International Journal of Pharmaceutical Research and Applications
Volume 6, Issue 4 July-Aug 2021, pp: 486-491 www.ijprajournal.com ISSN: 2249-7781

Formulation of Solid Lipid Nanoparticles Using Beta-Sitosterol and Its Characterization

Upadesh Lade, Sandip Agrawal, Prachi Barsagade, Santosh Gotefode, Tikesh Agrawal

Chhatrapati Shivaji College of Pharmacy, Deori, Gondia, Maharashtra-441901, India.

Date of Submission: 05-07-2021 Date of Acceptance: 20-07-2021

ABSTRACT:

Drug delivery technology is a tough task to deliver the medicament Solid Lipid Nano-particles is a promising tool to enhance the solubility of hydrophobic drug because lipids have been put forward as an substitute carrier, particularly for lipophilic pharmaceuticals. These lipid nanoparticles are known as solid lipid nanoparticles (SLNs) by using Beta-Sitosterol was suitable and compatible with the lipid matrix and no chemical interaction takes place in the formulation even in the particle size all the range shows good result and in the Zeta potential electrophoretic mobility is obtain. For the purity of Beta- sitosterol shows better absorption measured at 208nm, R- value is 0.997 which follows the Beers law linearity. The FTIR spectrum studies Beta- sitosterol compatibility of pure drug with the polymers indicated that the lipid forms the outer core and the drug has been successfully incorporated inside and suitably targeted through the site of action. This research work proves that the SLN is a suitable method to deliver the hydrophobic category drug to deliver at the site of action.

Key word: Solid lipid nanoparticles (SLN), colloidal drug carriers, homogenization, TEM, PCS, biodistribution, targeting

I. INTRODUCTION

Solid Lipid Nano Particle

Solid Lipid Nanoparticles (SLN) introduced in 1991 represent an alternative carrier system to traditional colloidal carriers such as emulsions,[1] liposomes, and polymeric micro and nanoparticles. Nanoparticles made from solid lipids are attracting major attention as a novel colloidal drug carrier for intravenous applications as they have been proposed as an alternative particulate carrier system. [2] SLN are sub-micron colloidal carriers ranging from 50 to 1000 nm, which are composed of physiological lipid, dispersed in water or aqueous surfactant solution. SLN offers unique properties such as small size, large surface area, high drug loading, and the interaction of phases at the interface and are attractive for their potential to improve the performance of pharmaceuticals**.**

Beta-Sitosterol

Beta-Sitosterol is one of the several phytosterols (plant sterols) with a chemical structure similar to that of cholesterol It is a white waxy powder with a characteristic order. Phytosterols are hydrophobic and soluble in alcohols. [3]

Chemical formula C29H50O

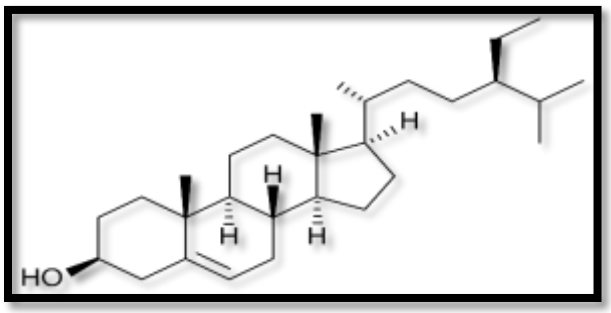

Fig. 1 Structure of β-sitosterol (17-(5-Ethyl-6-methylheptan-2-yl)-10,13-dimethyl-2,3,4,7,8,9,11,12,14,15,16,17-dodecahydro-1H-cyclopenta[a]phenanthren-3-ol)

International Journal of Pharmaceutical Research and Applications
Volume 6, Issue 4 July-Aug 2021, pp: 486-491 www.ijprajournal.com ISSN: 2249-7781

Advantages of SLN

1. It improves the stability of the pharmaceutical dosage form. [4]
2. Due to the stability it bioavailability and site of action of drug gives the therapeutics effects
3. Easy to scale up and sterilize.
4. Better control over release kinetics of encapsulated compounds.
5. Enhanced bioavailability of entrapped bioactive compounds.
6. Chemical protection of labile incorporated compounds. [5]
7. Much easier to manufacture than bio-polymeric nanoparticles.
8. No special solvent is required.

Disadvantages of SLN

1. Particle growth. [6]
2. Unpredictable gelation tendency.
3. Unexpected dynamics of polymeric transitions.

II. MATERIALS AND METHODS:-

Chemical and Solvent:-

Beta-Sitosterol (Drug), Glycerol Monostearate, and Tween 40 chemicals were provided by central chemical laboratories of Chhatrapati Shivaji College of Pharmacy.

Apparatus

Burette stand, capillary ignition tube, beaker, hot plate magnetic stirrer, homogenizer, digital melting point apparatus, particle size zeta potential UV visible spectrophotometer.

Formulation table of Solid Lipid Nano Particles

S. No.	Ingredient	F1	F2	F3	F4	F5
1.	Beta-Sitosterol	0.1	0.1	0.1	0.1	0.1
2	Glycerin	1.2	0.6	0.6	0.85	0.85
3	Tween40	0.25	0.25	0.8	0.8	0.25
4	Distilled Water	100	100	100	100	100

Table 1 :- formulation of SLN

Preparation of Solid Lipid Nano Particle[7]

Pure drug of β-sitosterol and tween 40 were dissolve in hot distilled water at temp.60^0 glycerin was melted at the temp of 70^0C and added drop wise to the hot aqueous solution under stirrer at 500 RPM for 20 min in a mechanical stirrer. This result in the formation of emulsion which was homogenized by + using a homogenizer at 1000 rpm for 30 min. This results in the formation of solid lipid nanoparticles which were stored in a refrigerator.

Evaluation parameter

- Zeta potential.
- FTIR (Fourier Transform Infrared Spectroscopy).
- SEM (Scanning Electron Microscopy).

Zeta potential:-

The zeta potential parameter is used to characterize the charge on the surface of the nanoparticles that plays a vital role in determining the stability of the formed nanoparticles. zetasizer nano ZS 90 (Malvern Instruments UK), [8] which calculates the zeta potential by determining the electrophoretic mobility and then applying the henry equation was used to determine the zeta potential of the formulation (F1-F5). the electrophoretic mobility is obtained by performing an electrophoresis experiment on the sample and measuring the velocity of particles using laser doppler velocimetry

Scanning Electron Microscopy (SAM)

The surface morphology of lyophilized β-sitosterol SLN's was visualized using SEM (Zeiss SEM EVO-18, Carl Zeiss Microscopy. The water suspended nanoparticles were mounted on a glass slide as a thin smear and left to dry. The particles on the dried glass slide were subjected to gold sputtering and the slide was attached to an SEM holder using a double-side carbon tape mounted on an aluminum stud. [9] The SEM photomicrographs were captured by operating at an accelerating voltage of 20 kV electron beam at desired magnification.

International Journal of Pharmaceutical Research and Applications
Volume 6, Issue 4 July-Aug 2021, pp: 486-491 www.ijprajournal.com ISSN: 2249-7781

Percentage Entrapment Efficiency (%EE)

The method for determination of entrapment efficiency was based on the amount of β-sitosterol recovered from supernatants. It was assumed that the rest of the β - sitosterol used during preparation had been encapsulated. The blank used was the supernatant obtained after centrifugation of dummy nanoparticles (without drug) at 10,000rpm for 30 minutes at 15^0 C. The supernatant obtained was diluted and analyzed spectrophotometrically at 208 nm. The following equation was to calculate entrapment efficiency.

%EE=Wt. of drug used in formulation-Wt of unbound drug in supernatant/Wt. of a drug in formulation X 100

III. RESULT AND DISCUSSION

UV Spectroscopy

PREPARATION OF STANDARD STOCK SOLUTION OF β-SITOSTEROL:-

The stock solution of β-sitosterol (1000µg/mL) was prepared by dissolving accurately 1mg β-sitosterol in 1ml chloroform and then withdrawn 0.1 ml β-sitosterol solution and dilute to 1ml to form 100µg/ml solution of β - sitosterol. Further,a series of dilutions were made with chloroform.

CALIBRATION CURVE OF β –SITOSTEROL

A series of calibrated volumetric flasks were taken and appropriate aliquots of the working standard solutions of β-sitosterol were withdrawn and diluted up to 10ml with chloroform. The absorbance measured at absorption maxima 208nm, against reagent blank prepared similarly without β-sitosterol and absorption maxima measured at 208nm, Absorption maxima and Beers law limit were recorded. Data that proves linearity and obeys Beers law limit were noted. The linear correlation between these concentrations (x-axis) and absorbance (y-axis) was graphically presented. Slope (m), intercept (b), and correlation coefficient (R2) were calculated from the linear equation (Y= mx+b) by regression.

Sn	Concentration µg/ml	Absorbanc in (208 nm)
1	1	0.035
2	2	0.079
3	3	0.111
4	4	0.159
5	5	0.193

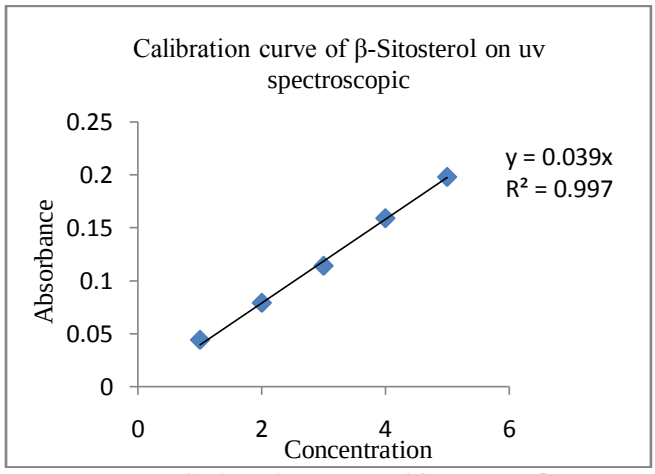

Fig. 2 Calibration curve of β-Sitosterol

International Journal of Pharmaceutical Research and Applications
Volume 6, Issue 4 July-Aug 2021, pp: 486-491 www.ijprajournal.com ISSN: 2249-7781

Evaluation Parameter

Particle size and Zeta potential

the zeta potential of the β-sitosterol solid lipid nanoparticles important to determine the stability and uptake mechanism of the particles inside the body. The zeta potential values of the formulation are shown in the table and zeta potential values of optimized formulation(F1-F3) are shown in the figure.

S.no	Formulation code	Particle size (nm)	Zeta potential(mV)
1	F1	1201	-28.6
2	F2	504	-21.3
3	F3	3088	-43.5
4	F4	806	-24.6
5	F5	1105	-27.8

Particle size

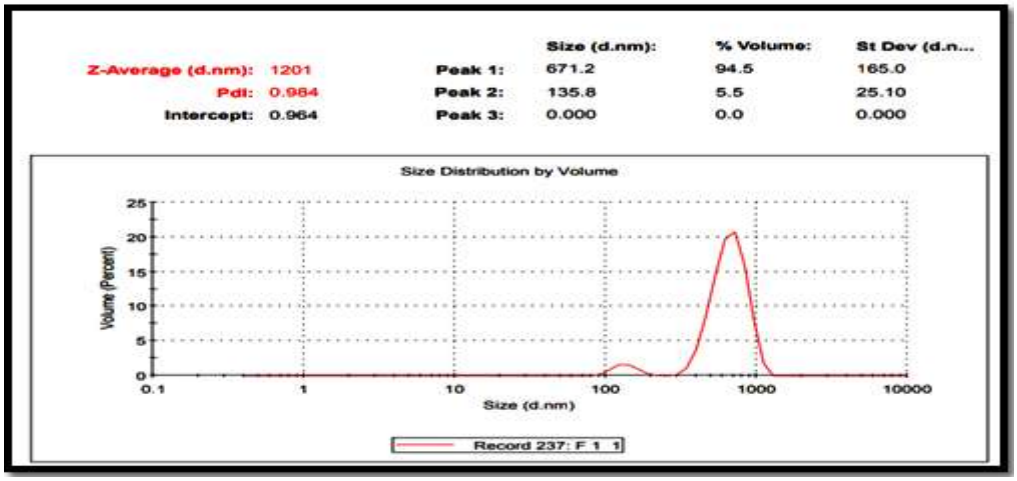

Fig. 3 Particle size of F1

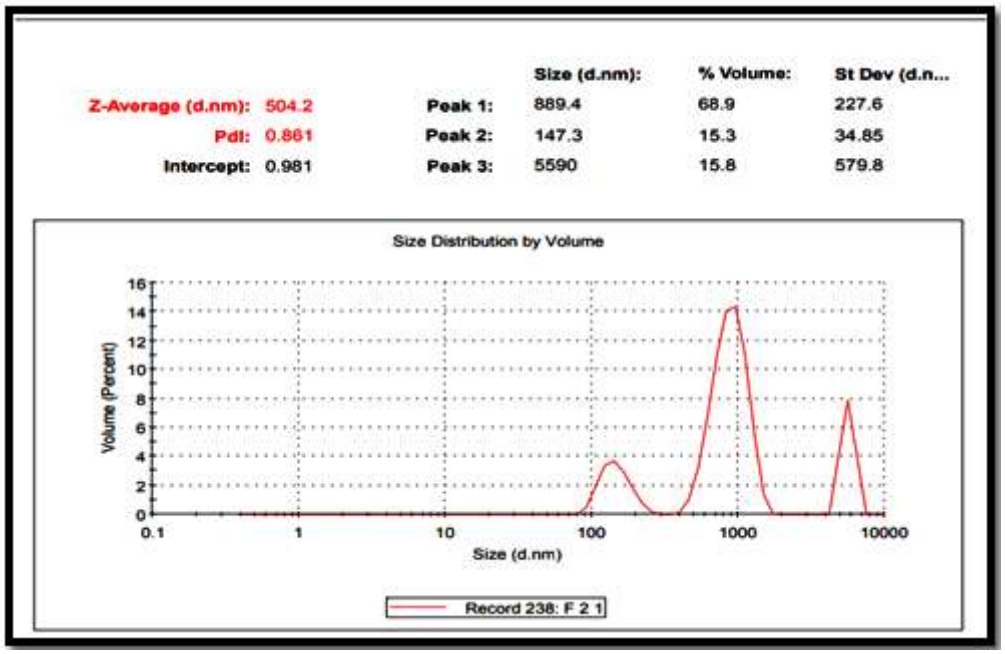

Fig. 4 Particle size of F2s

International Journal of Pharmaceutical Research and Applications
Volume 6, Issue 4 July-Aug 2021, pp: 486-491 www.ijprajournal.com ISSN: 2249-7781

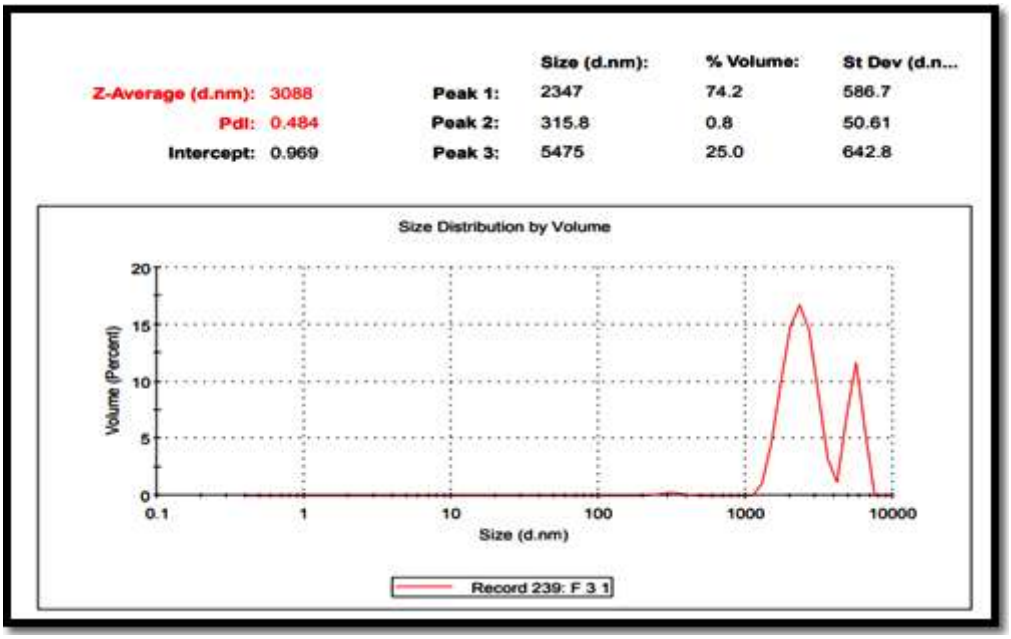

Fig. 5 Particle size F3

FTIR spectroscopy

FTIR spectroscopy (Fig.) was used to determine any possible active material-excipient interaction at the level of functional groups. The FTIR spectrum of the pure β sitosterol exhibited many characteristic absorption bands (cm−1) representing O–H stretching (3427.85), aliphatic C–H (CH3 and CH2) stretching (2850–2960), cyclic methylene (CH2)n groups (1464.59), gem-dimethyl (–CH(CH3)2) group (1382.09) and C–OH of secondary alcohol (1052.35). Applied lipid (PW and GB) showed peaks corresponding to aliphatic C–H stretching (2850–2950), C]O stretching vibration (around 1700 cm−1), and C–O stretching vibration in the ester group (1000–1300 cm−1). The FTIR spectra of the free and the β sitosterol NLC were almost the same. The IR spectrum of drug-loaded NLCs resembles that of the lipid and peaks corresponding to β sitosterol were disappeared or overlaid by the peaks of free NLC. It indicated that the lipid forms the outer core and the drug has been successfully incorporated inside. Similar results were also observed for other drugs (Fan, Liu, Huang, Li, & Xia, 2014; Fathi et al., 2013). This could be explained by the drug-enriched core model for the incorporation of active compounds into nano lipid carriers (Fan et al., 2014). On the other hand, all the characteristic peaks of the carriers were observed in the drug-loaded NLC spectrum and no predominate shifting of existing peaks or creation of new peaks occurred. This suggested that β sitosterol was compatible with the lipid matrix and no chemical interaction took place among them.

IV. CONCLUSION AND SUMMARY

Hydrophobic drug having a challenging task to all the scientists in a pharmaceutical industry so it is an attempt to overcome this problem. Solid lipid nanoparticle technology can bring enormous immediate benefits and will revolutionize the research and practice of medicine in the field of pharmacy. Beta-sitosterol has been used for anti-inflammatory, prostate cancer treatment, and antioxidant effects for quite a long time.

REFERENCES:-

[1]. Speiser P. Lipidnanopellets als Tragersystem fur Arzneimittel zur perolen Anwendung. European Patent, EP 0167825. 1990.
[2]. Schneider,K.;DiNovi,M.;Baines,J.;Schlatter, J.Phytosterols,phytostanolsandtheiresters. Saf.Eval.Certain Food Addit. 2009, 60, 117–157.
[3]. Sjostrom B, Bergenstahl B. Preparation of submicron drug particles in lecithin-stabilized o/w emulsions: I: Model studies of the precipitation of cholesteryl acetate. Int J Pharm. 1992;88:53–62
[4]. Raport, E. Consumption of food and beverages with added plant sterols in the European Union. EFSA J. 2008, 133, 1–21.

[5]. Meyer E, Heinzelmann H. Scanning force microscopy. In: Wiesendanger R, Guntherodt HJ, editors. Scanning tunneling microscopy II, Surface science. New York: Springer Verlag; 1992. pp. 99–149
[6]. Murthy RS. Solid lipid nanoparticles as carriers for anti-cancer drugs to solid tumours. Drug Deliv. 2005;12:385–92.
[7]. rana, Lide; Salado, Clarisa; Vega, Sandra; Aizpurua-Olaizola, Oier; Arada, Igor de la; Suarez, Tatiana; Usobiaga, Aresatz; Arrondo, José Luis R.; Alonso, Alicia (2015-11-01). "Solid lipid nanoparticles for delivery of Calendula officinalis extract". Colloids and Surfaces B: Biointerfaces. 135: 18–26
[8]. Rakesh Tiwle et al. "An Exhaustive Review On Solubility Enhancement For Hydrophobic Compounds By Possible Applications Of Novel Techniques." Science Alert –Trends Research In Applied Science And Research. 7(8): 596-619; 2012.
[9]. Shah, Mansi K.; Madan, Parshotam; Lin, Senshang (23 May 2013). "Preparation, evaluation and statistical optimization of carvedilol-loaded solid lipid nanoparticle for lymphatic absorption via oral administration". Pharmaceutical Development and Technology. 19 (4): 475–485.