GREEN SYNTHESIS OF COPPER NANOPARTICLES USING STEM EXTRACT OF MUSA SAPIENTUM AND ITS CHARACTERISATION - AN IN VITRO STUDY

ABSTRACT:

Introduction: Metallic nanoparticles (NPs) have attracted great interest because of their unique physical and chemical properties and among which copper nanoparticles are used for its low cost, better efficacy and environmentally friendly. *Musa sapientum* has been considered as one of the best medicinal value plants and can be used for the treatment of various periodontal diseases.

The aim of the study is to synthesize and characterize *Musa sapientum* mediated copper nanoparticles**.**

Materials and Methods: The Copper nanoparticles (CuNPs) were synthesized using *Musa sapientum* extract and characterization was done by UV-Visible Spectroscopy and Transmission Electron Microscope (TEM).

Results: The results confirmed that the synthesized *Musa sapientum* mediated nanoparticle was eco-friendly and non-toxic. The peak value has been centered at 75 nm, which has been mainly associated with absorbance of CuNPs. Absorbance rate increases with increase in wavelength. The formation of CuNPs as well as their morphological dimensions in the TEM study demonstrate that the average size is from 5.67 – 9.10 nm. The shapes of the CuNPs are proved to be spherical. TEM analysis reveals that the copper nanoparticles are predominantly spherical. The overall morphology of the copper nanoparticles produced by reduction of cu2+ ions with 2Mm CUSO4 is composed of almost uniform nanoparticles.

Conclusion: In this study, a simple, biological and low-cost approach was done for the preparation of copper nanoparticles using stem extract of *Musa sapientum*. Thus, *Musa sapientum* mediated copper nanoparticles can be subjected to the various other biological activities such as antibacterial, antifungal, cytotoxic evaluation to know the efficiency of these nanoparticles.

Keywords: *Musa sapientum*, copper, nanoparticles, green synthesis.

INTRODUCTION:

Metallic nanoparticles have multifunctionality nature, and they have been extensively used in a variety of sectors of industries and medicine including drug delivery, cancer treatment, wastewater treatment, and DNA analysis. Recently metallic nanoparticles (NPs) have attracted great interest because of their unique physical and chemical properties(1). The green synthesis of metallic nanoparticles has been proposed as a cost-effective and environmentally friendly alternative to chemical and physical methods. In recent years, copper nanoparticles (CuNPs) have attracted much attention from researchers due to its various applications in industries, medicine and various other fields(2). This study supports the use of copper nanoparticles as a biocidal agent because of its great antibacterial property which is known for a long time (3). (3)

Many plant parts or whole plants have been used for the green synthesis of Cu NPs due to the presence of a large number of bioactive compounds in plants. The extracts of plants have been efficiently applied for this purpose (4). Synthesis of Cu NPs has been successful with extracts of various parts of plant species that include stem extract of *Musa sapientum.* Bananas (Genus Musa) have been grown for a long time throughout the world (5). Pharmacological investigations shows that all parts of banana have nutritional and traditional medicinal uses and in many vitro studies, animal model studies and clinical studies suggest that various parts of banana can be used for the treatment of various diseases like diabetes, hypertension, cancer, ulcers, diarrhoea, and Alzheimer's disease (6). Other medicinal uses are in surgical dressing, pain relief, food and pharmaceuticals, nano medicine, pollution control, apoptosis and cell cycle.

Our team has extensive knowledge and research experience that has translated into high quality publications.(7–19), (20–24) (25) (26). For the first time, CuNPs were successfully synthesized using *Musa sapientum* stem extract in the current investigation. *Musa sapientum*, commonly known as banana, is an herbaceous plant of the Musaceae family. Different parts of the banana plant contain carotenoids, phenolic compounds, and biogenic amines such as dopamine, serotonin, noradrenaline, tryptophan, and tyrosine (27). Traditionally it is used in the treatment of various diseases like dysentery, intestinal lesions and various other abdominal infections (28).

Aqueous extract of banana stem has more antimicrobial activity which could be useful against the gram negative bacteria such as staphylococcus and the bio actives such as flavonoids, tannins are also useful against pathogenic bacteria causing periodontitis (29). Currently, a biological method has been followed for the green chemistry synthesis of metal nanoparticles due to it being free from hazardous chemicals (30). The metal nanoparticle synthesis method from plant extracts has more advantages over the microbial synthesis method because the microbial process is highly expensive due to the cost of microorganism isolation and their culture maintenance (31). Cu nanoparticles have been synthesised using biological sources and have been reported in potential applications such as for antimicrobials and photocatalytic activity (32). In recent times, plant- mediated synthesis of nanoparticles has garnered wide interest owing to its inherent features such as rapidity, simplicity, eco-friendliness, and cheaper costs. The analytical studies revealed that the synthesized copper sulphate nanoparticles from these two different methods have almost identical size and morphology (33). The aim of the study is to synthesize and characterize *Musa sapientum* mediated copper nanoparticles**.**

MATERIALS AND METHODS:

Plant extracts preparation:

1 g of *Musa sapientum* powder was measured and taken. The measured amount of plant powder was then mixed with 100 mL of distilled water and boiled for 5-10 min. The contents were filtered using a filter paper, funnel and measuring cylinder. A viscous filtrate was obtained (Figure 1).

Synthesis of *Musa sapientum* mediated CuNps

0.01 mg of $CuSO_4$ was weighed and mixed with distilled water of 8 mL and mixed with filtered extract. The extract is permitted to stand in the stirrer for a duration of 1 h and kept in the shaker for intermixing of the particles to obtain green synthesis (Figure 2). The reduction of $CuSO_4$ to CuNps was periodically monitored by an ultraviolet (UV) spectrometer.

UV-Vis spectra analysis:

UV-Vis spectroscopy was used for monitoring the signature of CuNps. This is a powerful tool for the characterization of colloidal particles. Metal particles are ideal candidates for study with UV-Vis spectroscopy since they exhibit strong surface plasmon resonance (SPR) absorption in the visible region and are highly sensitive to the surface modification. The presence of CuNP was confirmed by SPR property

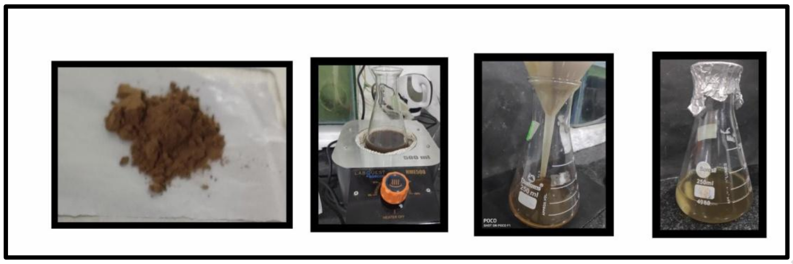

Figure 1: Preparation Of *Musa sapientum* stem extract.

Figure 2 : Preparation of *Musa Sapientum* copper nanoparticles.

Figure 3: Colour change from light green colour to brown colour.

RESULTS:

UV-Vis spectroscopy analysis as the sample composition extract was mixed in the CuSOo$_4$ solution, the color started to change from light green to brown due to the reduction of copper ions which indicated the formation of CuNps (Figure 3). Table 1 shows that as the wavelength increases with a rate of 0.25 AU absorbance rate is also increased and the maximum absorbance is found at the wavelength of 800 mnm. Wavelength and the absorbance is directly proportional as the wavelength is increased absorbance is also increased at the rate of 0.25 AU. More color changes and Cu settled in the synthesized exhibited at 750 nm (Graph 1). The average SPR phenomenon is absorbed at 780-840 nm. Nano-sized particles exhibit unique optical properties having an exponential-decay profile. UV-Visible absorbance spectroscopy has proved to be a very useful technique for studying metal nanoparticles because the peak positions and shapes are sensitive to particle size. The effect of ascorbic concentration in the extract on the UV-Visible absorbance spectroscopy of the synthesized CuNp showed a single peak at around 750 nm. The surface Plasmon peak of CuNp has been reported to appear at around 570 nm. However, when the particle size is less than 4 nm, the distinctive Plasmon peak is known to be broadened and replaced by a featureless absorbance, which increases monotonically towards higher energies. In our work, the resulting Cu dispersion did not show a plasmon peak at around 750 nm, but displayed a broadened peak with a higher wavelength, indicating the presence of more separated CuNp .

TEM technique was employed to visualize the size and shape of copper nanoparticles. The TEM image of the produced CuNPs is shown in Figure 4. The formation of CuNPs as well as their morphological dimensions in the TEM study demonstrates that the average size is from 5.67 – 9.10 nm. ~~The shapes of the CuNPs are proved to be spherical.~~ TEM analysis reveals that the copper nanoparticles are predominantly spherical. The overall morphology of the copper nanoparticles produced by reduction of ~~cu2~~Cu^{2+} ions. ~~with 2Mm $CUSO_4$ is composed of almost uniform nanoparticles~~

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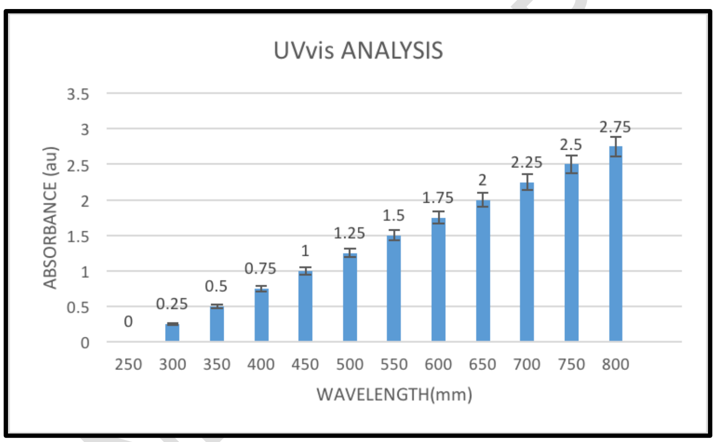
Table 1: This table represents the UV- vis spectroscopic analysis of copper nanoparticles. As the absorbance rate increases the wavelength also increases at the rate of 50 ~~m~~nm. Absorbance and the wavelength is directly proportional and the maximum absorbance is seen at the wavelength of 800 ~~m~~nm.

Absorbance (AU)	0.25	0.5	0.75	1.00	1.25	1.50	1.75	2	2.25	2.5	2.75
wavelength (mm)	300	350	400	450	500	550	600	650	700	750	800



Graph 1: This graph represents UV-vis spectroscopic analysis of copper nanoparticles. X axis represents various wavelengths of the green synthesized copper nanoparticles (in mm) ,while the Y axis represents the Absorbance rate at which the copper nanoparticles were absorbed (in Astronomical Unit). Absorbance rate increases with increase in wavelength.

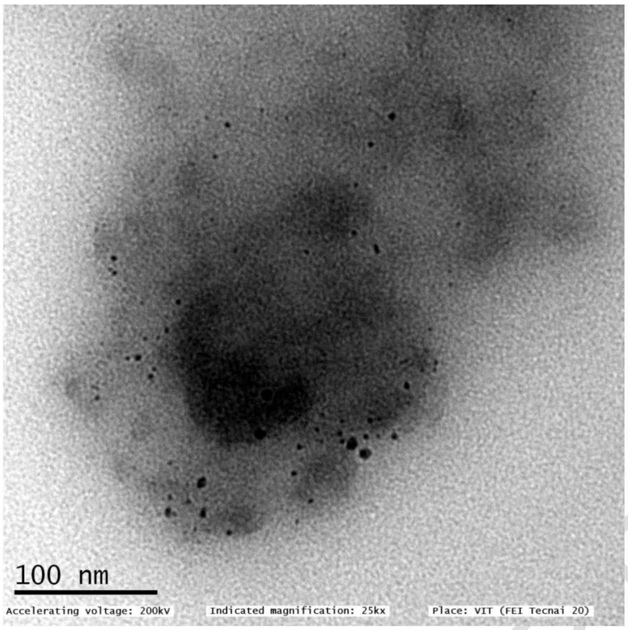


Figure 4: Transmission electron microscopic analysis of nanoparticles

DISCUSSION:

According to the previous article suggested, the UV–Visible absorption spectrum recorded for copper nano- particles, shown exhibits maximum absorption at 580 nm which was in a varied range (34). Another study suggested that the nanosized copper particles typically exhibit a surface plasmon peak at around 556 to 580 nm and the surface plasmon band at 580 nm which indicates the existence of copper nanoparticles (35). The previous article on the phytochemical content and free radical scavenging activity of banana peel indicates that peel extracts from these varieties may be useful to combat free radical mediated diseases (36). In recent days more use of herbs as the natural phytochemicals helps in suppressing the alveolar bone loss, which is the striking feature in periodontitis and have shown to possess a wide array of biological properties such as antimicrobial, antioxidant, and anti-inflammatory effects.

Recently, copper (Cu) nanoparticles have been synthesised, characterised and applied in various fields by different researchers. Previous articles on the oxidation of different Cu NPs have reported that those studies are incomplete, and learning about the initial oxidation and oxidation progress through time in different environmental conditions is needed (37). The value of this knowledge is to learn the oxidation degree of the Cu NPs after storage and to know the role of the coating in the chemical stability.

CONCLUSION:

Significant biological activity of *Musa sapientum* synthesized CuNP, established biological method is highly preferred in comparison to other methods as it is eco-friendly and requires less number of downstream processing(40)(Danda 2010) (41) (42) (43) (44) (45) (46) (47) (48) (49) (50) ((50,51) (52) (53). The SPR property of synthesized NP was studied by UV-Vis spectroscopy, and the peak of the spectra was found to be at 750 nm, which is characteristic property of CuNP.

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