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Green Nanotechnology Innovations in Methodology and their Applications in the Biological Synthesis of Herbal Nanoparticles

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A B S T R A C T

Nanoparticles often have one or more dimensions and a size range of 1 to 100 nm. In general, nanoparticles are categorized into three groups: inorganic, organic, and carbon-based particles. These groups have better properties than their corresponding larger-size counterparts. They exhibit enhanced qualities like strength, Because of their smaller size, they have more sensitivity, high reactivity, stability, surface area, etc. They were created by a number of Techniques that fall into three categories for both commercial and research applications: chemical, physical, and mechanical Procedures that had significantly improved. This paper is a review that we have prepared on nanoparticles. Their kinds, descriptions, synthesis techniques, and environmental applications.

Keywords: Nanotechnology, curcumin, Classification of Nanoparticles, Different Techniques Of Nanoparticles

1. Introduction

Nanotechnology is the study of the controlling the matter on an atom and molecular scale. Generally, nanotechnology deals with structures sized between 1-100 nanometers in at least one dimension, and involve modifying or developing materials within that size. It makes the material lighter, stronger, faster, smaller and more durable. Nanotechnology obligates the ability to frame components of molecular size and precise machine. Modern science based on the unifying features of nature at the nano scale contributes a new foundation for innovation, knowledge, and integration of technology.

1.1 Application of Nanotechnology:

Sustainable products with a natural bent.

Contamination materials remediation.

NPs put environmental decontamination sensors into place.

Nanomaterials such as nanocrystals and nanoparticles can be used directly to create advanced and powerful devices attributed to their distinctive properties. The benefits of nanomaterials could potentially affect the future of nearly all industrial sectors [1].

1.2 Nanoparticles:

Objects that are smaller than bulk material, with sizes ranging from 1 to 100 nm, are known as nanoparticles (NPs). The last ten years have seen a huge increase in interest in the production of nanoscale materials, particularly metallic nanoparticles (NPs) because of their special properties. The term "natural" describes both the component of the process and the type of materials used. To fully realize the potential of these alternatives as a sustainable resource for naturally occurring NP production, more research is required. Sulfur dioxide also produces hydrogen sulfide (H2S).

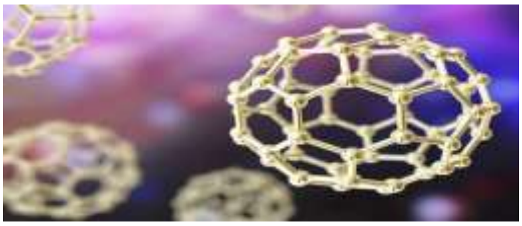

Figure 1: Structure of Nanoparticles

1.3 Classification of Nanoparticles:

In general, nanoparticles are divided into three categories: carbon-based, inorganic, and organic.

- Organic Nanoparticles:

Dendrim, micelles, Ferritin And liposomes, among other things, are widely recognized N polymers Natural nanoparticles. The non-toxic nature of these nanoparticles Biodegradable, and certain particles—like liposomes and Micelles, sometimes referred to as nano capsules, have a hollow core. And show sensitivity to Electrical and mechanical Radiation from sources like heat and light. [2] What's organic The biomedical field is where nanoparticles are most commonly utilized. Field, such as the current drug delivery systems Effective and can be injected into particular regions of the Body, a technique also referred to as targeted medication delivery.

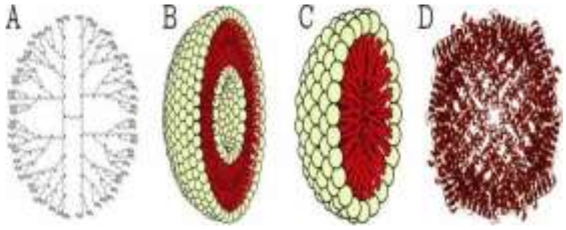

Figure 2: Structure Of Different Type of Organic Nanoparticles

Carbon- based Nanoparticles:

Carbon nanotubes (CNTs) and fullerenes are the two primary constituents of carbon-based nanoparticles. CNTs are only made of graphene. Rolled up into a tube form. The primary use for these materials Considering the structural reinforcement, given their 100-fold More robust than steel. There are two types of carbon nanotubes (CNTs): single-walled (SWCNTs) and multi- walled Nanotubes of carbon (MWCNTs). With CNTs, there is a Due to their lengthwise thermal conductivity And non-conductive throughout the entire tube. The fullerenes are Carbon allotropes with a hollow cage structure Sixty or more atoms of carbon. The C-60's structure is Known as Buckminsterfullerene, and has a hollow appearance. Soccer. These structures' carbon units have a hexagonal and pentagonal configuration.[3]

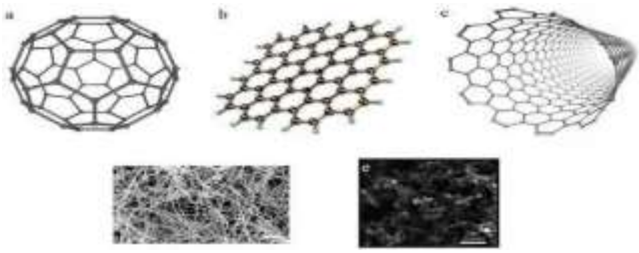

Figure 3: Structure Of Different Carbon-Based Nanoparticles

2. Curcumin

Turmeric, or Curcuma longa, is a rhizomatous herbaceous perennial plant that is used in traditional medicine to treat, prevent, and manage a wide range of illnesses, including diabetes, cancer, arthritis, psoriasis, inflammation, hepatobiliary diseases, gastric and peptic ulcers.

Figure 4: Structure Of Curcumin

Family: Zingibaraceae

Scientific name: Curcuma longa

3. Different Techniques Used In Curcumin Nanoparticles

- Single. Emulsion-Solvent Evaporation Technique.
- Thin Film Hydration Method.
- Micro Emulsion Method.
- Desolvation Method.
- Agitation and Sonication Method.
- Single Emulsion Solvent Evaporation Technique:

The single emulsion solvent evaporation method was used to create curcumin-loaded nanoparticles. To take a glass tube, dissolve 100–200 mg of PLGA polymer in 5 ml of dichloromethane (DCM). Next, dissolve 10–20 mg of curcumin powder in the solvent mixture and vortex intermittently for 30 minutes. As the glass tube holding 10 milliliters of an aqueous PVA solution was filled with a drug/polymer mixture. Afterwards, The drug/polymer mixture into the PVA solution, then vortex at a high speed for an additional 10 seconds. This resin Using a probe sonicate, the mixture was emulsified in an ice water bath for seven minutes at 40% amplitude. As this30 milliliters of 0.5% aqueous solution were filled with the emulsified mixture while being stirred by a magnet. Using strong magnetic stirring and 800 rpm, dichloromethane was evaporated.[18].

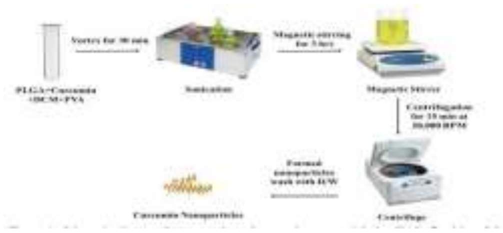

Figure 5: Single Emulsion Solvent Evaporation Technique

Thin Film Hydration Method:

A thin film hydration technique was used to create the drug-loaded lipid nanoparticles. This method involves mixing lipid phosphatidylcholine, cholesterol, and curcumin with methanol to achieve the required ratio. The solvent mixture is then evaporated under low pressure using rotatory evaporator apparatus. At 70 rpm for 15 minutes at 45°C. Elements in the solvent mixture are extracted using a vacuum. Pumping for three to four hours before the thin film form lastly, a thin layer of lipid nanoparticles loaded with drugs is hydrated for one hour using pH 7.4 phosphate. Buffering techniques. This mixture of lipids is subjected to probe sonication and filtered through a 0.45 µm membrane. Drug-loaded lipid nanoparticles are created, filtered, and then stored at 4°C. [19].

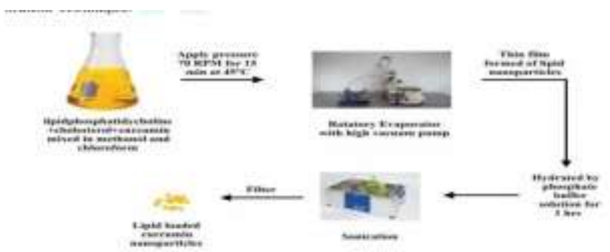

Figure 6: Thin Film Hydration Method

Micro Emulsion Method:

The micro emulsion method is used to prepare the Curcumin nanostructure lipid carriers (NLC). A sonicate is used in this procedure. Once the lipids of plutonic F127 and steric acid (SA) and capric triglycerides (CA) have melted, the surfactants tween 80 and plutonic F127 are added until the mixture becomes clear. One milliliter of additional distilled water, non-ionic surfactants, and melted lipid solution are heated to 75 degrees Celsius. Carrying out constant stirring while incorporating curcumin. Add the created emulsion to cold water between 2 and 4°C.Afterwards, they are homogenized for five minutes at 8000 rpm after they have solidified. And lastly, okay Lipid carriers containing distributed curcumin nanostructure are formed. Lipid-loaded Curcumin schematic diagram Nanoparticles through Micro-emulsion.[20].

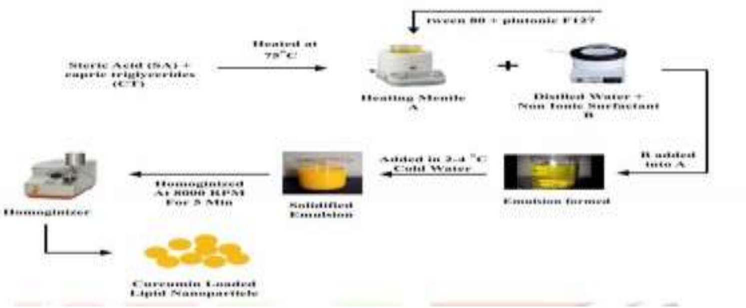

Figure 7: Micro Emulsion Method

Desolvation Method:

Using the desolvation technique, curcumin nanoparticles are produced. This method prepares cur cumin polysaccharide nanoparticles using an aqueous polysaccharide solution of ethanol precipitation. Fundamentally, curcumin serves as the active ingredient and pure ethanol as a dissolver.0.1% tween 20 emulsifying agent and a predetermined concentration of absolute ethanol ae used.5 mg/ml of chitosan and 0.1% tween 20 should be dissolved in deionized water with constant stirrer ng for an hour at90 °C. Next the chitosan solution is gradually mixed with dropwise additions of the absolute ethanol dissolving agent under combining at 70 degrees. The suspension of formed nanoparticles is centrifuged for two minutes at 10,000 rpm. Upon large particles using centrifugation, collecting the supernatant, and then centrifuging at 15,000 rpm for fifteen minutes later [21].

Figure 8: Desolvation Method

Agitation and Sonication Method:

Two techniques—agitation and sonication—are used to produce curcumin nanoparticles. Through the agitation method, 100 ml of this solution is added after 0.05g mL−1 of curcumin is added to ethanol. Amount of deionized water that has been preset. Next, at 200–1000 rpm for two hours at 50°C, this solution is stirred. The powder of curcumin is obtained by lyophilizing this solution after it has been stirred. Particles in nanoscale. Narrow-ended agitation (NEA) is the method used to extract the nanoparticles from ethanol. During the Sonication process, 0.10 gmL−1.Ethanol and 100 milliliters of this mixture are added after adding the mixture to the curcumin. In an exact volume of deionized water. This mixture was then sonicated for two hours at 50°C using 120W of power. Next Sound amplification lyophilized [22].

Figure 9: Agitation and Sonication Method

3.1 Clinical Importance Of Curcumin Nanoparticles:

3.1.1 Antimicrobial Activity:

A significant number of human infections are caused by microorganisms. To destroy bacteria, fungus, viruses, and protozoa, a wide variety of synthetic and natural substances were employed as antimicrobial agents. Turmeric has long been employed as an antimicrobial. Since curcumin nanoparticles are known to have stronger antimicrobial activity than regular curcumin, they were utilized. [23] Wet-milling-prepared nanocurcumin has been shown to have antibacterial and antifungal properties by Bhawana et al. Without any surfactants, the nanocurcumin was more water soluble and exhibited high antibacterial activity against Staphylococcus aureus, Bacillus subtilis, Escherichia coli, Pseudomonas aeruginosa, Penicillium notatum, and Aspergillus Niger.

3.1.2 Anticancer activity:

Throughout the world, cancer is the most frequently diagnosed and devastating disease. Adverse side effects are a result of traditional treatments like radiation therapy, chemotherapy, and surgery. To treat this cancerous illness, it is therefore imperative to develop safer and more effective treatment methods. Nowadays, new medications are discovered by using natural sources like plants. There are several pharmacological compounds found in plants that are thought to be non-toxic and capable of saving lives when applied to different forms of cancer. Curcumin is a plant-based product used to treat a wide range of cancers, including ovarian, breast, prostate, pancreatic, and skin cancer. By controlling several significant cellular signalling pathways, these effects are mediated. Particularly recently, curcumin nano formulations that were more bioavailable, soluble, and targeted to particular tumour cells were employed.

3.1.3 Anti- HIV activity:

HIV, or human immunodeficiency virus, targets and kills CD4+ T cells to compromise the immune system. Acquired immunodeficiency syndrome is ultimately caused by a progressive breakdown of immunity (AIDS). White blood cells known as CD4+ T cells are responsible for defending the body against infections. The antiretroviral medication suppresses the virus, but it hasn't entirely eradicated it yet. Therefore, to treat this deadly condition, an alternative therapy must be found. Curcumin-loaded apo transferrin nanoparticles made with the sol-oil technique were found to be highly effective in preventing HIV-1 replication through transferrin-mediated endocytosis, according to Gandapu et al. HIV-infected cells typically express transferrin receptors. Apo transferrin nanoparticles loaded with curcumin bind to the receptor in a particular way and transfer the medication inside the infected cell. The medication is gradually released, and the viral cDNA [24].

3.1.4 Antimalarial activity:

Female Anopheles mosquitoes transmit malaria, a disease caused by parasites. Dandekar et al.'s in vivo investigations on hydrogel nanoparticles loaded with curcumin demonstrated antimalarial activity. The toxicity tests validated the nano formulations' cytotoxic effects and oral safety [32]. By preventing the synthesis of hemozoin, chitosan nanoparticles loaded with curcumin were able to cure Plasmodium yoelii-infected mice [25].

3.1.5 Anti- Inflammatory Activity:

Turmeric has been used as an anti-inflammatory in traditional Indian medicine. In rats, Rocha et al. evaluated the anti-inflammatory properties of nanocurcumin and regular curcumin. The enhanced anti-inflammatory activity of nanocurcumin was demonstrated by the inhibitory effect it displayed at 50 mg/kg, which was comparable to that of standard curcumin at 400 mg/kg [26]. The effectiveness of curcumin-encapsulated exosomes in a lipopolysaccharide-induced septic shock mouse model was investigated. Curcumin delivered by exosomes in that experiment showed greater stability and target specificity, and blood levels of them were high [27].

4. Conclusion

Herbal medicine is the oldest form of health care known to mankind. It is an integral part of the development of modern evaluation. Nanotechnology is an innovative idea that can be used to overcome the problems associated with curcumin solubility, stability and bioavailability. In this review, the various methods of preparation of curcumin nanoparticles and its advantages and drawbacks are discussed. However, most of the known activities of curcumin are based only on in vitro and in vivo studies. Curcumin has yet not been approved for treatment of any human disease. Therefore, more extensive and well-controlled human studies are required to demonstrate this polyphenol's safety and efficacy. Future research should be focused on bringing this fascinating molecule to the forefront of therapeutic agents for the treatment of human diseases.

5. Future Perspective

For medicinal purposes, curcumin has been given broad-spectrum importance. The usefulness of curcumin as a therapeutic candidate when nanotechnology is used to alter its physio-chemical properties was detailed in a thorough analysis of the current review report. It has already been mentioned that the pharmacokinetic behaviour of this natural ingredient has allowed it to operate in a broad area. Since all substances have limitations, there are already mentioned disadvantages in this instance as well. In order to declare it an effective drug delivery agent, a number of issues and challenges remain unanswered. This review focuses on how traditional processing techniques have gradually changed over time and how they have been updated to accommodate nano formulation. Techniques including phase reversion and freeze-thawing are covered.

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