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Biochar Production from Agricultural Waste and its Application : A Technical Review

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ABSTRACT: Biomass is a plant or animal material used for energy production, or in various industrial processes as raw material for a range of products. Biochar is a carbon-rich highly porous substance which can be produced through different processes such as pyrolysis, gasification and hydrothermal carbonization of organic biomass. Major characteristics of biochar include large surface area and high cation exchange & water holding capacity. The common feedstocks of biochar production are energy crops, residues, agriculture waste, animal waste, kitchen waste, sewage sludge etc. Production of biochar helps in achieving the objective of waste minimization, energy recovery and mitigation of greenhouse gas emission. The applications of biochar have a wide range including soil conditioning, wastewater treatment, catalysis and energy production etc. This paper reviews the different methods used to produce biochar from agricultural waste with their advantages and disadvantages. Utilization of biochar for various environmental applications is also under scope of this paper and is discussed in detail.

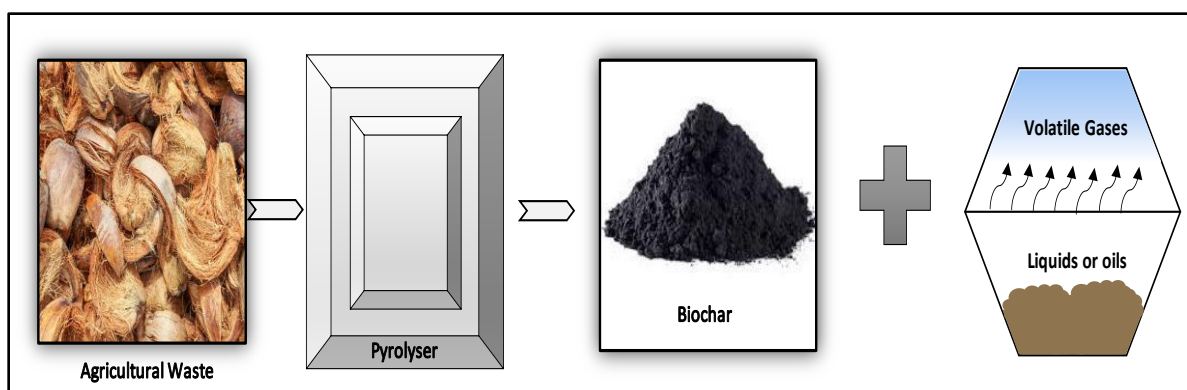
KEYWORDS: Biochar, pyrolysis, soil amendment, greenhouse gas

I. INTRODUCTION

India is known as an agricultural-based economy where approximately 60-70% of the country's public relies upon agriculture for their livelihood. Huge quantity of agricultural biomass is left after extraction of crop and this leftover is called as agricultural waste [1]. Usually this leftover waste is simply burnt by the farmers in order to make the land ready for next crop. Burning of agricultural waste not only leads to severe air pollution but also spoils one of the natural resources.

Many researchers have revealed that this agricultural biomass can be converted into liquid, solid and gaseous fuels with the help of different physical, chemical and biological conversion processes [2]. Biochar is one of the useful products of thermochemical degradation of agricultural waste produced under oxygen-deprived conditions, the process is also known as pyrolysis [3]. Pyrolysis is a multi-product green technology [4] which has shown the potential of recovering hydrocarbon liquid, char and the gaseous products from carbonaceous solid waste. Biochar is a solid carbon-rich product produced when biomass such as straw, wood and leaves is heated in a closed container without or limited presence of air. Figure 1 shows schematic diagram to produce Biochar.

Figure 1:



Biochar produced from this process has a large surface area due to the microspores developed during pyrolysis, and can be used for the filtration and adsorption of pollutants [5]. Biochar production has received huge attention because of its potential as a soil amender for soil carbon sequestration and to improve soil quality [6]. This study investigates the properties of biochar by slow pyrolysis for coconut shell and ground nut shell at different temperature at 350, 550, 750 and 950°C. Detailed properties of biochar from the samples were compared for the mass yield, elemental composition, pH, ash content and its functional group [7]. It is added to soil to improve the fertility and plant growth. [8] During the production of biochar, bio-oil and gases such as hydrogen is also produced that can be used for energy sources to power homes or automobiles. Biochar has the capacity for remediation of contaminated soil and provides additional benefits to the environment. The science involved with it is still poorly understood although the use of biochar dates back to thousands of years. [9]

II. BIOCHAR CHARACTERIZATION

- **Physical characterization**

- pH :Soil pH known as potential of hydrogen is a characteristic that describes the relative acidity or alkalinity of the soil [10]. pH is defined as the negative (-) log or base 10 value of the concentration of hydrogen ions [11]. According to [12], soil pH influences several soil factors that affect plant growth; these include soil bacteria, nutrient leaching, nutrient availability, toxic elements and soil structure. Soil pH is also called actual or active acidity [13] and it is the measurement of free hydrogen ions (H⁺) on the soil colloids [14]. A 1% (w/w) water suspension of each type of biochar was heated to approximately 90 °C and stirred for 20 minute then allowed to cool to room temperature before pH measurement with a coming pH 10 portable pH meter. The pH meter was calibrated with standard pH 4 and pH 7 buffers [15].
- Cation exchange capacity :In general the cation exchange capacity (CEC) of most biochar is relatively high, in part due to their negative surface charge and resultant affinity for soil cations, including most heavy metals. For these reason, several studies have been conducted investigating the adsorption of cations in to biochar, which is the primary mechanisms by which biochar can be used for remediation of heavy metal contamination. CEC varies significantly between terrestrial derived biomass from different feedstocks, ranging from 4.5 to 40 cmol /kg. Compared to many terrestrial biomass, the CEC of biochar from algae is relatively high (29 – 41 cmol/kg) with extractable Ca, Mg and K ranging from 27 to 485 cmol/kg. The CEC of biochar amended soil is strongly dependent on the age and surface functional properties and charge of the applied char.
- Pore volume:Scanning electron microscopy (SEM) is a microscopic technique in determining the image macro porosity and physical morphology of solid substances. The macro porous structure of biochar produced from cellulose plant material depends upon the feedstock, and it is potentially important to water holding and adsorptive capacity of pollutant in soil and solution systems. It can also be detected that the surfaces of low temperatures biochar can be hydrophobic, and these may reduce its capacity to store water in soil as well as adsorb pollutants
- Particle size distribution
- Zeta potential of biochar colloids
- Moisture content

- **Chemical characterization**

- Ash content :Pre-weighed ceramic crucible containing approximately 2 gm of oven dried biochar were used to measure ash content of the biochars. The sample were heated in muffle furnace at 760 °C for atleast 6 hrs. After cooling the remaining solids (ash) were weighted [15].

$$\text{Ash (\%)} = \left(\frac{\text{remaining solid wt (gm)}}{\text{original carbon wt (gm)}} \right) * 100$$
- Elemental analysis:Biochar is clearly amenable to elemental analysis, but as yet there is no international standard protocol for this method. Some biochars have very high carbon contents (>80 wt %) relative to most organic matter and many commonly used standards. As a result, comparatively little sample material needs to be weighed out for analysis of carbon content. This means that the balance used for weighing must be able to weigh in the low milligram range (1–10 mg) both accurately and precisely. It also means that the biochar sample must be homogeneous enough to allow analysis of a representative sample. Most biochars contain a component of highly condensed aromatic carbon that is difficult to combust, and can lead to poor peak shape, poor chromatographic separation of components and underestimation of carbon content. Many biochars contain calcium carbonate areas the content of total organic carbon is usually the parameter of interest. Either the inorganic carbon must be removed before analysis, or the analysis should be corrected for the presence of

inorganic carbon in the sample unless total carbon is the parameter of interest. Some biochars have very low N contents, if accurate analyses at low abundance are required, then large samples must be used for the analysis. This leads to potential issues in ensuring the quantitative combustion and complete degassing of atmospheric N from the samples before analysis, and difficulties ensuring separation of a small N peak from a much larger CO₂ peak. Most biochars are relatively hygroscopic, so that attention must be paid to adequate drying of samples before analysis and to ensuring that samples remain dry during the process of analysis.

III. BIOCHAR ACTIVATION

The physico-chemical properties of biochar can be improved by its activation. The methods of activating biochar and the synthesis of biochar are differentiated by the use of biochar.

Physical activation :The activation of biochar by physical activation is normally processed by a two-step treatment. In the first step, the carbonization step, a relatively low temperature between 700 and 1150 K is applied. A higher temperature (900-1200 K) is applied to the activation of carbonized biochar [16]. Due to the high energy and time consumption, the actual application of physical activation is limited, and other activation technologies have been attempted by many researchers[17].

Chemical activation :Chemical activation can produce high quality biochar with a higher surface area and porosity than physically activated biochar[18]. In addition, the chemical activation of biochar can proceed at a lower temperature than the physical activation of biochar. A long processing time and high energy are required in chemical activation during the washing step to eliminate the residual impurities[19].

IV. BIOCHAR PRODUCTION

The most common method to produce biochar is pyrolysis, which can be dated to thousands of years ago. Pyrolysis is the thermochemical decomposition of biomass at a temperature between 350-700 °C in the absence of oxygen. The decomposition process releases volatile species, while the carbon-rich solid, non-volatiles are collected as biochar. A portion of the gas-phase volatiles condenses into dark brown, viscous liquid phase termed bio-oil[18]. There are three widely used technologies involved in the production of biochar namely fast pyrolysis, slow pyrolysis, carbonization and gasification[19].The two most common methods of pyrolysis are “fast” pyrolysis and “slow” pyrolysis. As shown in Table 1, slow pyrolysis, also called conventional carbonization, produces biochar by heating biomass at a low heating rate for a relatively long residence time. On the other hand, fast pyrolysis yields 60-75% bio-oil, 15-30% biochar and 10-20% non-condensable gas, and can be done in seconds, whereas slow pyrolysis has the advantage that can retain up to 50% of the feedstock carbon in stable biochar [20], but takes up to several days to complete. Furthermore, the bio-oil and gas co products of these technologies can be produced on a large scale and they should find their applications in many fields.

Slow pyrolysis :Slow pyrolysis is a thermal conversion processes characterized by long residence times and slow heating rates that produce approximately equal compositions of solid, gas, and liquid products. Slow pyrolysis is conducted at atmospheric pressure, with heat provided by partial combustion of the feed, by external heaters, or by hot-gas recirculation. In this slow pyrolysis process, different types of reactors have been used for biochar production [21]. This reactor uses low pyrolysis temperatures (300–700 °C), high pressures, long vapor residence times (hours to days), extended vapor/solid times, low heating rates (0.01–2 °C s⁻¹), and optimized heat integration [22]. Comparatively higher biochar yields are favored by biomasses with high lignin and ash content, along with large particle sizes during slow pyrolysis conditions [24]. These conditions enhance biochar yield by increasing cracking reactions that reduce the production of liquids or bio-oil [23]. slow pyrolysis is a simple and inexpensive process that is applicable to small scale and farm-based biochar production [25].

Fast pyrolysis :Fast pyrolysis is also a thermal conversion process that is characterized by short residence times (<2 s), fast heating rates (> 2 °C s⁻¹), and moderate temperatures (500–1000 °C), and provides high yields of bio-oil (75%) from biomass, together with non-condensable gasses (13%) and solid biochars (12%). The bio-oil produced from biomass is an energy source and can also be used as a feedstock for the production of chemicals [26][27]. This process focuses on obtaining high yields of bio-oil compared to solid products or gasses; the bio-oil produced can be used directly in numerous applications or as an efficient energy carrier[29]. A dark brown, free-flowing liquid, possessing a



heating value about half that of conventional fuel oil, with a characteristic acid and smoky odor, is generated through fast pyrolysis [30]. Depending on the feedstock materials and the pyrolysis mode, the color of the liquid product, which is influenced by its chemical composition, varies from almost black through to dark red-brown and dark green. A translucent red-brown appearance is obtained through hot-vapor filtration, because of the absence of char. The dark-green tinge observed is due to high nitrogen content [28].

Table 1 : characteristics of different pyrolysis processes and typical yield of biochar in these processes

	Slow pyrolysis	Fast pyrolysis	Pyrolytic gasification
Heating rate(°C/min)	5-7	300-800	-
Temperature(°C)	300-800	400-700	750-1000
Vapour residence time	>1 hour	0.5-10 sec	<2 sec
Main product	Biochar	Bio-oil	Syngas

Table 2: the application of biochar produced from different feedstocks and techniques in aqueous solution

Biomass feedstock	Pyrolytic temperature(°C)	Pyrolysis techniques	Contaminants	References
Coconut shell	250-600	Slow pyrolysis	Cr	[31]
Corn straw	600	Slow pyrolysis	Cu, Zn	[32]
Rice straw	100-700	Slow pyrolysis	Al	[33]
Sugarcane bagasse	450	Slow pyrolysis	Sulphamethoxazole	[34]
Wood	200-600	Slow pyrolysis	Fluorinated herbicides	[35]
Rice husk	350	Slow pyrolysis	Pb, Cu, Zn, Cd	[36]

Feedstocks of biochar :

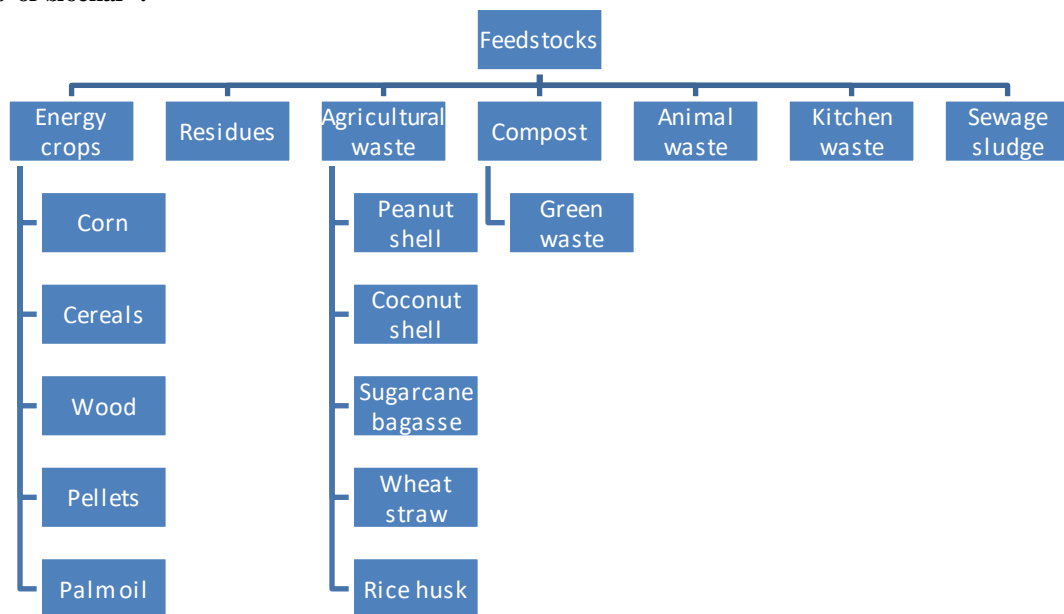
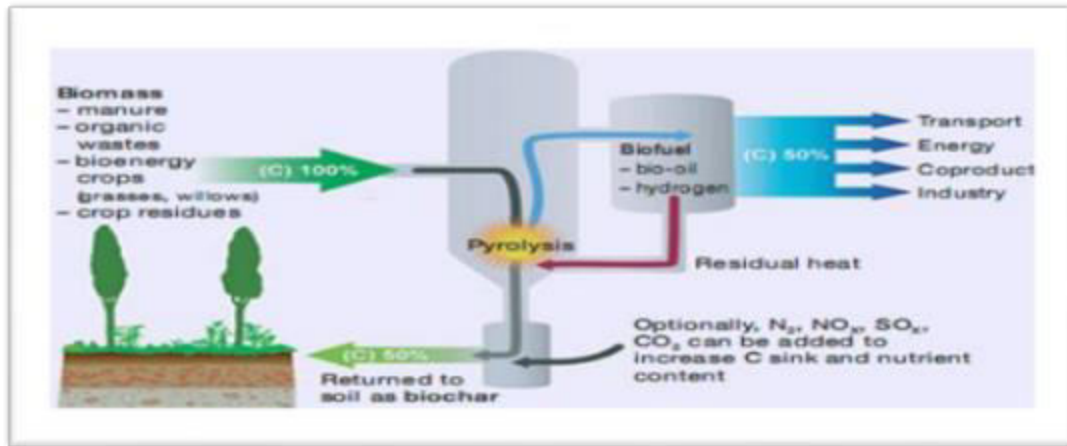


Table 3 : characteristics of biochar from different feedstock

Sr no	Feedstock	pH	Moisture	Ash	Volatile matter	C	H	N	O	Reference
1	Rice straw	9.68	7.20	15.40	62.40	44.80	5.10	0.90	22.39	Putun, et al. 2004; Shenbagavalli and Mahimairaja 2012; Bakar et al. 2012 4
2	Coconut shell	9.18	4.40	0.70	80.20	50.20	5.70	0.00	43.40	Raveendran et al. 1995; Werther et al. 2000; Shenbagavalli and Mahimairaja 201
3	Peanut shell	9.50	1.90	7.80	8.10	93.61	1.99	1.05	3.35	Apaydin-Varol et al. 2012
4	Sugarcane bagasse	9.30	1.30	8.57	9.17	85.59	2.82	1.11	10.48	Lee et al. 2013
5	Switch grass	8.00	-	7.80	13.40	84.40	2.40	1.07	4.30	Novak et al. 2009
6	Wood chips	10.90	-	31.00	-	74.80	0.14	0.15	4.20	Saarnio et al. 2013
7	Neem	-	3.70	24.50	32.00	82.34	7.89	5.76	3.57	Volli et al. 2012

V. METHODOLOGY

Literatures are reviewed across board including greenhouse and field experiment using biochar amended soils with the main target of finding the effect of biochar on plant growth and productivity. After general review, they are critically analyzed as to why certain type of biochar are used, why the choice of the biochar, the application method, the experimental approach among other factors are considered on them. It is then followed by data generated from the various articles for meta-analysis. Data on the authors of the articles, experimental procedures applied in their researches, the effect of biochar on plant growth, the pyrolysis temperature, the pyrolysis time, type of biochar, amount of biochar applied, the effect of biochar on soil pH, the effect on water holding capacity and greenhouse gas mitigating effects are derived from the reviewed articles.



VI APPLICATION OF BIOCHAR

Biochar enhances soils. Biochar also improves water quality and quantity by increasing soil retention of nutrients and agrochemicals for plant and crop utilization. More nutrients stay in the soil instead of leaching into groundwater and causing pollution. By converting agricultural waste into a powerful soil enhancer that holds carbon and makes soils more fertile. Research is now confirming benefits that include:

- Reduced leaching of nitrogen into ground water
- Increased cation-exchange capacity resulting in improved soil fertility
- Moderating of soil acidity
- Increased water retention
- Increased number of beneficial soil microbes

Areas with low rainfall or nutrient-poor soils will most likely see the largest impact from addition of biochar [37]. The organic material such as biochar may serve as a popular choice for this purpose because its source is biological and it may be directly applied to soils with little pretreatment [38]. Typically, alkaline pH and mineral constituents of biochar (ash content, including N, P, K, and trace elements) can provide important agronomic benefits to many soils, at least in the short to medium term. When biochar with a higher pH value was applied to the soil, the amended soil generally became less acidic [39]. The consequence of biochar addition on plant productivity depends on the amount added. Recommended application rates for any soil amendment should be based on extensive field testing. At present, insufficient data are available for obtaining general recommendations. In addition, biochar materials can vary greatly in their characteristics, so the nature of the particular biochar material (e.g. pH and ash content) also influences the application rate. Several studies have reported a positive effect of using biochar on crop yields with rates of 5–50 tonnes per hectare with appropriate nutrient management [40].

As a energy production :

Worldwide energy consumption is increasing, and the importance of energy conversion without increasing the level of environmental contamination has become an important factor in social and economic development. To meet the energy demand, it is necessary to develop a system to store clean energy that can reduce the fossil fuel consumption [41]. Biomass Converted to Renewable Energy during pyrolysis. Volatile gases (methane, carbon monoxide and other combustible gases), hydrocarbons and most of the oxygen in the biomass are burned or driven off, leaving carbon-enriched biochar. Biochar can be used as a substitute of coal for energy production. The most cost effective way of producing electrical energy from biomaterial is through pyrolysis. Also, syngas produced as a co-product during biochar production can be used as a fuel in gas engines and turbines or can be burnt or may be converted into clean diesel fuel through the Fischer Tropsch process, or can be used to produce methanol and hydrogen. Bio-oil can be used as a replacement for fuel oil. Syngas and bio-oil produced during the production of biochar can be upgraded to transportation fuels such as biodiesel and gasoline substitutes. The energy density of bio-oil is higher than the raw biomass. Bio-oil has high water vapour content that is detrimental to ignition; it also contains organic acids that are corrosive to steel containers.

As a soil conditioner:

As a soil conditioner Biochar is widely used as a soil amendment in fields. In certain poor soils, positive effects on soil fertility are seen when applying untreated biochar. It improves overall soil quality. Biochar improves water holding capacity of the soil thus helps in water retention for a longer period of time which may be attributed to its highly porous structure. Thus, it reduces the cost involved in the irrigation by reducing its frequency and intensity. Addition of biochar to acidic soil has shown an increase in soil pH. Thus, biochar possesses a liming effect on soil. Addition of biochar in soil results in increased cation exchange capacity (CEC) which in turn reduces the loss of nutrients through leaching. The best method of loading nutrients is to co-compost the char. This involves adding 10-30% biochar to the biomass to be composted. Co-composting improves both the biochar and the compost. The resulting compost can be used as a highly efficient substitute for peat in potting soil, greenhouses, nurseries and other special cultures. Since the biochar possesses high CEC it has the capacity to hold the nutrient present in the soil, therefore it increases the nutrient use efficiency of the soil which otherwise gets washed away due to precipitation. When the biomass is converted to biochar, 50% of carbon present in the biomass gets trapped in its structure which is more stable in nature as compared to the biomass which on degradation releases the carbon back in the atmosphere. Therefore, production of biochar and its subsequent use in the soil creates a carbon sink. Because biochar serves as a carrier for plant nutrients, it can produce organic carbon-based fertilizers by mixing biochar with such organic waste as wool, molasses, ash and slurry. These are at least as efficient as conventional fertilizers and have the advantage of not having the adverse effects on the ecosystem. Such fertilizers prevent the leaching of nutrients, a negative aspect of conventional fertilizers. The nutrients are available as and when the plants need them. Through the stimulation of microbial symbiosis, the plant takes up the nutrients stored in the porous carbon structure and on its surfaces.

As a Waste management tool :

Agricultural and animal wastes can provide severe environmental challenges that eventually lead to the pollution of ground and surface waters [42]. The utilization of this waste, as well as other by-products, as feed stocks for pyrolysis bioenergy [43] represents a significant environmental management and economic achievement. Numerous waste streams provide economic opportunities for energy recovery, especially when a trustworthy source of feedstock is generated at a specific location [42]. This decreases the energy required for transportation and reduces CH₄ emissions that would be produced if such waste materials were landfilled [44]. Pyrolysis provides a potential means of converting waste sludge to biochar, thereby improving the management of this waste, reducing its transport costs, and reducing production volumes [45]. The landfilling of organic waste and the anaerobic digestion of animal waste can result in the release of significant quantities of CH₄ and N₂O. Therefore, using this waste for biochar production, and its applications, is an effective waste management strategy that helps to reduce GHG emissions and reduce waste-disposal costs associated with traditional methods of waste management [44]. Biochar production from sewage sludge helps to reduce the volume of biosolids and eliminate pathogens, while transforming this organic matter into bio-oil and biochar [46][47]. Biomass feedstocks of very low-grade, or even byproduct waste, can be employed to produce energy and biochar using slow pyrolysis facilities [48], thereby transforming the carbon contained in these materials from short to long-term carbon cycles. Subsequently, recycling of the biochar back to the soil can be achieved, ensuring a positive feedback loop for improving the production of the next round of crops [49]. The results of this study showed that the co-composting of biochar (3% dry weight) with poultry manure increased OM degradability over a shorter composting period, with reduced formation of clumps and increased N mineralization [50].

As a Treatment of wastewater :

Treatment of waste water is the most effective and widely used method for removal of organic compound such as pesticides, volatile compounds, chlorine, certain metal etc, is the use of activated carbon (biochar). Carbon filtering is a method which works on the principle of adsorption. Due to highly porous structure of biochar, it provides a large surface area, thereby providing a maximum surface area for the contaminants and impurities to interact with the active site of the biochar. For removal of sediments, volatile organic compounds (VOCs), odour, chlorine and taste, active biochar filters proved to be most effective. Also the classical graphite structure of carbon in biochar enables the carbon to connect with neighbouring atoms or atoms from foreign molecules, which increases adsorption capacity. Biochar has been recognized as a good sorbent for different kinds of organic and inorganic pollutants. The aim to activate biochar is to increase its capacity for cation exchange. Activation of biochar is to treat it with physical and chemical agents to improve the porosity and increase the acidic functional groups on the mainly aromatic carbon surfaces. Activated carbon with increased acidic functional groups could be used for wastewater treatment. Few studies have conducted steam activation to increase the cation exchange capacity of biochar and thus improve nutrient retention in soils. The resultant effect of activation on the CEC of biochar is variable leaving the conclusion that studies on biochar activation

are required for each type of feedstock used.. Biochar enriched with NH_4^+ after treating wastewater may have the potential to be used as N fertilizer for pasture and crop plants and may defray some of these costs. If biochar is combined with materials that have P sorption capabilities then the final mixture may have the potential to remove both N and P from wastewater and produce a combined N and P fertilizer. There are no trials assessing the nutrient sorbing capacity of activated biochar and tephra in a combined system and use of these materials in soils as slow release fertilizers.

As a Carbon sequestration :

Carbon sequestration is a process in which carbon is captured and stored to prevent it from being emitted into the atmosphere [51]. Biochar is biologically and chemically more stable than the original carbon form, due to its molecular structure, and its origins. It is difficult for the sequestered carbon to be released as CO_2 , making this a good method for carbon sequestration [52]. The diversion of even 1% of the net annual uptake of carbon by plants into biochar would mitigate almost 10% of current anthropogenic carbon emissions [53]. It is assumed that 3 billion tonnes of biochar is produced annually. This, in turn, reduces approximately 3 billion tonnes of atmospheric carbon emissions if all of the biomass (60.6 billion tonnes) is regenerated in the form of biochar through pyrolysis [54]. An estimated 1 billion tonnes of carbon will be sequestered annually by 2030, which is a rationally conservative approximation of the potential of biochar [55]. The thermochemical conversion of biomass into biochar through pyrolysis increases the recalcitrance of the carbon that originated in the biomass. The addition of biochar of similar carbon content to soil leads to steady soil carbon levels, due to its stability in soil [56]. The biochar acts as a carbon sink that remains in the soil for long periods of time, possessing high levels of resistance to chemical and biological degradation, in turn increasing terrestrial carbon stocks. It is estimated that 20% of the total carbon biomass can be captured by conversion into biochar [56]. Despite the fact that soils contain over 80% of the terrestrial store of organic carbon [57], soils show low potential for carbon accumulation in conjunction with forest growth [56]. Therefore, has been suggested that the application of biochar, through the pyrolysis of biomass, to soil, is a potential approach to amending C in terrestrial ecosystems as a large and extended-term C sink. The common consensus is that soil is a finite C sink at best; the application of biochar provides an opportunity for reducing C emissions and sequestering C for soil remediation [58].

As a reduction of greenhouse gas emission

In the carbon cycle, atmospheric CO_2 is fixed by photosynthetic organisms (e.g. plants) and then it is converted into biomass that is mixed with soil when these organisms die. The biomass in soil is mineralized and microbial respiration causes the evolution of CO_2 to the atmosphere. When biochar is applied to soil, its recalcitrant nature causes it to stay in the soil for long periods of time, thereby reducing GHG emissions. Pyrolysis products (bio-oil, syngas) are burned as fuel, releasing CO_2 into the atmosphere that will be utilized by plants, and ultimately converted into biomass again. The carbon cycle of biochar production has some indirect GHG-emission sources as well. Yang et al. conducted a life cycle assessment of a pyrolysis plant in China and concluded that the operation and maintenance of the pyrolysis process contributes to 89% of its GCG emissions, while building works, equipment, and transportation contribute 7.2%, 3.33%, and 0.23%, respectively [59].

Cosmetic industries

The concept of use of biochar for removal of toxin and impurities from skin is not new in India. Its potential use as a beauty care product has been mentioned in Ayurveda, which is known as 'bhasma' or extracts made from woods. They open up clogged cells, cleanse skin and reduce inflammation. At the same time, they nourish and revitalize skin. The ability of biochar to adsorb chemical makes it a popular ingredient in facial mask, soap and beauty cream. It controls pimple, acne, oily patches and open pores. It gives even colour and texture, lifts up and moisturizes skin.

Food industry

The application of biochar in the form of activated carbon in food industry has been listed below:

- Purification of liquid sugar: activated carbon plays an important role in the beverage industry as it helps decolourization of the sugar solution.
- Cane sugar refining: since the decolourization of the cane sugar syrup is very important before it is crystallized into sugar, activated carbon plays a vital role so as to produce pure white colour. During the manufacture of sugar from sugarcane it is used to adsorb plant pigments.
- Alcoholic beverages: for purification of the ingredients as well as the final products after they are manufactured activated carbon are used in manufacturing process of wine, alcohol, beer, rum, whisky, vodka

etc. They are used for decolourization, removal of congeners that affect the taste or odour and prevention of turbidity during ageing.

- Fruit juices: In beverage industry activated carbon are used for decolourization of fruit juices such as apple juice, grape juice, pineapple juice, orange juice etc. After carbon treatment the juices becomes more concentrated in nature. It helps in the removal of patulin one of the mycotoxin present in fruit juices, in particular apple juice.
- Biochemical food products: for remove of molasses from citric acid, lactic acid and other forms of food substances, activated carbon is widely used. It can be also used for purification of gluconates and lactates.
- Starch based sweeteners: for production of starch based sweeteners like glucose, maltose, fructose, dextrose etc. activated carbon is being used for decolorization, polishing of syrups to meet the standards of the soft drink Industry.

VII. RESULT

Sr No	Parameters	Unit	Result	Method ref.
1	Nutrients value as Na	%	3.60	AS PER IS 3025 (PART 45)
2	Iodine value	mg/gm	1868	IODOMETRIC TITRAION
3	Nutrients value as K	%	9.78	IS method
4	Nutrients value as N	mg/lit	2.49	IS method
5	Nutrients value as P	mg/lit	0.79	IS method
6	Calorific value	Cal/gm	4584	IS:1448(PART-6):1984

VIII. CONCLUSION

Biochar can be produced from a variety of feedstock. The physicochemical properties of biochar depend on the type of feedstock, the pyrolysis condition and the technology involved in its production. Properties like number of pore, pH, ash and fixed carbon content increases with the increase in temperature; while yield, volatile matter, oxygen and hydrogen content in biochar decrease with increase in production temperature. Production of biochar and its subsequent use in the field as a soil amendment from agricultural waste fulfills the twin goal of waste management and improvement of soil quality. Biochar reduces money involved with agriculture by cutting down the amount of fertilizer required in the fields and by reducing the frequency of irrigation; as biochar helps in prevention of nutrient loss as well as increase the water holding capacity of the soil. Apart from agricultural benefits biochar also possess some environment benefits like mitigation of GHG, remediation of polluted soil and sequestration of carbon. Thus, biochar production and application can be regarded as a viable solution to an array of modern-day problems.

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