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A REVIEW ON CHITOSAN NANOPARTICLES

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Abstract: The chitosan nanoparticles because of their biodegradability, biocompatibility, better stability, low toxicity, simple and mild preparation methods, offer a valuable tool to novel drug delivery systems in the present. The methods such as micro emulsion method, emulsification solvent diffusion method are also in use. The present review describes properties, different methods of preparation and applications of chitosan nanoparticles.

Keywords: Chitosan, Nanoparticles, Ionotropic gelation method

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INTRODUCTION

The nanoparticles are defined as the particulate dispersions or the solid particles with the size in a range in between 10-1000nm. In this the drug is dissolved, entrapped, encapsulated or attached to the nanoparticle matrix. The Nano capsules, nanoparticles or Nano spheres can be obtained, depending upon the method of preparation. The Nano spheres are the matrix systems in which the drug is physically & uniformly dispersed. The Nano capsules are the systems in which a drug is confined to the cavity which is surrounded by the unique polymer membrane. The biodegradable polymeric nanoparticles particularly those that are coated with the hydrophilic polymer such as the PEG [polyethylene glycol] known as the long-circulating particles in the recent years, have been used as the potential devices for drug delivery due to their ability to circulate for the prolonged period time target the particular organ as the carriers of the DNA in the gene therapy & their ability to deliver the genes, proteins & peptides. In designing the nanoparticles as the delivery system the major goals are to control the particle size, surface properties & to release of the pharmacologically active agents in order to achieve a site specific action of a drug at the therapeutically optimal rate & the dose regimen. A physical approach to alter a pharmacodynamics & pharmacokinetic properties of the API [Active pharmaceutical ingredient] is a particulate drug delivery system nanoparticles approach. In the drug delivery system, the nanoparticles have captured a lot of attention of the pharmaceutical scientist due to its versatility in the accessing deep molecular targets, controlling drug release & targeting tissues. The nanoparticles are composed of the natural, semi-synthetic or the synthetic polymers encapsulating the drug molecule & they are the solid colloidal drug carriers ranging from 10-1000 nm in diameter. Because of its techniques biocompatibility, biodegradability, the easier formulation & versatility in the applications aided with the low toxicity the chitosan offers certain advantages over the other amongst the polymeric carriers for the Nano particulate drug delivery. [1-4]

PROPERTIES OF CHITOSAN

In the past decade the chitosan has attracted the increasing attention because of its unique properties which include the biodegradation, nontoxicity & biocompatibility & including many others. The One among the much exploited & notable is the antimicrobial commotion inhibiting a growth of the wide variety of the bacteria, fungi & yeasts & making it useful for the use in the biomedicine field.

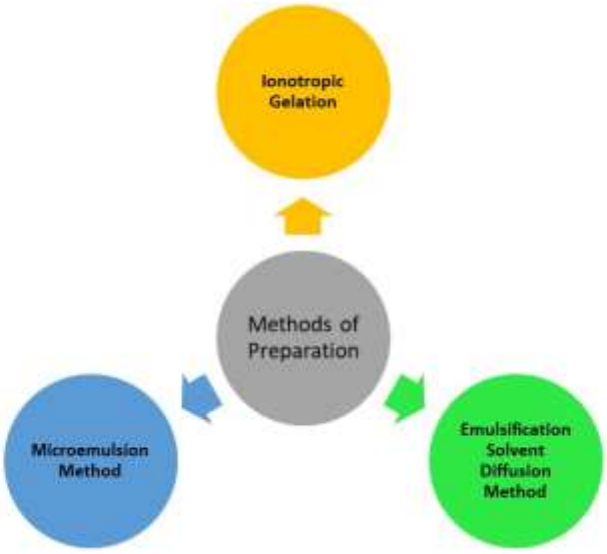
For the use in the air cleaning & water purification applications it can also bind to the toxic metal ions which is useful. As the result of the protonation of the NH2 groups on the chitosan backbone these properties arise. The chitosan structurally is the linear-chain copolymer

composed of the D-glucosamine & N-acetyl-Dglucosamine which is being obtained by the partial deacetylation of the chitin. [5-12]

The chitosan structure is very much similar to that of the cellulose & is a 2 nd most abundant natural polymer after the cellulose. On the extent of the protonated amino groups in the chain of the polymer the biodegradability, solubility & reactivity of the chitosan & the adsorption of the substrates depends. The chitosan is incapable of being dissolved in the organic solvents, aqueous bases & water however it gets dissolved after stirring in the hydrochloric, acetic, and phosphoric nitric & perchloric acids. In neutral or the alkaline medium the amino group of the chitosan is not protonated & hence it is insoluble in the water while in the acidic pH it gets a resultant soluble protonated polysaccharide. [13-15]

With the inorganic & organic acids including the tartarate, glyoxylate, malonate, glycolate, pyruvate, malate, ascorbate, acetate, citrate & lactate the chitosan forms the water-soluble salts. The Inherent chitosan becomes soluble in the organic acids when the solutions pH is less than 6.5. By the neutralization with the acids such as the acetic acid, formic acid, lactic acid or hydrochloric acid the water-soluble salts of the chitosan may be well formed. [16-17]

METHODS OF PREPARATION



A] Ionotropic Gelation Method

In this technique the chitosan solution [Positively charged] is dissolved in the acetic acid or any other polyanionic solution [Negatively charged] with or without the stabilizing agent such as the poloxamer. Due to the complexation between the positive & negative charged species during the mechanical stirring at the room temperature the nanoparticles are formed readily which results in the separation of the chitosan in the spherical particles of various sizes & surface charges. The reported particle size generally ranges from the 20 to 200 & 550 to 900 nm. The Chitosan-TPP/vitamin C nanoparticles were prepared via the ionotropic gelation between a positively charged amino groups of chitosan-TPP & the vitamin C with the constant stirring at the room temperature for 1 hour.

B] Emulsification Solvent Diffusion Method

By mixing the organic solvent into the solution of the chitosan with the stabilizer under the mechanical stirring which is followed by the high pressure homogenization the o/w emulsion is prepared. With this method the size range of the 300–500nm could be achieved. When the large amount of water is added to the emulsion the polymer precipitation occurs which results in forming the nanoparticles. This method is best suited for the entrapment of the hydrophobic drugs for which the entrapment efficiency is found to be high.

C] Micro emulsion Method

In this micro emulsion method the chitosan in the acetic acid solution & the glutaraldehyde are added to the surfactant in the organic solvent such as hexane. The continuous stirring of this mixture at the room temperature is done & allowing the nanoparticles to form overnight as the cross-linking process is completed. By evaporating under the low pressure the organic solvent is then removed. At this point the product has the excess surfactant which could be removed by precipitating it with the calcium chloride which is followed by the centrifugation. The final nanoparticles suspension is then dialyzed & then it is lyophilized. The very narrow size distribution is seen by this method & the size can be controlled by a concentration of the glutaraldehyde in a preparation of the nanoparticles. By this method the small sized nanoparticles are formed. [18-20]

APPLICATIONS OF CHITOSAN NANOPARTICLES

- Against the Escherichia coli & Staphylococcus saprophyticus the chitosan nanoparticles show effective antimicrobial activity.

- For the preservative purposes while packaging of the foods & in the dentistry to eliminate the caries the chitosan nanoparticles can be used.

- The chitosan nanoparticles can be used as the gene delivery vectors, antibacterial agents & carriers for the protein release & drug.

- To prolong the residue time & to improve the bioavailability of the drugs instilled topically on to the eye.

- To prevent the infection in the wounds & quicken the process of wound-healing by enhancing the growth of the skin cells.

- Chitosan nanoparticles are used as a potential adjuvant for the vaccines such as the hepatitis B, piglet paratyphoid vaccine & influenza vaccine.

- For producing clothes for the healthcare & other professionals chitosan nanoparticles can also be used as an additive in the antimicrobial textiles. [21]

Table 1. Drugs encapsulated in chitosan [22-25]

Name of drug encapsulated in the chitosan	Carrier
Doxorubicin	The Core shell chitosan nanoparticles
Docetaxel	The Chitosan nanoparticles
5-fluorouracil	The N,O-carboxymethyl chitosan [N,OCMC] nanoparticles
Gemcitabine	The Chitosan–pluronic nanoparticles

CONCLUSION

The chitosan is considered as the safe material as it is the natural polymer that possesses the biodegradable & biocompatible properties. The chitosan are available in the wide range of the molecular weights & it can be easily chemically modified by the coupling with the ligands providing the flexibility in the development of formulation. As chitosan is a water-soluble polymer which is an ideal property for the drug delivery carriers hence the mild & simple methods of preparation can be applied. So the chitosan nanoparticles are the most suitable for controlled drug delivery of a drug.

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