IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

NANOPARTICLES: ADVANCEMENT IN HERBAL TREATMENT

Ajinkya Ganesh Jadhav*, Prof. Vishal Pandit Kopnar, Dr. Amol Navnath Khedkar.

Department of Pharmaceutical Sciences, Saikrupa Institute of Pharmacy, Ghargaon, Shrigonda, Ahmednagar, Maharashtra, India 413728

Corresponding Authors Details: Mr. Ajinkya Ganesh Jadhav, Final Year B. Pharmacy, Department of Pharmaceutical Sciences, Saikrupa Institute of Pharmacy, Ghargaon.

ABSTRACT

Herbal treatments have been used for a very long time. Because they can treat a variety of disorders with fewer side effects, herbal medications are becoming more popular nowadays. Herbal treatments have not yet been able to deliver medications effectively. Several scientific approaches are now being investigated to deliver natural remedies. Novel formulations based on nanoparticles have been developed for the effective delivery of herbal medications. A potential advantage of nano particulate formulations such polymeric nanoparticles, liposomes, proliposomes, solid lipid nanoparticles, and micro emulsions is the efficient delivery of herbal remedies. Several Nano particle technologies have been researched for the delivery of herbal medicines in order to enhance therapeutic response. This article describes these technologies.

Key words: medication targeting, herbal medicines, innovative formulation, nanoparticle increase the bioavailability.

INDRODUCTION

In cultures as diverse as China, India, and even Nepal, herbal treatments have been used for thousands of years. The growing global market for herbal medications is proof that the use of herbal treatments has greatly expanded in recent decades. Herbal medicines are becoming more popular since they are less likely to have side effects than synthetic ones. Additionally, advances in herbal nutraceuticals and dietary supplements have increased the market share of herbal products.. However, the development of novel drug delivery systems for the production of herbal medicines is delayed when compared to the complexity of the active substances. Even though some herbal medication formulations have been created and have shown efficacy comparable to that of contemporary drugs created chemically, much more research is still necessary. One of the cutting-edge drug delivery systems that is considered important is that of nanoparticles. In order to target herbal medicine to particular organs, the use of nanoparticles improves selectivity, drug delivery, effectiveness, and safety, leading to dose reduction and increased patient compliance. Target cells and tissues must be able to be reached by an appropriate nanoparticle system, which must be able to circulate in the bloodstream. Various organs, including the brain, lung, liver, kidney, gastrointestinal tract, and others, can be addressed by herbal medications. The active ingredients included in herbal medicines are what give them their overall activity since they work synergistically to increase the therapeutic value. Due to their hydrophobic nature, the majority of herbal actives have poor water solubility. This property restricts the therapeutic use of herbal medicines by increasing systemic clearance and decreasing absorption, which necessitates more frequent administration or a higher dose. As a result, nanoparticles can be used to make herbal drugs more soluble and to localize the medicine in a particular area, improving both patient compliance and efficacy. [2] The core elements of nanotechnology are nanoparticles. The size of nanoparticles, which spans from 1 to 100nm, consists of metal, metal oxides, organic material, and carbon. Apart from their composition, nanoparticles differ in terms of diverse dimensions, shapes, and sizes. Surfaces can have surface variations can be uniform or uneven. There are some crystalline nanoparticles and some amorphous ones. Some nanoparticles have one or more crystals that are either clumped together or free.

The pharmaceutical industry suffers greatly as a result of the fact that the majority of drug candidates used in the synthesis of new medications are either insoluble in water or have low water solubility. One of the main factors contributing to a medicine's insolubility is its large and complex molecular structure. More than 65% of recently created active pharmaceutical ingredients (APIs) are either insoluble in water or have poor solubility, according to reports. Due to their poor water solubility and high permeability, they fall under class II of the Bio pharmaceutics Classification System (BCS), where the dissolving phase is the rate-limiting stage in drug absorption. The pharmaceutical industries are currently faced with the task of raising drug bioavailability by improving the dissolving characteristic of poorly water soluble medicines. For instance, they have advantageous controlled release capabilities and aid in improving the stability of medicines and proteins. The creation of various types of nanoparticles employing chemical, physical, and biological techniques was the main emphasis of this review. Biological options, however, are simple, non-toxic, rapid, and environmentally benign, whereas chemical and physical treatments are expensive and risky. It also covers nanoparticle characteristics, and it concludes with a list of applications.[3]

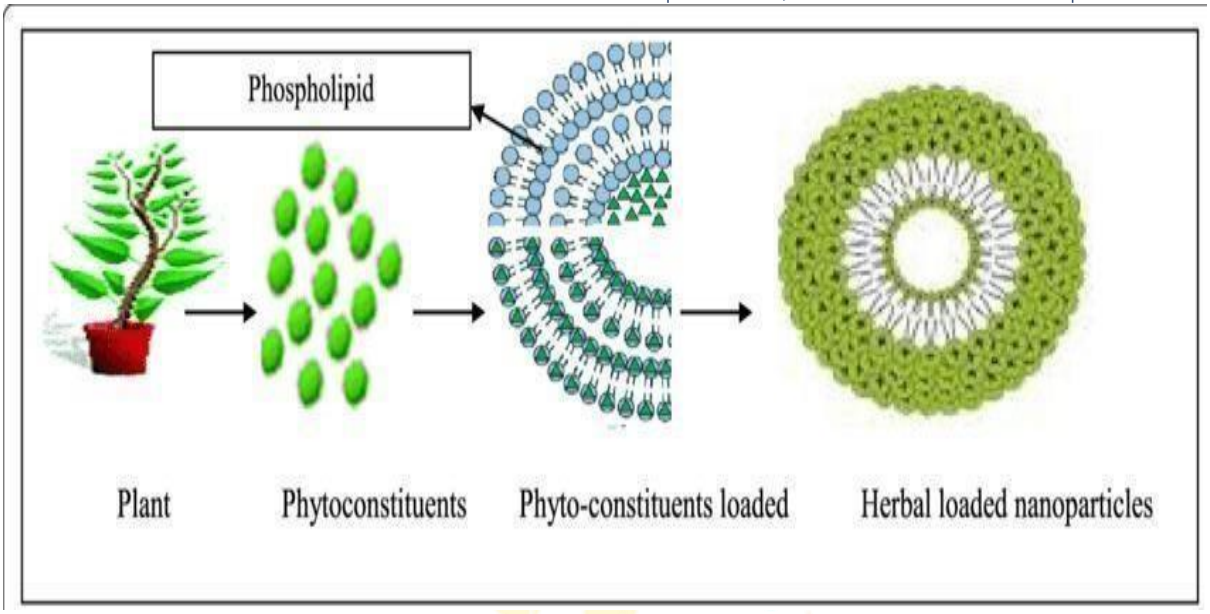

Fig: 1 Herbal Loaded Nanoparticle

Advantages of Nanoparticles

Some advantages of using nanoparticles as a drug delivery system include the following:

1. The simplicity with which one can alter the surface characteristics and particle size of nanoparticles to enable both passive and active medicine targeting following parenteral delivery.
2. Drugs can have their bio distribution and clearance altered by altering the nanoparticle surface, resulting in optimal therapeutic effectiveness and minimal medication adverse effects.
3. Controlled release and particle degradation properties can be easily altered by choosing the proper matrix elements.
4. This is essential for preserving the drug activity since drug loading is relatively high and medicines can be introduced to the systems without producing a chemical reaction.
5. Site-specific targeting can be achieved by attaching targeting ligands to particle surfaces, or by using magnetic guidance.
6. Due to the fact that polymer-based nanoparticles and liposomes normally biodegrade and do not accumulate in the body, they may not pose any risks.
7. Small nanoparticles' ability to pass through tiny capillaries may enable effective medication
8. Several delivery methods are available, including as intra-ocular, parenteral, nasal, and oral.[4]

Limitations

Despite these benefits, nanoparticles do have some drawbacks, such as,

1. Because of their small size and large surface area, nanoparticles have altered physical properties that lead to particle-particle aggregation. This makes it difficult to handle them physically in liquid and dry forms.
2. Nanoparticles are highly reactive in the cellular environment due to their larger surface area as particle size decreases.

3The tiny particle size limits the drug loading and burst release. These logical

Before using nanoparticles in therapeutic settings or commercializing them, problems need to be solved.[5]

Toxicity

These minute particles have the ability to enter the body through the skin, lungs, or digestive system, deposit in a number of organs, and then cause significant biological reactions by altering tissue's physiochemical properties. When utilised for drug delivery, non-

biodegradable particles may accumulate at the intended site, causing chronic inflammatory reactions. Inhalation of particulate matter that causes lung and cardiovascular illnesses is the primary cause of the majority of nano particle toxicity reactions.[6]

Classification of Nanoparticles

In general, there are three categories of nanoparticles: organic, inorganic, and carbon-based.

1. Organic nanoparticles: Micelles, Dendrimers, ferritin, and liposomes are some popular polymers or organic nanoparticles. These nanoparticles are non-toxic and biodegradable. Some of them, including micelles and liposomes, also have hollow center's called nano capsules that are sensitive to electromagnetic radiation, such as heat and light. Organic nanoparticles are most commonly used in the biomedical field since they are efficient and may be injected on specific bodily areas, which is also known as targeted medicine administration. Examples of organic nanoparticles include liposomes, dendrimers, and micelles.

2. Inorganic nanoparticles: Inorganic nanoparticles are those that are not made of carbon. Metal and materials based on metal oxides are frequent components of inorganic nanoparticles.

Metal NPs:

You can make nanoparticles out of practically any metal. The most often used metals for producing nanoparticles are aluminum (Al), cadmium (Cd), cobalt (Co), copper (Cu), gold (Au), iron (Fe), lead (Pb), silver (Ag), and zinc (Zn). You can create these nanoparticles using chemical, electrochemical, or photochemical processes. By decreasing the metal-ion, the metal nanoparticles are produced chemically. reducing chemicals in solution with precursors. These can adsorb small molecules and have a high surface energy. These nanoparticles can be used for bioanalytical, environmental, and bio molecular detection and imaging. Before SEM examination, the sample, for instance, is coated with gold nanoparticles. Typically, this was done to enhance the electrical current, which facilitates the creation of excellent SEM images. Because of their outstanding optical properties, metal NPs are utilised in many scientific domains.

a. Ceramic NPs: Ceramic nanoparticles are inorganic solids made of carbides, carbonates, oxides, carbides, carbonates, and phosphates that are heated and then cooled. They come in polycrystalline, dense, amorphous, hollow, porous, and polycrystalline forms. As a result of their use in procedures like catalysis, photocatalysis, and the photodegradation of dyes, these NPs are garnering a lot of research interest. By modifying certain physical properties, these nanoparticles can be created as drug delivery vehicles, specifically to target malignancies, glaucoma, and certain bacterial infections.

b. Semiconductor NPs: Semiconductor nanoparticles share traits with both non-metals and metals. They can be located in the periodic table's groups II–VI, III–V, or IV–VI. These particles can display a variety of behavior's when tuned because of their wide band gaps. They can be used in water splitting, photo-optics, electronics, and photocatalysis. Because semiconductor materials exhibit properties that lie between between those of metals and nonmetals, they have been employed in a variety of literary contexts. Group III-V semiconductors include GaN, GaP, InP, and InAs; Group II-VI semiconductors include ZnO, ZnS, CdS, CdSe, and CdTe; and Group IV semiconductors include silicon and germanium.

c. Polymeric NPs: These NPs are often based on organic materials, and the term polymer nanoparticle (PNP) is used to refer to them collectively in literature. These can be Nano spheres or nanocapsules depending on the preparation. In contrast to the latter, which are

matrix particles with an overall mass that is normally solid, the latter are molecules that are adsorbed at the outside edge of the spherical surface. In the latter case, the particle completely encloses the solid mass. . The PNPs have numerous applications and are simple to functionalize. written language. Polymeric nanoparticles have various benefits, including controlled release, drug molecule protection, the ability to combine therapy and imaging, accurate targeting, and many others. They are utilised for both medical delivery and diagnosis. Systems for dispensing medications based on polymeric nanoparticles are highly biocompatible and biodegradable.

d. Lipid-based NPs: Lipid nanoparticles are typically spherical in shape and range in diameter from 10 to 100 nm. It is composed of a soluble lipophilic molecular matrix and a stable lipid core. These nanoparticles' exterior core is stabilized by emulsifiers and surfactants. These nanoparticles are used in cancer treatment as an RNA release agent and medication carrier in the biomedical industry.

3. Carbon-based NPs: One of the most significant components of carbon-based nanoparticles is fullerenes, along with carbon nanotubes (CNTs). CNTs are nothing more complicated than coiled grapheme sheets. Because these materials are 100 times stronger than steel, they are primarily employed for structural reinforcement. Single-walled carbon nanotubes (SWCNTs) and multi-walled carbon nanotubes (MWCNTs) are the two main types of carbon nanotubes (CNTs). CNTs are unique in that they are thermally conductive along the length of the tube but non-conductive across it. A fullerene is a type of carbon allotrope that consists of at least sixty carbon atoms arranged in a hollow cage structure. Buckminsterfullerene (C-60) has a structure akin to a hollow football. In these forms, the carbon unit configurations are pentagonal and hexagonal.

Nanoparticles: Types

Silver: Silver nanoparticles have shown to be the most effective due to their excellent antibacterial efficacy against bacteria, viruses, and other eukaryotic microorganisms. They are unquestionably the most widely employed nanomaterial's, being used as antimicrobial agents, in the textile sector, for water treatment, sunscreen creams, etc. Studies have revealed that a variety of plants, such as Azadirachta indica, Capsicum annuum, and Carica papaya, are capable of producing silver nanoparticles.

Gold: Gold nanoparticles (AuNPs) are used in immunochemical research to pinpoint protein interactions. They are used as lab tracers in DNA fingerprinting to detect the presence of DNA in a sample. Additionally, they are used to find antibiotics called aminoglycosides, such streptomycin, gentamycin, and neomycin. Gold nanorods are being used to distinguish between different bacterial species, to detect malignancy, and to locate cancer stem cells.

Alloy: Alloy nanoparticles' structural properties are different from those of their bulk materials. Because of their high electrical conductivity and the fact that their oxides have significantly higher conductivities than those of many other metals, silver flakes are the most widely used metal filler. Bimetallic alloy nanoparticles have more advantages over traditional metallic NPs since both metals modify their properties.

Magnetic: Two varieties of magnetic nanoparticles, Fe3O4 (magnetite) and Fe2O3 (magnetite), are recognized as being biocompatible. For guided drug delivery, targeted cancer treatment (magnetic hyperthermia), gene therapy, DNA analysis, and magnetic resonance imaging, they have been the subject of ongoing research (MRI). [8]

Applications of Nanoparticles:

1. Tumor targeting using Nano particulate delivery system

Through increased permeability and retention effects, active nanoparticles will be able to deliver a concentrate dose of treatment in the vicinity of the tumor targets. This serves as the foundation for the use of nanoparticles in tumor targeting. Nanoparticles reduce the danger of drug exposure to healthy tissues by limiting drug distribution to the target organ. An trial demonstrated that mice treated with doxorubicin incorporated into poly (isohexylcynoacrylate) nano spheres had higher amounts of the medication in their livers, spleens, and lungs than mice treated with free doxorubicin did.

2. Nanoparticles for oral delivery of peptides and proteins

Significant advances in biotechnology and biochemistry have led to the discovery of numerous bioactive chemicals and vaccines based on peptides and proteins. The development of efficient carriers is challenging because the bioavailability of these chemicals is restricted by the gastrointestinal tract's epithelial barriers and they are susceptible to gastrointestinal degradation by digestive enzymes. Polymeric nanoparticles can be used to encapsulate bioactive substances, protecting them against enzymatic and hydrolytic degradation. For instance, after oral administration, diabetic rats were found to continue to respond to insulin and have decreased blood sugar levels for up to 14 days. The surface area of human mucosa is 200 times greater than that of skin. Proteolytic enzymes in the gut lumen like pepsin, trypsin, and chymotrypsin, proteolytic enzymes at the brush border membrane (endopeptidases), bacterial gut flora, mucus layer, and epithelial cell lining itself are just a few examples of physiological and morphological barriers that prevent the delivery of proteins or peptides. The histological structure of the mucosa is designed to successfully prevent the ingestion of ambient particle elements. Delivering the medication in a colloidal carrier system, such as nanoparticles, can help to improve the processes of interaction between the drug delivery system and the GI epithelia cells, and is one important strategy for breaking the GI barrier.

3. Nanoparticles for Gene delivery

When appropriate antigen-encoding genes are introduced into host cells, they are expressed, which is how polynucleotide vaccines work. Due to the development of the antigenic protein near skilled antigen-presenting cells, this causes an immunological reaction. These vaccines increase both immune system components by inducing intracellular protein synthesis rather than extracellular protein deposition, which results in the induction of both humoral and cell-mediated immunity.

4. Targeting of nanoparticles to epithelial cells in the GI tract using ligands Targeting strategies can be utilised to improve the interaction of nanoparticles with adsorptive enterocytes and M-cells of Peyer's patches in the GI tract, as well as targeted binding to ligands or receptors and nonspecific adsorptive mechanisms. On the surface of enterocytes and M cells, one can see cell-specific carbohydrates that may serve as binding sites for colloidal drug carriers that contain the appropriate ligands. Some glycoproteins and lectins bind specifically to this type of surface structure through a specialized receptor-mediated process. To enhance oral peptide adsorption, many lectins, including tomato and bean lectins, have been studied. Receptor-mediated endocytosis is the physiological process through which vitamin B-12 is absorbed in the gut. The oral bioavailability of many peptides and particles, including erythropoietin, granulocyte colony stimulating factor, and others, has been demonstrated to be increased by covalent coupling to vitamin B-12. This intrinsic method requires mucoprotein, which is produced by the mucus membrane in the stomach and specifically binds to cobalamin. The ileum receives all of the mucoprotein, and some of its receptors are in charge of facilitating resorption.

5. Nanotechnology in Medicine Application: Anti-Microbial Techniques

One of the first applications of nanomedicine was the use of nanocrystalline silver as an antibacterial agent for the treatment of wounds. An anti-staph cream has been demonstrated to work. The nanoparticles include nitric oxide gas, which has a reputation for eradicating pathogens. Studies on mice showed that the production of nitric oxide gas at the site of staph abscesses using a nanoparticle cream significantly reduced the infection. An antibiotic-containing nanocapsule-coated burn dressing. The nanocapsules rupture if an infection develops because of the harmful bacteria in the wound, releasing the antibiotics. This lessens the need for frequent dressing changes and expedites the treatment of an infection. In the early stages of research, the idea of curing bacterial infections in a patient in a matter of minutes as opposed to treating them with antibiotics over a period of weeks is welcome.

6. Absorption enhancement using non-specific interactions

In general, the gastrointestinal absorption of macromolecules and particulate materials involves either the Para cellular route or the endocytotic channel. The mucosa's surface area is utilised for the Para cellular pathway of nanoparticle absorption by less than 1%. Macromolecules can be made more permeable to Para cellular environments by using polymers such as chitosan, starch, or poly (acrylate).

The two endocytotic mechanisms for nanoparticle absorption are adsorption-mediated endocytosis, which doesn't require any ligands, and receptor-mediated endocytosis, which involves active targeting. This process is initiated by the non-specific physical adsorption of material to the cell surface by electrostatic forces such as hydrogen bonding or hydrophobic interactions. Adsorptive endocytosis is significantly influenced by the substance's size and surface properties. Adsorptive enterocytes will have an affinity for positive or uncharged nanoparticle surfaces despite the fact that they are hydrophobic, whereas negatively charged and hydrophilic surfaces have a stronger affinity for M cells and both adsorptive enterocytes and M cells. This illustrates the interaction between affinity and size, surface charge, and hydrophobicity. This is demonstrated with poly (styrene) nanoparticles and when it is carboxylated.[9]

Preparation of Nanoparticles

The best method for creating nanoparticles is determined by the drug that will be placed into them as well as the physicochemical properties of the polymer. The principal methods for producing nanoparticles include:

Emulsion-Solvent Evaporation Method

The preparation of nanoparticles mostly employs this method. Typically, this process consists of two parts. The emulsification of the polymer solution is necessary as the first step in an aqueous phase. Evaporating the polymer solution is the second stage.

occurs and Nano spheres are produced by triggering the polymer precipitation. Nanoparticles are gathered by ultracentrifugation, cleaned with distilled water to remove any residue or free medicines, and then lyophilized for storage. The solvent evaporation method and high-pressure emulsification are two more names for this procedure. This technique uses general stirring and homogenization under high pressure to remove organic solvent. The temperature, type, and quantity of the dispersion agent, the rate of stirring, the viscosity of the organic and aqueous phases, and the stirring rate can all be changed to alter the size. It is possible to employ this approach with lipid-soluble drugs, however there are limitations because of scale-up issues. The following polymers are used in this process: PLA, Poly (-hydroxybutyrate), Poly (caprolactone), PLGA, Cellulose Acetate Phthalate, and EC.[10]

Double Emulsion and Evaporation Method

The inadequate trapping of hydrophilic medications is the underlying issue with this method. The double emulsion method, in which aqueous drug solutions are added to organic polymer solutions while violently swirling creates emulsion-free mixtures, and therefore employed to encapsulate hydrophilic medicines. The mixed emulsion (w/o/w), which has been created through continuous stirring, is next exposed to a second aqueous phase. Once the solvent has been removed, a high-speed centrifuge can be used to separate the nanoparticles. Before lyophilization, the generated nanoparticles need to be cleaned. The factors employed in this process are the amount of hydrophilic drug included, the amount of polymer, the volume of the aqueous phase, and the concentration of the stabiliser. These variables also affect how nanoparticles are classified. [11]

Solvent Displacement/Precipitation method

Solvent displacement techniques include the diffusion of an organic solvent into an aqueous medium whether or not a surfactant is present, as well as the precipitation of a preformed polymer from an organic solution. A semi-polar, water-miscible solvent like acetone or ethanol is used to dissolve polymers, medications, and lipophilic surfactants. Then, while being magnetically agitated, the solution is injected or poured into the stabiliser that already contains the aqueous solution. Rapid solvent diffusion is the process that produces nanoparticles. After that, the solvent is removed from the suspension under reduced pressure. One more element that affects particle size israte of aqueous phase addition of the organic phase. As mixing rate was increased, it was found that both particle size and drug entrapment decreased. The nano precipitation method works well for the vast majority of drugs with poor solubility. By changing the preparation conditions, it is possible to successfully control the size of the Nano sphere and the rate of drug release. While altering the polymer's concentration results in the production of smaller Nano spheres.[12]

Polymerization method

In this method, monomers are polymerized in an aqueous solution, and once polymerization is complete, either the drug dissolves in the polymerization media or it adheres to the nanoparticles to be integrated. The nanoparticle suspension is re- suspended in an isotonic surfactant-free medium after being purified by ultracentrifugation to remove various stabilizers and surfactants used for polymerization. The process for making polybutyl cyanoacrylate or poly (alkyl cyanoacrylate) nanoparticles has been documented. 7 The creation of nano capsules and the size of their particle are influenced by the surfactant and stabiliser concentrations used.[13]

Coacervation or ionic gelation method

The production of nanoparticles utilizing biodegradable hydrophilic polymers including chitosan, sodium alginate, and gelatin has been extensively studied. a method developed by Calve and colleagues for the ionic gelation-based synthesis of hydrophilic chitosan nanoparticles. The two aqueous phases of the technique contain chitosan, a polymer, and sodium tripolyphosphate, a poly anion. In this method, coacervates in the nanometer size range are produced by the interaction of the positively charged chitosan amino group and the negatively charged tri polyphosphate. Two aqueous phases interact electrostatically to form coacervates, but ionic interactions at ambient temperature result in a transition from liquid to gel known as ionic gelation.[14]

Salting Out Method

By salting out the water-miscible solvent from an aqueous solution, this procedure separates them. The saltingout agent (electrolytes, such as calcium chloride and magnesium chloride, or sucrose as a non-electrolyte) and polyvinyl pyrrolidone (PVP) or hydroxyethyl cellulose as a colloidal stabiliser are then emulsified with the polymer and medication to create an aqueous gel. This oil in water emulsion is thinned out with water or an aqueous phase to promote the solvent diffusion, which indicates the creation of Nano spheres. The amount of polymers in the organic phase, the kind of stabiliser, the rate of stirring, and the internal/external phase ratio are some of the variables that can be altered. This technique produces extremely efficient Nano spheres of ethyl cellulose, PLA, and poly (methacrylic) acids and is simple to scale up. Because salting out doesn't require a rise in temperature, it may be advantageous for materials that are sensitive to heat. This method has some drawbacks, such as the fact that it can only be used with lipophilic medications and that cleaning nanoparticles takes a long time. [15]

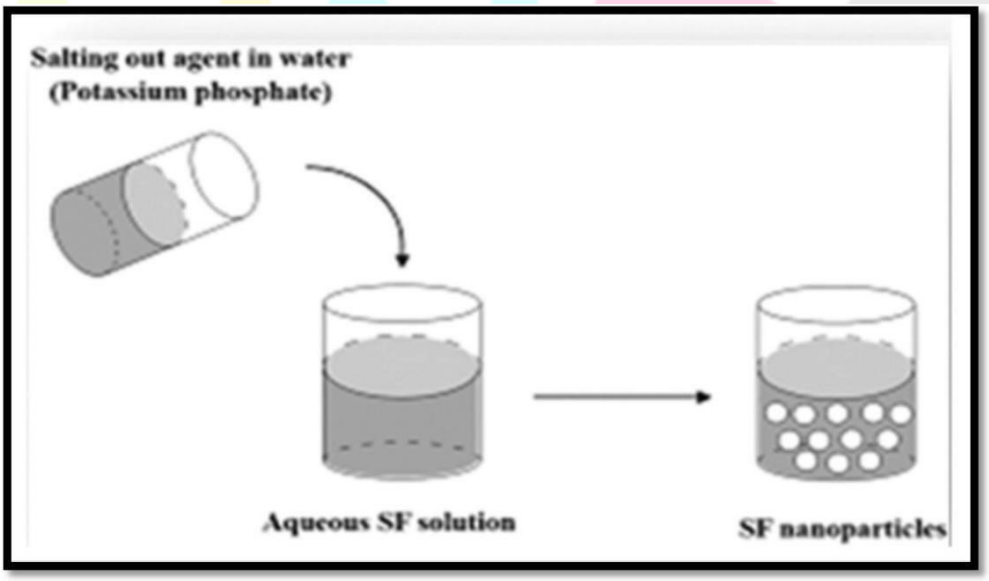

Figure 2: Salting-out method

Emulsions Diffusion Method

Emulsions diffusion method is another frequently used technique for making nanoparticles. The encasing polymer is dissolved in a partly polar solvent.

Propylene carbonate and benzyl alcohol are both liquids that are miscible with water, hence it is important to guarantee the initial thermodynamic equilibrium of both liquids saturated with water. The polymer-water saturated solvent phase is then emulsified in an aqueous solution containing stabiliser, causing solvent diffusion to the exterior phase and the formation of Nano spheres or nanocapsules depending on the oil-to-polymer ratio. Finally, the solvent is eliminated by evaporation or filtration in accordance with the boiling point. This method has a number of benefits, including good batch-to-batch reproducibility, minimal need for homogenization, high encapsulation efficiency (often 70%), simplicity, narrow size distribution, and ease of scaling up.

The enormous volumes of water that must be removed from the suspension and the reduced effectiveness of encapsulation during emulsification due to drug leakage in the saturated-aqueous exterior phase are some disadvantages of this approach. Examples of certain drug-laden nanoparticles made using this method are sodium glycol ate nanoparticles loaded with cyclosporine (cy-A-), mesotetra (hydroxyphenyl) porphyrin-loaded PLGA

(p-THPP) nanoparticles, and doxorubicin-loaded PLGA nanoparticles.[16]

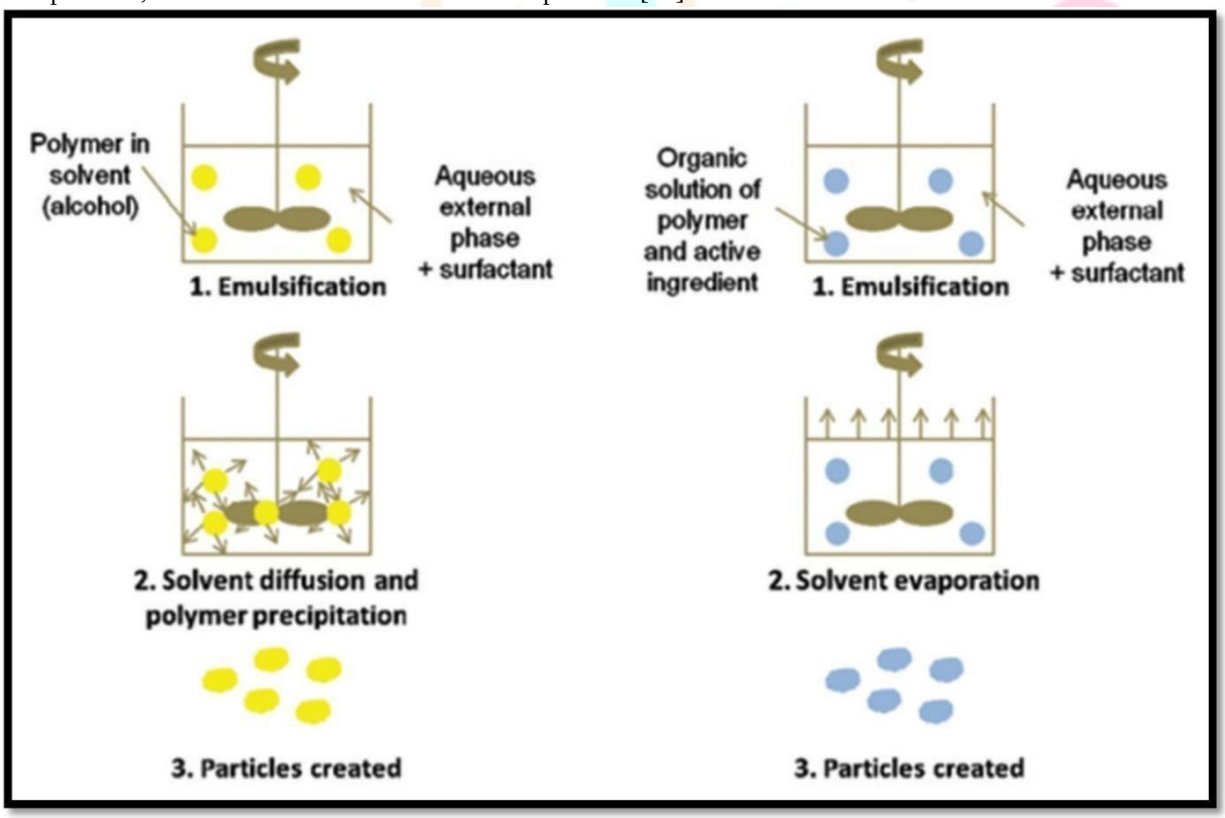

Fig.3 Solvent evaporation diffusion method Characterization of Nanoparticles Zeta potential:

The zeta potential of the nanoparticle is widely used to explain the surface charge characteristics of nanoparticles. It reflects the electrical potential of the particles and is influenced by the chemical composition of the particle as well as the media in which it is dispersed. Nanoparticles with zeta potentials between 10 and +10 mV are nearly neutral, whereas those with zeta potentials more than More than +30 mV and less than 30 mV are regarded as strongly cationic and anionic states, respectively. The zeta potential can be used to detect the presence of an encapsulated charged active material or an adsorb ate on the surface of a nanocapsule. The Zeta Potential's magnitude determines the stability of a particle; bigger magnitude potentials show increased electrostatic repulsion and hence greater stability.

Particles have a propensity to coalesce or agglomerate at 0–5 mV.

Particles are least stable between 5 and 20 mV.

Particles are relatively stable at 20–40 mV.

40+ mV: Particles are extremely stable

It is important to remember that the pH of the solution influences how much charge is on the surface of the nanoparticles.
The Henry equation is then used to compute the zeta potential, z:

It is important to remember that where Ue is the electrophoretic mobility, e is the dielectric constant, 0 is the absolute zero-shear viscosity of the medium, f(ka) is the Henry function, and ka is a measurement of the particle radius to Debye length ratio.[17]

UV-visible absorption spectroscopy:

Utilizing absorbance spectroscopy, it is possible to determine a solution's optical properties. Light is shone on the sample solution, and the amount of light absorbed is calculated. as soon as the wavelength is altered and the absorbance at each wavelength is measured. Using Beer-Law, Lambert's the absorbance can be used to determine a solution's concentration. There are several absorbance peaks in the optical measurements of UVvisible spectrophotometers, such as 410 nm.

X-ray diffraction (XRD) analysis:

An established method for figuring out the morphology and crystallographic structure is X-ray diffraction. The intensity changes depending on the amount of a constituent. This method is used to determine whether a particle is metallic, gives information on the density of electrons inside the unit cell, specifically where the atoms are positioned from peak positions, as well as information on the size and shape of the translational symmetry of the unit cell.

intensities. Cu K Radiation, X per Rota Flex Diffraction Meter, and =1.5406 were used to compute XRD patterns. Crystallite size is calculated using the Scherer equation:

K / cos = CS CS stands for crystallite size. Full width at half maximum [FWHM] in radius [] = FWHM x /180 is constant [K] = 0.94.

Bragg angle = Cos. Researchers have performed X-ray diffraction analysis using a variety of nanoparticles to determine the prepared sample's high crystallinity.[18]

Fourier Transform Infrared [FTIR] spectroscopy:

It investigates the connection between infrared brightness and light wavelength and is used to pinpoint the structural elements and functional groups of biological extracts that are associated with nanoparticles. The predicted spectra clearly show how the optical properties of nanoparticles depend on each other. Using Fourier Transform Infrared [FTIR], the greenly generated silver nanoparticle made from diverse leaf extracts was examined.] [19]

Microscopic techniques:

SEM and TEM are two methods that are primarily employed for morphological research on nanoparticles. These methods were widely employed by researchers to demonstrate that the produced nanoparticles were generally homogeneous in size and shape.[20]

Transmission electron microscopy (TEM):

The microscopy method known as transmission electron microscopy transmits a stream of electrons through an extremely thin specimen, interacting with the material as it does so. An image is created as a result of the interaction of the electrons moving through the material. This picture is then enlarged and focused onto an imaging device, such as a fluorescent screen, on a layer of photographic film, or to be detected by a sensor like a CCD camera. TEM is a crucial analytical method in many scientific fields, including the physical and biological sciences. In industries including semiconductors, nanotechnology, materials science, virology, and cancer research, TEMs are employed.[21]

Focus On Nanoparticles Size:

Since this is one of the most fundamental characteristics of NPs, we include several examples from the literature in this part that illustrate the application of various techniques to specific samples to quantify their size. Akbari et al. assessed the size and size distribution of alumina NPs using TEM, PCS, BET, and XRD. It was discovered that the NP size ranged from 5 to 95 nm. For these particles, the size values obtained from XRD and TEM agreed. According to the study's authors, PCS works well for measuring narrow particle size distributions in the 1–500 nm range, although it is advised to compare it with alternative techniques in situations where agglomeration happens. As would be predicted for particles having a spherical form, the size value inferred from BET was likewise consistent with those obtained from TEM and XRD; however, the recorded PCS value was greater.Gollwitzer et al. evaluated a number of methods for measuring the size of silica nanoparticles (NPs) that were dissolved in water and in the medium used for cell culture. Particle tracking analysis (PTA), centrifugal liquid sedimentation (CLS), SAXS, and DLS were the methods employed. Though PTA is a more general term that encompasses a wider variety of particle sizes, PTA and NTA are nearly identical. Because agglomerates reduce the accuracy of DLS, the DLS results in the cell culture medium differed significantly from the results of the other methods

Dynamic Light Scattering (DLS):

One useful method for describing nanoparticles and other colloidal fluids is dynamic light scattering, or DLS. When a laser beam travels through a colloidal solution, DLS detects the light that is dispersed. The size of the particle in solution can be determined by examining the variation of the scattered light intensity as a function of time .A function of DLS autocorrelation. The rate of diffusion of nanoparticles is correlated with the time delay at which the function diminishes. Larger particles will travel more slowly and scatter more light than smaller particles, according to the theory of Brownian motion, which describes the diffusive motion of particles in solution. The time dependence of the scattering intensity measurements can be used to derive the hydrodynamic diameter, which is the diameter of a hypothetical nonporous sphere that diffuses at the same rate as the particles being described. Since the hydrodynamic diameter offers information on the aggregation state of nanoparticle solutions, it is a valuable addition to other size measurements like TEM. Highly aggregated solutions have hydrodynamic diameters that are significantly bigger than the TEM size, whereas stable unaggregated colloidal solutions will contain particles with hydrodynamic diameters that are comparable to or slightly larger than their TEM size.

Inductively Coupled Plasma Mass Spectrometry (ICP-MS):

A sensitive analytical method for determining and measuring the elemental composition of materials, including metals and certain nonmetals with atomic masses between 7 and 250, is inductively coupled plasma mass spectroscopy, or ICP-MS. Compared to atomic absorption spectroscopy (AAS), ICP-MS is more sensitive, more flexible in measuring many analytes at once, has a better throughput, and can handle samples with a smaller volume. Furthermore, for many elements, the parts per trillion (ppt) or even parts per quadrillion (ppq) range corresponds to the ICP-MS detection limits. If interference effects are caused by co-contaminants or plasma interactions, the measurement's sensitivity may be decreased. Many of these interferences can be eliminated using ICP-MS instruments equipped with a collision cell, such as the one utilized at Nanocomposix.

Conclusion

Because they have the potential to treat practically all ailments, herbal medications have recently attracted increased attention. However, a number of issues, including low solubility and poor bioavailability, can be resolved with the use of nanoparticles. Numerous nanoparticles, including polymeric nanoparticles, liposomes, proliposomes, solid lipid nanoparticles, and micro emulsions, have the potential to deliver herbal drugs with enhanced therapy.

References:

1. .Raj Kumar Thapa, Gulam Muhammad Khan, 2013. Kalpana Parajuli-Baral, Parbati Thapa. Herbal Medicine Incorporated Nanoparticles:Advancements in Herbal Treatment. Asian Journal of Biomedical and Pharmaceutical Sciences 03(24): 7-14.

2. M. Mohan Varma, K. T. Sunil Kumar and I. Durga Srivalli 2021. A REVIEW ON NANOPARTICLES: SYNTHESIS, CHARACTERIZATION AND APPLICATIONS, World Journal
Of Pharmaceutical And Medical Research, 7(8):169 – 179.

3. Anupam Kumar Sachan* and Ankita Gupta 2015. a review on nanotized herbal drugs, IJPSR, Vol. 6(3): 961-970.

4. Vani Mamillapalli , Amukta Malyada Atmakuri1 2016. Padmalatha Khantamneni,
Nanoparticles for Herbal Extracts, Asian Journal of Pharmaceutics 10 (2): S5

5. Namdeo R Jadhav, Trupti Powar, Santosh Shinde 2014. Sameer Nadaf, Herbal nanoparticles: A patent review, Asian Journal of Pharmaceutics, 1-12

6. Saba Hasan. 2015. A Review on Nanoparticles: Their Synthesis and Types, Research Journal of Recent Sciences.

7. Beena Kumari, 2018. A review on nanoparticle Their preparation method & application, Indian Research Journal of Pharmacy and Science, ;1420-1426

8. Aarti P. Nikam, Mukesh. P. Ratnaparkhiand, Shilpa.P.Chaudhari,2014. NANOPARTICLES – AN OVERVIEW, International Journal of Research and Development in Pharmacy and Life Sciences, ; 3(5): 1121-1127

9. Cristina Buzea, Ivan Pacheco, Kevin Robbie.2007. Nanomaterials and
Nanoparticles: Sources and Toxicity. Biointerphases, ; 2: MR17– MR71.

10. Paul JA, Borm and Wolfgang Kreyling.2004. Toxicological Hazards of Inhaled
Nanoparticles- Potential Implications for Drug Delivery. J Nanosci Nanotech, 4(6):1- 11.

11. Mohsen J, Zahra B.2008. Protein nanoparticle: A unique system as drug delivery vehicles. African Journal of Biotechnology, 25:4926-4934.

12. Rawat M, Singh D, Saraf S, 2006 .Nano carriers: Promising Vehicle for Bioactive Drugs. Biol. Pharm. Bull, 29(9):1790-1798.

13. Gong P, Li H, He X, Wang K, Hu J, Tan W, Tan S, Zhang XY.2007. Preparation and antibacterial activity of Fe3O4 at Ag nanoparticles., Nanotech, 18: 604–611.

14. Mahendra R, Yadav A, Gade A.2009, Biotech Adv, 27(1): 76-83.
15. Rai .M, Yadav A, Gade A.2009. Biotech Adv,; 27(2): 813-817.

16. Sharma VK, RIA AY, Lin Y.2009. Adv Colloid and Interface Sci,; 145: 83-96

17. Bar H, Bhui DK, Sahoo GP, Sarkar P, De SP, Misra A.2009. Colloids and Surfaces, Physicochem.Eng. Aspects, 339: 134-139.

18. Shankar SS, Rai A, Ankamwar B, Singh A, Ahmad A, Sastry.2004. Biological synthesis oftriangular gold Nano prisms. Nat Mater, 3: 482-488.

19. Jha AK, Prasad K.2010. Green Synthesis of Silver Nanoparticles Using Cycas Leaf. Int J Green Nanotech: Physics and Chemistry, 1: 110-117.

20. Baban D, Seymour LW.1998. Control of tumor vascular permeability., Adv Drug Deliv Rev, 34: 109-119

21. Tomar A, Garg G.2013. Short Review on Application of Gold Nanoparticles, Global Journal of Pharmacology, 7 (1): 34-38.

22. Ceylan A, Jastrzembski K, Shah SI. 2006. Enhanced solubility Ag-Cu nanoparticles and their thermaltransport properties. Metallurgical and Materials Transactions A, 37: 2033.

23. Mohl M, Dobo D, Kukovecz A, Konya Z, Kordas K, Wei J, Vajtai R, Ajayan PM. 2011.Electrocatalytic Properties of Carbon Nanotubes Decorated with Copper and Bimetallic CuPd Nanoparticles., J Physics ,Chemistry C, 115: 9403.

24. Gaur A. and Bhatia A. L, Asian J. Mishra B., Bhavesh B., Patel B. B., TIwari 2005.Nanomedicine.

25. la-Van D., McGuire 1: langer R., Nat Biotechnol 2003,. Reverchon E and Adami R.
Nanomaterial and supercritical fluids, 37:1-22.

26. Rolland JP, Maynor BW, Eullis LE, Exner AE, Denison GM and Desimonal JM. Direct fabrication and harvesting of monodispersed shape specific nanobiomaterial.j am chem soc, 127:10096-10100.

27. KompellaUB, Bandi N, Ayalasomayajula SP. 2001 .Poly (lactic acid) nanoparticles for sustained release of bubesonide. Drug deliv Technol (1:1-7)

28. Li YP, Pei YY, Zhou ZH, Zhang XY, GuZH and Ding J.2001 nanoparticles as tumor necrosis factor-[alpha] carriers. J control release. , 71:287-296.

29. Zhang Q, Shen Z and Nagai T 2001. Prolonged hypoglycemic effect of insulin-loaded polybutylcyanoacrylatenanoparticles after pulmonary administration to normal rats.Int J Pharm, 218:75- 80.

30. Boudad H, Legrand P, Lebas G, CheronM, Duchene D and Ponchel G.2001. Combined hydroxypropyl-[beta] - cyclodextrins; nanoparticles intended for oral administration of sequinarvir.
ind j pharm. 2001;218:113-124

31. Ekor, M. 2014.the growing use of herbal medicines: issues relating to adverse reactions and challenges in monitoring safety. front. pharmacol. , 4, 177.

32. Sheridan, H.; Kopp, B. krenn, l.; guo, d.; sendker, j. 2015. Traditional Chinese herbal medicine preparation: invoking the butterfly effect. Science, 350, S64–S66.

33. Li, J.W.; vederas, j.c. 2009 .drug discovery and natural products: end of an era or an endless frontier? Science, 325, 161–165.

34. Jiang, Y.; David, B. 2010. recent analytical approaches in quality control of traditional Chinese medicines review. Anal chim.acta, 657, 9– 18.

35. Atanasov, A.G. waltenberger, b.; pferschy-wenzig, e.m.; linder, t.; wawrosch, c.; uhrin, p.; temml, v.; wang, l.m.; schwaiger, s.; heiss, e.h.; et al. 2015 discovery and resupply of pharmacologically active plant-derived natural products: a review. Bioethanol. adv.33, 1582–1614.

36. Newman, D.J 2016. Cragg, G.M. natural products as sources of new drugs from 1981 to2014. j. nat. prod , 79, 629–661.

37. Elfawal, M.A.; Towler, M.J.; Reich, N.G. weathers, p.j.; rich, s.m. 2015 dried whole- plant artemisia annua slows evolution of malaria drug resistance and overcomes resistance to artemisinin. proc. natl. acad. sci. usa ,112, 821–826.

38. Wagner, H.; Ulrich-Merzenich 2009.g. synergy research: approaching a new generation of phytopharmaceuticals. Phytomedicine, 16, 97–110.

39. Mishra B., Bhavesh B., Patel B. B., TIwari 2010. Nanomedicine: Nanotechnology, Biology, and Medicine , 6: 9 -24

40. Reverchon E and Adami R. 2006. Nanomaterial and supercritical fluids. ;37:1-22

41. Rolland JP, Maynor BW, Eullis LE, Exner AE, Denison GM and Desimonal JM. 2005 .Direct fabrication and harvesting of monodispersed shape specific nanobiomaterial. J Am Chem Soc., 127:10096-10100.

42. KompellaUB, Bandi N, Ayalasomayajula SP.2001. Poly(lactic acid) nanoparticles for sustained release of bubesonide. Drug deliv Technol. 1:1-7.

43. Li YP, Pei YY, Zhou ZH, Zhang XY, Guzu and Ding J.2001. Nanoparticles as tumor necrosis factor[alpha] carriers. J control release. 71:287-296.

44. Champeau Rachel. 2006. Assessing safety health risks of nanomaterials.15:2005.

45. Kreuter J, Ramage PV, Hamm S, Gelpenia SE, Engeltatdt B and AlyantdinRyvonBriesen H.2003. Direct evidence that polysorbate -80 coated poly (butylcyanocrylate) nanoparticles deliver drugs to the CNS via specific mechanisms required prior binding of drug to the nanoparticles. PhrmRes.20:409-16.

46. Jin Y, Wu M and Zhaox. 2005. Toxicity of nanomaterial's to living cells.274-277.

47. Delvecchio Rick.2006. Berkeley considering need for nano safety.articles.sfgate.com;

48. Cho K, Wang X, Nie S, et al. Therapeutic nanoparticles for drug delivery in cancer. Clin

49. Cincinnati, OH, Approaches to safe nano-technology; an information exchange with NIOSH; 2006, www.(dc.gov/niosh/topics/nano/exchange.hmt.)

50. Kaur IP, Bhandari R, Bhandari S, 2008.et al. Potential of solid lipid nanoparticles in brain targeting. J Control Release, 127:97–109.

51. Theresa Phillipos.2009. Nanoparticles safe !About .co. Guide.