

# A Compressive Review On: Nano-technology in Herbal Medicines

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**Abstract**—Herbal remedies have been utilized for many years all throughout the world, but they are particularly popular in India. Because herbal remedies may treat a variety of illnesses with fewer adverse effects, their use has grown. Herbal remedies have been utilized for many years all throughout the world, but they are particularly popular in India. Because herbal remedies may treat a variety of illnesses with fewer adverse effects, their use has grown. To address a number of limitations, including low bioavailability, in vivo stability, water insolubility, intestinal absorption, and an unspecific site of action, the development of innovative drug delivery systems (NDDS) is crucial. The potential of herbal medications to cure chronic illnesses like cancer and devastating diseases is enhanced by the incorporation of nanotechnology as an NDDS in traditional medicine. Depending on the characteristics of the nanoparticles, new techniques including polymer, magnetic, and metallic nanoparticle production can be used. The characterization of the nanoparticles to ascertain the toxicity profiles for their physical and chemical characteristics would be made possible by the latest technologies. The creation of nanoparticles, their characterisation using different manufacturing methods, and the potential effects of nanotechnology on intelligent herbal medications will all be briefly covered in this review paper. A unique approach to drug distribution that overcomes the drawbacks of conventional drug delivery methods is known as a novel drug delivery system. The potential of the extensive Ayurvedic knowledge base in our nation has only just come to light. However, the herbal medication is administered to the patient via an antiquated and conventional drug delivery method, which reduces the medication's effectiveness. The effectiveness and adverse effects of different herbal compounds and plants may be improved if the new drug delivery technology is used in herbal therapy.

**Index Terms**—Nanotechnology, polymer nanoparticles, metallic nanoparticles, magnetic nanoparticles, Scanning electron microscope.

## I. INTRODUCTION

One of the traditional medicinal practices in India is Ayurveda. Physicians and patients have acknowledged the potential therapeutic benefits of herbal remedies, as well as the fact that they have less adverse effects than other medications while also increasing the medication's bioavailability. Due to processing challenges and a lack of scientific support, herbal medicines were long disregarded for the creation of innovative formulations.[1][2] The future of medicine is anchored in the past, before pharmaceutical firms attached our collective health to what has become a multibillion-dollar wagon, and before scientists set out to create synthetic silver bullets for all those illnesses. Almost all medications used in the past came from plants, which for a very long time served as man's only source of chemicals. The popularity of herbal remedies can be attributed to three basic factors:

- 1) Concerns over the safety and dependence on medications and surgery are becoming more prevalent.
- 2) Many of the most prevalent medical disorders are not being adequately treated by modern medicine.
- 3) Numerous natural remedies have been demonstrated to outperform medications or surgery without the negative side effects.[3]

The delivery mechanism of a medication might have a significant impact on its effectiveness. greatest benefit is obtained, and concentrations inside or outside of this range may be hazardous or generate absolutely no therapeutic benefit. However, the extremely sluggish improvement in the effectiveness of treating severe

illnesses has shown an increasing demand for a multidisciplinary strategy for delivering medications to tissue targets. This led to fresh concepts for managing the pharmacokinetics, pharmacodynamics, immunogenicity, non-specific toxicity, and bio- Drug efficacy and recognition were produced. These fresh Drug delivery systems (DDS) are solutions that are based on multidisciplinary methods that include polymer science, Molecular biology, bioconjugate chemistry, and pharmaceuticals [4] Nanoparticles are regarded as one of the most significant NDDS. Herbal remedies may be targeted to specific organs using nanoparticles, which enhance the medication's efficacy, safety, and tailored drug delivery. To put it another way, nanotechnology is the engineering and production of materials at the molecular and atomic levels. Notwithstanding the size constraint, nanotechnology is frequently used to structures as small as a few hundred nanometers. It is the application and modification of materials at a small scale. Atoms and molecules function differently at this scale, offering a range of unexpected and fascinating outcomes. It offers chances for the creation of materials, such as those used in medicine, where traditional Techniques could have their limits. [5]

Advantages of nanoparticles:

- Benefits of Nanoparticles
- Below are some notable benefits of nanoparticles:
- Increased bioavailability,
- Dose proportionality,
- Reduced toxicity,
- Smaller dosage form,
- Less fed or fast variability

## II. NOVEL DRUG DELIVERY APPROACHES

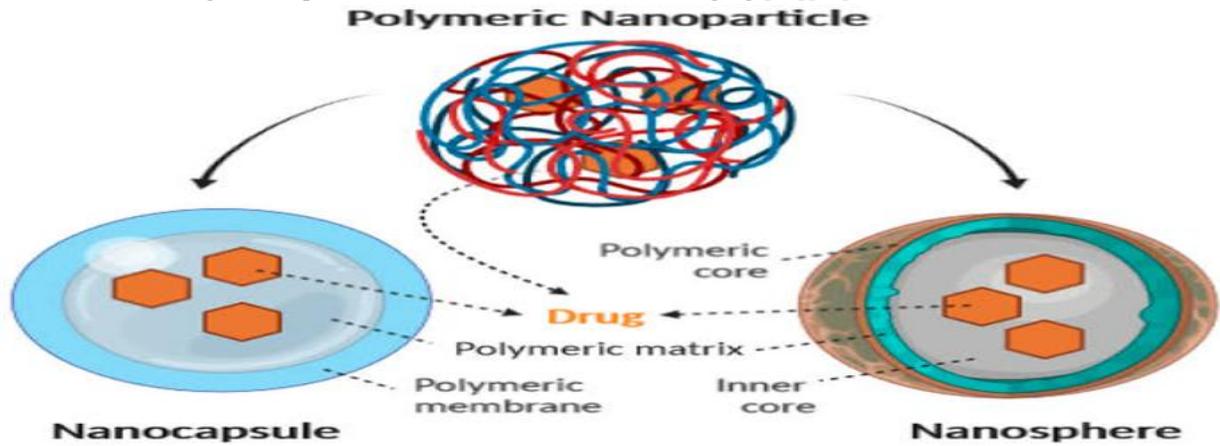
Drug release under control and the biodegradation that follows are crucial for creating effective formulas. Possibility Release processes include: (i) desorption of surface-bound (ii) diffusion across the carrier matrix; (iii) adsorbed medications (iv) erosion of the carrier matrix and (v) a combination of erosion and diffusion procedure. The distribution method may make a difference between success and failure of a medication, as the selection of a medication is frequently impacted by how the medication is given.[6] Polymers that release a medicine at a regulated rate by diffusion out of the polymer or

gradual polymer breakdown are known as sustained (or continuous) release. Since pulsatile release closely resembles how the body naturally generates hormones like insulin, it is frequently the favored form of medication administration. Drug-carrying polymers that react to particular stimuli—such as light exposure, pH or temperature changes—are used to do this.[7] For more than two decades, scientists have recognized that nanotechnology has the potential to greatly enhance medicine delivery and targeting. Enhancing delivery methods that reduce toxicity and boost effectiveness has enormous potential benefits for patients and creates new opportunities for pharmaceutical and drug delivery businesses. Other drug delivery strategies concentrate on getting past specific physical barriers, like the blood–brain barrier, to better target the medication and increase its efficacy, or on finding acceptable and different ways to deliver protein drugs outside of the gastrointestinal tract, where degradation may take place.[8] Polymer Nanoparticle: Solid, colloidal particles are known as polymer nanoparticles. between 10 and 1000 nm. Polymer nanoparticles are referred to as nanocapsules and nanospheres. These can be made in two ways: either by direct polymerization of premade polymers or monomers. Various techniques, such as salting and solvent evaporation out, supercritical fluid evaporation, dialysis, and quick Supercritical solution expansion is utilized. The selection of the preparation technique is based on a number of With elements including the kind of polymeric system, region of application, dimension specifications, etc. The nanoparticles made of polymer can be produced using any of these methods are demonstrated for effective therapeutic action. [9]

Metallic Nanoparticles: Nanosized metals with dimensions ranging from 1 to 100 nm are referred to as metal nanoparticles. Metallic nanoparticles may be produced using a variety of liquid phase techniques, including chemical reduction, sol gel, and reversed micelle. Nobel Prize Chemical reduction techniques consistently yield spherical-shaped and sized nanoparticles. This schematic illustration shows how the metallic because of their unique properties, such as their enormous surface area, ability to handle a large number of low coordination sites, and ability to give precise electronic structure between molecular and metallic states, metal nanoparticles are frequently employed. These are employed in radiofrequency

techniques for the catabolism of tumors by heat, therapeutic drug, gene, and radionuclide administration, magnetic separation of labeled cells

and other biological entities, and contrast enhancement agents for magnetic resonance imaging.[10][11]



Magnetic Nanoparticles: Pure metals like CO, Fe, and Ni as well as metal alloys like FePt and CoPt have been used to create magnetic nanoparticles in a variety of phases and compositions. A particle size of around 3 nm may be achieved by using magnetic nanoparticles. By properly arranging the particles, we can create recording medium with a recording density of up to 1 Tb/in<sup>2</sup> because the particles will be hundreds of atoms in size. Coprecipitation, sonochemistry, colloidal method, solvothermal, combustion synthesis, hydrothermal method, microemulsion, and thermal breakdown methods are a few of the techniques that have been documented. The major uses of MNPs are in Bio separation where the conjugation between MNPs and the target biomolecules, which are functionalized with particular receptors, creates complexes, and may be easily attracted by the supplied magnetic field and

taken out of the pure mixture, offering a quick and easy method for bioseparation as compared to traditional approach like centrifugation and filtering. This method is also employed in biosensing, drug delivery, magnetic resonance imaging and hyperthermia. The major uses of MNPs are in Bio separation where the conjugation between MNPs and the target biomolecules, which are functionalized with particular receptors, creates complexes, and may be easily attracted by the supplied magnetic field and taken out of the pure mixture, offering a quick and easy method for bioseparation as compared to traditional approach like centrifugation and filtering. This method is also employed in biosensing, drug delivery, magnetic resonance imaging and hyperthermia . [12][13]

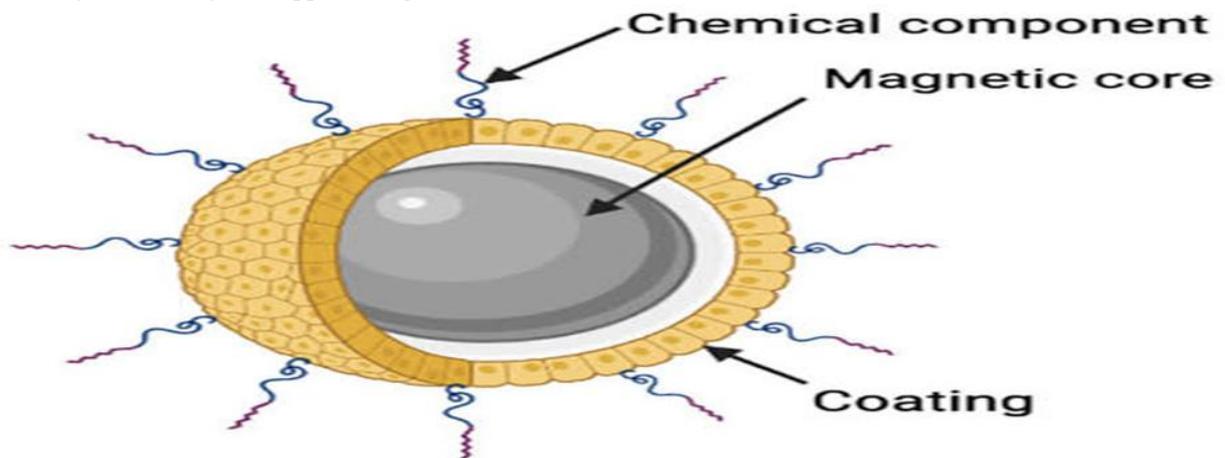


Fig: Magnetic Nanoparticles

### III. POTENTIAL OF NOVEL DRUG DELIVERY FOR HERBAL DRUGS

The potential of the extensive Ayurvedic knowledge base in our nation has only just come to light. However, the patient's medication is administered via an antiquated and conventional drug delivery method, which reduces the medication's effectiveness. The stomach's extremely acidic pH increases the likelihood that many components in herbal extracts may be destroyed. The liver may process additional ingredients before they enter the circulation. Consequently, the necessary dosage of the medication could not enter the bloodstream. There won't be any therapeutic benefit if the medication doesn't enter the bloodstream at a certain level, referred to as the "minimum effective level." Pharmaceuticals that use traditional substances obtained from plants rather than chemicals are known as phytopharmaceuticals.

The body may metabolize natural chemicals more quickly and effortlessly. As a result, they have fewer, if any, adverse effects and improve bloodstream absorption, leading to more comprehensive and successful therapies. Adverse side effects are common with pharmaceuticals derived from chemical substances. Certain chemical compounds that are not found in nature likely to be rejected by the human body. These rejections manifest as adverse consequences, ranging from moderate headaches to potentially fatal ones. It is crucial to note although phytopharmaceuticals have minimal to nil side effects, chemical interactions with various prescribed medications can take place. Additionally, because they are pure, single compounds, they are readily standardized, which facilitates incorporation. them in contrast to botanicals in contemporary medication delivery methods [16] Drug delivery methods based on lipids have been studied in several investigations and have demonstrated their usefulness in controlled and targeted medication administration. Amphiphilic pharmacosomes phospholipid drug compounds with

active hydrogen that attach to phospholipids. They provide superior biopharmaceutical characteristics to the medication, enhancing its absorption. Phytosomes are new substances made up of lipophilic complexes of phospholipid and plant-based components, such as ginseng, ginkgo biloba, silybum Marianum, and so forth. [17]

#### Characterization of Synthesised Nanoparticles:

Characterization is the study of a material's composition, structures, and physical and chemical characteristics. Using sophisticated microscopic methods like atomic force microscopy (AFM), transmission electron microscopy (TEM), and scanning electron microscopy (SEM), nanoparticles are often described by their size, shape, and surface charge. The general form of polymeric nanoparticles, which may impact their toxicity, may be determined with the help of electron microscopy methods. The polymer dispersion's physical stability, redispersibility, and in vivo performance are all impacted by the nanoparticles' surface charge.

Scanning electron microscope (SEM) :SEM, or scanning electron microscopy, provides direct viewing for morphological analysis. The method is based on electron microscopy, which we employed for sizing and morphological research. Nevertheless, they don't offer much insight into the size distribution. The nanoparticle solution must first be turned into a dry powder for SEM characterization.

This powder is then placed on an example holder and coated with conductive metal, such gold, using a sputter coater. After that, a concentrated, fine electron beam is employed to scan the sample. The secondary electrons released from the sample surface provide information about the sample's characteristics. The nanoparticles must be resistant to electron beams and vacuums that might harm the polymer. The results from dynamic light scattering are similar to the mean size determined by SEM. [18]

## Scanning Electron Microscope (SEM)

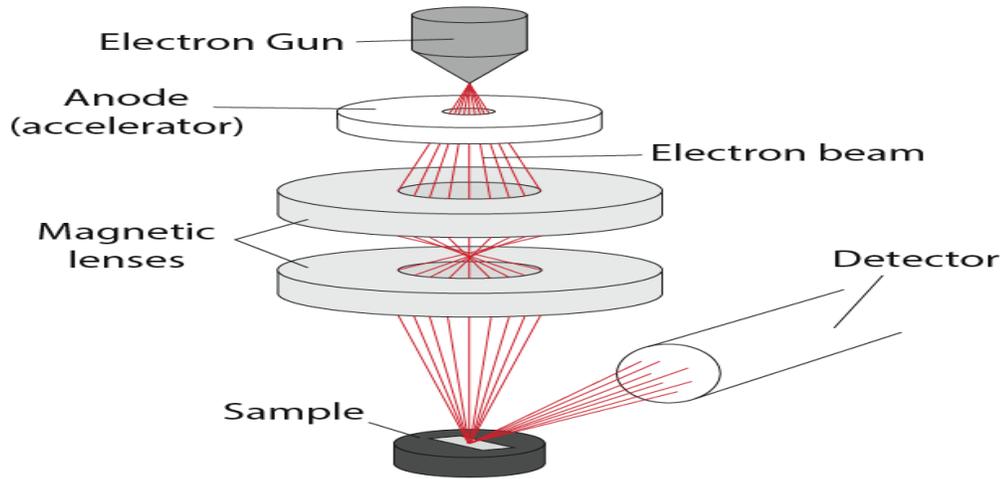


Fig: Scanning electron microscope (SEM)

Particle size analyzer: The most crucial factors for characterizing produced nanoparticles are their shape and particle size distribution. Drug targeting and release are the main uses for nanoparticles. Particle size has been discovered to have an impact on drug release; as smaller particles have more surface area, the majority of the pharmaceuticals put onto them will be exposed to the particle surface, resulting in quick

drug release. On the other hand, medications gradually permeate bigger particles. One disadvantage of nanoparticle dispersion is that smaller particles have a tendency to group together when being transported and stored. As a result, there is a trade-off between nanoparticles' maximal stability and their small size.[19]



Fig: Particle size analyzer

Dynamic light scattering (DLS): Photon-correlation spectroscopy (PCS) or dynamic light scattering (DLS) are now the most widely used techniques for assessing particle size. Brownian nanoparticles in colloidal solutions in the nano and submicron range are frequently measured using DLS. When a monochromatic light source (such as a laser) strikes a solution of spherical particles moving in Brownian motion, the light induces a Doppler shift, which modifies the incoming light's wavelength.[20]

Atomic force microscopy (AFM): AFM uses an atomic-scale probe tip to physically scan materials at

the sub-micron level, providing ultra-high resolution in particle size determination. Depending on their characteristics, samples are often scanned in either contact or noncontact mode. The probe hovers above the conducting surface in non-contact mode and is tapped on the sample's surface to create the topographical map in contact mode. The main benefit of AFM is that it can picture non-conducting materials without any further processing, making it possible to examine delicate biological and polymeric nanostructures.[21]

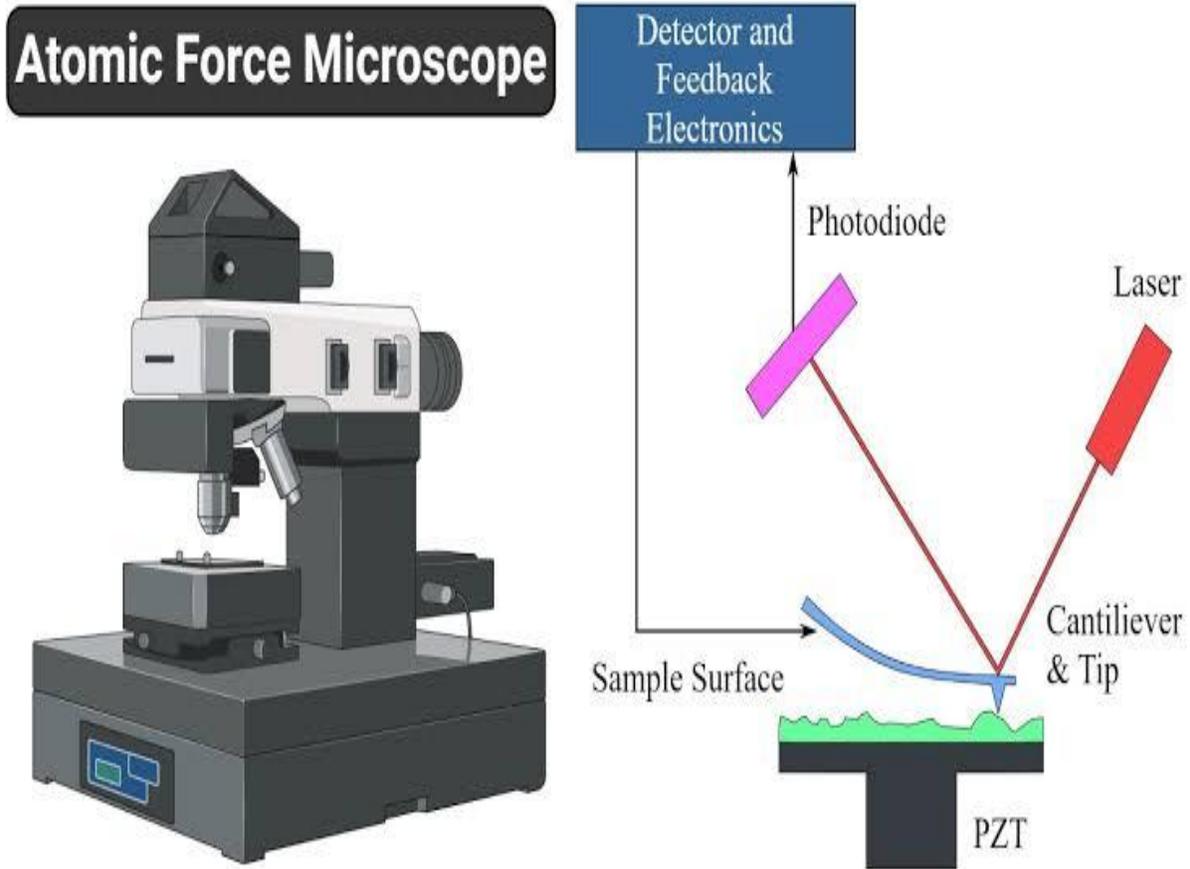


Fig: Surface area analysis

The total of the areas of the particles' exposed surfaces per unit mass is the particles' specific surface area. Particle size and surface area are inversely correlated. A powder's specific surface area may be determined via nitrogen adsorption. To calculate the total surface area, the Brunauer, Emmett, and Teller (BET) technique is frequently utilized.[22] The specific

surface area yields an average particle diameter in nanometers if the particles are thought to be spherical and have a narrow size dispersion.

$$\text{Formula: } d_{\text{BET}} = 6000/\bar{n}S$$

Where,

S is specific surface area in m<sup>2</sup>/g.  $\bar{n}$  is the theoretical density in g/cm

SL No.	Nanoparticle Name	Functionalization	Uses	Method of synthesis
1	Curcumin	Anticancer	Potent Anticancer and Antitumor.	Wet-milling technique.
2	Paclitaxel	Antineoplastic	Acts against several tumours, ovarian and breast cancers.	Nanoprecipitation.
3	Berberin	Anticancer	Inflammation and several cancers.	Emulsion, Ionic gelation.
4	Camptothecin	anticancer	Potent anticancer	Encapsulated with hydrophobically modified glycol.
5	Ginkgo biloba	Alzheimer's dementia	Acts against loss of memory, thinking, language, behaviour.	Combination of Dry and wet process. (Gas-phase and liquid-phase grinding)
6	Triptolide	Anti-arthritis	Inflammatory and autoimmune diseases, especially for rheumatoid arthritis.	Nano encapsulation
7	Salvia miltiorrhiza	Anti-hyperlipidaemia	Cerebrovascular diseases, improve blood stasis.	Phospholipid complex loaded.
8	Quercetin	Anti-oxidant	Potent anticancer	Gelatin and chitosan loaded.
9	Breviscapine	Anti-cardiovascular	Cerebrovascular and cardiovascular diseases also against pulmonary fibrosis.	Lipid encapsulation.
10	Naringenin	Antioxidant, Anti-inflammatory.	Acts against several tumours and hepatoprotective.	Nano precipitation.
11	Dodder	Antioxidant	Acts against carcinogenesis and ageing also used as hepatoprotective.	Nano precipitation.
12	Silymarins	Hepatoprotective	Several liver diseases, breast cancer.	Cold homogenization.
13	Genistein	Antioxidant	Used in cardiovascular diseases, breast and uterine cancer also in osteoporosis.	Nano emulsion and chitosan microsphere.
14	Centellaasiatica	Anxiolytic	Acts as anti-anxiety, also used in leprosy, cancer, syphilis and allergy.	Ionic gelation.
15	Annual mugwort	Antimalarial	Also used for Asthma	Hydrophilic encapsulation.

Table: Nanoparticles formulations and their pharmacological actions

Health Implications of Nanoparticles: Nanoparticles may enter the human body in a number of ways, such as through the lungs, where they can quickly move through the bloodstream to key organs like the blood brain barrier (BBB) and be absorbed by the skin and intestinal system.[15]

#### IV. FUTURE PROSPECT OF NANO SIZED HERBAL MEDICINES

Herbal medicines that are nanosized have the ability to improve biological activity and solve issues with pure herbal medications. The viability of scaling up processes that swiftly bring novel therapeutic approaches to the market and the potential to obtain multifunctional systems to satisfy various biological and therapeutic requirements. Nanotoxicology is a new area of toxicology that studies the negative effects

of nanoparticles. Nanoparticles may have toxicological effects. Health innovations were formerly assessed based on how well they worked and how well they enhanced patient quality of life. These days, health care expenses must also be taken into account. The goal of nanotherapeutic devices, which are more expensive and have a more complicated structure than traditional alternatives, is to lower health care expenses overall. [14]

#### V. CONCLUSION

Since ancient times, herbal remedies have been used extensively throughout the world, and both doctors and patients have acknowledged their superior therapeutic value due to the fact that they have fewer side effects than contemporary medications. Ayurvedic medications can be used more effectively

by incorporating them into contemporary dosage forms. However, in order to improve patient compliance and prevent repeated administration, phytotherapeutics require a scientific approach to deliver the components in a novel way. Creating innovative drug delivery methods for herbal components can help achieve this. In addition to lowering the need for repeated administration to address non-compliance, innovative drug delivery methods also contribute to higher therapeutic value by lowering toxicity, raising bioavailability, and other factors. Recent years have seen an increase in interest in herbal medicines due to their potential to treat nearly every illness. However, the use of herbal medicines is restricted by a number of issues, including poor solubility, poor bioavailability, low oral absorption, instability, and unpredictable toxicity. Nanoparticles can be crucial in solving such issues. Therefore, various nanoparticles have the potential to be used to deliver herbal medicines with improved therapeutic outcomes. The synthesis and characterization of nanoparticles are examined in this review, and plants, their parts, or their products have been reported to have anticancer, antioxidant, anti-anxiety, anti-malarial, liver and kidney tonic, and cardiovascular disease properties-circumvent these drawbacks, drug delivery systems that contain nanocarriers have been created. The use of nanocoating Herbal medicines were made utilizing a variety of techniques, like the homogenization approach, sequential simplex optimization, Wet and dry precipitation with the solvent evaporation technique method, etc. Due of its large surface area and compact size, Nanoparticle drug carriers enhance the volume ratio. therapeutic drug pharmacokinetics and biodistribution. They can avoid bleeding in addition to their site-specific effect. barrier, increase hydrophobic substances' solubility as as well as make them more stable.

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