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GREEN – SYNTHESIS AND THE CHARACTERIZATION OF PLANTINUM-NANO COMPLEX USING LEAVES EXTRACT OF *VERNONIA CINEREA*

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Abstract

Green platinum nano-sized particles (GPt – NPs) was synthesized using an aqueous extract of *Vernonia cinerea*. The size-tunable complex was obtained by volume ratio of platinum chloride/*Vernonia cinerea* 1:10 and characterized by the Atomic Absorption spectrophotometer (AAS), Fourier transform infrared (FT-IR) spectroscopy, scanning electron microscopy (SEM) and transmission electron microscopy (TEM). The result showed that the GPt – NPs were spherical and hexagonal shapes with the average particle size of 10.24 nm from TEM. The FT-IR spectrum showed that the sharp absorption band in the region 2650 – 3309 cm^{-1} is assigned to C – H vibration, while the band at 1636 – 1815 cm^{-1} showed the stretching vibrations of C=O. The atomic absorption spectrophotometer showed the presence of calcium, magnesium and sodium, while the UV-visible spectroscopy showed the presence of flavonoid, phenol and alkaloid, account for it unique properties that necessitate it applications in different field of science and technology.

Key words: Nano-size, phytochemicals, mineral element, green synthesis, *Vernonia cinerea*.

1.0 Introduction

Platinum-based nano materials have attracted increasing attention in the area of science and technology due to their size, shape, diverse physical and chemical compositions such as the functional groups which enhances their physicochemical, phytochemical, antimicrobial and optical properties, thus, making them valuable in diverse applications including catalysis, electronics, biomedicine and environmental remediation (Azad, *et al*., 2024).

However, the bioactive substance-based synthesis exhibits more promising potentials for numerous applications including their broad spectrum potentials, the morphology and their stability (Malode *et al*., 2023). Literature review had reported on several studies using plant extract for green synthesis of diverse metallic nanoparticles due to the primary and secondary metabolites content of the plant extracts which function as reducing and capping agents (Fahmy *et al.*, 2020). Thus, green synthetic technique of plant extracts and microorganisms offer eco-friendly alternatives that enhances the physicochemical, phytochemical, antimicrobial and optical properties that distinguish them from the traditional physical and chemical techniques (Zhou *et al*., 2023), that uses various techniques including the solvothermal, hydrothermal, sol-gel, hence, often pose health challenges (Kumari *et al.*, 2023). Therefore, in this study, the green synthesis and characterization of platinum nano particles of *Vernonia cinerea* leaves extract is reported.

Vernonia cinerea also known as purple fleabane (Theja and Nirmala, 2024) is a perennial herbaceous plant and genus in the Asteraceae family. It is known as Sahadevi in India or "Bach dau ong" in Vietnamese traditional medicine and is distributed mainly in the tropical regions, mostly in southeast Asia, South America and India (Trang *et al*., 2024).

The plant contains various primary and secondary metabolites and these metabolites contains numerous functional groups including the hydroxyl group (O – H), amine group (– NH_2), carbonyl group (C – O) etc which functions as reducing agents (Azim *et al*., 2022).

2.0 Materials and Methods

Chemicals and reagents

All reagents used in this work were of analytical grade.

Collection of plant samples and the preparation of extracts

The leaves of *Vernonia cinerea* were collected from the premises of University of Cross River State (UNICROSS) staff quarters, Calabar, Cross River State, Nigeria and carried to the Herbarium of Botany Department of the University of Calabar, Cross River State, for identification.

Sample preparation for mineral-elements analysis

The fresh leaves of test plants were rinsed with deionized water several times, air-dried and then pulverized into powder using corona grinding machine and store in airtight sample

One gram (1g) of the pulverized sample was weighed separately and placed into 3 different 250 ml of Kjeldhal digestion flasks. Each flask was filled with strong acid mixture of concentrated nitric acid (HNO_3), perchloric acid (PCA) and concentrated sulphuric acid (H_2SO_4). The mixture in each of the flasks was thoroughly shaken for proper mixing for 1 minute under tap water and then heated for 30 minutes with the help of Kjeldhal apparatus in a fume cupboard until a clear solution was obtained. The clear solutions were filtered with No. 1.

Whatman filter papers and transferred into a 100 ml volumetric flasks and then made to mark with de-ionized water. In triplicate, the flasks were then analysed for mineral elements using Atomic Absorption spectrophotometer, unicam 919 model in accordance with standard method (Idim, 2021).

Preparation of the aqueous leaves extract

Five (5) grams of the homogenized powder of the *Vernonia cinerea* leaves was weighed into 250 ml beaker containing 100ml of de-ionized water. The content were then boiled for ten minutes at 100 ^{o}C, kept to macerate for 24h, then filtered through filter paper. The filtrate was then centrifuged at 10000 rpm for 10 min. Thereafter, the supernatant was filtered and used for further analyses.

Green synthesis of Pt – NPs

10 ml of the leaves extract of Vernonia cinerea was added to 1ml of platinum chloride (1M). The mixture was subjected to constants stirring and heating at 70 ^{0}C for 3 hr. A colour change from light brown to deep brown was observed, indicating the formation of the platinum nano-particles. It was then centrifuged at 10,000 rpm for 10min. the supernatants was used for the characterization of the platinum nanoparticles.

Qualitative and the quantitative determination of the phytochemical content of the aqueous extract

The UV – visible spectrophotometer was used for the determination of the phytochemical content of the *Vernonia leaves* extract. The reduction of pure platinum ion was monitored by measuring the UV – visible spectrum of the reaction medium at 3h after diluting small aliquots of the samples into distilled water. The spectral analysis was carried out at 300 – 600 nm using 1M platinum chloride solution and the control extract (extract without platinum) while the quantitative determination was carried out by measuring the absorbance of the standard solution, the sample and the absorbance of the blank solution, then determine using the formula.

$$\frac{\text{Absorbance of sample} - \text{Absorbance of blank X Standard concentration X dilution factor}}{\text{Absorbance of the standard solution}}$$

3.0 Results and Discussion

The UV – visible and the Atomic absorption spectrophotometers were used for the determination of the phytochemicals and the mineral elements composition of the *Vernonia cinerea* leaves extract respectively. The results of the mineral compositions as shown in Table 1 showed that calcium (48.22g/100g) content was higher in the leaves extract than magnesium (3.97g/100g) and sodium (8.97g/100g). The result of the phytochemical analysis in Table 2 showed that flavonoid content of the extract was higher (4.66 ± 0.04) than the alkaloid (2.23 ± 0.03) and phenol (0.08 + 0.00) Content. The SEM and the TEM images were used for the surface morphology of the Pt – NPs in Figures 1 and 2 respectively.

Table 1: Mineral elements composition of the *Vernonia cinerea* leaves extract

Sample	Ca (g/100g)	Mg (g/100g)	Na g/100g
Vernonia cinerea leaves extract	48.22	3.97	8.97

All values are means ± standard deviation of triplicate measurement

Table 2: The phytochemical composition of the leaves extract of *Vernonia cinerea*

Sample	Flavonoid(Mg/100ml)	Phenol(Mg/100ml)	Alkaloid(Mg/100ml)
Vernonia cinerea leaves extract	4.66 ± 0.04	0.08 ± 0.00	2.23 ± 0.03

All values are means ± standard deviation of triplicate measurement

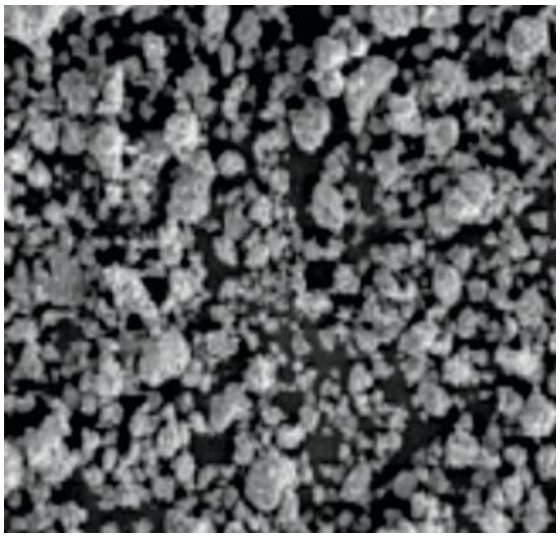

Figure 1: The SEM image of Pt – NPs

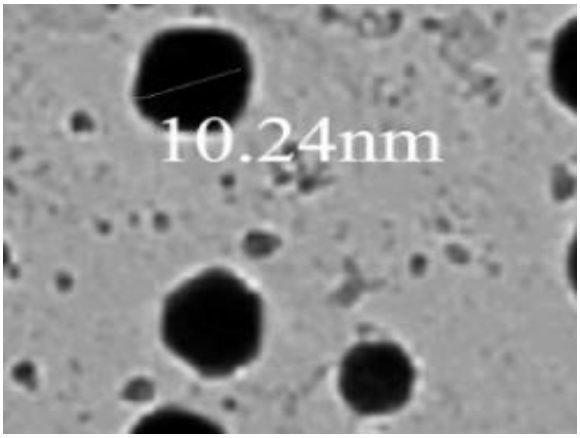

Figure 2: The TEM image of the Pt – NPs

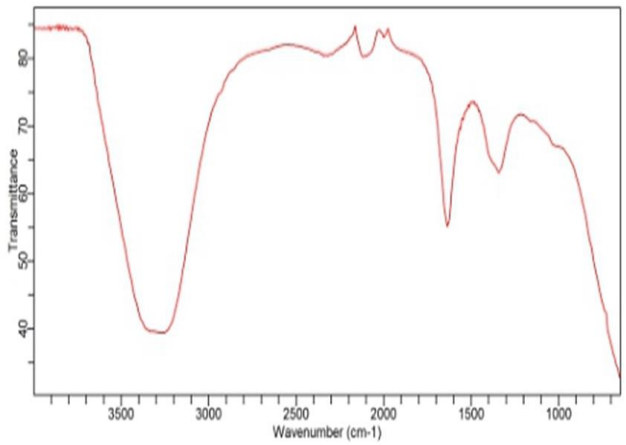

Figure 3: The FT – IR spectrum of the Pt – NPs

4.0 Discussion

The result of the mineral elements determination of the *Vernonia cinerea* leaves extract as shown in Table 1, confirmed the presence of the bioactive compounds. The concentration of calcium (48.22g/100g) in the extract was higher than that of sodium (8.97g/100g), while the least concentration was magnesium (3.97g/100g).

Mineral elements are naturally occurring inorganic elements or compounds with characteristic chemical and physical properties (Idim, 2021).

Thus, the presence of these essential mineral elements ascertains the fact that the plant is of health benefit. For instance, calcium helps in the regulation of muscle contractions and

heart beat as well as building of strong bones and teeth (Yu and Sharma, 2023).

Furthermore, the therapeutic benefit of medicinal plants is nonetheless attributed to their antioxidant properties. The results of the phytochemical analysis of the extract showed the presence of flavonoid, phenol and alkaloid with the corresponding values of 4.66 ± 0.04, 0.08 ± 0.00 and 2.23 ± 0.03 respectively, are also responsible for the versatile medicinal properties of this plant, as well as the reduction of the metal ion, forming the green metallic nanoparticles (Fahmy *et al*., 2020). Thus, the concentration of flavonoid was higher than that of phenol and alkaloid.

The scanning electron microscopy image of the complex and that of the transmission electron microscopy in Figures 1 and 2 showed the spherical and hexagonal particles with the average size of 10.24 nm respectively.

The FT – IR spectrum as shown in Figure 3 showed the sharp absorption band in the region 2650 – 3309 cm^{-1} assigned to C-H vibration. The band at 1636 – 1815 cm^{-1} and 3231 – 3350 cm^{-1} showed the stretching vibrations of C=O and broad band of O–H functional group of alcohol. However, the functional groups are attributed to the various vibrations while the change in colour of the platinum leaves extract from light brown to deep brown indicated the formation and the coordination of the green metallic nanoparticles.

5.0 Conclusion

A new synthesized green platinum-nanoparticles, with potentials for biological, medical, environmental and optical applications, due to it high surface area-to-volume ratio, valuable nutritional, medicinal and spectral compositions, contributing to its rich medicinal and industrial properties. Hence, are vital sources for pharmaceutical therapies as well as other industrial applications such as in catalysis, cosmetics and environmental remediation. Research is underway for the antimicrobial activity of the synthesized green platinum-nanoparticles.

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