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# An Insight of Microsponges for Acne Treatment

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**A B S T R A C T**
Dermatological disorders have a significant psychosocial impact, impairing the patient's life significantly. Topical therapy is crucial in the treatment of such disorders. Overmedication and under medication are common outcomes of traditional topical delivery systems, resulting in adverse effects and a reduction in therapeutic efficacy. As a result, researchers have been working to develop alternative delivery systems for dermatological applications. Microsponges have emerged as an appealing option for topical delivery over the last decade. Their unique particle size provides additional benefits, making them superior to modern microcarriers. Microsponges are uniform, spherical, porous polymeric microspheres with a plethora of interconnected voids ranging in particle size from 5-300 µm. These microsponges can entrap a wide range of active ingredients, such as emollients, fragrances, essential oils, sunscreens, anti-infectives, and so on, and then release them onto the skin over time in response to a trigger. Despite their microscopic size, these systems are too large to pass through the stratum corneum, preventing excessive drug accumulation within the epidermis and dermis and thus systemic drug entry.
**Keywords:** Microsponges, Acne, Dermatological, Topical application

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**C O N T E N T S**



## 1. Introduction

In dermatological problems, the human skin is an important target site for drug application. Topical drug delivery is an appropriate approach for the treatment of skin disorders because it limits the therapeutic effect to the affected region and reduces systemic side effects. The stratum corneum (SC), the skin's outermost layer, acts as an effective barrier to external agents such as drugs. This innate feature of stratum corneum also poses a significant challenge to formulation scientists, and this barrier must be overcome in order to deliver therapeutically effective drug concentrations in various skin layers[1]. Acne vulgaris is the most common skin disease, resulting in comedos or severe inflammatory lesions in the face, back, and chest with a large number of sebaceous follicles, and the disease's condition is associated with an elevated rate of sebum excretion. Acne pathophysiology includes abnormal keratinocyte proliferation and differentiation, increased sebum production, hyper proliferation of Propionibacterium acne, and an inflammatory response triggered by bacterial antigens and cytokines[2]. Acne occurs on the face as a result of an excess production of male hormone androgen and oil producing glands in the skin.

The primary two no inflammatory lesions in acne are closed comedones (whiteheads) and ripen comedones (blackheads). When the contents rupture, the lesions can progress to inflammatory papules and pustules. Cysts and nodules, which are larger and more painful, may also form[3]. The use of novel delivery systems to the skin gradually distributes the topical agent, reduces the irritancy of some antiacne drugs, and demonstrates good efficacy.

Lipid-based colloidal carriers have been extensively researched in recent years and have proven to be effective in facilitating drug delivery. The fact that the lipids used in such formulations are similar to physiological lipids lends credence to this. As a result, lipid-based colloidal systems improve dermal penetration, making them an appealing option for delivering dermatological actives. Other characteristics that make them particularly suitable for dermal applications include their ability to adhere to the skin's surface, improved hydration, and replenishment of epidermal lipids by allowing lipid exchange between colloidal carriers and the epidermis's outermost layer[4]. Drug targeting is now possible thanks to the development of micro-colloidal drug delivery systems, in addition to enhanced percutaneous absorption. Numerous studies have been conducted, as well as patents granted, in this context, in which lipid-based colloidal carriers have been used to provide therapeutic benefits in the treatment of various dermatological disorders[5].

Novel drug carriers for use in skin diseases are frequently designed to increase the load ability of APIs while minimizing side effects. Dermatotherapy research on new drug entities and drug delivery systems focuses on common but difficult-to-treat diseases, such as acne and psoriasis. For severe manifestations, highly active APIs, which can also have serious side effects, must be prescribed for systemic use. The advancement of novel drug delivery systems may allow for the safer use of these agents via the topical route[6]. Liposome, niosome, microsponge, micro emulsion, microsphere, SLN, hydrogel, aerosol, fullerenes, and other novel carrier systems are being studied for application and treatment of acne.

Controlled drug release and subsequent biodegradation of these novel carrier-based delivery systems are critical for developing successful formulations. Adsorbed drug desorption, diffusion through the carrier matrix, erosion, and a combination of erosion and diffusion methods are among the drug release mechanisms used in these systems. Along with numerous benefits, novel vesicular carrier systems have some serious drawbacks that limit their use: drugs passively may result in low drug loading efficiency and drug leakage during preparation, preservation, and transport in vivo. Furthermore, the main issue of their stability acts as a barrier and limits their use[7].

Microsponge delivery systems are made up of uniform, spherical, porous polymeric microspheres with a plethora of interconnected voids ranging in particle size from 5-300µm. These microsponges can entrap a variety of active ingredients such as emollients, fragrances, essential oils, sunscreens, anti-infectives, and so on, and then release them onto the skin over time and in response to a trigger. Micropores within the spheres have a total pore density of about 1mL/g and a pore length of 10 ft, allowing for extensive drug retention. Additionally, these porous microspheres containing active ingredients can be incorporated into formulations such as creams, lotions, and powders[8].

Microsponges are non-collapsible structures with a porous surface that allows active ingredients to be released in a controlled manner. When applied to the skin, the MDS releases its active ingredient in a time-dependent manner as well as in response to other stimuli (rubbing, temperature, pH, etc). Cosmetics, over-the-counter (OTC) skin care, sunscreens, and prescription products all use MDS technology[9]. Their high degree of cross-linking produces particles that are insoluble, inert, and strong enough to withstand the high shear commonly used in the manufacture of creams, lotions, and powders. Their distinguishing feature is the ability to adsorb or "load" a high concentration of active materials into the particle and onto its surface. Microsponge products are distinguished from other types of dermatological delivery systems by their large capacity for entrapment of actives, which can be up to three times their weight. The microsponge particle protects the active payload in the formulation, and it is delivered to the skin via controlled diffusion[10].

Targeting drug delivery has long been a problem for medical researchers - how to get them to the right place in the body and how to control drug release to prevent overdoses. Microsponges, which are new and complex molecules, have the potential to solve these problems. Microsponges are a new class of materials made of microscopic particles with a few micrometres wide cavities that can encapsulate a wide range of substances. These particles can transport both lipophilic and hydrophilic substances and improve the solubility of molecules that are poorly water soluble. Microsponges are tiny mesh-like structures that have the potential to revolutionise the treatment of many diseases. Early trials indicate that this technology is up to five times more effective than conventional methods at delivering drugs to patients with breast cancer.

The microsponge is about the size of a virus and has a naturally degradable polyester "backbone"[11]. The long polyester strands are mixed in solution with small molecules known as cross-linkers, which have an affinity for specific portions of the polyester. They ‘cross link' segments of polyester to form a spherical shape with numerous pockets (or cavities) for drug storage. Because the polyester is predictably biodegradable, the drug can be released on a predetermined schedule when it degrades in the body.

Microsponges are encapsulating microparticles that contain drug molecules within their core. The microparticles can be

classified into encapsulating microparticles, complexing microparticles, and conjugating microparticles based on how they interact with drugs. Microsponges and microcapsules are examples of the first type. Microsponges, such as alginate microsponge, are sponge-like microparticles with numerous holes that transport drug molecules. Microparticles are also encapsulated by microcapsules such as poly (isobutyl-cyanoacrylate) (IBCA). They have the ability to entrap drug molecules in their aqueous core. The second type of microparticle is a complexing microparticle, which attracts molecules with electrostatic charges. Conjugating microparticles are the third type, and they form covalent bonds with drugs. These microsponges are a novel class of microparticles that are typically obtained through natural derivatives[12]. As compared to the other microparticles, they are insoluble both in water and organic solvents, porous, nontoxic and stable at high temperatures up to 300°C.

Because of their 3D structure, which includes cavities of micrometric size and tunable polarity, they can capture, transport, and selectively release a wide range of substances. Furthermore, microsponges have a significant advantage over common microparticles in that they can be easily regenerated through various treatments such as washing with environmentally friendly solvents, stripping with moderately inert hot gases, mild heating, or changing pH or ionic strength. Microsponges have already been used in a variety of applications, including the cosmetic and pharmaceutical industries, due to all of these characteristics. Microsponges can be used as a vessel for pharmaceutical principles in order to improve the aqueous solubility of lipophilic drugs, protect degradable molecules, and develop drug delivery systems for routes other than the oral. The simple chemistry of polymers and cross linkers poses few challenges in preparation, and this technology can be easily scaled up to commercial production levels. Microsponges are water soluble but do not dissolve chemically[13].

They combine with water to form a transport fluid. They can be used to mask unpleasant flavours as well as to convert liquids to solids. The chemical linkers allow the microsponges to bind to the target site preferentially. The ability of these microsponges to include only small molecules is their main disadvantage. Microsponges could be either par crystalline or crystalline[14]. The loading capacity of microsponges is primarily determined by the degree of crystallization.

Loading capacities of paracrystalline microsponges can vary. By varying the proportion of cross linker to polymer, the microsponges can be synthesized to be a specific size and to release drugs over time. Microsponge' s engineering capability stems from the relatively simple chemistry of its polyesters and cross-linking peptides when compared to many other miroscale drug delivery systems. When these microsponges are prepared in the presence of magnetic compounds, they can be magnetised. Because of their small size, microsponges can be delivered via pulmonary and venous routes.

## 2. Materials and Methods

### Advantage of Microsponge

- Topical agents are a mainstay in cosmetics and the treatment of dermatological disorders. Microsponge delivery system when applied to the skin, the release of drug can be controlled through diffusion or other variety of triggers, including rubbing, moisture, pH, friction, or ambient skin temperature[15].
- Controlled release of drug from a delivery system to the skin could reduce the side effect while reducing percutaneous absorption. Microsponges are capable of absorbing skin secretions, therefore reducing oiliness and shine from the skin.
- Microsponge polymers possess the ability to load a wide range of actives providing the benefits of enhanced product efficacy, mildness, tolerability, and extended wear to a wide range of skin therapies.
- As compared to liposomes, which suffer from lower payload, difficulty in formulation, limited chemical stability, and microbial instability, the microsponge system in contrast is stable over range of pH 1 to 11 and temperature up to 130◦C; compatible with most vehicles and ingredients, self-sterilizing as average pore size is 0.25 $\mu$m where bacteria cannot penetrate, higher payload (50 to 60%), still free flowing, and cost effective.
- One of the most suitable examples is the microsponge of benzoyl peroxide, for topical delivery which maintained efficacy with decreased skin irritation and sensitization.

### Engineering of microsponges

Aside from the composition of the microsponge, preparation techniques play a significant role in regulating the performance of this delivery system. However, due to their complexity and high cost, microsponge preparation methods are limited. With or without modification, techniques such as liquid-liquid suspension and quasi-emulsion solvent diffusion can be used to produce microsponge. A method for preparing microsponges based on free radical suspension polymerization was reported in the literature. It is a one-step process in which monomers are dissolved in a suitable solvent with a non-polar drug, and the resulting solution is dispersed in an aqueous phase containing a suitable surfactant and suspending agent. Polymerization is triggered by irradiation, the addition of a catalyst, or an increase in temperature. Although this method is convenient, it produces non-uniform structures with poor reproducibility. Furthermore, the reaction of the monomers takes a long time[16]. Entrapment of unreacted monomer residues is another limitation. This constraint can be overcome by employing the quasi-emulsion solvent diffusion method. The most commonly used technique for designing microsponges is the quasi-emulsion solvent diffusion method. It is a two-step process in which a suitable polymer internal phase is dissolved in solvents such as dichloromethane (DCM), acetone, or ethanol in the presence of a plasticizer and a diffusible substance (porogen). This internal phase is then dispersed into an

external aqueous phase containing polyvinyl alcohol as a stabilizer. Following emulsification, the system is continuously stirred for a suitable time interval and, if necessary, kept at a high temperature. Porogen diffuses into the external medium, resulting in a highly porous scaffold structure called 'microsponge'.

The final product is subsequently washed and dried in vacuum oven at 60 °C for 24 h. When the active molecule is sensitive to polymerization conditions, this process may be a better option. Furthermore, the process avoids the toxicity of solvents. Importantly, drug solubility, solvent type, temperature and rate of emulsification, nature of polymer cross-linking, diffusibility of porogen, and type and concentration of plasticizer all influence the formation of microsponges. This process is not only quick, but also simple and repeatable. In addition, this technique produces uniform microsponges with a narrow size distribution[17].

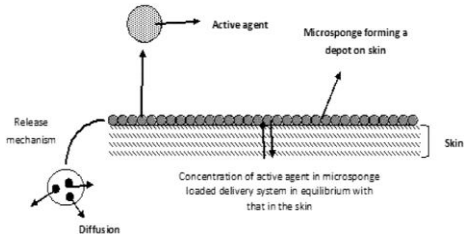


Figure 1: Mechanism of drug release from topical microsponges

**Mechanism of drug release from topical microsponges**

A number of variables can be changed to control the release of a drug from microsponges, taking into account the physicochemical properties of the active agent and the cutaneous environment. As previously stated, the vehicle used to dissolve the polymer is critical in the release of the active agent from the system. At first, there is equilibrium between the concentration of active agent in the polymer and the vehicle. As the concentration of the active agent from the vehicle in the skin decreases, the MDS releases more active agent in response to the demand created by the equilibrium shift. The active agent is continuously and steadily released onto the skin as a result of such a system. Furthermore, as shown in Figure 1, the MDS can act as a depot, continuously releasing the active agent to the skin even after the vehicle has been absorbed or dried by the skin.

**Applications of microsponges in cosmetics and dermatology:** Won's original patents for microsponge technology were assigned to Advanced Polymer Systems, Inc. in 1987. The microsponge technology was used by this company for cosmetic, over-the-counter (OTC), and prescription pharmaceutical products. MDS ensures drug localization on the skin's surface and within the epidermis, thereby bridging systemic and local cutaneous side effects. Only in terms of technology do microsponges for dermatological and cosmetic products differ. Cosmetic products have a much shorter production, marketing, and introduction time than dermatological products due to minor regulatory conditions.

The ability of microsponge to absorb skin secretions, such as oil and sweat, is one of their most important characteristics[18]. Many commercially available microsponge loaded deodorants, antiperspirants, and sunscreens are highly absorbent. Furthermore, microsponge drug delivery systems can be used for skin targeting, preventing drug absorption into the percutaneous blood circulation. This feature may be beneficial in skin conditions such as skin cancer, wounds, acne, alopecia, sunburn, hyperhidrosis, and wrinkles. The application of active compounds with microsponges demonstrates the breadth of the MDS platform, which serves as a carrier for cosmetic and dermatological products.

## 3. Conclusion

An improved understanding of skin physiology, as well as its structure and function, can be used to create innovative cosmetic and dermatological formulations. Furthermore, in order to successfully apply this new technology in drug delivery, the pharmaceutical formulator must have a solid understanding of the physicochemical properties of the drugs and polymers used. Addition of polymers to existing formulations will rarely result in acceptable results unless further optimized. Microsponge-based delivery systems have been one of the most important technologies studied in recent years. These systems demonstrate a compelling rationale for cosmetic and dermal applications in order to improve the therapeutic performance of active molecules while improving patient compliance. Microsponges are already being used or are being proposed for use as a carrier of cosmetic and dermatological actives in commercial formulations. Researchers, regulators, and manufacturers should collaborate to develop safe topical products using new technologies for both medicinal and cosmetic purposes, and to help pass on these benefits to consumers in a cost-effective manner.

## 4. References

[1] ZakiRizkalla C.M., Latif Aziz R., Soliman I.I. In vitro and in vivo evaluation of hydroxyzine hydrochloride microsponges for topical delivery. AAPS Pharm Sci Tech. 2011; 12: 989–1001.

[2] Carbone C., Leonardi A., Cupri S., Puglisi G., Pignatello R. Pharmaceutical and biomedical applications of lipid-based nanocarriers. Pharm Pat Anal. 2014;3(2):199–215.

[3] Bagwe R.P., Kanicky J.R., Palla B.J., Patanjali P.K., Shah D.O. Improved drug delivery using microemulsions: rationale, recent progress, and new horizons. Crit Rev Ther Drug Carrier Syst. 2001;18(1):77–140.

[4] Wester R.C., Patel R., Nacht S., Leyden J., Melendres J., Maibach H. Controlled release of benzoyl peroxide from a porous microsphere polymeric system can reduce topical irritancy. J Am AcadDermatol. 1991;24(5):720–726.

[5] Barde P.M., Basarkar G.D. Formulation, development and in vitro evaluation of

terbinafineHCl microsponge gel. Int J Pharm Sci Rev Res. 2015;32:310–314.

[6] Pawar A.P., Gholap A.P., Kuchekar A.B., Bothiraja C., Mali A.J. Formulation and evaluation of optimized oxybenzone microsponge gel for topical delivery. J Drug Deliv. 2015; 2015:1–9.

[7] Jadoul A., Bouwstra J., Preat V. Effects of iontophoresis and electroporation on the stratum corneum: review of the biophysical studies. Adv Drug Deliv Rev. 1999;35(1):89–105.

[8] Osmani R.A., Aloorkar N.H., Ingale D.J., Kulkarni P.K., Hani U., Bhosale R.R. Microsponges based novel drug delivery system for augmented arthritis therapy. Saudi Pharm J. 2015;23:562–572.

[9] Osmani R.A., Aloorkar N.H., Thaware B.U., Kulkarni P.K., Moin A., Hani U. Microsponge based drug delivery system for augmented gastroparesis therapy: formulation development and evaluation. Asian J Pharm Sci. 2015;10:442–451.

[10] Jain V., Singh R. Design and characterization of colon-specific drug delivery system containing paracetamol microsponges. Arch Pharm Res. 2011;34:733–740.

[11] Shah C.N., Shah D.P. Design and optimization of fluconazole microsponges containing ethyl cellulose for topical delivery system using quality by design approach. Pharma Science Monitor. 2014;5:95–133.

[12] Kumar P.M., Ghosh A. Development and evaluation of silver sulfadiazine loaded microsponge based gel for partial thickness (second degree) burn wounds. Eur J Pharm Sci. 2017;96:243–254.

[13] Amrutiya N., Bajaj A., Madan M. Development of microsponges for topical delivery of mupirocin. AAPS PharmSciTech. 2009;10:402–409.

[14] Jelvehgari M., Siahi-Shadbad M.R., Azarmi S., Martin G.P., Nokhodchi A. The microsponge delivery system of benzoyl peroxide: preparation, characterization and release studies. Int J Pharm. 2006;308:124–132.

[15] Patel S.B., Patel H.J., Seth A.K. Microsponge drug delivery system: an overview. J Global Pharma Technol. 2010;2(8):1–9.

[16] Orlu M., Cevher E., Araman A. Design and evaluation of colon specific drug delivery system containing flurbiprofen microsponges. Int J Pharm. 2006; 318(1):103–117.

[17] Patravale V.B., Mandawgade S.D. Novel cosmetic delivery systems: an application update. Int J Cosmet Sci. 2008;30(1):19–33.

[18] Nokhodchi A., Jelvehgari M., Siahi M.R., Mozafari M.R. Factors affecting the morphology of benzoyl peroxide microsponges. Micron. 2007; 38(8):834–840.