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SYNTHESIS, CHARACTERIZATION AND APPLICATIONS OF COCONUT- SHELL ACTIVATED CARBON

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ABSTRACT:

In order to create coconut shell activated carbon (CSAC), this study demonstrated that a waste sample of coconut shell was subjected to characterization and synthesis using a chemical activation method with one of the activating agents, such as KOH. The synthesized carbon was then characterized using scanning emission microscopy (SEM). The sample's particle surface topology is uneven and porous. Toxic metals and dyes can be effectively removed by this particle form. The rough surface of coconut shell activated carbon indicates how well it removes impurities from aqueous solutions. These results imply that using coconut shell carbon to remove colors from wastewater might be a less expensive option than using commercial activated carbon.

Key Words: Coconut shell, SEM, CSAC, Activated Carbon.

INTRODUCTION

Activated carbon can be prepared from many materials that have a high content of carbon. In recent years, various research on the production of activated carbon from renewable precursors have been reported, such as rice hull com-cob, cattail, coconut husk, dates tree's fronds and pruning mulberry shoot. There are a lot of cheaper and renewable materials that can be used to produce activated carbon; one of them is coconut shell. (Lutfi et al., 2021). The cost effectiveness of preparing activated carbon from agricultural waste and the possibility of tailoring its structure and properties makes it desirable for adsorption process. They could possess tunable functionality, large specific surface area, and well-defined porosity (Oribayo et al., 2021).

Waste management has been the most difficult aspect in different part of our life activities. Among the common sources of liquids wastes are the effluents discharged from textile and tannery industries. In addition to the health effect, the environment could also be affected by the pollution of dyes as this water-soluble compound cannot be easily removed through a filtration method. As a result, it can affect the symbiotic process due to the prevention of light penetration, which leads to low photosynthesis activity in the water (Gibson, L. T. 2014). Among the physical, chemical and biological methods of dye removal, oxidation (using oxidizing agents like ozone, ultraviolet [UV] irradiation, and hydrogen peroxide), membrane separation, coagulation and flocculation, and adsorption are commonly used. However, other than the adsorption techniques, these methods have either high costs and/ or are technically complicated. The adsorption method is highly preferable due to its low cost consumption, easy operation, higher efficiency, insensitivity to toxic materials and versatility (Islam et al., 2016).

APPLICATION

1. Water Treatment: Coconut shell activated carbon is effective in removing impurities and contaminants from water (Ahmad and Rahman, 2017).

2. Air Purification: Coconut shell activated carbon can capture volatile organic compounds (VOCs) and odors (Wang and Li, 2020).

3. Gold Recovery: Coconut shell activated carbon is used in gold mining to recover gold from ore. (Amenorfe and Addai-Mensah 2013).

4. Medical Applications: Coconut shell activated carbon is used in medical applications, such as hemoperfusion cartridges. (Senthil and Sankar 2019).

5. Environmental Remediation: Coconut shell activated carbon can be used to clean up contaminated soil and groundwater (Kumar and Palaniyappan 2020).

6. Fuel Storage and Transportation: Coconut shell activated carbon can absorb fuel vapors and prevent fuel contamination (Singh and Singh 2020).

MATERIALS AND METHODS

Sample Collection

Samples were collected from the edible market in Na'ibawa, Kano State, they are disposed wastes in the area. It was washed, dried and grounded to powder for carbonization using a chemically activated method.

Preparation of Activated Carbon

100g of coconut shells and palm kernel shells were carbonized in a specially constructed chamber, after cooling, the charred products were grounded with the use of mortar and pestle. The samples were screened to obtained samples of different sizes with the use of local sieve 0.112 – 0.125µm, 0.125 – 0.3 µm, and 0.3 – 0.5 µm. The charred products were purified by placing the charred sample in a 500 cm^3 beaker. About 250cm^3 of 0.5M HCl was added to the sample in the beaker. The mixture was stored and heated until evolution of gas occurred and stopped. The content was filtered and carbon residue was rinsed with distilled water until it was neutral to litmus paper. Chemical activation was done using different activating agents such as H_3PO_4, KOH, $ZnCl_2$. 25.0g sample of the purified carbon was put into a beaker containing 500cm^3 of 1.0M H_3PO_4. The content was thoroughly mixed and heated until a paste was formed according to the method described by Odebumi and Okeola, 2001. This was transferred into crucible and placed in a muffle furnace fixed at 500^oC for 2 hours. The activated sample was allowed to cool to room temperature after which it was washed with distilled water until the pH became neutral the sample was dried in an oven at about 80^oC – 100^oC. The same procedure was repeated using 1.0M KOH and saturated solution of $ZnCl_2$ as described by Adekola and Adegoke, 2005.(Andas et al., 2017).

RESULT AND DISCUSSION

The result of coconut shell activated carbon after has been treated with an activating agent KOH, it shows that the surface of the particle is rough compared to original sample of coconut shell. This shows the effectiveness of the treated coconut shell as a good remover of dye in the aqueous solutions.

Yield and characteristics

Figure 1 shows the Scanning Electron Microscope images for the coconut shells and prepared activated carbon. As shown in Figure 1a, the surface of un-activated coconut shells is very smooth compared to Figure 1b with rougher surface. After KOH impregnation and activation at 500 °C activation temperature, it was observed that the homogeneity between the un-activated coconut shell carbon and its matrix decreases in comparison to coconut shell activated carbon (CSAC). The surface of CSAC became rougher and its surface topology differed as shown in Figure 1 b.

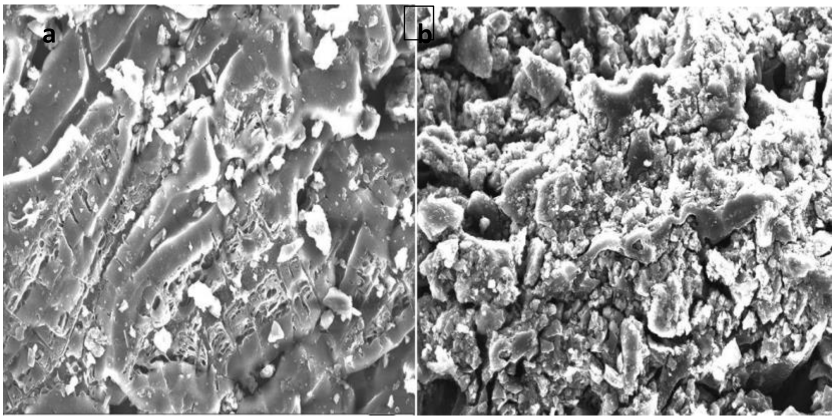

Figure 1: Surface morphologies of coconut Carbon (CSC) and coconut shell Carbo (CSAC))

CONCLUSION

The scanning electron microscope (SEM) images reveal a significant transformation in the surface morphology of coconut shells upon activation. The activation process, involving KOH impaction and heat treatment at 500°C, induces a pronounced increase in surface roughness and alters the surface topology of the coconut shell carbon. This transformation suggests that the activation process successfully creates a more porous and heterogeneous structure, which is desirable for enhancing the adsorption capacity of the activated carbon. The resulting coconut shell activated carbon (CSAC) exhibits a distinctly different surface morphology compared to its un-activated counterpart, indicating the effectiveness of the activation process in modifying the material's surface properties.

REFERENCES

Adekola, F.A. and Adekoge, H.I. (2005). Adsorption of Blue Dye on activated carbon from rice husk, coconut shell and coconut coir pith'' Ife Journal of Soc. Nigeria, 7(1); 151

Ahmad, M. A., & Rahman, N. K. (2017). Removal of heavy metals from wastewater using coconut shell activated carbon. *Journal of Environmental Science and Health, Part B,* 52(5), 351-358. Doi: 10.1080/03601234.2017.1285434

Amenorfe, E. K., & Addai-Mensah, J. (2013). The use of coconut shell activated carbon in gold recovery. *Journal of the South African Institute of Mining and Metallurgy,* 113(7), 567-574.

Andas, J., Rahman, M. L. A., & Yahya, M. S. M. (2017). Preparation and Characterization of

Activated Carbon from Palm Kernel Shell. *IOP Conference Series: Materials Science and Engineering*, *226*(1), 188–197. https://doi.org/10.1088/1757-899X/226/1/012156

Islam, M. S., Ang, B. C., Gharehkhani, S., & Afifi, A. B. M. (2016). Adsorption capability of activated carbon synthesized from coconut shell. *Carbon Letters*, *20*(1), 1–9. https://doi.org/10.5714/CL.2016.20.001

Kumar, P. S., & Palaniyappan, M. (2020). Coconut shell activated carbon for environmental remediation: *A review. Journal of Environmental Management, 255,* 109899. doi: 10.1016/j.jenvman.2019.109899

Lutfi, M., Hanafi, Susilo, B., Prasetyo, J., Sandra, & Prajogo, U. (2021). Characteristics of activated carbon from coconut shell (Cocos nucifera) through chemical activation process.
IOP Conference Series: Earth and Environmental Science, *733*(1). https://doi.org/10.1088/1755-1315/733/1/012134

Odebunmi, E.O and Okeola O.F (2001) "preparation and characterization of activated carbon from Waste Material", J. Chem. Soc. Nigeria 26 (2), 149- 155

Oribayo, O., Olaleye, O. O., Akinyanju, A. S., Omoloja, K. O., & Williams, S. O. (2021). Coconut shell-based activated carbon as adsorbent for the removal of dye from aqueous solution: equilibrium, kinetics, and thermodynamic studies. *Nigerian Journal of Technology*, *39*(4), 1076–1084. https://doi.org/10.4314/njt.v39i4.14

Senthil, K., & Sankar, M. (2019). Coconut shell activated carbon for medical applications: A review. *Journal of Biomedical Materials Research Part B: Applied Biomaterials,* 107(5), 1231-1243. doi: 10.1002/jbm.b.34271

Singh, R., & Singh, A. (2020). Coconut shell activated carbon for fuel storage and transportation.

Journal of Energy Storage, 29, 101341. doi: 10.1016/j.est.2020.101341

Tseng R L, Tseng S K, Wu F C 2006 Preparation of high surface-area carbons from corn cob with KOH etching plus CO2 gasification for the adsorption of dyes and phenols from water *Colloids Surf. A Physicochem. Eng. Asp.* 279 1-3 69–78

Wang, J., & Li, Q. (2020). Coconut shell activated carbon for air purification: *A review. Journal of Cleaner Production, 243,* 118531. Doi: 10.1016/j.jclepro.2019.118531