number remains relatively constant, with only a slight increase observed.
This suggests limited surface area development at these lower ratios.
Significant Increase (1.5:1 to 2:1):
A noticeable and steady rise in the iodine number begins at a ratio of 1.5:1, peaking at 2:1 (approximately 1140 mg/g).
This indicates substantial pore formation and an increase in surface area due to the higher KOH concentration.
Correlation:
The data clearly show that increasing the KOH ratio enhances the carbon activation process, resulting in higher adsorption capacity, as reflected by the iodine number.

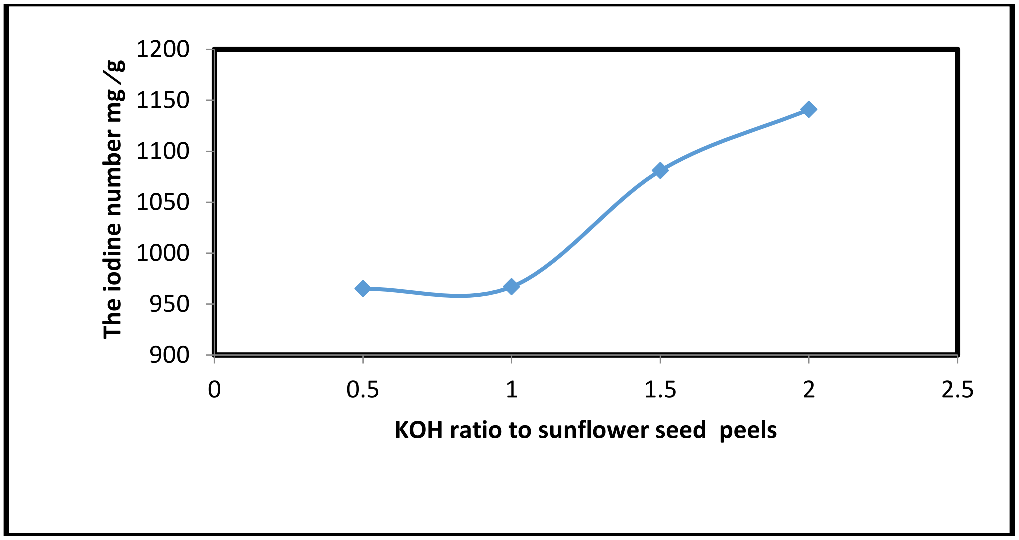

Figure 2: The relationship between the added (KOH) ratio and the iodine number

The figure 3 depicts the relationship between the KOH-to-sunflower seed peel ratio and the ash content (%) of the prepared activated carbon.
Initial Decline (0.5:1 to 1:1):
At low KOH ratios, the ash content slightly decreases, indicating effective removal of inorganic components during the activation process.
Stabilization (1:1 to 1.5:1):
The ash content remains relatively stable within this range, suggesting a balance between the carbonization process and the retention of mineral residues.
Significant Increase (1.5:1 to 2:1):
At higher KOH ratios, the ash content rises sharply, reaching its peak at 2:1.
This increase may result from the excessive KOH reacting with the raw material, leaving behind residual salts or inorganic by-products after activation.

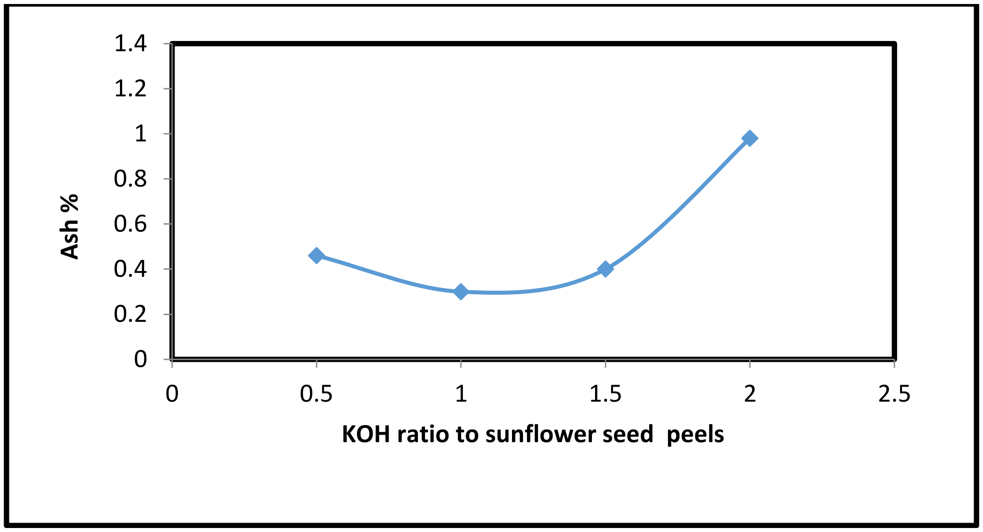

Figure 3: The relationship between the added (KOH) ratio with Ash contented carbon

Figure 4 directly illustrates a positive correlation between the proportion of potassium hydroxide (KOH) added to sun flower seeds and the resulting moisture content in the activated carbon. As the amount of KOH increases, so does the moisture content in the final product (activated carbon).

Role of KOH in Activation: Potassium hydroxide serves as an activating agent in the process of converting sun flower into activated carbon. KOH removes unwanted organic substances from the plant structure of the apricot seeds, leaving behind a highly porous structure. This porosity is responsible for the activated carbon's ability to absorb moisture and other substances.

Relationship between KOH Proportion and Moisture: Increasing the proportion of KOH leads to an increase in the internal surface area of the activated carbon. This increased surface area enhances the activated carbon's capacity to absorb moisture from the surrounding environment. Consequently, the rise in moisture content with increasing KOH levels is a natural result of this process.

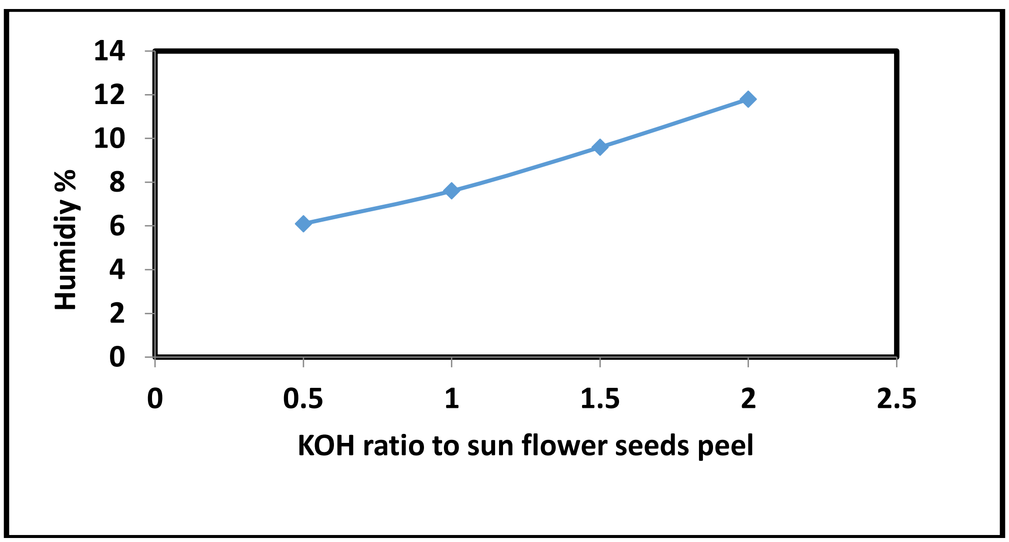

Figure 4: Relationship between KOH Addition and Moisture Content in Activated Carbon

Figure 5 displays the relationship between the added proportion of potassium hydroxide (KOH) to sunflower seed peels husks and the density of the resulting activated carbon. The figure reveals a non-linear variation in the density of activated carbon as the KOH ratio changes.

Role of KOH in Activation: Similar to the previous figure, KOH acts as an activator for sunflower seed husks by removing organic substances, leading to increased porosity.

Relationship between KOH Ratio and Density:
Low KOH Ratio: Initially, with a slight increase in the KOH ratio, the density of activated carbon decreases significantly. This decrease in density is attributed to the increased porosity resulting from the activation process, where more organic materials are removed.
Intermediate KOH Ratio: At a certain point, the density begins to increase slightly. This could be due to other reactions occurring between KOH and the remaining substances in the plant structure, leading to changes in the material's physical properties.
High KOH Ratio: With a significant increase in the KOH ratio, the density increases again. This can be explained by the fact that a large increase in KOH may lead to the blockage of some pores or the formation of new materials with higher density.

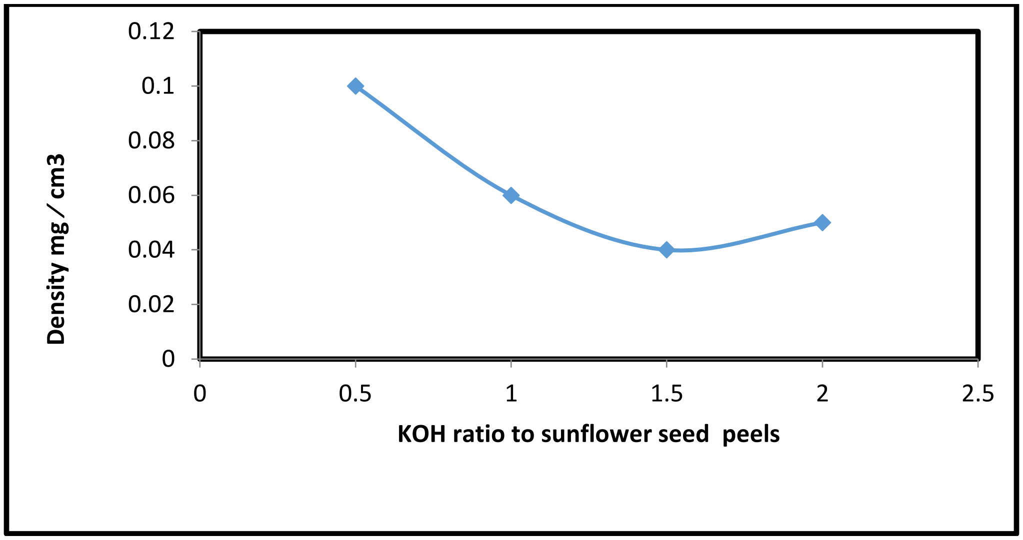

Figure 5: the relationship between the added proportion of potassium hydroxide (KOH) to sunflower seed and the density of the resulting activated carbon

DISCUSSION
The porous, solid, black substance known as activated carbon has no flavor or odor. Its capacity to eliminate pollutants and purify water by adsorption sets it apart from regular carbon. There are many different sources and methods for making activated carbon. Depending to the standard standards for activated carbon, researchers have separated it into many forms, such as furnace coal, carbon it was produced from plant sources, especially in which lignin is abundant, i.e. nut shells or hardwoods, etc. In this currently study, one type of nut shell sunflower seed peels was adopted which is characterized by extreme hardness and high lignin content to prepare an activated carbon. The quantity of iodine adsorbed by the experimental material surpassed that of the commercial model, especially at a 1:1 ratio. The experimental material achieved an iodine number of 907 and a methylene blue dye adsorption of 91- indicating superior performance and higher density. Additionally, increasing the proportion of the carbonated material from 0.5 to 2 significantly enhanced the number and quality of internal pores, leading to improved adsorption properties.
The samples (4, 3, 2) demonstrate that increasing the base percentage resulted in a decrease in density, despite the commercial model having 5 times the ash content. This suggests that the carbonization process has caused the structural formula to almost completely collapse, the stratified chains to separate from one another, and a decrease in mass per unit volume, all of which contribute to a decrease in density. This type of activated carbon, especially model (4), is highly effective and has neutral characteristics in terms of PH and low density. So can be use to sterilize wounds or given to children in the form of capsules to remove and adsorb gases from the stomach and intestines. When treating the resulting activated carbon with concentrated sulfuric

acid (as a future study) was found to react generating great heat, which indicates the occurrence of bonds breaking and the formation of new bonds. Preliminary studies showed a great ability to adsorption of heavy metals from their solutions [39, 40,41].

In view of the unexpected increases in the case of using green seed peel powder for adsorption values and the cost of sunflower seed, we suggest accuracy in work and economy in raw materials and its use for medical purposes as it is free from sulfur and nitrogen compounds that have carcinogenic properties. Increasing the KOH ratio to sunflower seed peels enhances pore formation, increasing the effective surface area and adsorption capacity.The best results were recorded at a 1:2 ratio (S(4)), achieving the highest adsorption performance.

The prepared activated carbon can be used to remove organic and inorganic contaminants from water or air due to its excellent adsorption properties. The activated carbon prepared using higher KOH ratios exhibits very high adsorption efficiency for organic materials like methylene blue [42].

This aligns with the table results, which showed increased methylene blue index with higher KOH ratios. The increase in adsorption is directly linked to the creation of fine pores in the carbon structure due to the strong interaction between KOH and the raw material (sunflower seed peels) [43]. As the KOH ratio increases, the process becomes more effective in removing non-carbon components and forming a more extensive porous network [44]. The results suggest that the produced activated carbon can be effectively used in removing organic pollutants from water or solutions, offering broad environmental applications [45]. Despite its high efficiency, the production process could be refined to reduce moisture content, which might affect performance under certain conditions, as mentioned in the earlier analysis. The iodine number growth reflects the improved porosity and active surface area of the carbon as the KOH concentration increases. This aligns with the chemical role of KOH in creating and enlarging pores during the activation process [46]. The ratio of 2:1 appears to be optimal for maximizing surface area without reaching saturation or diminishing returns, as there is no sign of plateauing.The high iodine number indicates that the prepared carbon is suitable for adsorbing small molecules, making it ideal for environmental applications like water purification [47]. Lower ash content is desirable for high-quality activated carbon as it indicates minimal inorganic residues, which can block pores and reduce adsorption capacity [48]. The slight decrease at lower ratios aligns with this goal.The increase in ash content at higher KOH ratios (above 1.5:1) may compromise the purity of the activated carbon. This highlights the need to optimize the KOH ratio to balance pore development and minimize ash accumulation. Excessive ash content can affect the efficiency of activated carbon in specific applications, such as water or air filtration [49]. Thus, maintaining ash content within a controlled range is essential. These findings can be utilized to determine the optimal KOH proportion for producing activated carbon with specific moisture absorption characteristics. This has significant applications in various industries, including water purification, air filtration, and gas storage [50 -51].

CONCLUSION:

This study demonstrates that sunflower seed peels, combined with enhanced chemical processing, can produce highly efficient activated carbon. The results indicate significant potential for environmental and industrial applications. However, strategies to reduce moisture content and costs should be explored to maximize the benefits.

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Conflicted interest: None

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