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Production of Activated Carbon from Coconut Shells: Preparation, Characterization and Applications

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***Abstract*-- Activated carbon is one of the most widely used adsorbent materials due to its high surface area, well-developed pore structure, and strong affinity toward organic and inorganic pollutants. Coconut shell, an abundant agricultural waste, is an excellent precursor for activated carbon production because of its high carbon content and low ash percentage. The present study describes the preparation of activated carbon from coconut shells through carbonization and chemical activation. The influence of activation parameters such as temperature, time, and activating agents on pore development and adsorption performance is discussed. Characterization techniques including iodine number, methylene blue adsorption, FTIR, and SEM are considered for quality evaluation. The study highlights the environmental and economic benefits of converting coconut shell waste into value-added activated carbon for water purification and industrial applications.**

***Keywords*-- Activated carbon; Coconut shell; Chemical activation; Adsorption; Pore structure; Water purification; Agricultural waste; Surface characterization**

I. INTRODUCTION

Environmental pollution has become a serious global issue due to rapid industrial growth. Discharge of dyes, heavy metals, pesticides, and other toxic substances into water bodies threatens human health and ecosystems. Among various treatment methods, adsorption using activated carbon is considered highly effective because of its simplicity and high removal efficiency.

Activated carbon is a porous carbon material possessing large internal surface area ranging from 300 to 2500 m^2 per gram. It can be produced from many carbonaceous materials such as coal, wood, and agricultural residues. Coconut shell is recognized as one of the best raw materials because it provides hard carbon with well-developed micropores. In many regions coconut shells are treated as waste and burned, creating environmental problems. Transforming this waste into useful activated carbon supports sustainable development.

II. OBJECTIVES

The objectives of this work are:

- To utilize coconut shell waste as raw material for activated carbon.
- To study carbonization and activation processes.
- To evaluate the effect of process parameters on quality.
- To characterize the prepared activated carbon.
- Environmental applications.

III. MATERIALS AND METHODS

3.1 Raw Material

Coconut shells were collected, cleaned with water to remove dirt, dried under sunlight, and crushed into small pieces of 2–3 cm.

3.2 Carbonization

The dried shells were placed in a closed furnace and heated to 450–550 degree Celsius in absence of oxygen. During this process moisture and volatile matter were removed leaving carbon-rich char.

3.3 Chemical Activation

The char was impregnated with phosphoric acid and kept for 24 hours. Then it was heated at 600 degree Celsius in a muffle furnace for 1 hour. After cooling, the material was washed with distilled water until neutral pH and dried at 110 degree Celsius.

IV. ACTIVATION MECHANISM

Activation develops pores inside the carbon structure. In chemical activation, dehydrating agents such as H_3PO_4 or KOH break carbon chains and create new cavities. Physical activation using steam or CO_2 at high temperature also widens pores through gasification reactions.

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V. Characterization

5.1 Iodine Number

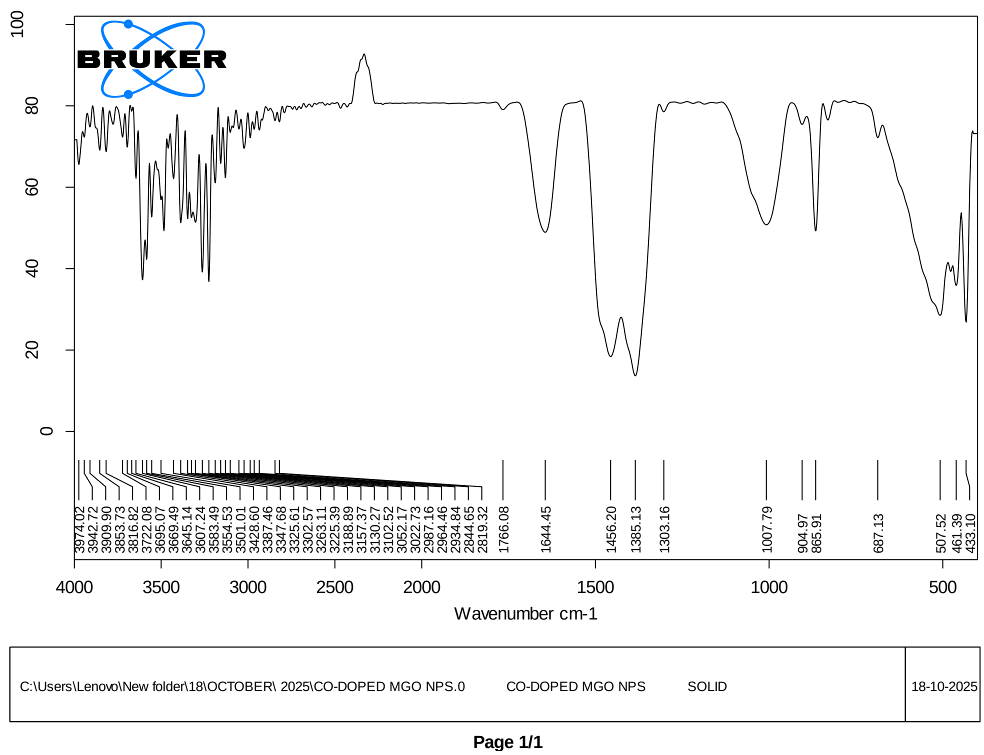
Iodine adsorption test estimates micropore content. Values above 800 mg per gram indicate good quality.

5.2 Methylene Blue Test

This measures adsorption of larger molecules and represents mesoporous nature.

5.3 FTIR Analysis

FTIR spectra reveal surface functional groups such as hydroxyl and carboxyl which participate in adsorption.



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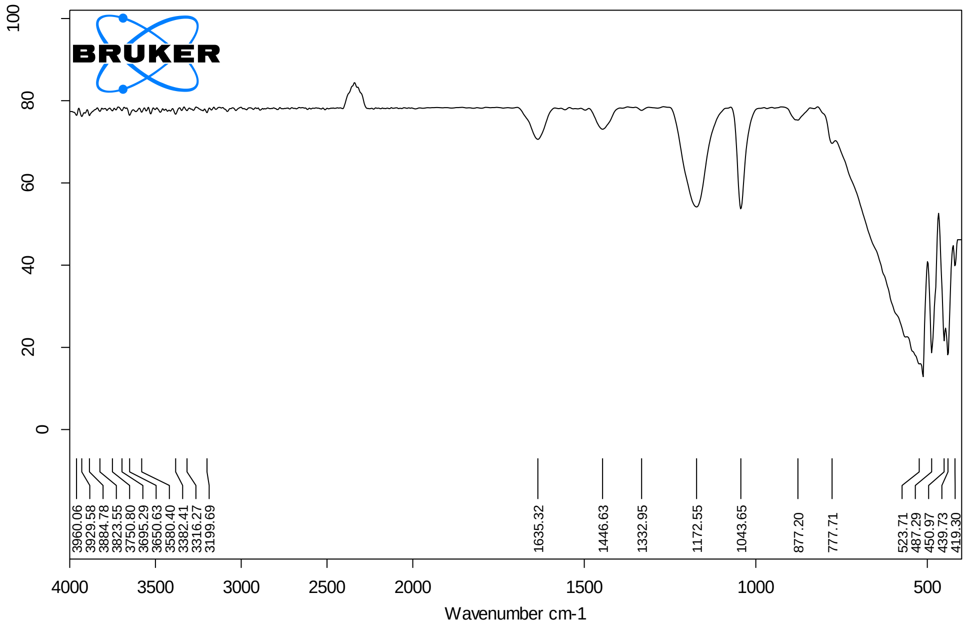

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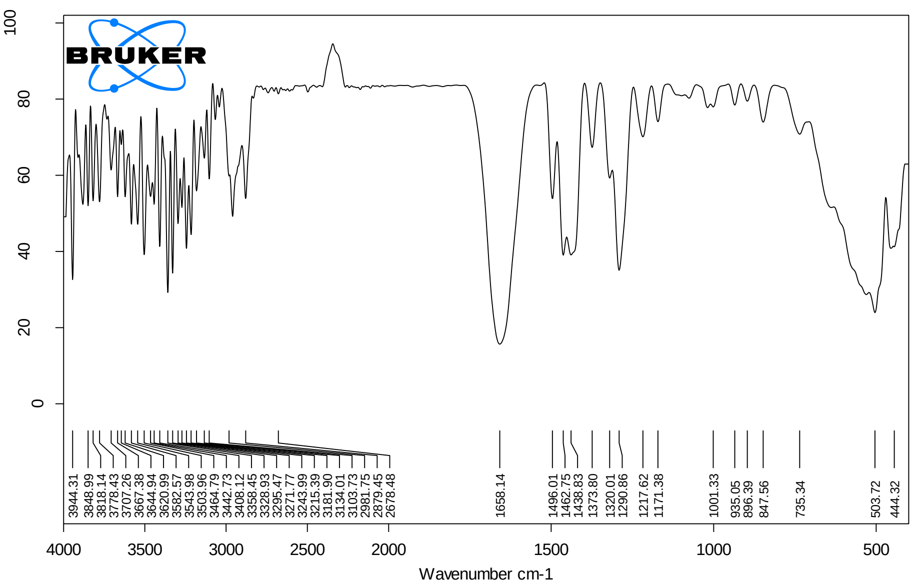

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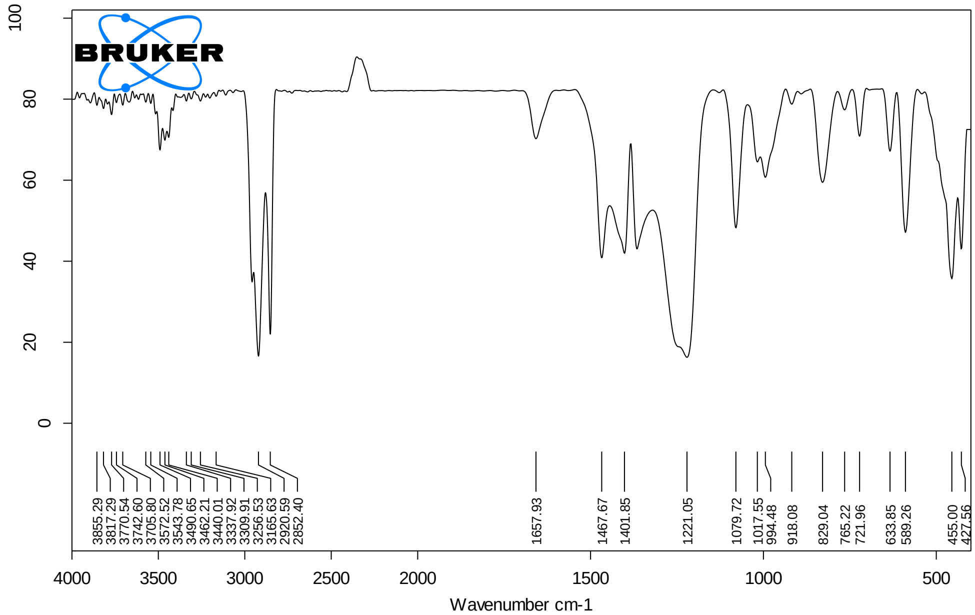

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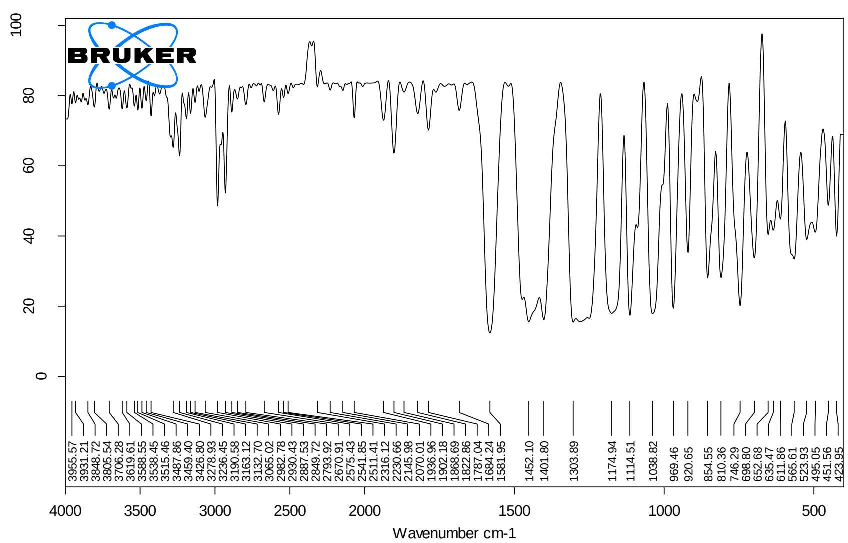

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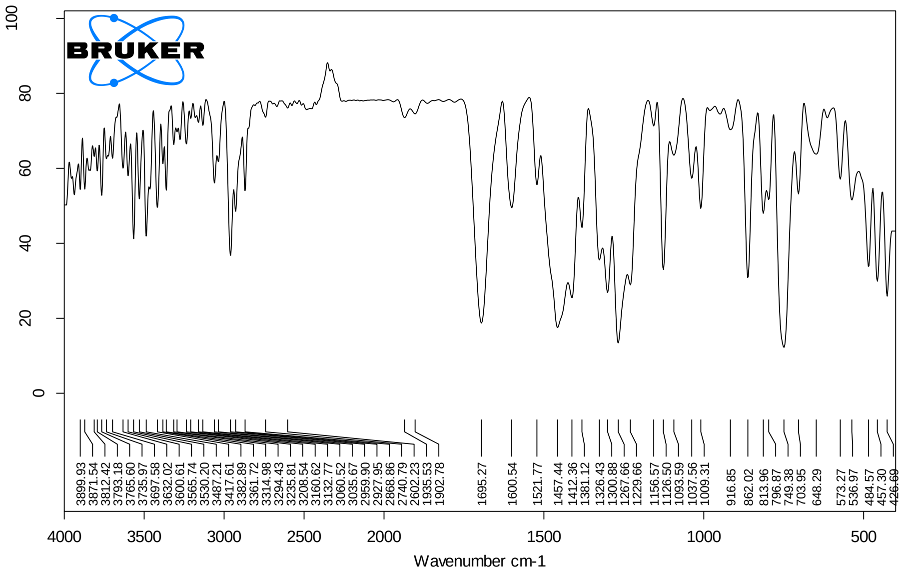

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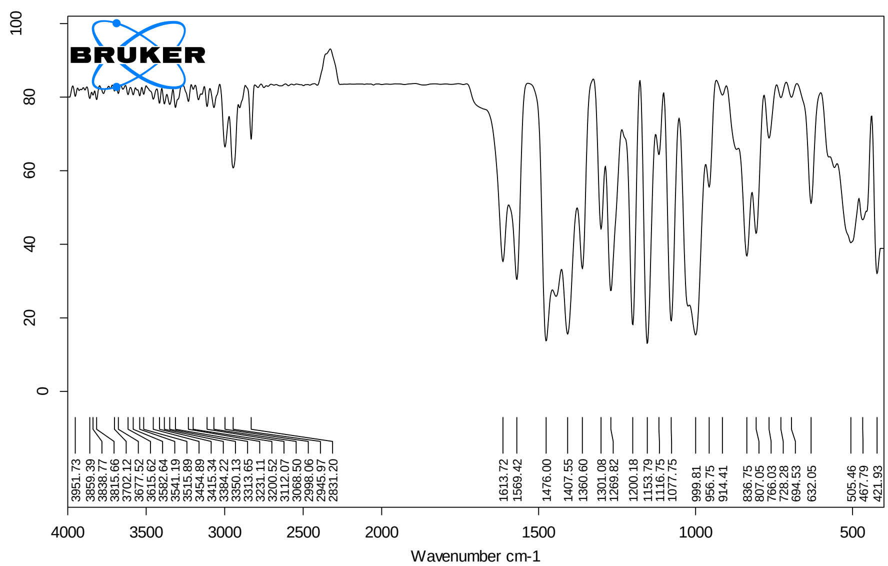

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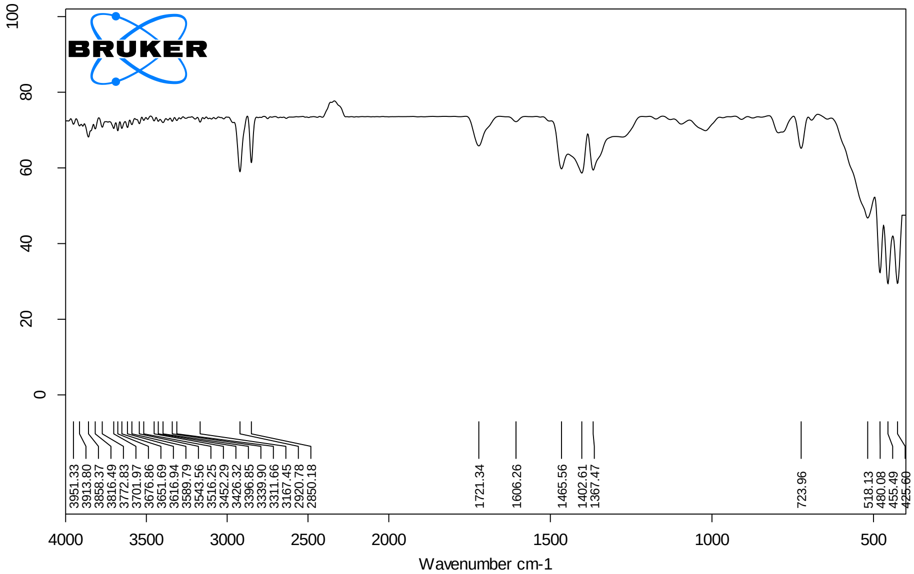

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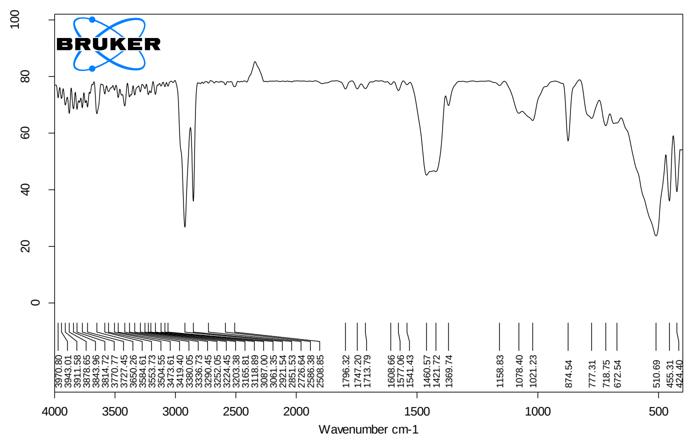

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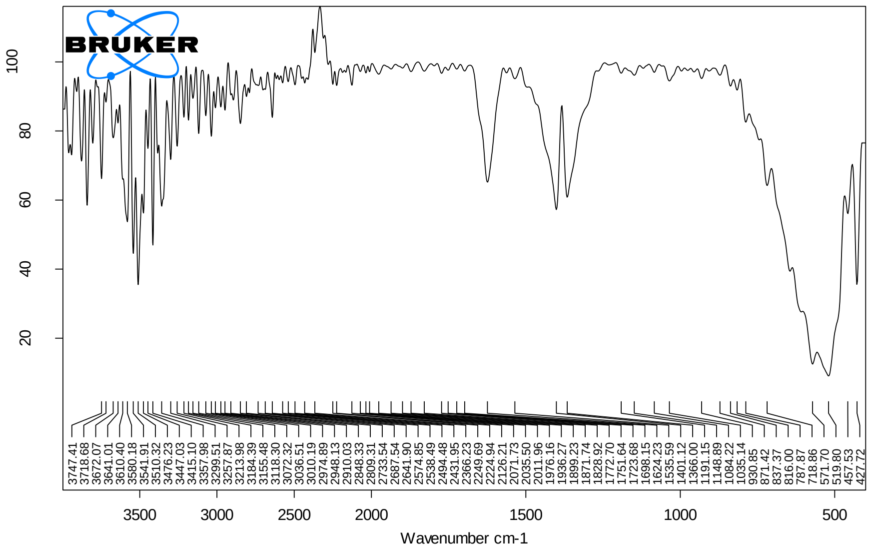

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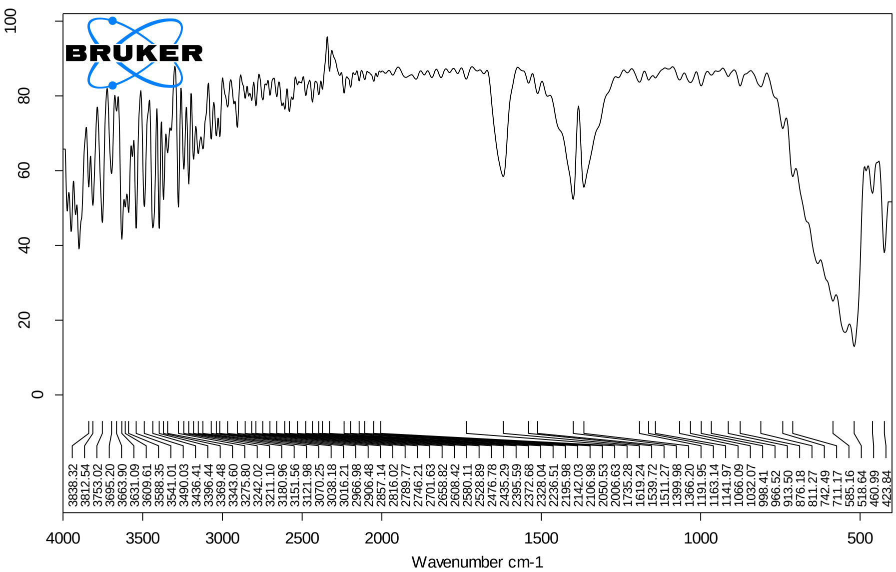

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5.4 SEM Analysis

SEM images show rough surface with numerous pores confirming successful activation.

VI. Results And Discussion

The activated carbon obtained from coconut shell exhibited dark black color, low ash content, and high porosity. Increase in activation temperature improved surface area up to optimum level. Phosphoric acid activation produced balanced micro and mesopores suitable for dye adsorption.

The material showed excellent removal efficiency for methylene blue and phenolic compounds. Compared with commercial carbon, coconut shell carbon demonstrated comparable performance at lower cost. Regeneration using mild heating restored most adsorption capacity.

VII. Applications

- ➢ Drinking water purification
- ➢ Industrial wastewater treatment
- ➢ Air and gas cleaning
- ➢ Decolorization in food industry
- ➢ Catalyst support and energy storage

VIII. Environmental And Economic Benefits

Using coconut shells reduces agricultural waste disposal problems. Production units can be established in rural areas providing employment. The process converts low-value biomass into high-value adsorbent.

IX. Challenges

Proper control of temperature and chemical ratio is essential. Residual chemicals must be completely washed to avoid secondary pollution.

X. Conclusion

Coconut shell is a highly suitable precursor for activated carbon production. Through controlled carbonization and activation, adsorbent with high surface area and strong adsorption capacity can be produced. The approach supports waste-to-wealth concept and offers economical solution for water and air purification. Further research on optimization and large-scale implementation is recommended.

REFERENCES

[1] Bansal RC, Goyal M. Activated Carbon Adsorption. CRC Press.
[2] Marsh H, Rodriguez-Reinoso F. Activated Carbon. Elsevier.
[3] Ioannidou O, Zabaniotou A. Renewable and Sustainable Energy Reviews.
[4] Sudaryanto Y. Microporous and Mesoporous Materials.
[5] Mohan D, Pittman C. Journal of Hazardous Materials.