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A Review on Micro sponges Drug Delivery System

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Abstract

Micro sponge Technology has been brought in topical drug transport to facilitate the managed release of active element into the pores and pores and skin to be able to limit systemic exposure and limit nearby cutaneous reactions to lively drugs. Micro sponge includes microporous beads, that are usually 10 to twenty-five µm in diameter, loaded with active sellers. When applied to the pores and skin, the micro sponge releases its active element on a time mode and moreover in reaction to distinct stimuli which might be rubbing, temperature and pH. The micro sponges are used regularly for topical and recently for oral administration. Micro sponge technological knowledge has many beneficial developments which make it a flexible drug delivery vehicle. Micro sponge systems can entrap a large variety of substances, after which be protected right into a formulated product including a Gels, Creams, Liquids and Powders. The outer ground is generally porous, allowing the sustained float of substances out of the sphere. Micro sponge drug delivery tool can supply expanded efficacy

for topically active sellers with more potent safety, extended product stability, extra tremendous method flexibility, reduced facet consequences and extended aesthetic homes in an surroundings pleasant and novel manner. In addition to this, those are non-irritating, non-mutagenic, non-allergenic, and nontoxic particles.

Keywords: Novel Drug Delivery, Micro sponge, Topical formulation.

Introduction

With advances in biotechnology, genomics, and combinatorial chemistry, a vast variety of new, greater robust and precise therapeutics are being created.1 Because of common issues which include low solubility, immoderate potency, and/or horrible stability of lots of those new drugs, the functionality of drug transport will have an impact on efficacy and attainable for commercialization as an lousy lot because the nature of the drug transport.2 Indeed, wonderful drug transport structures designed to provide a healing agent withinside the wanted amount, at the

oper time, to the proper location in the body, in a manner that optimizes efficacy, extend compliance and limit side effects.

Micro sponges are polymeric transport system composed of porous microspheres which having a particle dimension vary of 5-300 μm with a functionality to entrap a large vary of active components and are used as a provider for topical drug delivery. Micro sponges are tiny sponge-like spherical particles that consistof a myriad of interconnecting avoids inside a non-collapsible shape having a large porous surface.[3]

This agency developed a giant variety of variations of the approach and utilized these tocosmetic as nicely as over the counter and prescription pharmaceutical products. At the present time, this fascinating technological know-how has been

licensed to Cardinal Health, Inc. for use in topical supply a pharmaceutically active ingredient efficiently at the minimal dose and additionally to enhance stability, minimize aspect effects, and adjust drug release profiles. These attributes have been successfully verified in the FDA-approved Retin-A Micro® (0.1% or 0.04% tretinoin) and Carac (0.5% 5- fluorouracil) release for acne treatment and actinic keratoses, respectively.[4] Micro sponges are viewed a good candidate to supply one-of- a-kind active ingredients to exceptional drug transport systems related to its benefits such as; micro sponges are biologically protected (non-allergic, non-toxic, non-irritant and non- mutagenic), have the ability to soak up or load a high degree of energetic substances into the particle or into its surface, secure over a pH range of 1-11 and temperature up to 130 ºC, self-sterilizing as common pore measurement is 0.25 μm where bacteria can't penetrate, capable to entrap various ingredients in a single microsphere with measurement 10-25 μm, micro sponges are chemical, physical, and thermally stable, have a suitable compatibility with various motors and ingredients, furnish a continuous motion up to 12 h, which capability that these particles can prolong drug release, so improve product elegancy, and payload is

up to 50-60 %, with an gain of value effectiveness over the other formulations.[5]

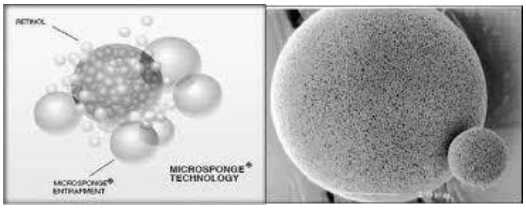

Figure No. 01. Structure of micro sponge[6] Method of preparation of micro sponges

Drug loading in micro sponges can take vicinity in two ways, one-step system (Liquid-liquid suspension polymerization) or by means of two-step method (Quasiemulsion solvent diffusion method) which are based on physicochemical homes of a drug. If the drug is usually an inert non-polar material, it will create a porous shape and this referred to as Porogen. Porogen drug, which neither hinders the polymerization nor becomes activated via it and secure to free radicals are entrapped with the aid of the one-step technique.**Advantages of micro sponge:**

1. Microcapsules cannot usually control the release rate of the active pharmaceutical ingredients (API). Once the wall is ruptured the API contained within the microcapsules will be released.
2. Liposomes suffer from a lower pay load, difficult formulation, limited chemical stability, and microbial instability.

Characterization of Micro sponges:

1. **Particle size and size distribution**: Particle measurement and measurement distribution are evaluated using either an optical microscope or an electron microscope. This is an extraordinarily critical step, as the measurement of the particles notably influences the texture of the formulation and its stability. Free-flowing powders with fine aesthetic attributes are feasible to reap by using controlling the dimension of particles at some stage in polymerization. Particle size analysis of loaded and unloaded Micro sponges can be performed by using laser light diffractometry.[13]

2. **Determination of pH**: The pH of the Micro sponges enriched gel was determined the usage of a calibrated pH meter. The readings were taken for a common of three samples.[14]

3. **Determination of true density:** The proper density of micro particles is measured the use of an ultra-pycnometer beneath helium gas and is calculated from a imply of repeated determinations.[15]

4. **Surface Topography of Micro sponge (SPM):** For morphology and surface topography, various techniques have been used like Photon Correlation Spectroscopy (PCS), Scanning Electron Microscopy

(SEM), Transmission Electron Microscopy (TEM) and Freez Fracture Microscopy (FFM). SEM is used widely for which organized Micro sponges are covered with gold– palladium below an argon surroundings at room temperature and then the surface morphology of the micro sponges is studied.[16]

5. **Scanning Electron Microscopy (SEM):** The morphology and size of micro sponges were observed by Scanning Electron Microscopy by coating with gold under vacuum at room temperature.[17]

6. **Determination of Loading Efficiency (LE):** The drug content material in the micro sponges used to be determined by High Performance Liquid Chromatography (HPLC) method. A pattern of drug containing micro sponges (10mg) used to be dissolved in a hundred ml of methanol. The drug contentused to be calculated from the calibration curve and expressed as loading effectivity which is calculated by using the followingsystem.

Loading efficiency (%) = (DCP/ DCT) × 100

DCP and DCT are practical and theoreticaldrug content in micro sponge.

7. **Determination of Production Yield (PY):** The manufacturing yield of the micro sponges was determined by way of calculating precisely the preliminary weight of the raw materials and the final weight of the micro sponges acquired via the use of the equation asmentioned below.[18]

PY (%) = (PM/ TM) × 100

PM and TM are practical and theoretical massof micro sponge.

8. **Dissolution Test:** Dissolution launch price of micro sponges can be studied by use of issolution equipment with a modified basket consisting of 5μm stainless steel mesh. The pace of the rotation is one hundred fifty rpm. The dissolution medium is selected while thinking about solubility of actives to make sure sink conditions. At a number of intervals,the samples from the dissolution medium havebeen analyzed by way of appropriate analyticalmethods.[19]

9. **Thermoanalytical Methods:** Thermal evaluation the use of differential scanning calorimetry (DSC) is carried out for the pure drug, polymer and the drug-polymer bodily combination to affirm compatibility. DSC is additionally carried out for the micro sponge formulations to make sure that the components procedure does no longer change the nature of the drug. Samples (approximately two mg) are positioned in aluminum pans, sealed and operated at a heating charge of 20 °C/min overa temperature vary 40 to 430 °C. The thermograms acquired through DSC for the physical mixtures, as properly as micro sponges, must be observed for broadening,moving and look of new peaks or disappearance of sure peaks.

The peak corresponding to the melting of the drug must be preserved in all thermograms.[20]

10. **Resiliency:** Resiliency (viscoelastic properties) of micro sponges can be modified to produce beadlets that are softer or firmer according to the wants of the last formulation. Increased cross-linking tends to sluggish downthe price of release.[21]

11. **Compatibility Studies:** Compatibility of drug with response adjuncts can be studied through thin layer chromatography (TLC) and Fourier Transform Infra-red spectroscopy (FTIR). Effect of polymerization on crystallinity of the drug can be studied by way of powder X-ray diffraction (XRD) and Differential Scanning Calorimetry (DSC). For DSC approximately 5 mg samples can be precisely weighed into aluminum pans and sealed and can be run at a heating price of 15 ºC/min over a temperature vary 25 to 430 ºC inthe surroundings of nitrogen.[22]

12. **Safety Consideration:** Safety research of micro sponges can be set up by eye inflammation research in rabbits, pores and skin infection research in rabbits, mutagenicity in bacteria, oral toxicity research in rats and allergenicity in guinea pigs.[23]

Factors affecting drug release from microsponge delivery system:

1. Physical properties of micro sponge systems like pore diameter, pore volume, resiliency etc. Properties of vehicles in which the micro sponges are finally dispersed.

2. Pressure rubbing/ pressure applied can release active ingredients from micro sponges onto skin.

3. Temperature change some entrapped actives can be too viscous at room temperature to flow spontaneously from micro sponges onto the skin. Increased skin temperature can result in an increased flow rate and hence release.

4. Solubility micro sponges loaded with water-soluble ingredients like antiperspirants and antiseptics will release the ingredient in the presence of water. The release can also be activated by diffusion taking into consideration the partition coefficient of the ingredient between the micro sponges and the outside system.[24]

APPLICATIONS OF MICROSPONGESYSTEMS:

Micro sponges are commonly utilized for topical and recently for oral administration. micro sponges allow to release a pharmaceutical active ingredient effectively at the low dose and also to reinforce stability, decrease adverse effects and alter drug release.[25]

Characteristics of materials that's entrapped in micro sponges:

Most soluble or liquid ingredients will be entrapped within the particles. Actives that may be entrapped in micro sponges must meet following requirements,

1. It should non-miscible in water or at the most only soluble hardly in water.
2. It should not react with monomers.
3. It should be steady in reality with polymerization catalyst and conditions of polymerization.
4. it should be structurally stable.
5. Polymer and payload of the micro sponges must be designed in such a way that the active must be enhanced
6. for required release rate for given time.[26]

Advantages over Conventional Formulations:

When compared to conventional formulations, micro sponge system can prevent excessive accumulation of ingredients within the epidermis and the dermis. Potentially, the micro sponge can reduce significantly the irritation of drugs without reducing their efficacy.

Properties of the actives for the entrapment into

micro sponges

1. It should be either fully miscible in a monomer or capable of being made miscible by the addition of a small amount of a water-immiscible solvent.
2. It should be water immiscible or at most only slightly soluble.
3. It should be inert to monomers and should not increase the viscosity of the mixture during formulation.
4. It should be stable when in contact with the polymerization catalyst and under conditions of polymerization.
5. It must be stable.[27]

Applications of micro sponges

Micro sponge delivery system is used to improve the effectiveness, safety and aesthetic quality of topical prescription, over the counter and personal care products. micro sponges can be used in variety of applications. It is used generally for topical and newly for oral administration. Due to its sustained release ability and high loading capacity several patents have reported that it can be used as an excipient. It offers the formulator a range of alternatives to develop drug and cosmetic products. micro sponges are designed to deliver a pharmaceutical active ingredient efficiently at the minimum dose and also to improve stability, decrease side effects and modify drug release. Over the counter products that incorporate micro sponge

drug delivery system include numerous moisturizers, sunscreens and specializedrejuvenated products.[28]

Advantages over conventional formulation

Topical drug conventional formulations are planned to apply on the outer most layer of the skin, and that products release their active ingredients upon application, producing a highly concentrated layer of active ingredient that is quickly absorbed. When compared to the micro sponge delivery system can prevent extreme accumulation of ingredients within the epidermis and the dermis. Potentially, the micro sponge delivery system can decrease extensively the effective drug irritation without decreasing their efficacy. For example, micro sponge delivery system Benzoyl peroxide formulations have good efficacy with minimum irritation by deliveringthe active ingredient slowly to the skin.[29]

Advantages over Ointments

Ointments are often aesthetically unappealing, stickiness, greasiness etc. the frequent results into lack of patient compliance. These vehicles require active agents with high concentrations for effective therapy because of their low efficiency of delivery system, resulting into allergenic reactions and irritation in important users. The other disadvantages of topical formulations are unpleasant odour, uncontrolled evaporation of active ingredient and potential incompatibility of drugs with the vehicles, when micro sponge system maximizethe amount of time that an active ingredient is present either within the epidermis or on the surface of skin, while minimizing itstransdermal penetration into the body.[30]

Advantages over microencapsulation andliposomes

The micro sponge delivery system has benefits more than other technologies like liposomes and microencapsulation. Microcapsules regularly cannot control the actives release rate. Once the wall is burst the microcapsules which contains actives will be discharged. The liposomes undergo tough formulation, minimum payload, restricted microbial instability and chemical balance. While micro sponge system in contrast to the above systems are stable over range of temperature up to 130˚C, pH 1-11 compatible with maximumingredients and vehicles, higher payload (50- 60%).[31]

Sl. No.	Loaded Drug	Method	Pharmacological Actions	Conclusion
02	Havan ash	Quasi emulsion solvent diffusion method	Anti-microbial effect & Acne Vulgaris	Quasi emulsion solvent diffusion method is simple, less time consuming and involves use of safer ingredients than free radical polymerization and hence more preferred. Eudragit RS100 micro sponges containing Havan ash were successfully prepared by this method.
03	Benzoyl peroxide	Quasi-emulsion solvent diffusion method	antibacterial, anti-inflammatory, keratolytic and wound-healing properties	Benzoyl peroxide was successfully formulated as micro sponges by using Quasi- emulsion solvent diffusion method
04	Clindamycin hydrochloride	Two-phase emulsification method	Acne treatment	Topical semi-solid dosage form chitosan gel with ethyl cellulose based micro sponges loaded with clindamycin hydrochloride, for acne treatment was developed.

Table No. 01 Applications of micro sponges in Acne **treatment**

Conclusion: . The micro sponge drug shipping machine affords entrapment of its components and is believed to make a contribution towards decreased facet effects, increased stability, expanded elegance, and more desirable method flexibility. In addition, severa research have demonstrated that micro sponge structures are non-irritating, non-mutagenic, non- allergenic, and non-toxic. This science is being used presently in cosmetics, over-the-counter pores and skin care, sunscreens, and prescription products. This

sort of drug shipping technological know- how can also lead to a higher appreciation of the restoration of various diseases. Hence, the micro sponge-based drug transport technological know-how is probable to come to be a treasured drug transport matrix substance for quite a number therapeutic purposes in the future.

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