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# ACTIVATED CARBON FROM THE PERICARP OF PEANUT

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This study was undertaken to carbonize pericarp of peanut, an agricultural waste material, in the presence of various concentrations of pure sulphuric acid at different activation temperatures. Percent yield of the product was determined and its adsorption capacity was measured against methylene blue. The best adsorption capacity was obtained at 700°C with 9N sulphuric acid in solid-liquid ratio of 1:4. Increase in combustion loss as well as activity was also observed with rise in temperature.

Key words: activating agent, active carbon production, adsorption capacity, peanut pericarp

## INTRODUCTION

All activated carbons possess a porous structure, usually with small amounts of chemically bound oxygen and hydrogen. In addition, activated carbon can contain up to 20% of mineral matter, which after ignition is usually indicated as ash or residue. A large number of very fine pores (micro pores) gives the activated carbon a large linner surface, which is the basis of its remarkable adsorption properties. Total surface area of activated carbon ranges between $2x10^4$ and $6x10^4$ $cm^2$ per gram. X-ray investigations show that carbon is mainly in the form of very small crystallites with a graphite structure.

Activated carbon can be divided into two main classes i.e. those used for adsorption of gas and vapours for which hard granules or pellets are generally employed and those used in purification of liquids for which light, fluffy powder is desired. The latter type is used in improving the colour of manufactured chemicals, oils and fats as well as controlling odour, taste and colour in potable water supplies, beverages and some foods, while former is used in gas separators, recovering solvent vapours, air conditioning, gas masks and supporting metal salt catalysts, particularly in the production of vinyl resin mcnomers. Over 29 million rupees per annum are spent to import more than 544 metric tonnes carbon (Anonymous, 1998). In order to cope with this situation it was imperative to exploit the locally available agricultural residues/plant materials for the preparation of activated carbon so as to cater the industrial needs.

Peanut is grown round the world in tropics and comparatively warmer regions of the temperate zones. In Pakistan, peanut crop is abundantly grown in rainfed areas and sub-mountainous regions such as parts of Rawalpindi and Sargodha Divisions. Estimated production of peanut crop in Pakistan was 0.12 million tonnes for the year 1996-97(Anonymous, 1998). Pericarp comprises about 20 to 30% of the weight of mature peanut depending upon variety and environmental conditions. It is a cheap carbonaceous raw material.. This study was undertaken to evaluate pericarp of peanut for the manufacture of activated carbon. The basic purpose of this study was to use available indigenous material to produce quality activated carbon.

## MATERIALS AND METHODS

The research work was completed in the Department of Chemistry, University of Agriculture, Faisalabad. Peanut pericarp (300g) was washed with water and sun dried for seven days. The sample was pulverized to a mesh having pore size of 1mm and dried in an oven at 105 - 110°C. Dried sample was stored in a glass bottle as a stock sample. It was then activated at different temperatures using various concentrations of pure sulphuric acid

Activation: Solutions of pure sulphuric acid (5N, 7N and 9N) were prepared and poured in crucibles containing 5.0g stock sample each, keeping solid-liquid ratio at 1:4 *WN*. The samples were placed in desiccators and allowed to digest for an hour. These were removed form the desiccator and placed in an oven at 110°C for an hour for the expulsion of volatile substances. After drying, these samples were heated in a furnace by using lid-covered crucibles to related activation temperatures ranging form 400-700°C for an hour. The samples were cooled and leached with 2M hydrochloric acid and then washed with distilled water. Each sample was heated at 110°C in hot air oven following which these were heated at the respective activation

**Table 1. Average percentage yield of active carbon obtained by chemical activation of peanut pericarp at different temperatures**

| | One hour activation at various temperatures (OC) | | | |
|---|---|---|---|---|
| Pure H2S04 (1:4 *WN)* | 400 | 500 | 600 | 700 |
| 5N | 51,38 | 38.47 | 32.03 | 25.17 |
| 7N | 50,46 | 37.41 | 31,09 | 23.18 |
| 9N | 50.20 | 35.78 | 30.23 | 21,18 |

**Table 2. Average adsorption capacity expressed as milligrams of methylene blue decolourized by one gram of** active carbon **obtained from peanut pericarp at different temperatures**

| | One hour activation at various temperatures (OC) | | | |
|---|---|---|---|---|
| Pure H2S04 (1:4 *WN)* | 400 | 500 | 600 | 700 |
| 5N | 9 | 12 | 21 | 48 |
| 7N | 12 | 15 | 27 | 57 |
| 9N | 14 | 18 | 30 | 60 |

temperature for 15 minutes. Cooled material was ground, weighed and stored in desiccators.

**Adsorption Capacity of Activated Carbon:** The activity of carbon thus prepared was compared with the reference from E. Merck, purchased from the market, against methylene blue using standard method of Beg and Usmani (1985). The data obtained were subjected to analysis of variance using randomized complete block design and means were compared using Duncan.s multiple range test (Steel and Torrie,1980)

**RESULTS AND DISCUSSION**

Activated carbon can be prepared by almost any carbonaceous material using various activating agents. However from industrial point of view, many faetors such as availability of the material used, economic aspect, quantity and quality of product obtained are important. Thermal decomposition (chemical activation) of weighed pericarp of peanut was undertaken in the presence of various concentrations of sulphuric acid at different temperatures i.e. 400°C, 600°C, and 700°C in an ordinary furnace.

**Effect of Temperature and Concentration of the Activating Agent on the Yield of Active Carbon:** Results showed that treatment of pericarp with *5N,* 7N and 9N solutions of pure sulphuric acid at solid-liquid ratio 1:4 *WN* gave 51,83, 50,46 and 50.20% yield respectively at 400°C while using the same concentrations of pure sulphuric acid, the maximum yields obtained at 700°C were 25.17, 23.18 and 21,18% respectively as shown in Table 1. It is evident that the increase in combustion temperature decreased the percentage yield of the aetivated carbon. This decrease may be due to oxidation of carbon into carbon dioxide and carbon monoxide. It is also indicated that the percentage yield decreased with increasing concentration of sulphuric acid. Decreased yield of activated carbon with sulphuric acid may be due to its oxidizing character resulting into more decomposition of the carbonaceous material.. Similar findings have also been reported by Chughtai and Nisa (1987). Duncan's multiple range test showed that temperature means and concentration means differed significantly (Table 3).

**Effect of Temperature and Concentration of Activating Agent on the Adsorption Capacity of Active Carbon:** Table 2 shows the effect of temperature and acid concentration on the adsorption capacity of the product in terms of milligrams of methylene blue decolourized by one gram of activated carbon. It is indicated that with increase in combustion temperature, adsorption power increased at the cost of percentage yield. Maximum and minimum adsorptions were obtained at 700°C C and 400°C respectively. Activated carbon

Table 3. Analysis of variance of data concerning the effect of temperature and acid concentration on percentage yield and adsorption power of active carbon

| S.D.V. | d.f | M.S. (% yield) | M.S. (adsorption power) | P-value |
|---|---|---|---|---|
| T | 3 | 408.989 ** | 1164.083 ** | P<O.Ol |
| C | 2 | 6.398 ** | 66.083 ** | |
| Error | 6 | 0.333 | 3.083 | |

**: Highly significant

Duncan's multiple range test

Mean (%) yield and mean adsorption power at different temperatures of activation

| | 700°C | 600°C | 500°C | 400°C |
|---|---|---|---|---|
| Yield (%) | 23.180 a | 31.119 b | 37.218 c | 50.830 d |
| Adsorption power | 11.667 a | 15.000 a | 26.000 b | 55.000 c |

Mean (%) yield and mean adsorption power at different concentration of pure *H2SD4*

| | 5N | 7N | 9N |
|---|---|---|---|
| Yield (%) | 34.348 a | 35.534 b | 36.876 c |
| Adsorption power' | 22.500 a | 27.750 b | 30.500 b |

'"Milligrams of methylene blue decolourized by one gram of active carbon.

prepared by using 9N sulphuric acid (at 1:4 w/v) at 400°C adsorbed 14 mg of methylene blue per gram, while one gram of sample treated with the same activating agent in the same concentration at 700°C adsorbed 60 mg of methylene blue. It was also observed that decolourizing efficiency increased with increasing concentration of activating agent. This may be due to the formation of additional active areas, the active centers. Active centers may be broadly defined as the sum of the forces that hold an adsorbed molecule. Adsorption capacity of activated carbon obtained by using 5N, 7N and 9N sulphuric acid (1:4 *WN)* at combustion temperature 400°C was 9, 12 and 14 mg per gram respectively for methylene blue showing an increase in activity with increase in concentration of activating agent. Similar results were obtained at other activation temperatures (Chughtai *et al., 1996).*

A rapid increase in adsorption power was observed when the temperature was increased from 600 to 700°C, indicating this range to be the optimum activation temperature range. Below this range though the percentage yield is maximum but decolourizing power is minimum and above this range percentage yield is very poor. Increase in combustion loss and adsorption capacity by increasing carbonizing temperature has been reported by Chughtai *et al.* (1992). Taking into account the effect of temperature and acid concentration on the percentage yield and adsorption power of the active carbon, it may be stated from the data that the maximum adsorption capacity observed in this study was 60 mg methylene blue/gram of active carbon which is less than 50% of adsorption shown by activated carbon of E. Merck used as standard. It is thus apparent that although pure sulphuric acid converted pericarp of peanut into active carbon but the active carbon produced by it did not show the desired adsorption power since pure sulphuric acid acts as oxidizing and dehydrating agent and not as a good activating agent.

## REFERENCES

Anonymous. 1998. 50 Years of Pakistan in Statistics (1947-1997). Government of Pakistan, Islamabad.

Anonymous. 1998. Monthly Statistical Bulletin, 46(6): 279. Government of Pakistan, Islamabad.

Beg, AN. and T.H. Usmani. 1985. Low ash activated carbon from rice husk. J. Sci. Ind. Res. 28(4): 22-287.

Chughtai, F.A andF. Nisa. 1987. Activated carbon from sarkanda. Sarhad J. Agri. 3(3): 405-408.

Chughtai, F. A, Z.H. Nazli and M. Moazzam. 1992. Chemical activation of various indigenous materials to prepare active carbon. J. Pure Applied Sci. 11(1): 11-13.

Chughtai, F.A, I. Zafar, Z.H. Nazli and J. A Awan. 1996. Activated carbon from saw dust. JAPS. 6(3-4): 119-120.

Steel, RG.D. and J.H. Torrie. 1980. Principles and Procedures of Statistics. McGraw Hill Book Co. Inc., New York.