Influence of Temperature on Pyrolysis of Biomass

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Abstract: The Antimicrobial and anti-inflammatory nature of the castor oil is used for the treatment of constipation and also used to clean the intestine before a surgical treatment. The growing demand castor oil due to its cheaper price and have much demand to grow hairs faster which give proteins to hair and increases the life span of hair and increases the hair capacity and provide hair smoothness because it has high ricinoleic ratio which is beneficial for skin and hair. The main objective of this paper is by observing its usefulness and the current aim for the research work is to produce bio-char/carbon compounds and extraction of higher carbon content. The castor leaves are collected and dried in the sun light to get it moisture free and proximate analysis is studied that reveals 14% of fixed amount of carbon. The dried leaves of castor plant are pyrolized at different temperature ranges 250°C, 350 °C, 450°C, 600°C and 900°C. The pyrolised specimens were studied by Fourier-transform infrared spectroscopy analysis which shows the transformation and formation of several bonds including carbon bonds which are affected during carbonization. Scanning electron microscope and energy dispersive x-ray spectroscopy have been studied on pyrolised specimen to get microstructures elements in the bio-char. The parameter called carbon/oxygen ration gives the advantage of char in the agricultural land for fertility motive and discrepancy of carbon and oxygen contents have been analysed. It has been found that carbon/oxygen ration increased along increment in Pyrolysis tempt. Up to 500°C and therefore along moreover increment in tempt. Beyond 500°C there is a decrement trend has been found.

Keywords: temperature, pyrolysis, FTIR, bio-char.

1. Introduction

Biomass is stated as a industrial word from which energy is generated by burning the wood and organic wastes which releases carbon emission but it has been classified as a renewable source of energy. In the current scenario the bio wastes are substitute as a auxiliary source of energy and several works have completed previously due to degradation of the fossil fuels and increasing demands for the energy. A huge amount of bio wastes and biomass residues generated from various economic action and human activities [1-2]. By burning biomass carbon emission is released. The large amount of biomass and bio-waste are generated from different economic activity. Pyrolysis is stated as the thermal decomposition of substance at elevated temperature in presence of inert atmosphere as a vacuum or nitrogen gas. It turns organic substance in to carbon containing residue where several reactions occur at the same time which effectively applied to the castor leaves resulting in to some different product such as biomass. The products of Pyrolysis might be such as bio-char, fuel gas, oil and tar [3]. Pyrolysis is done to get pyrogenic carbon [4] which include black carbon, soot, bio-char. Bio-char is stated as a carbonaceous product produced by Pyrolysis or gasification in which bio mass
is heated in the absence of oxygen or under reduction. Bio-char is used additionally as a soil enhancer which increases the water holding capacity of the agricultural land and also increases the fertility of the soil. Castor leaves provide high char on the basis of its high lignin content and also has metallic quantity high. Polysaccharide gives less char as compared to lignin which has been analyzed in the study [5].

2. Materials and methods

The leaves of castor plant have been gathered from the college compound. These leaves were dried under the sunray for two months to get rid of the moisture and then it was made in fine powder form by the help of grinder machine by running at the speed of 250 rev/min for forty minutes subsequently grinder is stopped and powdered leaves is collected from the machine and then it is stored in a zip packet to avoid from contaminated air and vapors.

2.1 Proximate analysis

Castor leaves powders are subjected for proximate analysis. 2 gram of sample were putted in to uncovered crucible and stored in an oven for 1 hour in a maintained temperature of 105°C to get the moisture content. Again, above amount of powdered leaves were kept into a covered silica cup and after that is placed inside the pit furnace for 7 minutes in a maintained temperature of 910°C to know volatile quantity of matter. Afterwards, same quantity of powdered leaves putted into the uncovered silica cup and placed inside the pit furnace for 30 minutes in a maintained temperature of 770°C. Then after it crucible is seized and amount of ash content was studied and thereafter fixed amount of carbon is studied on the basis of proximate to determine the features of raw specimen which is to be pyrolised.

2.2 Pyrolysis

The char is being obtained after paralyzing the organic substance and stated as a disintegration of biological substance at high temperatures thermal decomposition take place in presence of inert atmosphere or in presence of nitrogen. Bio char is carbon dense solid. This enhances a solid mixture which known as bio char and some liquid amount of substance is called as bio-oil and gaseous amount of substance produced is called syngas. Temperature plays an important role in in yielding the Pyrolysis process. At a low temperature range between 400-500°C incurs more bio char while at higher temperature generally greater than 700 the liquid and gaseous products are obtained.

2.3 Processing and characterization of raw material

The composition and microstructure of Specimen have been examined by applying a Nova Nano SEM 450 branded by FEI fesem machine with an INCA analyzer system before analyzing the sample it has being coated with gold coating in a stutter coating for 300 seconds after that sample is brought up and positioned inside a case to occupy the sample and to read the sample in the machine and capturing space of the specimen is 6mm. after that picture of char is recorded at several magnifications. hydraulic press machine is used to make the pellet which contain powdered samples and potassium bromide which contain the ration of the ration of one: nine and 8-9-ton load was applied in the hydraulic press to make the pellet and this pellet is subjected to IR Radiation and from which chemical functional group is identified by using FTIR Perkin Elmer Spectrum.

3. Result and Discussion

3.1. Proximate analysis

Castor leaves powders are subjected for proximate analysis. 2 gram of sample were putted in to uncovered crucible and stored in an oven for 1 hour in a maintained temperature of 105 to know the content of the moisture present in the specimen. Again, above amount of powdered leaves were kept in a covered silica cup and after that is placed inside the pit furnace for 7 minutes in a maintained
temperature of 910°C to know the content of volatile matter. Afterwards, above quantity of powdered leaves kept in the uncovered silica cup and placed inside the pit furnace for 30 minutes in a maintained temperature of 770°C. Then after it crucible is seized and amount of ash content was studied and thereafter fixed amount of carbon is studied on the basis of proximate to determine the features of raw specimen which is to be pyrolised.

The amount of organic substances such as moisture content, ash content, fixed carbon and volatile matter can be determined by applying proximate analysis and gas been tabulated as below: -

| Proximate analysis of castor leaves | Wt.% |
|-----------------------------------|------|
| Moisture content                  | 11   |
| Ash content                       | 10   |
| Fixed carbon                      | 14   |
| Volatile matter                   | 65   |

Table 1. Proximate analysis

3.2. Characterization and analysis of bio chars:

3.2.1 Microstructure- analysis

Powdered castor leaves which is carbonized at different temperature is subjected to fesem for the micro structural analysis which reveals the feedstock along with bio char which is described below. It reveals irregular, packed morphology with cross linkage structure shown in given below figures. The cross linkage shows the presence of network consist of lignin, pectin, hemicelluloses and cellulose. In few pores of char lamellae is also observed.

![Fig: 1. FESEM microstructure of Bio char carbonized at 250°C](image1)

![Fig: 2. FESEM microstructure of Bio char carbonized at 350°C](image2)
3.2.2 Analysis of the Element

EDS is employed for the analysis of the element of the sample. It is the analytical method. The element which is analyzed is given below in the Table 2. And plotted in the fig. 5. We observed that in carbonized sample the percentage of atomic weight of oxygen, silicon, carbon, calcium and potassium varies with carbonized temperature. Above all we found that percentage of atomic weight of oxygen and carbon is high on various temperatures.

| Temperature | oxygen  | silicon | carbon  | calcium | potassium |
|-------------|---------|---------|---------|---------|-----------|
| 0           | 34.39   | 1.01    | 59.93   | 0.23    | 0.88      |
| 250         | 27.52   | 0.67    | 55.34   | 3.23    | 4.10      |
| 350         | 32.87   | 1.08    | 56.52   | 2.41    | 4.46      |
| 450         | 30.01   | 0.45    | 61.19   | 2.35    | 3.23      |
| 600         | 55.01   | 2.02    | 12.99   | 9.98    | 9.21      |
| 900         | 51.99   | 3.01    | 11.01   | 0.00    | 0.03      |

Table 2. Atomic weight percentage of various element with carbonizing temperature.

Fig 3. FESEM microstructure of Bio char carbonized at 600°C

Fig 4. FESEM microstructure of Bio char carbonized at 900°C

Fig 5. Atomic weight % percentage VS Tempt. Graph
3.3 FTIR Analysis

Fourier transform infrared spectroscopy technique were performed to determine the distribution of functional group present in the pyrolised product (bio char) which is either solid, liquid or gas as infrared spectrum of adsorption or emission. IR radiation is passed through the sample to detect is functional group or various organic system. In given below figure 6 show different functional group present in the castor leaves.

![Fig 6. Graph of FTIR of the samples](image)

The absorption peak originating from the molecules as vibrational transitions shows the characteristics of different organic group. Occurrence of absorption band shows the characteristics of class compound. (e.g. Aromatic, alcohols, acid, ethers, amides etc.). The Powdered castor leaves are subjected to ftir spectroscopy which determines the functional group of organic matter shown in above figure 6 which reveals the presence of the alkenyl group (CH$_2$=CH-), phenols, aliphatic cyanide and nitride. The presence of O-H stretching vibration band between 3250 and 3500 cm$^{-1}$ shows the presence of carboxylic and alcohol as well as water. The C=O stretching vibration band shows the presence of ketones, carboxylic acid and aldehyde between 1870 and 1600 cm$^{-1}$. The C-O stretching vibrations Band between 920 and 650 cm$^{-1}$ shows the appearance of alcohol and esters. The bio chars spectrum shows the presence of aliphatic character indicated by the absorption band present between 2990 and 2780 and slight peaks have been also observed between 1300 and 1440 cm$^{-1}$. Little peaks have been also observed between 515 and 700 which reveal the presence of aromatic stretching vibration. These all characteristics have been analyzed in pyrolised specimen at several temperatures.
4. Conclusion
The main purpose of this research work is to use the bio waste product as a useful resource and to make high value product and to conserve it for future generation as well as alternative source of exhausting fossil fuel and to save environment from pollution as well as to generate employees in rural areas and skilled person. The efficient way to utilize the bio waste product thermally for various applications. Bio char is obtained after the Pyrolysis of castor leaves process. The fixed carbon is studied 14%. These bio char is used to enhance the fertility of the soil and used for water holding capacity in the agriculture land, and also there is variation of such element oxygen, nitrogen, silicon, calcium with the variation of temperature is observed and amount of carbon content is also affected with temperature variation is observed. and metallic element etc. There is variation in bonding during temperature treatment is observed. Ftir studied proves the presence of carboxylic, aldehyde, ketones etc. The recent study of this research will also determine bio char properties which would be beneficial for the future work.

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