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MICROSPONGES: A NOVEL DRUG DELIVERY SYSTEM

Virender Singh*, Sana Rafiq[1] and Mohammad Mujahid[2]

Jaipur College of Pharmacy, Sitapura, Jaipur (Raj.)

***Corresponding Author: Virender Singh**

Jaipur College of Pharmacy, Sitapura, Jaipur (Raj.)

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ABSTRACT

One of the main objectives among all the drug delivery system is to provide a certain amount of drug to a particular region in the body so that it can give the desired result and maintain drug concentration. Drugs which are readily absorbed form the GI tract and which have a short half life get eliminated rapidly from blood circulation. The efficient oral drug delivery system depends on several factors like gastric emptying, gastrointestinal transit time of the drug or dosage form, drug release from designed dosage form and site of absorption of drug. The administered release on to the epidermis with confidence that the remain primarily localized and does not enter the systemic circulation in considerable amount still remains an area of study, which is done by the microsponge delivery system.

INTRODUCTION

Microsponges are the type of polymeric drug delivery system which contain porous microsphere. They are the tiny sponge like spherical particles that consist of bunchof interconnecting voids of particle size ranging from 5 to 300 µm. They are use as a carrier system as they can entrap numerous active ingredients within a non-collapsible structure with a large porous surface (Fig.1).[1,2]

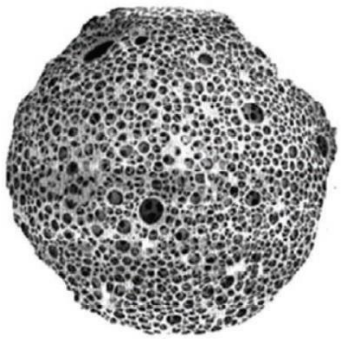

Fig. 1

Microsponges are the microspheres which are capable of enclosing a huge variety of substance, and then can be blended into a pharmaceutical formulation like cream, gel, liquid, lotions or powder and provide a broad package of benefits. It improves the efficacy of tropically active agents with increased safety, elevated product stability, etc.[3,4] When microsponge's formulations are applied on the skin, the microsponge drug delivery system (MDS) librate its active ingredient on a time mode and also in response to some other stimuli like temperature, rubbing and pH. Microsponges are capable of absorbing and loading high degree of active material into the particle or onto its surface.[5] When these are introduced with the carrier system, it can also alter its duration of activity of drug and therapeutic index. The microspheres of microsponges composed of clump of tiny spheres which are capable of holding four times their weight in skin secretions. Microsponge particles are excessively small, inert and irrefragable, so they collected into the tiny nooks of the skin and slowly release the entrapped drug as per the need of skin. They also prevent the enormous aggregation of ingredient within the epidermis and dermis. MDS can also vividly reduce the irritation of drug entrapped in it without harming its efficacy. They are also prescribed to reduce oiliness of skin and provide skin to the skin.

Microsponges are the patented polymeric drug delivery system containing porous microspheres which are capable of entrapping vast spectrum of active ingredients like essential oils, emollients, sunscreen, anti-fungal agents, anti-infective agents, anti- inflammatory agents, etc. The particles of microsponges are too large, that why they do not get absorbed by the skin. Another safety concern is the potential bacterial contaminations of the material entrapped in the microsponges, as the diameter of pores are smaller, so the bacteria ranging between 0.007- 02 µm cannot penetrate into the tunnel structure of microsponges.

The microsponge technology was established by Won in 1987, but the original patents were assigned to Advanced Polymer System, Inc. microsponge technology offers many benefits like enhance efficiency of product, its mildness, its tolerability and also enhance its range to skin therapies.[6,7]

Advantages over other techniques

The advantages are as follow[8]:

1. Microsponges have better chemical stability, higher payload and can be easily formulated when compared toliposomes.
2. Microsponges show more effective control on release then microcapsules. In microcapsules once the wall get broken, the AIP encapsulated within the microcapsules are entirelyreleased.
3. In contrast to ointments, microsponges have the ability to absorb skin secretions and thus reduce greasiness.
4. Because of small pore size ranging between 0.007-02 µm, prevent bacterial contamination.
5. Allow incorporation of immiscibleproduct.
6. Improve material procession e.g. liquids can be converted intopowder.

Characteristics of Microsponges

Microsponges have following characters

1. These formulations are stable over a wider range of pH(1-11).
2. These formulations can bear temperature upto 130° C.
3. These formulations show compatibility with maximum number of vehiclesand ingredient.
4. Sterilization of these formulations are not necessary because the average pore size is around 0.25 µm through which bacteria's cannotpenetrate.
5. Their entrapment capacity is near about 50 to60%.
6. These formulations are very cost effective and they can be used even incosmetic marketalso.
7. These formulations are able to absorb oil from the skin up to 6 time of its own weight without even getting dried.
8. These formulation offers uninterrupted action up to 12 hours.
9. These are flexible dosageform.

Characteristics of Material That Is Entrapped In Microsponges

1. The material should be miscible with the monomer, if it's not then can be made miscible by the addition of some amount of water immiscible solvent.
2. Material should be non-reactive with themonomer.
3. The microsphere formed must benon-collapsable.
4. It should not get dissolve in water or slight solubility is acceptable.
5. It should not get deteriorate when it comes in contact with the polymerizing agent or under the environment of polymerization.

Preparation of microsponges

1. Liquid-liquid suspension polymerization[8]

Microsponges are generally prepared using liquid-liquid suspension polymerization method. In this method the active ingredient is mixed with the monomer (monomer should be immiscible) in a suitable solvent monomer. After this the mixture of active ingredient, monomer and solvent is dispersed into an aqueous phase containing suspending agent, surfactant, etc. to promote formation of suspension.

When the suspension with separate droplets of desired size is formed polymerization is initiated by extending the temperature or irradiation or by the introduction of some catalyst. The polymerization process results in the formation of a reservoir type of system, which opens at the surface through pores. In some cases an inert liquid immiscible with water but completely miscible with monomer is used during the polymerization to form the pore network. After the polymerization the liquid is removed leaving the porous microspheres, i.e., microsponges.(fig.2)

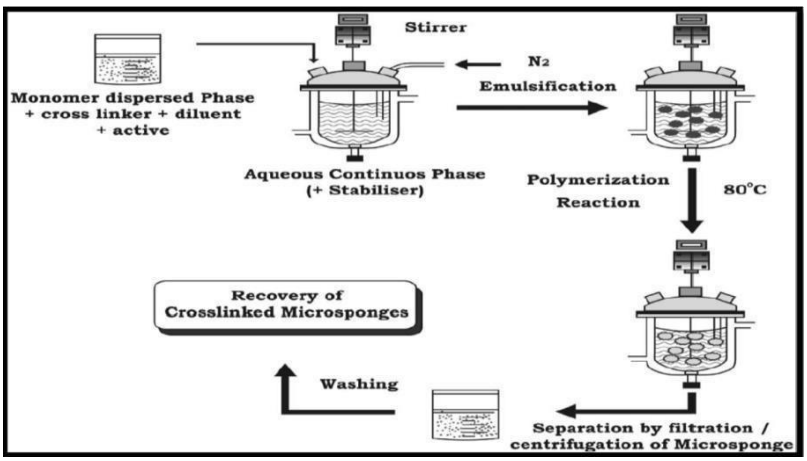

Figure 2

The various steps in the preparation of microsponges are summarized as:

1. Firstly we select the monomer or its combination.
2. A chain of monomer begins to form when polymerization get initiated.
3. Ladders are formed due to cross linking that occurs between chain monomers.
4. Then the monomer ladders are folded to form spherical shaped particles.
5. A cluster of microspheres are formed, which

ultimately gets converted into bunches of microspheres.

6. Finally the bunches are bind together resulting the formation of a structure known as microsponges.

2. Quasi-Emulsion Solvent Diffusion Method[9]

Some drugs are sensitive to polymerization condition, so to overcome this problem two-step process is adopted. In this method different amount of polymers are used.

This method contain two phases one is the external phase which contain 200 ml distilled water and 40 mg PVA and another one is the internal phase which contain Ketoprofen, polymer, ethyl alcohol, triethycitrate etc, these are added at an amount of 20% of the polymer to promote plasticity. After this the drug is added to solution and dissolved using ultrasonicator at 35°C. The internal phase and external phases are added at different temperature; the internal phase is prepared at 60°C and added with external phase at room temperature. After emulsification, the mixture was stirred repeatedly for 2hrs. Finally the mixture is filtered to get the microsponges and then the product was washed properly and dried using vacuum oven at 40°C for about 24 hrs. (Fig.3)

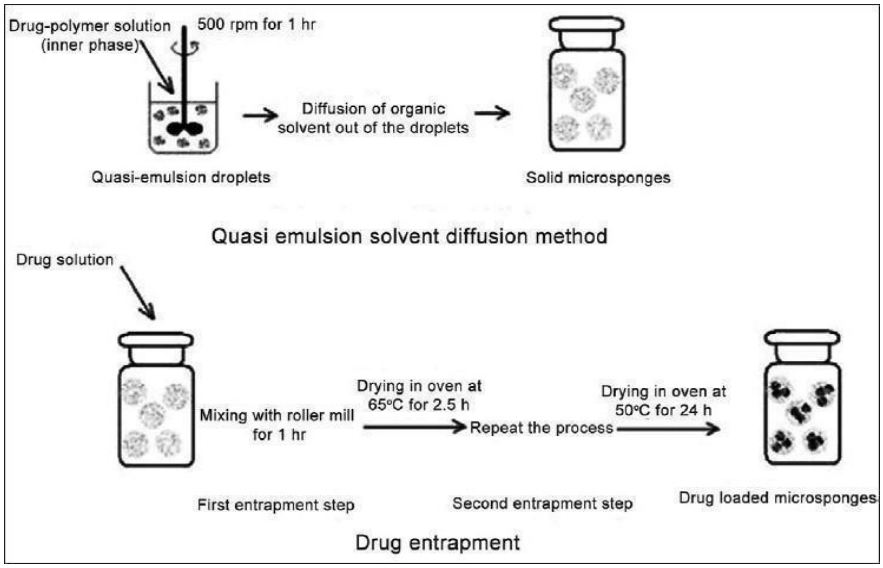

Figure 3

Evaluation of Microsponges

- Particle size (microscopy).
- Morphology and surface topography.
- Loading efficiency and production yield.
- Resiliency.
- Drug release study.
- Compatibility studies.

1. Particle size

The most commonly use method to visualize micro particles are conventional light microscopy (LM) and scanning electron microscopy (SEM). Both are used to identify the shape and outer structure of micro particles. SEM offers higher resolution in contrast to LM. There are some other devices also which are used to determine microscopy of microsponges like, Conflocal fluorescence microscopy which is used for structure characterization of multiple walled micro particles. Laser light scattering and multi size coulter counter are also considered for the characterization of shape, size and morphological character of micro particles (microsponges).[10]

2. Morphology and surface topography For the determination of morphology and surface topography, microsponges are taken and coated with gold–palladium in an artificial argon atmosphere at room temperature and then the surface morphology of the microsponges are studied by using scanning electron microscopy (SEM). SEM of a ruptured Microsponge particle can also be taken to illuminate its ultra structure.[11]

3. Loading efficiency and production yield[12]

For the determination of loading efficiency (%) following equation is used

$$\%\text{loading efficiency} = \frac{\text{actual drug content in microsponges}}{\text{theoretical drug content}} \times 100 \quad \text{-----Eq no. (1)}$$

For the calculation of production yield (%) the given equation can be used

$$\%\text{Production yield} = \frac{\text{Production yield}}{\text{theoretical mass (polymer + drug)}} \times 100 \quad \text{-----Eq no. (2)}$$

4. Resiliency[13]

Resiliency (viscoelastic properties) of microsponges is also very important for their stability and it can be remould to produce beadlets and these are softer or

firmer according to the requirement of the final formulation.

5. Drug release study[13]

Dissolution apparatus USP XXIII is use for the determination of dissolution profile of microsponges. This apparatus consists of a stainless steel mesh of pore size 5 µm. Rotational speed of the basket is kept 150 rpm. For the selection of suitable dissolution medium solubility of the actives ingredient in considered to ensure the sink condition.

6. Compatibility studies[14]

Compatibility study of the drug with the additives can be performed with the help of thin layer chromatography (TLC) and Fourier Transform Infra-red spectroscopy (FT-IR). Polymerization also affects the crystallinity of the drug, so the effect of polymerization is determined by X-ray diffraction (XRD) and Differential Scanning Colorimetry (DSC).

MARKETED PRODUCTS

SR. NO.	PRODUCT	MANUFACTURE
1	Carac Cream, 0.5%	Dermik Laboratories, Inc.
2	Retinol cream	Biomedic
3	Oil Control Lotion	Fountain Cosmetics
4	Sportscream RS and XS	Embil Pharmaceutical Co. Ltd
5	EpiQuin Micro	SkinMedicaInc
6	Oil free matte block spf20	Dermalogica
7	Micro Peel Plus	Biomedic

CONCLUSION

Microsponges can target drugs to their desired sites of action. The most eminent advantages of this delivery system are its enhanced stability and reduced side effects. Therefore microsponge delivery system is regarded as a promising vehicle for the targeted and controlled release of numerous topical and orally active agents. Microsponges have a distinct advantage over the pre-existing conventional topical dosage forms which are used for the treatment of tropical diseases; MDS is a unique technology employed for the controlled release of topical agents also use for some other oral and biopharmaceutical drug delivery. This shows advantageous over other products by non-mutagenic, non-toxic, non-irritant. Microsponge drug delivery system is a promising drug delivery system and it has got huge of potential and it is a very emerging field which is necessary to be explored in the future with most research study.

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