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GREEN SYNTHESIS AND CHARACTERISATION OF SILVER NANOCATALYST BY USING *CORIANDRUM SATIVUM* L.

ANJALI DADHEECH[1] AND K.S. MEENA[2]

Department of Chemistry, M. L. V. Government College, Bhilwara 311 001, Rajasthan, India

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ABSTRACT

Synthesis of nanoparticles by the biologically inspired processes evolving into an important branch of nanotechnology. Increasing demands of nanoparticles for textile and other industries discovered the new eco friendly green method for the synthesis of nanoparticles. In this study, synthesis of stable silver nanoparticles was done using *Coriandrum sativum* leaf extract. UV-Vis spectrometer used to monitor the reduction of Ag ions and formation of silver nanoparticles in medium. XRD, SEM and SEM EDX was used to characterise the synthesis of particles at nanoscale. UV spectral analysis gave the prior prediction of formation of silver nano particles. The peaks in the XRD pattern associated with that of face-centered-cubic (FCC) form of metallic silver. SEM and SEM EDX associated with the size of the particle at nanoscale and the content associated in the synthesis procedure. The synthesized naoparticles were used for the effective photocatalytic degradation of the textile dyes.

KEY WORDS : Silver nanoparticles, *Coriandrum sativum* L., Face-centered-cubic structure, SEM.

INTRODUCTION

Application of silver nano particles in various areas such as nanomedicine, (De Gaetano, 2005; Crabtree, 2003; Chung *et al.*, 2016), chemical sensing, electronics, textile industres led to their increased demand. Nanotechnology is the design, characterisation, production and application of material devices and systems by controlling the shape and size of the nanometer scale. Nanoparticles are particles that have a size of 1 to 100 nm in at least one dimension and possess unique physical and chemical properties due to their large surface area to volume ratio and smaller size. There are two basic approaches used in nanoparticle synthesis one is top down (communication and dispersion) approach and the second one is bottom up (nucleation and growth) approach. Chemical, physical and biological methods have been developed to synthesis nanoparticles but chemical and physical methods involved in the production of toxic by products which are very harmful and moreover they are very expensive.

The physical method involves ball milling of bulk materials to nano scale size. Similarly, by physical vapour deposition in which a bulk material is vaporised by heat source followed by rapid condensation to form nanosized clusters that settle in the form of powder.

The chemical methods employed include sonochemical process generally involves the use of ultra sound to chemical reactions and processes. Photochemical reductions are absorbed by reactant molecules to give excited molecules or free radicals, which undergo further reaction and sol gel process.

The sol gel process generally involves the use of metal alkoxides, which undergo hydrolysis and condensation polymerisation process to give gels.

Plants and micro-organisms such as bacteria, yeast and fungi are used in the biological method (Song, 2009) of nano particle synthesis. The laboratory preparation of microbial culture, the complex extraction and purification process of synthesized nanoparticles make the microbial technique of nanoparticle synthesis expensive.

There is need to develop new methods of synthesizing nano particles that are less costly, non toxic and energy efficient, environment friendly renewable resources such as phyto-chemical extractes from plants (Awwad, 2013; Balaji, 2009). This would definitely mean that to apply the "green chemistry" principles.

Green chemistry is the utilisation of a set of principles that will help to reduce the use and generation of hazardous substances during the manufacture and application of chemical products. Green chemistry aims to protect the environment not by cleaning up, but by inventing new chemical processes that do not pollute. It is very important area and rapidly growing in the chemical sciences.

Silver nano particles have greatly drawn the interest of many researchers because of their unique physical and chemical properties that make them to use in various application. Various plant extracts (Tripathi, 2010) have been successfully used in the synthesis of the silver nanoparticles. Some of the plant extracts used incude *Camellia sinesis* leaf extract, *Cinnamomum camphora* leaf extract, *Aloe vera* extract, *Allium sativum* extract and *Capsicum annum* leaf extract, *Ocimum sanctum,* (Singhal, 2011) *Petroselinium crispum* (Roy, 2015) (*murraya koenigii* (Christensen, 2011), *Aspergillus oriza* (Phanjom, 2015), *Crinum latifolium* (Thanhtruc *et al.*, 2017) *Coriandrum sativum* (Sathyathi, 2010), (Khan, 2018) as for the synthesis of metal nano particles.

Nano particles synthesized using biological techniques or green technology have diverse natures, with greater stability and appropriate dimensions since they are synthesized using a one step process. Plants provide a better platform for nano particles synthesis (Banerjee, 2014) as they are free from toxic chemicals as well as contain natural capping agents. Among various plants we have selected the *Coriandrum sativum* leaf extract (Santos, 2012) for this study. We attempted to get the reduction of water solution silver ions by the leaf extract of *Coriandrum sativum* and collected the silver nanoparticles by using the green method of synthesis.

MATERIALS AND METHODS

Synthesis of Silver nanocatalyst

The fresh and mature leaves of *Coriandrum sativum* were collected from Bhilwara district in Rajasthan. About 30 g of leaves were washed thoroughly four times with de-ionised water to remove dust particles and air dried at room temperature. Then the leaves finely chopped into small pieces and added to 120 mL of deionise water. Stirring done using magnetic stirrer at 60^0 for 20 min. After cooling the leaf extract was filtered with whatman filter paper. Thus about 85 mL of transparent yellowish green color leaf extract stored at 4 ^oC. In the synthesis of silver nano particles 0.01M of aqueous solution of $AgNO_3$ (99.99%) was used 10 ml of leaf extract added to 50 mL of 0.01M $AgNO_3$ aqueous solution and allowed for suitable conditions for the reaction. After different time interval color change of reaction mixture observed from transparent yellow to dark brown color which gives the basic idea of formation of silver nanoparticles in solution. This solution was centrifuged at 4000 rpm and the excess liquid was drained and again centrifuged and then the remaining liquid was removed by evaporation and the black colored silver nano powder obtained.

Characterisation

Biologically reduced silver nano particle solution sample used to observe the optical absorbance between 190 and 800 nm with a UV-Vis spectrometer at room temperature. X-ray diffraction measurement was done with Cu-K á radiation of 0.154060 nm wavelength to investigate the formation, crystalline behaviour and the quality of synthesized silver nano particles.

The Scanning was done in the region of 2è from 10 to 80^0 and the time constant was 2s. The size of AgNPs was calculated by Debye-Scherer equation. The surface morphology and the particle size of silver nano particles investigated by scanning electronic microscope. SEM EDS analysis was done to confirm the semi-quantitative elemental analysis.

RESULTS AND DISCUSSSION

Ultraviolet Spectroscopy

The reacted mixture of Silver Nitrate solution and the *Coriandrum sativum* extract are shown in the Fig. 1 using water as a solvent. A visible color changes from yellow to light brown within 30 min of time confirms the formation of AgNPs. Which was priorly confirmed by the UV spectral analysis and then the SEM, SEM EDX analysis and followed by XRD pattern which confirm the formation of catalyst at nanoscale. Absorbance of the silver nano particles observed in UV-Vis spectra and the maximum absorbtion observed at 410-420 nm range which confirms the formation of the silver nanoparticles as shown in the graph Fig. 2 given below.

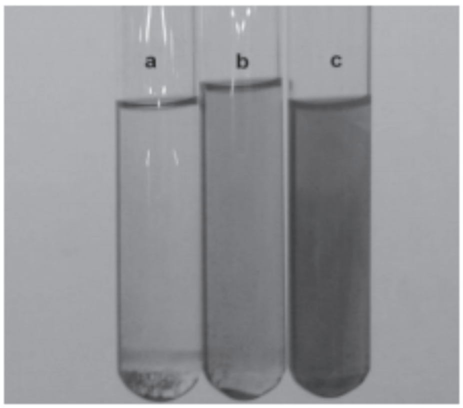

Fig. 1. Silver nanocatalyst suspension

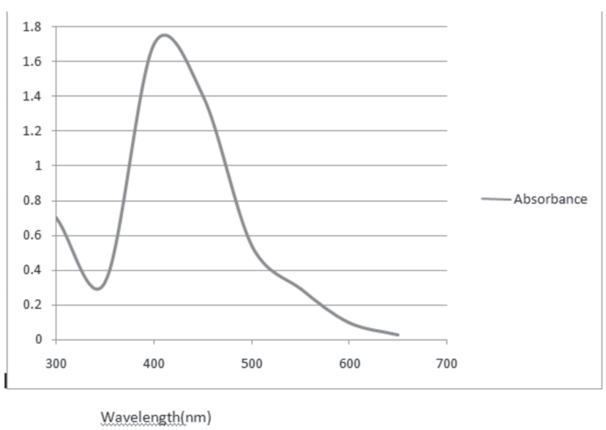

Fig. 2. UV-Vis Absoption maximum of Ag nanocatalyst

X-ray diffraction analysis

The X-ray of the sample observed at 2θ and the XRD pattern of the synthesized AgNPs using *Coriandrum sativum* leaf extract was shown in Fig. 3. The XRD was done to determine the crystalline nature of AgNPs and the resulted peaks were observed at 38.33^0, 44.50^0, 64.64^0 and 77.57^0 representing (111), (200), (220) and (311) face centered cubic structure of silver (Mehta, 2017) few intense unassigned peaks were also noticed these Braggs peaks may have resulted from some bioorganic compounds, proteins present in the *Coriandrum sativum* leaf extract. The average particle size was calculated by Debye-Scherer equation

$$\tau = K\lambda / \varpi \cos\theta$$

Where τ is the particle size, K is the dimension shape factor, λ is the X-ray wavelength, β is the line broadening at half the maximum intensity, θ is the Braggs angle (in degrees).

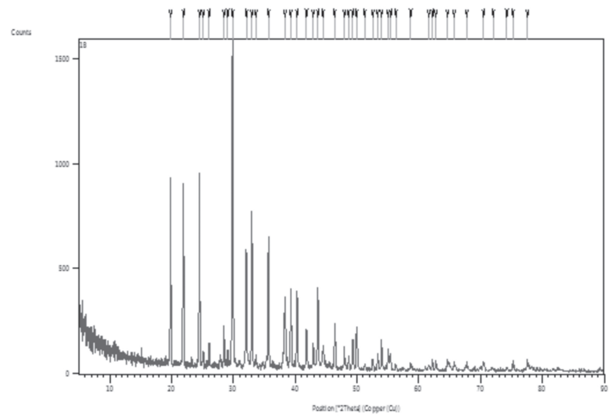

Fig. 3. XRD pattern of Synthesized Silver nano particles

Scanning electron microscopy- (SEM, SEM-EDX)

SEM is the surface imaging method, fully capable of resolving different particle sizes, size distributions, nanomaterial shapes and the surface morphology of the synthesized particles at the micro and the nano scale. The combination of SEM with energy dispersive X-ray spectroscopy used to examine silver powder morphology and conduct chemical composition analysis. The SEM and the SEM EDX images are shown in Fig. 4 and 5. The SEM image showed that most of the silver nanoparticles are spherical in shape having smooth surface and well dispersed with close arrangement. The average particle size was found around 20-30 nm using an advanced software named IMAGEJ and the obtained particle size is almost similar to XRD.

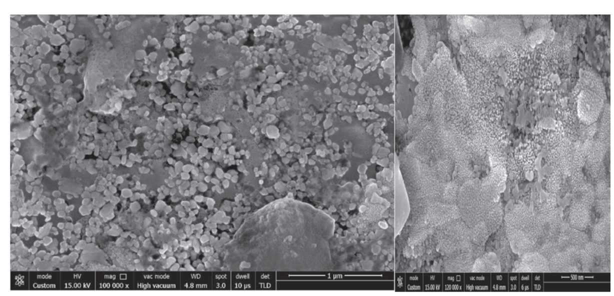

Fig. 4 & 5. SEM images of synthesized Silver nano-particles at different scales of measurements.

CONCLUSION

The green synthesis of Silver nanoparticles using *Coriandrum sativum* leaf extract was shown to be eco-friendly and produced nanoparticles are fairly

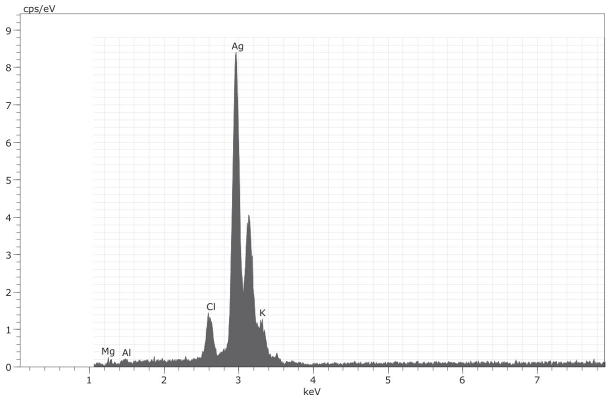

Fig. 6. SEM EDX analysis of synthesized silver nano particles from *Coriandrum sativum* leaf extract.

uniform in size and shape. It was found that formation of nano particles was increased with time. The UV absorption shown in 410-420 nm and the XRD revealed the FCC structure of particles. SEM analysis shown the formation of nano particles at nano scale and particles formed are spherical in shape and the size found in the range of 20-30 nm. Green synthesis of silver nano particles from the *Coriandrum sativum* leaf extract was found to be cost effective eco-friendly.

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