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(REVIEW ARTICLE)

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A review on the functions, preparation and future aspects of nanocapsules

K MADHURI *

Department of pharmacy, Joginpally B R pharmacy college, Hyderabad, telangana, India.

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Abstract

The nano technology in medicinal field offers many exciting possibilities. Many techniques are being usedtoday. The application of many nanoparticles were developing and these involve the utilization of manufactured nanocapsules to form repairs at cellular level and it's sometimes refers as nano medicine. Nanocapsules are submicroscopic colloidal drug carrier systems composed of an oily or an aqueous core surrounded by a thin polymer membrane. Two technologies can be used to obtain such nanocapsules: the interfacial polymerization of a monomer or the interfacial nanodeposition of a preformed polymer. In future the nanotechnology can creat many wonders in medical field. Nanotechnology is wonderfull technology that can used in diagnosis and treatment in medical field. This review was aimed to knowing the preparation, new aspects, and the applications of the nanocapsules.

Keywords: Nanoparticles; Drug delivery system; Polymerisation; Novel effective drug deliver; Polymers; monomers

1. Introduction

A Nanocapsule is nanoscale shall made from a nontoxic polymer. They are vesicular systems made of aplymeric membrane which encapsulates an inner liquid core at at the nanoscale.Nanocapsules, existing in miniscule size, and range from 10nm to 1000 nm. Nanocapsules have many uses, including promising medical applications for drug delivery, food enhancement neutraceutical and for self-healing materials[1]. The benefits of encapsulation methods are for protection of these substance to protect in the adverse environment, for controlled release, and for precision target. Nanocapsules can potentially be used as MRI-guided nanorobots, although challenges remain [2].

Nanoparticles are solid, submicron-sized drug carriers that can be eighter biodegradable or non-biodegradable. Nanospheres have mtrix type of structure. Nanocapsules are vasicular that the drug isconfined to a cavity consisting of an inner liquid core surrounded by a polymeric membrane. the activesubstance are usually dissolved in the inner core but may also be absorbed to the capsule [3].

Nanocapsules are used as drug delivery system for several drugs by different ways of administration suchas oral and parentral, lessen the toxicity of drugs, improve the stability of drug. Nanocapsules are seen as active vectors because of their capacity to release drugs;their subcellular size allows higer cellular vector. They also improve active substance [4].

Nano capsules, existing in miniscule size. They consist of a liquid/solid core in which the drug is placedinto a cavity, which is surrounded by adistinctive polymer membrane made up of natural or synthetic polymer. The nanocapsules have attracted great interest because of their protective coating, which is easily oxidized. Nanopaeticles have also been extensively investigated as drug carrier and for the pastfive decades, many of such carriers in the nanometer range have been in development [1]t. Polymeric nanocapsules are named nanocapsules when they contain a polymeric wall composed of non-ionicsurfactants, macromolecules, phospholipids and an oil core[3]. These are prepared mostly by

*Corresponding author: K MADHURI

two technologies: the interfecial polymerisation and interfacial nano deposition. Due to small size, nanocapsules possess greater capability to take on the extenssive range of application [5].

The production of nanocapsules depends on their application and pharmaceutical, biochemical,electrical, optical or magnetical characters.

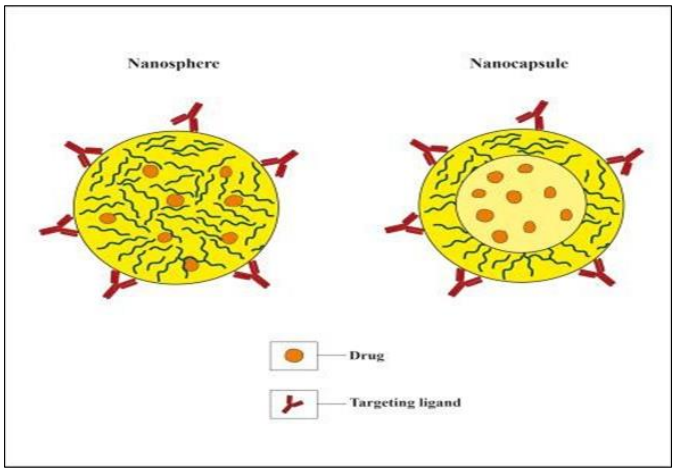

Figure 1 structure of nano capsules

1.1. Composition of nanocapsules

Nanocapsules are sub microscopic colloidal drug carrier system consists of aqueous or organic phase which is surrounded by thin polymer membrane [2]. The membrane may composed of natural or synthetic polymer.In organic phase it contains solvent, polymer,oil and drug, in aqueous phase it contains water and surfactants inside the membrane module and remove the nano capsules forming at pore outlets. Toprepare such nanocapsules there are derived under two-technologies: “The interfacial deposition for polymer “, “The interfacial polymerisation for monomer “. In capsule preparation, the positively or neg-atively charged polymer will added. Each new layer has been opposite charged to the previous layer [4].They create the shells of poly electrolytes complex layers. It can form the capsule walls in 4-20 layerswith 8-50 nm thickness.[6]

1.2. Methods of preparation of nanocapsules

The preparation of nanocapsules can be different types they are:

- Polymerisation method
- Emulsion polymerisation
- Interfacial polymerisation
- Encapsulation of nanocapsules

2. Polymerisation method

The monomers are polymerized in an aqueous solution to form nanoparticles followed by placing thedrug either by dissolving in the medium of polymerisation or by the adsorption of nanoparticles [3].

Ultracentrifugation method, which has been utilized for purifying the nanoparticles suspension, removes various stabilizers and surfactants employed for polymerisation. The nanoparticles are then resuspende-d in an isotonic surfactants free medium. It has been suggested for making polybutylcyano-acrylate or polyalkylcyanoacrylate nanoparticles. The formation of nanocapsules and their particle size depends on the usage concentration levels of the surfactants and physical and chemical stabilizers. Based on phase- inversion process, the nanoparticles are formulated and the result suggests a mean diameter range of 20nm-100nm [7].

3. Emulsion polymerisation method

Pre-emulsion preparation for one of the nanocapsules is provided as an example. The pre-emulsion wassynthesized by blending two parts; Part 1 contained 40g styrene, 0.8 g Divinylbenzene0.82g 2,2'- azobisisobutyronitrile and 40 g Desmodur BL3175A;and part 2 contained 1.71 g SDS (Sodium dodecyl sulfate) , 1.63 g Igepal CO- 887,and 220 g water[9]. Part 1 and 2 were magnetically blended in separate containers for 10 min. Part 2 was added to part 1 under mechanical agitation and the contents were stirred 1,800 rpm for 30 min. The resulting pre-emulsion was cooled to

<5°C before sonication using a Misonix Sonicator 3000.The pre-emulsion was transferred to a Three-neck round bottom flask, which was equipped with a mechanical stirrer, reflux condenser, and nitrogen inlet, and degassed for 30 min. The temperature was increased to 70°C and preserved for 8 hours to complete the polymerization [8].

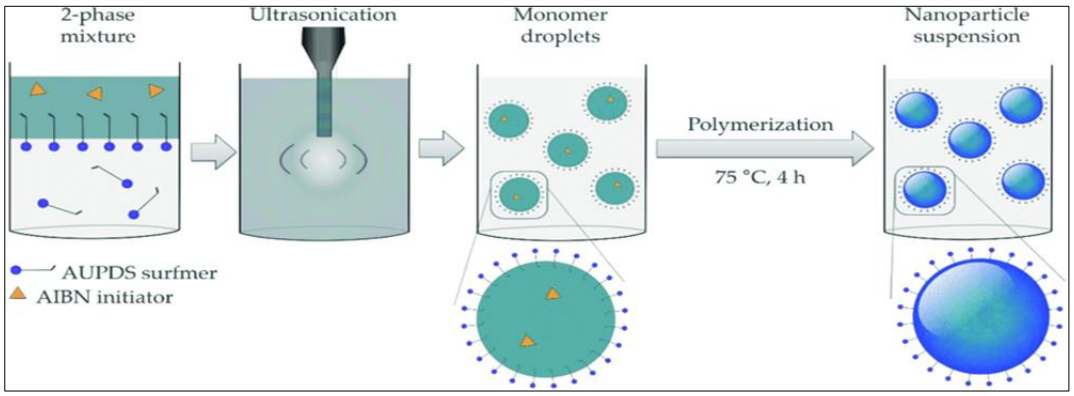

Figure 2 Schematic representation of emulsion polymerisation method

4. Interfacial polymerisation method

Interfacial polymerisation is an alternative to bulk polymerisation of condensation polymers, which would require high temperatures. It comprises of two immiscible solvents, in which monomer in one Solvent instantaneously reacting with monomer of the other solver or it may depend on the time scale.Higher molecular weights of monomers are obtained since it is more likely to stumble up on a growing chain than the opposing monomer [10]. The nano capsules can be formulated by using the aqueous core Containing oligonucleotides of isobutylcyanoacrylate in a W/O emulsion. Both organic phase and aqu- Eous phase are used in the synthesis of nanocapsules. Solvent phase containing solvents, polymers, thedrug 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, supplemanted with one or more naturally occurring or Synthetic surfactants. In the solvent displacement method, commonly used biodegradable polymers are Poly-e- caprolctone (PCL)[11].

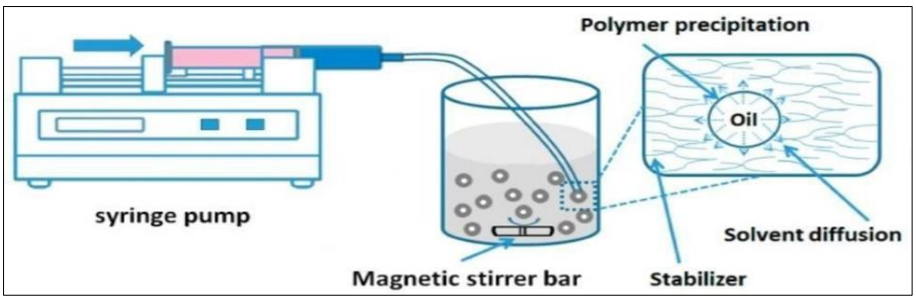

Figure 3 Schematic representation of nano precipitation Or interfacial polymerisation method:4 :

5. Encapsulation of nanocapsules

Recent advances in the encapsulation technology has been utilized to formulate micro/nanocapsules with their explict application properties used in food, biology, and medicine [12]. Most encapsulation technique employ isocyanates in either solvent or bulk to construct shell, or making pressure on sensitive copying paper. Encapsulation delays the release of drug from nanocapsules, e. g., Xerogels and Aerosil 200 that are used as encapsulated materials. The Aerosil

200 has the strong drawback as bursting the nanocapsules. To diminish the burst release of drugs from xerogel mesopores, differentstrategies have been proposed [13].

The table below displays how nanocapsules exhibit different traits based on the method by which they were prepared. Nanocapsule types vary by size, drug concentration, and active substance releasetime.[citation needed]:

Table 1 How nanocapsules exhibit different traits based on the method by which they were prepared

	Mean size(nm)	**Drug conc in diluted dispersion (mg/ml)**	**Drug conc in concentration dispersion (mg/ml)**	**Active substance release time (90%) (min)**
Nanoprecipitation	250	0.002-0.09	0.15-6.5	750
Emulsion- diffusion	425	~0.2	50	60
Double emulsification	400	2-5	20-50	45
Emulsification coacervation	300	~0.24	12	>2000

5.1. Characterisation of nanocapsules

5.1.1. Particle size

The smaller particles have greater surface area; therefore, most of the therapeutic agents associated ator near to the surface particle, Lead to instant drug release, whereas, the larger particles having the large core surfaces gradually diffuse out [14].

5.1.2. Determination of ph

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[14].

5.1.3. 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 [14].

5.1.4. Structural characterisation

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 Operatedat 20-200 kv while the Fe-SEM was carried out using Hitachi S-4800 FE-SEM equipped with energy dispersion spectrometer (EDS) [15].

5.1.5. In-Vitro 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 membraneand dipped in Dissolution medium which was kept inert thermostatically at 37±0.50C. The stirring ratewas 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 [15].

5.2. Applications

5.2.1. Nanocapsule 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 tothe tumor, an instant Blast occurs that

makes the capsules to open up and Discharge their therapeuticcontents. 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 [16].

5.2.2. Nanocapsule as drug delivery system

Dispersed polymer nanocapsule can serve as nano-sized drug carriers to achieve controlled release as well as efficient drug targeting. The dispersion stability and the primary physiological response are mainly determined by the type of the surfactant and the nature of the outer coating. Their release anddegradation properties largely depend on the composition and the structure of the capsule walls [17].

5.2.3. Food science and agriculture

Liposomes, spherical bilayer vesicles from dispersion of polar lipids in aqueous solvents, have been widely studied for their ability to act as drug delivery vehicles by shielding reactive or sensitive compounds prior to release. Liposome entrapment has been shown to stabilize encapsulated, bioactivematerials against a range of environmental and chemical changes, including enzymatic and chemical modification, as well as buffering against extreme pH, Temperature, and ionic strength changes [16].

5.2.4. Nanocapsule for self-healing materials

Damage in polymeric coatings, adhesives, microelectronic components, and structural composites canspan many length scales. Repair of large-scale damage (e.g. a projectile or blast is difficult and, when possible, requires use of bonded composite patches over the effective area 8. For smaller scale crack damage, However, a novel method of autonomic repair has Been achieved through the use of self- healing polymers microcapsules that contain the healing agent must possess adequate strength, long shelf-life, and excellent bonding to the host material17].

5.2.5. New cancer weapon-nuclear nanocapsule

The radioactive compound Astatine, like radium and uranium, emit high velocity alpha particles by theprocedure of radioactive decay, which is about 4,000 Times faster than the beta decay of the emitted electrons, and is most commonly used to treat cancer. The unique combination of the low penetratingpower as well as large particle size make the alpha particle unique for Ttageting tumor at the single cellular level [18].

5.2.6. Future nanocapsule bandages to fight infection

The conventional dressings require to be taken out if the Skin becomes affected or it slows the healing. In contrast, nanocapsular dressings trigger automatically to discharge antibiotics when the wound becomes infected. They do not require to be removed, Thereby enhancing the chances of healing wound without Scarring [19]. Nanocapsular bandages can also be used for Additional types of wounds like ulcers and most consistently by the military people on the battlefield. These Medicinal dressings' releaseantibiotics from the nanocapsules activated by the presence of disease causing Pathogenic or causative bacterial organism, targeting the Treatment prior to the infection aggravates. The bacterial Toxins burstthe capsules comprising the antibiotics, which cover as the dressings [6].

5.3. Future benefits, opportunities and challenges of nanocapsules

Benefits: The nanocapsules have the ability to deliver existing drugs to their target, nanocapsules shouldallow as much as a 10,000 fold decrease in drug dosages, reducing the harm full side effects of drug usedin chemotherapy[20].

Opportunities & challenges: There are many challenges can exist for developing the techniques like; Architecting of biomemetic polymers, control of sensitive drugs, functions of active drug targeting, Bioresponsive triggered systems, systems interacting with smart delivery, carrier for advanced polymers for delivery of proteins drug delivery techniques were developed to deliver or control the rate & amountof delivery[21].

6. Conclusion

As per the review the nanocapsules are the shells made by non-toxic polymer. Mainly the polymerization and interfacial polymerisation can develop the nanocapsules. These can have the certain characters like particle size, shape and ph and sufficient drug content. The applications of nanocapsules can shows the drug delivery system, self-healing materials and also have the various field of Cancer treatment, genetic engineering, cosmetics, cleaning products, as well as food and agriculture. Finally, the Nanocapsules can see has "novel effective drug delivery system" in future.

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