

The Versatile Bamboo Charcoal

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Abstract- Bamboo is a very sustainable resource. Bamboo charcoal; which is produced from bamboo. This is a kind of environmentally functional material; which has very good absorbing and eco-friendly properties to the surrounding. It requires minimum maintenance and can be easily manufactured with reliable resources. It acts as an anti-bacterial agent; which is capable of absorbing bad odour and toxic substances. Treatment of water requires less effort than existing water purification techniques and it provides cost effective way of water purification in rural areas as well. It conceivably has a higher enrichment capacity for heavy metal ions due to its micro-porous structure and large surface area. In this paper we are reviewing classification, properties and different applications of bamboo charcoal.

Keywords: *Bamboo charcoal, water-purification, micro porous structure, sustainable resource, activated carbon.*

I. INTRODUCTION

Bamboo is most fascinating and useful plant in the world although it looks like a tree. But it is actually considered to be a grass. In a time when global warming, depletion of resources, deforestation, it balances the eco-system. Bamboo charcoal also known as “Black Diamond” is produced from plants and trees. Wood charcoal is also used but due to deforestation and environmental concern, wood charcoal is prohibited. So bamboo charcoal has been introduced as a substitute over wood charcoal [1].

Bamboo grows faster than wood. They are known to grow 4 feet per day and mature in 4 to 8 years [2]. More than 1200 species of bamboo are found all over the world. Bamboo forests are world widely divided into three big divisions e.g. Asia and Pacific, America and Africa. China, India etc. are also the nations where bamboos are found. Among 35 genera of bamboo and approximately 400 species are found in China. It can be harvested non-destructively [3]. 80% of agricultural communities use bamboo charcoal instead of gas, oil or electricity. It has C_4 carbon fixation; which makes it useful to handle the condition of drought and flood.

II. STRUCTURE OF BAMBOO CHARCOAL

Bamboo charcoal is made up of piece of bamboo; which are taken from plants burned in oven at some particular temperature. Bamboo charcoal is produced by pyrolysis process [4]. According to the type of raw material bamboo charcoal can be classified as:

- Raw bamboo charcoal: It is made up of bamboo plant parts such as culms, branches and roots.
- Bamboo briquette charcoal: It is made up of bamboo residues, for example bamboo dust, saw powder etc. by

compressing the residue into sticks of a certain shape and carbonizing the sticks [5].

Bamboo charcoal has micro porous structure and countless small cavities. Compared to wood charcoal, bamboo charcoal has about four times more cavities and its surface area of $300\text{m}^2/\text{gram}$ is 10 times more. Cell wall mainly consists of cellulose, hemicellulose and lignin [6].

The cellulose of bamboo is a natural linear macromolecular compound; which is joined with β -D-glucose 4 glycoside linkage. The cellulose content in bamboo varies from 40-50% and hemicelluloses in 20-30% range [7].

Bamboo charcoal is an outcome of pyrolyzing bamboo and is a sort of porous material with excellent adsorption and electromagnetic shielding (Fig. 1). The surface area to weight ratio of bamboo charcoal is 600:1. This is because of the presence of C_{60} carbon molecule that is like a ball shape [8].

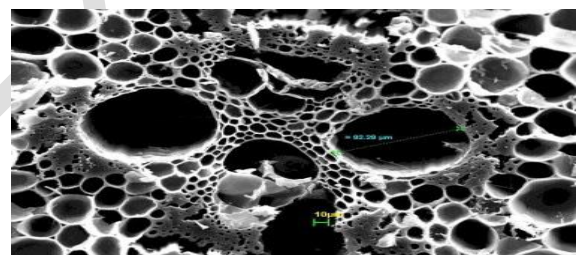


Fig.1: Micro porous structure of bamboo charcoal

III. PROPERTIES OF BAMBOO CHARCOAL

Bamboo charcoal is a sort of renewable organic resource for sustainable development. It has numerous attractive properties. Bamboo charcoal is not soluble in water and other solvents. It demonstrates high stability in various working conditions except with strong oxidant at high temperature [9]. Properties of bamboo charcoal are described below:

a) A rich source of minerals

Bamboo charcoal is rich in mineral ingredients such as calcium, magnesium, acetic acid, hydroxyl benzene etc., which can inhibit the growth of bacteria. Bamboo charcoal purifies water by absorbing the chlorine and other contaminants. It contains acetic acid and diethyl ether; which can provide sterilizing and antiseptic function [10].

b) Warming effect of infra-red rays

Far infrared rays are a type of electromagnetic waves and are capable of warming substances. This ray is well absorbed by organic materials. Bamboo charcoal emits rays ranging from $4\text{--}16\text{ }\mu\text{m}$. The human body, upon being exposed to far infrared

rays, warms up like under the sun and its blood circulation improves considerably [11].

c) Supplier of negative ions

Bamboo charcoal can produce a good quantity of negative ions; which have the characteristics of giving electrons to nearly matter while charcoal absorbs positive ions. The air we breathe is full of charged particles and bamboo charcoal donates electron to these particles and hence the air becomes richer in negative ions [12].

d) Dissipates electromagnetic waves

Electromagnetic waves are emitted by all electrical devices and electronic appliances such as microwave ovens, cellular phones, TVs, computers etc. Bamboo charcoal scatters these electromagnetic waves by bouncing the positive ions emitted by electrical appliance. When waves leave from these devices, they are being absorbed by bamboo charcoal before reaching human body [13].

e) Micro porous structure

The micro porous structure of bamboo charcoal makes it very unique and natural absorbing system like a hard sponge, which can trap impurities, harmful matters and gases (Fig. 1). This property makes it good for deodorization, purification and humidity control [14].

IV. APPLICATIONS OF BAMBOO CHARCOAL

a) In water purification and waste water treatment

Because of its porous structure, the bamboo charcoal has a good absorption capacity. During experiments it has been observed that when the surface temperature of bamboo charcoal reaches 700 degree Celsius, it has porous structure and its specific surface area is maximized; the specific surface area of bamboo is also very large [15].

Due to its excellent absorption capacity experiments have been carried out on filtering ability of bamboo charcoal in wastewater treatment and for drinking water purification and it has been found that bamboo charcoal is antibacterial and anti-fungus agent that also eliminates harmful substances such as chlorine, chloroform, chloramines, 2,4-dichloro-hydroxyl benzene etc.; which are being used in the productions of pesticides and the trace of these compounds are found in waste water; which is ultimately polluting the rivers and seas. It also removes arsenic and fluoride ions completely from water [16]. It contains rich natural mineral, for example, potassium, magnesium, sodium, calcium etc. Study result shows that if bamboo charcoal is dipped in water, metal ion can be adsorbed out and hence water quality can be improved when bamboo charcoal is used in cooking and boiling and other way it can be used in purification of water [17].

Five biological bamboo charcoal were built on a 120m long side-shoot and the high density household wastewater flowing through them was purified in much cleaner water.

According to the total daily amount of wastewater to be treated, up to \$2 million will be needed to establish a wastewater treatment factory with a capacity of 10,000 tonnes/day and with a matching control system on rainwater and wastewater [18]. The plant will occupy a large area of land with heavy running cost. In contrast, the establishment of an improved biological bamboo charcoal waste water treatment with the same daily treatment capacity of 10,000 tonnes/day would only cost \$50,000. Furthermore, it would cost merely \$5000 to run the system for one year, with all the water treated meeting nation criteria.

This technology is extremely suitable for application on rivers in both cities and rural areas. Since the most farmers in rural areas are relatively dispersed, the bamboo charcoal facility should be set up at the end of rivers and canals, so that it does not affect the usage and transportation of water.

Water purification by bamboo charcoal is ecofriendly, requires minimum maintenance, can be easily manufactured with locally available resources and is cheapest solution for the water purification. It can be reused by placing it out in direct sunlight for three hours in order to allow it to shed its impurities.

b) In adjusting humidity

Bamboo charcoal has almost no water as it is activated under situation of very little oxygen and high temperature water and also under these conditions it has pores; which makes it extremely efficient and useful in controlling humidity [18]. When the humidity of surrounding exceeds that of bamboo charcoal, then the bamboo charcoal can absorb the moisture from surrounding. Also when the surroundings humidity becomes less than that of charcoal, it can release moisture to maintain a dynamic equilibrium. As a result it can be used in health care products to adjust micro surroundings [19].

c) Bamboo charcoal as a deodorant and preservative

Bamboo charcoal absorbs unpleasant smell and harmful gases. Now a days, it is used in deodorant and also in sole of shoes to absorb the unpleasant odour. Refrigerators in households are mainly used to store food but, then the problem is with design that they leave specific odour of circulation of cold air on food materials. If in a refrigerator, we keep a bamboo charcoal small bags, odours can be removed due to its absorption action. Also, because of bamboo charcoal's ability to adjust humidity, the time of preservation of food and other materials can be increased [20].

d) In cosmetic industry

In natural acne treatment, bamboo charcoal soap has been used in many Asian countries for centuries. After the bamboo is harvested, it is carbonized at very high temperature to increase its surface area to weight ratio to nearly 1200:1. The resultant charcoal is called activated carbon or activated bamboo charcoal.

When soap is manufactured with activated bamboo charcoal, soap is more capable of absorbing dirt and dust, toxins and

harmful substances from skin, resulting in a healthier skin hence it is widely used as an effective natural treatment of acne. There are many varieties and brands of bamboo charcoals soap; which are available in Asian and European market. Now bamboo charcoal skin scrubs are also available [21].

V. CONCLUSION

Bamboo is the most sustainable bio resource. It is the fastest growing plant in the world having advantage over deforestation. This property of bamboo makes use of bamboo charcoal more suitable than wood charcoal. Also bamboo charcoal's production is eco-friendly, cost effective. It has excellent adsorbent capacity; which makes it useful in cosmetics. It is capable of removing harmful gases and absorbs unpleasant smell from surrounding that is why it is used in refrigerators and deodorants. It has highly porous structure and ability to trap many harmful compounds in it. It adsorbs benzene, ethyl benzene, methanal, ammonia, 2,4-dichloro hydroxyl benzene and chloroform. Now a days bamboo charcoal bags are used for controlling humidity. Because of these ultimate properties, bamboo charcoal is used in purification of water and waste water treatment. Experiments also showed that biological bamboo charcoal is capable of removing arsenic and fluoride ions completely from water in single run. In present scenario every country is facing scarcity of clean water and billions of money is invested in the treatment of waste water, as well as in purification. The bamboo charcoal technique, if scaled up in proper way, can become a significant piece from economic point of view.

Footnote

Commercial use of bamboo charcoal provides cost effective way of treating water and widen applications of bamboo charcoal.

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