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ECO-FRIENDLY SYNTHESIS OF METAL OXIDE NANOPARTICLES USING *CARISSA CARANDAS*FRUITEXTRACT

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ABSTRACT

Green synthesis of nanoparticle is a novel way to synthesis nanoparticles using biological sources. It is gaining attention due to its cost effective, ecofriendly and large scale production possibilities. In the present study *(Carissa carandas)*redberryfruits were taken to investigate their potential to synthesis metal oxide nanoparticle. The ZnO, CuO, MgO nanoparticles synthesized were confirmed by their change of colour due to the phenomenon of surface Plasmon resonance. The characterization study was done by UV-Vis spectroscopy, Fourier Transmission Infrared Spectroscopy (FTIR), X-Ray diffraction (XRD), The above metal oxide nanoparticles were found to be effective against Pseudomonas, Bacillus and staphylococcus.

KEYWORDS: Green synthesis, UV, FTIR, XRD.

I. INTRODUCTION

During the last few years, synthesis of nanostructured metal oxide materials have attracted considerable attention(ZnO,CuO,MgO,TiO_2,Fe_3O_4,ZrO2,SnO2).[1] Nanotechnology broadly refers to a field of applied science and technology whose unifying theme is the control of matter on the molecular level in scales smaller than 1 µm, normally 1-100 nm and its fabrication of devices within the range.[2] It is a highly multi-disciplinary method drawing from fields such as pharmaceutical sciences, applied physics, material sciences, colloidal sciences, device physics, supra molecular chemistry and even mechanical and electrical engineering.[3]

*Carissa carandas*leaf and fruits are used in case of intermittent fever, diarrhea, oral inflammation and earache. The root is employed as a bitter stomachic and vermifuge and it is an ingredient in a remedy for itches.[4-5] The roots contain salicylic acid and cardiac glycosides causing a slight decrease in blood pressure.[6-7] Traditional healers have expertise in treatment of different types of cancer using *C. carandas*. They use its different plant parts to dress the cancerous wounds and to kill the maggots. In this present work, The Metal oxide Nps were synthesized for the first time using the extract of *Carissa carandas*fruit and were characterized by various analytical techniques.

2. METHODOLOGY

2.1 Preparation *Carissa Carandas*of Extract

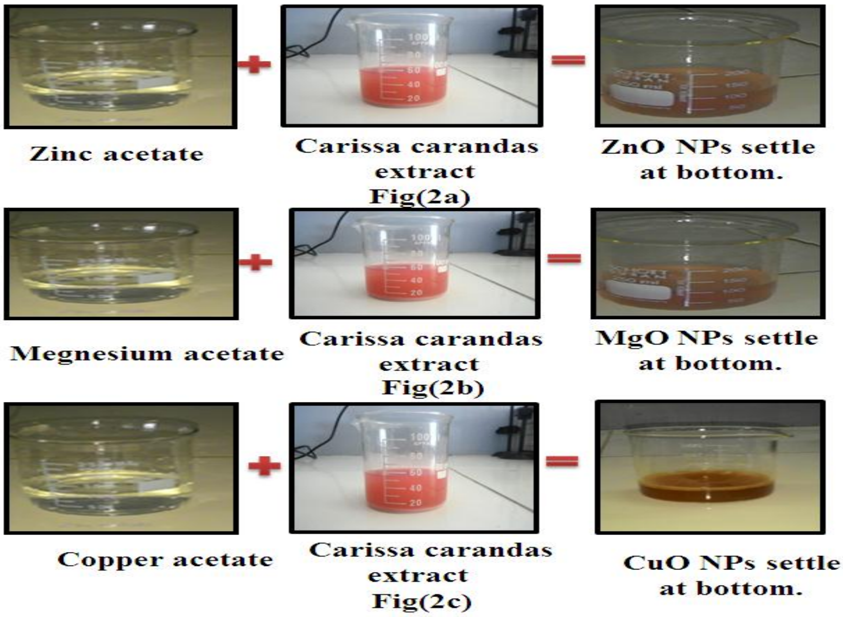
Fresh *Carissa carandas* fruits werecollectedfrom shops (Fig.1). After the collection thefruits were thoroughly washed in de-ionized water to remove the surface impurities. 50 g fruits were crushed using a blender and finely macerated and 100 ml of de-ionized water was added. The extract obtained was filtered through Whatmann No.1 filter paper and was immediately used for the biosynthesis of metal oxide nanoparticles.

Kingdom	:	Plantae
Order	:	Gentianales
Family	:	Apocynaceae
Sub-family	:	Rauvolfioideae
Genus	:	*Carissa*
Species	:	*carandas*

Carissa carandas Fruit Fig. 1. Scientific classification

2.2 Synthesis of ZnO, CuO, MgO Nanoparticle

To synthesis metal oxide nanoparticles, 1mM of zinc acetate/magnesium acetate/copper acetate was dissolved in Double distilled water separately. Fruit (*Carissa carandas*) extract was added drop by drop under constant stirring (1200 rpm) thecolour changed into brown ZnO nanoparticle (Fig.2a), Appearance of pink colour indicated the Mgo nanoparticle (Fig.2b) and dark brown indicated the copper oxide nanoparticles(Fig.2c). Then mixture was subjected to stirring for 4 hours continuously at room temperature. At this period nanoparticles formation occurred and they settled at the bottom of the flask. Then, those nanoparticles were using Whatmann No.1 filter paper and the particles were washed with double distilled water repeatedly to remove the by-products from the sample. The nanoparticles were dried at 100^0C.



2.3 CHARACTERIZATION

Ultra Violet Spectroscopy

UV–vis spectrum of metal oxide nanoparticles was recorded, by taking 0.1 ml of the sample and diluting it with 2 ml deionized water, as a function of time of reaction using a (Shimadzu -1800), spectrophotometer in the wavelength region 200 to 800 nm operated at a resolution of 1 nm.

FTIR Spectra analysis

The FTIR spectra of fruit extract and synthesized metal oxide nanoparticles were recorded by FTIR spectrometer KBr pellet method (in the range of 4000–400 cm-1) (Shimadzu).

X-ray diffraction (XRD)

The crystalline phase formation and size of metal oxide nanoparticles were analysed by X-Ray Diffraction (XRD) measurements which was carried out using (XPERT-PRO)with Cu(Kα) radiation (λ =1.5416 A˚) operating at 40 kv and 30 mA with 2θ ranging from 10- 80˚. The average particle size of metal oxide nanoparticles was determined usingScherrer's equation. D=kλ / β Cos θ where k is a constant, λ is the X-ray wavelength which equals to

0.15416 nm, β the full width half maximum intensity (FWHM) and θ the half diffraction angle.

Antibacterial assays

The antibacterial assays were done on human pathogens such as *Staphylococcus aureus*and *Bacillius P.seudomonas* by standard disc diffusion method. Agar medium was used to grow bacteria. Fresh inoculums (100 µl) of overnight cultures were spread on to agar plates. Sterile Whatman No.1 paper discs of 5mm diameter (containing 10µg of ZnO, MgO, CuOnanoparticles) along with Ampicillin standard antibiotic containing discs were placed on each plate. After incubation overnight at 37^0C, zone of inhibition was measured (mm in diameter).

3. RESULTS AND DISCUSSIONS

3.1 UV–Vis absorption spectroscopy analysis

Ultraviolet-visible spectroscopy (UV-Vis) refers to absorption spectroscopy in the UV-Visible spectral region. This means it uses light in the visible and adjacent (near-UV and near-infrared) ranges.

In this region of the electromagnetic spectrum, molecules undergo electronic transitions. The UV Visible spectrum of ZnO, MgO, CuONPs in the aqueous carrissacarandas fruit extract is shown in Figure 3. The absorption peaks at wavelengths of 292 nm, 320 nm and 386 nm indicate the formation of metal oxide nanoparticles.

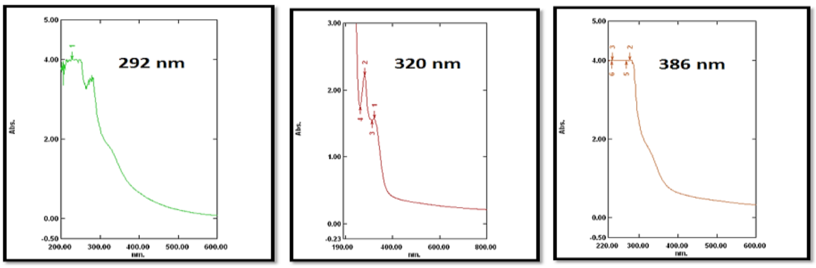


Fig3- shows the UV-Vis spectra of ZnO/MgO/CuO nanoparticles synthesized by Carissa carandas. The peak of the above spectra was found at 292,320,386 nm and this peak is due to Surface Plasmon Resonance (SPR) property of ZnO/MgO/CuO nanoparticles.

3.2 Fourier Transform Infrared Spectroscopy Analysis (FTIR)

In order to determine the functional groups on Red berry(Carissa carandas)extract and identify their role in the synthesis of metal oxide nanoparticles, FT-IR analysis was performed in ZnO, CuO and MgONps. Metal oxide NPs FTIR spectrum is shown in Figs.4 the FT-IR spectrum showed strong absorption bands at 3432 cm^{-1} (O-H Stretch H-bonded) and this functional group is alcohols, phenols. 2365 cm^{-1} (–C ≡ C– stretch; alkynes) 1575 cm^{-1} (N–H bend; 1 amines) 1409 cm^{-1}(C–C stretch (in–ring) aromatics and 1326 cm^{-1} (C–N stretch; aliphatic amines) 1026 cm^{-1} C–N stretch aliphatic amines which is characteristic of the –OH stretching vibration, -CH stretching, respectively and the higher frequency region 3432 cm-^{1} and lower region 1326 cm^{-1}. The FTIR spectrum of metal oxide (ZnO, MgO and CuO) nanoparticles band at 1010 cm^{-1} (C-N Amines)1467 cm^{-1} (aromatic ring), 2095 cm^{-1} (alkynes group)3475 cm^{-1}=O-H stretching vibration1432 cm^{-1} C-C bonds, 1567 cm^{-1} (Amide C=O)672 cm^{-1} Mg-O vibration bonds and 650-1000 cm^{-1}=C-H bending vibrationscopper oxide band1597 cm^{-1} corresponds to N-H bend of primary amines.1480 cm^{-1} C-N stretching of aromatic amino group.

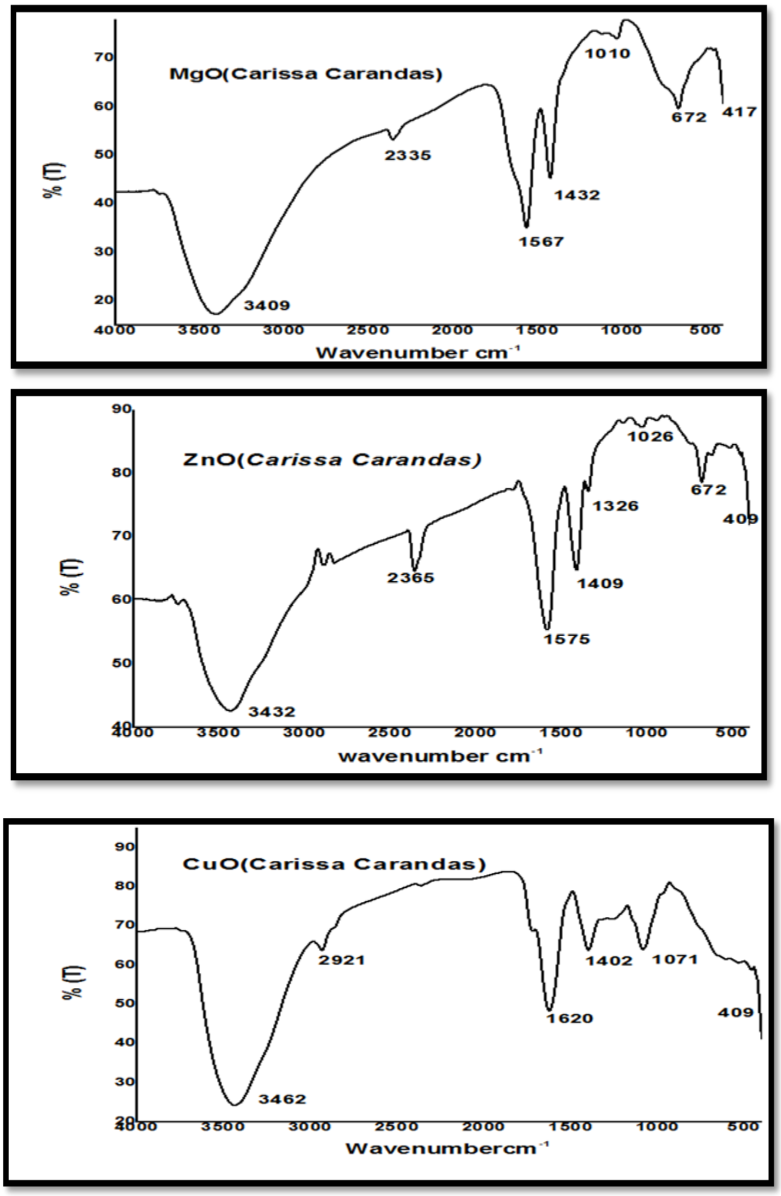


Fig 4. FTIR Spectrum of Bio-synthesized ZnO, MgO, CuO Nanoparticles

3.3 X-ray diffraction analysis

XRD pattern of synthesized metal oxide nanoparticles synthesized using *Carissa carandas* extract. The XRD pattern shows (Fig.5) a high crystallinity of sample level with diffraction angles of 23.4°, 27.9°, 35.3° and 44.3°, which correspond to the characteristic face centered cubic (FCC). ZnOhkl plane is (111), (220) and (220), (311). The MgOhkl plane is (200), (111), (002), (220), (222) and (311) and the CuOhkl plane is (110), (111), (202) and (114) respectively. The diffraction angle observed is related to the extract medium. The average crystallite sizes of the metal oxide nanoparticle using Redberry(Carissa carandas) extract can be estimated to be 5,7 and 4 nm (ZnO, MgO and CuO). Using Debye-Scherer Equation, The equation is written below:

$$D=K\lambda/\beta COS\theta$$

Where

K known as Scherer's constant (shape factor), ranges from 0.9 to 1.0

λis 1.5418 Å, which is the wavelength of the X-Ray radiation source,

β1/2 is the width of the XRD peak at half height and

θis the Bragg angle.

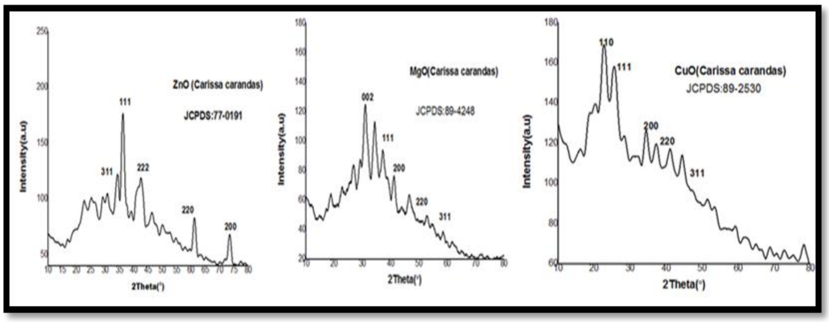
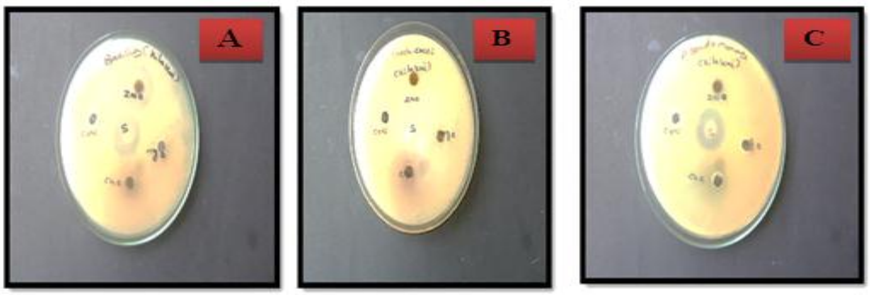


Fig 5. XRD spectrum, structure and size analyze of ZnO,MgO,CuO Nanoparticle

3.4 Antibacterial assays



Antibacterial activity of ZnO,MgO,CuO nanoparticles on (A) *Bacillus* and (B) *Staphylococcus aureus*(c)*P.seudomonos*

Table 1 Antimicrobial activity of the ZnO,MgO,CuONpssynthesized using *Carissa carandas*extract by Disc diffusion method.

SAMPLECODE(KILAKAI)	STAPH	PSEUDO	BACILLUS
ZNO	2mm	3mm	9mm
MGO	1mm	7mm	6mm
CUO	2mm	8mm	1mm

4. CONCLUSION

The present works represents an economical, non-toxic and eco-friendly method for synthesizing metal oxide nanoparticles. These metal oxide (ZnO, MgO, CuO) nanoparticles were initially confirmed by UV-Vis spectroscopy at 292,320,386 nm respectively. FT-IR analysis indicates the presence of phytoconstituents such as amine, aldehyde, phenol and alcohols. XRD analysis reveals that the average size of the nanoparticles was found to be 5,7 and 4 nm. The metal oxide nanoparticles synthesized via fruit extract are highly toxic to multidrug resistant bacteria (Fig.6, table-1) and due to its great potential it can be considered as one of biomedical application.

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