Nanocapsules: Nano novel drug delivery system

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ABSTRACT

Nano capsules are vesicular systems in which the drug is confined to a cavity consisting of an inner liquid core surrounded by a polymeric membrane. Nano capsules having various advantages and disadvantages. Preparation of Nano capsules can be used as a two types of polymers 1) Natural polymers 2) Synthetic polymers. Nano capsules are prepared by different method those are a) Solvent evaporation b) Nano precipitation c) emulsification/Solvent diffusion d) Salting out e) Dialysis f) Super critical fluid technology. Different characterization and evaluation tests are performed to Nano capsules. Dispersed polymer nanocapsules can be used as nano-sized drug carriers to get controlled release as well as efficient drug targeting. Drug-loaded polymeric nanocapsules have showed possible applications in the field of drug delivery systems. Enormous research efforts have been performed in order to develop modern nano-particulate drug delivery systems. However, newly developed drug molecules with moderate biopharmaceutical profile are still missing. The entrapment of this drug molecule can protect them from the biological environment and facilitate their transport through biological barriers. Therefore nano-carriers especially nanocapsules (NC) can give the promise for therapeutic benefits in the field of drug delivery system. Nanocapsules, existing in miniscule size, range from 10 nm to 1000 nm. They consist of a liquid/solid core in which the drug is placed into a cavity, which is surrounded by a distinctive polymer membrane made up of natural or synthetic polymers. They have attracted great interest, because of the protective coating, which are usually pyrophoric and easily oxidized and delay the release of active ingredients.

Keywords: Nanocapsules, Nano novel drug delivery, Preparation, Characterization

INTRODUCTION

Nanocapsules, as characteristic class of nanoparticles, are made up of one or more active materials (core) and a protective matrix (shell)[1] in which the therapeutic substance may be confined. Nanocapsules have been developed as drug delivery systems for several drugs by different routes of administrations such as oral and parental. Reduce the toxicity of drugs. Polymeric nanoparticles are named nanocapsules [2] when they contain a polymeric wall composed of non-ionic surfactants, macromolecules, phospholipids [3]and an oil core [4].

METHOD OF PREPARATION

Solvent displacement method or interfacial deposition method

Interfacial polymerization is an alternative to bulk polymerization of condensation polymers, which would require high temperatures[5]. It comprises of two immiscible solvents, in which monomer in one solvent instantaneously reacting with monomer of the other solvent or it may depend on the time scale. Higher molecular weights of monomers are obtained since it is more likely to stumble upon a growing chain than the opposing monomer. For instance, the nanocapsules can be formulated by using the aqueous core containing oligonucleotides of isobutylcyanoacrylate in a W/O emulsion. The resultant nanocapsules are then purified by ultracentrifugation followed by resuspending in water to yield a dispersion of aqueous core nanocapsules. Both solvent (organic phase) and non-solvent phases (aqueous phase) are used in the synthesis of nanocapsule. Solvent phase containing solvents (ethanol, acetone and hexane), polymers (natural or synthetic polymer), the drug molecule and oils. On the other hand, the non-solvent phase consisting of a non-solvent or a mixture of non-solvents for the polymers, supplemented with one or more naturally occurring or synthetic surfactants. The solvent is an organic medium, while the non-solvent is mainly water. In the solvent displacement

method, the nanocapsules are obtained as a colloidal suspension formed when the organic phase is added slowly with continuous moderate stirring to the aqueous phase. In the Solvent displacement method, commonly used biodegradable polymers are poly-e-caprolactone (PCL)

Polymerisation method

The monomers are polymerized in an aqueous solution to form nanoparticles followed by placing the drug either by dissolving in the medium of polymerization or by the adsorption of nanoparticles. Ultracentrifugation method, which has been utilized for purifying the nanoparticle suspension, removes various stabilizers and surfactants employed for polymerization. The nanoparticles are then resuspended in an isotonic surfactant free medium. It has been suggested for making polybutylcyanoacrylate or polyalkylcyanoacrylate nanoparticles [6].

Emulsion Polymerisation

Pre-emulsion preparation for one of the nanocapsules (M-6) is provided as an example [7]. The preemulsion was synthesized by blending two parts; Part I contained 40 g styrene, 0.8 g DVB (divinylbenzene), 0.82 g AIBN (2,2'-azobisisobutyronitrile) and 40 g Desmodur BL3175A; and Part II contained 1.71 g SDS (sodium dodecyl sulfate), 1.63 g Igepal CO-887, and 220 g water. Parts I and II were magnetically blended in separate containers for 10 minutes. Part II was then added to Part I under mechanical agitation and the contents were stirred at 1,800 rpm for 30 minutes. The resulting preemulsion was cooled to <5°C before sonication using a Misonix sonicator 3000 (until a particle size <250 nm was achieved). The pre-emulsion (Jackson et al 1991) was transferred to a three-neck round bottom flask, which was equipped with a mechanical stirrer, reflux condenser, and a nitrogen inlet, and degassed for 30 minutes. The temperature was increased to 70°C and preserved for 8 hours to complete the polymerization. Other preparation methods for nanocapsules include electron irradiation deposition , chemical vapor deposition [8], laser vaporization-condensation [9], charge transferring [10], organic reagent assisted method [11], solution-liquid-solid method and catalytic vapor-liquid-solid growth [12].

CHARACTERIZATION OF NANOCAPSULES

PARTICLE SIZE: The smaller particles have greater surface area; therefore, most of the therapeutic agents associated at or near to the surface particle, lead to instant drug release, whereas, the larger particles having the large core surfaces gradually diffuse out [13].

DETERMINATION OF THE pH OF NANOCAPSULE: Nano capsules formulation pH was measured using a digital pH meter at room temperature. Nano capsules dispersion pH values fall within a range of 3.0-7.5.

DETERMINATION OF DRUG CONTENT: Drug content was determined by dissolving 1ml of prepared nanocapsules in 20ml of acetonitrile. Appropriate quantity of sample was then subjected to the UV Spectrophotometer at 232nm. The absorbance for each sample was measured and compared with the standard.

STRUCTURAL CHARACTERIZATION: Structural characterization can be done by using field emission scanning electron microscopy (FE-SEM) and transmission electron microscopy (TEM) to determine the various attributes like shape, size and surface morphology. Micrographs of the nano capsules were obtained using a Phillips Cm 200 operated at 20-200 kv while the Fe-SEM was carried out using Hitachi S-4800 FE-SEM equipped with energy dispersion spectrometer (EDS)

IN-VITRO DRUG RELEASE: In vitro dissolution studies were carried out using USP type 11 dissolution apparatus. The study was carried out in 100 ml of buffer (PH 3.0). the nano capsules suspension was placed in dialysis membrane and dipped in dissolution medium which was kept inert thermostatically at 37±0.50C. The stirring rate was maintained at 100 rpm. At predetermined time intervals 5ml of sample were withdrawn and assessed for drug release spectrophoto metrically. After each withdrawal 5 ml of fresh dissolution medium was added to dissolution jar.

APPLICATIONS : Nanocapsules for drug delivery

Nanocapsules, which measure 1 thousandth of a millimeter, can be coated with an antibody on the surface, which assists in directing them from the

blood stream to an induced tumor. After reaching to the tumor, an instant blast occurs that makes the capsules to open up and discharge their therapeutic contents. On the surface of the polymer, there are tiny gold particles in the range of 6 nm i.e. 6 millionth of a millimeter which stick across and are specific to the laser light and lead the capsules to position their drug load capacity at the desired time. The rupturing of the capsule can be seen when near infrared light hits the gold spots and they melt instantaneously without harming the content.

CONCLUSION

Nanocapsules are a contribution to the methodological development for formulation by various methods, mainly the interfacial polymerization and interfacial nano-deposition. They can also be released as the monodisperse particles with well-defined biochemical, electrical, optical, as well as magnetic properties. In drug delivery system, they are confined to suit the complexity of the application as they intend to produce contents in response to a specific bimolecular triggering action mechanism. Nanocapsules also have the efficient applications in various fields of the agrochemicals, wastewater treatments, genetic engineering, cosmetics, cleaning products, as well as in adhesive component. They are also used in encapsulation of enzymes, adhesives, catalysts, polymers, oils, inorganic micro and nanoparticles, latex particles, and even the biological cells. In conclusion, they can be used in the delivery of active pharmaceutical ingredients (APIs). They provide the novel effective drug delivery systems in the up-coming future.

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