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A REVIEW ON PLANT EXTRACT MEDIATED BIOLOGICAL SYNTHESIS OF ZINC OXIDE NANOPARTICLES AND ITS ANTIMICROBIAL APPLICATIONS

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ABSTRACT: In present world nanotechnology is emerged with various applications. Zinc oxide nanoparticles have implementations in different fields such as environmental remediation, pharmaceutical, food and cosmetic industries. Rest of these implementations, zinc oxide nanoparticles are enormously applicable in catalytic activity, antibacterial, anticancer, antioxidant, antifungal, photo catalytic activity as well as active catalyst for organic transformation. So, the zinc oxide nanoparticles attracting focus of researchers towards it. Besides chemical and physical methods for synthesis of nanoparticles biological synthesis of nanoparticles gaining more weightage due to its environment friendly, sustainable and cost effectiveness. In green approach of NPs synthesis plant material provide reducing, capping as well as stabilizing agents and bring downs biological and environmental risk due to use of toxic chemicals. SEM, TEM, XRD, FTIR, EDS, UV-Vis spectroscopy etc. are some of the methods used for characterization of biosynthesized NPs. Biologically synthesized ZnONPs shows effective antimicrobial activity against pathogenic bacteria is also revealed in this review.

Key words: - Plant extract, Zinc oxide nanoparticles, antibacterial activity.

INTRODUCTION :

Nanotechnology can be considered as the science and engineering behind the design, synthesis, characterization, manipulation and application of nanoparticles. NPs ranges 1-100 nm, has greater aspect ratio i.e., greater surface area compared to their volume, so can possess physical properties such as uniformity, conductance, or special optical properties that makes them desirable in material science and biology. Due to extensive applications of metal/ metal oxide nanoparticles both physical and chemical approach used for its synthesis. However, physical-based method requires complex and expensive instruments and the chemical-based method employ toxic chemicals as capping agents which are environmentally hazardous and difficult to degrade. On the other hand, plant extract come up with various phytochemicals and biomolecules, such as vitamins, proteins, amino acids, polysaccharides, polyphenols, terpenoids, and organic acids which serves stabilizing properties in metal or metal oxide nanomaterial formation [1]. Biologically synthesized nanoparticles shows higher efficiency than physicochemical nanoparticles in biomedical applications [2]. Several studies shown that, higher applicability of biologically synthesized nanoparticles against human pathogenic bacteria compared with physicochemically derived nanoparticles [2].

Zinc oxide nanoparticles gained special interest of researchers in past decade due to its emmense applications in the field of biomedical

systems, electronics and optics [8]. The biological synthesis of ZnONPs by using plant extract attracted much attention due to its simple method, cost effective and environment friendly [10, 11]. Zinc oxide is considered to be the best photocatalyst in the degradation of organic pollutants present in the water due to its photosensitivity, low cost, and non-toxic nature [12]. Beside this zinc oxide have applicability in areas such as optoelectronics [13], food science, agriculture, cosmetics [15].

PLANT EXTRACT MEDIATED SYNTHESIS OF ZINC OXIDE NANOPARTICLES

Phytonanotechnology i.e., nanomaterial synthesis by using plant extract provides, ecofriendly, simple, stable and cost-effective method for nanoparticles synthesis and have advantages such as, biocompatibility, scalability and medical applicability, etc. [2]. The mechanism of nanoparticle synthesis is the reduction of metal salt and then capping and stabilizing the synthesized nanoparticles, which is carried out by the phytochemicals, and biomolecules present in plant extract [4]. Till date many plants are used for the synthesis of ZnO nanoparticles, some of them are *Calotropis procera* [6], *Aloe barbadensis* [7], *Anisochilus carnosus* [8], *Hibiscus subdariffa* [9], *Calotropis gigantea* [16], *Corriandrum sativum* [17], *Sargassum myriocystum*[18], *Acalypa indica*[19] ,*Vitex negundo*[20] , *Citrus paradise* [21] ,*Catharanthus roseus* [22], *Hibiscus rosa-sinensis* [23], *Ficus benghalensis* [24], *Cassia fistula* [25], *Cassia auriculata* [26].

The method of nanoparticles synthesis with plant extract is quite simple, easy and eco-friendly and for this reason plant extract mediated biosynthesis of nanoparticles gained much interest of researchers. The various ZnO nanoparticles were synthesized by combining zinc salt with plant extract. For the biosynthesis of nanoparticles first step is collection of plant material and its washing with distilled water. Then the thoroughly washed plant material must dry in shade. The dried plant material has to grind to make powder. The prepared powder is used for the extract preparation which is the source of reducing and capping agent for the nanoparticles synthesis and stabilization. Now few ml of plant extract combines with mM Zinc salt solution with constant stirring and heating which results in formation of nanoparticles [15]. Obtained paste then transfers for thermal annealing at 400-500^0 C resultant ZnO nanoparticles is used for further characterization such as SEM, TEM, XRD, EDS, UV-Visible spectroscopy, FTIR etc. and biological activities such as antimicrobial and anti-oxidant activity. The characterization has to be done for the identification whether nanoparticles synthesized or not and if synthesized which conformation and size it carries.

ANTIBACTERIAL ACTIVITY OF BIOSYNTHESIZED ZnO NANOPARTICLES

Study carried out by Anbuvannan et. al. [28] showed a comparative study of antibacterial activity of the *Emblica Officinalis* leaf extract and the biosynthesized Zinc oxide nanoparticles against bacteria *S. paratyphi, V. cholerae, S. aureus,* and *E. coli.* The finding showed that the leaf extract show less inhibition of bacteria compared with biosynthesized zinc oxide nanoparticles. N. Bala et. al. showed that ZnO nanoparticles inhibits the growth of both gram positive as well as gram negative bacteria [9]. The finding of M. Sundrarajan et. al. clearly revealed that the prepared ZnO nanocrystals using P. pinnata extract could be applied to the fabrics is an excellent antimicrobial activity [30].

CONCLUSION :

Increasing awareness towards green chemistry and use of biological way for synthesis of nanoparticles lead a desire to develop environment-friendly techniques. Benefit of synthesis of zinc oxide nanoparticles using plant extracts is an economical, energy efficient, cost

effective; provide protecting human health and environment leading to lesser waste and safer products. It is having with significant aspects of nanotechnology through several applications. Hence, in this regard; use of plant extract for synthesis can form an impact in coming diagnosis and treatments of different diseases. There is still a need for commercially viable, economic and environment friendly route to find capacity of natural reducing constituent to form ZnO nanoparticles which has not yet been studied.

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