Research Article

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Phytochemistry, Antioxidant Property of Carbon Dots of the Biosoot of *Datura metel*

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ABSTRACT

The medicinal importance of the plant, *Datura metel*, is enlisted as curing skin disorders, asthma, diabetes, heart disease, epilepsy, rheumatic disorders and dental pain. Also, it is used minimally in medicine because of its toxicity, which causes hallucinations, dilated pupils, coma, convulsions, headache and fatality in some cases. Research says the smoke derived from the *Datura* species acts deadly on organs. This created the curiosity for the researchers to study the nature of the Biosoot, i.e. soot generated from the materials of biological origin. Biosoot are generated from the plant, *Datura metel*, using open pyrolysis, and the soot was allowed to settle on the porcelain tile and collected. The Biosoot thus collected were characterized for their properties using DLS, XRD and FTIR for their characterization as Carbon nanoparticles (CNPs). The presence of secondary metabolites in Biosoot of *Datura metel* and antioxidant potency was determined using a DPPH assay. The DLS has revealed the size range of Biosoot as 144-486nm, XRD revealed the size range as 40 – 191nm and the nature of CNPs as amorphous, and FTIR revealed the presence of C-H aromatic, C-H aliphatic and C=C unsaturated compounds as its associated compounds. The Biosoot was evaluated for secondary metabolites, which showed the presence of Flavonoids, Terpenoids, Steroids and Coumarin. The EC50 value recorded for DPPH was 18µg. The study revealed that the Biosoot are of nanosize, possessing few associated compounds along with plant secondary metabolites and a high antioxidant nature as they possess related compounds which can be used even as an antibacterial or antifungal agent. The other advantage is that carbon nanoparticles are highly biocompatible. Thus, the CNPs synthesized in the form of Biosoot can can be potentially used in the field of medicine/pharmaceuticals after proper evaluation of their cytotoxicity.

Keywords: Biosoot, *Datura metel*, CNPs; Phytochemistry; Antioxidant.

1. INTRODUCTION

Datura metel, also called Devil's trumpet, is a plant belonging to the family Solanaceae. The plant is a perennial shrub which may grow upto 6 feet in height. *Datura metel* in ayurvedic medicine cures skin disorders, diabetes, heart disease, epilepsy, and pain (Chopra *et al.*1986). It has hallucinogenic properties and helps to heal dental pain (Yang *et al.* 2014). *Datura* plant is used minimally in medicines because of its toxicity, which causes hallucinations (Abubakar *et al*. 2009), dilated pupils, coma, convulsions, and headaches and also causes death sometimes. The plant is found to possess secondary metabolites like saponins, tannins, steroids, alkaloids, withanolides and triterpenoids (Kuganathan and Ganeshalingam, 2011). The plant is not allowed to be sold or bought and even cultivated in some parts of the world (Preissel and Hans-George *et al.* 2002). In India, the plant is banned but accepted for use only as a traditional medicine because of its antimuscarinic, anticholinergic and psychoactive properties.

It is known that the plants are used in the form of smoke for medicinal purposes (Mohagheghzadeh *et al*. 2006). Many species of *Datura* are used in the form of smoke for a few therapeutic purposes, which include the smoke of *Datura innoxia* used to treat Respiratory tract diseases (Singh *et al*. 2002), *Datura ferox* in treating Respiratory tract diseases and treatment of the ear (Scarpa, 2004), *Datura metel* in treating Respiratory tract diseases and as a tooth ache remedy (Defilipps *et al*. 2004), *Datura stramonium* in treating Respiratory tract diseases, tooth ache remedy, analgesic and as a narcotic (Joshi and Joshi, 2000), and *Datura wrightii* as Narcotic, hallucinogen, purgative and as an aphrodisiac in USA (Moerman, 1998). Further, frequent forest fires occurring in different parts of the world and their associated problems made the authors study the nature of the Biosoot of *Datura metel*.

Biosoot is defined as the soot developed due to the burning of biological materials (Udayaprakash and Bhuvaneswari, 2019). The developed soot is airborne, serving as an Aeronanosol, and its biological origin serves as a Bioaeronanosol, posing respiratory problems.

In order to learn the nature of these airborne biosoot of the plant *Datura metel*, the present study is conducted. The Biosoot are investigated for their size property, associated compounds, presence of secondary metabolites and their Anti-oxidant nature.

2. MATERIALS AND METHOD

2.1 Preparation of Biosoot

The fresh leaves of *Datura metel* were collected from the marshy land near Pallikaranai, Chennai, India during November 2024. The collected leaves were washed to remove the dust particles and kept under shade for drying. The leaves were left to become crispy, and the Biosoot were generated using the open pyrolysis method. The Biosoot generated by burning the leaves in the laminar air flow chamber were caught using a stainless steel plate (Chun *et al.* 2016). The Biosoot deposited on stainless steel plates were scraped and stored.

2.2 Characterization of Biosoot as Carbon Nanoparticles (CNPs)

2.2.1 Dynamic Light Scattering Spectroscopy (DLS)

The Biosoot of *Datura metel* dispersed in ethanol was examined for their size range using Dynamic Light Scattering (DLS) (Nanotrac Wave II, Microtrac Inc, USA).

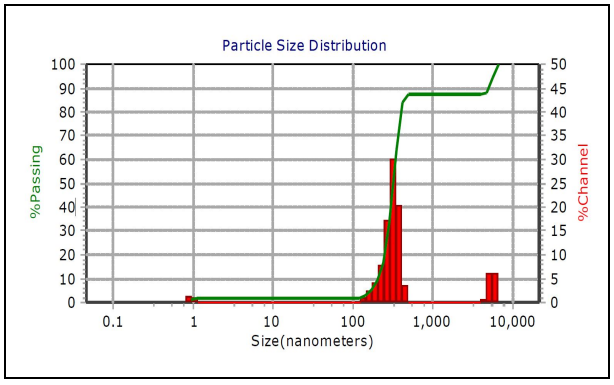

Fig. 1: Dynamic light scattering spectrum of the Biosoot of *Datura metel*

2.2.2 Field Emission Scanning Electron Microscopy (FESEM)

The FESEM studies of the Biosoot of *Datura metel* was studied for its size using Vega 3 Tescan Electron Microscope in Anna University, Chennai.

2.2.3 Energy Dispersive X-ray Analysis

Energy Dispersive X-ray Analysis of the biosoot of *Datura metel* is studied using Zeiss Smart EDX in Bannari Amman Institute of Technology, Sathyamangalam, Erode.

2.2.4 X-ray Diffraction Spectrum

To learn the size range and the crystalline nature of the Biosoot, they were examined using an X-ray diffraction spectrophotometer (Smartlab, Rigaku Corporation International Marketing Division, Japan)

2.2.5 Fourier Transform Infra-Red Spectrum

As the Biosoot is of plant origin, it is suspected that they may possess associated organic compounds and thus, the Biosoot was evaluated using a Fourier Transform Infra-Red Spectrophotometer (Spectrum Two FT-IR/Sp10, Perkin Elmer, USA).

2.2.6 Phytochemical Analysis

The aqueous extract of a sample of *Datura* metal prepared, and the qualitative phytochemical analysis for the presence of steroids, alkaloids, quinones, coumarins, cardiac glycosides, phlobatannins, flavonoids, steroids, tannins, saponins and terpenoids was carried out with standard procedures (Evans, 2009)

2.2.7 Antioxidant Activity (DPPH Scavenging Activity)

The aqueous extract of the Biosoot sample of *Datura metel* was studied for their free radical scavenging assay using DPPH (2, 2 diphenyl-1-picryl hydrazyl) under different concentrations (10µg, 20µg, 30µg, 40µg and 50µg) in methanol was taken in small tubes and 0.5 ml of DPPH was added. At 517nm absorbance solution was read which was incubated for 30 minutes (Bhuvaneswari *et al.* 2014; Kannaian *et al*. 2000).

Percentage inhibition of free radical scavenging of DPPH was calculated as,

$$\text{Effective concentration } \% = \frac{(Controlabsorbance - Testabsorbance)}{Controlabsorbance} \text{x } 100$$

3. RESULTS

3.1 Dynamic Light Scattering Spectroscopy (DLS)

The Dynamic light scattering studies on the Biosoot of *Datura metel* showed that the particle size ranges from 144-486nm. Further, the size of the particles was recorded at the size range of 4620nm to 6540nm. The characterization of Biosoot of *Datura metel* using DLS registered double peaks in their size. The particle size distribution recorded for the Biosoot of *Datura metel* is presented in Fig. 1.

3.2 FESEM and EDAX

The SEM image of the Biosoot of *Datura metel* revealed the size range of the particles as 68-91nm (Fig. 2). The EDAX revealed the presence of Carbon and

Oxygen as major component. Trace of sulphur and Chlorine is also recorded (Fig. 3 and Table 1).

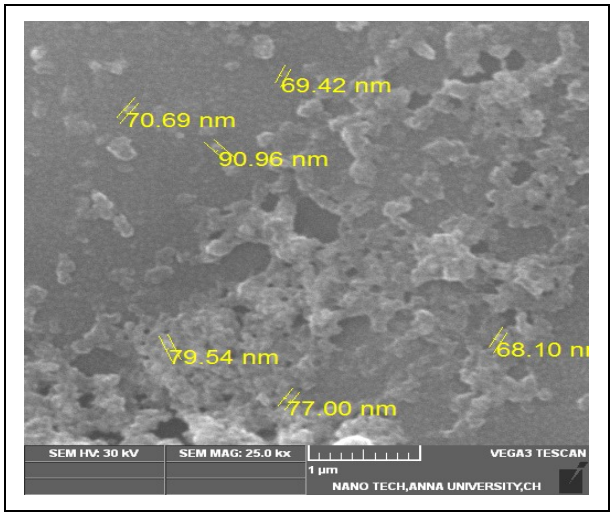

Fig. 2: Scanning Electron Microscope Image of the Biosoot of *Datura metel*

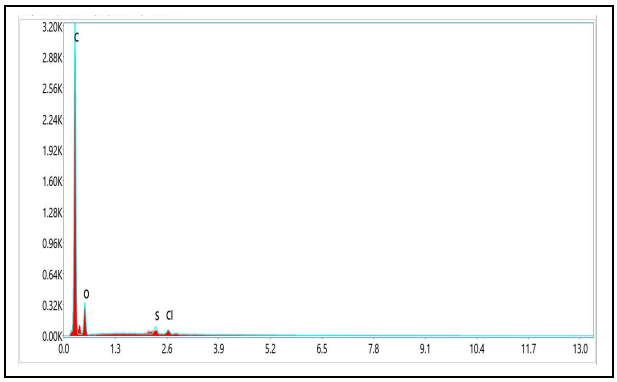

Fig. 3: Energy Dispersive X-ray Spectrum of the Biosoot of *Datura metel*

Table 1. Elemental composition of the Biosoot of *Datura metel*

Element	Weight %	Atomic %
C K	85.54	88.98
O K	13.79	10.77
S K	0.40	0.15
Cl K	0.27	0.09

Table 2. Presence of phytochemicals in Biosoot of *Datura* metal

	Tannin	Phlobatannins	Saponins	Flavonoids	Terpenoids	Cardiac Glycosides	Steroids	Alkaloids	Quin-ones	Coumarins
Soot	-	-	-	+	+	-	+	-	-	+

3.3 XRD Spectrum of Biosoot of *Datura metel*

The Biosoot of *Datura metel* was subjected to X-ray crystallography to know about the crystalline nature of the Biosoot (Figure 4). The study revealed the 2θ value range was registered at 21.89°, which predicts the Biosoot as amorphous. The size range registered for the particle was from 40 – 191nm.

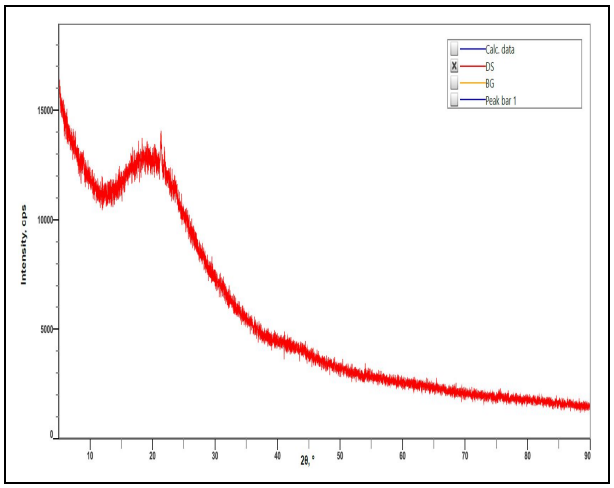

Fig.4: X-ray diffraction spectrum of the Biosoot of *Datura metel*

3.4 Fourier Transform Infra-Red Spectrum of the Biosoot of *Datura metel*

The FTIR spectral analysis of the Biosoot of *Datura metel* (Figure 5) revealed the presence of C-H aromatic, C-H aliphatic and C+C unsaturated compounds as associated compounds.

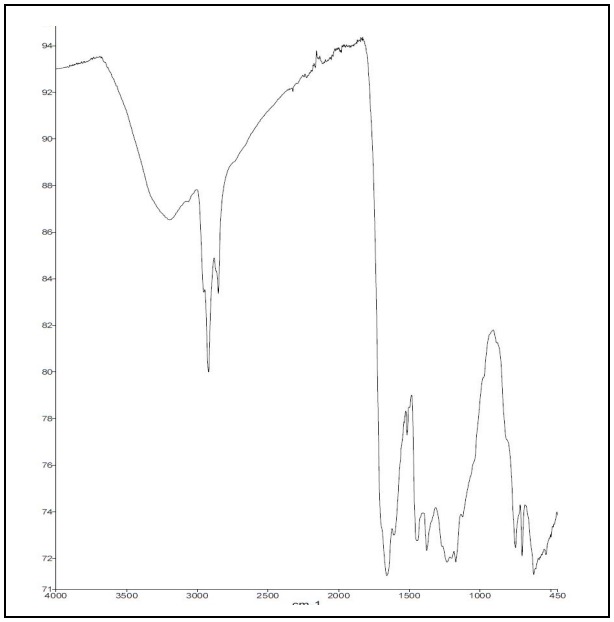

Fig. 5: FTIR spectrum of the Biosoot of *Datura metel*

3.5 Phytochemistry of CNPs

The sample prepared by burning the *Datura metel* dried leaves was studied for the presence of Secondary metabolites. The Biosoot of *Datura metel* revealed the presence of Flavonoids, Terpenoids, Steroids and Coumarins. The presence of different phytocompounds in the Biosoot of the leaves of the plant *Datura metel* is presented in Table 2.

3.6 Antioxidant Nature of CNPs

The EC_{50} value recorded for Biosoot was 18µg. The percentage of scavenging activity recorded for different concentrations of Biosoot is presented in Table 3. The 50 % inhibition of DPPH free radical is termed Effective Concentration 50 (EC_{50}).

Table 3. Free radical scavenging activity of Biosoot of *Datura* metal against DPPH

	Concentrations					
Datura metel	10 µg	20 µg	30 µg	40 µg	50 µg	EC_{50} value
Biosoot	41.33	51.55	78.13	83.33	93.33	18 µg

4. DISCUSSION

The present study demonstrated the Biosoot of *Datura metel* as a carbon nanoparticle (CNP). Chun *et al.* (2016) has been shown that the smoke of turmeric is a carbon nanodot. Similar to the study, the Biosoot of *Datura metel* also proved that the Biosoot is a carbon nanomaterial. This is confirmed by their size range studied using DLS and XRD, where it resulted in a size range of 144-191nm. However, as they are in the form of Biosoot, they have the property of coalescing and thus form the bigger-sized Particulate matter. This coalescing property of the CNPs is due to the ionic force between them, the van-der wall's force and their respective charge. Thus, the Aeronanosol generated in the form of Biosoot grows in size to produce Particulate matter of $PM_{2.5}$ to PM_{10}. The occurrence of double or triple peaks by the Biosoot has been previously reported. Further, the XRD has confirmed that the Biosoot of *Datura metel* is amorphous; thus, they can easily be carried to the atmosphere, as a bioaeronanosol posing challenges in case of forest fire or while burning the plant.

The FTIR studies on the Biosoot of the leaves of *Datura metel* revealed the presence of organic compounds as an associated compound with the CNPs in the form of Biosoot. Further phytochemical analysis of the Biosoot revealed the presence of flavonoids, terpenoids, steroids and coumarines, which can potentially be utilized. The presence of these phytochemicals is reported in the leaves of *Datura metel* (Diallo *et al.* 2022). It is known that these phytocompounds are of medical importance. These carbon dots, along with phytocompounds, which are airborne as a Biosoot, can be successfully exploited as medicinal smoke. The utilization of many plants in different parts of the world is used in the form of smoke (Mohagheghzadeh *et al*. 2006). The other advantage is that carbon nanoparticles are highly biocompatible. The carbon nanostructure if they are not modified are biocompatible and nontoxic to animal or human cells (Baierl *et al.* 1996) The carbon dots of turmeric smoke were studied for their pharmacological activities (Chun *et al.*2016).

The high antioxidant activity of the Biosoot of the plant *Datura metel* can be used successfully in the cosmetic industry for its antioxidant nature. The carbon nanoparticles synthesized in the form of Biosoot from the leaves of *Eicchornia crassipes* were evaluated for their antioxidant and cytotoxicity studies. These CNPs can be amended in topical creams for their antioxidant potency, thus serving cosmetic products after evaluation of their toxicity. This can also overcome the problems associated with the availability of the plant material throughout the year, plant damage due to microbial and pest infestation and also to overcome storage problems.

5. CONCLUSION

The present research confirms that the Biosoot generated from the leaves of *Datura metel* is a Carbon Nanoparticle. The carbon nanoparticle is found to possess plant secondary metabolites as they originate from the plants. Further, a few organic compounds are also found associated with the CNPs, which will be serving as a Reductive Oxidative Species (ROS), which can be successfully exploited as an antioxidant agent. This again confirmed that the Biosoot of *Datura metel* is a strong antioxidant agent through DPPH scavenging activity. Thus, the Biosoot of *Datura metel* can be successfully exploited in Cosmeceuticals.

AUTHOR CONTRIBUTION STATEMENT

N. K. Udaya Prakash and S. Bhuvaneswari – Conceptualization and Review, Selvakumar Priyanka – Experimental, Investigation, Writing, Depuru Manoj Kumar and Meda Priyanka – Writing, Interpretation and Editing

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CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

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