RESEARCH ARTICLE

Fabrication and *in vitro* characterization of peppermint oil nanosponges as sun protecting agent

Upendra Nagaich, Neha Gulati, Swati Chauhan

Department of Pharmaceutics, Amity Institute of Pharmacy, Amity University, Noida, Uttar Pradesh, India

ABSTRACT

On penetration, solar ultraviolet radiations can lead to damage of skin and to a higher extend can tend to cause skin cancer. Broad spectrum sunscreen agents which are widely used for protecting skin damage have been reported to cause skin irritations and other side effects. The objective of the present investigation is to formulate the nanosponges of peppermint oil, an herbal approach to reduce side effects of chemical as sun protecting factors. Nanosponges were evaluated for particle size, surface morphology, and *in vitro* sun protection efficiency. 2^3 Factorial design was used to optimize the formulation for peppermint oil loaded nanosponges. Sun protection factor was calculated and it was found to be 5.28713 ± 0.722. Therefore, it can be concluded that nanosponges formulated can be efficiently used as a sun protecting agent with no or fewer side effects.

Keywords: Emulsion solvent diffusion method, nanosponge, sun protection factor

Introduction

Skin physiology gets promptly affected by ultraviolet (UV) radiations. Mainly, wavelengths in the UVB (290-320 nm) region of the solar spectrum are absorbed into the skin, which are able to cause erythema, burns, and also skin cancer.[1] Regular exposure of skin in this UVB region results in activation of apoptotic sites by keratinocytes leading to death of keratinocytes. These cells are basically known as "sunburn cells."[2] The herbal approaches in medication have shown their potential to treat different skin diseases, to adorn and improve the skin appearance causing minimal side effects contrary to synthetic preparations. It can be due to the capability of vanishing free radicals present in the body.[3] Natural products such as *Aloe vera* and coconut oil have the potential to act as sunscreen resource due to their absorption in the UV region.[4] Peppermint oil also possesses the capability to act as sun protecting agent.[5] This is the basis of taking peppermint oil as a key ingredient for formulation of nanosponges. Nanosponges are porous polymeric delivery systems having small spherical particles with large porous surface.[6] These are trending novel class of encapsulating nanoparticles having a sponge-like with an average diameter below 1 µm, which enables them to encapsulate or complex a wide range of active ingredients within their cavities and releasing them in a controlled manner onto the skin over a time and also in response to other stimuli including rubbing, moisture, pH, friction, or ambient skin temperature.[7,8] The aim of the present investigation is to prepare nanosponges of peppermint oil and to calculate its sun protection efficiency.

Access this article online	
Website: sjpr.sperpublications.com	**E-ISSN:** ***

How to cite this article: Nagaich U, Gulati N, Chauhan S. Fabrication and *in vitro* characterization of peppermint oil nanosponges as sun protecting agent. SPER J Pharm Res 2016;1(1):8-10.

Source of Support: Nil, **Conflict of Interest:** None declared.

Materials and Methods

Materials

Peppermint oil, Eudragit RS. 100, polyvinyl alcohol, and dichloromethane were purchased from CDH Pvt. Ltd., New Delhi. All solvents used were of analytical grade.

Methods

Preparation of peppermint oil nanosponges

For preparation of nanosponges, two solutions or phases were prepared. Organic phase was prepared by dissolving peppermint oil and Eudragit RS. 100 in dichloromethane (Solution A). Another phase or aqueous phase was prepared by adding polyvinyl alcohol in distilled water (Solution B). Solution A was drop-wise added to Solution B. The mixture was continuously stirred at 1,000-2,000 rpm for 3 h at room temperature. The solution was then filtered, washed with distilled water, and dried at room temperature.[9,7] 2^3 Factorial

Correspondence: Swati Chauhan, Department of Pharmaceutics, Amity Institute of Pharmacy, Amity University, Noida - 201 313, Uttar Pradesh, India, E-mail: swati.chauhan.chauhan@gmail.com

design was used to optimize the formulation for peppermint oil loaded nanosponges, described in Tables 1 and 2.

Characterization of Peppermint Oil Nanosponges

Shape and surface morphology of nanosponges

Scanning electron microscopic (SEM) analysis was done for analyzing particle shape and morphology. The shape and surface morphology of the silver nanoparticles was visualized by SEM (Cart Zeiss EV018). The samples were prepared by lightly sprinkling nanoparticles on double-sided adhesive tape on an aluminum stub. The stubs were then coated with gold to a thickness of 200-500 Å under an argon atmosphere using a gold sputter module in a high vacuum evaporator. The samples were then randomly scanned, and photomicrographs were taken at different magnifications with SEM.[10]

Production Yield

Production yield was calculated from the weight of dried microsponges, so obtained and initial theoretical mass of starting materials using the following formula:

% production yield = Weight of dried microsponges/theoretical mass of starting materials ×100

For accuracy of results, determinations were done in triplicate.[11,12]

Sun Protection Factor (SPF)

SPF was calculated by calculating the absorption obtained in the range of 290-320 nm (every 5 nm), and three determinations were made at each point.[13] Then, Mansur equation was used to determine the SPF values of the formulations.[14,15] Mansur equation is as follows:

$$\text{PF}\ (\text{spectrophotometric}) = \text{CF} \times \sum_{290}^{320} \text{EE}(\lambda) \times \text{I}(\lambda) \times \text{Abs}(\lambda)$$

Where,
EE(I) is the erythemal effect spectrum
I(I) is the solar intensity spectrum
Abs is the absorbance of sunscreen product
CF is the correction factor (=10)
The value of EE × I is constant, determined by Mansur *et al*. (1986) and shown in Table 3.

Results and Discussion

Peppermint oil nanosponges were successfully prepared using emulsion solvent diffusion technique. Nanosponges were found to spherical in shape and porous in surface texture. The particle size of nanosponges was found to be in nanorange, i.e., 200 nm indicating best suitability for topical delivery and hence can easily permeate through the skin. It can be clearly depicted in Figure 1. *In vitro* sun protection efficiency was found to be good, i.e., 5.28713±0.722 as compared to standard peppermint oil, i.e., SPF value of 7. SPF calculations of peppermint oil loaded microsponges are shown in Table 4.

Table 1: 2^3 Factorial design for peppermint oil loaded nanosponges

S.N	Factors	Levels	
		0	1
A	Eudragit RS. 100 (mg)	250	350
B	Polyvinyl alcohol (%w/v)	1.0	1.5
C	Stirring speed (rpm)	6500	7500

Table 2: Formulation table for peppermint oil loaded nanosponges

Formulation code	(A)	(B [%])	(C)
F1	0 (250)	0 (1.0)	0 (6500)
F2	0 (250)	1 (1.5)	1 (7500)
F3	1 (350)	0 (1.0)	0 (6500)
F4	1 (350)	1 (1.5)	1 (7500)
F5	1 (350)	0 (1.0)	1 (7500)
F6	0 (250)	1 (1.5)	0 (6500)
F7	1 (350)	1 (1.5)	0 (6500)
F8	0 (250)	0 (1.0)	1 (7500)

Table 3: Data for erythemal effect spectrum at different wavelengths

Wavelength (λ nm)	EE×I
290	0.0150
295	0.0817
300	0.2874
305	0.3278
310	0.1864
315	0.0839
320	0.0180

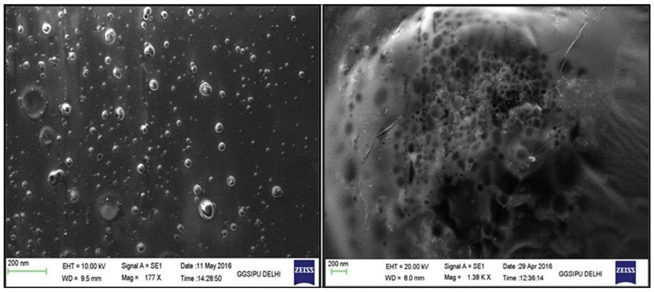

Figure 1: Photomicrograph of peppermint oil loaded nanosponges

Conclusion

Peppermint oil was successfully incorporated in Eudragit nanosponge using the emulsion solvent evaporation method. Optimized formulation was subjected to surface investigation, using scanning and transmission electron microscopy, which revealed the spongy structure with minute pores. Formulation showed promising *in vitro* SPF efficiency and has great potential with respect to the practical application of the incorporation of peppermint oil in cosmetic formulations.

Table 4: SPF value calculation of peppermint oil loaded nanosponges

S. No.	Wavelength (λ)	EE× I (Normalized)	SPF
1	290	0.0150	0.159
2	295	0.0817	0.761
3	300	0.2874	1.720
4	305	0.3278	1.720
5	310	0.1864	0.764
6	315	0.0839	0.142
7	320	0.0180	0.021

References

1. Ananthaswamy HN. Sunlight and skin cancer. J Biomed Biotechnol 2001;1:49.
2. D'Orazio J, Jarrett S, Amaro-Ortiz A, Scott T. UV radiation and the skin. Int J Mol Sci 2013;14:12222-48.
3. Korac RR, Khambholja KM. Potential of herbs in skin protection from ultraviolet radiation. Pharmacogn Rev 2011;5:164-73.
4. Ebrahimzadeh MA, Enayatifard R, Khalili M, Ghaffarloo M, Saeedi M, Charati JY. Correlation between sun protection factor and antioxidant activity, phenol and flavonoid contents of some medicinal plants. Iran J Pharm Res 2014;13:1041-7.
5. Kaur CD, Saraf S. *In vitro* sun protection factor determination of herbal oils used in cosmetics. Pharmacognosy Res 2010;2:22-5.
6. Kaity S, Maiti S, Ghosh AK, Pal D, Ghosh A, Banerjee S. Microsponges: A novel strategy for drug delivery system. J Adv Pharm Technol Res 2010;1:283-90.
7. Aldawsari HM, Badr-Eldin SM, Labib GS, El-Kamel AH. Design and formulation of a topical hydrogel integrating lemongrass-loaded nanosponges with an enhanced antifungal effect: *In vitro/in vivo* evaluation. Int J Nanomedicine 2015;10:893-902.
8. Selvamuthukumar S, Singireddy A, Krishnamoorthy K, Rajappan M. Nanosponges: A novel class of drug delivery system-review. J Pharm Pharm Sci 2012;15:103-11.
9. Amrutiya N, Bajaj A, Madan M. Development of microsponges for topical delivery of mupirocin. AAPS PharmSciTech 2009;10:402-9.
10. Gulati N, Nagaich U, Saraf SA. Intranasal delivery of chitosan nanoparticles for migraine therapy. Sci Pharm 2013;81:843-54.
11. Sonali, Singh RP, Prajapati SK. Formulation and evaluation of prednisolone loaded microsponges for colon drug delivery: *In vitro* and pharmacokinetic study. Int J Pharm Sci Res 2014;5:1994-2005.
12. Osmani RA, Aloorkar NH, Thaware BU, Kulkarni PK, Moin A, Hani U, *et al*. Microsponge based drug delivery system for augmented gastroparesis therapy: Formulation development and evaluation. Asian J Pharm Sci 2015;10:442-51.
13. Kunasekaran V, Krishnamoorthy K. Multi criteria decision making to select the best method for the preparation of solid lipid nanoparticles of rasagiline mesylate using analytic hierarchy process. J Adv Pharm Technol Res 2014;5:115-21.
14. Dutra EA, Oliveira DA, Kedor-Hackmann ER, Santoro MI. Determination of sun protection factor (SPF) of sunscreens by ultraviolet spectrophotometry. Braz J Pharm Sci 2004;40:381-5.
15. Mansur JS, Breder MN, Mansur MC, Azulay RD. Determination of sun protection factor by spectrophotometry. Bras Dermatol 1986;61:121-4.