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Biosynthesis of Nanoparticle by Curcumin using Raw Turmeric

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Abstract: *Nanotechnology is a developing field in biotechnology. The synthesis of nanoparticles is an important step in the field of nanotechnology. Overcoming the limitations of traditional methods, a green scheme for synthesizing nanoparticles has emerged. Plants and microorganisms are mainly used for the green synthesis of metal nanoparticles. Some of the nanoparticles showed strong antimicrobial effects against different plant pathogens. Compared with microorganisms, the use of plants to synthesize nanoparticles is on the rise, and has advantages compared with microorganisms, because plants have a wide range of bio molecular variability which can act as blocking agents and reducing agent thereby increasing reduction rate and stability of synthetic nanoparticle. This paper focuses on the use of microbial and plant sources to synthesize nanoparticle and their application in agriculture.*

Keywords: *Nanotechnology, Biosynthesis, Turmeric extract, Curcumin, Green synthesis, Pathogens.*

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Introduction:

Nanotechnology is an emerging field in area of research, especially in Biotechnology. In nanotechnology the construction management and use of materials range in nano-meters. Nanotechnology refers to the science and technology and benefit from as reported earlier (Rediguieri, 2009).

Nanomaterials are of interest from a fundamental point of view because with new materials, come new properties, which result in new opportunities for technological and commercial development, and applications of nanoparticles have been proposed in areas as diverse as microelectronics, coatings and paints, and biotechnology. From these applications has come the development of nanopharmaceuticals, nanosensors, nanoswitches, and nanodelivery systems (Kanaparthy and Kanaparthy, 2011).

It is commonly attributed for the technology of which matter is controlled in nanoscale materials at nanometre dimension (10^{-12} nm). In the field of herbal medicine and medicinal plant biology with the cross-development of nanotechnology. Scientific knowledge has been improved and technology has been advanced. Nanotechnology has many applications in different fields including medicine and agriculture. As reported by Khan and Rizvi (2014), in agriculture, Natural Science technology can be developed by using natural resources to protect produce, crops and moderate technology. No toxic chemicals, controlling plant disease, with nanotechnological products is an emerging application of nanotechnology. There are so many different types of methods which can be used to synthesize nanoparticles. These methods are chemical, electrochemistry radiation and photochemical methods, Langmuir and biological techniques. The chemical methods used to synthesize nanoparticles, often rely on toxic and hazardous substances, which can pose biological risks and in some cases these chemicals badly affect the ecological environment. This increases the demand for environment friendly developments through green synthesis. Utilizing plant-based material and extract for nanoparticle synthesis offers an ecofriendly and sometime more advantageous approach compared to traditional biosynthetic material which requires strict microbial culture conditions. Considering these points this paper aims to investigate biosynthesis of nanoparticle by Curcumin using raw turmeric and discuss their various applications.

Materials and Methods:

Materials: Turmeric powder, Organic solvents, ethanol, Reflux apparatus (round-bottom flask, condenser, heating mantle), Distilled water, Filter paper, Funnel.

Preparation of Curcumin:

Initially 10 grams of turmeric powder was weighed and transferred into a round-bottom flask. Organic solvent like ethanol in the amount of around 75–100 mL was poured into the flask. The flask was attached to a reflux condenser and placed on a heating mantle. The mixture of ethanol was heated at 78℃. It was then allowed to cool at room temperature after refluxing. The cooled solution was filtered to remove insoluble residues (turmeric fibres). The filtrate was then collected, which contained curcumin dissolved in the organic solvent. Afterwards the solution was centrifuged under 10,000 rpm (Revolutions per minute) for 15 minutes and then it was kept in vacuum oven for 2 days (Fig. 1). Curcumin was ready to be used in further nanoparticle synthesis as reported earlier by Kusumaningrum et al., (2022).

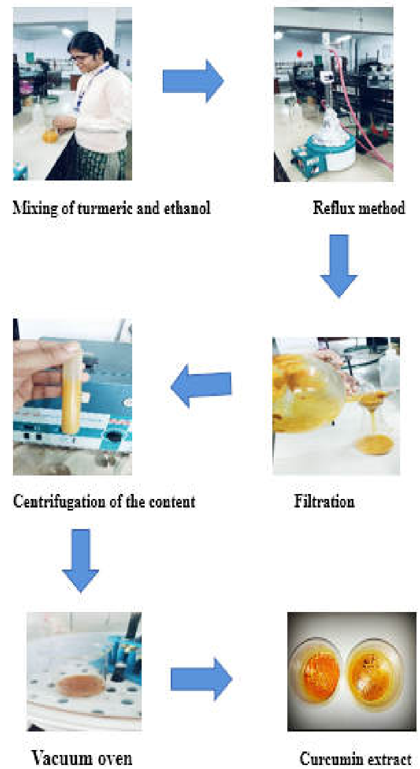

Fig. 1. Diagrammatic flowchart of method of preparation of Curcumin

Green synthesis of Zinc Oxide (ZnO) nanoparticle:

The synthesis of Green-ZnO nanoparticle were synthesised using the following steps:

A primary solution of curcumin was first prepared by dissolving it in ethanol concentration of 10 mM. This solution was then diluted with distilled water of concentration 0.2 mM. Separately a Zinc Nitrate (Zn $(NO_3)_2$) stock solution (0.5 mM) was prepared by dissolving it in 20 mL of ethanol. Then, 20 mL of curcumin solution was added to Zinc Nitrate and ethanol mixture. The two solutions were mixed at room temperature using continuous stirring at 200 rpm for 2 hours. The resulting ZnO nanoparticle was centrifugated at 10,000 rpm for 10 minutes followed by the filtration of the solution to remove any unreacted curcumin from the ZnO nanoparticle surface. The precipitate was washed thrice using distilled water. Finally, the purified nanoparticle was dried at 70°C for 24 hours in an oven as shown in Fig. 2. This methodology was followed according to El-Kattana et al., (2022).

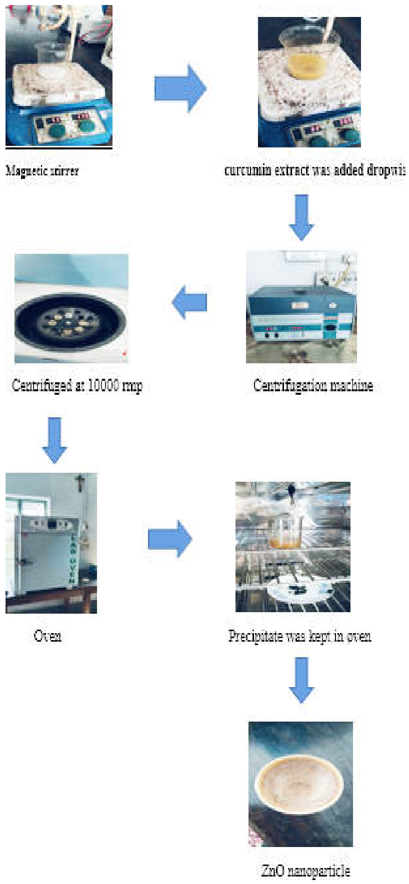

Fig. 2. Diagrammatic flowchart of Green synthesis of ZnO nanoparticle

Results and Discussion:

The nanoparticle was successfully synthesised by the green synthesis approach. Here Zinc Nitrate was used as precursor material and plant extract (Curcumin) was used as natural reducing and capping agent. The yield product was tested for its characterization by X Ray Diffraction (XRD) method, where X-ray is diffracted through particle crystal which is acting as a diffraction grating to form patterns.

The sharp peak in the graph shows the nanoparticles have crystalline nature (Fig. 3). The graphical representation of synthesized nanoparticles was similar to various other verified graphical observations given by other researchers on the same subject. This is confirmed by Arefi and Zarchi (2012).

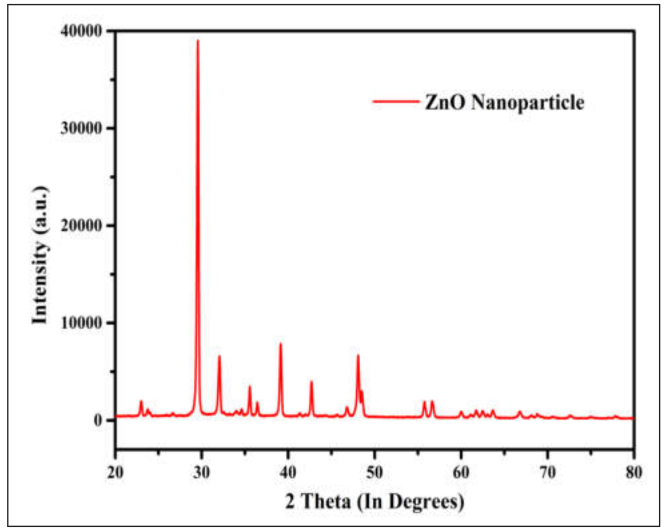

Fig. 3. XRD pattern of obtained ZnO nanoparticle

The size of the nanoparticle was calculated by using Scherrer Equation.

Scherrer equation relates the size of sub micrometre crystallites in solid to broadening of peaks in a diffraction pattern. It is used in the determination of size of the crystals in powder form.

Scherrer equation can be expressed as:

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

Where

D = Average crystalline size

K = Scherrer constant or shape factor (dimensionless)

λ = X-ray wavelength

β = full width at half maximum intensity (FWHM) of the peak

θ = Bragg angle

The peak value used for calculation:

$2\theta = 29.5°$

$\theta = 14.75°$

$\beta = 0.23196$

$K = 0.9$

$\lambda = 1.543$ nm

Using the above values in Scherrer's equation the value of D was obtained:

D = 35.4 nm

Hence, the Zinc Oxide nanoparticle was synthesised and the dominant peak was at $2\theta = 29.5°$. These peaks were consistent with the JCPDS (Joint committee powder diffraction) card no 36.1451. The crystallite size was 35.4 nm. The structure of ZnO crystal obtained was Hexagonal.

Conclusion:

Chemical and physical methods for nanoparticle synthesis face challenges when scaled up for industrial level production. These issues arise due to the use of harmful chemicals and toxic organic solvents which results in the creation of dangerous by-product and need high energy inputs.

Such a process may lead to increased nanoparticle reactivity and toxicity, posing to human health and environment due to uncertainty in their composition and behaviour. As a result, biological synthesis offers a safer and more sustainable alternative. It is environmentally friendly and does not pose any significant health threats to humans or animals.

References:

Arefi MR, Zarchi SR (2012). Synthesis of zinc oxide nanoparticles and their effect on the compressive strengths. International Journal of Molecular Sciences 13: 4340–4350

El-Kattana N, Emam AN, Mansour AS, Ibrahim MA, Abd El-Razik AB, Allam KAM, Riadi NY, Ibrahim SA (2022). Curcumin assisted green synthesis of silver and zinc oxide nanostructures and their antibacterial activity against some clinical pathogenic multi-drug resistant bacteria. *RSC Advances 12 :* 18022- 18038.

Kanaparthy R, Kanaparthy A (2011). The changing face of dentistry: Nanotechnology. Int J Nanomedicine 6:2799-804.

Khan MR, Rizvi TF (2014). Nanotechnology: Scope and application in plant disease management. Plant Pathology Journal 13: 214-231.

Kusumaningrum M, Ardhiansyah H, Putranto AW, Trihardini A, Kinanti PA, Masalahah DN, Harianingsih (2022). Turmeric Extration (*Curcuma longa L*) using Reflux Method and the Extract Characterization. JBAT 11(1) :85-91

Rediguieri C (2009). Study on the development of nanotechnology in advanced countries and in Brazil. Brazilian Journal of Pharmaceutical Sciences 45:189-200.