

BIOCHAR FROM DURIAN PEELS

A GOLDEN MATERIAL FOR
SUSTAINABLE AGRICULTURE

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Overview

Vietnam is one of the world's largest durian producers. While durian, a tropical delicacy, is renowned for its unique flavor, it also presents a significant waste management challenge. As the durian industry grows, so does the pressing issue of disposing of vast quantities of durian peels.

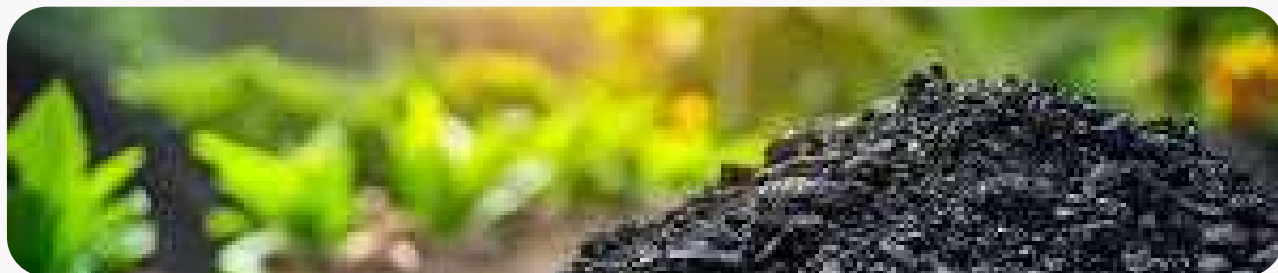
Millions of tons of durian peels are discarded annually, exerting immense pressure on the environment and squandering valuable resources. Improperly disposed of peels can contaminate the environment, release greenhouse gasses, and pose various other risks.

In this context, converting durian peels into biochar - a porous, carbon-rich biomaterial - is seen as an innovative and sustainable solution. Through pyrolysis, a high-temperature process under anaerobic conditions, durian peels can be transformed into valuable biochar.



I/ BIOCHAR - A GREEN SOLUTION FROM WASTE

Biochar is a product created by heating organic materials in the absence of oxygen at temperatures between 400-450 degrees Celsius. This process is known as pyrolysis.



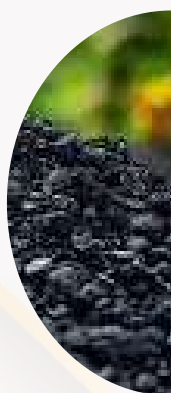
Biochar is highly stable in soil and can increase the amount of carbon stored in the soil, reducing carbon emissions into the atmosphere and positively impacting soil productivity.

1. Properties of Biochar



Adsorptive properties

Biochar can bind heavy metals, pesticides, herbicides, and hormones; prevent the leaching of nitrates and harmful bacteria into waterways; and reduce N₂O and CH₄ emissions from soil.



Physical properties

Biochar is black, highly porous, lightweight, fine-grained, and has a large surface area. These properties contribute to increased microbial activity, water retention, and nutrient holding capacity in the soil. Consequently, biochar often allows for reduced fertilizer and chemical use, improving soil quality and boosting crop yields.

2. Benefits of Biochar



Improving soil quality:

- Increases soil porosity, water retention, and nutrient-holding capacity.
- Improves soil structure, facilitating root growth.
- Enhances the activity of beneficial soil microorganisms.



Mitigating climate change:

- Biochar acts as a natural carbon sink, reducing CO2 emissions into the atmosphere.



Increasing crop yields:

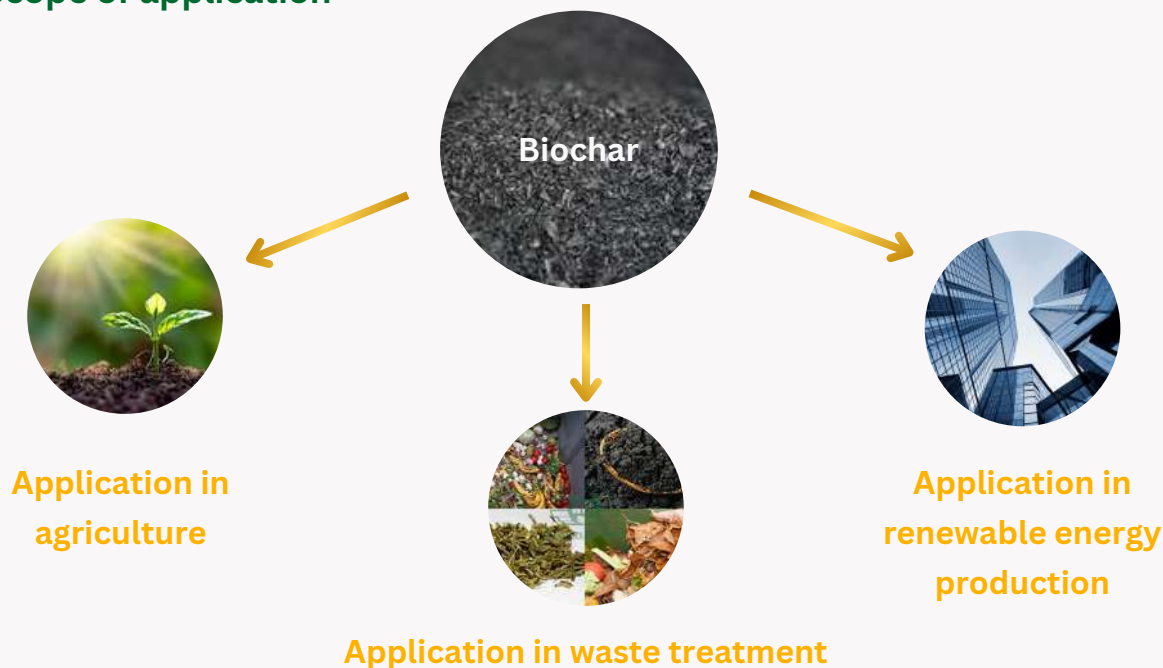
- Crops grown in biochar-amended soils often exhibit higher yields, better quality, and increased disease resistance..



Diverse applications:

- Wastewater treatment: Absorbs pollutants from water.
- Construction materials: Creates environmentally friendly building materials.
- Energy production: Produces biogas.

3. Scope of application



In agriculture: Biochar is used to increase crop yields and improve soil quality. According to research by the United Nations Industrial Development Organization (UNIDO), biochar can sequester carbon in the soil for up to a century. Just 1 gram of biochar can be used to improve 120 square meters of soil. It has the ability to retain moisture in the soil and help absorb nutrients. Biochar can also stabilize soil pH and improve drainage. Additionally, it is used to improve the quality of red soil and saline-alkali soil, especially in rural areas and barren lands.

In waste treatment: Biochar is used to treat organic waste such as sludge and organic garbage. Biochar can adsorb harmful substances in waste and reduce their dispersion into the environment.

In renewable energy production: Biochar can be used to produce biofuels and burned to generate energy. Using biochar as a clean fuel can help reduce greenhouse gas emissions and contribute to reducing dependence on fossil fuels.

4. Biochar production methods

There are various methods to produce biochar, but they all generally involve heating biomass with limited or no oxygen to remove volatile gasses and leave behind carbon. This simple process is called pyrolysis, often achieved through pyrolysis or gasification. These methods can produce clean energy in the form of hot gas or bio-oil along with biochar. These energy sources can be recovered for other uses or simply burned to release heat.



Biochar production technologies

- **Pyrolysis systems:** Pyrolysis systems use furnaces, kilns, and other specialized equipment to contain biomass and thermally decompose it under oxygen-deficient conditions. The reactor is vented to allow the release of pyrolysis gas (syngas). Pyrolysis gas, often referred to as "syngas" or "synthesis gas," is produced. This process becomes self-sustaining when the produced syngas is burned, releasing heat. Currently, there are two types of pyrolysis systems used: fast pyrolysis and slow pyrolysis. Fast pyrolysis tends to produce more bio-oil and acetic acid, while slow pyrolysis produces more syngas.
- **Gasification systems:** Gasification systems produce a smaller amount of biochar in a reactor that is directly heated with incoming air. The more oxygen the production unit can remove, the more biochar can be produced. Biochar production is optimized under oxygen-free conditions.

II/ Biochar production from Durian peels

1.The harm of durian peel disposal

Durian peels are a type of biomass derived from agricultural waste. The organic waste from durian peels releases greenhouse gasses. Anaerobic decomposition of organic waste in landfills produces large amounts of methane (CH₄); aerobic decomposition produces carbon dioxide (CO₂); and the decomposition of nitrogen in durian peel waste also produces nitrous oxide (N₂O). Additionally, the decomposition of organic waste such as durian peels causes unpleasant odors, affecting human health and polluting water sources, impacting the living environment.

2. Why are durian peels suitable for biochar production?

Durian, a popular tropical fruit, is also a significant source of organic waste. Durian peels, accounting for up to 60% of the fruit's weight, can pollute the environment and release greenhouse gasses if not properly treated. However, they are a potential raw material for producing biochar - a type of biochar that can improve soil quality and mitigate climate change.

Durian peels have high cellulose and lignin content, which are the main components for producing high-quality biochar. Moreover, the supply of durian peels is abundant, especially in major durian-producing countries like Vietnam. Converting durian peels into biochar not only helps reduce organic waste but also creates a valuable product.

The pyrolysis of durian peels under anaerobic conditions produces biochar, a carbon-rich product with a porous structure. Biochar can adsorb pollutants, improve soil porosity and water retention, thereby increasing crop yields. Additionally, biochar acts as a natural carbon sink, helping to reduce CO₂ emissions.

3. Potential of durian peel Biochar in Vietnam

In Vietnam, the area cultivated for durian is rapidly increasing, reaching 151,000 hectares. Currently, about 60% of the durian area yields fruit, but the output has reached 1.5 million tons. Besides the amount exported to China, most durians are consumed in the domestic market. Therefore, our country generates a huge amount of durian peel waste each year. Researchers from the Department of Resources and Environmental Sciences at Nanjing Agricultural University (NAU) have found that 1 kg of durian produces greenhouse gas emissions equivalent to about 2 kg of carbon dioxide (CO₂).



Currently, durian peels are not commercially used, although there have been many studies on their potential uses such as antioxidant and anti-inflammatory activities. To avoid environmental pollution, studies on the pyrolysis of durian peels have shown its potential use in the production of biofuels and biochemicals. According to studies, biochar, a product of the anaerobic pyrolysis of organic materials, has the potential to improve soil properties by increasing water holding capacity, cation exchange capacity, and organic carbon content; while reducing nutrient leaching or neutralizing soil acidity, thereby increasing crop yields.



Biochar can be used for adsorption, soil remediation, as a catalyst, etc., while pyrolysis liquid has been used in organic agriculture, alternative medicine, food processing, etc. Biochar also has the ability to remove pollutants such as heavy metals, dyes, pesticides or organic waste from aqueous solutions. Besides, this type of charcoal is also effective in reducing greenhouse gas emissions, acting as a natural carbon sink capable of storing CO₂ in the soil.

In a study conducted by a group of authors including Do Thi My Phuong, Phan Thi Thanh Tuyen, and Nguyen Xuan Loc from the Faculty of Environment and Natural Resources (Can Tho University), durian peels discharged from processing facilities in some provinces of the Mekong Delta were used to create biochar, pyrolyzed at a temperature of 500 degrees C in an inert nitrogen atmosphere. Durian peels can be converted into biochar and have the potential to be applied in improving the environment of soils with low pH or degraded soils. However, biochar made from durian peels should be applied in practice to evaluate its role in soil remediation.

4. Challenges in producing biochar from durian peels

- *Lack of large-scale production facilities:* Most biochar production facilities are currently small-scale.
- *High production costs:* The biochar production process requires significant investment in equipment and technology.
- *Limited supportive policies:* There are limited supportive policies for biochar-producing enterprises.

5. Proposed solutions

To develop the biochar production industry from durian peels, there needs to be a synchronized solution such as:

- **Building modern biochar production plants:** Investing in advanced production technology to ensure quality and economic efficiency.
- **Durian peel collection and treatment system:** Building an effective durian peel collection and treatment system to ensure a stable supply of raw materials.
- **Support policies:** The government needs to have preferential policies to encourage enterprises to invest in biochar production.
- **Raising awareness:** Enhancing the promotion of the benefits of biochar so that people and businesses have a better understanding of this product.

The production of biochar from durian peels is not only an effective solution for treating organic waste but also an opportunity to develop sustainable agriculture in Vietnam. With the attention of government agencies, investment from businesses, and the creativity of scientists, the biochar production industry from durian peels in Vietnam will have strong development in the coming time.

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*Together, we can make a difference that transcends boundaries
and leaves a positive legacy for generations to come.*



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