# Application of Activated Carbon Produced from Licuri Bark (*Syagrus coronata*) in Water Filtration

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**This work aims to produce activated carbon from the bark of licuri (*Syagrus coronata*) and evaluate its effectiveness in water filtration. The bark was separated from the pulp, and biochar was produced through pyrolysis and chemical activation. The filtration performance was assessed by measuring the optical density using a spectrophotometer and analyzing the samples that passed through the filtration system containing the licuri-based activated carbon. The results confirmed the efficiency of activated carbon derived from licuri bark. Regarding adsorption capacity, the pyrolyzed charcoal alone demonstrated superior performance, yielding results comparable to commercial activated carbon commonly used in drinking water filtration systems.**

**Keywords: Licuri. Activated Carbon. Filtration.**

The Northeast region of Brazil faces significant challenges related to water scarcity and poor water quality, particularly during prolonged drought periods. These issues affect not only the availability of water but also critically impact sectors such as agriculture, public health, and the daily lives of local communities. To mitigate these effects, developing sustainable technologies is essential to ensure reliable access to water in the region.

Activated carbon is currently widely used as an adsorbent in water filtration systems due to its porous structure. This structure enables it to trap and retain contaminant molecules, thereby improving water quality.

Licuri, a native fruit of the semi-arid Northeast region, is harvested from the *Syagrus coronata* palm. It is abundant in various commercial applications, including handicrafts and regional culinary dishes. However, agro-extractivist communities often discard the fruit's bark as agricultural waste agro-extractivist communities often discard. Repurposing this by-product for the production of activated carbon adds both economic and social value to the lecture bark. In this context, two primary methods can be employed to produce activated carbon using simple and effective techniques: pyrolysis, which involves thermal decomposition in the absence of oxygen, and chemical activation, which entails treating the material with chemical agents to enhance porosity and adsorption capacity.

This study's objective is to explore the use of lecture bark (*Syagrus coronata*) in the production of activated carbon for water filtration, with the goal of reducing the concentration of microbial cells in contaminated water samples. Furthermore, the study investigates the microorganism removal potential of samples prepared from pretreated bark subjected to pyrolysis and chemical activation methods.

## Materials and Methods

This study is applied as it seeks to apply experimental techniques derived from methodological theory to assess the efficiency of activated carbon produced from licuri bark for removing microorganisms from water. It

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adopts a quantitative approach, analyzing data by measuring optical density in different samples. Additionally, it is classified as exploratory research, based on hypotheses concerning the quality of activated carbon derived from the selected raw material. The research also fits the experimental design category, as it involves subjecting licuri bark to controlled variables to obtain measurable outcomes. Specifically, the study examines the influence of licuri bark–based activated carbon on removing contaminants from water.

Collection and Preparation of Raw Materials

Licuri fruit was obtained from residents of the municipalities of Dias D'Ávila, Alagoinhas, and Salvador, Bahia, during the first quarter of 2023. After collection, 150 g of material was weighed and washed in hot water. The material was then dried in an oven at temperatures ranging from 95°C to 170°C for 1 hour to remove excess moisture. Following this, it was cooled to room temperature. The bark was manually separated from the pulp and fragmented into smaller pieces.

Pyrolysis

The fragmented licuri bark was subjected to pyrolysis, a thermal decomposition process of organic material without oxygen, used to create a porous structure. Five pyrolysis tests were conducted. In each test, 100 g of bark was weighed on an analytical balance and distributed into crucibles. The process was conducted in a muffle furnace with continuous heating up to 700°C. After pyrolysis, the samples were allowed to cool to room temperature.

Chemical Activation

Chemical activation was performed to enhance the porosity of the charcoal. Sulfuric acid ($H_2SO_4$) was selected for this process. In three activation assays, 20 mL of $H_2SO_4$ was added to 50 g of charcoal from the pyrolysis stage, with contact time ranging from 12 to 24 hours. After activation, the samples were filtered under vacuum and washed with distilled water until reaching a pH of approximately 5. Subsequently, the samples were dried in an oven at 120°C, yielding chemically activated carbon derived from licuri bark.

Prototype Assembly

A filtration prototype was constructed to test the effectiveness of the produced activated carbon, mimicking the structure of a household water filter. The prototype consisted of a PET bottle, a plastic sheet, and hydrophilic cotton to retain charcoal particles. A cap with a central hole was installed at the top, connected to a siphon tube linked to a drainage pump attached to a larger PET bottle used to store the contaminated sample. The pump facilitated water flow, while the upper bottle held the saline solution inoculated with microorganisms. The contaminated sample was placed in the upper bottle, passing through the siphon and into the charcoal-filled chamber, allowing filtration. The filtered solution was then collected and analyzed using a spectrophotometer to measure optical density.

Microbiological Analysis

Microbiological tests were conducted to evaluate the water quality after filtration with licuri-based charcoal using Bacillus subtilis, a bacterium cultivated under laboratory conditions. The bacteria were grown in tryptic soy broth (TSB) and distributed into Falcon tubes after inoculation. The cultures were centrifuged to sediment the inoculum, which was then resuspended in a sterile saline solution. The resuspended inoculum was transferred to a 1 L beaker, resulting in a contaminated test sample. The optical density of this sample was measured using a spectrophotometer. Filtration tests were then performed using different filtering materials: commercial activated carbon, chemically activated licuri carbon, pyrolyzed licuri carbon, and untreated licuri bark. The performance of each was evaluated by comparing the reduction in optical density of the filtered samples. Figure 1 briefly demonstrates the experimental steps performed in this study.

## Results and Discussion

### Filtration System

The filtration prototype built to evaluate the retention capacity of the samples—obtained during the experiments and compared with commercial activated carbon—proved to be effective. It successfully allowed the passage of contaminated water through the coals and bark samples without overflow and with a consistent flow rate throughout the filtration process.

### Charcoal Yield

Approximately 51.8 g of pyrolyzed charcoal was obtained from 100 g of original biomass. This relatively low yield can be attributed to the absence of a controlled heating ramp during the pyrolysis process. The available muffle furnace allowed only for continuous heating until the final temperature of 700°C was reached. The lack of a gradual temperature increase likely contributed to excessive biomass carbonization, resulting in a substantial amount of ash.

**Figure 1.** Flowchart of the processes performed during the research.

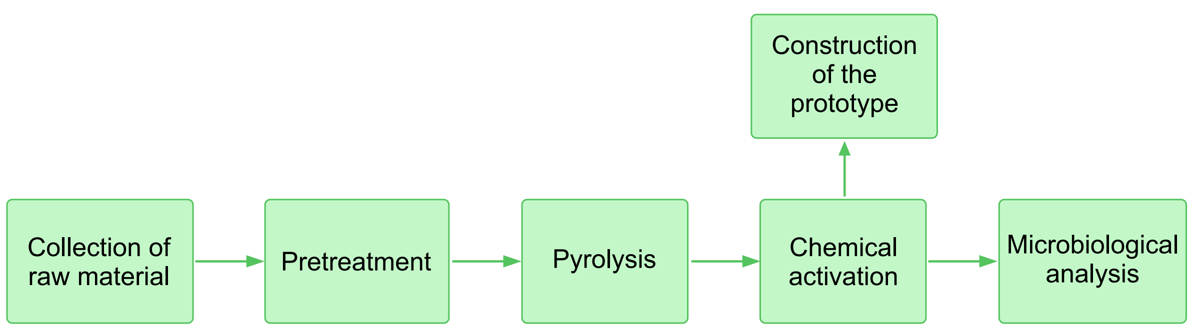


**Table 1.** Optical density of samples obtained with initial concentration of the contaminated solution of $10^8$ cells of microorganisms.

| Samples | Optical density (540 nm) | | | Average |
|---|---|---|---|---|
| | 1° read | 2° read | 3° read | |
| Contaminated solution | 0.116 | 0.122 | 0.111 | 0.116 |
| Shell pretreated | 0.089 | 0.091 | 0.090 | 0.090 |
| Coal pyrolysed | 0.058 | 0.058 | 0.058 | 0.058 |
| shell activated | 0.070 | 0.071 | 0.071 | 0.070 |
| Coal pyrolysed and actived | 0.076 | 0.075 | 0.074 | 0.075 |
| Commercial carbon | 0.058 | 0.056 | 0.056 | 0.056 |

Optical Density

Based on the results presented in Table 1, the following order of efficiency was observed regarding the removal of Bacillus subtilis: Commercial activated carbon > Pyrolyzed licuri charcoal > Activated bark > Chemically activated carbon > Pretreated bark.

This ranking suggests that the pyrolyzed licuri charcoal exhibited promising adsorptive performance, approaching that of commercial activated carbon. Notably, the chemically activated carbon, although processed to increase porosity, did not surpass the performance of the pyrolyzed sample. This may be due to reagent concentration, exposure time, or incomplete pH neutralization during washing. While less efficient, The pretreated and activated bark still demonstrated measurable microbial reduction, indicating the potential for further optimization.

Pyrolyzed and Chemically Activated Carbon

The filtration capacity of the pyrolyzed and chemically activated charcoal was 35.3%. Given the combination of thermal and chemical treatments, this result was lower than expected. One possible explanation for this underperformance is the presence of excess $H^+$ ions in the medium, which may have influenced the adsorption process. This finding indicates the need for pH correction and stabilization during or after the chemical activation process to optimize filtration efficiency.

Activated Bark

Like the chemically activated and pyrolyzed charcoal, the activated bark demonstrated a lower-than-expected optical density reduction. Although derived from the same biomass (licuri bark), this sample yielded a less satisfactory result. This suggests that proper pH correction could enhance its performance, bringing it closer to that of conventional activated carbon.

Pyrolyzed Charcoal

The pyrolyzed licuri bark exhibited excellent performance, closely approaching commercial activated carbon. The difference in optical density between the two samples was only 0.002. This result reinforces the potential of producing effective adsorbent charcoal from agricultural waste using relatively simple methods with fewer procedural steps. It highlights the viability of pyrolysis as a cost-effective and efficient alternative for water filtration.

Commercial Activated Carbon

As anticipated, the commercial activated carbon—commonly used as an adsorbent—achieved a high adsorption efficiency, removing approximately 51.7% of microorganisms from the contaminated water sample. This result validates the comparative benchmark for the study.

Pretreated Bark

The pretreated bark sample achieved a removal rate of 22.41%, demonstrating a modest yet measurable adsorption capacity. Despite minimal processing, the bark reduced the optical density compared to the unfiltered contaminated sample. This outcome suggests that even raw or lightly processed licuri bark has inherent filtering potential.

## Conclusion

This study demonstrates a significant advancement in the environmental field by developing an activated carbon derived from licuri bark—a renewable and widely available agricultural residue. The research not only contributes to sustainability efforts but also encourages the adoption of more environmentally conscious practices.

The comparative analysis of two industrially applicable methods—pyrolysis and chemical activation—revealed that both can yield satisfactory results. Notably, the pyrolyzed licuri bark performed most closely to conventional activated carbon in microorganism removal, confirming the hypothesis that effective adsorbent carbon can be produced from this biomass. In addition to its scientific relevance, the project is of socioeconomic importance due to its low cost of production and its potential to benefit regions with limited access to clean water. Future studies will explore the use of this biochar in soil bioremediation, leveraging its strong adsorptive properties for broader environmental applications.

## References

1. Sá IP. et al. Estudo de remoção de Cu(II) em meio aquoso utilizando carvão preparado a partir da casca do licuri (*Syagrus coronata*). Revista Virtual de Química 2017;9(5):2121-2134. Available at:<http://rvq.sbq.org.br>.
2. Drumond M. Licuri. *Syagrus coronata* (Mart.) Becc. Embrapa Semiárido 2007:1-16. Available at: < https: // ainfo.cnptia.embrapa.br/digital/bitstream/CPATSA/36697/1/SDC199.pdf.>.
3. Teixeira JL. Obtenção e caracterização de carvão ativado a partir da casca de coco verde. 2020. 88 p. Dissertation (Master's Degree in Engineering) - Universidade Federal do Rio Grande do Sul, [S. l.], 2020. Available at: <http://hdl.handle.net/10183/212986>.
4. Werlang EB et al. Produção de carvão ativado a partir de resíduos vegetais. Revista Jovens Pesquisadores, 2013;3(1):1-12. Available at:<https://online.unisc.br/seer/index.php/jovenspesquisadores/article/view/3600.
5. Rabinovitch L et al. Coletânea de procedimentos técnicos e metodologias empregadas para o estudo de Bacillus e gêneros esporulados aeróbios correlatos. Fiocruz. 2015:160. Available at:<https://www.fiocruz.br/ioc/media/Coletanea%20de%20Procedimentos%20Tecnicos%20para%20Bacillus.PDF>.
6. Leão MA. Fibras de licuri: um reforço vegetal alternativo de compósitos poliméricos. 2009:109. Dissertation (Master's Degree in Mechanical Engineering) - Universidade Federal do Rio Grande do Norte, [S. l.], 2008. Available at: <https://repositorio.ufrn.br/bitstream/123456789/15549/1/MirtaniaAL.pdf>.