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Scavenging Efficiency of Activated Charcoal of Sweet Corn Cop and Areca Nut Shell for Carcinogenic Salicylic Acid and Methylene Blue

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Abstract: Activated plant charcoal plays major role in adsorption chemistry and finds a huge application in industry, pharmaceuticals, cosmetics and water treatment. Present work planned to utilize waste sweet corn cop and areca nut husk to prepare charcoal by chemical method. The charcoal was carbonized at 800^0C using muffle furnace. The adsorption efficiency of the experimental activated carbon adsorbents towards the model organic compounds methylene blue and salicylic acid were assessed by UV-Vis spectrophotometric method. Experimental results clearly indicates that sweet corn cop charcoal recorded maximum absorption for salicylic acid 640ppm/g in compare to areca nut shell husk charcoal 480ppm/g. Sweet corn cop charcoal recorded optimum absorption for methylene blue 240 ppm/g in compare to areca nut shell husk charcoal 240ppm/g. The experimental charcoal projects noticeable results in scavenging salicylic acid and methylene blue from polluted samples. This experimental results and affordable cost the raw material made the sweet corn cop and areca nut husk activated carbon a powerful alternative for the adsorption of carcinogenic organic compounds salicylic acid and methylene blue.

Keywords: Methylene blue, Salicylic acid, Sweet corn cop, Areca-nut, Adsorption, Efficiency.

1. INTRODUCTION

Activated charcoals play a vital role in the adsorption chemistry and its adsorption properties are widely utilized in industries, pharmaceuticals and cosmetics. Wood charcoal is a best adsorbent as it is less expensive and eases of method of preparation. One of the most popular adsorbents used for the removal of liquid pollutants of either organic or inorganic origin is activated carbon (Tang. G etal., 2019; Jiang. C etal., 2020). Materials based on activated carbon show excellent adsorption properties determined by the highly-developed porous structure and high surface reactivity (Siddiqa. A etal., 2022; Liu. X etal., 2022; da Silva. E.L etal., 2022; Gayathiri. M etal., 2022). A large variety of materials with high carboncontent (hard (bituminous) coal, brown coal, coke, peat, and wood) from which activatedcarbon adsorbents can be obtained translate into a low price and a wide spectrum of applications (Lee. S.M etal.,2022; Yusop. M.F.M etl., 2022; Nowicki. P, Pietrzak.R., 2011). Activated carbons plant charcoalis a versatile adsorbent. Adsorption capacity of the activated carbon of plant charcoal is due to their high surface area, a microporous structure, and a high degree of surface reactivity (Bedmohata M.A etal., 2015). The morphological property of activated carbon depends on the method of preparation and starting material (Mohd Din A.T., Hameed B.H., 2009). Differentresearch studies reported the preparation of activated carbonusing nutshells (Hayashi J etal.,2002; Baklanova O.N etal., 2003), Bamboo (Samorm H etal., 2011), rice husk(Yakout S. M ., 2014), plant stem(Arun kumar A etal., 2014] etc. as raw material. Activated carbon from plant and wood source is the commonly used as an adsorbent for the removal of dyes and many organic compounds like phenolic compounds (Baklanova O.N etal., 2003). Many renewable resources like wood and coconut shell are dominant in the preparation of activated carbon (Ragan S. and Megonnell N., 2011). Rajeshwar Man Shrestha(Rajeshwar Man Shrestha., 2016) suggested different activated carbons prepared by variable parameters with optimal conditions like Lapsi seed stone particles to Phosphoric acid ratio (1:1), temperature of carbonization (400 ^{o} C). The utilization of cheaper wastes and agricultural by- products like apricot stones (Lotfi M etal., 2011), guava seeds (Collin GJ etal., 2007), black stone cherries (Maria JR etal., 2010), peach stones (Amina AA etal., 2008; Dong SK., 2004), orange peel (Foo KY and Hameed B.,2002), Peanut shell (Tau X and Xiaoqin L., 2008), coconut shell and wood (Rajeshwar Man Shrestha., 2016), rubber seeds (Lotfi M., etal., 2011), molasses (Laine J., 1989) are used for the preparation of activated carbon. Commercialactivated can be usually prepared fromnaturally occurring carbonaceous materials such ascoal, wood, and peat (Legrouri K., etal., 2005). A. A. Attia et al.,(A. A. Attia et al.,2010) proposed that charcoal produced from olive stones waschemically activated using sulfuric acid and utilizedas an adsorbent for the removal of Cr(VI) from aqueoussolution in the concentration range 4-50 mg/L.

Adsorption is also efficient in removal of organic micro-pollutants such aspharmaceuticals and personal care products; this is usually preformed using activated carbon (De Olivieria T., etal., 2017). It hasbeen observed that adsorption of nonpolar hydrophobic and/or negatively chargedcontaminants, such as diclofenac is temperature and pH dependent (Hernández-Leal L., et al., 2011). Phthalates contamination is a large problem because of its use in a wide range of industries.There are many methods to adsorb phthalates from aqueous solution and one of them is theusage of activated carbon (Hongbo W., et al., 2017) Adsorption of industrially important dyes namely bromophenol blue, alizarine red-S, methyl blue, methyleneblue, eriochrome black-T, malachite green, phenol red and methyl violet from aqueous media on activated charcoal has been investigated Muhammad J. Iqbal and Muhammad N. Ashiq., 2007). Activated carbon impregnated with organic compounds with active groups like –SH, -NH can provide more effective adsorption and elimination of heavy metals from the effluents (A. Mohammad-Khah and R. Ansari., 2009).

This research article aimed prepare waste sweet corn cop and areca nut shell husk were charred by chemical method and activated at 800^{0}C. The adsorption capacities of the obtained activated carbon adsorbents towards the model organic compounds methylene blue andsalicylic acid were assessed by UV-Vis spectrophotometric method.

2. MATERIALS AND METHODS

2.1 Chemicals

Conc. H_2SO_4, Double distilled water, NaOH, $FeCl_3$, Salicylic acid and Methylene blue. All chemicals are AR grade and purchased from Nice chemical suppliers.

2.2 Collection and processing of sweet corn cop and areca nut shells

Sweet corn cop and areca nut shells were collected from the local formers around Mysuru, Karnataka, India. It was dried in air oven at 105^{0}C 8hours per day for 5 days.

2.3 Preparation of Charcoal

The crushed cop was leached in concentrated suphuric acid for five days to char it. The charred cop was mixed with distilled water and filtered using number one filter paper. Resulting mass in the filter paper was washed thoroughly with distilled water, transferred into sample trey and dried at 105^0C for 24 hours. Dried charred mass was finely ground and carbonized in muffle furnace at 500^0C for four hours. The carbon was activated whenever it was used at 1050C for one hour in an air oven.

2.4 Sampling

2.4.1 Stock solution Methylene blue

0.1g of methylene blue was dissolved in one 100ml of distilled water using a standard volumetric flask. 10 ml of this solution was diluted to 100ml in standard volumetric flask which was utilized for the determination of adsorption.

2.4.2 Stock solution salicylic acid and ferric chloride

1g of salicylic acid was added 1g ferric chloride in HCl solution in 100ml volumetric flask. The solution is diluted up to the mark and mixed well to get uniform concentration. 10 ml of this solution was diluted to 100ml in volumetric flask which forms violet coloured complex and used for measuring adsorption

2.4.3 Adsorption efficiency experimental charcoal

Adsorption efficiency is determined using the formula below and it is expressed in terms of ppm per gram

$$\text{Adsorption Efficieny} = \frac{\text{Volume 100 \% absorption x concentration per ml}}{\text{Wt. of activated carbon in gram}}$$

3. RESULTS AND DISCUSSIONS

3.1 Adsorption efficiency of experimental charcoals for ferric chloride –salicylic acid complex

A weak ferric chloride –salicylic acid complex aqueous solution was prepared and allowed to stand for ten minutes at room temperature. Absorption was recorded for the prepared complex soon after its preparation and at the end of tenth minute. The values were closely related which proves that aqueous ferric chloride –salicylic acid complex at pH 3.5-5. Two concentration of 40 and 80 ppm of salicylic acid complex were scanned from 320nm to 700 nm and the scan fix a Ʌmax at 580nm as shown in the Figure 1

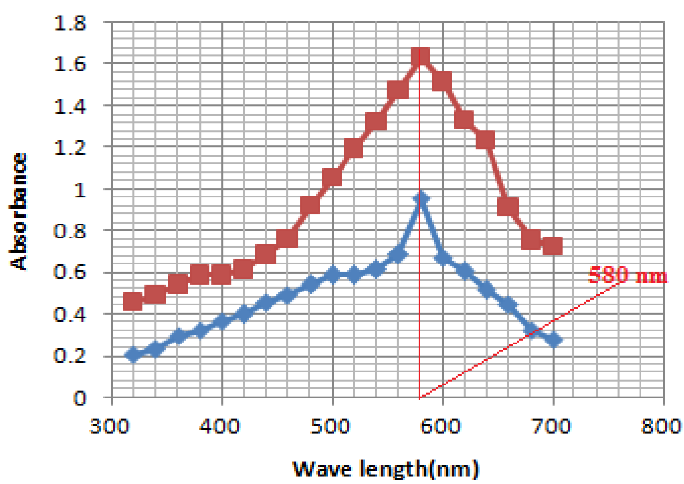


Figure 1: Scan of Ʌmax for Fe^{3+}-salicylic acid complex

Simultaneous adsorption of ferric chloride –salicylic acid complex by sweet corn cop and areca nut husk activated charcoal was recorded UV- Spectrophotometrically as shown in the Table 1. Salicylic acids of concentration ranging in the interval of 40 ppm were prepared and developed colour by adding 0.1M ferric chloride solution. The colour developed was allowed for 10 minute and added 0.5 g activated experimental charcoal to each sample. Each sample solution was mixed well and allowed for ten minutes to achieve uniform adsorption, filtered through Whatman filter paper and absorbance was recorded for the resulting filtrate starting from volume 1ml to 14 ml.

Table 1: Complex concentration versus absorbance

Volume of the complex(ml)	Absorbance	
	Sweet Corn	Areca nut
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0.026
6	0.028	0.055
8	0.079	0.312
10	0.366	0.772
12	0.995	1.202
14	1.387	1.647

The Figure 2 clearly indicates that the absorption increases from 4th ml for areca nut husk activated carbon and 5th ml to that of sweet corn cop activated carbon. Up to 8 ml of complex absorbs almost entire salicylic acid by sweet corn cop activated carbon and 6ml to that of areca nut husk activated carbon. Scavenging efficiency of the activated carbon of sweet corn and areca nut husk was recorded as 64mg per gram and 48mg per gram respectively. This experimental results and affordable cost the raw material made the sweet corn cop and areca nut husk activated carbona powerful alternative for the adsorption of carcinogenic salicylic acid asFe^{3+}-salicylic acid complex (Fig 2)

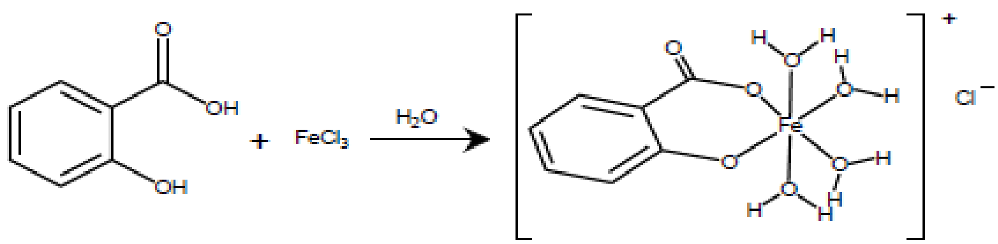


Figure 2: Purple salicylic acid-$FeCl_3$ complex

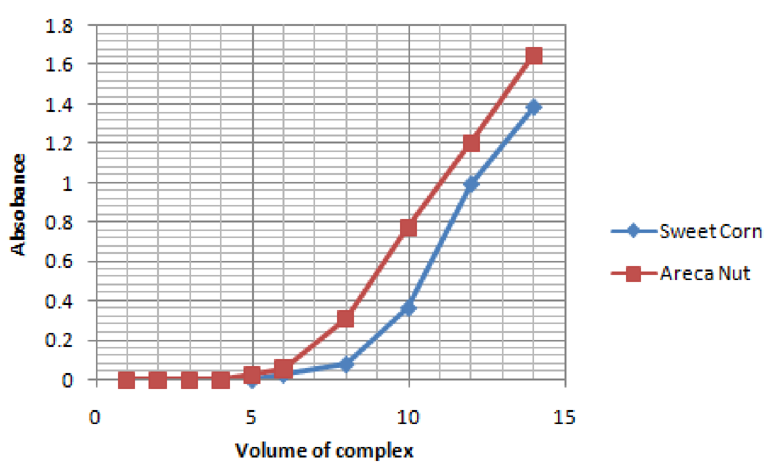
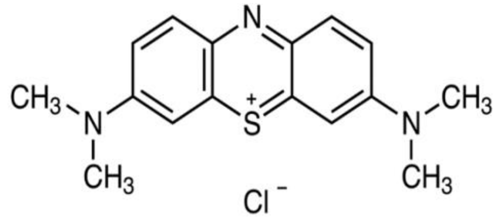


Figure3: Plot of Volume of salicylic acid versus Absorbance

3.2 Absorption of aqueous solution of Methylene blue

Mehylene blue is an adsorbate for activated carbon and adsorption efficiency increases with nature of solvent. The aqueous solution of methylene blue was used to adsorbed on the activated carbon of sweet corn cop and areca nut shells.



100ml of 1x10^{-4}M aqueous solution of methylene blue was prepared using double distilled water. The resulting solution was shaken well for uniform concentration and allowed to stand for 10 minute. λ_{max} was determined by recording wave length begin with 320 nm filter to 700nm filter in the interval of 20 nm in UV-spetrophotometer. A maximum absorption was recorded at 660nm compare to 580nm. Therefore, 660nm was fixed as λ_{max} to record the absorption and the scan plot is as shown in the Figure 4

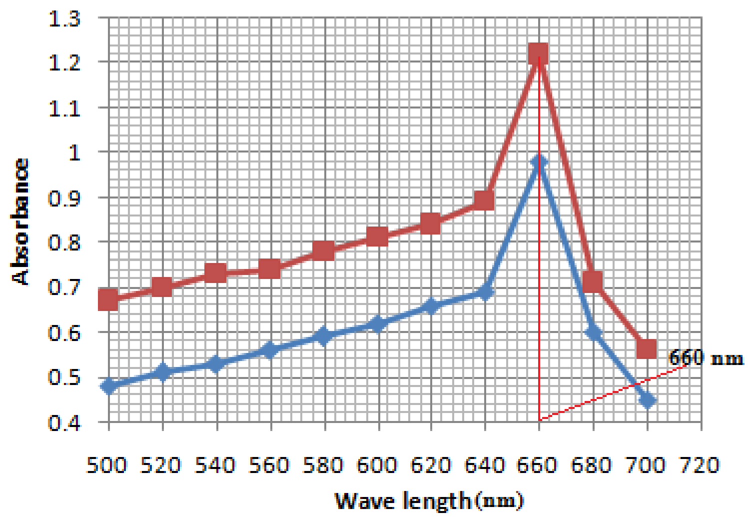


Figure 4: Scan of λmax for aqueous solution of Methylene blue

3.3 Adsorption of experimental charcoals for Methylene blue

Adsorption of methylene blue by sweet corn cop and areca nut husk activated charcoal was recorded UV-Spectrophotometrically as shown in the Table 2. Methylene blues of concentration ranging in the interval of 40 ppm were diluted to 25ml standard flask. The colour developed was allowed for 10 minute and each solution was with 0.5g experimental activated carbon. The samples were mixed well and allowed to stand for 10 minutes to attain maximum and equilibrium adsorption, filtered using Whatman filter paper. Absorptions were recorded at λmax 660nm for each sample solution.

Table 2: Concentration of methylene blue versus absorbance

Methylene Blue(mg)	Absorbance	
	Sweet Corn	Areca nut
1	0.000	0.000
2	0.000	0.000
3	0.000	0.075
4	0.000	0.258

Methylene Blue(mg)	Absorbance	
	Sweet Corn	Areca nut
5	0.044	0.518
6	0.258	0.927
7	0.470	1.425
8	0.887	1.832

The Figure 5 clearly indicates that the absorption increases from 4th ml for areca nut husk activated carbon and 5th ml to that of sweet corn cop activated carbon. Up to 8 ml of complex absorbs almost entire salicylic acid by sweet corn cop activated carbon and 6ml to that of areca nut husk activated carbon. Scavenging efficiency of the activated carbon of sweet corn and areca nut husk was recorded as 640 ppm and 480 ppm per gram whereas, 320 ppm and 240 ppm per gram for methylene blue respectively. This experimental results and affordable cost the raw material made the sweet corn cop and areca nut husk activated carbon a powerful alternative for the adsorption of carcinogenic organic compound methylene blue.

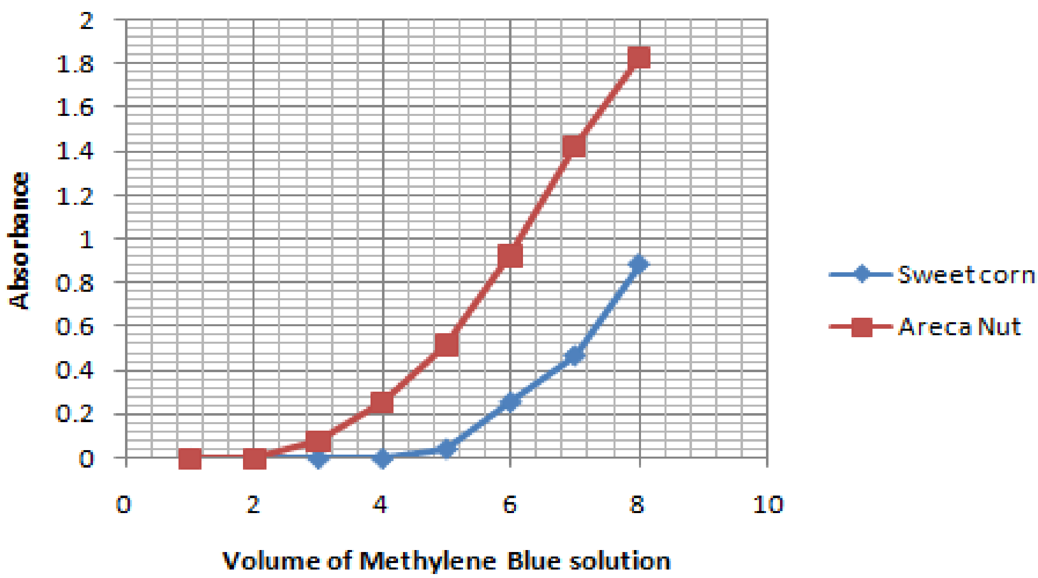


Figure 5: Plot of Volume methylene blue versus absorbance

3.4 Adsorption Efficiency of experimental charcoals

Activated sweet corn cop charcoal shows hundred percent absorption up to 5ml and to that areca nut shell activated carbon shows a maximum of 3ml. Figure 5 clearly attributes the efficiency of absorption of methylene blue and it is expressed amount of adsorption per gram of charcoal. As experiment was carried out against 0.5g of activated carbon, the efficiency and percentage of efficiency were determined as show in the Table 3

Table 3: Adsorption efficiency of experimental activated charcoals

Activated Charcoal	Organic compound	Wt. of activated charcoal (g)	Max. adsorption (ppm)	Adsorption Efficiency (ppm/gm)	Percentage of adsorption (ppm/100g)
Sweet corn cop	Salicylic acid	0.5	320	640	64000
	Methylene Blue	0.5	160	320	32000
Areca nut shell	Salicylic acid	0.5	240	480	48000
	Methylene Blue	0.5	120	240	24000

4. CONCLUSION

Activated plant source charcoals find large industrial, pharmaceutical and biological applications. Activated charcoals are successfully utilized in purification of water, effluent treatment, study of COD and BOD and textile industries. In this article, the byproductsweet corn cop and areca nut shell husk are utilized for preparation of activated charcoal by chemical method. The activated charcoals are utilized to study the scavenging efficiency for salicylic acid and methyleneblue. From the experimental results it is clear that sweet corn cop charcoal recorded maximum absorption for salicylic acid 640ppm/g in compare to areca nut shell husk charcoal 480ppm/g. Sweet corn cop charcoal recorded optimum absorption for methylene blue 240 ppm/g in compare to areca nut shell husk charcoal 240ppm/g. The experimental charcoal projects noticeable results in scavenging salicylic acid and methylene blue from polluted samples. This experimental results and affordable cost the raw material made the sweet corn cop and areca nut husk activated carbon a powerful alternative for the adsorption of carcinogenic organic compounds like salicylic acid, methylene blue, organic dyes etc.,

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Declaration of conflict of interest

The authors declare no conflict of interest

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