International Standard Serial Number (ISSN): 2249-6807

International Journal of Institutional Pharmacy and Life Sciences 10 (2): March-April 2020

INTERNATIONAL JOURNAL OF INSTITUTIONAL PHARMACY AND LIFE SCIENCES

Pharmaceutical Sciences **Review Article……!!!**

Received: 12-03-2020; Revised: 30-03-2020; Accepted: 02-04-2020

NANOSPONGE: A VERSATILE DRUG DELIVERY SYSTEM

Shubhangi S. Shinde*, Lokesh G. Barade, Harshal L. Tare

TSPM's, Trimurti Institute of Pharmacy Jalgaon, Maharashtra, India

Keywords:

Nanosponges, bioavailability, poorly soluble drugs, preparation, characterization, applications

For Correspondence:

Shubhangi S. Shinde

TSPM's, Trimurti Institute of Pharmacy Jalgaon, Maharashtra, India

ABSTRACT

The invention of nanosponges has become a significant step towards overcoming these problems. These small sponges can circulate around the body until they encounter the target site and stick on surface and began to release the drug in controlled and predictable manner which is more effective for a particular given dosage. There small size and porous nature they can bind poorly soluble drugs within their matrix and improve their bioavailability. They can be crafted for targeting drugs to specific site, prevent drug and protein degradation and prolong the drug release in a controlled manner. This review attempts to elaborate the interesting features of nanosponges, preparation, characterization, applications and recent updates of nanosponges in drug delivery system.

INTRODUCTION

Nanosponges are particle look like red blood cell and protect the body.Nanosponges were originally developed for topical delivery system in 21st century[2]. Nanosponges are administered by oral as well as intravenous route. Nanosponges are made up of tiny particles with narrow cavity of few nanometers. This tiny particles have capability is able to carry both hydrophilic and lipophilic drug substance and increase stability of poorly water soluble drug substance or molecules. Effective drug delivery systems have a dream for long time. Nanosponges are tiny sponges with size of about virus average diameter is below 1mm[2]. They can be crafted for targeting drugs to specific sites, prevent drug and protein degredation and prolong drug release in a controlled manner[3].Nanosponges are made up of different organic or inorganic materials. There structure presents nanomatric dimension or smaller. Examples are titanium or other metal oxide base nanosponges, silicon nanosponges particle carbon-coated metallic nanosponges, hyper cross-linked polystyrene nanosponges and cyclodextrin based nanosponges[2]. Nanosponges are provide prolonged release as well as improving drug bioavailability and some case modifying pharmacokinetics parameter. Nanosponges are decrease side effect and protect drug from degredation[2]. Nanosponges are complex molecule can be used to deliver anticancer drug within the body.

Topical agent:

A topical prescription is medicine that is connected in the body. Topical organization implies application to body surfaces, for example, the skin or mucous layers to treat diseases by means of an extensive scope of classes including creams, froths, gels, salves and balms [1].

Advantages of Nanosponges:

1. Nanosponges drug delivery system minimize side effect.
2. Increase aqueous solubility of poorly water soluble drug.
3. Nanosponges remove toxic substance from the body.
4. The formulations are stable over range of pH 1 to 11.
5. The formulations are stable at temperature upto 130 degree celcius.
6. Increase formulation stability and enhance flexibility of the formulation.
7. Nanosponges are non-irritating, non-mutagenic, non-allergenic and non toxic.
8. Extend release-continuous action upto 12 hours.
9. Entrapment of ingredients and reduced side effects.

10. Allows incorporation of immiscible liquid improves material processing liquid can be converted to powders.[5,6]
11. Particles can be made smaller or larger by varying the proportion of cross-linker to polymer. [7,8,9,10]
12. Easy scale-up for commercial production. [7,8,9,10]
13. Improved stability, self-sterilization, increased elegance and enhanced formulation flexibility, improve dissolution. [11,12,13,14,15]

Table 1: A topical prescription

Topical products	Lotions	Creams	Gels	Ointment
Over-the-counter(OTC)	Bananaboat cool colors vanishing sunblock, SPF30	BENGAY pain relieving cream	BENGAY pain relieving gel	Cortizone10
Prescription	Metroloti on (metronidazole0. 75%)	Carac cream (flurouracil 0.5%)l	BenzaClin topical gel (clindamycin1%, benzoyl peroxide5%)	Eloc ointment (Mometasonefuroate 0.1%)
		Metro Cream (metronidazole0.75 %)	Temovate(CP)gel	
		FerndaleHCAlipo cream, 2%	Metro Gel (metronidazole0. 75%)	Temovate (CP)ointment

Disadvantages of nanosponges:

1. Nanosponges include only small particles.
2. Dose dumping may occur at time.
3. Depend only upon loading capacities.

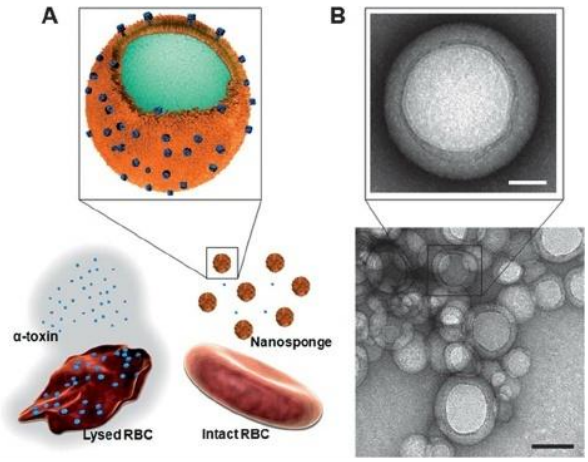

Fig.1: Structure of Nanosponges

Methods of preparation of nanosponges:

1) **Hyper cross linked beta cyclodextrins:[16,17]**

Cyclodextrins break down gradually in body a roughly spherical structure about size of protein which channels and pores inside. They obtained by reacting cyclodextrins with cross linker such as diisocianates, diaryl carbonates, dimethyl carbonates, diphenyl carbonates and carbonyl diimidazoles, carboxylic acid dianhydride and 2,2-bis acetic acid. The surface charge density, porosity and pore size of sponges can be controlled to attach different molecules. A nanosponge with low cross linking gives a fast drug release. Nanosponges can be synthesized in neutral or acidic forms, depending in turn on agent used as cross-linker. Nanosponges have been used for removal of organic impurities in water.

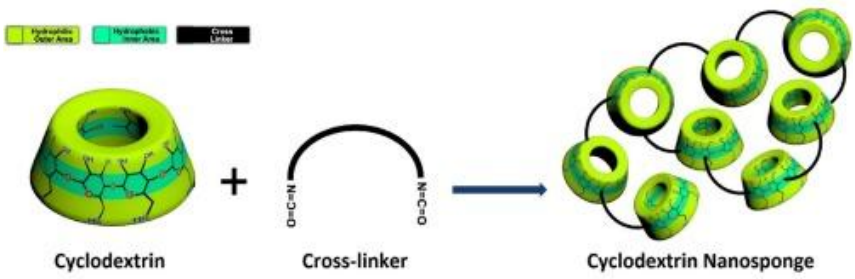

Fig. 2: Preparation of nanosponges

2) **Emulsion solvent diffusion method:[18]**

In this method 2 phases are used in different proportion of organic and aqueous (ethyl cellulose and polyvinyl alcohol). Dispersed phase having ethyl cellulose and drug get dissolved in dichloromethane (20ml) and a definite amount of polyvinyl alcohol added to 150ml of aqueous continuous phase. Then, the mixture is stirred properly at 1000 rpm for

2hr. The required nanosponges were collected by the process of filtration and kept for drying in oven at 40 degree celcius for 24hr. Nanosponges which are dried were stored in dessicators and ensurity of removal of residual solvent is done.

3) **Quasi-emulsion solvent diffusion:[21,22]**

The nanosponges prepared using the polymer in different amounts. The inner phase is prepared using eudragit rs 100 and added to suitable solvent. Drug used provided with solution and dissolved under ultrasonication at 35 degree celcius. This inner phase added into external phase containing PVA act as emulsifying agent. The mixture is stirred at 1000-2000 rpm for 3hr at room temperature and dried in an air-heated oven at 40 degree celcius for 12hr.

Factors Affecting Drug Release From Nanosponges:[21,22]

1. Type of polymer: Type of polymer is used which can influence formation as well as performance of nanosponges. For complexation, cavity size of nanosponges should be suitable.
2. Temperature: Temperature changes can affect drug/nanosponges complexation. Increase in temperature decrease the magnitude of apperent stability constant of drug due to result of possible reduction of drug interaction forces.
3. Methods of preparation:

   The method of loading drug into nanosponges can affect drug complexation. Effectiveness of method depends on nature of drug and polymer.
4. Degree of substitution: Nanosponges are greatly affected by type, number; position of substituent on parent molecule and due to this affects its complexation.

Chemical Used For the Synthesis of Nanosponges: [23, 24]

1. **Polymers:**

   Hyper cross linked polystyrenes, cyclodextrins ant its derivatives like methyl beta-cyclodextrin. Alkyloxycarbonylcyclodextrins, 2-hydroxy propyl beta-cyclodextrins and copolymers like poly (valerolactone-allylvalerolactone and ethyl cellulose and PVA).
2. **Cross linkers:**

   Diphenyl carbonate, diarylcarbonates, epichloridine glutarldehyde, carboxylic acid dianhydride, acetic acid and dichloromethane.

Applications of nanosponges:

1. They can be used as excipients in preparation of tablets, capsules, pellets, granules, suspensions, solid dispersion or topical dosage forms.

2. Prolonging dosage intervals.
3. Drug toxicity and improving patient.
4. Providing site particular drug delivery system.
5. The nervous system act as multifunctional carriers for enhanced product performance and elegancy, extended release, irritation is reduced, improved thermal, physical and the chemical stability of product.
6. Nanosponges' delivery system is a unique technology for the controlled release of topical agents of prolonged drug release and retention of drug form on skin.
7. Oral delivery of drugs using bioerodible polymers, especially for colon specific delivery and controlled release drug delivery system thus reducing.
8. Nanosponges could be used to from contaminated water nanosponges shave been used for the removal of organic impurities in water.

CONCLUSION:

Nanosponges have been recognized as drug delivery system to encapsulate or accumulated for both hydrophilic and lipophilic drug by forming a complex. They can effectively deliver the drug in controlled manner at a target site. Nanosponges can be incorporated into topical preparation such as lotions, creams, ointments, etc. and liquid and powder forms. The advantage of this technology offers targeting the drug to specific site reduces side effects, improve stability and improve formulation flexibility and better patient compliance. Nanosponges offer application in other areas such as cosmetics, biomedicines process, agro chemistry and catalysis, etc.

REFERENCES:

1) Prashant D. Jain, Monika L. Girase, Krunal B. Borse, Yash K. Karandikar, Sanket S. Chintawar, Ayush S. Kharache, Adarsh Mohan Gupta.

2) Cavalli R. Trotta F and Tumiatti (2006) W Cyclodextrin-based nanosponges for drug delivery. J of inclusion phenomena and macro chemistry; 56 (1-2): 209-213

3) RanaZAhmed, Gunjan patil, and ZahidZahee drug Dev Ind pharma (2012) nanosponge – acompletely new nano-horizon: pharmaceutical applications and recent advances. Drug Dev Ind pharma. 2012 Jun 11. PMID 22681585.

4) Cavalli R. Trotta F and Tumiatti (2006) W Cyclodextrin-based nanosponges for drug delivery. J of inclusion phenomena and macro chemistry; 56 (1-2): 209-213

5) Eki S, Lei T, Jingquan L, Zhongfan J, Cyrille B and Thomas PD. Biodegradable star polymers functionalized with cyclodextrin inclusion complexes. Biomacromolecules 2009;10(9):2699-2707.

6) Davankov VA, Ilyin MM, Tsyurupa MP, Timofeeva GI and Dubrovina LV. From a dissolved polystyrene coil to Intramolecularly-Hyper-Cross-Linked "Nanosponge" macromolecules 1999; 29 (26): 8398-8403.

7) Nilesh J, Ruchi J, Navneet T, Brham Prakash G, Deepak Kumar J, Nanotechnology : A safe and effective drug delivery systems, Asian journal of pharmaceutical and clinical research, 2010 vol. 3, 159-165.

8) Necht S, Kantz M.: (1992) The microsponge: a novel topical programmable delivery system, In: Topical Drug Delivery Systems, David W.O. and Anforon H.A.(ED), 42.

9) Delattre L, Delneuville I, Biopharmaceutical aspects of the formulation of dermatological vehicles. J Eur Acad Derm Vener, 1995, 5:S70.

10) http://Sciencematters, Unimelb.edu.au/ 2011/05/nanosponges for targeted-cancer-treatment/visited on 12/10/2011.

11)Jilsha G, Vidya Viswanand, Nanosponge A novel approach of drug delivery system international journal of pharm. Science review and research 2013, 19 (2).

12)Balasaheb M.T, Patil P.M, Jahagirdar A.C, Khzandekar D.B, Nanosponge An emerging drug delivery system. International journal of institutional pharmacy and life sciences, 2015, 5 (6).

13)Vishwakarma A, Nikam P, Mogal R, Talale S, Nanosponges. A benification for novel drug delivery system, International journal pharma. Tech sciences, 2014, 6 (1).

14) E.K. Patel and R.J. Oswal, Nanosponges and Micro sponges: A novel drug delivery system, International journal of research in pharmacy and chemistry, IJRPC 2012, 2 (2) ISSN: 2231-2781, 237-244.

15) Nilesh J, Ruchi J, Navneet T, Brham Prakash G, Deepak Kumar J, Nanotechnology: A safe and effective drug delivery systems, Asian journal of pharmaceutical and clinical research, 2010 vol. 3, 159-165.

16)Eki S, Lei T, Jingquan L, Zhongfan J, Cyrille B and Thomas PD. Biodegradable star polymers functionalized with cyclodextrin inclusion complexes. Biomacromolecules 2009; 10 (9): 2699-2707.

17) Davankov VA, Ilyin MM, Tsyurupa MP, Timofeeva GI and Dubrovina LV. From a dissolved polystyrene coil to Intramolecularly-Hyper-Cross-Linked "Nanosponge" macromolecules 1999; 29 (26): 8398-8403.

18)Sharma R, Roderick B, and Pathak K, Evaluation of kinetics and mechanism of drug release from Etraconazole nitrate nanosponges loaded carbopol Hydrogel. Indian journal of pharma education and research, 2011, 45 (1): 25-31.

19) Embil K, and Nacht S. The microsoponges delivery system atopical delivery system with reduced irritancy incorporating multiple triggering mechanisms for the release of actives. J Microencapsule, 1996, 13:575-88.

20) Mishra M.K, Shikhri M, Sharma R, and Goojar M.P, Optimization, formulation, development and characterization of Eudragit RS 100 loaded microsponges and subsequent colonic delivery International journal of drug discovery and herbal research, 2011, 1 (10): 8-13.

21) Amber V., Shailendra S., Cyclodextrin based novel drug delivery system. J Incl phenom macrocycl chem.., 2008, 62:23-42.

22) Rajeshwari C., Alka A., Javed A., Khar R.K., cyclodextrins in drug delivery: an update review. AAPS PharmSciTech, 2005, 6(2): E329-E357.