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ACTIVATED CARBON FROM THE PERICARP OF PEANlIT USING ZINC CHLORIDE

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The present investigations were undertaken to carbonize pericarp of peanut.. an agricultural waste material.. in the presence of zinc chloride in various concentrations at different activation temperatures. Percent yield of the product was determined and its adsorption capacity was measured against methylene blue. TIle best adsorption capacity was obtained at 7()()"C with :'iN zinc chloride in solid: liquid ratio of 1:4. Increase in combustion loss as well as activity was also observed with rise in temperature

Key words: activated carbon. adsorption capacity. peanut pericarp. zinc chloride

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'X. of mineral matter. which after ignition is usually indicated as ash or residue. A large number of very fine pores (micro-pores) give the activated carbon a large inner surface. which is the basic of its remarkable adsorption properties. Total surface area of activated carbon ranges between Zx 10^4 and 6x $10^4 cm^2$ per gram. X-ray investigations show that carbon is mainly in the form of very small crystallitcs with a graphite structure.

Activated carbon can be divided into two main classes: those used for adsorption of gas and vapours for which hard granules or pellets arc generally employed and those 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 for controlling odour.. taste and colour in potable water supplies. beverages and some foods. while the 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 monomers.

More than two million rupees per annum in the form of foreign exchange are spent on the import of about 54421 kg of active carbon (Anonymous. 1998). In order to cope with the situation it was imperative to exploit the locally available agricultural residues/plant materials for the preparation of activated carbon so as to cater the needs of pertinent industries.

Peanut also called groundnut and earthnut is grown round the world in tropical countries and warmer regions of the temperate zone. In Pakistan. peanut crop is abundantly grown in rainfed areas and submountainous regions such as Rawalpindi and Sargodha Divisions. Final estimate for the prod.uction of peanut crop in Pakistan was ll7000 tonnes for the year 1996-97. Pericarp comprises about 20 to 30% of the weight of mature peanut depending upon the 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.

MATERIALS AND METHODS

The research work was undertaken in the Department of Chemistry. University of Agriculture. Faisalabad. Pcricarp of peanut was washed with water and sun dried for seven days. The sample was pulverized to a mesh having pore size of Imm diameter and placed in au electric oven at 105-110°C.. Dried sample was stored in a glass bottle as stock sample. It was then activated at different temperatures using various concentrations of zinc chloride.

Activation: Solutions of zinc chloride (I N.. \ N and :'iN) were prepared and poured in crucibles each containing 5.0g stock sample. keeping solid:liquid ratio at 1:4 *wtv.* The samples were placed in a desiccator and were allowed to digest for a period of one hour. The samples were then placed in an oven at 110°C for one hour for the expulsion of volatile substances. After dl) I\1g. these samples were heated in a furnace. by using lid-covered crucibles to varying activation temperatures ranging from -WO-700"C for one hour. The samples were cooled and leached with 2M hydrochloric acid and then washed" ith distilled water. Each sample was heated at 110°C in an hot air oven following which it was heated at the respective activation temperature for 1.5 minutes. Cooled material was ground. weighed. and stored in a desiccator: The activity of c;~rbon prepared above was compared with that of the reference from E. Merck. purchased from the market,. against methylene blue (Beg and Usmani. 1985). The data obtained with different concentrations at different temperatures for percent yield and adsorption power of active carbon was aualyzcd b~ applying randomized complete block design and analysis of variance technique (Steel and Torrie. IIJXO).

RESULTS AND DISCUSSION

Activated carbon can be prepared by almost an~ carbonaceous material using various activati ng agent s From industrial point of view. many factors such as availability of the material used. economic aspect.. quant it~ and quality of the product etc. are very important. The basic purpose of this study was to use available indigenous material for producing activated carbon keeping the above factors in consideration.

Effect of Temperature and Concentration of Activating Agents on the Yield of Active Carbon: Results showed that treatment of pericarp with IN. 3N and 5N solutions of zinc chloride at solid:liquid of 1:4 w/v gave maximum yields i.e. 5089.53.17 and 53.12% respectively at 400°C, while using the same concentrations of zinc chloride the maximum yields obtained were 29.88. 34.22 and 36.73% respectively at 700°C as shown in Table I. It is evident that the increase in combustion temperature decreased the percentage yield of the activated carbon. The decrease may be due to oxidation of carbon into carbon dioxide and carbon monoxide. while percentage yield of activated carbon increased with increasing concentration of zinc chloride. It appears that zinc chloride does not help in the oxidation mechanism. but it acts only as a dehydrating and activating agent. Similar findings have been reported by other workers (Ahmad, 1968: Chughtai et al., 1996).

Effect of Temperature and Concentration of Activating Agent on the Adsorption Capacity of Active Carbon: It was observed that with increase in combustion temperature. adsorption power increased at the cost of percentage yield as shown in Table 2. Maximum and minimum adsorptions were obtained at 700°C and 400°C respectively. Activated carbon prepared by using 5N zinc chloride (l:4 w/v) at 400°C adsorbed 87 mg of methylene blue per gram. while one gram of sample treated with the same activating agent at the same concentration at 700°C adsorbed 225 mg of methylene blue. It was also observed that the decolourizing efficiency increased with increasing concentration of activation 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 IN. 3N and 5N zinc chloride (1:4 w/v) at combustion temperature of 400°C was 30. 69 and 87mg per gram respectively for methylene blue showing increased activity with increase in concentration of activating agent. Similar results were obtained at other activation temperatures. A rapid increase in adsorption power was observed when the temperature was increased from 600 to 700°('. indicating this range to be an 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.

The maximum adsorption with 5N zinc chloride (225 mg/g for methylene blue) was obtained at 700°C. This value is much higher than that with the available sample of E. Merck (126mg/g for methylene blue). Increase in combustion loss and adsorption capacity by increasing carbonizing temperature has already been reported by various workers who have prepared active carbon from materials other than pericarp of peanut (Chughtai and F. Nisa. 1987: Chughtai et al., 1992).

Taking into account the effect of temperature and concentration on the percentage yield and adsorption power of the active carbon. it is evident from the data that the maximum adsorption (225 mg methylene blue/gram of active carbon) was shown by the activated carbon prepared by using 5N zinc chloride at 700°C as against 12(lIug of methylene blue by one gram of standard sample from E Merck. The optimal pericarp zinc chloride ratio was 1:-l yielding 16.73% activated carbon. It was observed that means of percent yield and adsorption power at different temperatures and concentrations differed significantly.

The present work shows that activated carbon may be prepared from pericarp 'Of peanut at 600- 700"C keeping the quality and quantity of product in view. Moreover. it is obvious from these results that with the increase in combustion temperature. the percentage yield of activated carbon decreased while adsorption power increased. It may be pointed out here that although a longer time for activation and high temperature produced greater adsorption power but oxidation process involves a considerable loss of carbon. Therefore. there is a point beyond which it will no longer be economical to conduct the activation.

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

Pericarp and zinc chloride ratio (w/v 1:4)	Activation tempcraturer"C) for onc hour			
	'400	sn	(~M)	7t10
IN	50.89	37.96	J(),)3	29.88
2N	53.17	41.01	19.51	14.22
3N	53.12	42.14	~1.IO	16.73

Table LAverage adsorption capacit~, expressed as milligrams of methylene blue decolourizcd b)' one gram of active carbon obtained from pericaep of peanut at different temperatures of activation

Pericarp and zinc chloride ratio (w/v 1:4)	Activation tempcnuurctrC) for one hour			
	400	sn	(~M)	7tX)
IN	30	39	51	90
2N	69	90	105	1.1)2
3N	87	III	118	225

and yield parameters were recorded using standard procedures. Data collected were analysed using Fisher's analysis of variance technique. and the least significant difference test at 0.05 probability level was employed to compare the difference among the treatment means (Steel and Tome, 1984).

RESULTS AND DISCUSSION.

Data recorded regarding various parameters are given in Table 1.

1. Number of Fertile Tillers m,l: Both the seed rates produced statistically different number of fertile tillers m,l. Seed rate of 150 kg ha"· produced more number of fertile tillers m? than seed rate of 100 kg ha". These results are contrary \0 \he r\\\\\\\%~o{ Ram. et 'd\. (\\)<)5) 'Nb.o reported a decrease in tillering capacity of wheat by increasing seed rate. Number of fertile tillers m? was decreased significantly by increasing wild oat competition durations. The highest number of fertile tillers was recorded where the plot was kept free of weeds throughout the crop season. All the treatments of wild oat competition showed significantly different results from each other. The linear decrease in the number offertile tillers m? with the increase in competition duration may be due to competition of weeds with wheat plants for different soil and climatic sources. These results agreee with those of AIi et al. (2000).

Table 1. Growth and yield of wheat as influenced by different seed rates and wild oat competition durations

	No. of fertile tillers m,2	No. of grains spike:'	1000-grain wieght(g)	Biological yield (t ha")	Grain yield (t ha")	Harvest index (%)
Seed rate (kg ha:')						
SI = 100	333.40b	44.53a	34.31^{NS}	14.88b.	4.89^{NS}	32.65^{NS}
S2= 100	350.86a	39.73b	33.50	15.78a	5.20	32.83
Competition durations						
Do = Noweed competition (Control) .	.379.67a	46.33a	34.97^{NS}	16.28a	5.63a	34.59a
D1 = Competition for 25 DAE	365.50b	43.67b	34.45	15.85a	5.23b	33.71ab
D2= .Competition for40DAE	330.67c	39.67bc	33.79	15.78a	5.05bc	32.39bc
D3 = Competition , for 55 DAE	324.50d	38.83c	33.66	14.92b	4.88c	32.22bc
D4 = Competition for fullgrowing season	310.33e	37.67c	32.84	13.81c	4.44d	30.79c

Means in the same column having different letters differ significantly ($P < 0.05$).
NS = Non-significant; DAE = Days after emergence.

2. Number of Grains Spike? : Data given in Table 1 revealed that seed rates significantly affected the number of grains spike"! Seeding rate of 150 kg ha"' produced less number of grains spike". This might be due to the fact that higher seed rates produced more plant population which ultimately resulted in more competition among plants for water and nutrients and a subsequent reduction in the supply of assimilates from source to sink.. The decrease in number of grains spike' 1 by increasing seed rate was also reported by Bellatore er all. (1985). In weed competition treatments, wild oat free plots produced higher number of gr .• spike-I which was also significantly higher than;

all other treatments. The number of grains spike" progressively decreased by increasing wild oat competiition durations. The plots where weeds were not allowed to compete with wheat plants resulted in better growth and increased the number of grains spike", Significant effect of weed competition durations on number of grains spike" was also reported by Abmad (1999).

3. lOOO-Grain Weight (g): The two seed rates produced statistically similar WOO-grain weight. Although WOO-grain weight was not significantly affected by the wild oat and wheat competition for various durations, yet a linear decrease in 1000-grain weight was observed by progressive competition durations. The results are similar to the findings of Ahn\ad (1999) and Aliet al. (2000).

4. Biological Yield (t ha") : Biological yield increased significantly by increasing seed rate. It appeared that higher seed rate resulted in more plant population which ultimately increased biological yield. These results are in line with those of Bellatore et al. (1985). Biological yield was also significantly affected by wild oat competition durations. Treatments embodying no weed competition and those involving competition for 25 and 40 days postemergence produced statistically similar biological yields but significantly higher than those obtained after competition for 55 days postemergence and competition for full crop season. The lowest biological yield was recorded in plots where wild oats were allowed to compete for the entire season. The results conform to those of Sarwar (1994) and Ali et al. (2000) who reported significant reduction in biological yield by increasing weed competition durations,

5. Grain Yield (t ha:') : The two seed rates produced statistically similar grain yields. These results are in line with those of Bellatore et al. (1985). however. disagree with those of Koc (1995) and Ahuja et al. (1996). The difference in results might be due to variation in climatic factors. soil fertility and management practices. There was a highly significant effect of weed competition durations on grain yield of wheat. The highest grain yield was obtained when field was kept free of wild oats throughout the crop season.

It was followed by the competition duraiton of 25 days after emergence which was statistically at par with the competition duraiton of 40 days postemergence. The latter yield in turn did not differ significantly from that of competition duration of 55 days after emergence. The lowest grain yield (4.44 t ha-1) was recorded in plots with full season competition. Prolonged competition durations significantly depressed the main components of yield like number of fertile tillers per unit area and number of grains spike", Such results were also reported by Tanveer (1995) and Ali et al. (2000).

4. Harvest Index : The values given in Table I indicated that seed rate had no significant effect on harvest index. However. it was significantly affected by wild oat competition durations. The results showed that where weeding was done throughout the crop growth period or after 2~ days of weed competition, significantly higher harvest index values were obtained which decreased progressively due to increasing wild oat competition duralions.

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