Review Article

A Novel Approach on Microsponge : Multifunctional Modern Dosage Form

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ABSTRACT

In the field of drug delivery system, there are so many new formulation techniques. Microsponges are one of the recent unique techniques which are gaining popularity now days due to their use of controlled release and targeted drug delivery system. Microsponge also hold a certification as one of the potential approaches for gastric retention where many orally dosage forms face several physiological restriction due to non uniform absorption pattern, inadequate medication release and shorter residence time of the dosage form in the stomach. MDS technology has been introduced in topical drug products to facilitate the controlled release of active drug into the skin in order to reduce the systemic exposure and minimize local cutaneous reactions to active. It is a polymeric delivery system and composed of porous microsphere. It has microscopic tiny sponge like shape and consists of spherical particles containing a large porous surface which are believed to contribute towards reduced side effects, improved stability, increased elegance and enhanced formulation flexibility at the minimum dose. This type of drug delivery system which is non-irritating, non-allergic, non-toxic, can suspend or entrap a wide variety of substances, and can then be incorporated into a formulated product such as gel, cream, liquid or powder and have recently been used for oral administration that is why it is called "versatile drug delivery system. The present review elaborates about the multifunctional microsponge technology including its preparation, characterization, evaluation methods along with recent research and future potential.

Keywords: Microsponge, Porous microsphere, Bioerodible, Control release, Over the-counter (OTC), multifunctional drug delivery system.

INTRODUCTION

The oral route of drug administration is known to be the most convenient and commonly employed route. Drugs that get easily absorbed in the gastrointestinal tract and having a short half life get eliminated rapidly through blood circulation. To shun these problems, orally controlled release formulations have been developed, which release drug slowly into the gastrointestinal tract and help in keeping constant drug concentration in the serum for a longer period of time. Oral route of drug administration has broad acceptance. Up to 50–60% of oral solid dosage forms are well-liked because of usual, straightforward and suitable administration with precise dosage, self medication, pain evasion and most prominently patient compliance. The most admired solid dosage forms are tablets and capsules; these dosage forms may envelop wide range of applications in novel drug delivery systems such as nanoparticles, microparticles, microspheres, nanospheres and microsponges.[1] Microsponge Delivery System (MDS) is highly cross-linked, porous, polymeric microspheres that can entrap broad range of active ingredients and release them into the skin over an extended period of time and in response to triggers. This system was implied earlier for the enhancement of performance of drugs. It is a unique technology for the controlled release of drug, which consists of microporous beads loaded with active agents.[2,3] One of the major challenges faced by pharmaceutical scientists is to control the delivery rate of actives to a predetermined site in the body. The prime aim of any drug delivery system is to provide therapeutic amount of drug to a proper site in the body, to punctually achieve and maintain the desired drug concentration. Most of these drug delivery systems include polymers which encapsulate drug. Oral drug delivery systems are used for enhancing therapeutic index of the drug and also for reducing side effects. Oral route is the chosen route for the administration of active and/or therapeutic agents owing to its low cost of therapy and ease of administration, which may lead to higher level of patient acquiescence. The efficient oral drug delivery may depend upon 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.[4] A Microsponge drug delivery system (MDDS) is a patented, highly cross-linked, porous, polymeric microspheres system (10-25 µ) consisting of porous microspheres particles consisting of a myriad of inter connecting voids within non-collapsible structures with a large porous surfactant can entrap wide range of actives (cosmetics, over-the-counter (OTC) skin care, sunscreens and prescription products) and then release them onto the skin over a time and in response to trigger. The size of the microsponges can be varied, usually from 5 – 300 µm in diameter, depending upon the degree of smoothness or after-feel required for the end formula. A typical 25µm sphere can have up to 250000 pores and an internal pore structure equivalent to 10ft in length providing a total pore volume of about 1ml/g. The microsponge particles themselves are too large to be

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absorbed into the skin and this adds a measure of safety to these microsponge materials. As the size of the pore diameter is smaller, the bacteria ranging from 0.007 to 0.2 µm cannot penetrate into the tunnel structure of the microsponges. Microsponge does not pass through the skin (capable of holding four times their weight in skin secretions). Rather, they collect in the tiny nooks and crannies of skin and slowly release the entrapped drug, as the skin needs it. The microsponge system can prevent excessive accumulation of ingredients within the epidermis and the dermis. These products are typically presented to the consumer in conventional forms like creams, gels or lotions and they contain relatively high concentration of active ingredients. Microsponges are polymeric delivery systems consisting of porous microspheres that can entrap a wide range of active ingredients such as emollients, fragrances, essential oils, sunscreens, and anti-infective, anti-fungal, and anti-inflammatory agents. The microsponge technology was developed by Won in 1987 and the original patents were assigned to Advanced Polymer Systems, Inc. This Company developed a large number of variations of the technique and applied those to cosmetic as well as OTC and prescription pharmaceutical products. At the present time, this interesting technology has been licensed to Cardinal Health, Inc., for use in topical products as shown in figure 1.[5,6]

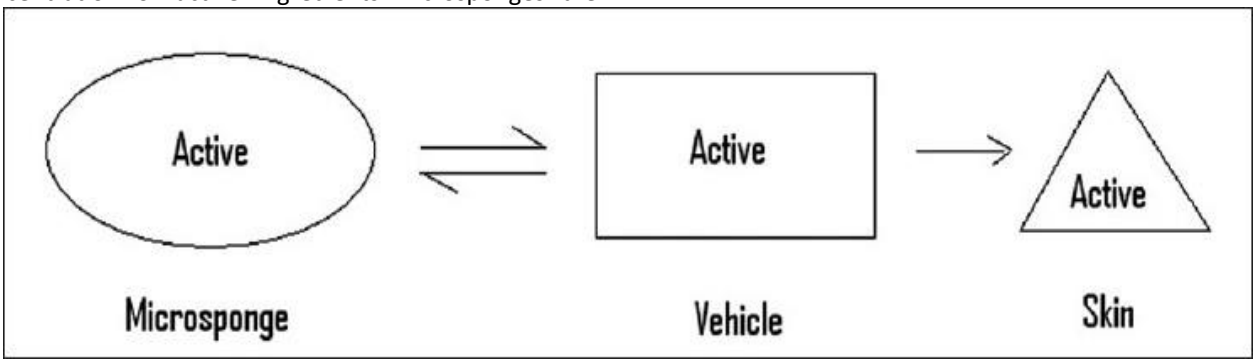
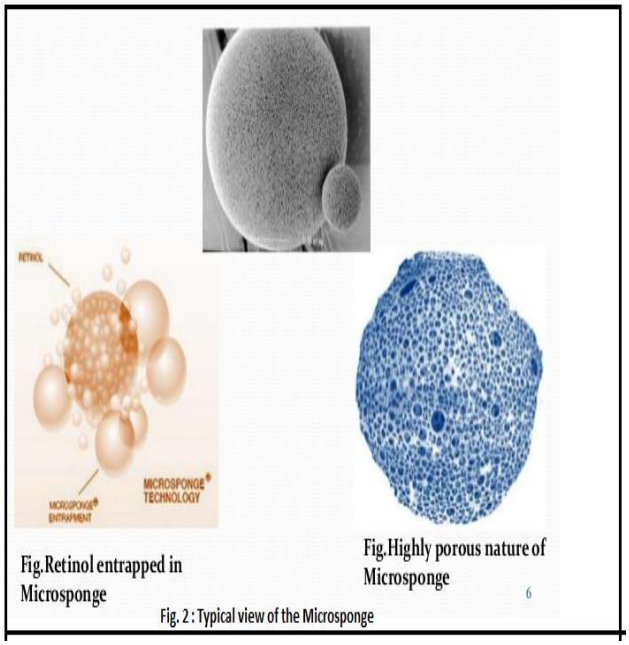


Figure 1: Schematic representation of the distribution of the loaded material (active) on skin.

Microsponges are stable over a range of pH 1-11 and temperature up to 130°C and are compatible with most vehicles and ingredients and self-sterilizing as their average pore size is 0.25 µm where bacteria cannot penetrate these formulations are free flowing and can be cost-effective. Microsponges approaches are applied occupied for the improvement of performance of topically applied drugs to overcome difficulties like greasiness, stickiness related with topical formulations.[6] At the current time, this interesting approach has been licensed to Cardinal Health, Inc., for use in topical products. The scanning electron microscopy (SEM) of the microsponge's particle reveals that its internal structure appears as the bag of marbles. The porosity is due to the interstitial spaces between the pores that can entrap many wide ranges of active ingredients such as emollients, fragrances, essential oils, sunscreens, anti-infective, and anti-inflammatory therapeutic compounds. These systems are the porous microspheres having myriad of interconnected voids of particle size range of 5-300 micrometer. They consist of non collapsible structure with porous surface through which active ingredients are released in controlled manner. Depending upon the size, total pore length may range up to 10ft and pore volume up to 1ml/g. When applied to the skin, the microsponge drug delivery system (MDS) releases it's active ingredient on a time mode and also in response to other stimuli such as rubbing temperature and pH. They have capacity to absorb or load a high degree of active materials into the particle or onto its surface. Its large capacity for entrapment of actives up to 3 times its weight and it differentiates microsponges from other type of dermatological delivery systems. Rashes and more serious side effects occur sometimes due to rapid penetration of active ingredients of cosmetics and skin care formulation below the skin's surface. Microsponge technology allows a prolonged rate of release of the active ingredients and offers potential reduction in the side effects while maintaining the therapeutic efficacy.[7,8] A typical view of microsponge is given in the Fig. 2 and Fig. 6.



Benefit of Microsponge Drug Delivery System[6]

When Microsponges are applied to the skin, its drug release can be controlled through diffusion.

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Microsponges release active ingredient in programmed manner on target site of skin, thus provide benefits of improved product efficacy, reduced irritation usually associated with potent therapeutic agents as benzoyl peroxide. Several benefits of Microsponge based drug delivery approaches are mentioned below (Fig. 2).

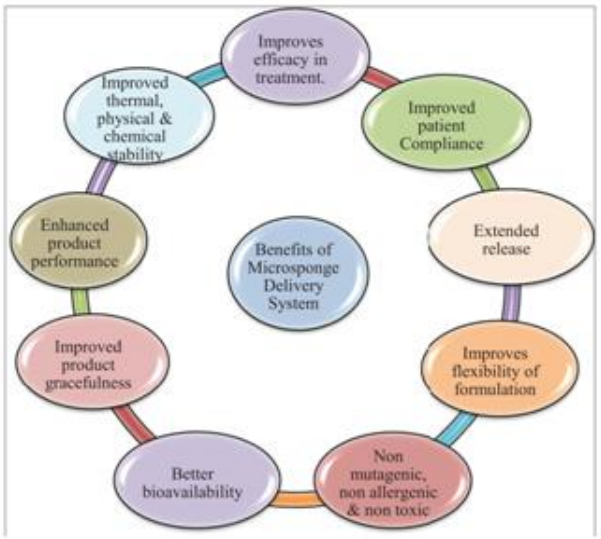

Figure 3: Benefits of Microsponge Drug Delivery System.[6]

The characteristics or features of microsponge drug delivery are the following[6, 9, 10]

- Microsponges show acceptable stability over pH ranging from 1-11.
- They also show acceptable stability at high temperature upto 130 degree centigrade.
- They have high entrapment efficiency upto 50-60%.
- They show good compatibility with various vehicles and ingredients.
- They have free flowing properties.
- The average pore size of microsponges is small (0.25 micrometer) and therefore the prevent penetration of bacteria and they do not need sterilization or addition of preservatives.
- They are non-irritating, non-mutagenic, non-allergenic and non-toxic.
- They can absorb oil upto 6 times of its weight without drying.

The materials entrapped in the microsponge must meet the following requirements[9, 10]

- It should be fully miscible in monomer or capable of being made miscible by addition of a water immiscible solvent in a small amount.
- It should be inert to monomer.
- It should be stable in contact with polymerization catalyst.
- It should not increase viscosity of mixture during formulation.
- It should not collapse spherical structures of the microsponges.
- The solubility of active ingredients in the vehicle must be limited.
- Not more than 10-12% w/w microsponges must be incorporated into the vehicle to avoid cosmetic problems.

Preparation of Microsponge[6,11,12]

Microsponge drug delivery system can be prepared in two ways which is described in the Fig. 4.

- One step process i.e, liquid-liquid suspension polymerization.
- Two step process i.e, quasi-emulsion solvent diffusion techniques.

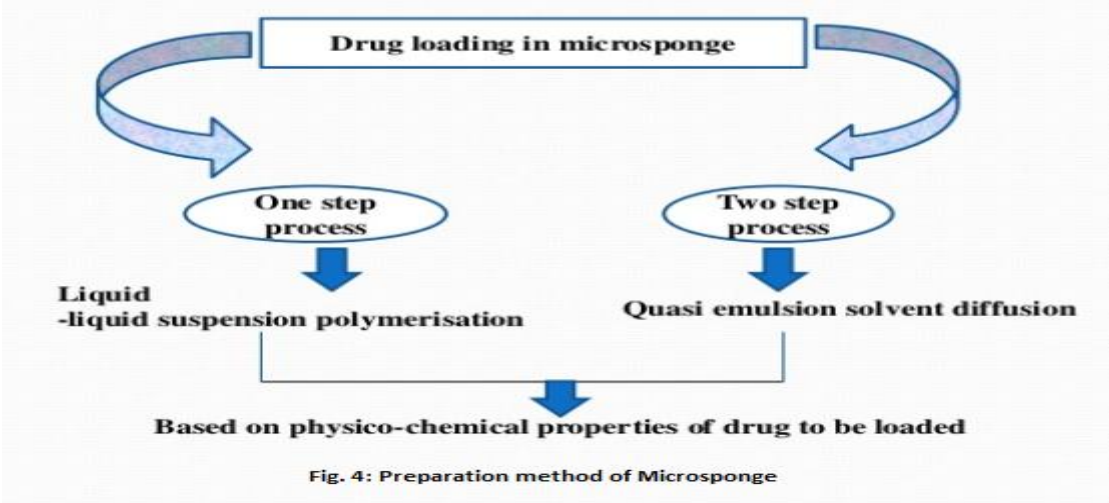

Fig. 4: Preparation method of Microsponge

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Liquid-Liquid Suspension Polymerization Method

In this vehicle of polymerization, the monomers are dissolved along with the active ingredients, i.e., surfactant in suitable solvent followed by addition of additives, suspending agent are added to the formation of suspension. The polymerization is such as initiated by adding catalyst or by increasing temperature; ultimately solvent is removed leaving the spherical structure porous. After the polymerization process, the solvent is removed leaving the spherical porous structure microsponges (Fig. 5).[5,6,12]

The various steps involved in the preparation of microsponges are summarized as follows[17]

Step 1: Selection of monomer as well as combination of monomers.

Step 2: Formation of chain monomers as polymerization starts.

Step 3: Formations of ladders as a result of cross-linking between chain monomers.

Step 4: Folding of monomer ladder to form spherical particles.

Step 5: Agglomeration of microspheres leads to the production of bunches of microspheres.

Step 6: Binding of bunches to produce microsponges.

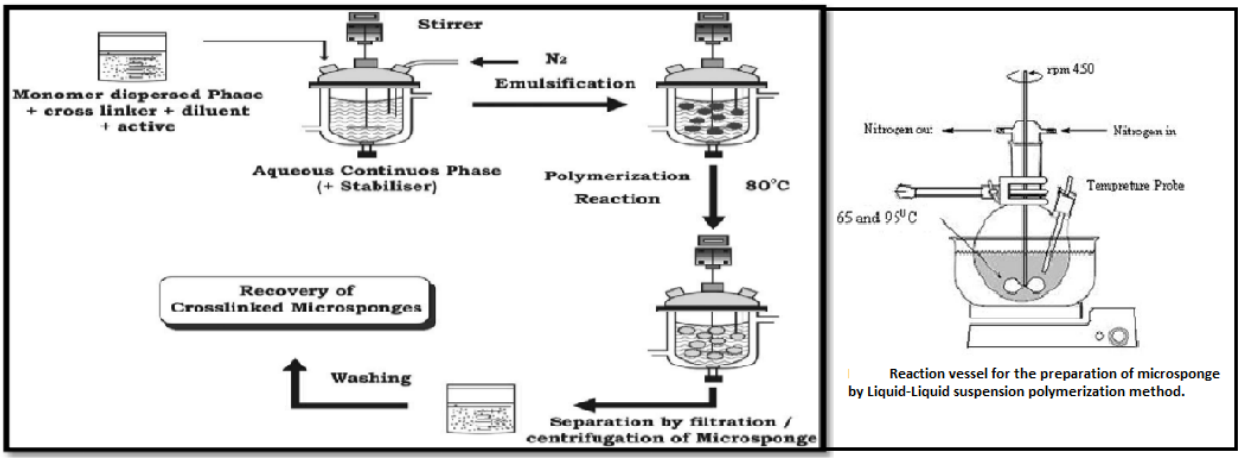

Figure 5: Suspension Polymerization System up Method.[5]

Quasi Emulsion Solvent Diffusion Method[5, 6, 12, 13]

Quasi emulsion solvent diffusion method or top-down approach or two step process is used when the drug is sensitive to the polymerization conditions. In this method, the drug is dissolved in the good solvent. Then the solution is dispersed into the poor solvent and produces emulsion (quasi) droplets, even though the pure solvent is miscible. The good solvent diffuses gradually out of the emulsion droplets and poor solvent diffuses into the droplets. Therefore, drug crystallizes inside the droplets.

This is top-down approach starting with preformed polymer along with the active ingredient, plasticizer and diffusible substance (porogen). This process involved formation of quasi-emulsion of two different phases‟ i.e. internal phase and external phase similar to emulsions. To prepare the inner organic phase, polymer dissolved in suitable solvent followed by addition drug dissolved under ultrasonication at 35°C. This solution made inner phase. The internal phase of drug--polymer solution made in a volatile solvent like ethanol or acetone or dichloromethane was added to external phase comprising the aqueous polyvinyl alcohol (PVA) solution with vigorous stirring. Triethyl citrate (TEC) was added at an adequate amount in order to facilitate plasticity.

After emulsification, the system is continuously stirred for 2 hours and maintains higher temperature if required. Stirring lead to the formation of discrete emulsion globules called quasi-emulsion globules. Solvent was then extracted out from these globules to form insoluble, rigid microparticles. Diffusion of porogen into the external phase or medium results the formation of a highly porous microparticles called “Microsponge”. Then the mixture is filtered to separate the microsponges. Then the product is washed and dried in vacuum oven at 50^0c for 24 hours. Conceptually, the finely dispersed droplets of the polymeric solution of the drug (dispersed phase) get solidified in aqueous phase via counter diffusion of organic solvent and water out of and into the droplets. The diffused aqueous phase within the droplets decreased the drug and polymer solubility resulting in the co-precipitation of both the components and continued diffusion of the organic phase results in further solidification, producing matrix-type porous microspheres. In comparison with liquid--liquid suspension polymerization method, this method offered the advantage of less exposure of the drug to the ambient conditions, low solvent residues in the product because the solvent get extracted out due to its solubility in aqueous media or due to its volatile nature (Fig. 8).

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In another method that is drug entrapment method, drug loading is done after the formation of microsponges. In this method, blank microsponges and drug solution in ethanol is added. Bottles are arranged on roller mill and mixed for 1hr. The mixture is dried in an oven at 65 °C for 2.5 h. This process is repeated for a second entrapment step and the drying process is held at 50 °C for 24h (Fig. 8)[5].

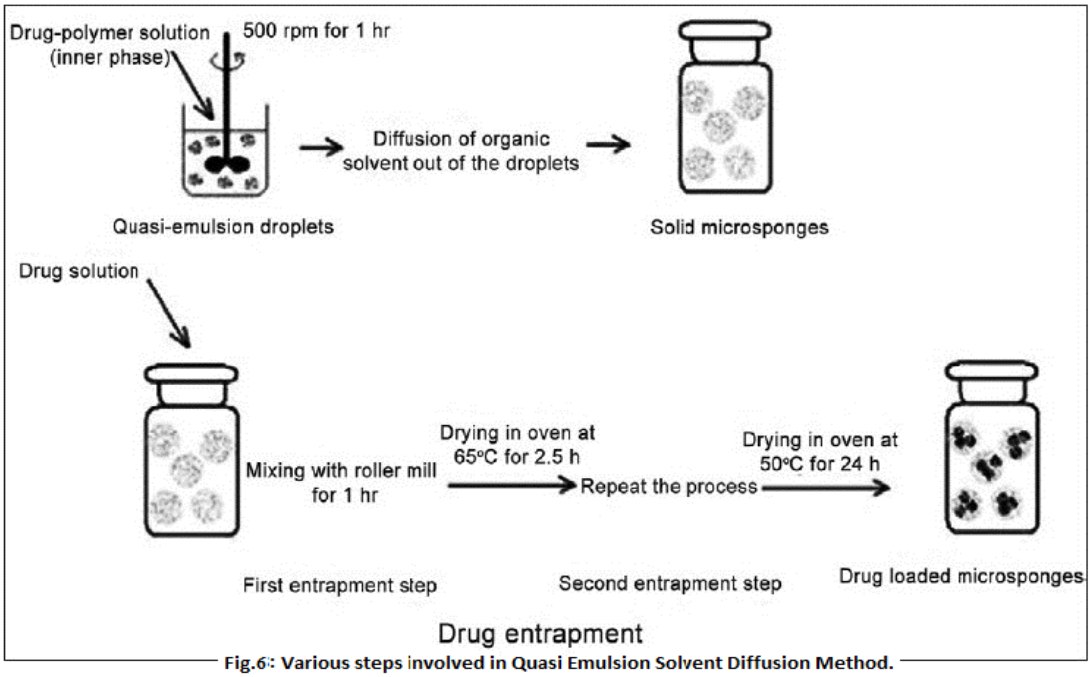

Fig.6: Various steps involved in Quasi Emulsion Solvent Diffusion Method.

Formulation considerations[5, 6. 7]

Actives entrapped in MDS can then be incorporated into many products such as creams, gels, lotions, powders and soaps or can be compressed into tablets. When formulating the vehicle, certain considerations are taken into account in order to achieve desired product characteristics.

- The solubility of actives in the vehicle must be limited. Otherwise the vehicle will deplete the microsponges before the application.
- To avoid cosmetic problems; not more than 10 to 12% w/w microsponges must be incorporated into the vehicle.
- Polymer design and payload of the microsponges for the active must be optimized for required release rate for given time period.

Hypothetical Mechanism of Action[5,14]

The active ingredient is added to the vehicle in an entrapped form. As the microsponge particles have an open structure (they do not have a continuous membrane surrounding them), the active is free to move in and out from the particles and into the vehicle until equilibrium is reached, when the vehicle becomes saturated. Once the finished product is applied to the skin, the active that is already in the vehicle will be absorbed into the skin, depleting the vehicle, which will become unsaturated, therefore, disturbing the equilibrium. This will start a flow of the active from the microsponge particle into the vehicle, and from it to the skin, until the vehicle is either dried or absorbed. Even after that the microsponge particles retained on the surface of the stratum corneum will continue to gradually release the active to the skin, providing prolonged release over time. This proposed mechanism of action highlights the importance of formulating vehicles for use with microsponge entrapments. If the active is too soluble in the desired vehicle during compounding of the finished products, the products will not provide the desired benefits of gradual release. Instead they will behave as if the active was added to the vehicle in a free form. Therefore, while formulating microsponge entrapments, it is important to design a vehicle that has minimal solubilising power for the actives. This principle is contrary to the conventional formulation principles usually applied to topical products. For these conventional systems it is normally recommended to maximize the solubility of the active in the vehicle. When using microsponge entrapments, some solubility of the active in the vehicle is acceptable, because the vehicle can provide the initial loading dose of the active until release from the microsponge is activated by the shift in equilibrium from the polymer into the carrier. Another way to avoid undesirable premature leaching of the active from the microsponge polymer is to formulate the product with some free and some entrapped active, so the vehicle is pre-saturated. In this case there will not be any leaching of the active from the polymer during compounding. The rate of active release will ultimately depend not only on the partition coefficient of the active ingredient between the polymer and the vehicle (or the skin), but also on some of the parameters that characterize the beads. Examples of these include surface area and primarily, mean pore

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diameter. Release can also be controlled through diffusion or other triggers such as moisture, pH, friction or temperature (Fig. 1).

Release Mechanism[5,6]

MDS consists of a multitude of porous microsphere that forms a complex network of interconnecting voids with a non-collapsible structure. The rate of release of active ingredients depend on several factors like pore diameter, the extent of cross linking of the polymers, differences in concentration of the active ingredient between the microspheres and vehicle. Microsponge can be designed to release active ingredients over time in response to one or more external triggers. The release mechanisms from MDS are accelerated or triggered by the following system.

Pressure

Microsponge releases the active ingredient onto skin when pressurized or rubbed.

Temperature Change

Some active ingredients are too viscid to flow from microsponge onto skin. In that case temperature is increased for increasing the release of active medicaments from microsponge. It is possible to modulate the release of substances from the microsponge by modulation of temperature. That is viscous sunscreens were show a higher release when exposed to higher temperatures.

Solubility

Microsponges are 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 partition coefficient of the ingredient between the microsponge and the outside system. Perspiration can trigger the release rate of active ingredients.

pH

Triggering the pH based release of the active ingredient can be obtained by modifying the coating the microsponge.

Characterization of Microsponge[14,15, 16,17]

Particle size determination

Particle size analysis of loaded and unloaded microsponges can be performed by laser light diffractometry or by any other suitable method.

Morphology and surface topography

Surface morphology can be studied by scanning electron microscopy (SEM).During this study the prepared microscope can be coated with gold-palladium under an argon atmosphere at room temperature. Scanning Electron Microscope of a fractured microsponge particle can also be taken to illustrate its ultra structure.

Determination of loading efficiency and production yield

The loading efficiency (%) and production yield of the microsponges can be calculated by the following equations.

Loading efficiency = actual drug content in Microsponge / theoretical drug content X 100.

Production yield = practical mass of microsponges/theoretical mass (polymer+ mass) X 100.

Determination of true density

The true density of micro particles can be measured by using an ultra-pycnometer under helium gas. It is calculated from a mean of repeated determinations.

Characterization of pore structure

Mercury intrusion porosimetry can be employed to study the effect of pore diameter and pore volume with the rate of drug release from microsponges. Porosity parameters of Microsponge such as intrusion-extrusion isotherms pore size distribution, total pore surface area, average pore diameters, interstitial void volume, percent porosity, percent porosity filled, shape and morphology of pores, bulk and apparent density can be determined by using mercury intrusion porosimetry.

Resiliency

Resiliency or viscoelastic properties of microsponges can be modified to produce beadlets that are softer or firmer according to the needs for the final formulation.

Compatibility studies

The drug-excipient compatibility studies are carried out in order to ensure that there is no inadvertent reaction between the two when formulated into a dosage form. These studies are commonly carried out by recording the differential scanning Colorimetry (DSC) of the chemicals viz., API and excipient individually and also together and checking for any addition or deletion of any peaks or troughs. For DSC approximately 5 mg samples can be accurately weighed into aluminium pans and sealed and can be run at a heating rate of 15^0C/min over a temperature range 25–430^0C in atmosphere of nitrogen. Infrared (IR) spectroscopy can also reveal the incompatibilities between the chemical moieties. Compatibility of drug with reaction adjuncts can also be studied by thin layer chromatography (TLC) and FT-IR. Effect of polymerization on crystallinity of the drug can be

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studied by powder X-ray diffraction (XRD) and Differential Scanning Colorimetry (DSC).

Dissolution tests

Dissolution study of microsponges can be done using the dissolution apparatus USP XXIII with a modified basket consisted of 5 micrometers stainless steel mesh. The speed of the rotation is 150 rpm. The dissolution medium is selected while considering solubility of actives to ensure sink conditions. Samples from the dissolution medium can be analysed by suitable analytical method at various intervals

Kinetics of release

To determine the drug release mechanism and to compare the release profile differences among microsponges, the drug released amount versus time was used. The release data were analysed with the following mathematical models:

$Q= k_1t$ n or log Q= log k_1 + n log t ……Equation (1), Where Q is the amount of the released at time (h), n is a diffusion exponent which indicates the release mechanism, and k_1 is a constant characteristic of the drug–polymer interaction. From the slope and intercept of the plot of log Q versus log t, kinetic parameters n and k_1 were calculated.

For comparison purposes, the data was also subjected to Equation (2), which may be considered a simple, Higuchi type equation.

$Q = k_2t$ 0:5 +C …… Equation (2).

Equation (2) for release data dependent on the square root of time, would give a straight line release profile, with k_2 presented as a root time dissolution rate constant and C as a constant.

Safety considerations[17,18]

Safety studies of microsponges can be confirmed by;

1. Allergenicity in guinea pigs

2. Eye irritation studies in rabbits

3. Mutagenicity in bacteria

4. Oral toxicity studies in rats.

5. Skin irritation studies in rabbits.

Advantages of Microsponges Over Other Formulations[17,18]

Microsponges have several advantages over other formulation available in the market.

1. **Advantages over conventional formulations** Conventional formulation of topical drugs release their active ingredients upon application and produce a highly concentrated layer of active ingredient and it causes irritation of the skin. Microsponge system can prevent excessive accumulation of ingredient within the epidermis and dermis. Potentially, the microsponge drug delivery system can reduce irritation of effective drugs without reducing their efficacy.

Advantages over microencapsulation and liposome Microcapsules cannot usually control the release rate of active ingredients and liposome suffer from lower payload, difficult formulations, limited chemical stability, microbial instability while microsponge system in contrast to above system has several advantages like thermally, physically and chemically stable and have higher payload(upto 50-60%).

Advantages over ointments

Ointments are often aesthetically unappealing greasy and sticky that reduces patient's irritation. Others drawbacks of topical formulations are uncontrolled evaporation of active ingredient, unpleasant order, incompatibility between drugs and vehicles where as microsponge system maximize amount of time that an active ingredient present either on skin surface or within the epidermis, while minimizing its transdermal penetration into the body.

Applications[17, 18, 19]

Microsponge delivery systems are used to enhance the safety, effectiveness and aesthetic quality of topical prescription, over-the-counter and personal care products. This technology is designed to allow a prolonged rate of release of the active ingredients, thereby offering potential reduction in the side effects while maintaining the therapeutic efficacy. Products under development or in the market place utilize the Topical Microsponge systems in three primary ways:

1. As reservoirs releasing active ingredients over an extended period of time,

2. As receptacles for absorbing undesirable substances, such as excess skin oils, or

3. As closed containers holding ingredients away from the skin for superficial action.

Microsponge for topical delivery

The Microsponge systems are based on microscopic, polymer-based microspheres that can bind, suspend or entrap a wide variety of substances and then be incorporated into a formulated product, such as a gel, cream, liquid or powder. A single Microsponge is as tiny as a particle of talcum powder, measuring less than one-thousandth of an inch in diameter. Like a true sponge, each microsphere consists of a myriad of interconnecting voids within a non-collapsible structure that can accept a wide variety of substances. The outer surface is typically porous, allowing the controlled flow of substances into and out of the sphere. Microsponge systems are made of biologically inert polymers. Extensive safety studies have demonstrated that the polymers are non-irritating, non-mutagenic, non-allergenic, non-toxic and non-

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biodegradable. As a result, the human body cannot convert them into other substances or break them down.

Microsponge for oral delivery

In oral applications, the microsponge system has been shown to increase the rate of solubilisation of poorly water-soluble drugs by entrapping such drugs in the microsponge system's pores. As these pores are very small, the drug is in effect reduced to microscopic particles and the significant increase in the surface area thus greatly increases the rate of solubilisation. Giving an example, controlled oral delivery of ibuprofen microsponges is achieved with an acrylic polymer, Eudragit RS, by changing their intraparticle density. Sustained release formulation of chlorpheniramine maleate, using powder-coated microsponges, which is prepared by the dry impact blending method, for oral drug delivery.

Microsponge for Bone and Tissue Engineering

Bone-substitute compounds were obtained by mixing pre polymerized powders of poly methyl methacrylate and liquid methyl methacrylate monomer with two aqueous dispersions of tri calcium phosphate grains and calcium deficient hydroxyapatite powders. The final composites appeared to be porous and acted as microsponges. Basic fibroblast growth factor (bFGF) incorporated in a collagen sponge sheet was sustained released in the mouse subcutis according to the biodegradation of the sponge matrix, and exhibited local angiogenic activity in a dose-dependent manner.

Microsponges are used mostly for topical administration and recently for oral administration as well as biopharmaceutical delivery. Various applications as well as the marketed product are shown in the table 1 and Fig. 9.

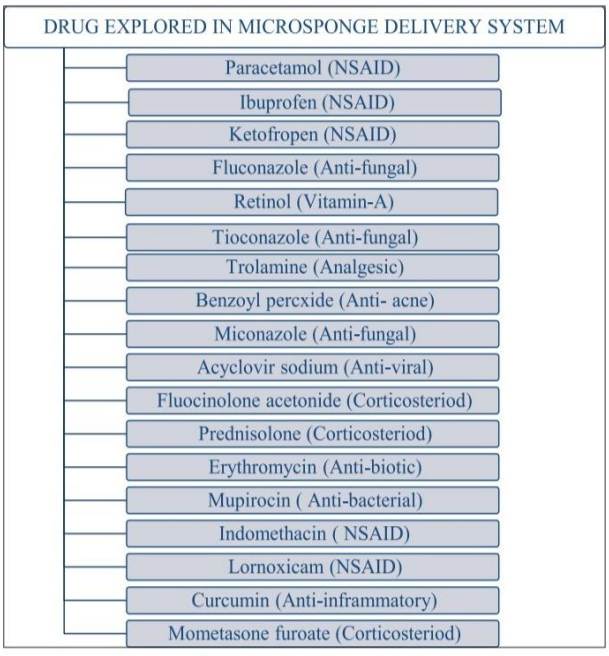

Figure 7: Marketed Drug in the form of Microsponge.[6]

Table 1: Applications of microsponge with respect to their advantages. [16,17,18]

Sl. No.	Active Agents	Application
1.	Sunscreens	Long lasting product efficacy with improved protection against sunburns and sun related injuries.
2.	Anti-acne e.g. benzoyl peroxide	Maintained efficacy with decreased skin irritation and sensitization.
3.	Anti-inflammatory e.g. hydrocortisone	Long lasting activity with reduction of skin allergy response and dermatoses.
4.	Anti-fungal	Sustained release of actives.
5.	Anti-dandruffs e.g. zinc pyrithione, selenium sulfide	Reduced unpleasant odour with lowerd irritation with extended safty and efficacy.
6.	Antipruritics	Extended and improved activity.
7.	Skin de pigmenting e.g. hydroquinone	Improved stabilization against oxidation with improved efficacy and aesthetic appeal.
8.	Rubefacients	Prolonged activity with reduced irritancy greasiness and odour.

Future Outcome

Microsponge drug delivery system holds a promising opportunity in various pharmaceutical applications in the upcoming future as it has unique properties like enhanced produce performance and elegancy, extended release, improved drug release profile, reduced irritation, improved physical, chemical and thermal stability which makes it flexible to develop novel product forms. The real challenge in future is the development of the delivery system for oral peptide delivery. Bioerodible and biodegradable polymers are used in this delivery system and it causes safe as well as effective delivery of active material. These porous systems have also been studied for drug delivery through parenteral and pulmonary route. Microsponge particles can be used as cell culture media and thus can also be employed for stem cell culture and cellular regeneration in the body. In future microsponge carrier systems have also found their application in cosmetics. This versatility in formulation utilizes those in various fields and also opens the new pathway for drug delivery system.

CONCLUSION

Microsponge technology is rapidly evolving and highly competitive technology and more research are carried out to optimize cost as well as efficacy of therapy. Complemented by novel development approaches and

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creative formulation techniques, microsponge delivery system can be winning a strategy for a new generation of pharmaceutical and cosmetics industry. These unique technology for controlled release topical agents also use for oral as well as biopharmaceutical drug delivery. The microsponge delivery technology of controlled release system in which active pharmaceutical ingredients are loaded in the microporous beads and initiates reduction in side effects with improved therapeutic efficacy. Microsponges constitute a significant part by virtue of their small size and efficient carrier characteristics. It has a distinct advantage over the existing conventional topical dosage forms for the treatment of tropical diseases. This shows advantageous over other products by non mutagenic, non toxic, non irritant. So, microsponge drug delivery system has got a lot of potential and is very emerging field which is needed to be explored in the future with most research study.

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