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Utilization of Metallic Nanoparticles Obtained from Therapeutic Plants in Clinical Applications

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Abstract

Modern scientists are interested in the use of theranostics. Researchers have attempted to take advantage of theranostics' potential applications in a variety of fields in recent years. The development of complex diagnostic and therapeutic agents is the goal of the broad science of theranostics. It is also established that these cutting-edge systems can bridge the bio distribution and site specificity gap between imaging molecules and therapeutic agents when combined into a single platform. Nanotechnology is currently utilized in theranostics to deliver APIs to absorption sites, resulting in increased bioavailability. Through the use of MNPs, theranostics have been proposed to be effective in a variety of diseases, particularly cancer, malaria, microbial diseases, and cardiovascular diseases, in addition to the benefits previously mentioned. In addition, theranostics are important for personalised medicine because they can be made by identifying biomarkers. MPNs are one of modern medicine's most promising diagnostic and therapeutic entities due to their adaptability. The biosynthesis of MNPs from medicinal plants has recently increased significantly, which is important for the development of theranostics. Natural bioactive compounds come from medicinal plants, which are a reliable and necessary source.

Keywords: Microbial diseases • Cardiovascular diseases • Metallic nanoparticle

Introduction

Modern scientists are interested in the use of theranostics. Researchers have attempted to take advantage of theranostics' potential applications in a variety of fields in recent years. The development of complex diagnostic and therapeutic agents is the goal of the broad science of theranostics. It is also established that these cutting-edge systems can bridge the biodistribution and site specificity gap between imaging molecules and therapeutic agents when combined into a single platform. Nanotechnology is currently utilized in theranostics to deliver APIs to absorption sites, resulting in increased bioavailability. Through the use of MNPs, theranostics have been proposed to be effective in a variety of diseases, particularly cancer, malaria, microbial diseases, and cardiovascular diseases, in addition to the benefits previously mentioned. In addition, theranostics are important for personalised medicine because they can be made by identifying biomarkers. MPNs are one of modern medicine's most promising diagnostic and therapeutic entities due to their adaptability.

The biosynthesis of MNPs from medicinal plants has recently increased significantly, which is important for the development of theranostics. Natural bioactive compounds come from medicinal plants, which are a reliable and necessary source. Eighty percent of the world's population still relies on medicinal plants for primary healthcare and the creation of numerous medicines, according to reports. Digoxin, chloroquine, quinine, lumefantrine, atovaquone, aspirin, and artemisinin are just a few examples of the natural ingredients that are used in over 40% of pharmaceutical formulations at the moment. Metal nanoparticles are the primary material of nanoparticles (NPs), which are materials with a length of 100 nm. Significant advancements in nanomedicine have been made possible by the use of nanoparticles (NPs), particularly with regard to the reduction of dosing frequency, enhancement of drug solubility, and lengthening of some drugs' half-lives. This has led to positive changes in the delivery of targeted drugs.

In addition, it has been demonstrated that NPs are more selective and sensitive in the diagnosis of diseases, particularly cancer. The use of biosynthesized MNPs as nano-vehicles for the most effective drug delivery is one of the most recent developments in nanomedicine. As a result, research into the biosynthesis of MNP from medicinal plants is becoming increasingly popular as a new scientific discipline. Phytochemicals in medicinal plants can be used in place of chemical-reducing agents like sodium citrate, sodium borohydride, and ascorbate, which are extremely toxic, costly, and frequently harmful to the environment. In order to engineer MNPs, a variety of physicochemical methods have been used, including the economical use of medicinal plant parts like leaves, fruits, stems, roots, and seeds..

Literature Review

It has been demonstrated that phytochemicals found in plant extracts, such as polysaccharides, flavonoids, phenolic acids, and alkaloids, effectively reduce metal ions like Ag^{+}, $Cu2^{+}$, and $Au3^{+}$. During the formation of NPs, phytochemicals also play a significant role in their capping, stabilization, and chelation. Consequently, phytochemicals make excellent partners in MNP biosynthesis. Additionally, it is emphasized that the biosynthesis of MNPs with medicinal plants enhances the safety profile of theranostics agents by lowering expected toxicity. It has been reported that the traditional physical and chemical methods for making MNPs are more labor-intensive and toxic. In contrast, biologically-mediated synthesis, which makes use of a variety of biological systems like bacteria, fungi, and extracts from medicinal plants, has the potential to make large quantities of MNPs with particular sizes in a way that is safer and better for the environment. Not only are the current medicinal plant-derived MNPs the focus of this review, but also the theranostics' unmet needs are brought to light.

Green nanotechnology is derived from green chemistry, which aims to create appropriate phytoformulations. Phytochemicals derived from medicinal plants that are used in the green synthesis of mnps The ability of

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green nanotechnology to synthesize nanoparticles (NPs) and nanoproducts has made a significant contribution to environmental sustainability. The use of medicinal plants to make nanoparticles is interesting because they are easy to find and have a wide range of metabolites that are needed to make NPs. In this way, medicinal plants are used in green nanotechnology to make nanomaterials like MNPs, which could help diagnose and treat a variety of diseases. MNPs derived from medicinal plants are safer and less expensive to use. In addition, the literature suggests that plant-derived MNPs can be shaped and sized to meet formulation requirements. Despite the benefits of using MNPs derived from plants, their safety profile remains questionable. Due to their low biocompatibility, MNP formulation in the desired medium is challenging. Additionally, some MNPs may cause cumulative toxicity due to their poor biodegradability.

Because they consistently supply a variety of chemical entities necessary for MNP biosynthesis, medicinal plants play a crucial role in modern medicine. Alkaloids, flavonoids, saponins, tannins, phenols, and terpenoids from medicinal plants are used to synthesize MNPs. These substances interact with NPs by reducing MNPs and serve as reducing, capping, and stabilizing agents. In this regard, phytochemicals that can be combined with MNPs to manage diseases are the subject of research. In the green synthesis of MNPs, leaves, flowers, roots, stem bark, and fruits are frequently added to an aqueous solution of metal ions to begin the biosynthesis process [1-4].

Discussion

Organic acids, flavonoids, terpenoids, and other phytochemicals found in medicinal plant extracts are mostly used as stabilizing and reducing agents. By preventing NP agglomeration, caps are known to stabilize NPs. Additionally, the morphology of nanostructures is significantly impacted by capping agents. In addition, it has been hypothesized that the van der Waals interaction, the capillary interaction, and the hydrogen bond effect are all influenced by phytochemicals used as capping agents' molecular weight (MW). A reducing agent is used to transform metal ions into nanometal during the synthesis of nanoparticles, particularly MNPs. A thorough understanding of raw materials like plant extracts, particularly in relation to their synthesis into nanometals, is necessary for the biosynthesis method. Lastly, reducing, capping, and stabilizing agents have significantly increased in use in biosynthesis-based MNP synthesis. When choosing the best organisms for extract synthesis, the metabolic pathways, phytochemical content, enzyme activity, cell proliferation, and appropriate reaction conditions must all be taken into consideration.

In order to compete with the well-established hazardous methods that primarily make use of toxic materials, there is an urgent requirement for environmentally friendly, dependable, and clean methods. Consequently, eco-friendly nanoparticle manufacturing techniques utilizing microorganisms, marine algae, and extracts from medicinal plants have emerged. The synthesis of MNPs like AgNPs now has a better platform thanks to biological methods. The green synthesis method has the most advantages over the chemical and physical approaches because it is less expensive, better for the environment, and easy to scale up for large-scale synthesis without using energy, high pressure, high temperature, or dangerous chemicals.

Metallic Nanoparticle Synthesis (MNPS) During nanoparticle synthesis, the method of preparation for MNPs is crucial. Techniques for physical and chemical synthesis are known to be toxic, and when MNPs are synthesized and stabilized, a lot of expensive compounds are used, which can harm the environment. The morphology, stability, and physicochemical properties of MNPs are significantly influenced by a variety of experimental methods, as well as the kinetics of the metal ion interaction with a reducing agent and MNP absorption. The synthesis of MNPs involves a variety of approaches, which can be broken down into two broad categories: top-down and bottom-up approaches. Physical methods like pulverization are used in the top-down approach to break down bulk matter until it is the size of a tiny nanoparticle. Chemical reduction builds up matter of the size of small atoms until NPs are synthesized using a bottom-up method [5-8].

In the physical and chemical synthesis of MNPs, the breakdown technique (top-down) is frequently utilized. The top-down approach, also known as the mechanochemical method, uses physical forces like grinding and pulverization to shrink bulk materials before they reach the nano scale. The coalescence or assembly of atoms by atom, molecules by molecules, and clusters by clusters are examples of bottom-up strategies that produce a yield with a wide variety of NPs. Chemical nano structural precipitation, laser pyrolysis, plasma or flame spraying, sol-gel processing, chemical vapour deposition (CVD), self-assembly of both monomer and polymer molecules, and bio-assisted synthesis are all methods utilized in the synthesis of NPs.

Conclusion

In general, the diagnostic application of MNPs derived from medicinal plants appears to be in its infancy. MNPs derived from chemical and physical synthesis have been used in the majority of studies, but little is known about their potential use as diagnostic tools in plants. To demonstrate the self-fluorescence capabilities of Ag-Cu nano composites in microbial cells, Olax scandens was studied. The authors came to the conclusion that Ag-Cu nano composites produced red fluorescence in bacterial cells, whereas untreated cells produced no fluorescence. For instance, the distinct characteristics of MNPs' surface plasma resonance (SPR) properties have sparked a lot of interest. In MNP SPR, important factors include the particle's size, shape, composition, optical properties, internal particle interactions, and dielectric properties of the surrounding fluids. The SPR of metal nanoparticles can be adjusted from UV to near-infrared (NIR), which makes them useful for bio sensing.

Acknowledgement

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Conflict of Interest

No potential conflict of interest was reported by the authors.

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