SYNTHESIS OF CARBON NANOPARTICLES FROM *CHROMOLAENA ODARATA* AS BIOSOOT AND THEIR CHARACTERIZATION

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ABSTRACT

Carbon nanoparticles are utilized in numerous medicinal and scientific procedures due to its low toxicity, biocompatibility and easy availability. They are synthesized using physical and chemical methods which involves consumption of more energy or usage of toxic chemicals. Hence, an alternate to synthesize carbon nanoparticles was evaluated using open pyrolysis and generation of soot. As the soot are generated from biological material in this study, i.e. *Chromolaenaodorata*, they are termed as Biosoot. Biosoot is defined as the smoke or soot generated when burning the biomaterials which may either be of plant or of animal origin. These soots are found to differ in their characteristic features as size, shape and their chemical composition according to the plants. In this study, an attempt was made to characterize the biosoot developed using the leaves of *Chromolaenaodarata* (an aromatic plant). The biosoot was evaluated using Dynamic Light Scattering (DLS) for their size distribution, Field Emission Scanning Electron Microscopy (FESEM) to know their morphology, X-ray Diffraction (XRD) spectroscopy to know their morphology and Fourier Transform Infra-Red (FTIR) spectroscopy to know the associated chemicals present with the biosoot of *Chromolaenaodorata*. The DLS registered the peak at different levels revealing the particle size range between 90 to 250 nm, 250- 1000nm and 1400 – 3500nm. The SEM images revealed the shape of the nanoparticles as mostly spherical and few assubspherical. The size range recorded for the biosoot varies from 25nm to 60nm in size. The XRD revealed that the biosoot are amorphous in nature and the size range between 50 to 90nm. FTIR revealed the presence of associated organic compound along with the core Carbon

Nanoparticle. The peak registered in FTIR revealed the presence of alkenes and phenols, C-N stretching aromatic amines groups, C-C stretching Alkenes and ketones. The study proves that the biosoot generated from the leaves of *Chromolaenaodorata*are nanosized particles, thus the synthesis of carbon nanoparticles in the form of biosoot is easy, cheaper and can be produced in volumes with less time. The synthesized Carbon Nanoparticles in the form of biosoot can be utilized in pharmaceutical and cosmetic industries after proper evaluation of their toxicity.

Keywords: Biosoot, *Chromolaenaodorata*, SEM, DLS, XRD, FTIR, Carbon Nanoparticles

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1.INTRODUCTION

Carbon nanoparticles are utilized in numerous medicinal and scientific procedures due to carbon's low toxicity, biocompatibility and easy availability. Further as they are found to be porous in nature with a lot of surface area they can also be used for binding, chemical reactions, or absorption activities [1].They are synthesized using physical and chemical methods which involves consumption of more energy or usage of toxic chemicals.The two most significant physical methods are laser ablation and evaporation-condensation. The evaporation-condensation technique has previously been used to create a number of metal nanoparticles, including silver, gold, lead,and cadmium. The benefits of physical procedures over chemical processes include the absence of solvent contamination in the generated nanoparticles and the homogeneity of in their distribution [2]. It has been proven that a small ceramic heater with a nearby heating source can be used to create carbon nanoparticles [3]. The temperature gradient around the heater surface is so much steeper than it would be in a tube furnace, the evaporated vapour can cool at an appropriately rapid rate [4].The chemical approach allows further expansion of synthesis of large variety of nanoparticles. The scope of applications for nanoparticles is substantially expanded when particular molecules are frequently attached to the surface of the particles to vary their chemical properties [5].

The synthesis of carbon nanoparticles at desired amount with desired associated compound is achieved using chemical method of synthesis the usage of chemicals, solvent and other reducing agent may cause environmental pollution, hazard in handling and pose other health risk. Hence, an alternate to synthesize carbon nanoparticles was evaluated using open pyrolysis and generation of soot. In this study an attempt is made to synthesize carbon nanoparticles using the leaves of *Chromolaenaodorata*an aromatic medicinal plant. As the soot are generated from biological material in this study, i.e. *Chromolaenaodorata*, they are termed as Biosoot.Biosoot is defined as the smoke or soot generated when burning the biomaterials which may either be of plant or of animal origin [6].

*Chromolaenaodarata*is a species of flowering plant belongs to the family Asteraceae, is a rapidly growing perennial herb. It is a multi-stemmed shrub which grows up to 2.5 m (100 inches) tall in open areas. It has soft stems but the base of the shrub is woody. In shady areas it becomes etiolated and behaves as a creeper, growing on other vegetation. It can then become up to 10 m (33 feet) tall. The plant is hairy and glandular and the leaves give off a

pungent, aromatic odour when crushed. The leaves are opposite, triangular to elliptical with serrated edges. Leaves are 4–10 cm long by 1–5 cm wide (up to 4 x 2 inches). The medical importance of the plant is reviewed by Vijayaraghavan*et al.*, [7].

2.MATERIAL AND METHODS

Sample Collection:

Fresh healthy leaves of *Chromolaenaodarata*were collected from Villiambakkam Village, Chengalpet District of the state of Tamil Nadu in India during December 2021 (Fig. 1). The collected leaves were dried in shade until becoming crispy in nature (Fig. 2).

Fig. 1. Habit of *Chromolaenaodorata*

Fig. 2. Shade Dried Leaves of *Chromolaenaodorata*

Biosoot Preparation:

The biosoot from the leaves of *Chromolaenaodorata*was collected by burning the leaves through direct flame. The soot emanated from the burning leaves are trapped using a stainless

steel plates. The deposited biosoot were scrapped using sterile scalpel and stored in Eppendorf tubes for further characterization (Fig. 3).

Fig. 3. The collected Biosoot of *Chromolaenaodorata*

Characterization of Biosoot as Carbon Nanoparticles:

Particle size Analyser:

The Dynamic light scattering (DLS) is used to determine the size and distribution of the Carbon nanoparticles using the model Nanotrac Wave II, Microtrac Inc. USA. The study was conducted in the Central Instrumentation Laboratory (CIL), Vels Institute of Science, Technology and Advanced Studies (VISTAS), Chennai, India.

Field Emission Scanning Electron Microscopy (FESEM):

The biosoot were characterized for their morphology using Field Emission Scanning Electron Microscopy (FESEM) (Model: Quattro S, Thermofischer Scientific, USA) in Central Instrumentation Laboratory (CIL), Vels Institute of Science, Technology and Advanced Studies (VISTAS), Chennai, India.

XRD (X-ray Diffraction) Analysis:

The synthesized CNPs in the form of powder was coated on a glass substrate. Diffraction measurement were carried out with the XRD having an operating power at 40 kV and 30 mA (SmartLab SE X-ray, Rigaku, Japan) available in the Central Instrumentation Laboratory, Vels Institute of Science, Technology and Advanced Studies (VISTAS), Pallavaram, Chennai.

4.4.2 FTIR (Fourier Transform Infrared Spectroscopy) Analysis:

FTIR (Spectrum II FT-IR/Sp10 software, Perkin Elmer, USA) was used to perform measurements in the range of 4000-400 cm-1 with a resolution of 4 cm-1. The samples were prepared by uniformly dispersing carbon nanoparticles in a dry matrix of KBr, compressed to form nearly transparent discsand analysed using the above stated model.

3. RESULTS

Dynamic light scattering (DLS):

Dynamic light scattering (DLS) is used to calculate the diameter of different types of particles dispersed in a liquid medium. The DLS study showed that the Biosoot exhibits the size range recording Different peaks (Fig. 4). The first peak was recorded between the size range of 90 to 250nm, followed by the second peak with the size range of 250 to 1000nm and the third with 1400 – 3500nm. The particles are distributed with different sizes as polysized nanomaterials.

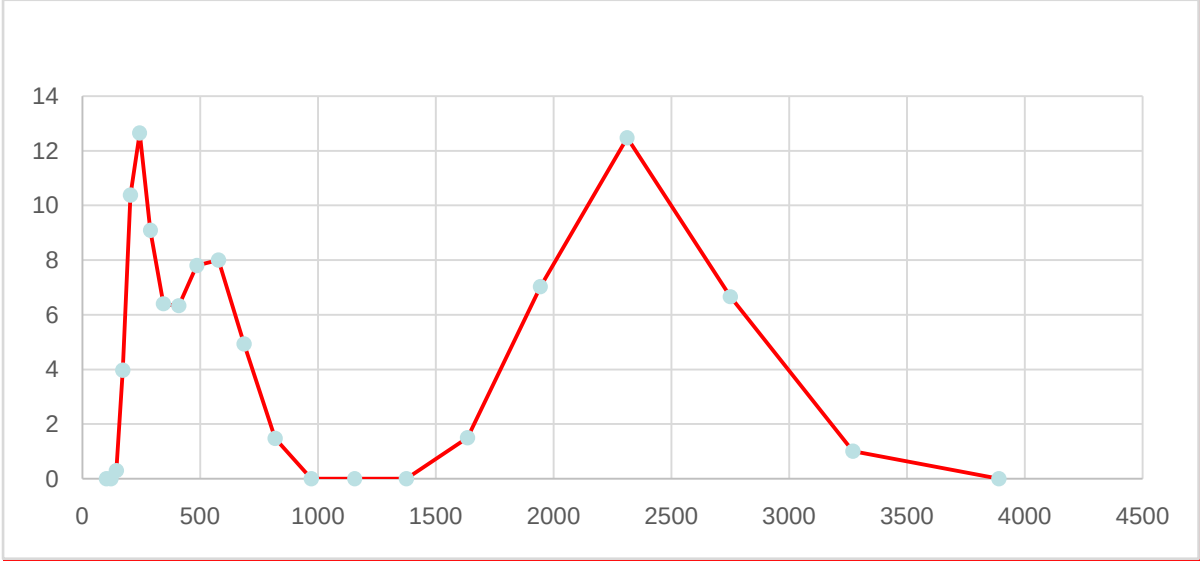

Fig.4.DLS size distribution of particles of Biosoot of *Chromolaenaodarata*

Scanning Electron Microscope (SEM)

The Scanning Electron Microscopic images of the biosoot of the leaves of *Chromolaenaodorata*revealed the shape of the nanoparticles as mostly spherical and few are subspherical in their shape. The image clearly depicts that the carbon nanoparticles are with the size range of less than 25nm. Few of the sizes are recorded as 60nm in size.

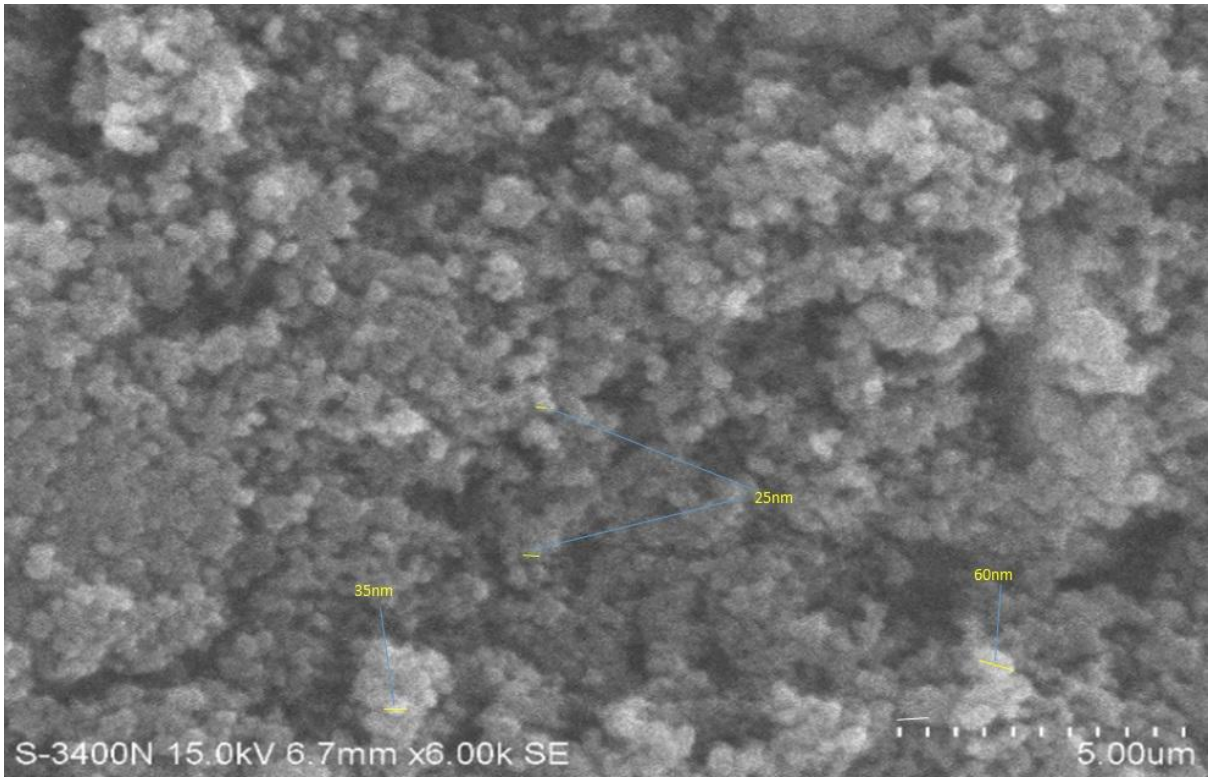

Fig.5. SEM image of the Biosoot of *Chromolaenaodarata*

X-ray diffraction (XRD):

XRD provides information regarding the crystalline structure, nature of the phase, lattice parameters and crystalline grain size. The latter parameter is estimated by using the Scherrer equation using the broadening of the most intense peak of an XRD measurement for a pecific sample. The peaks of XRD patterns indicate that the carbon nanoparticles are small. The diffraction peaks in XRD pattern at 24.5, 25.6, 28.5 and 40.7° can be assigned to reflections from (111), (200), (220), and (222) planes of the face centered cubic carbon. The broad peaks of XRD patterns indicate that the carbon nanoparticles are small. The average crystalline size of carbon nanoparticle was determined to be between 50-90nm. The XRD revealed that the biosoot are amorphous in nature. The XRD spectrum recorded for the biosoot of the leaves of *Chromolaenaodorata*is presented in Fig. 6.

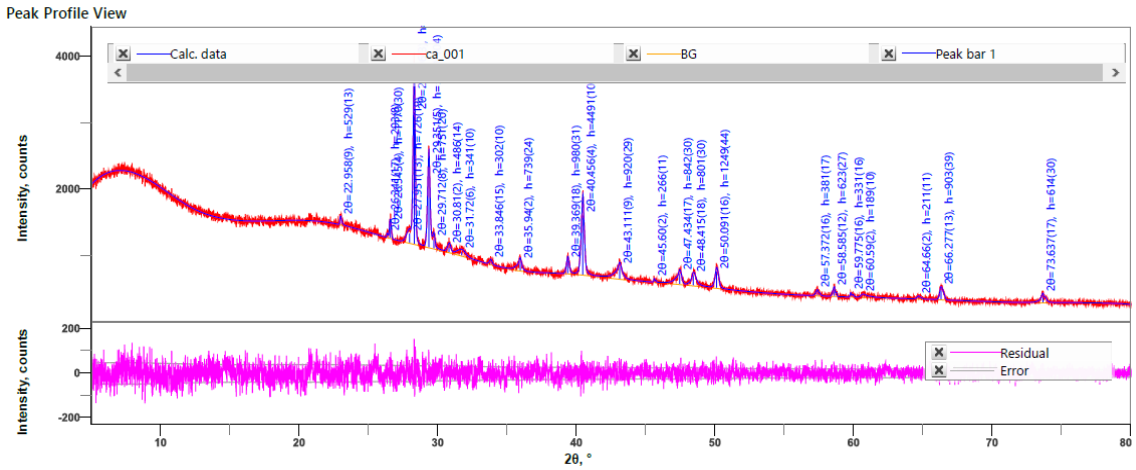

Fig.6. XRD spectrum recorded for the Biosoot of *Chromolaenaodarata*

Fourier transform infrared spectroscopy (FTIR)

Fourier transform infrared spectroscopy (FTIR) revealed the presence of many peaks in the spectrum. Based on their spectral band, the compounds associated with the carbon nanoparticles are assigned to different compounds. The results of FTIR – IR spectrum of carbon nanoparticles shows band at 3352.28cm-1, 2920.23cm-1, 2920.23cm-1, 1601.56cm-1, 1224.8 cm-1 corresponds to C-H stretching alkenes and phenols, C-N stretching aromatic amines groups, C-C stretching Alkenes and ketones.The FTIR spectrum recorded for the biosoot of the leaves of *Chromolaenaodorata*is presented in Fig. 7.

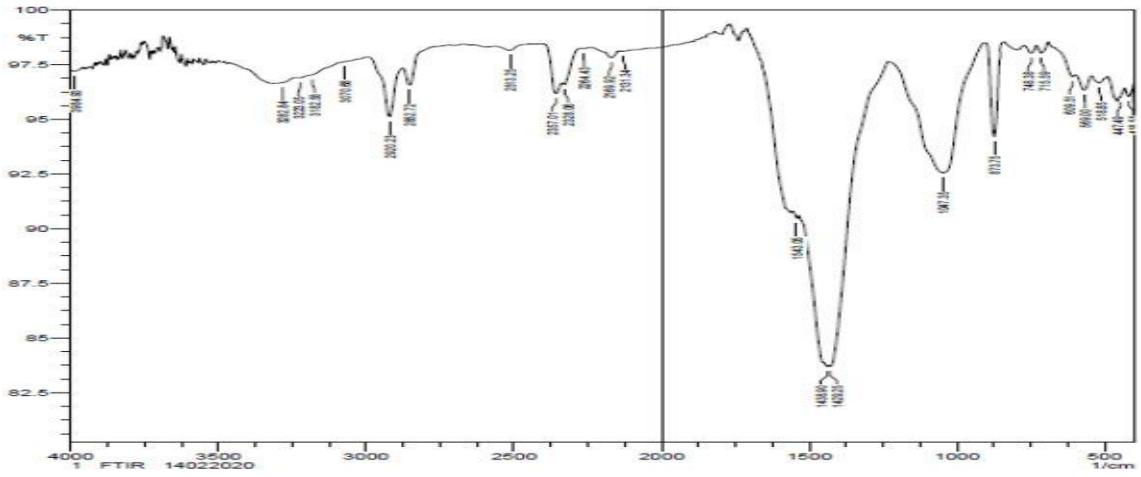

Fig.7. FTIR spectrum recorded for the Biosoot of *Chromolaenaodarata*

4. DISCUSSION

Researchers in the field of Nanotechnology are highly engaged in engineering simple and complex nanoparticles apart from the applications of nanoparticles in different fields. Nature of nanoparticles are concerned, metallic oxides are widely used among which silver oxide is used extensively because of their antimicrobial activity and other activities like anticancer ability. Many of the metallic oxides as an individual compound and mixed metallo-complex oxides are also used in the Traditional system of medicine in India. However, their biocompatibility is under question due to their toxic nature. Thus, finding and synthesizing a suitable biocompatible nanomaterial is the need of the hour among which carbon nanoparticles are highly regarded as a suitable component for their application in the field of medicine. The constant demand for nanomaterials is mostly met by their synthesis using physical, chemical and biological methods. The synthesis of nanoparticles by physical, chemical and biological methods involves their own drawbacks and advantages. Thus finding a suitable method which are easy, cost effective, less time consuming and can be synthesized in volume is the need of the hour. The current study fulfil that the carbon nanoparticles can easily be prepared in the form of Biosoot.

The DLS study revealed the presence of carbon nanoparticles of different size. It is noticed that the carbon nanoparticles are co-alesce to form bigger sized nanoparticles. They grow in size, due to aggregation which may be due to their charge either as negative and positive nature, their reactive ability and even Vander Waal's force existing between the particles. The study provides an input how the biosoot grow in size to form a particulate matter. The carbon nanoparticle originating as a soot grows in size into 1 micron size and again grow into the size as $PM_{2.5}$. The study reveals the origin of particulate matter from the nanoparticles. The formation of double peak of biosoot and the synthesis of carbon nanoparticles from the leaves of *Eicchorniacrassipes*an aquatic plant in the form of biosoot was already reported [8].

The characterization of biosoot using SEM and XRD confirmed that the size of the particles recorded in the biosoot of the leaves of *Chromolaenaodorata*falls well below 100nm which is clearly defined as a nanoparticle rather than nanomaterial. Nanotechnology is a branch of science, studying the particles of Nanosize, i.e. 10^{-9}m. The field comprises of synthesis or generation of nanoparticles and its applications in different fields. Any material falling well below 10^{-9}m of size on all dimensions is termed as nanoparticle and on any one or two

dimensions as Nano objects. Nanoparticle is defined as a particle with a size range between 1 nm to 100 nm, in all the potential dimensions and the nanomaterial as at least in one of their dimensions [9].

The FTIR studies on the biosoot of the leaves of *Chromolaenaodorata*showed the presence of many compounds associated with the carbon nanoparticles. The presence of these compounds is attributed to the secondary metabolites present in the plant. The presence of phytocompounds and their bioactivities of the leaves of *Chromolaenaodorata*was studied by Udayaprakash*et al.*, [10]. These associated compounds are generally considered as Reactive Oxdidative Species (ROS) where they have many role. Based on the ROS the carbon nanoparticles can be exploited in different fields. The biosoot of different weeds were exploited for the antibacterial and antifungal activities [11], as an alternate for charcoal in cosmetics[12]. The study strongly suggest that the naturally synthesized nanoparticles can be exploited in pharmaceutical industry and cosmetic industry after proper evaluation for their toxicity.

5. CONCLUSION:

The study demonstrates the synthesis of carbon nanoparticles as biosoot using the leaves of*Chromolaenaodorata*, an aromatic medicinal plant. The size of the particles of biosoot fall well below the size of 100nm which clearly defines that the biosoot formed are nanoparticles. This was confirmed by SEM and XRD. The study also provides evidence for the origin of Particulate matter (PM) due to the aggregation and coalescent of the nanoparticles which grow in size to form PM. The study reveals many organic compounds are associated with the carbon nanoparticles as reactive associated species. The study also paves the way of exploiting the naturally synthesized particles for exploitation in pharmaceutical industry and cosmetic industry after proper evaluation of their toxicity.

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