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A REVIEW: NANOPARTICLES LOADED DRUG DELIVERY SYSTEM USING NATURAL POLYMER

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ABSTRACT

Nanoparticles can be defined as colloidal particles. Nanoparticles are the basic components of Nano technology. The nanoparticles range in size from 1 to 100 nm and are composed of metal, metal oxides, organic material and carbon. Nanoparticles come in different sizes, shapes and sizes regardless of the material they are made of. The surface may be irregular with surface variations or uniform. The advantage of nanotechnology is the delivery of safe and effective medicines (nanomedicine) with a significant impact on the pharmaceutical and biotech industry landscape. Nanomedicine is a broad field and includes nanoparticles acting as biological mimics (e.g. functionalized carbon nanotubes), "nanomacha" (e.g. those made up of interchangeable pieces of DNA, and DNA -scaffolds such as the octahedron and the cube) and nanofibers and polymers nanostructures as biomaterials ,shape memory polymers such as molecular switches, and devices based on nanoscale microfabrication, sensors, and laboratory diagnostics.The prefix "nano" has found in last decade an ever-increasing application to different fields of the knowledge. Inflammation is generally defined as a response to stimulation by invading pathogens or endogenous signals such as damaged cells that results in tissue repair or sometimes pathology, when the response goes unchecked. Active ingredient and excipients are two main ingredients of any pharmaceutical formulation. This paper presents a review on Nanoparticles their types, properties, synthesis methods and its applications.

KEYWORD: Nanoparticles, Drug delivery, Collagen, Inflammatory disease, Treatment.

INTRODUCTION

The prefix "nano" has seen increasing use in various fields of knowledge over the last decade. Nano sciences, nanotechnologies, nanomaterials or nano chemistry are some of the new nano terms that appear frequently in scientific reports, popular books and newspapers and have become known to a wide public, including lay people. The prefix comes from Ancient Greek νᾶνος via Latin nanus, which literally means dwarf, and by extension, very small.[1]

In the International System of Units (SI) convention, means a reduction factor of 109. Thus, a nanoscale world is typically measured in nanometers (1 nm equals 10-9 m) and includes systems whose molecular dimensions are greater than and smaller than macroscopic (generally > 1 nm and < 100 nm).[2,3]

Nanoparticles can be defined as colloidal particles ranging in size from to 1000 nm. The advantage of nanotechnology is the effective delivery of drugs (nanodrugs) identified as have a significant impact on the landscape of the pharmaceutical and biotechnology industries. They have applications in various areas of the life sciences such as separation technology, histology, clinical diagnostic tests, and drug delivery systems (DDS).[4]

Nanoparticle research is currently an area of intense scientific interest. The reason why nanoparticles are attractive is based on the important and unique characteristics of, such as their surface-to-mass ratio, which is much larger than that of other particles and materials., the ability to absorb and transport other materials. compounds such as drugs, probes and proteins as well as allowing to catalyze reactions.[4,5]

Recent research has developed a range of nanoparticles such as metals, semiconductors and polymer particles for use in molecular imaging and particle carriers. Polyethylenimine liposomes, silica nanoparticles, micelles and chitosans play an important role in drug delivery with minimized side effects.[6] They have also been used as anticancer agents. Basically, nanotechnology is concerned with the construction of artificial cells, enzymes, genes, or repair in the synthesis of the protein. In this Review, we discuss the synthesis, types, applications, advantages, and limitations of nanoparticles.[7]

Advantages of Nanoparticles

- After parenteral administration to obtain passive and active agents targeting particle size and surface properties of nanoparticles, can be easily manipulated.
- Site-specific targeting can be achieved by attaching targeting ligands to the surface of the particles or by using the magnetic guide.
- The system can be used for a variety of routes of administration, including oral, ophthalmic, parenteral and intranasal administration.
- In the body, drug delivery to small areas is best achieved with nanoparticles.
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- In the body, drug delivery in small areas can best be achieved with nanoparticles.[8-11]

Limitations

Despite these advantages, nanoparticles present limitations, such as.

1. Altered physical properties leading to particle-to-particle aggregation, making physical handling of liquid and dry nanoparticles difficult due to their smaller size and their largest surface difficult.
2. The smaller the particle size, the greater the surface area, and this property makes nanoparticles very reactive in the cellular environment.
3. The small particle size results in limited drug loading and pulse delivery. These practical problems must be solved before nanoparticles can be used clinically or commercially.
4. The small size and large surface area can lead to aggregation of nanoparticles, making physical manipulation of nanoparticles in liquid and dry form difficult.
5. In addition, the small particle size and high surface area of easily result in limited drug loading and burst release. These practical problems must be overcome before nanoparticles can be used clinically or commercially.[12-15]

Applications of NPs

1. Nanoscale inorganic particles of simple or complex nature exhibit unique chemical and physical properties and represent an increasingly important material in the development of

novel nanodevices that can be used in many physical, biological, biomedical and pharmaceutical applications.

2. Nanocrystalline materials provide very interesting substances for materials science because their properties differ from the corresponding bulk materials in a size-dependent manner.

3. The increasing location of engineered NPs in industrial and domestic applications leads to the release of these materials into the environment. Risk assessment of these NPs in the environment requires understanding their mobility, reactivity, ecotoxicity, and persistence.

4. There has been growing interest in the development of printed electronics in recent years as printed electronics offer the appeal of traditional silicon engineering and the potential for low-cost, large-scale electronics. Large area for flexible screen, sensor.

5. Recent studies have warned us about the limits and scarcity of fossil fuels in the coming years due to their non-renewable nature.[16-19]

Characterization and properties NPs

Different characterization techniques were used to analyze the different physicochemical properties of the NPs.[20]

1. *Morphological characterizations*

The morphological properties of NPs are always of great interest as morphology still influences most properties of NPs. There are various characterization techniques for morphological studies, but the most important are microscopic techniques such as polarized light microscopy (POM), SEM and TEM. The SEM technique is based on the principle of electron scanning and provides all available information about nanoparticles on a nanometric scale. There is an extensive literature where people have used this technique not only to study the morphology of their nanomaterials but also the dispersion of nanoparticles within a volume or matrix.[20-23]

2. *Structural characterizations*

Structural features are of primary importance for studying the composition and properties of bonding materials. It provides various information about the overall properties of the material in question. XRD, energy dispersive X-ray size (EDX) analyzers, XPS, IR, Raman, BET and Zieta are commonly used techniques to study the structural properties of NPs.[20,24] XRD is one of the most important characterization techniques to reveal the structural properties of NPs. It provides enough information about the crystallinity and phase of NPs. It also provides an approximate idea of the particle size using the Debye Scherer formula. This

technique works well for the identification of single- and multi-phase NPs. However, in the case of smaller NPs with sizes smaller than hundreds of atoms, it can be difficult to obtain and accurately measure the structure and other parameters.[25-27]

3. *Particle size and surface area characterization*

Various techniques can be used to estimate the size of NPs. These include SEM, TEM, XRD, AFM, and dynamic light scattering (DLS). SEM, TEM, XRD and AFM can give a better idea of the particle size, but the Zeta Potential Size Analyzer/DLS can be used to find the size of NPs at extremely low levels. In one study, Sikora et al. used DLS technique to study the size change of silica NPs with serum protein uptake. The results show that the size increases when the protein layer is obtained. This technique allows to find the size distribution profiles of NPs with diameters from 10 to 1000 nm in the liquid medium. This technique produces good results compared to DLS and has been found to be very accurate for sizing both single-dispersion and multi-dispersion samples, with significantly better peak resolution.[28,29]

4. *Optical characterizations*

Optical properties are of great importance in photocatalytic applications, which is why photochemists have developed a good understanding of this technique to unveil the mechanism of their photochemical processes. These features are based on the famous Lambert-Beer law and basic lighting principles. These techniques provide information about the absorption, reflection, luminescence, and phosphorescence properties of nanoparticles. It is known that NPs, especially metal and semiconductor NPs, have different colors and are therefore more suitable for photographic applications.[30-32]

METHOD OF PREPARATION FOR NANOPARTICLES

Various methods can be used to produce nanoparticles. For example, drugs can be encapsulated in a polymer matrix, encapsulated in a nanoparticle core, encapsulated in a polymer shell chemically conjugated to the polymer, or they can be bound to the surface of the particle by adsorption be.[33]

Fig: Method of Preparation for Nanoparticles.

A. Emulsion solvent evaporation Method

One of the methods of obtaining nanoparticles using the method is the emulsification solvent evaporation technique. It is generally used to encapsulate hydrophobic drugs, but shows poor results when incorporating bioactive agents of hydrophilic nature.[34,35] Evaporation of the solvent is performed on the polymer and the compound is dissolved in an organic solvent such as chloroform, ethyl acetate or methylene chloride and then emulsified with in an aqueous phase containing the stabilizer (e.g. PAV). Immediately after the formation of the nano-emulsion, the solvent diffuses into the outer phase until saturated. The solvent molecules that reach the water-air interface evaporate, resulting in a continuous diffusion of the solvent molecules from the inner droplets of the emulsion toward the outer phase; At the same time, the precipitation of the polymer leads to the formation of nanospheres.[30,32]

B. Emulsion Diffusion Evaporation Method

Another method that can be used to produce nanoparticles is the diffusion emulsion method. The method uses a partially water-soluble solvent such as acetone or propylene carbonate. The polymer and active ingredient are dissolved in the solvent and emulsified in the aqueous phase containing the stabilizer. The role of the stabilizer prevents the aggregation of the emulsion droplets by adsorption on the surface of the droplets. Addition of water to the

emulsion, allowing the solvent to diffuse into the water. The solution is mixed, resulting in the precipitation of nanoparticles. In addition, it can be collected by centrifugation or the solvent can be effectively removed by dialysis.[33-35]

The main problem with this method is that water-soluble drugs tend to leach out of the polymer phase during the diffusion steps. In order to avoid this problem, in, the dispersion medium of was changed from aqueous medium to medium-chain triglycerides, and a small amount of surfactant was added. The nanoparticles are recovered from the oil suspension by centrifugation.[36]

C. Nanoprecipitation method

Nanoparticles can be synthesized by nanoprecipitation. In this method, the polymer and drug are dissolved in acetone, ethanol, or methanol and mixed in an aqueous solution of the surfactant using a magnetic stirrer. The organic solvent immediately diffuses into the outer aqueous phase, followed by the precipitation of the polymer and the drug. Once the nanoparticles have formed, the solvent is removed and the suspension concentrated under reduced pressure. The advantage of this method is that no surfactant is used; However, this method is limited to highly soluble drugs in a polar solvent.[37,38]

D. Salting -Out Method

The salting out method is another method for obtaining nanoparticles. This technique, based on the precipitation of a hydrophobic polymer, is suitable for encapsulating hydrophilic or hydrophobic drugs, since different solvents, including polar (e.g., acetone or methanol) and non-polar (e.g., acetone or methanol) and non-polar (methylene or chloroform), can be selected Drugs remover.[38]

Evaluation of Nanoparticles

Zeta potential

The Zeta potential of nanoparticles is commonly used to describe the surface charge properties of nanoparticles. It reflects the potential of the particles and is affected by the composition of the particle and the medium in which it is dispersed. Nanoparticles with a zeta potential greater than (±) 30 mV have been shown to be stable in suspension, as the surface charge prevents the agglomeration of the particles.[15-17]

Particle Shape

SEM characterizes the nano-suspension before conducting the evaluation; The nano suspension was lyophilized to form solid particles. Solid particles are coated with platinum alloy by spray paint.[19]

Particle size

Particle size and distribution are the most important characteristics of nanoparticle systems. They determine the in vivo distribution, biological fate, toxicity and targeting ability of the nanoparticle system. In addition, they can also affect drug loading, drug release, and stability of nanoparticles.[10]

The currently fastest and most common method for particle size determination is photon correlation spectroscopy or dynamic light scattering. The results obtained with photon correlation spectroscopy are usually verified by scanning or transmission electron microscopy (SEM or TEM).[18]

Drug Entrapmaent Efficiency

The nanoparticles were separated from the aqueous medium by ultracentrifugation at 10,000 rpm for 30 minutes at 50°C. The resulting supernatant was then decanted and dispersed in phosphate buffered saline, pH 7.4. Therefore, the process was repeated twice to completely remove unentrapped drug particles. The amount of drug entrapped in the nanoparticles was defined as the difference between the total amount of drug used to prepare the nanoparticles and the amount of drug present in the aqueous medium. Drug capture efficiency (%) = amount of lysed nanoparticles released x 100 amount of drug initially absorbed to produce nanoparticles.[20,21]

Nanoparticles for Inflammatory Drug Delivery

Although they provide little or no recognition signal, some advances in the use of nanoparticles to deliver anti-inflammatory drugs are worth noting. RA is a chronic, progressive autoimmune disease characterized by inflammation and destruction of the joints. Therapeutic drugs are available; However, their usefulness is limited by undesirable side effects that occur with long-term use at high doses. A better but less practical approach is to deliver drugs directly to the site of inflammation by intra-articular injection, which requires skillful administration at multiple sites, making therapy costly and time-consuming. The most

desirable approach would be to develop carriers such as nanoparticles that can deliver the payload directly to the site of ignition.[39-41]

Nanoparticles such as drugs encapsulated in liposomes have emerged as potential candidates and have been used to encapsulate and deliver clodronate- and glucocorticoid-based drugs in the treatment of arthritis in an animal model. In another arthritis model, showed that intravenously administered clodronate-liposomes can inhibit disease onset by targeting macrophages. An alternative approach was to encapsulate the glucocorticoid prednisolone in PEG-coated liposomes and administer the nanoparticles to rats with adjuvant-induced arthritis. Analysis showed that the nanoparticle approach was 10 times more effective than the "free" control, with symptoms disappearing by 2 days and complete remission occurring by 6 days.

Like the other approaches discussed in this review, coating liposomes with PEG polymers increases in vivo stability and has resulted in a series of long-circulating drug transporters known as sterically stabilized liposomes.[41-42]

NANOPARTICLE-BASED DRUG DELIVERY SYSTEM IN ANTI-INFLAMMATORY TREATMENT

Recently, several hybrid NPs have been investigated for anti-inflammatory treatment. For better biocompatibility and targeting ability of, recent research mentions that or more materials are synthesized into nanostructures and the properties of each material are fully utilized. Each structure has a different feature that allows NPs to be placed in the corresponding tissues. The synthesized NPs are used as carriers and loaded with anti-inflammatory drugs to form a NPs-based drug delivery system.[40-42]

Connection between Inflammation and Diseases

1. Inflammation in cardiovascular diseases

Inflammation is an important pathophysiological symptom in vascular disease, ischemic heart injury and ischemic brain injury. There is evidence that inflammation plays a role in atherosclerosis from the onset of atherosclerosis to the progression of atherosclerotic lesions. Inflammation also affects the stability of atherosclerotic plaques. In addition, the role of inflammation is also important in ischemic heart injury and ischemic brain injury.[43] There is good evidence that locally active inflammation is the main cause of plaque formation and composition. Mature plaque contains a central core of necrotic tissue and a fatty infiltrate

surrounded by inflammatory cells. Atherosclerotic plaques are covered by a cap rich in cells and fibrous tissue called the fibrous cap. This plug seals the procoagulants and platelet-activating materials in the vessel wall, preventing them from interacting with blood clotting factors and platelets.[44]

2. Inflammation in the gastrointestinal tract

Inflammation of the digestive system can be thought of as a preservation mechanism, a means by which the host protects itself from invading pathogens and noxious stimuli. The inflammatory response aims to remove and inactivate the pollutant and is assisted by a variety of cellular proteases and reactive oxygen products, as well as soluble mediators. The inflammation usually goes away on its own. However, in some cases, the inflammation can become chronic and lead to excessive tissue damage as long as the triggers persist.[45-48] Infection with Helicobacter pylori is associated with inflammation in the digestive tract. Helicobacter pylori inhabits more than half of the world's population and is an important risk factor for gastric ulcers, gastric adenocarcinoma and gastric lymphoma.

Damage to the gastric mucosa results from the host's immune response to Helicobacter pylori infection and not from the bacterium itself. During the innate immune response to infection, the bacterium induces rapid recruitment of neutrophils, followed by T cells, B cells, plasma cells and macrophages. Activated neutrophils contribute to epithelial cell damage by releasing proteolytic enzymes and reactive oxygen species.[49-51]

3. Inflammation in skin diseases

Psoriasis is a skin condition caused by chronic inflammation. In a genetically prepared person, there is a complicated relationship between the innate immune system and the adaptive immune system when responding to unidentified antigens. Immune cells, including T cells, DCs, monocytes and macrophages, are thought to contribute to the progression of psoriasis. Among the T cell subsets, cytotoxic T cells (CD8þ T cells, CTL) are mainly localized in the epithelial tissue near keratinocytes and Langerhans cells, while helper T cells (CD4þ, Th) mainly in it reside the papillary dermis. It is believed that T cells in the epithelium are involved in the pathogenesis of psoriasis. Helper T cells 1 are thought to be a phenotype of memory-activated T cells involved in the development of psoriasis, and helper T cells 17 are another important component with a potential role in the pathogenesis of psoriasis. Antigen-presenting DCs have the ability to fuel the adaptive immune system by activating T cells, B cells, and natural killer cells.

As the number of cutaneous DCs increases, cytokine production from autologous T cells in psoriatic lesions will also increase.[52-55]

4. Inflammation in cancer

Epidemiological data also show a compelling link between chronic inflammation and the malignant transformation of inflamed tissue into cancer. These cells and mediators that contribute to inflammation also contribute to the tumor microenvironment. In some cancers, inflammation precedes tumor development, but in other cancers, oncogenic changes cause the tumor to promote inflammation. Tumor angiogenesis and metastasis are also associated with inflammation. tumor cells recruit neutrophils and macrophages through the expression of cytokines. The cytokine and chemokine network is involved in tumor-related inflammation and can regulate both normal and tumor cells in the tumor microenvironment. Pro-inflammatory mediators such as proteases, eicosanoids, cytokines and chemokines are generally overexpressed by tumor cells.[49,55-58]

5. Inflammation in rheumatoid arthritis

New arthritis is not uncommon and about half of arthritis sufferers go away on their own within months. Otherwise, however, the inflammation that leads to arthritis cannot be eliminated, contributing to the progression of a chronic disease characterized by the accumulation of leukocytes and stromal cells marked in the synovia.

Rheumatoid arthritis (RA) is the most common type of arthritis that progresses with persistent inflammation. Symmetrical peripheral inflammatory polyarthritis is one of the symptoms of rheumatoid arthritis. Many immune cells are involved in the inflammation in the early stages of rheumatoid arthritis. After the onset of clinical joint pathology, the synovia, which is usually hypocellular, becomes hyperplastic. RA is also associated with inflammatory diseases of the skin, lungs and vascular system. Although systemic lupus erythematosus has symptoms similar to those of rheumatoid arthritis, the role of inflammation in its development is nearly the same.[59-61]

6. Inflammation in other diseases

Pneumonia is a normal, basic physiological response, but it can also accompany certain respiratory diseases, particularly chronic inflammation. Chronic inflammation is closely associated with many lung diseases such as asthma, chronic obstructive pulmonary disease, bronchiectasis and interstitial lung disease. Although the purpose of inflammation is defense,

an overreaction of the immune system can lead to severe respiratory disease, and acute inflammation can also lead to lung disease. Breathing in a specific pathogen, toxin, or allergen can trigger an immune system response and lead to aggravation of bronchiectasis, chronic obstructive pulmonary disease, and asthma. Inflammation of the central nervous system occurs after a brain injury.

The immediate cause can be a hypoxic event such as stroke, chronic neurodegeneration, or an infectious process.[62-65]

CONCLUSION

Nanoparticles are a promising drug carrier for various drug delivery systems. Nanotechnology is a revolutionary technology that permeates all areas. new applications in this area are being researched worldwide. Nanoparticles represent a technology to overcome drug solubility and bioavailability problems, which can be applied to all poorly soluble drugs in general. Due to their unusual chemical and physical properties, nanoparticles show interesting properties and are suitable for various areas of pharmacy. Various methods have been developed to produce nanoparticles of various sizes and shapes, including evaporation of a solvent emulsion.

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