Crystallinity and Morphology Study of Anionic and Nonionic Surfactants Stabilized Solid Lipid Nanoparticles by Atomic Force Microscopy

Sacheen Kumar and Jaspreet Kaur Randhawa
Center for Material Science and Engineering
National Institute of Technology
Hamirpur, India
E-mail:sacheen3@gmail.com, jaspkaur2001@yahoo.com

Abstract
The Surfactant stabilized lipid matrix nanoparticles are novel carriers which have potential for drug delivery system. Gelucire 50/13 and Sodium Deoxycholate were the surfactants whose effect studied on the crystallinity and morphology of SLNs. SLNs shape was affected by crystalline character of lipid matrix material whose proportionality studied by X-ray diffraction, dynamic light scattering and non-contact atomic force microscopy. Relative crystallinity of Gelucire 50/13 stabilized SLNs was found to be lower than sodium deoxycholate SLNs. Spherical shape of Gelucire 50/13 SLNs was observed by non-contact mode AFM whereas as RBC type shape for Sodium Deoxycholate.

1. Introduction
Nanotechnology have provided various nanocarriers for the drug delivery system, but solid lipid nanoparticles are the superior class which have drug molecule entrapped in its matrix. Stability, bioavailability and targeting with controlled kinetics are main concern in today's drug delivery systems. SLNs have advantages over the polymeric nanoparticles and liposomes in case of stability and toxicity issues [2]. Our molecule of interest Paliperidone has lower bioavailability so SLNs approach utilized. In this study we have used Capmul GMS 50K as matrix material whereas Gelucire 50/13 and Sodium Deoxycholate (NaD) were used as non-ionic and anionic surfactant respectively. Sodium deoxycholate is a bile salt which have emulsifying characteristics whereas Gelucire 50/13, an ester of polyethylene glycol with stearic acid was used as non-ionic surfactant. Surface covering of surfcatnta layers have effect on crystallinity [1], [4]. In this study we estimated effect of emulsifiers on crystallinity of SLNs. Further the shape of SLNs was observed by non-contact mode AFM [3]. Proportionality of shape and crystallinity was further analyzed by dynamic light scattering. Area under curve method was applied on XRD data to compute the relative crystallinity of samples.

2. Materials and Methods
Lipid matrix material used was Capmul GMS-50K was a gift from Abitec Corporation, Gelucire 50/13was gifted by Gattefosse, Paliperidone was also gifted. Other chemicals were procured from sigma and purified water was used in all the preparation. Magnetic stirring at temperature 5°C above the melting point of lipid was used to prepare pre-emulsion of surfactant, lipid and paliperidone mixture. Further ultrasonic probe was used to prepare the nanoparticles. Prepared suspension was further cooled down to 2-6 °C for the solidification of lipid matrix material in the droplet.

3. Result and Discussion
Powder X-ray diffraction study was performed to study the crystal structure of SLNs and its components. Paliperidone was crystalline dopants drug material which was entrapped in lipid matrix material as amorphous, it was revealed from the XRD data showing no characteristic peak paliperidone in the SLNs XRD spectra. Percent relative crystallinity (%RC) of Gelucire 50/13 and Sodium Deoxycholate with respect to lipid matrix material Capmul GMS 50K was calculated from X-ray diffraction data by area under curve method, we have found that %RC of NaD stabilized SLNs was 66.379% whereas Gelucire 50/13 Stabilized SLNs as 78.29% w.r.t. Capmul GMS 50 K. DSC curves observed lower melting temperature for Gelucire 50/13 Stabilized SLNs as compared to NaD stabilized SLNs.

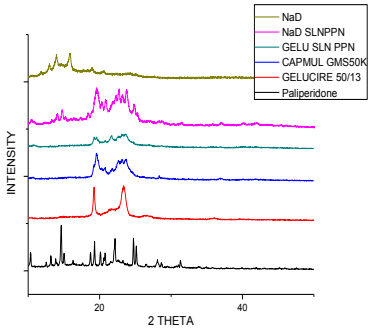

FIGURE 1. XRD spectra of Sodium Deoxycholate Stabilized SLN (NaD SLNPPN), Gelucire 50/13 Stabilized SLNPPN (GELU SLNPPN) and other components of both the SLNs formulations.

Temperature effect on size was studied by dynamic light scattering (Figure 2) from 10-65°C. Gelucire 50/13 stabilized SLNs shows decrease in size at lower temperatures as compared to NaD stabilized SLNs. Initially the size of NaD based SLNs was around 185 nm whereas

Gelucire 50/13 based SLNs have size around 155nm. Gelucire 50/13 based SLNs are smaller in size as compared to anionic surfactant stabilized SLNs.

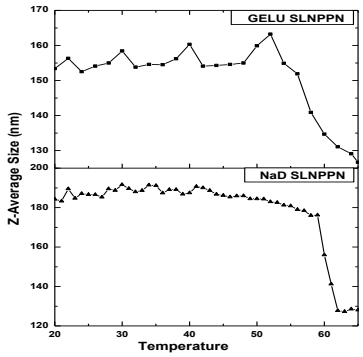

Figure 2. Temperature trend of Gelucire SLNPPN and Sodium Deoxycholate SLNPPN.

It may be due to changes in phase of crystalline SLNs or change in shape in both the types. During the increase in temperature of suspension lipid nanoparticles matrix changes phase, this was detected by DLS. The decrease in size of Gelucire 50/13 stabilized SLNs was observed after the 52°C. Further the shape of SLNs was observed by non-contact mode atomic force microscopy (Mühlen, Mühlen et al. 1996), which reveals that lower %RC Gelucire 50/13 stabilized SLNs have spherical shape as compared to higher %RC NaD stabilized SLNs have a disc or a doughnut type shape of nanoparticles as shown in figure 3. AFM images reveal the three dimensional structure of SLNs which was obtained by Picoimage software processing of the raw AFM data.

4. Conclusion

Lipid nanoparticles which have doughnut type shape are crystalline as compared to the spherical shaped SLNs, because during the crystallization lipid nanoparticles which crystalline surfactant coating attained a more stable crystal strcture as compared to amorphous polymeric surfactant gelucire 50/13 coating the SLNs. DLS and AFM data correlated with XRD and DSC data reveals that emulsifiers used in the formulation affect the size and shape of SLNs by affecting crystallization of lipid in matrix material of SLNs.True-Type 1 fonts are preferred.

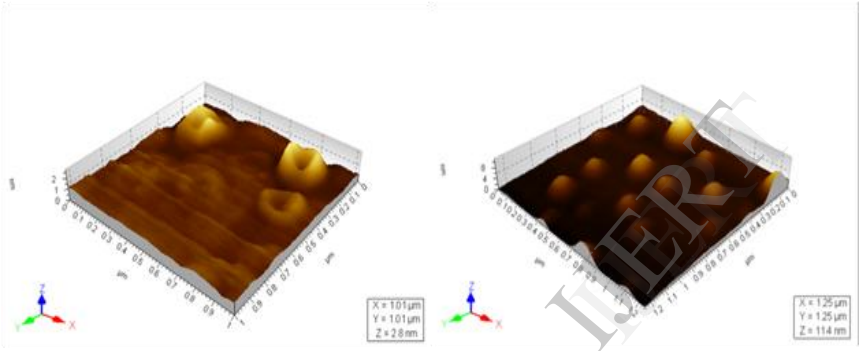

Figure 3. AFM images of Sodium Deoxycholate stabilized SLNs (A) and Gelucire stabilized SLNs (B) showing spherical and doughnut shapes respectively.

5. Acknowledgments

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6. References

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