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Research Article

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Plant Based Biosynthesis and Characterization of Copper Oxide Nanoparticles from Phoenix Dactylifera and Murraya Koenigii

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Abstract

Background and Objectives: *Plants can be used in biological, inexpensive, and environmentally friendly nanoparticle production. Plant extract is utilized as a naturally occurring precursor. We used two distinct plants in our research, including Phoenix dactylifera seeds and Murraya koenigii leaves, both of which are widely accessible and simple to grow. Due to its ease of use, environmental friendliness, and affordability, its synthesis using green chemistry principles is becoming more significant as a source of next-generation antibiotics. The aqueous extract of Murraya koenigii (AE-MK) and Phoenix dactylifera (AE-PD) was used to create CuO nanorods (CuO NRs), which were then characterized using various analytical methods. Aqueous extracts of P. dactylifera and M. koenigii were combined in a 1:4 (v/v) ratio with 2 mM of CuSO4.5H2O solution, heated to 50°C, followed by washing and drying.*

Results: *Utilising several analytical methods, including scanning electron microscopy (SEM), transmission electron microscopy (TEM), and UV visible spectroscopy, the synthesized CuO NRs were subjected to characterization. The UV spectral investigation that confirmed the absorbance band at 360 nm and 310 nm served as a preliminary method of characterization. Copper oxide vibration was found by FTIR analysis at a peak at 628 cm. Clusters of agglomerated particles were found via TEM examination. However, using TEM, it was possible to see clear nanorods.*

Conclusion: *According to the findings, it is reasonable to assume that greenly synthesized CuO NRs will have potential uses in the area of nanomedicine.*

Keywords: CuO NRs, Copper Oxide nanorods, Scanning electron microscope: UV Spectrophotometer: *Murraya koenigii: Phoenix dactylifera.*

1. Introduction

As more and more commercial items, such as agrochemicals, paints, semiconducting materials, sensors, catalysts, and antimicrobial treatments contain copper nanoparticles, they are being released into terrestrial and aquatic environments at an increasing rate. The synthesis and application of nanoparticles (NPs) exploring their novel properties have attracted the attention of researchers from different branches of science and technology such as physics, chemistry, biology, engineering and material science. The different routes of synthesis include either bottom-up or top-down approaches. Due to its intriguing features, copper oxide (CuO) nanoparticles are regarded as one of the most significant transition metal oxides in the developing area of nanotechnology. Since materials that are synthesised at the nanoscale have different chemical and physical characteristics from bulk materials, nanotechnology has drawn more attention. As a result, applications in the fields of agriculture, medicine, and the environment may all use nanomaterials [1-4].

One of the most recent areas of interest in contemporary nanotechnologies and nanosciences is the use of biomaterials in the creation of nanoparticles. A growing amount of research is being done on environmentally friendly ways to create metal oxide nanoparticles (NP), with the aim of avoiding the potential risks of harmful chemicals for a clean and safe environment. The phytochemicals from Murraya koenigii leaves and Phoenix dactylifera seeds were used in this work to create copper nanoparticles (CuNPs). When the phytochemicals from

P. dactylifera and M. koenigii come into contact with Cu+2 ions, CuNPs instantly and spontaneously develop, as shown by the ocular observation of a colour shift from dark green to blue green. CuNPs were created under various circumstances, such as pH, temperature, concentration ratio, and duration, and were then examined using a scanning electron microscope (SEM), Transmission electron microscope (TEM) and by UV Spectrophotometer (UV). While SEM demonstrates the spherical yet agglomerated structure of CuNPs, UV-Vi's investigation reveals the surface plasmon resonance property (SPR) of CuNPs, revealing a distinctive absorption peak.

Extensive research on various nano-metals has been conducted in recent years to explore their applicability in many sectors in light of the increased characteristics of metals at nano-sizes. Ongoing research on copper oxide nanoparticles (CuONPs) is one example of this. Due to their distinctive thermal, optical, electrical, chemical, and biological capabilities, copper oxide nanoparticles have gained popularity as nanomaterials. (Devi HS, et al, 2014 and Bhattacharjee A, et al, 2016) [5]. Due to these characteristics, they may be used in a broad range of industries, such as the production of sensors, supercapacitors, storage devices, and infrared filters, as well as in the sectors of health and the environment [5, 6]. In this way, a few enhanced amalgamation techniques that include physical, chemical, and biological processes are gradually developing. Although the synthesis of CuONPs is more affordable than that of silver (Ag), gold (Au), and platinum (Pt) nanoparticles, creating their stable form is a difficult process. [7]. On the synthesis of CuONPs, several investigations have been conducted, including vapour deposition, electrochemical reduction, radiolysis reduction, thermal decomposition, and chemical reduction [8-11]. However, both the environment and people may be harmed by these tactics. Thus, the green chemistry approach employing biological materials like microorganisms and plants might be employed as a viable solution to synthesise the desired nanomaterials and solve the aforementioned issues [7].

The top-down strategy takes a path that uses physical synthesis. Chemical and biological synthesis pathways are included in the overall bottom-up strategy. Although there are several methods for creating interesting nanomaterials through chemical and physical synthesis, their usage has been constrained by time-consuming processes and the use of hazardous substances. Therefore, biologically derived materials have been utilized in green synthesis. Without employing hazardous and unnecessary chemicals, it is a lot safer, easier, more affordable, and more environmentally friendly technique that can be readily scaled up for large-scale synthesis. Additionally, phytochemicals and secondary metabolites found in biological materials like plants and microorganisms improve the stability of synthesised nanomaterial by acting as a capping [6, 10].

Experimental Design/Work Plan

Flowchart Representation of Work Plan

Green synthesis of copper oxide nanoparticles (CuONPs) from *Murraya koenigii* and *Phoenix dactylifera*

⇩

Characterization of copper oxide nanoparticles (CuONPs) from *Murraya koenigii* and *Phoenix dactylifera*

⇩

Copper oxide nanoparticles (CuONPs) formed

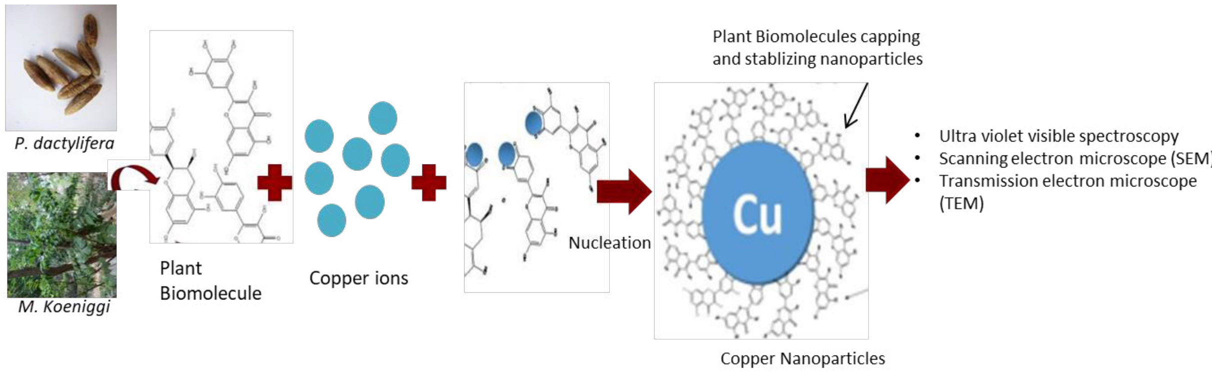

Figure 1: Flowchart representation of work plan

Green Synthesis and Characterization of Copper Oxide Nanorodss (Cuonrs) from *Phoenix Dactylifera* (Curry Leaves) and *Murraya Koenigii* (Date Seeds).

■ Synthesis from the aqueous extract of Phoenix dactylifera (Curry leaves) and Murraya koenigii (Date seeds).
■ haracterization using various analytical techniques:
• Ultra violet visible spectroscopy
• Scanning electron microscope (SEM)
• Transmission electron microscope (TEM)

2. Material and Methods
2.1. Materials
Both dimethyl sulfoxide (DMSO) and copper (II) sulphate pentahydrate (CuSO4.5H2O) were purchased from Sigma-Aldrich. The fresh leaves of M. koenigii (MK) and and seeds of P. dactylifera (PD) were taken from the CCS University, Meerut, and Department of Botany. Sodium Hydroxide and other chemicals were purchased from local vendors.

2.2. Methods
Preparation of an Extract: The fresh leaves of *M. koenigii* (MK) and and seeds of *P. dactylifer*a (PD) were procured from department of Botany. The leaves and seeds were thoroughly washed, crushed to a smaller particle size, and then extracted using the decoction process to produce a crude aqueous extract [12]. After crushing the leaves and seeds separately, the powder was saved to create the extract by decoction technique by boiling it in 90 ml of distilled water in a beaker while stirring with a magnetic stirrer heated at 50 °C for 15-20 minutes. Following stirring, strain the extract using a funnel and Whatman filter paper no 1, then allow it to cool to room temperature. To get rid of contaminants, the extract was centrifuged one more.

Green Synthesis of CuO NRs: The Mary, et al. methodology was used to synthesise CuO NRs with a few minor adjustments [13]. In a nutshell, aqueous extracts of M. koenigii and P. dactylifera (AE-MK and AE-PD) were combined with 0.2 M of CuSO4.5H2O solution in a 1:3 (v/v) ratio, and the pH was then adjusted to 11 by adding sodium hydroxide (NaOH) drop by drop. The solution was then heated at 50 °C until it became brown, perhaps indicating the production of CuO NRs. The solution containing the synthesised CuO NRs underwent three washings, each of which was followed by a 5000-rpm centrifugation for ten minutes. The pellet was then collected, dried, and kept at 4 °C until needed.

CuO NRs' Physiochemical Characterization: Several physiochemical characterization approaches were employed to support the production of CuO NRs.

UV-Visual Spectroscopy: By visualizing the peaks from a UV-Visible spectrophotometer (Motras Scientific; UV Plus) UV-Vi's spectrum scan from 200 nm to 800 nm, optical characteristics were examined.

Fourier Transform Infrared Spectroscopy: The sample was grounded with KBr pellets for the fourier transform infrared spectroscopy (FTIR) investigation, and it was examined on a Perkin Elmer (Model: Spectrum Two) with a spectrum recorded in the 400–4000 cm1 range.

Transmission Electron Microscopy: TEM analyses were done at Sophisticated Analytical Instrumentation Facility (SAIF), AIIMS New Delhi. To assess the size of the synthesized particles, a 200kV JEOL transmission electron microscope (TECNAI G20 HR-TEM) was used for TEM investigation. In order to prepare the sample for TEM examination, 20 L of CuO nanomaterial solution was added to a Cu grid, which was then dried at room temperature before being examined under a microscope at various magnifications.

Scanning Electron Microscopy: Sophisticated Analytical Instrumentation Facility (SAIF), AIIMS New Delhi's scanning electron microscope (ZEISS, Evo 18) was used to analyse the morphology of synthesised nanoparticles to determine their shape lattice and chemical composition. Microscopic imaging was then carried out from 1000X to 30,000X with 0.5-1m resolution at 15kV.

3. Result and Discussion

3.1. Green Synthesis of CuO NRs and UV-Vis Spectroscopic Analysis

The current work focuses on the quick green synthesis of CuO NRs from M. koenigii leaves and P. dactylifera seeds extract. Numerous investigations have indicated the existence of different bioactive substances in *M. koenigii* and *P. dactylifera*, including triterpenes, alkaloids, steroids, phenols, [14, 15]. The phenolic component of M. koenigii leaves and P. dactylifera seeds extract, which is known to have a strong reducing capacity, can be used to hypothesise and explain the process of CuO NRs production in the current work [16, 17]. It is widely known that plant extract contains flavanoids and phenols, which may aid in the reduction of Cu (OH)2 to CuO with a nanometer-sized particle size [18]. When the pH level is raised to between 11 and 13, the reaction's colour changes from blue to brown to black [19].

The colour variations may be explained in terms of the generation of copper (II) hydroxide (blue) by the interaction of copper (II) sulphate pentahydrate with sodium hydroxide, which then combines with secondary metabolites acid to produce dehydrogallic acid and copper(I) oxide (brown) [20].

Eq 1 $CuSO4.5H_2O + 2NaOH \rightarrow Na_2SO_4 + Cu\ (OH)_2 + 5H_2O$

Eq 2 $2\ Cu\ (OH)_2 + C7H6O5 \rightarrow Cu_2O + C_7H_4O_5 + 3H_2O$

But as the reaction progressed over time, copper (I) oxide was created, and ultimately CuO nanoparticles were created by a succession of subsequent reactions (Figure 2) [21].

Eq 3 $Cu2O + OH^- + H_2O \longrightarrow (Cu(OH)_2) + CuOH$

Eq 4 $2CuOH \longrightarrow Cu_2O + H_2O$

Eq 5 $2CuOH + O_2 \longrightarrow 4CuO + 2H_2O$

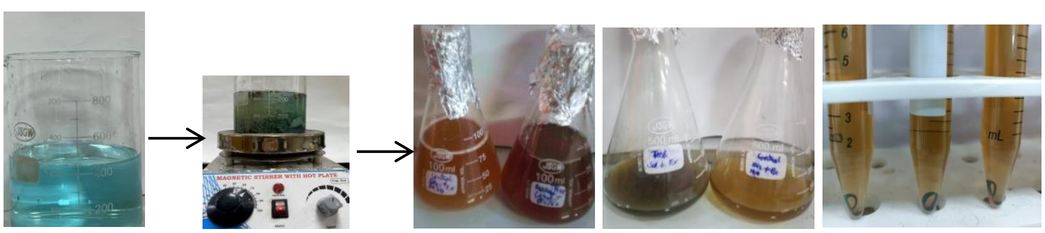

Figure 2: Sequential colour changes occur as CuO nanorods are being formed.

The existence of polyphenolics as an antioxidant source resulting from $\pi \rightarrow \pi^*$ transitions and the colour shift from dark green to brown owing to activation of surface Plasmon resonance suggested the production of CuO NRs [22]. Additionally, the absorption spectra obtained between 200 and 600 nm for both *M. koenigii* and *P. dactylifera* revealed a single absorbance peak at 360 nm for *M. koenigii* and 310nm for P. dactylifera that matched the typical absorbance band of CuO NRs, which was consistent with previously published research [20, 22-26].

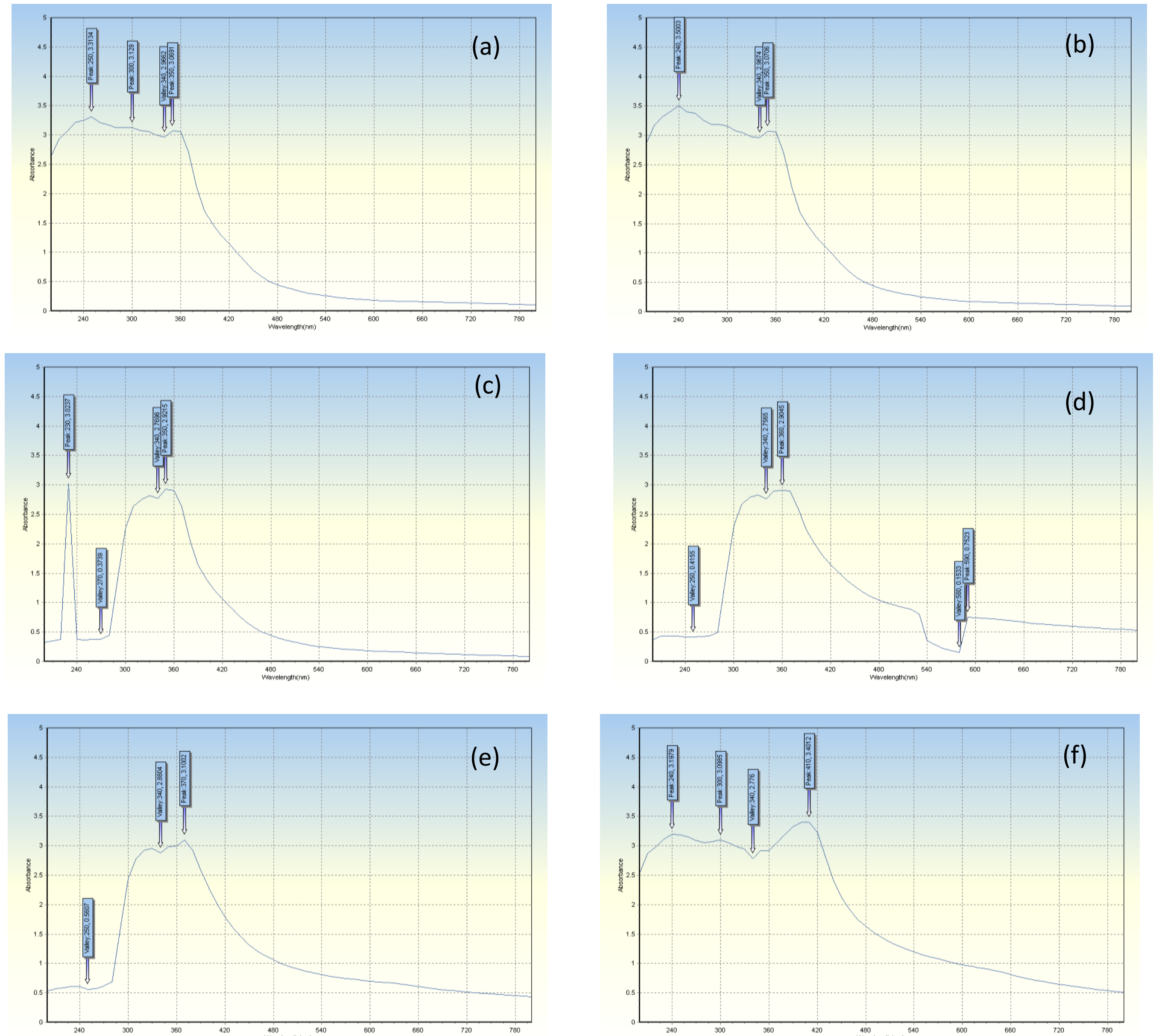

Figure 3: UV visible spectral analysis of CuO nanorods by *M. koenigii* shows from (a) – (f)

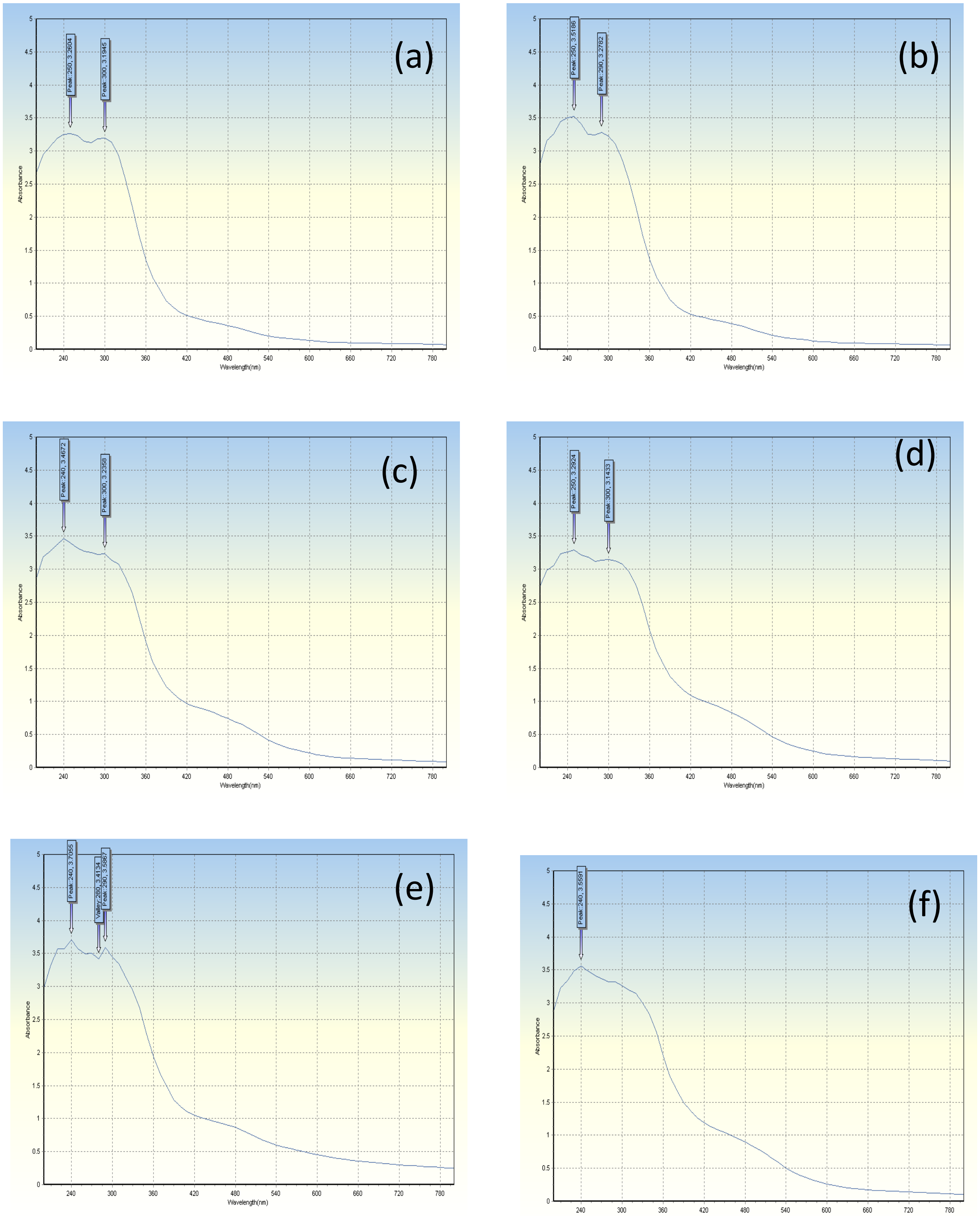

Figure 4: UV visible spectral analysis of CuO nanorods by *P. dactylifera* shows (a) – (f)

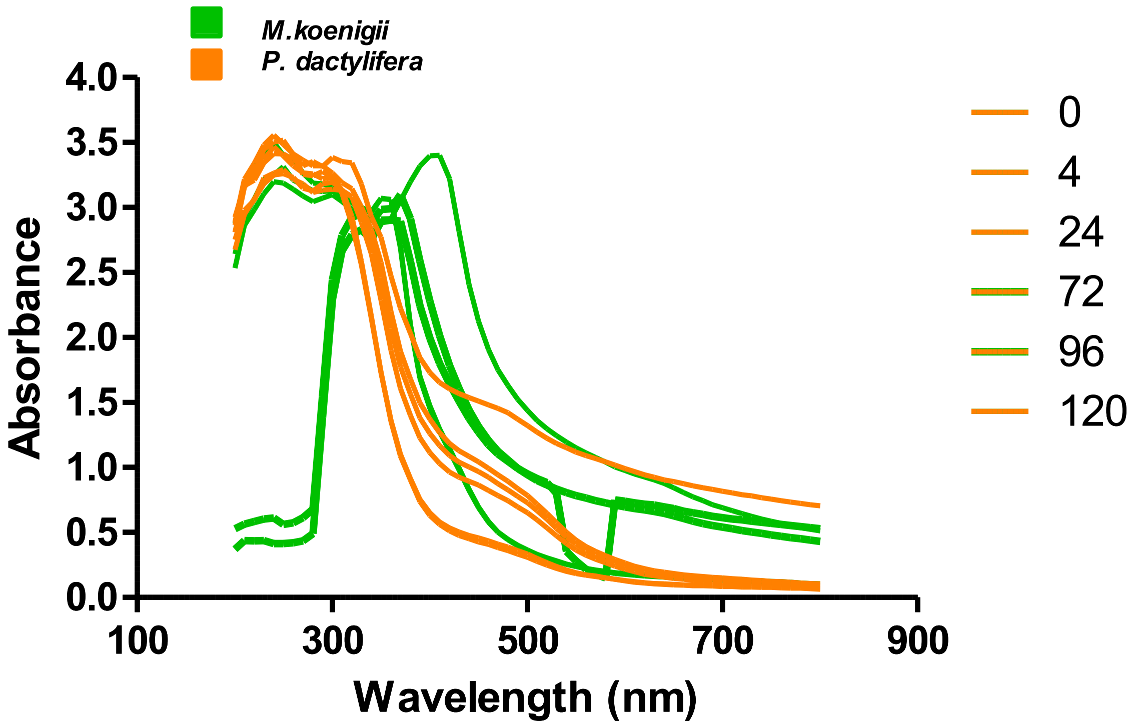

Figure 5: UV visible spectral analysis of CuO nanorods of M. koenigii (green) and P. dactylifera (orange).

TEM Analysis of CuO NRs

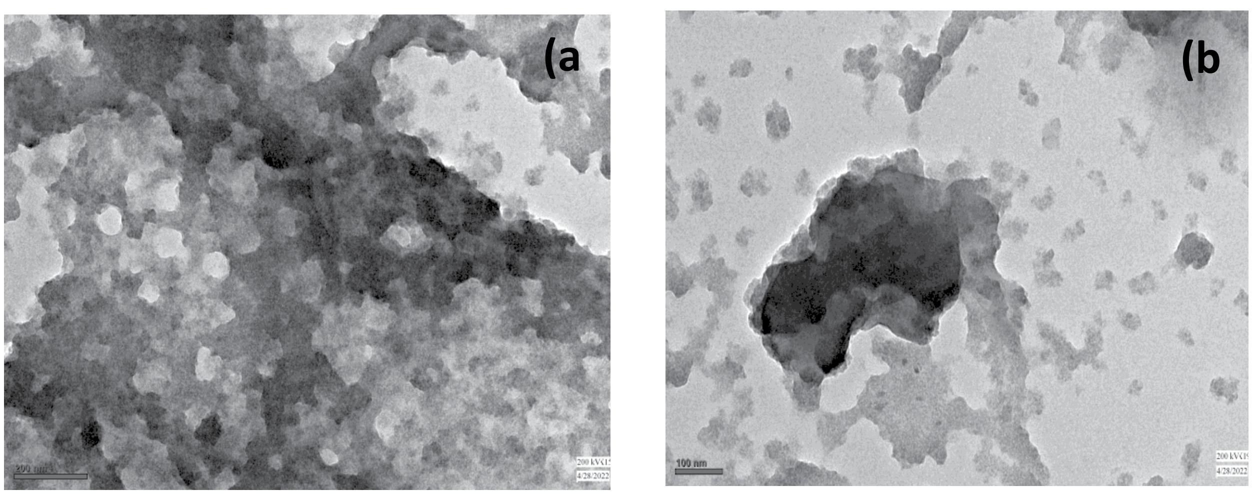

Figure 6: TEM analysis of CuO nanorods (a) *M. koenigii* and (b) *P. dactylifera*

Rod-Shaped Nanoparticles were Widely Disseminated, According to Tem Examination.

SEM Analysis of CuO NRs

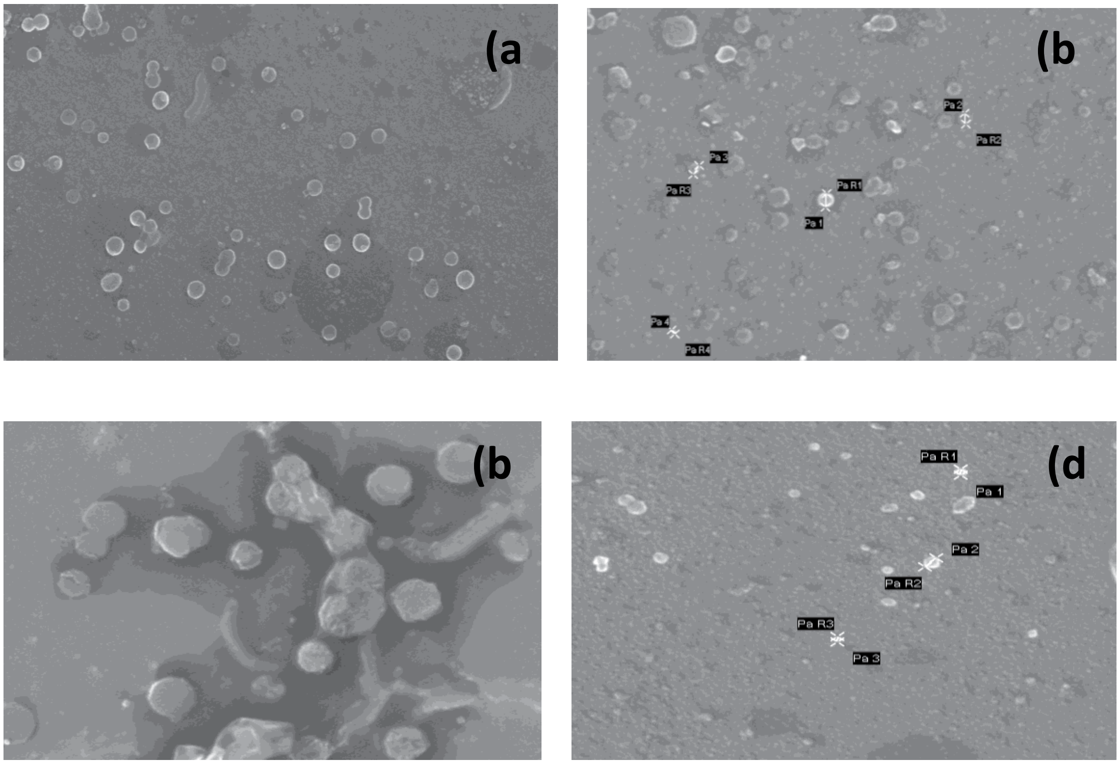

Figure 7: Sem Analysis Of Cuo Nanorods (a) *M. koenigii* and (b) *P. dactylifera*

Particles may be spherical, according to a microscopic sem study. As the particles displayed agglomeration and clumped to create clustered particles, it was unable to represent a distinct morphology.

4. Conclusions

M. koenigii leaves and *P. dactylifera* seeds extracts were used as a cost- and environmentally-friendly source for the extraction of CuO nanorods. Results from the UV-Vis and FTIR spectra indicated the presence of nanoparticles. The green synthesised CuO NRs have potential usefulness in the realm of nanomedicine and may be utilised to create specialised treatments for viruses, bacteria, and fungus.

Acknowledgements

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