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Nanoparticle As A Novel Drug Dilivery System: A Review

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Abstract*: Nanotechnology is the science that deals with matter at the scale of 1 billionth of a meter and is also the study of manipulating matter at the atomic and molecular scale. Recently particulate systems like nanoparticles have been used as a physical approach to alter and improve the quality of human life. The potential use of polymeric nanoparticles as carriers for a wide range of drugs for therapeutic applications has been increased due to their versatility and wide range of properties Different types of nanoparticulate material used in electronic, magnetic pharmaceutical, cosmetics, energy, catalytic and material industries. In this review the systhesis method of nanoparticals and their applications has been discussed..*

Keywords: Nanoparticles, Methods of preparation evaluation, route of administration.

I. INTRODUCTION

The prefix "nano" comes from the ancient Greek Vanoc through the latten nanus meaning very small. Nanotechnology employs knowledge from the fields of physics, chemistry, biology, materials science, health sciences, and engineering.
It has immense applications in almost all the fields of science and human life. Nanoparticles can be defined as particulate dispersions or solid particles with a size in the range of 10-1000nm [1].
A Manometer is billionth of a meter, which is 250 millionth of inch, about 1/80,000 of the diameter of a human hair or 10 times of the diameter of hydrogen atom [23].
The use of plant extract in the synthesis of nanoparticles have proven to be cost effective and opens up a wide area in non-toxic nanoparticle synthesis.
Drug is confined to a cavity surrounded by a unique polymer membrane called nanospheres and,while nanospheres are matrix systems in which the which the drug is physically and uniformly dispersed.

Advantages of nanoparticles

Nanoparticles offers numerous advantage in drug delivery system. These advantage include, but are not limited:

- Nanoparticles have many significant advantage over conventional and traditional drug delivery system.
- Nanoparticles are control and sustain release form at the site of localization, they alter organ distribution of drug compound. They enhance drug circulation in blood, bioavailability, therapeutic efficacy and reduce.
- Nanoparticles can be administer by various routes including oral, nasal, parenteral, intra-ocular etc.
- Ease of formulating smaller drug doses.
- Less toxicity.
- Good control over size and size distribution.
- Protects the encapsulated drug from degradation.
- Faster dissolution generally equates with greater bioavailability.
- Improving drug bioavailability through enhancing aqueous solubility.

The use of biodegradable materials for nanoparticle preparation allows sustained drug release within the target site over a period of days or even weeks.

Limitations:

- Their small size and large surface area can lead to particle aggregation, making physical handling of nanoparticles difficult in liquid and dry forms.

- In addition, small particles size and large surface areas readily result in limited drug loading and burst release.
- The major threat to safety question is yet to be revealed. Due to small size, nanoparticles could gain access to unintended environments with harmful consequences such as a nanoparticle might erroneously cross the nuclear envelope of a cell & cause genetic damage & mutations.

Type of nanoparticles

According to material used for synthesis, nanoparticle is classified as follows:

a) Polymeric Nanoparticles.
b) Solid Lipid Nanoparticles.
c) Peglyted Nanoparticle.
d) Magnetic Nanoparticle.
e) Metallic Nanoparticle.

Different techniques for preparation of nanoparticles:

1) Amphiphilic macromolecule cross-linking:

a) heat-cross linking.
b) Chemical cross linking.

2) Polymer precipitation methods:

a) Solvent extraction.
b) Solvent displacement.
c) Salting out.

3) Polymerization based methods:

a) Emulsion polymerization.
b) Dispersion polymerization.
c) Interfacial polymerization.

4) Miscellaneous:

1) Amphiphilic macromolecule cross-linking:

It involves aggregation of amphiphile followed by further stabilization either denaturation or chemical cross linking by heat.

Cross linking in w/o emulsion. The cross-linking method is used for the nano- encapsulation of drug. The method involves the emulsification of bovine serum albumin (BSA/Human serum albumin) or protein aqueous solution in oil using high pressure homogenization.

1) Emulsion Chemical dehydration:

It is used for producing BSA nanoparticles with a narrow size distribution. Hydroxy propyl cellulose solution in chloroform was used as a continuous phase of emulsion.

A chemical dehydrating agent 2, 2-dimethyl propane was used to translate internal aqueous phase into a solid particulate suspension.

This method avoids coalescence of droplets and could produce nanoparticles of small size.

2) Nanoparticle preparation using polymer precipitation methods:

The polymer precipitation occurs as consequence of the solvent extraction/evoparation at which can be brought by;

a) Increasing the solubility of the organic solvent in the external medium by adding an alcohol (i.e isoproprонolol).
b) By incorporating additional amount of water into the ultra-emulsion.

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a) Solvent evaporation:

polymer solutions are prepared in a volatile solvent and emulsion is formulated.

The emulsion is converted into a nanoparticles suspension on evaporation of the solvent for the polymer, which is allowed to diffuse across the continuous phase.

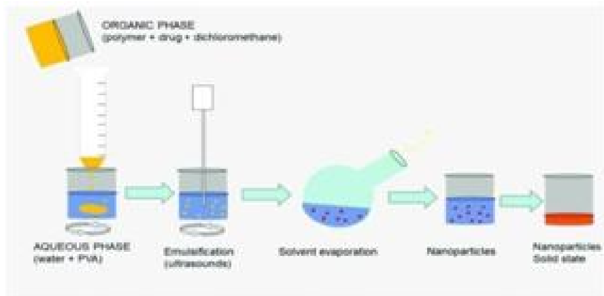

Fig no-1

b) Nano precipitation:

Also known as the solvent displacement method, the basic principle of this method is based on the interfacial deposition of a polymer after displacement of a semipolar solvent, miscible with water, from a lipophilic solution. Rapid diffusion of the solvent into non-solvent phase results in the decrease of interfacial tension between the two phases, which increases the surface area and leads to the formation of small droplets of organic solvent.

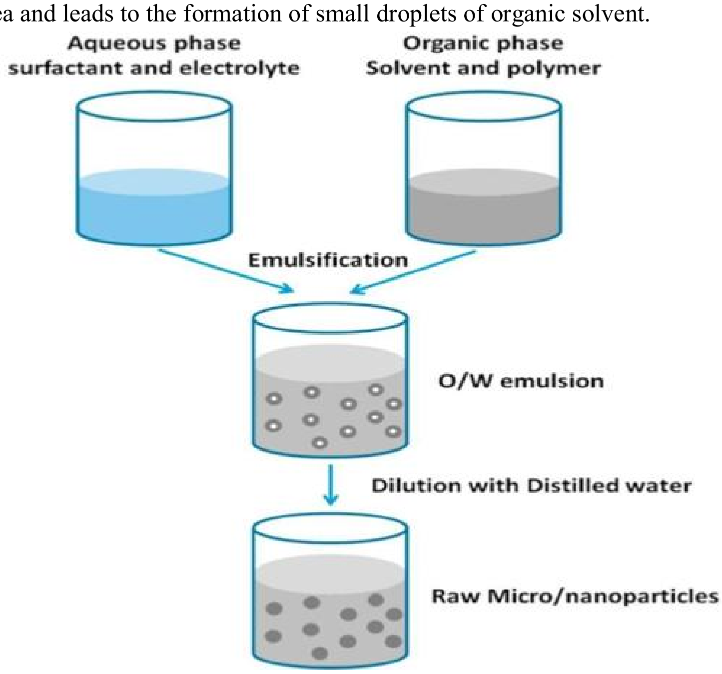

Fig no -2

c) Salting out:

This process is a modified version of emulsion process which involves a salting-out process, which avoids surfactants and 23 International Journal of Research in Pharmacy and Pharmaceutical Sciences chlorinated solvents.

The emulsion is formulated with a polymer solvent which completely miscible with water and emulsification of the polymer solution in the aqueous phase is achieved, without utilization of any high sheer forces, by dissolving high concentration of salt or sucrose chosen for a strong salting-out effect in the aqueous phase.

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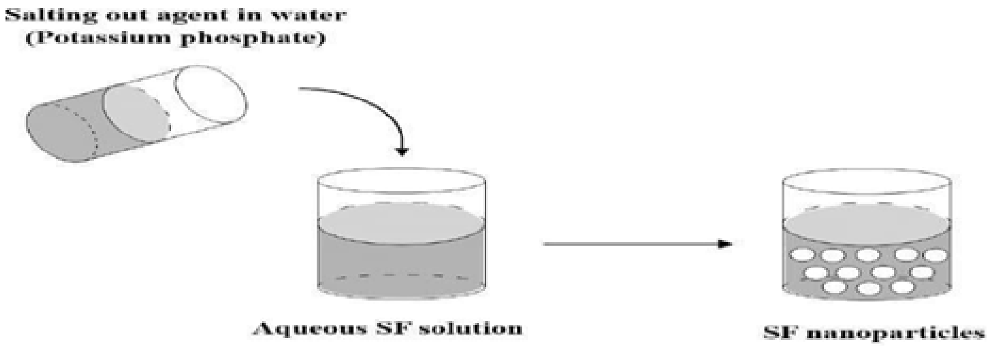

Fig no-3

3) Polymerization based methods:
Polmerization of monomers in an aqueous solution form the basis of this method. Two different techniques are used for the preparation in aqueous solution.
a) Emulsion polymerization: - This method involves emulsification of monomer in non-solvent phase.
b) Dispersion polymerization: - This method involves dispersion of monomer in non-solvent phase.

4) Miscellaneous:
a) Coacervation or ionic gelation method:
Chitosan, sodium alginate and gelatin are hydrophilic biodegradable polymers which are used for the preparation of nanoparticles by coacervation method.
Preparation of hydrophilic chitosan nanoparticles by ionic gelation was developed by Calvo and Co-worker.

b) Production of nanoparticles using supercritical fluid technology:
Various conventional approaches like solvent diffusion, solvent extraction- evaporation and organic phase separtion require the use of organic solvent are hazardous to the environment as well as the physiological systems.
Supercritical fluid technology thus has been invested as an alternative to prepare biodegradable micro and Nanoparticles.
Formation of hydrophilic drug Dexamethsone phosphate by the use of modified SAS had been reported by Thote and Gupta (2005). RESS diffuse from SAS process in that its solute in dissolved in super critical fluid.
Thus with solvent power of supercritical fluid decrease and the solute eventually precipitate.

Characterization of Nanoparticles:
1. Study of drug excipient-interaction.
2. Particle size analysis and stability.
   - Particle Size
   - Zeta Potential
3. Surface morphology (SEM).
4. Drug content.
5. Encapsulation efficiency.

Synthesis of Nanoparticles:
Nanoparticles can be synthesized chemically or biologically. Many adverse effects have been associated with chemical synthesis methods due to the presence of some toxic chemical absorbed on the surface.
Eco friendly alternatives to Chemical and physical methods are Biological ways of nanoparticles synthesis using microorganisms, enzymes, fungi and plants or plant extracts.

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The developments of these ecofriendly methods for the synthesis of nanoparticles is evolving info an important branch of nanotechnology especially silver nanoparticles, which have many applications.

Biosynthesis: Mechanism:

Biosynthesis of nanoparticles by microorganisms is a green and eco-friendly technology.

Diverse microorganisms, both International Science Congress Association prokaryotes and eukaryotes are used for synthesis of metallic nanoparticles viz. silver, gold, platinum, zirconium, palladium, iron, cadmium and metal oxides such as titanium oxide, zinc oxide, etc.

These microorganisms include bacteria, actinomycetes, fungi and algae. The synthesis of nanoparticles may be intracellular or extracellular according to the location of nanoparticles.

Intracellular synthesis of nanoparticles by fungi:

This method involves transport of ions into microbial cells to form nanoparticles in the presence of enzymes.

As compared to the size of extracellularly reduced nanoparticles, the nanoparticles formed inside the organism are smaller.

Extracellular synthesis of nanoparticles by fungi:

Extracellular synthesis of nanoparticles has more applications as compared to intracellular synthesis since it is void of unnecessary adjoining cellular components from the cell.

Mostly, fungi are known to produce nanoparticles extracellularly because of their enormous secretory components.

Microbes for production of nanoparticles:

Both unicellular and multicellular organisms produce inorganic materials either intra- or extracellularly14.

The ability of microorganisms like bacteria and fungi to control the synthesis of metallic nanoparticles is employed in the search for new materials.

Nanoparticles Types:

Silver:

Silver nanoparticles have proved to be most effective because of it's good antimicrobial efficacy against bacteria, viruses and other eukaryotic micro- organisms.

They are undoubtedly the most widely used nanomaterials among all, thereby being used as antimicrobial agents, in textile industries, for water treatment, sunscreen lotions etc.

Studies have already reported the successful biosynthesis of silver nanoparticles by plants such as Azadirachta indica20, Capsicum annuum 21 and Carica papaya22.

Gold:

Gold nanoparticles (AuNPs) are used in immunochemical studies for identification of protein interactions.

They are used as lab tracer in DNA fingerprinting to detect presence of DNA in a sample.

They are also used for detection of aminoglycoside antibiotics like streptomycin, gentamycin and neomycin.

Alloy:

Alloy nanoparticles exhibit structural properties that are different from their bulk samples. Since Ag has the highest electrical conductivity among metal fillers and, unlike many other metals, their oxides have relatively better conductivity Ag flakes are most widely used.

Bimetallic alloy nanoparticles properties are influenced by both metals and show more advantages over ordinary metallic NPs.

Magnetic:

Magnetic nanoparticles like Fe_3O_4 (magnetite) and Fe_2O_3 (maghemite) are known to be biocompatible.

They have been actively investigated for targeted cancer treatment (magnetic hyperthermia), stem cell sorting and manipulation, guided drug delivery, gene therapy, DNA analysis, and magnetic resonance imaging (MRI).

Applications:

Nanomedicine has tremendous prospects for the improvement of the diagnosis and treatment of human diseases.

Use of microbes in biosynthesis of nanoparticles is an environmentally acceptable procedure.

Nanotechnology has potential to revolutionize a wide array of tools in biotechnology so that they are more personalized, portable, cheaper, safer, and easier to administer.

II. REVIEW OF LITERATURE

1. Saad Haroon Anwar' a brief review on nanoparticles: types of platform, biological synthesis and applications.
2. Tinatin Doolotkeldieva, Saikal bobusheva, Zhanarbek Zhasnakunov, and Abduraim Satybaldiev.Biological activity on Ag and Cu monometallic nanoparticles and Ag-Cu bimetallic Nonocomposites against plant pathogens and seeds.
3. Alessio Becheri. Maximilian Durr. Pierandrea Lo Nostro. Piero Baglioni. Synthesis and characterization of zinc oxide nanoparticles: application to textiles as UV absorbers.
4. Anup A Teragundi, Bhavana K B, Dr T S Nanjundeswaraswamy, literature review on synthesis of zinO nano particles using natural and synthetic methods.

III. CONCLUSION

In this review, we presented a brief overview about NPs, types of nanoparticles platforms, their biological synthesis and applications.

Due to their small size, NPs have large surface area, which make them suitable candidate for various applications.

Different biological methods for the synthesis of nanoparticles are also briefy described in the review.

Furthermore, medicinal applications and its uses in routine life are briefy discussed in the review.

Nanoparticle technologies have great potentials, being able to convert poorly soluble, poorly absorbed and labile biologically active substance info promising deliverable substance.

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