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NANO SPONGES: A VERSATILE NANO PARTICLE DRUG DHELIVERY SYSTEM

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Abstract
Nanotechnology is one of the most promising technologies of the 21 centuries. It is related to design characterization, production and applications of structures, devices and systems by controlling shape and size at manometer scale. These nano particles are characterized by unique physical, optical and electrical features that are attractive for disciplines ranging from material science to biomedicine. So various nanoforms have been attempted as drug delivery systems. Nano sponges are novel class of hyper crosslinked polymer based colloidal drug carries with nanosized cavities to encapsulate both lipophilic and hydrophilic drug moieties. it has a backbone long length biodegradable polymer these polymer strands are mixed with small molecules called cross linkers that have an affinity certain portion of the polymer to form a spherical shape that has many packets or cavities where drugs can be stored. They can circumvent the various formulation challenges associated With poor water solubility, low bioavailability, targeting and controlled release of activities. In this present review various formulations additives like polymers, solvents and crosslinkers for the preparation of nano sponges, its advantages, characteristics, and various methods of preparations like melt method, emulsion solvent evaporation, emulsion solvent diffusion method, ultrasound assisted synthesis were studied.

Keywords: Nano sponges, Encapsulation, Characteristics Preparation methods.

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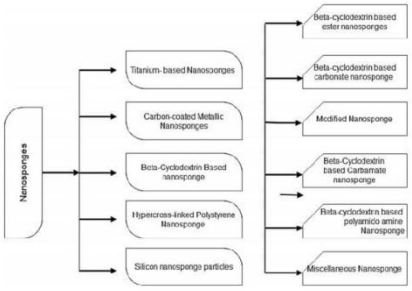
Introduction

Nanotechnology is one of the most promising technologies of 21 century nanotechnology is related to design characterization, production and application of structure, device and controlling shape and size at manometer scale. Nanotechnology could be implemented in developing drug delivery system to achieve desired pharmaceutical. Biopharmaceutical, pharmacokinetic and pharmacodynamic properties of drug molecules. various nanoforms have been attempted as drug delivery system one of such is encapsulating type of nano particle that is a nano sponge. nano sponges are mesh like minute structure that can encapsulate large variety of substances and medication molecules. it was an innovative drug delivery system. Nano sponges are like a three-dimensional network or scaffold, whose backbone is long length polyester. it is mixed in solution with small molecules called crosslinkers that act like tiny grappling hooks to fasten different parts of the polymer together. The net effect to form spherically shaped particles filled with cavities where drug molecules can be stored. the polyesters are biodegradables, so its breakdown gradually in the body. Nano sponges are composed of nano a meter-sized particle that passes few nano meters wide pores in which a large numerus of substances can be encapsulated. These particles can carry both lipophilic and hydrophilic substances and to improve the solubility of poorly water solvable molecules. Nano sponges are a class of encapsulating type of nano particles that encapsulate the drug molecules with its core.5 In contrast to other nano particles, nano sponges are water in soluble and organic solvents porous non-toxic and stable at high temperature up to 3000cs.



Advantages

1. Enhance the aqueous solubility of the lyophilic drugs
2. Drug degradation can be protected

3. For the formulation of drug delivery systems for administrating the drugs through different routes other than the oral route.
4. The simple chemistry of polymers and cross linkers does not present may issues in the preparation and this technology can easily be scaled up to commercial production levels.
5. Nano sponges can release the drug molecules in a predictable fashion due to their small spore size (0.25nm) bacteria cannot penetrate the nano sponges and they act like a self-stabilizer.
6. They are non-irritating, non-mutagenic and non-toxic
7. Increase the formulation stability and enhance the flexibility of the formulation.
8. Nano sponges suspend clear to milky colloidal suspension in aqueous media, and it is easy to regenerate by means of solvent extraction thermal desorption with ultrasound.

Disadvantages

1. Nano sponges can encapsulate small molecules but are not able to do for large molecules.
2. Nano sponges may be crystalline or para crystalline in nature.
3. The degree of crystallization is what primary determines the loading capacity of a nano sponge.
4. The NSs can accommodate small drug molecules. the drug loading capacity is afunctional of the degree of crosslinking since the crosslinking determines the void space available in the NSs which can utilize in drug loading
5. There is a possibility of dose dumping due to early dissolution of crosslinker.

Applications

1. The NS due to the versatile ensnare capacity and small size has considerable boon in nanomedicine that can target to deliver the drug at both the lipophilic and lyophobic sites.
2. Compared with other Polymers NS fabricated by using beta-cyclodextrin are said to be five times more efficient in drug delivery at a preferred site in the body.
3 It can be used for the administration of orally, topically, via inhalation, and parenterally through suitable excipients and diluents.
4. Already, drugs like paclitaxel, tamoxifen, quercetin, curcumin, resveratrol, carboplatin, etc., have demonstrated their efficiency and enhanced bioavailability in the NS formulation.
5. Nano sponges have a wide application in the pharmaceutical field, because of its biocompatibility and versatility.
6. In the pharmaceutical industry, nano sponges can be used as an excipient for the formulation of tablets, capsules, granules, pallets, suspensions, solid dispersions, and topical dosage forms.
7. Nano sponges can accommodate both lipophilic and hydrophilic drug molecules, basically, those drugs substances which belong to the biopharmaceutical classification system.

Preparation Methods

1. Ultrasound Assisted Synthesis

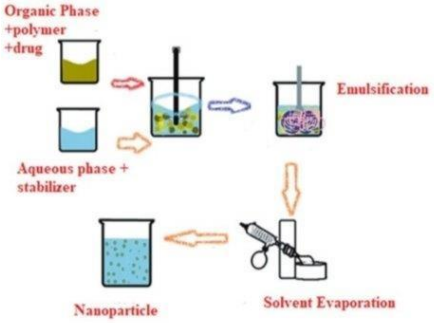
Fig: 1

In this approach, nano sponges can be prepared by cross linking polymers in the absence of solvent under sonication. The Nano Songes obtain by this method will be spherical and uniform in size. mix the polymer add the cross linker in a definite molar ratio in a flask. the flask was submerged into an ultrasound batch contain water and heat it to 90cs. sonicate the mixture for 5hrs.then let the mixture cool and break the product roughly. Rinse the product with water to remove the nonreacted polymer and then purify by prolonged Soxhlet extraction with ethanol dry the obtained product under vacuum and store at 25cs.

2. Solvent Method

The solvent method is used to prepare Nano sponges by mixing polymer with polar aprotic solvents such as dimethylformamide and dimethyl sulfoxide. In a 1:4 ratio, a crosslinker is added to this mixture. Commonly utilized cross-linkers include carbonyl compounds and carbonyl diimidazole and the reaction [10cs] should occur to reflex the solvent temperaturefor 1-48h. the cooled solution is added to bi-distal water the substance is dried drained and refine using the Soxhlet method with ethanol. The product is vacuum -dried, and then a mechanical mill is used to grained it into a uniform powder.

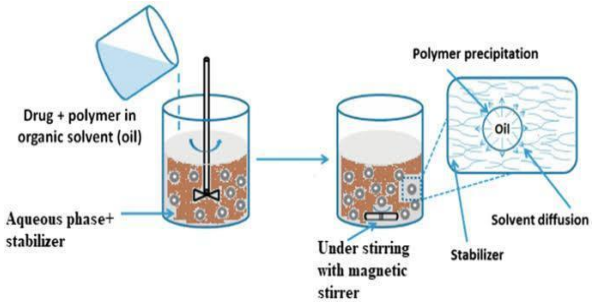
3.Emulusion Solvent Evaporation Method



Nanoparticle by emulsification solvent evaporation method

From the various methods of preparation of nanoparticles emulsification solvent evaporation method is quite renowned. it is a process which is widely used owing to its ease and it basically enables or facilities effective encapsulation of different compounds which are lipophilic in nature. Emulsification solvent evaporation comprises two steps the first one includes the dissolution of the polymer and the drug in a volatile organic solvent in the past dichloromethane and chloroform were commonly used but these have now been replaced by ethyl acetate to minimize residual solvent toxicity concerns initially there is an aqueous phase used for emulsification of the polymer. During the second step, polymer solvent is evaporated which leads to polymer precipitation on a central core to give nanoparticles. The nano particles are collected by ultracentrifugation and washed with distilled water to remove stabilizer residue or any free drug and lyophilized for storage. Recently modifications took place in this method which is known as high pressure emulsification followed by solvent evaporation method. This method involves first preparation of emulsion followed by homogenization using high pressure and further it is subjected to stirring to evaporate organic solvent. Various parameters as a result of the composition and amount of dispersion agents mixing speed, temperature and viscosities of both organic and aqueous phases extremely affect particles size. Conversely, this process ca be employed to lipophilic drugs, and limitations are imposed by the problem of scale up.

4.Solvent emulsification diffusion technique



The technique described is a widely used method for nanoparticle preparation, where a polymer and drug are dissolved in a water-immiscible organic phase, and the system is further saturated with water to ensure thermodynamic equilibrium between the two solvent phases (Allemann et al., 1993). The organic solvent, selected for its partial solubility in water, facilitates the saturation of the aqueous phase, maintaining the partition equilibrium of the dispersed and dispersing phases (Petros and DeSimone, 2010). After emulsification of the polymer-water solution into an aqueous stabilizer solution, such as polyvinyl alcohol, solvent diffusion occurs from the internal phase to the external phase, leading to nanoparticle formation. The emulsion droplets are then diluted in water, triggering interaction between the droplets and the dilution phase. This interaction causes the polymer to precipitate due to its poor solubility in water. Two potential mechanisms contribute to the formation of nanoparticles: one driven by mechanical forces and the other by particle formation from emulsion droplets.

Conclusion

Nano sponge-based systems, which have tremendous porosity and involve straightforward functionalization procedures, distinctive topologies, eco-friendliness, and cost-effectiveness, have been found to act as attractive substitutes for targeted drug delivery. The quality of cyclodextrin Nano sponges distinguishes them from other analogues mainly because of their excellent biocompatibility, low toxicity, and ease in surface modification; hence, they are the most often tested nano sponges in nanomedicine. The appropriate size can be obtained by adjusting the polymer or other material concentration and crosslinker ratio. This also aids inimproving the solubility of various drugs that are poorly soluble and safeguards them against degradation. Nano sponges offer applications in many areas such as targeting, improvement of stability and solubility, prevention of photodegradation of the medication, flexibility of formulation, administration of gas, blood purification, etc., which is not achievable with other nanocarrier

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Conflict of Interest

No Conflict of interest

Informed Consent and Ethical Statement

Not Applicable.

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