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# Synthesis of Copper Nanoparticles Using *Syzygium aromaticum* (Cloves) Aqueous Extract by Using Green Chemistry

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**Abstract:** The morphology of Copper nanoparticles was confirmed by Transmission Electron microscopy (TEM). Herein, we are reporting a novel biological approach for the formation of copper nanoparticles using *clove*. Copper sulphate was made to reduce with aqueous soln of clove extracts. X-Ray diffraction (XRD) pattern reveals the formation of Cu nanoparticles, which shows crystallinity. Transmission electron microscopy (TEM) suggested particles size and shape in the range of 5-40 nm. Scanning electron microscopy (SEM) image reveals that the particles are of spherical and granular nature. UV-V in absorption shows characteristic absorption peak of Cu nanoparticles.

**Key words:** *Copper sulphate · TEM · pH · SEM · UV-VIS*

## INTRODUCTION

Copper nanoparticles, due to their excellent physical and chemical properties and low cost of preparation, have been of great interest. Copper nanoparticles have wide applications as heat transfer systems,antimicrobial materials, super strong materials, sensors and catalysts. Copper nanoparticles are very reactive because of their high surface-to-volume ratio and can easily interact with other particles [1] and increase their antimicrobial efficiency. Colloidal copper has been used as an antimicrobial agent for decades. Copper nanoparticles (2-5 nm) have revealed a strong antibacterial activity and were able to decrease the microorganism concentration by 99.9%. Due to the stability of copper nanoparticles supported on a matrix and their disinfecting properties, copper nanoparticles can be used as a bactericide agent to coat hospital equipment.

**Copper Nanoparticles and Its Antibacterial Activities:** Nanomaterials are the leading in the field of nanomedicine, bionanotechnology and in that respect nanotoxicology research is gaining great importance. The US Environmental Protection Agency (EPA) has approved registration of copper as an antimicrobial agent which is able to reduce specific harmful bacteria linked to potentially deadly microbial infections (European Copper Institute, 2008). In addition, no research has discovered any bacteria able to develop immunity to copper as they often do with antibiotics [2, 3]. The emergence of nanoscience and nanotechnology in the last decade presents opportunities for exploring the bactericidal effect of metal nanoparticles. The bactericidal effect of metal nanoparticles has been attributed to their small size and high surface to volume ratio, which allows them to interact closely with microbial membranes and is not merely due to the release of metal ions in solution [4, 5].

**Plant Description**

**Cloves (*Syzygium aromaticum*)** are the aromatic dried flower buds of a tree in the family Myrtaceae, The clove tree is an evergreen tree that grows to a height ranging from 8–12 m, having large and sanguine flowers in numerous terminal clusters. The flowers buds are at first of pale colour and gradually become green after which they develop into a bright red, when they are ready for collecting. Cloves are harvested when 1.5–2 cm long and consist of a long calyx, terminating in four spreading sepals and four unopened petals which form a small ball in the center.

Cloves (shown in Figure 1) are used in Indian Ayurvedic medicine, Chinese medicine and western herbalism and dentistry where the essential oil is used as an anodyne (painkiller) for dental emergencies. Cloves are

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Fig. 1: Image of Cloves

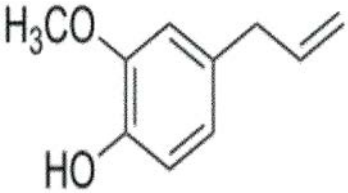


Fig. 2: Chemical Structure of Compound Eugenol

used as a carminative, to increase hydrochloric acid in the stomach and to improve peristalsis. Cloves are also said to be a natural anthelmintic. The essential oil is used in aromatherapy when stimulation and warming are needed, especially for digestive problems. Topical application over the stomach or abdomen are said to warm the digestive tract. Clove oil, applied to a cavity in a decayed tooth, also relieves toothache.

Cloves may be used internally as a tea and topically as an oil for hypotonic muscles, including for multiple sclerosis. Some recommend avoiding more than occasional use of cloves internally in the presence of *pitta* inflammation such as is found in acute flares of autoimmune diseases. Eugenol (shown in Figure 2) comprises 72-90% of the essential oil extracted from cloves and is the compound most responsible for the cloves' aroma.

## MATERIALS AND METHODS

**Collection of Extracts:** Cloves were collected from the local market. They were washed and cleaned with triple distilled water and dried with water absorbent paper.


Fig. 3: Tube A- contain copper sulphate solution, Tube B- contain clove extract, Tube C- contain sea green coloured copper nanoparticles solution.

Then it was crushed with the help of mortar and pestle dispensed in 10 ml of sterile distilled water and heated for 2-3 minutes at 70-80°C. The extract was then filtered using Whatman's No.1 filter paper. The filtrate was collected in a clean and dried conical flask by standard sterilized filtration method and was stored.

**Synthesis of Copper Nanoparticles:** For the synthesis of copper Nanoparticles, both the precursor and the reducing agent were mixed in a clean test tube in 1:1 proportion. For the reduction of Cu ions, 5ml of filtered Copper extract was mixed to 5 ml of freshly prepared 0.001 M aqueous of CuSo4 solution. It was then kept for incubation for 1hr.Within a particular time, the change in colour was noted from Dark brown to sea green. Thus colour change indicates reduction and reduced copper nanoparticles were obtained.

**pH Analysis:** The pH was determined by using Digital pH meter. The pH of the reduced solution with Nanoparticle synthesized was found to be 1.89.

**UV-Vis Spectra Analysis:** The reduction of pure Cu to nanoparticle was monitored by measuring the UV-Vis spectrum the most confirmatory tool for the detection of

Table 1: Change in color of the solution during Iron Nanoparticle synthesis

| | | Color change | | | |
|---|---|---|---|---|---|
| Sr. No | Solution | Before Reduction | After Reduction | Color intensity | Time |
| 1. | Cloves Extract | Dark brown | Sea green | + | 24 hours |
| 2. | 0.001 M CuSo4 Solution | cyan | | | |

Color intensity: + = Light color, ++ = Dark color, +++ = Very dark color

Table 2: Change in pH during iron nanoparticle synthesis

| Plant Extract | | Plant Part Taken | Ph change | | UV range | Result |
|---|---|---|---|---|---|---|
| Binomial Name | Local name | Flower | Before | After | 500-600nm | + |
| *Syzygium aromaticum* | Clove | | 3.43 | 1.89 | | |

Result: '+' Positive, '- 'Negative.

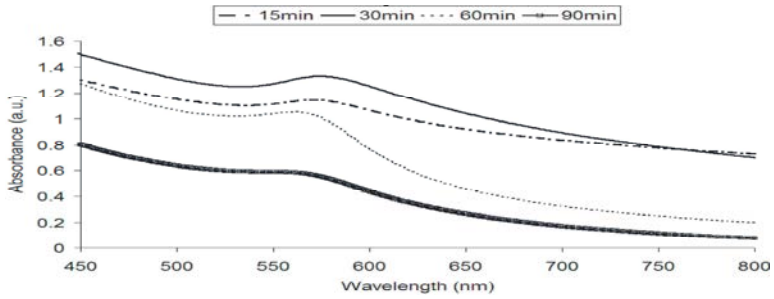


Fig. 4: The absorption maxima of copper nanopartciles at 570 nm.

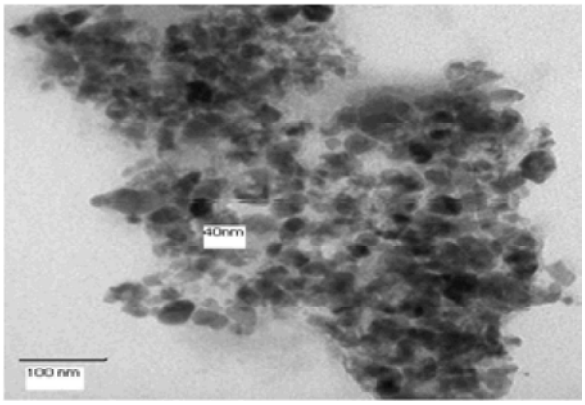


Fig. 5: TEM image of Copper Nanoparticles

Fig. 6: SEM image of Copper Nanoparticles

surface Plasmon resonance property (SPR) of CuNPs, by diluting a small aliquot of the sample in distilled water. UV-Vis spectral analysis was done by using UV-Vis spectrophotometer Systronics 118 at the range of 500-600 nm.

**Transmission Electron Microscopy:** The shape and size distribution of colloidal particles were characterized by transmission electron microscopy (TEM) two days after preparation. With a size range between 14 and 50 nm we can say that those particles are large and widely dispersed.

**Scanning Electron Microscopy:** The morphology of the as-prepared Cu productswas examined by FESEM. The typical SEM image shows that the product mainly consists of particle-like Cu nanoclusters with panoramic view and the size ranges from 150 to 200 nm. However, further observation with high magnification reveals that these Cu nanoclusters are assembled by smaller nanoparticles, which exhibit good uniformity and the average diameter is about 40 nm. The average size Of these nanoparticles is about 40–45 nm, almost in accordance with that from SEM observations.

## RESULT AND DISCUSSION

We have prepared spherical Cu nanoparticles in nanoregime by a novel biological synthesis technique which is simple and environmentally benign. It is an easy, fast and cost effective technique and doesn't involve any harmful and environmentally toxic chemicals used previously in conventional chemical reduction methods. Aqueous solutions of Cu nanoparticles with very good stability have been synthesized. It has been also discussed that the biomolecules present in the biomass not only reduce the metal ions and but also stabilize the metal nanoparticles bypreventing them from being oxidized after the preparation.

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