SYSTEMATIC SYNTHESIS OF COPPER NANOPARTICLES USING *Salvadora persica* AS A BIOREACTOR: A GREEN METHOD

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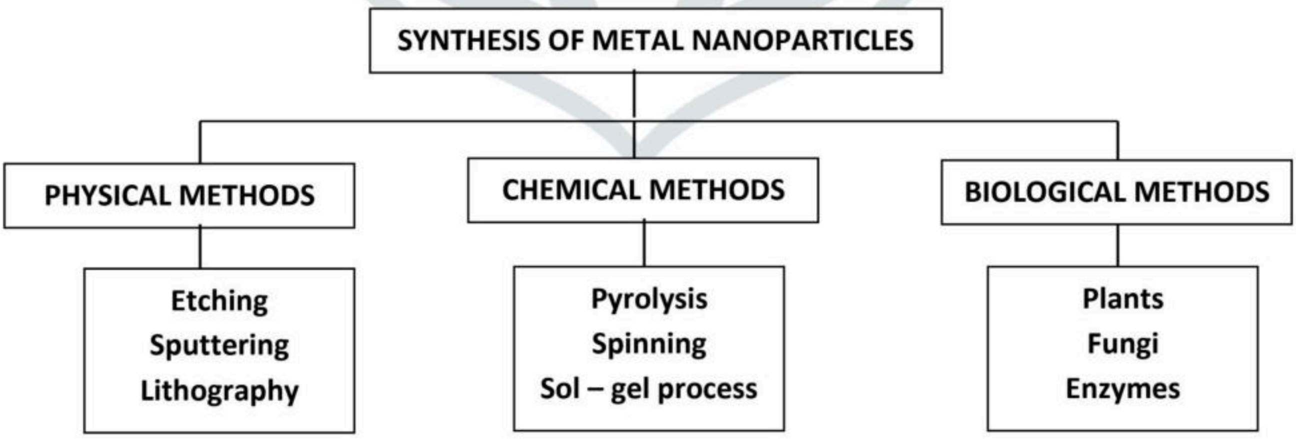
***ABSTRACT*:** In present study, Copper nanoparticles were produced by the mixing the leaf extract of *Salvadora persica* with 10mM copper sulphate pentahydrate solution using the Green Method. The characterization of the synthesised copper nanoparticles was carried out using FTIR, UV – Visible spectroscopy and TEM techniques. The preliminary result was provided by UV – Visible, while the bio-reduction of copper ion was observed through FTIR. TEM analysis confirmed the morphology and size of the synthesised copper nanoparticles.

Keywords: Copper nanoparticles, *Salvadora persica*, Green method, characterization

I. INTRODUCTION

Nanotechnology is the science and technology that is carried out at nano – scale. It is an emerging field of interdisciplinary research that utilizes the nano – based system [1]. In nanotechnology, a nanoparticle is defined as the particles with size ranging between 1 to 100 nm and having an interfacial layer. These nanoparticles are known to have many potential applications in different fields of science such as physics, medicine, optics, organic chemistry, surface science, molecular biology, etc. Nanoparticles can be synthesised using various techniques, typically classified as physical and chemical methods. The physical methods generally involves reducing the required material to nanosized dimension by physical methods such as etching, thermal decomposition, etc. while the chemical methods involves construction of the nanoparticles. Due to the environmental concerns, the chemical methods are more preferred than the physical ones[2,3]. However, the chemical synthesis methods involves the use of toxic chemical reducing reagents and hence these conventional methods are known to have various limitations such as generation of hazardous chemicals, expensive, shortage of raw materials, etc. and hence the researchers focused on developing methods that are safe, clean, environmental friendly and cost effective[4-6].



Working on the principles of green chemistry, the green synthesis method concentrates more on how to maximize the efficiency of chemical method without compromising the safety concern of the product [7]. Biological method involves the bio - reduction of the metals using organisms as bioreactors. The nanoparticles synthesised are highly stable and well characterized when carried out at controlled conditions such as temperature, pH, substrate concentration, centrifugation, etc. Green synthesis using fungus, micro – organisms [8-10], enzymes [11], and plants [12-14] as bioreactors, has garnered attention in recent times due to it being eco – friendly, clean and cost effective in nature.

Copper is a malleable, soft and ductile metal and has a very high thermal and electrical conductivity. Copper is known to occur directly in nature in usable metallic form. Copper is an essential mineral for living organisms. Copper is commonly used in electrical wiring, buildings, electronics and related devices. Since ancient times, copper has known to be used as a durable metal for architecture. Copper is a natural antimicrobial material and shows oligodynamic effect i.e. at very low concentration, copper shows biocidal effect.

Copper nanoparticles have garnered massive attention from the researchers due to its industrial and medical applications. The following biological properties are known to be shown by copper nanoparticles:

- → Wound dressings and medical properties[15,16]
- → Anti – bacterial properties[17]
- → Potential industrial uses such as gas sensors, catalytic process, high temperature superconductors and solar cells[18-20]

Out of the various bioreactors used in the green synthesis of nanoparticles, plants and plant extracts are more preferred option as they are low maintenance and easily available. The process involved in synthesising nanoparticles with plant as bioreactors is less elaborate and much cheaper than other organisms. Mangroves are reported to have many uses and possess various types of phytochemicals. The chemical constituents present in mangroves have toxicological, pharmacological and ecological importance [21]. *Salvadora persica* is a mangrove commonly known as Miswak or toothbrush tree, which has been in use for centuries. It is mainly found around coastal regions and creeks and is widely distributed all over the world. *S. persica* is used as natural toothbrush and has been promoted for oral hygiene by World Health Organisation (WHO). The main objective was to carry out the green synthesis of silver nanoparticles, by bio - reduction of the copper ions with the aqueous extract of leaves of *S. persica*. This biogenic process of synthesising copper nanoparticles was cost effective and time saving and hence, an efficient alternative to the conventional methods.

II. MATERIALS AND METHOD

The leaves of *Salvadora persica* are used for the synthesis of copper nanoparticles. The *S. persica* leaves were collected from Naigaon, Mumbai.

Fruits of *Salvadora persica*

Leaves of *Salvadora persica*

Tree of *Salvadora persica*

2.1. Preparation of plant extract

The leaves of *S. persica* were thoroughly washed and shadow dried. The dried leaves were then grinded into a fine powder using an electric blender. 10 grams of powdered *S. persica* leaves was then mixed with 100 ml of distilled water and boiled for 20 minutes. After boiling, the decoction was filtered through Whatmann filter paper no. 1 and allowed to cool. The required volume of the plant extract was used for the nanoparticle synthesis, while the remaining extract was stored in the refrigerator at 4°C.

2.2. Preparation of 10mM $CuSo_4.5H_2O$ solution

Copper Sulphate Pentahyrdate was used in the synthesis of nanoparticles. The concentration of the solution was 10mM and 2.496g of copper sulphate pentahydrate was weighed and dissolved in 1000 ml of distilled water.

1000 cm^3 of 1M $CuSO_4.5H_2O$ = 249.68g

1000 cm^3 of 0.01M (10mM) $CuSO_4.5H_2O$ = 2.496g

2.3. Synthesis of Copper nanoparticles

10 ml of the plant extract was mixed with 100 ml of 10mM copper sulphate pentahydrate solution at the room temperature. On addition of $CuSO_4$ solution, the colour change of plant extract was observed.

III. CHARACTERIZATION OF CuNPS

The copper nanoparticle solution was sonicated for 3 minutes before the analysis.

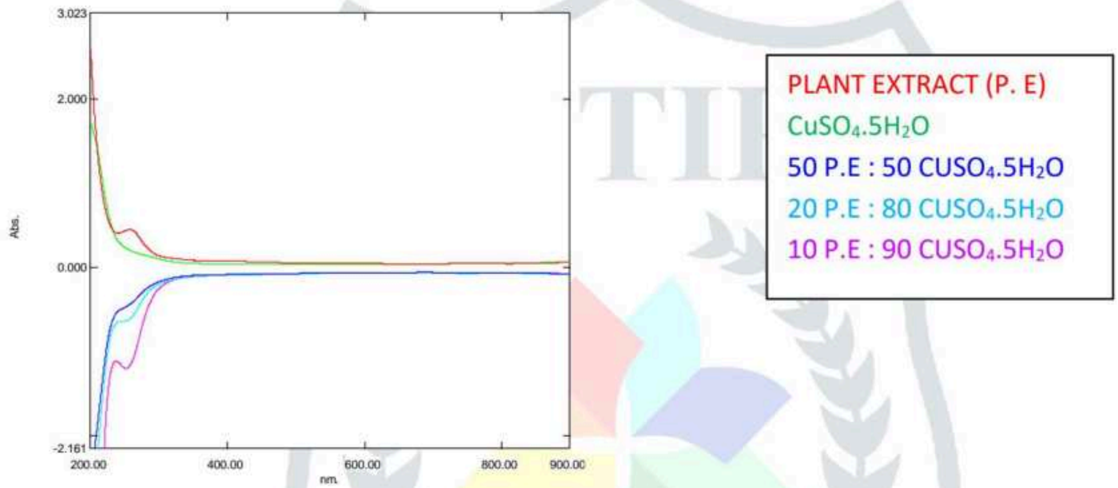
The plant extract, 10mM $CuSO_4$ solution and copper nanoparticle solution was monitored using UV - Visible spectrophotometer. The analysis was carried out in the range of wavelength was between 200 to 600nm. The analysis showed the absorbance peak in the range of 230nm to 250nm.

The Fourier Transform Infra-Red spectroscopy (FTIR) of *Salvadora persica* plant extract, 10mM $CuSO_4$ solution and copper nanoparticles was carried out for determining the changes and different functional groups that are present in the nanoparticle solution.

The morphology and size of the copper nanoparticles was confirmed by Transmission Electron Microscopy (TEM).

IV. RESULT AND DISCUSSION

4.1. UV – Visible spectrophotometer – When copper sulphate pentahydrate solution (10mM) was added to the plant extract at room temperature at varying concentrations of 10:90, 20:80 and 50:50, the colour of the solution changed to green with blue tinge. The solution was kept in dark for 24 hours and observed later. Better absorbance peak was shown by the ratio10: 90 and the absorbance peak was observed at 245 nm. The colour change was due to the excitation of surface plasmons and this indicates the presence of copper nanoparticles and reduction reactions in the medium.



4.2 FTIR analysis –

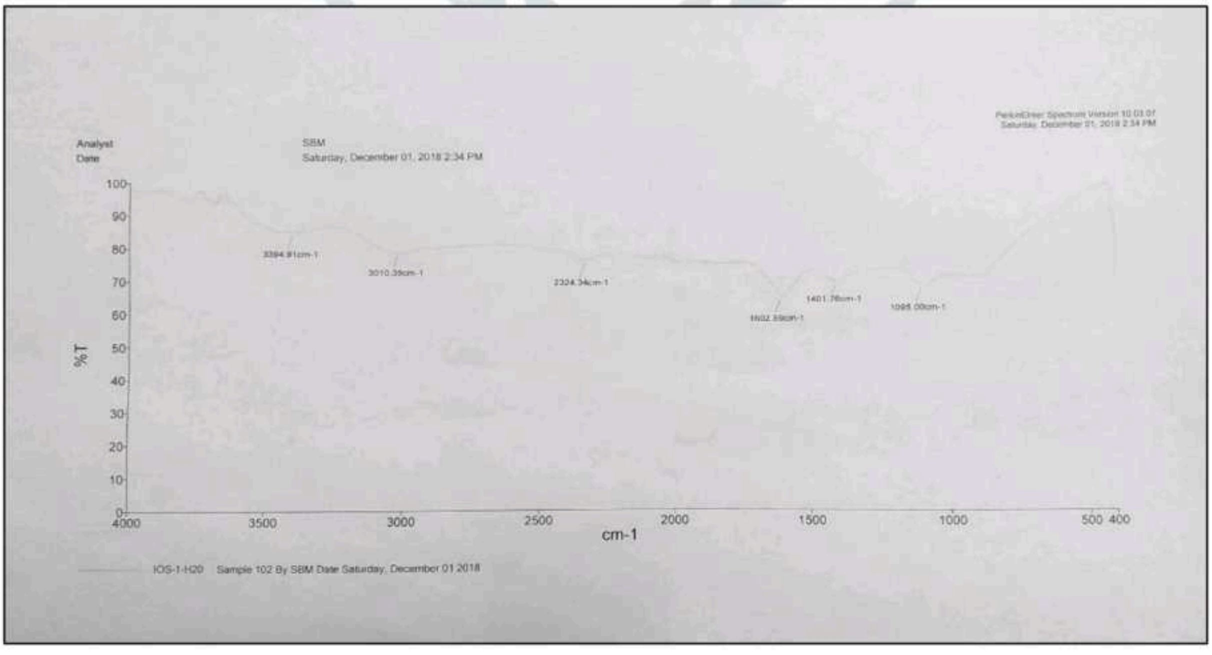


Figure no.1: FTIR spectra of *Salvadora persica* extract

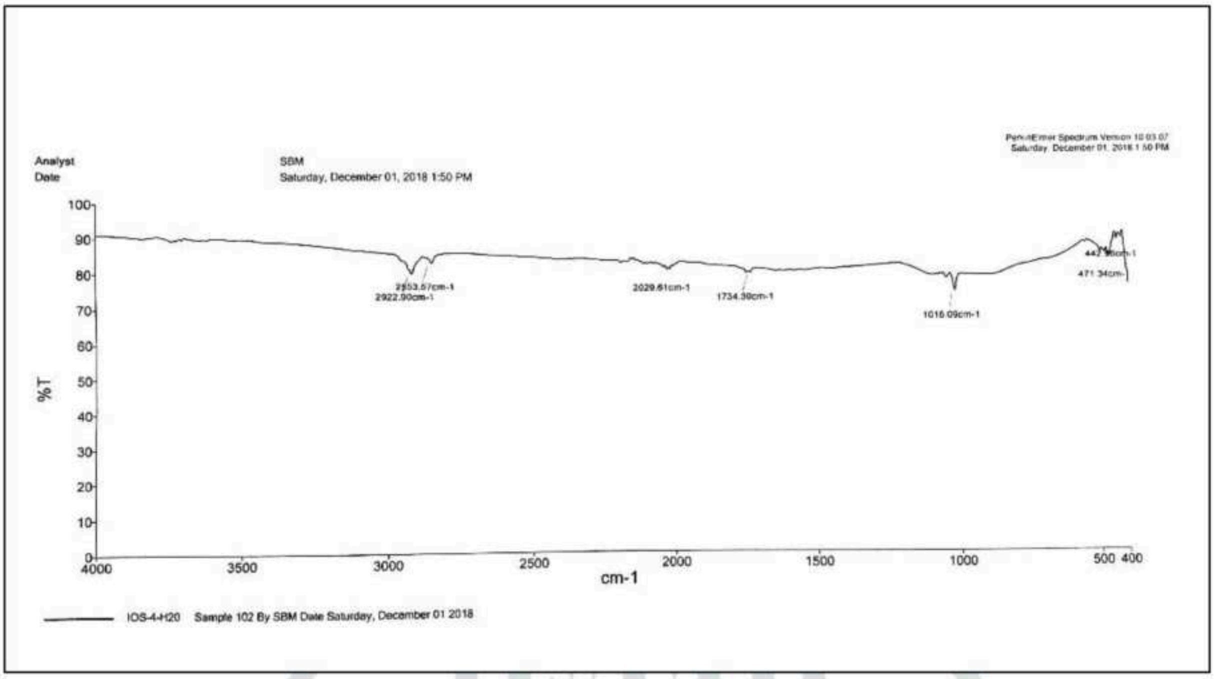


Figure No. 2: FTIR spectra of 10mM $CuSO_4.5H_2O$ solution

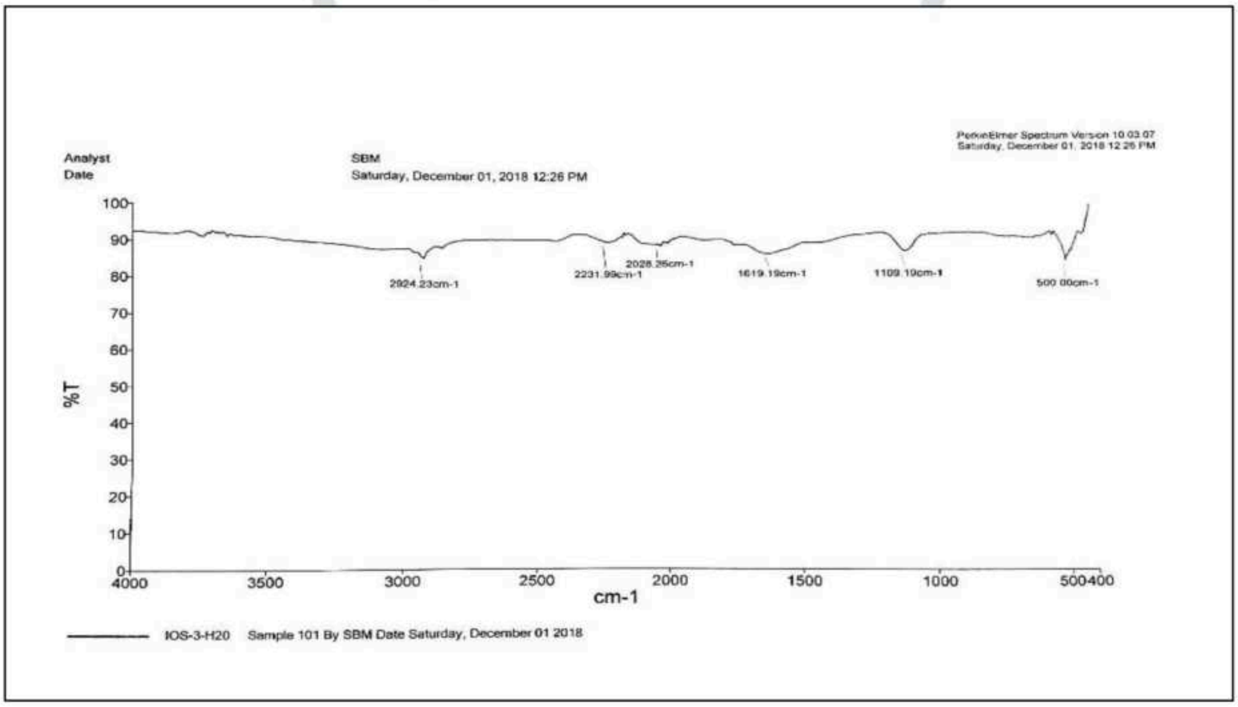
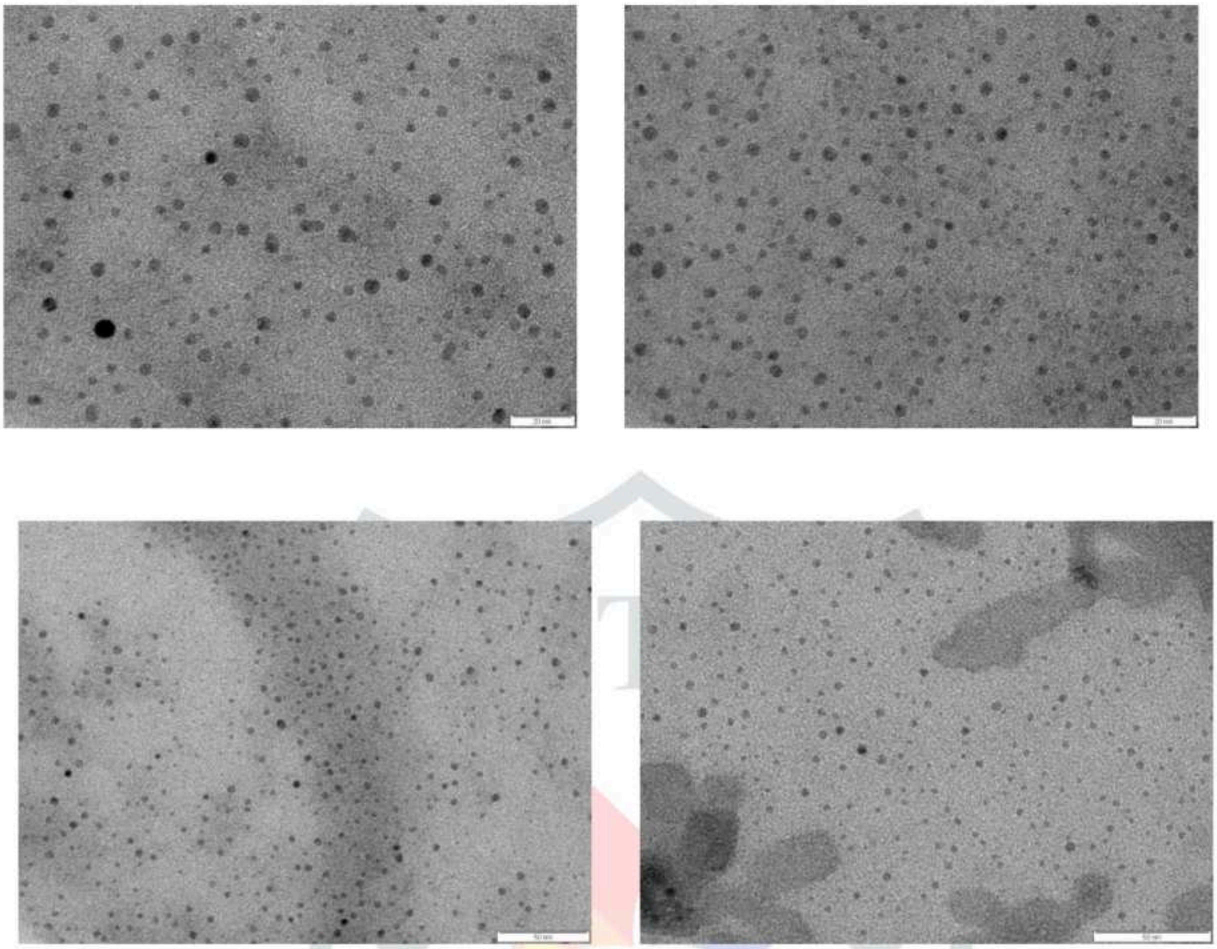


Figure No. 3: FTIR spectra of Copper nanoparticles

In Figure no. 3, the peak at 2924.23 cm-1 corresponds to the C – O stretch of carboxylic acid. The peak at 2231.99 cm-1 and 2028.25 cm-1 corresponds to disubstituted alkynes and secondary amines respectively. The peak at 1619.19 cm-1 corresponds to the C=O carbonyl stretch of carbonyl group. The peak at 1109.19 cm-1 corresponds to secondary alcohols. These peaks show that the Copper nanoparticles that were synthesised by the Green method are surrounded by various functional groups such as carboxylic acids, amines, alcohols, aldehydes, ketones, etc, thereby suggesting that these groups help in the formation and stabilization of the copper nanoparticles.

4.3. TEM analysis – The TEM analysis confirmed the formation of copper nanoparticles from *Salvadora persica* leaves extract. The nanoparticles were observed to be spherical in shape and the size ranged from 2 to 10 nm, with the average size of 5nm.



V. CONLUSION

There has been need in developing methods for synthesising nanoparticles that are eco – friendly, cost effective and do not require much requirements that are toxic to the environment. The copper nanoparticles that were synthesised using *Salvadora persica* fulfil the above mentioned requirements and can be studied furthermore for its various applications.

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