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REVIEW

Lemongrass and Lemon Monometallic and Bimetallic Nanoparticles Synthesis and Their Applications

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Abstract
Nanotechnology has a lot of potential and versatility in various fields due to its special features and functions. Studies on nanotechnology have attracted a lot of attention, including those on nanomedicine and nano-absorbent to prevent, treat, diagnose, manage diseases, and degrade harmful substances. Metallic nanoparticles have great potential in this field due to their diverse properties, shapes, and sizes, which are significant to suppress microbial infections and degrade coloring toxic compounds. Among metallic nanoparticles, monometallic and bimetallic nanoparticles from biogenic plants have become intensively studied due to their effectiveness to cure infections and biofilms, treating cancer, improving dental and bone health, enhancing cardiovascular implants, speeding up wound healing, and wastewater treatment. In this review lemongrass and lemon of monometallic and bimetallic nanoparticles are comprehensively discussed focusing on the current synthesis, appearance, and the significant function of the monometallic and bimetallic nanoparticles in the health care and medicinal applications.

Keywords Successive method · Spherical · Size · Plant · Degradation

1 Introduction

Nanoparticles (NPs) have a wide range of applications particularly in the pharmaceutical industry [1] as antifungal [2], antibacterial [3, 4], biolabeling [5], hyperthermia [6], and in other industrial usages as anticorrosive [7], biopesticides, adsorbents, engine performance [8, 9], contaminants removal [10, 11], biofuels [12], lithium-ion batteries [13], water treatment [14], and food industry [15]. Due to their numerous properties and applications, the NP has gained wide interest and actively study. There are many types and synthetic approaches in the preparation of NPs.

Green synthesis *via* chemical methodology especially bio-reduction, electrochemical reduction and reduction approach is mostly preferred for NPs synthesis [16]. Among these synthetic approaches, bio-reduction is commonly reported because of the low cost, eco-friendly and simple reduction of plant extracts or plant-derived essential oils [16].

NPs have been classified into three categories. The first category is based on the shapes or structures such as micelles, liposomes, dendrimers, quantum dots and core shells. The second category is based on the synthetic method into physical, chemical and biological methods. The last category is based on the composition of NPs which are organic, hybrid and inorganic (Fig. 1). All these types of NPs have unique properties and wide applications. Due to the extensive research conducted on bioactive reducing agents, inorganic NPs have been the preferred choice for biogenic NPs compared to other types of NPs. Inorganic NPs, such as metal and metal oxide NPs, offer several advantages in terms of their physical and chemical properties [17].

Inorganic NPs contain metallic components such as aluminum (Al), cadmium (Cd), cobalt (Co), copper (Cu), iron (Fe), lead (Pb), silver (Ag), zinc (Zn) and gold (Au) [17–19] in their structures. Numerous applications in areas like biotechnology, magnetic separation, and gene transfer

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