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Niosome – The Magic Bullet

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Abstract

Target oriented drug delivery systems are the areas of the major interest in the modern pharmaceutical research. The selective drug delivery to the target tissues increases the therapeutic efficacy of the drug and reduces its undesirable effect to non target tissues.The concept of drug targeting or site specific drug delivery was introduced first time by Paul Elrich in 1909, when he reported 'magic bullet' to deliver a drug to the desired site of action without affecting the non target organs or tissues (Juliano, 1980) by associating the drug with a pharmacologically "inactive carrier" capable of conveying the drug selectively towards its target cells. Niosomes or nonionic surfactant vesicles are microscopic lamellar structures formed on admixture of nonionic surfactant of the alkyl or dialkyl polyglycerol ether class and cholesterol with subsequent hydration in aqueous media. In niosomes, the vesicles forming amphiphile is a nonionic surfactant such as span 60 which is usually stabilized by addition of cholesterol and small amount of anionic surfactant such as dicetyl phosphate. Niosomes can entrap both hydrophilic and lipophilic drugs, either in aqueous layer or in vesicular membrane made of lipid materials. It is reported to attain better stability than liposomes. It can prolong the circulation of the entrapped drugs. Because of the presence of nonionic surfactant with the lipid, there is better targeting of drugs to tumour, liver and brain. It may prove very useful for targeting the drug for treating cancers, parasitic, viral and other microbial disease more effectively.

Key-Word :- magic bullet, Target oriented drug delivery systems, inactive carrier, Niosome, site specific drug delivery, liposomes, cancers.

1. Introduction

The main goal of a site specific drug delivery system is not only to increase the selectivity and drug therapeutic index, but also to reduce the toxicity of the drug. (Widder *et al.*, 1982)

Vanlerbeghe *et al.* (1972) first reported the niosomes as a feature of cosmetic industry. In 1979, Handjanivila *et al.* reported that the hydration of a mixture of cholesterol and single alkyl chain, resulted in formation of non ionic surfactant vesicular systems (i.e. Niosomes). Further, Okhata *et al*. reported the formation of such vesicles by dialkyl polyoxyethylene ether with non ionic surfactants. Fendler (1982) published his work on ionic amphiphiles which were found to be toxic. Baillie and Azmin (Baille *et al*., 1985, Azmin *et al*., 1985) brought the revolution by preparing vesicles with non ionic surfactants and studying various parameters. Since then, a number of non ionic surfactants were used to prepare vesicles viz. poly glycerol alkyl ether (Handjanivila *et al*., 1979 & Baillie *et al*., 1986), glucosyl dialkylether (Baillie *et al*., 1986), crown ethers (Kiwada. *et al*., 1985) polyoxytheylene alkyl ethers (Echegoyen *et al*., 1988 & Hofland *et al*., 1991), ester linked surfactants, Brij (Naresh *et al*., 1993 & Parthasarthi *et al*., 1994), and series of Spans and Tweens. (Naresh *et al*., 1993, Parthasarthi *et al*. 1994).

These non ionic surfactant vesicles can entrap both hydrophilic and lipophilic drugs, either in aqueous layer or in the vesicular membrane made of lipid materials, which can be used to prolong the circulation of the entrapped drugs. Due to the presence of non ionic surfactant and the lipid, there is a better targeting of drug(s) to tumor, liver and brain. Thus, they are useful in targeting of the drug for treating cancers, parasitic, viral and other microbial diseases more effectively.

These non-ionic surfactant based vesicles (niosomes) are regarded either as a inexpensive alternative of non-biological origin to liposomes or perhaps as a carrier system of drug physically similar to liposome *in vivo*, with specific properties to attain different drug distribution and release characteristics.

1.1 *Rationale For Site Specific Drug Delivery(Tomilinson, 1991):*

1.1.1 To reach previously inaccessible domains e.g. intracellular site, bacteria, viruses, parasites etc.

1.1.2 Exclusive drug delivery to the specific cells or diseased site in the body.

1.1.3 Reduction in the drug dose and side effects.

1.1.4 To control the rate and frequency of drug delivery at the pharmacological receptor.

1.1.5 To protect the drug and the body from one another until it reaches at the desired site of action.

2. Niosomally Entrapped Bioactive Agents

A variety of drugs/active agents have been encapsulated in Niosomes.(Table 1)

3. Materials And Methods

Various material and methods requires for preparation of niosomes. (Table 2)

4. Method of Preparation

The entire process of preparation of niosomes has been shown in the flow diagram. (Flow Diagram 1)

5. Conclusion

The success of liposomal system has stimulated the search for other vesicle forming amphiphiles. Non-

ionic surfactant vesicles (niosomes) are among the first alternative materials studied for the drug

delivery. Niosomes, the multilamellar vesicles made up of non-ionic surfactant with or without cholesterol

surrounding aqueous compartments are one of those carriers.

Niosomes are efficient carriers for controlled drug delivery, to entrap hydrophilic drugs in the larger

interior aqueous layer , whereas, lipophilic drugs in the outer lipid bilayer. Since, the niosomes, are

biodegradable and non toxic and hence, a good carrier for targeting of therapeutic agents at the site of

interest with reduced systemic toxicity.

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Table 1: various agents encapsulated in niosomes and the corresponding results:

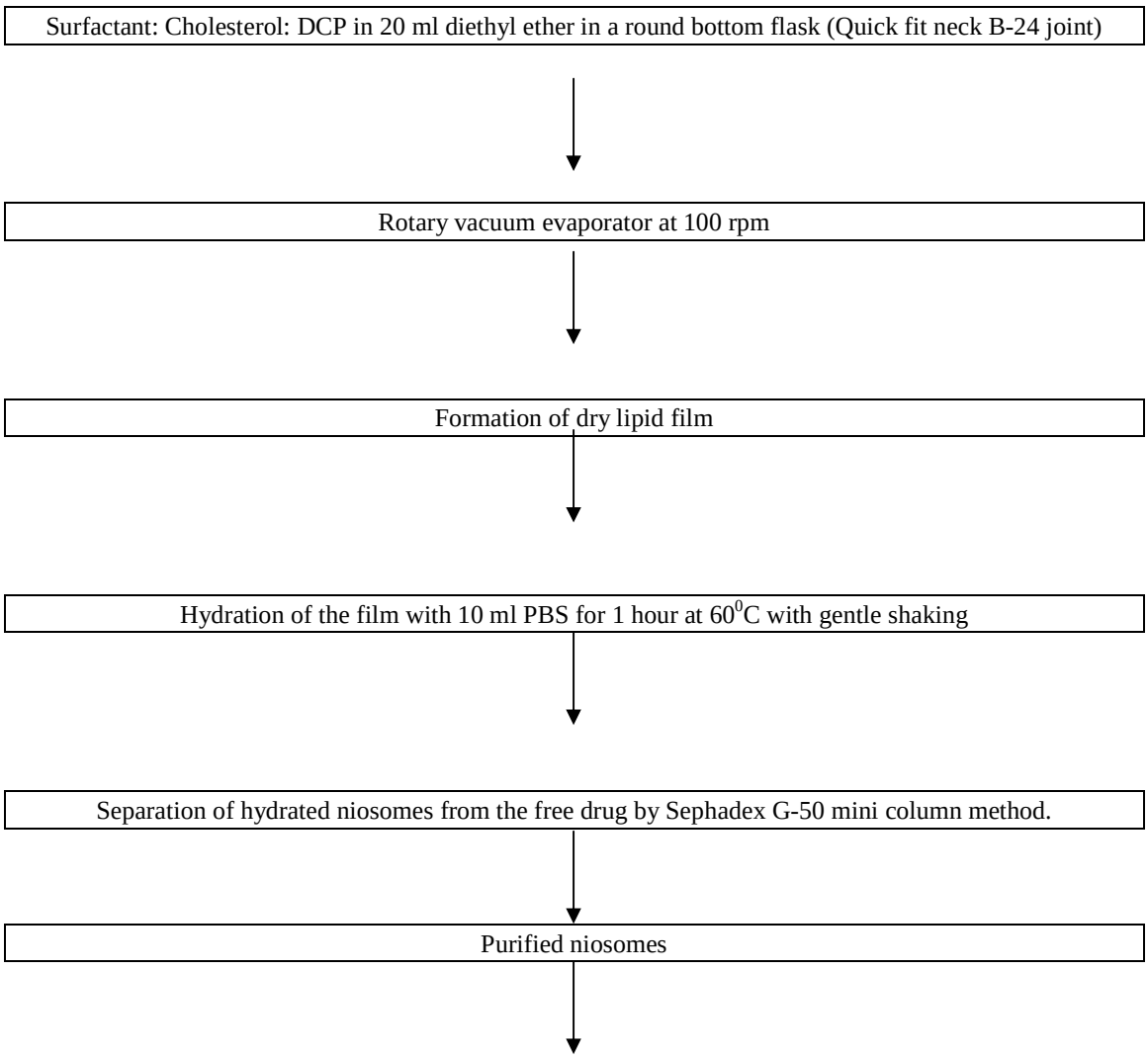
Drug	Result	References
Estradiol	Enhanced *in vitro* skin permeation of pronisome formulations.	Fang *et al*., 2001
Iopromide	Targeting of lopromide entrapped in MLV to the Kidney.	Erdogan *et al*., 1996
Flurbi profen	Enhanced bio-availability and anti-inflammatory activity of niosome encapsulated formulations as compared to conventional ointment base.	Reddy *et al*., 1993
Timolol maleate	Sustained activity on ocular administration	Vyas *et al*., 1998
Cytarabine Hydrochloride	Niosomal encapsulation provides sustained release delivery.	Ruckmani *et al*., 2000
Rifampicin	Prolonged drug release	Kamath *et al*., 2000
Cisplatin	Significant antimetastatic activity	Gude, *et al*., 2002
Cytosine arabinoside	Effective release in acid environment	Roux *et al*., 2002
Tretinoin	Span 20 and Tween 80, Span 60 and Tween 80 combination gives good entrapment	Manconi *et al*., 2002, Desai and Finlay, 2002
Daunorubicin Hydrochloride	Improved therapeutic efficacy	Bala subramaniam *et al*., 2002
Colchicine	Sustain release & reduced toxic side effects	Hao *et al*., 2002.
Insulin	Sustained release after oral dosage form Enhancing effect on vaginal delivery of insulin Improved stability against proteolytic enzyme	Pardakhty *et al*., 2007 Ning *et al*. 2005 Varshosaz *et al*. 2003
Finasteride	Enhance drug concentration by topical application	Tabbakhian *et al*., 2006

Hydroxycamphothecin	Enhanced stability and antitumor activity.	Shi *et al*., 2006
Acetazolamide	Prolonged effect and decrease in Intraocular pressure	Guinedi *et al*., 2005
Clotrimazole	Sustain and controlled release of clotrimazale for local vaginal therapy	Ning *et al*., 2005
Timolol maleate	Improved pharmacodynamics	Agrawal and Kaur 2005
Tetanous Toxoide	Mannosylated niosomes were found to be useful oral vaccine delivery carrier.	Jain and Vyas, 2006
Propylthiouracil	Control the release of propyl thiouracil.	Suwakul *et al*., 2006.

Table 2: Various material and methods requires for preparation of niosomes

Sr. No.	Equipment	Manufacturer
1.	UV-Visible Spectrophotometer	Perkin Elmer EZ 301 Double beam
2.	Digital pH meter	Systronics
3.	Electronic Balance	A & D Japan
4.	Rotary vacuum evaporator	Steroglass, Italy
5.	Microscope	Olympus (India) Pvt. Ltd., Delhi
6.	Vacuum Pump	Ital Scientific, Genova
7.	Magnetic Stirrer with hot plate	Remi Sales & Engg. Ltd., Mumbai
8.	Research Centrifuge	Remi Sales & Engg. Ltd., Mumbai
9.	Digital Vernier Caliper	Mitutoyo digimatic, Japan
10.	Transmission electron microscope	Fei-Philips Morgagni 268 D
11.	Water Bath	Narang Scientific Works Pvt. Ltd., Delhi
12.	Diffusion Cell	Fabricated

Flow Diagram 1: Flow diagram showing preparation of niosomes


Surfactant: Cholesterol: DCP in 20 ml diethyl ether in a round bottom flask (Quick fit neck B-24 joint)
Rotary vacuum evaporator at 100 rpm
Formation of dry lipid film
Hydration of the film with 10 ml PBS for 1 hour at 60^{0}C with gentle shaking
Separation of hydrated niosomes from the free drug by Sephadex G-50 mini column method.
Purified niosomes
Storage of purified niosomes in vials (in refrigerator) till