

# Utilization of Rice husk as an Activated Carbon Adsorbent for the Purification of Used Cooking Oil

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**Abstract**—The use of cooking oil on a regular basis can result in an increase in the amount of free fatty acids and peroxide in the food. As a result, prolonged exposure to spent cooking oil has been linked to harmful effects on the environment as well as human health. As a result, used cooking oil must be purified before being released into the environment. Rice husk has cellulose in the range of 30 to 40%, making it suitable for use as a carbon adsorbent's raw material in the purification of used cooking oil (UCO). This research created a carbon adsorbent from rice husk utilising a two-hour carbonization procedure at 500°C combustion temperature and chemical activation with 1 N H<sub>2</sub>SO<sub>4</sub>. This work was performed with a 6 g adsorbent with contact durations of 30, 60, 90, 120, and 150 min. After 150 min of contact time, the most favourable results were free fatty acids 0.0526 percent, peroxide value 0.40 meq O<sub>2</sub>/kg and density 0.9052 g/mL.

**Keywords:** rice husk, cooking oil purification, adsorbent, activated carbon

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## 1. INTRODUCTION

South Asia, India, and China are the top three countries in terms of rice husk biomass production. Compared to other farming bio-waste materials, rice husk has low utilization value as husk and high utilization value as ash made up largely of silica. Rice husk organic matter have been utilized as source of energy and also the non-carbon content has high value added utilization potential. Rice is that the third most significant cereal crop grown around the world with an annual production of

greater than 650 million tons [1]. Rice husk that is a layer protective for rice grain is that the major by-product obtained from rice processing mill [2, 3]. Rice husks are principally composed of cellulose (32.24%), hemicelluloses (21.34%), lignin (21.44%), water (8.11%), extractives (1.82%) and mineral ash (15.05%) as well as high percentage of silica in its mineral ash that is 94.5–96.34% [4, 5]. Components of rice husk illustrated in Fig. 1.

When related to some other agro-wastes like scrap of woods and maize straw, husk of rice is notable for

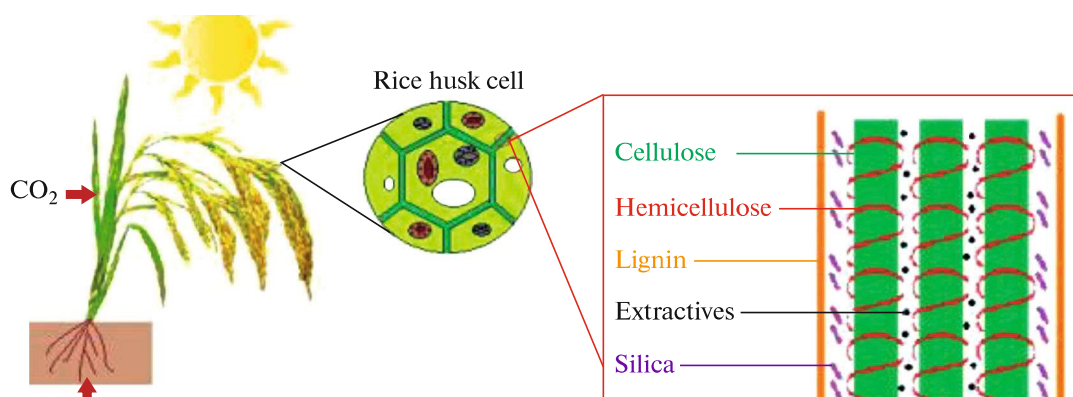


Fig. 1. Illustration of components of rice husk.

low value of utilization of the rice husks themselves and high value of utilization of their ash that is for the most part silica [6, 7]. Rice husk is used extensively, as a result of the  $\text{SiO}_2$  may be a low-cost of silicon source, that is commonly utilized for the synthesis of materials like cement, filter aids, and silicide's [8, 9]. Especially, RHA has greater than 80 percent of silica, the silica is principally poised of amorphous cristobalite [10]. Rice husks also may be used as reinforcement of cement [11]. Due to very good porous nature of rice husk, can also be utilized as catalyst carrier [12], and as a low-cost adsorbent [13].

Additionally, UCO management is still regarded as inadequate. Cooking oil will almost certainly alter the colour and produce an odour when used. Furthermore, the amount of free fatty acids and peroxides increases. When cooking oil is heated at a high temperature with air contact, it undergoes hydrolysis, polymerization, and oxidation, which alters its chemical properties [14]. Human health is being jeopardised as a result of these situations. As a result, used cooking oil must be purified before being released into the environment. There are a number of methods for purifying UCO, one of which is the process of adsorption. So many investigations have been conducted on the adsorption of wasted cooking oil utilising  $\text{H}_2\text{SO}_4$  activators and diverse source materials. In a prior work, activated carbon from ketapang was employed for the purification of UCO as an adsorbent using  $\text{H}_2\text{SO}_4$  activator, with the best results 0.78% free fatty acids [15]. A prior research looked at the quality of UCO after employing bagasse carbon adsorbent and activating it with  $\text{H}_2\text{SO}_4$ , the peroxide value was 6.4295 milli equivalents for kilogram is most beneficial [16]. Another investigation employed for maize stalks to purify UCO with  $\text{HNO}_3$  and  $\text{H}_2\text{SO}_4$  like two different activators, given best results Peroxide value 14.78 meq/kg and FFA 0.0548 percent [17]. For the adsorption process of UCO purification, many types of activated carbons derived from several source materials have been used. The goal of this study is to employ activated carbon adsorbent from rice husk to test the quality of spent cooking oil. As a result, a more cost-

effective approach is predicted to create an eco-friendly UCO.

According to proximate analysis rice husk contains moisture content 11.8%, volatile matter 50.6%, fixed carbon 15.3% and ash content 22.6%. It depends on how the rice is grown, the soil chemistry, the climatic conditions, and even the geographic location. Rice husk contains 12 to 18 percent fixed carbon and 17 to 22 percent ash [18].

In this study rice husk is used for production of activated carbon as a raw material, because it has enough carbon content. When cooking oil is used repeatedly for frying and then heated at high temperatures, the chemical content of the cooking oil can be harmed, since the cooking oil's components have oxidised, changing its chemical composition. The colour of the cooking oil darkens as it is used more frequently, which is one of its properties of the oxidation reaction. Furthermore, the cooking oil's free fatty acid value provides information about oxidation and hydrolysis reactions, whereas its water content results from hydrolysis. When cooking oil is hydrolyzed, oxidized, or polymerized, undesirable components occur that produce foam, increased density and viscosity [19].

## 2. MATERIAS AND METHOD

### 2.1. Preparation of Rice Husk Activated Carbon (RHAC)

Rice husk was collected out of a rice mill near Telaprolu in Vijayawada, India, and thoroughly cleaned with distilled water, then oven-dried overnight at  $110^\circ\text{C}$ . We calcined rice husks for four hours at different temperatures in different atmospheres. It was programmed to maintain a temperature of  $10^\circ\text{C}$  per minute and a gas flow of 40 mL per minute [20]. Afterward, rice husk carbon is activated using a 1 N  $\text{H}_2\text{SO}_4$  solution. The process of activation takes 1 day to complete. After being cleaned with distilled water till pH is equal to 7, activated carbon is filtered. To eliminate its water content, powdered activated carbon is dried at  $110^\circ\text{C}$  for two hours. Flow chart of activated carbon

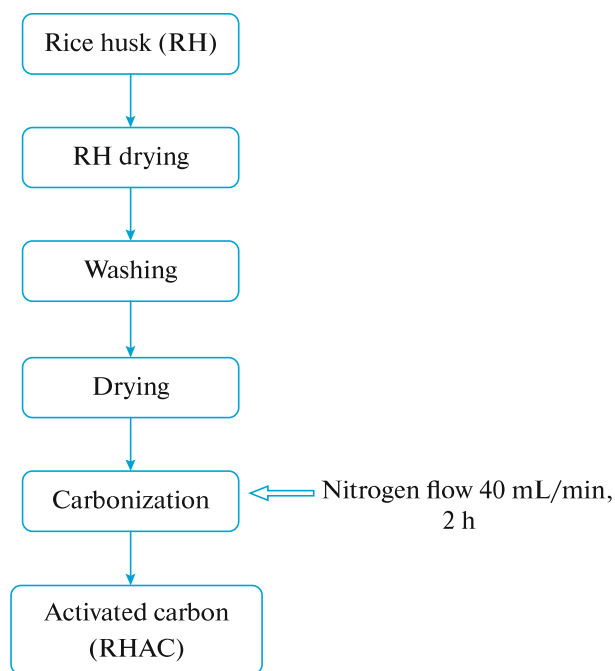


Fig. 2. Flow chart of preparation of activated carbon.

shown in Fig. 2. Digital images of rice crop, rice husk and its activated carbon were shown in Fig. 3.

### 2.2. Purification Method

500 grams of UCO are weighed and combined with distilled water by 1 : 1 ratio composition. Using heat, volume of this mixture is reduced to half of what it was before. A separating funnel is then used to remove and deposit the oil layer for an hour. To remove any left-over contaminants oil layer is then filtered. For the odour removal process, 450 g of used cooking oil was heated to 35°C, then 16 percent NaOH 18 ml was added to the UCO and swirled for 10 minutes at 40°C. After waiting 10 minutes for the mixture to cool, the oil and NaOH mixture will generate soap, which must be separated from the oil. At room temperature, 6 g of activated carbon is mixed with 200 mL of UCO, and

allow to contact for 30 to 150 min with 30 min interval. Lastly, filter paper is used to filter pure cooking oil for analysis.

## 3. RESULTS AND DISCUSSION

### 3.1. Free Fatty Acids

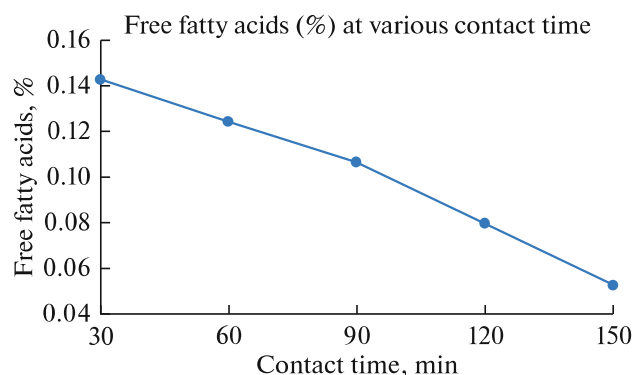
Hydrolytic processes create free fatty acids at any point during the process. The amount of FFAs in palm oil is generally less than 1%; nevertheless, the high level of FFAs indicates quality of the oil is low; oil becomes rancid if the amount of FFAs greater than 1%, and the surface of the tongue can taste it [21]. Furthermore, free fatty acids have been linked to type-2 diabetes in humans and metabolically unhealthy obesity, and they are thought to have a role in final stage renal disease regardless of the implicit in kidney illness [22].

According to Fig. 4 and Table 1, the values of FFAs decrease as contact duration increases. Longer contact times are associated with lower FFA values. This is because the adsorbent surface and UCO interact more deeply when the contact time is longer. Furthermore, the more adsorbent mass employed, the more surface is generated, allowing the adsorbent to adsorb more FFAs. Adsorption occurs on the adsorbent's surface when there is a greater surface area and a longer contact time, which result in the fatty acids being freed from the surface and the oxidation of unsaturated fatty acids occurs, which is what improves adsorption.

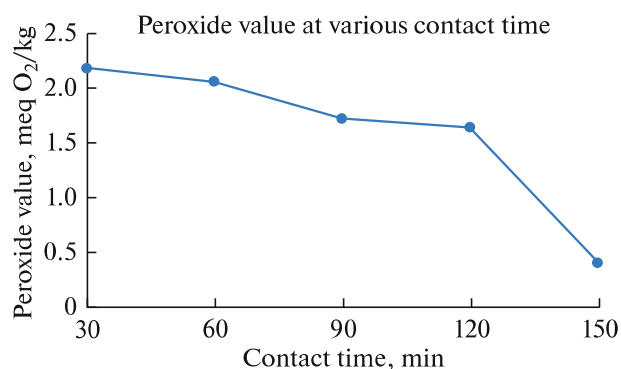
The carbon is activated by immersing it in 1 N  $H_2SO_4$  solution to expand the length and breadth of its pores, which are then coated by organic metal oxide components or materials. As a result, these carbon holes aid in the adsorption of contaminants, lowering the amount of FFAs in UCO. According to the findings of the investigation, the contaminant free fatty acids is dramatically decreased following the adsorption procedure. This occurs because the higher the amount of adsorption, the longer the adsorbent is used. During the adsorption phase, the adsorbent absorbed contaminants into pores of carbon material,



Fig. 3. Digital images of rice crop, rice husk and activated carbon.



**Fig. 4.** FFAs percentage variation by the influence of contact time.



**Fig. 5.** Effect of peroxide value by contact time.

and the activation method increased the rate of adsorption.

### 3.2. Peroxide Value

To dissolve UCO mixture of chloroform and acetic acid is used, and saturated KI solution is then used to expose this mixture to excess iodide. Titration of iodine is carried out using sodium thiosulfate and starch as indicators used for a colorimetric endpoint following the oxidation of iodide by the peroxides present. Iodine is produced proportionally to peroxide present. It is usually associated with rotten oils when peroxide levels above 30–40 mEq/Kg, but fresh oils have a peroxide value greater than 10 mEq/Kg. As a result, the degree of oil deterioration is determined also by peroxide value in oil. The graph indicates with longer contact time peroxide value steadily decreases,

as seen in Table 2 and Fig. 5. The removal of double bonds in oil causes a drop in peroxide value. Furthermore, peroxide includes oxygen as a polar molecule, making it easier to bind to the adsorbent [23]. As a result, the less damage the oil suffers when lower the peroxide value,

In this work activation of carbon material done with 1 N H<sub>2</sub>SO<sub>4</sub> to increase its surface area and pores. Hence, in the oil it binds and adsorbs more peroxide chemicals. There is drop in peroxide value but it does not affected by adsorption process because it does not involve heating [24]. Moreover, the peroxide compounds may regenerate when heating is involved in adsorption process. Peroxide is produced when unsaturated fatty acids in oil are oxidized by oxygen.

Activated carbon derived from rice husk is used in the adsorption process, resulting in peroxide values of 10 meq O<sub>2</sub>/kg after 30 min of contact time, as shown

**Table 1.** FFAs at different contact time

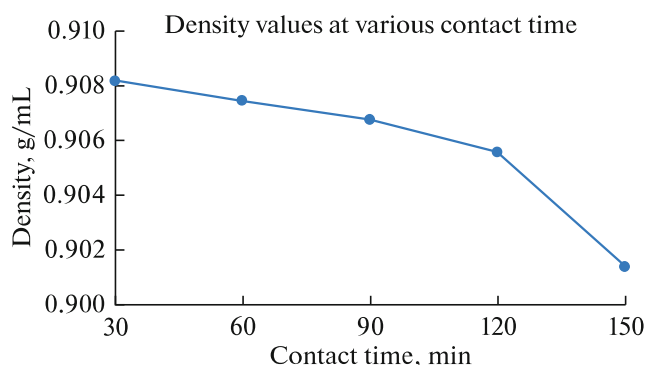
Used cooking oil, g	Adsorbent weight, g	Contact time, min	Free fatty acids, %
450	6	30	0.1426
		60	0.1242
		90	0.1064
		120	0.0795
		150	0.0526

**Table 2.** Variations in peroxide value with different contact times

Used cooking oil, g	Adsorbent weight, g	Contact time, min	Peroxide value, meq O <sub>2</sub> /kg
450	6	30	2.18
		60	2.06
		90	1.72
		120	1.64
		150	0.40

**Table 3.** Density at various contact time

Used cooking oil, g	Weight of adsorbent, g	Contact time, min	Peroxide value, meq O <sub>2</sub> /kg
2	6	30	0.9082
		60	0.9075
		90	0.9068
		120	0.9056
		150	0.9014

**Fig. 6.** Effect on density by contact time.

by the peroxide value analysis. As a result, carbon-based adsorption method is thought to be impressive for adsorption.

### 3.3. Density

It can be observed in Fig. 6 that the density of UCO drops dramatically. By adsorbing a large amount of impurities from UCO, the adsorbent reduces the molecular bonding in the oil, removing odours and dark color [25].

The density of the oil is affected by its water content and the amount of impurities present. As shown by the density study of UCO after it has been adsorbed with activated carbon the density found to be 0.9014 g/mL, all samples do not satisfy the standard value of 0.900 g/mL at adsorbent weight of 6 gramme with a contact time of 150 min.

## 4. CONCLUSIONS

The adsorbent in this study was used at 150 min contact times without activation to determine free fatty acid values, peroxide values and densities. By using 6 g of adsorbent, the best density was determined to be 0.0526%, 0.40 meq O<sub>2</sub>/kg, and 0.9014 g/mL.

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## CONFLICT OF INTEREST

The authors states that there is no conflict of interest.

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