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A NOVEL GREEN SYNTHESIS OF COPPER NANOPARTICLES USING THE LEAF EXTRACT OF ARGEMONE MEXICANA AND THE CHARACTERISATION STUDIES

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ABSTRACT

There is an increasing commercial demand for nanoparticles due to their wide applicability in various areas such as electronics, catalysis, chemistry, energy, and medicine. Metallic nanoparticles are traditionally synthesized by wet chemical techniques, where the chemicals used are quite often toxic and flammable. In this work, describing a cost effective and environment friendly technique for green synthesis of Copper nanoparticles from 10mM $CuSO_4$ and $CuCl_2$ solutions through the extract of Argemone Mexicana leaf extract as reducing agent as well as capping agent. The present study was to examine the characterization studies of copper nano materials which prepared using green synthesis method. Nanoparticles were characterized using UV–Vis absorption spectroscopy, FTIR and XRD. The most important outcome of this work will be the development of value added products from Argemone Mexicana (a potential weed of India) for biomedical and nanotechnology based industries.

Keywords: *Argemone Mexicana, Green synthesis, Copper nano particles,UV-Visible spectroscopy, FT-IR spectroscopy, X-Ray diffraction.*

I. INTRODUCTION

Human dreams and imagination often give rise to new science and technology. Nanotechnology, a 21st-century frontier, was born out of such dreams. Nanotechnology is defined as the understanding and control of matter at dimensions between 1 and 100 nm where unique phenomena enable novel applications. Although

human exposure to nanoparticles has occurred throughout human history, it dramatically increased during the industrial revolution. The study of nanoparticles is not new[1].

Generally, metal nanoparticles are synthesized and stabilized by means of chemical methods such as chemical reduction, electrochemical techniques, and photochemical reactions in reverse micelles and nowadays via green chemistry. Synthesis of nanoparticles through biological methods is a good, eco-friendly and economically alternative method. Use of green chemistry to the synthesis of nanomaterials has an essential value in medicine[2].

Copper nanoparticles with great catalytic activities can be applied to biosensors and electrochemical sensors. Redox reactions utilized in those sensors are generally irreversible and also require high overpotentials (more energy) to run. In fact, the nanoparticles have the ability to make the redox reactions reversible and to lower the overpotentials when applied to the sensors[5,6].

Here in, the aim of this project is the report of the first time synthesis of copper nanoparticles, reducing copper sulphate and copper chloride ions using the aqueous extract of Argemone Mexicana leaves. In previous years copper nano particles are prepared by using the various leaf exatract of different type of plants. Now it is a novel synthesis of copper nano particles using the leaf exract of **Argemone Mexicana** and to estimate the medicinal potential of anti microbial activities.

II. MATERIALS AND METHODS

2.1 Plant materials and preparation of extract

Fresh green Argemone leaves were collected from the areas of Theni district and washed thoroughly under the running tab water. 15g of leaves were weighed and then crushed into fine pieces. The crushed leaves were boiled into 200ml of double distilled water for one hour. Then it was filtered using Whatman No.1 filter paper (pore size 25µm).

2.2 Synthesis of Copper nanoparticles

2.4965g of $CuSO_4.5H_2O$ and 1.3445g of $CuCl_2$ were added separately into each 1L of double distilled water to prepare 10mM solutions of $CuSO_4.5H_2O$ and $CuCl_2$. 15ml of prepared leaf extract is added to the 10mM solutions of $CuSO_4.5H_2O$ and $CuCl_2$. The color of the solution is changes from green into greenish yellow.

2.3 UV-Visible spectrum analysis

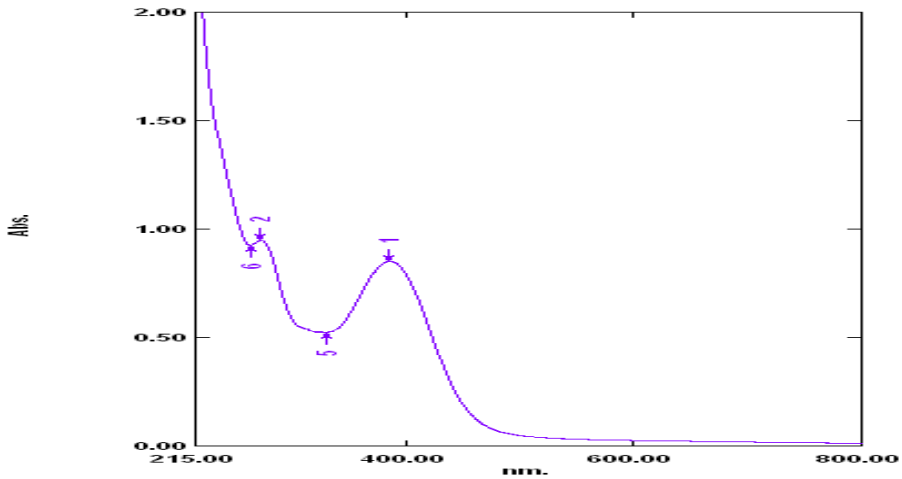

Fig 1: UV spectra of A.Mexicana leaf extract

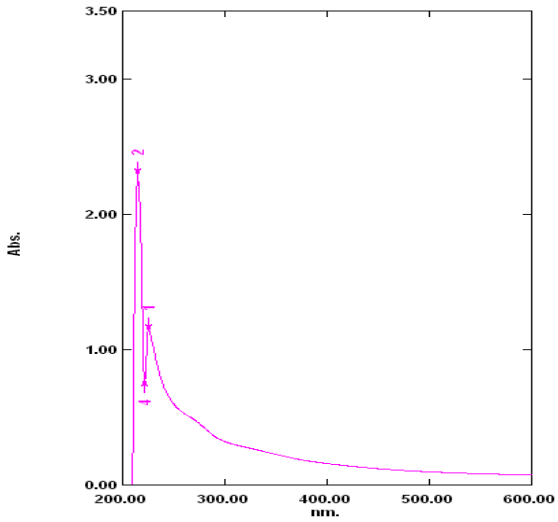

Fig 2: UV spectra of A.Mexicana -CuCl2

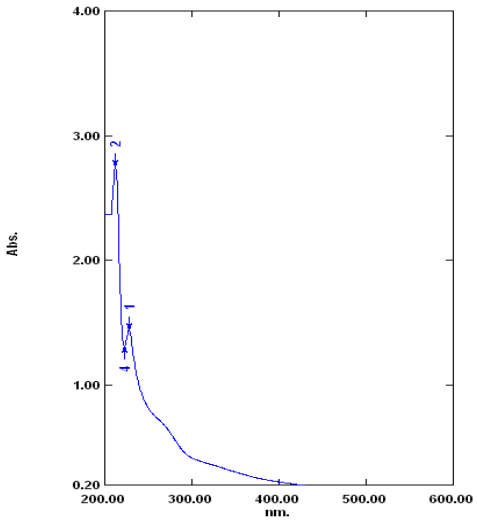

Fig 3: UV spectra of A.Mexicana -CuSO4

Fig 1. shows the UV absorbance of pure leaf extract without any contamination of copper ions. Fig 2 & 3 shows the SPR band of copper nanoparticles present in the solutions of leaf extract- $CuCl_2$ & $CuSO_4.5H_2O$. In fig 2, the SPR band shows that Copper nanoparticles centered at 215nm also in fig 3, CuNps centered at 212nm.

As the reaction continued, absorbance peaks became narrower and were shifted as shorter wavelength. This indicates the particles became smaller and are getting dispersed.

2.4 FT-IR SPECTRUM ANALYSIS

FT-IR spectra of NH_3OH soluble extract after reduction of Cu^+ are shown in fig 4, the FT-IR spectra of CuNps depicted at 1897.95cm^{-1} corresponding to the stretching vibration of Cu-N bonds and broad bands at 1629.85cm^{-1} attributed to asymmetric C=O stretching vibration of CO_2. Fourier transform infrared spectrometer is a common laboratory instrument used for this technique. Absorbance bands in fig 4 are observed in 500-4500cm^{-1}.

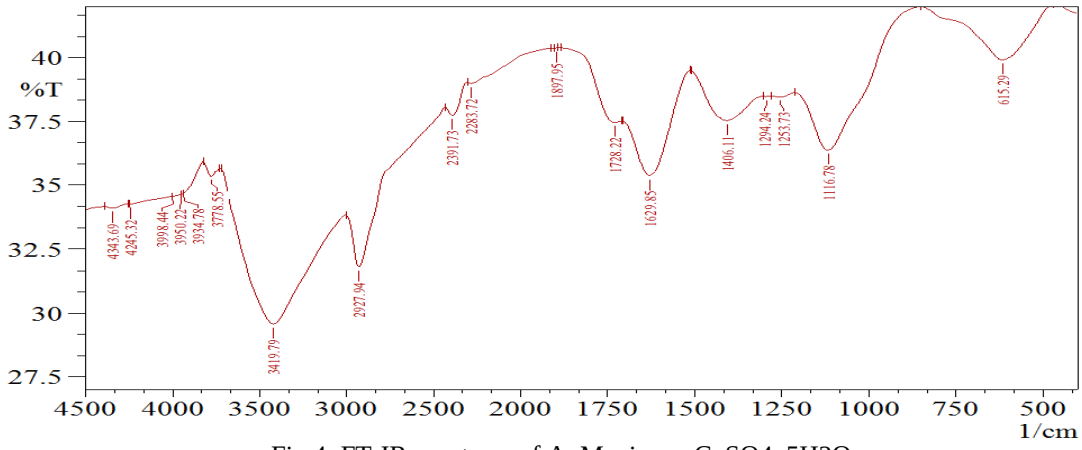

Fig 4: FT-IR spectrum of A. Mexicana-CuSO4 .5H2O

Table 1: FT-IR spectra of AM-CuNps & their assignments

AM-CuNps	Assignment
3419.79	-NH_2
2927.94	-OH
1629.85	-NH
1116.78	C-O
615.29	C-Br

In fig 5, CuNps are present at 1942.32cm^{-1} corresponding to stretching vibration of the Cu-N bonds and broad bands at 1631.75cm^{-1} attributed to asymmetric C=O stretching vibration of CO_2. Absorbance bands in fig 5 are observed in 500-4500cm^{-1}.

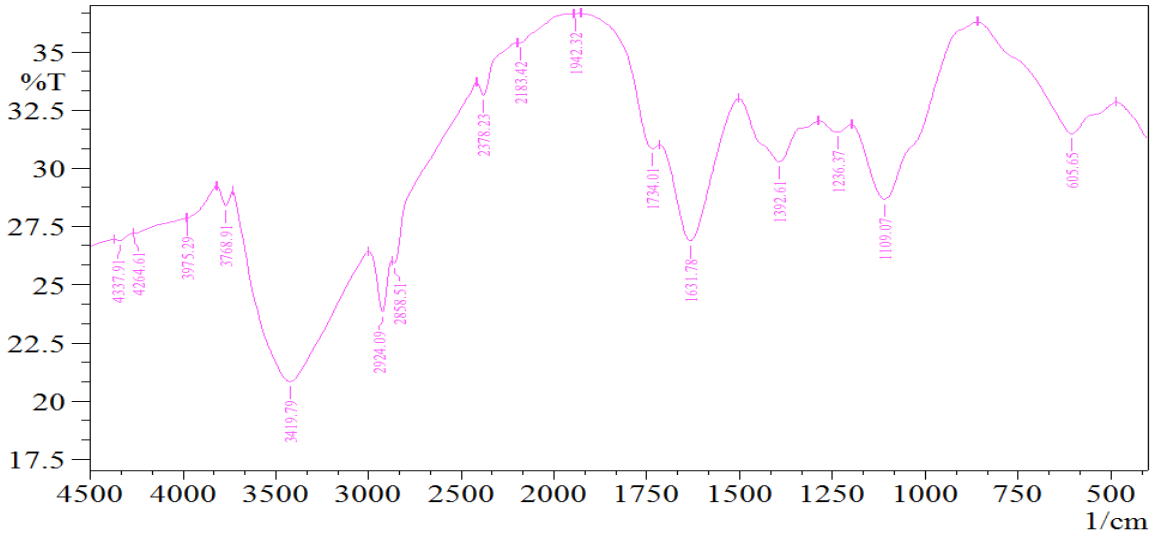

Fig 5: FT-IR spectrum of A. Mexicana-$CuCl_2$

Table 2: FT-IR spectra of AM-CuNps & their assignments

AM-CuNps	Assignments

3419.79	$-NH_2$
2924.09	-OH
1734.01	C=O
1392.61	$-CH(CH_3)_2$
605.65	C-Br

2.5 X-RAY DIFFRACTION

In here, XRD is used for the determination of crystalline nature crystalline nature, purity and the size of synthesized metallic nanoparticles. The bio synthesized Copper nano particles by employing A. Mexicana leaf extract was further demonstrated and confirmed by the XRD characterization peak images. From this study, the peaks are considered as degree and the average particle size has been calculated using Debye-Scherrer equation.

$$D=k\lambda/\beta \cos\theta$$

Where,**k (~0.94)** = **S**hape factor, **λ** = Wavelength of X-Ray (0.154nm),**β** = Full width at half maximum, **θ** = Diffraction angle, **D** = Particle diameter size

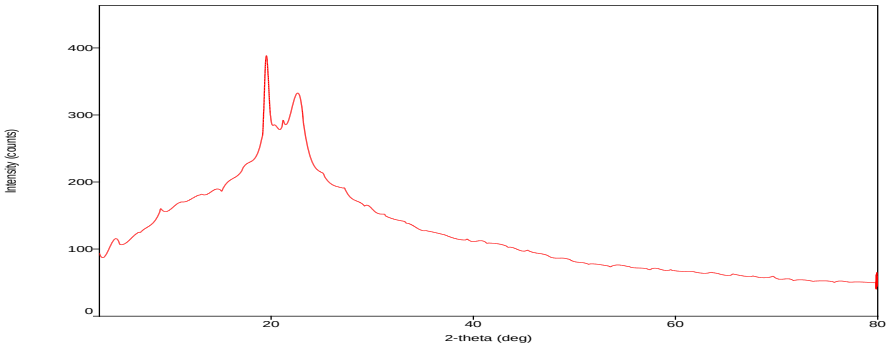

Fig 6: X-Ray diffraction of A. Mexicana-CuSO4 .$5H_2O$

Table 3: Crystalline size

S. No	Peak no.	2 theta (deg)	D (deg)	FWHM (deg)	Crystalline size (nm)
1	1	9.6537	9.15446	5.0127	1.66
2	2	13.9534	6.34167	7.3949	1.13
3	3	19.6435	4.51565	1.3461	6.26
4	4	22.5494	3.93987	3.6124	2.34
5	5	30.6386	2.9156	8.3217	1.03

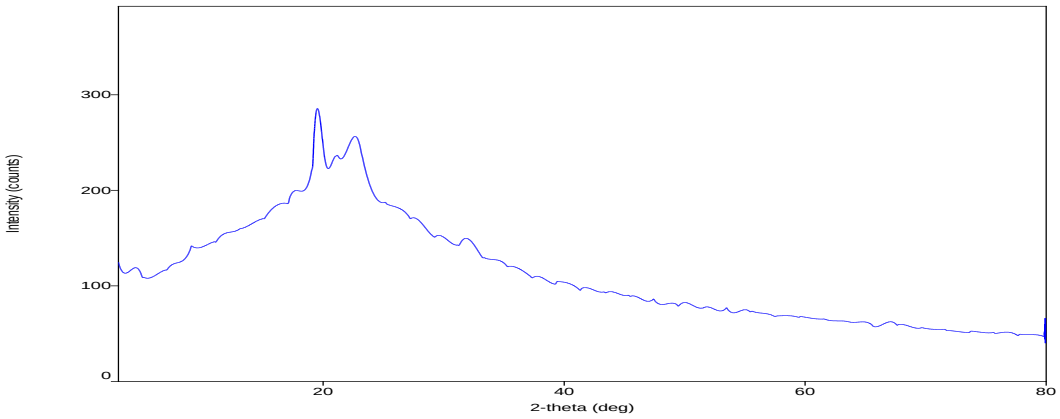

Fig 7: X-Ray diffraction of A. Mexicana-$CuCl_2$

Table 4: Crystalline size

S. No	Peak no.	2 theta (deg)	D (deg)	FWHM (deg)	Crystalline size (nm)
1	6	16.7259	5.29621	2.1261	3.95
2	7	19.5634	4.53397	1.083	7.78
3	8	22.4994	3.94851	3.8674	2.19
4	9	32.1677	2.78041	0.4584	18.85

III. RESULT AND DISCUSSION

UV-Visible spectrum shows the conformation of Argemone Mexicana-CuNps exhibit the SPR band of CuNps. In Argemone Mexicana-$CuSO_4.5H_2O$, CuNps are present in the size of 212nm and in A. Mexicana-$CuCl_2$, CuNps are present as 215nm. FT-IR spectrum reveals the informations of the potential of biomolecules in Argemone Mexicana Leaf extract which is responsible for reducing and capping the bioreduced CuNps can be obtained. Crystalline nature and the purity were characterized by XRD. The crystalline size was otained from 1 to 18nm.

IV. CONCLUSION

Green synthesis of nanomaterials is an environmental friendly method also their is no need to use any harmful reagents. Green synthesis of Copper nanoparticles shows more compatible, low cost, eco friendly and also less time consuming process. The reduction of metal ions through leaf extracts leading to the formation of CuNps of fairly well definedstructure and dimensions. The bio reduction of Cu^+ ion by Argemone Mexicana leaf extract has been demonstrated. In this method, Copper nano particles were prepared into 60 minutes. Application of such eco friendly nanoparticles in bactericidal, wound healing and other medicinal and electronic applications, makes this potentially exciting for the large scale synthesis of other inorganic materials(nanomaterials). This green chemistry approach toward the synthesis of Copper nanoparticles has many advantages such as, ease with which the process can be scaled up, economic valuablity.etc. Most importantly, the reaction was simple and convenient to handle.

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