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Microsponges: A Novel approach of drug delivery system

Harish kothari[1], Shaffi K Tangri[2]

[1]School of Pharmaceutical Sciences, Shri Guru Ram Rai University, Patel Nagar, Dehradun, Uttarakhand,

Pin code - 248001

[2]Head of Department,Department of Pharmaceutics, School of Pharmaceutical Sciences, SGRR University, Dehradun, Uttarakhand, India.

Abstract

Microsponges with cutting-edge methods that provide more benefits for medication administration systems. Micro sponges are described as biologically porous in active microspheres with particles between 10 and 25 micrometers in size. The quasi-emulsion solvent diffusion method is frequently used to develop controlled release formulations. Microsponges distribute the medication release in a regulated manner to a specific location within the body. The microsponges had been the subject of several patents. The drug delivery mechanism used by microsponges is thought to be an inventive and unique approach to reaching the intended drug delivery goal; using this method, controlled medication delivery may be completed fast and simply.

Keywords: Microsponges, Novel, Controlled, Active, Patent, Micrometer.

Introduction

Controlled drug delivery systems are thought to be the most effective technique in the development of targeted medication delivery systems. By acting on the target cells and releasing the medicine at a controlled rate, they aid in achieving the intended effect [1]. Micro sponges are porous materials that can contain a variety of active substances, including essential oils, perfumes, and emollients, which have anti-inflammatory and anti-fungal properties[2].Advanced Polymer System, Inc. was awarded the first patent for Microsponges, which were developed by "Won" in 1987. This group created a variety of preparations using microsponge technology for over-the-counter, cosmetic, and pharmaceutical products [3].

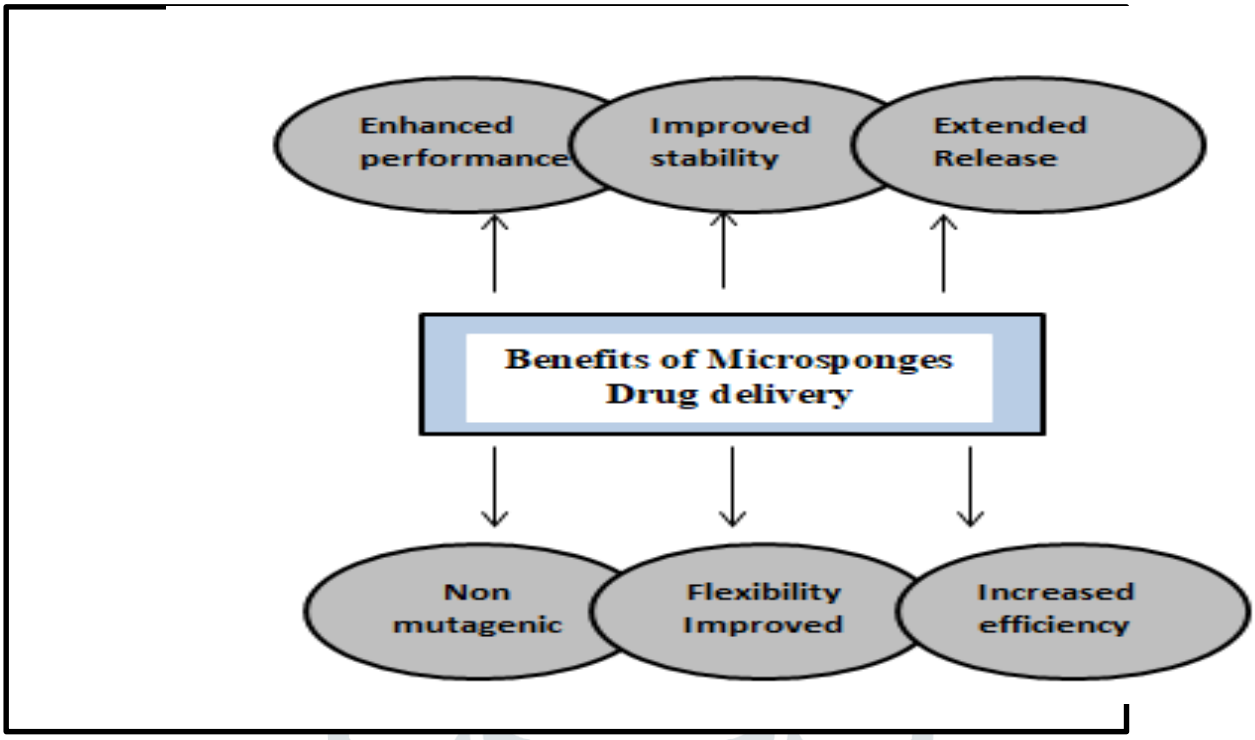
Cardinal Health, Inc. has been granted a patent for the topical application of microsponge technology. The microspheres are prepared in sizes ranging from 5 to 300 micrometers.the internal pore's length is 10 feet, and its volume is up to 1 milliliter per gram. This generates a sizable pool for storage. The fact that the microsponges' particles are too big for the skin to absorb adds to their safety. Bacterial contamination of the microsponges is another indicator of safety because smaller bacteria have a lower chance of penetrating the pore diameter[5]. Microspheres DDS are made up of tiny, silent, inert spherical microsponges that don't pass through the skin's barrier. This formulation aids in the delivery of medication molecules at a precise location at a low dosage [4-5].

According to certain research, microsponges systems are non-toxic, non-allergenic, non-mutagenic, and non-irritating [6].The manufacture of microsponges was reviewed in this paper using a variety of techniques, including the quasi-emulsion solvent diffusion method and liquid-liquid suspension polymerization. There are several benefits that the Microsponges drug delivery technology has over traditional medication administration methods. Microsponges are spherical and porous, which gives the active component the best stability while reducing side effects and adjusting the drug's release [30].

Benefits of the Drug Delivery System with Microsponges [6, 7, 18]

- Non-irritating, Non Mutagenic, Non-toxic and non-allergic formulations.
- Formulate Incompatible products.
- Decrease irritation
- Enhances product stability, including thermal.
- Enhance drug bioavailability.
- Enhance therapeutic efficacy.
- Required minimum dose for drug targeting
- Extended release sustained action up to 12 hours.
- Stable at PH 1-11 and temperature 130 degree Celsius.
- Most of the vehicles are compatible.
- Loading capacity 50-60%
- Cost effective and free flowing

- **Fig 1: Benefits of Microsponges [28]**



Benefits over Conventional formulations [8, 9]

Microsponges in smaller quantity produce maximum effect as microsponges blocks the excessive deposition inside epidermis and dermis and also reduces the adverse side effects and thus increase the safety and patient compliance.

Benefits over microencapsulation and Liposomes [8, 10]

Microsponges having entrapment efficiency 50-60% on the other hand liposomes having entrapment efficiency 30%. Therefore Liposomes are difficult to formulate, not microbial stable and chemical stable.

Limitations [19]

Since organic solvents are very flammable and pose a risk to public health and safety, they are employed in the creation of microsponges, which are made from porogens.

Mechanism of Release [11]

In order of External stimuli, Microsponges are formulated to release specific amount of active chemicals over time.

1. **Temperature change:** Temperature is directly proportional to the release of drug. As we rise the temperature; drug release of microsponges will be higher.

2. **Pressure:** The incorporated molecules in the microsponges release on the skin by rubbing or producing pressure to the microsponges.
3. **Solubility:** Chemicals soluble in water, like antiperspirants and antiseptics, are released from Microsponges into the water medium. The purpose of microsponges is to release a precise quantity of medication in response to external stimuli, such as particle size, pore characteristics, and monomer composition.

Technique of Preparation[12, 13, 14, 15, 16, 17]

1. **Liquid-Liquid Polymerization Suspension:**

The steps listed below should be taken into consideration when making microsponges.

Select a monomer and monomer combination

⬇

Polymerization process initiate and chains of monomers start to formed

⬇

A series of chain of monomers formed by cross linking of monomers

⬇

Spherical shape start to formed by series of chain of monomers

⬇

By accumulation of microsphere results in formation of microsphere bunches

⬇

Formation of Microsponges

2. **Quasi-Emulsion Solvent Diffusion Method:**

Following steps to be taken in below steps.

Internal Phase: Polymer (Eudragit RS 100 etc.) dissolved in ethyl alcohol

⬇

Active moiety added to polymer solution to improve plasticity.

⬇

External Phase: Polyvinyl Alcohol and purified water and after 2 hours continuously Stirring internal phase mix into external Phase

The microsponges separated by filtering from the mixture.

Prepared microsponges were washed and dried in air oven.

Summary for the method of preparation of Microsponge drug delivery system

Fig 3: PREPARATION OF MICROSPONGES

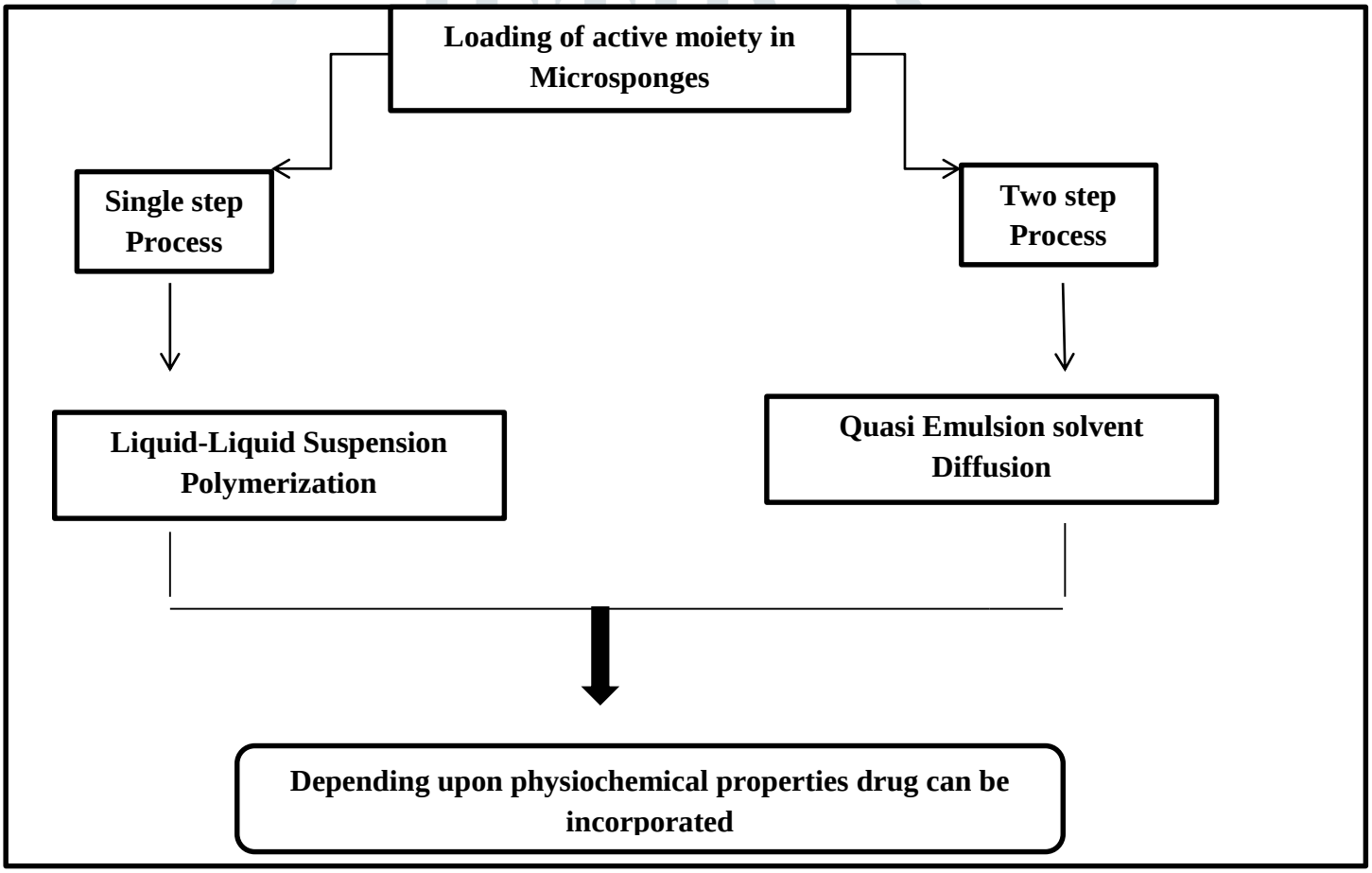


Fig 2: Preparation of Microsponges [29]

Use of Microsponges in Therapeutic Applications to Deliver Drugs:

1. **In Topical Preparation:** Due to market demand, Industrial Producibility and short application of dermatological products, Microsponges in the topical preparation are widely used. As Microsponges are porous in nature due to this property microsponges loaded antiperspirants, deodorant and sunscreens are

widely marketed [31].Various drug loaded Microsponges were prepared and evaluated for topical preparation like Curcumin loaded microsponges were formulated using QESD technique and polyvinyl alcohol and ethyl cellulose as carrier[32] and Acyclovir microsponge loaded emulgel are formulated to improve the transdermal application using DOE approach[33] and Oxiconazole nitrate loaded microsponges were prepared and evaluated for topical preparation to enhance the solubility of drug [34].

2. **For Anti-Acne preparation:** The bacteria causing acne is *Propioibacterium acne.* Hyper secretion of Sebum from distorted follicles results in Acne. Benzoyl peroxide, azelaic acid and salicylic acid are localized topical agent used in the prevention of Acne [35]. Various preparations were formulated for Acne treatment like: Miconazole nitrate loaded microsponges were prepared and evaluated using quasi emulsion solvent diffusion method [36] and Dapsone loaded microsponges were prepared and evaluated for treating the microbial property [37] and preparation and analyzation of Havan Ash loaded microsponges for the treatment of Acne using Quasi emulsion solvent diffusion method[38]

3. **For Skin Cancer:** In the white skinned peoples skin cancer is commonly occurred disease. In general ratio approx. one million Americans per year were affected from skin cancer [39-41]. Generally two types of skin cancer were defined namely: Melanoma and Non Melanoma [40-42].Tacrolimus loaded microsponges were prepared to cure the skin disorders [43].

4. **Microsponges for Peroral Drug delivery:** Microsponges can enhance the drug release rate of poorly water soluble agents and can cause entrapment of these drugs because of porous nature of microsponges and thus resulting in enhancement of bioavailability and decrement of side effects [44,45]. Hence Microsponges DDS is the ideal via Peroral route.

Current trend of Microsponges drug delivery system:

Microsponges presently have the greatest advantages in the area of topical and cosmetics products but with the advancement of time few new advancement have been identified with the modification of Microsponges like nanoferrosponges, nanosponges and porous microbeads. After hyper cross linked of nanosponges with cyclodextrins forms alpha Cyclodextrines, Beta cyclodextrines and gamma cyclodextrines [46]. Limited researches have been discovered like ethyl cellulose Nano sponges have been prepared for skin disorders by combining with hydrogel formulations [47]. Ferrosponges also known as magnetic sponges like hydrogels produced by using in-situ magnetic nanoparticles using different concentration of gelatins. Nanoferrrosponges were prepared by polymer coprecipitation with magnetite [48].

Patent filed for Microsponges:

Patent number	Title	Inventor
US4690825	Technique for delivering an active component with a regulated release period that makes use of a vehicle that can be made by using the active ingredient as a porogen	Richard Won,1987[3]
US4863856	Weighed collagen Collagen Microsponges for Immobilizing Bioactive Materials	Dean RC Jr et al., 1989 [20]
US5292512	composition used in cosmetics or pharmaceuticals that includes polymerized fatty material microspheres containing at least one active ingredient.	Schaefer et al, 1989[21]
US5135740	Porous particles in preparations involving immiscible phases	Katz et al., 1992[22]
US5679374	Anti-Acne composition for the Simultaneous treatment of the surface layers and Deep layers of the Skin and Use thereof.	Fanchon et al.1997[23]
US5316774	Blocked Polymeric Particles having internal pore networks for delivering active substances to selected environments.	Robert P. Eury.1994[24]
US5725869	Microsphere Reservoirs for controlled release application	Lo; Ray J. R,1996[25]
US6395300	Porous Drug matrices and method of Manufacture thereof	Straub et al.1999[26]
US6211250	Percutaneous Delivery system	Tomlinson et al.2001[27]

Conclusion:

The creation of microsponges addresses the main drawbacks of other traditional forms of systems, such as quick drug release and quick clearance. The hydrophilic and hydrophobic properties of the active moiety can be combined with microsponges to extend the duration of the drug's retention at the site of action. Drugs can be incorporated into microsponges three times greater than their weight. Unlike the oral and topical routes of drug delivery, microsponges can be used in the parenteral, intestinal, and pulmonary drug delivery systems. The microsponges' porosity nature allows for the maintenance of a controlled release of the medication. Drug stability and safety can be preserved by microsponges without compromising toxicity.

Declaration of interest:

The authors declare that they have no financial relationships or affiliations with any organization or institution that could have a financial conflict or financial interest in the topics or materials included in the work. This covers work, consulting, honoraria, options or stock ownership, expert witness, grants obtained or pending, and royalties.

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