IOSR Journal of Biotechnology and Biochemistry (IOSR-JBB)
ISSN: 2455-264X, Volume 1, Issue 6 (Sep. – Oct. 2015), PP 121-124
www.iosrjournals.org

Effect of Techniques in Preparing VCO Nanoparticles

Farah Diana Ariffin[1],Rosnani Hasham[1], Mariani AbdulHamid[1], Ahmad M. Eid[1], Aref T. Mohamed[2], Eseldin I. Keleb[2], Assad Elmahgoubi[3],Yosef S. Issa[4], Nagib A. Elmarzugi[1,2,3,*]

[1]*Research and Innovation Dept., Institute of Bioproduct Development, Universiti Teknologi Malaysia, 81310 UTM, Johor, Malaysia.*
[2]*Dept. of Industrial Pharmacy, Faculty of Pharmacy, Tripoli University, Tripoli, Libya.*
[3]*BioNano Integration Research Group, Biotechnology Research Center, LARST, Libya.*
[4]*Faculty of Medicine, Tripoli University, Tripoli, Libya.*
**The corresponding address email: nelmarzugi@gmail.com.*

Abstract:*This study presents the effects of two techniques in preparing solid lipid nanoparticles (SLN) incorporated with virgin coconut oil (VCO). VCO-SLNs were prepared using two different techniques which were high pressure homogenizer (HPH) and probe sonicator. HPH was done at 400 bars for six cycle and for probe sonicator, three different amplitudes were used; 30, 50 and 70. The VCO-SLNs were characterized with respect to particle sizes, polydispersity index (PDI) and size distribution by intensity. VCO-SLNs using HPH had an average diameter of 289.4 and PDI of 0.680. The average diameter and PDI for probe sonicator with amplitude 30, 50 and 70 were 113.4 and 0.336, 345.4 and 0.441, and 276.7 and 0.386, respectively. This study demonstrates that different techniques in preparation of SLNs can manipulate the physicochemical properties of SLNs especially particle size and PDI.*

Keywords: *Nanoemulsion, Nanoemulgel, Emulsifying method, Liposomes, Thixotropic, Hydrogel*

I. Introduction

Solid lipid nanoparticle (SLN) is a new type of colloidal carrier systems which were introduced to overcome the problems in delivery system for pharmaceutical drugs and cosmetic active ingredients in various application routes [1-3]. SLN possess various advantages which was developed as an alternative carrier system to emulsion, liposome, nanosuspensions and polymeric nanoparticles [4]. SLN show more advantages such as a good tolerability, ability to produce on industrial scale and biodegradable [1]. The factors in development of carrier systems include the size of the carrier and materials used. The size of the carrier ranges from nanometers, micrometer and to several millimeters which depends on the desired route of administration [5]. The development of SLN originally is the combination of the advantages of solid particles, emulsions and liposomes [4]. The SLN formulation consists of spherical solid lipid which is dispersed in water and surfactant(s) / emulsifier(s) in the nanometer range [1, 3, 5]. The matrix of solid lipid (lipid solid in room temperature) is made from physiological lipids which decrease the danger and acute toxicity [5]. Various methods are available in producing SLN such as high pressure homogenizer (HPH), microemulsion based SLN preparations, solvent emulsification, and high shear homogenization and ultrasound [1, 5]. High pressure homogenizer requires several times of homogenization cycle at high pressure in order to produce nanometer size range, with narrow droplet size distribution [6]. Ultrasonication works by two mechanisms to produce SLN; which is through the application of acoustic field and application of low frequency ultrasound [6]. Physic-chemical characterization of SLN is necessary for the quality control of the product. The stability of SLN usually determined by particle size and distribution, morphology, zeta potential, drug loading capacity and the physical state of the solid particles [1, 3].The aim of this paper is to compare the characterization of the solid lipid nanoparticles (SLN) incorporated with virgin coconut oil (VCO) prepared by two different techniques.

II. Materials And Methods

2.1 Materials

Soy lecithin (L-α-Phosphatidylcholine), Stearic acid (n-octadecanoic acid) 95% and Tween 80 were purchased from Sigma Aldrich M (Selangor, Malaysia). Virgin coconut oil (VCO) was obtained from Institute of Bioproduct Development (Universiti Teknologi Malaysia, Malaysia) and deionized water was taken on site from a Sartorius Arium 611 water system.

2.2 Preparation of pre-emulsion VCO-SLNs

VCO-SLN prepared consisting of 15% (w/w) of lipid phase and 2.5% of emulsifier by Hydrophile-Lipophile Balance (HLB) method. Stearic acid was dispersed in the emulsifier of Tween 80 with addition of virgin coconut oil in a double boiled beaker. The dispersion medium (distilled water with soy lecithin) was heated using double boiled technique. A pre-emulsion was obtained by emulsified the hot lipid phase in the dispersion medium using a high-speed stirrer (IKA Ultra Turrax® T25) for 2 minutes at 12000 rpm.

2.3 Preparation of VCO-SLNs by high pressure homogenizer

Half of the prepared pre-emulsion was then subjected to high-pressure homogenizer (HPH) at 400 bars and six cycles to narrow down the particle size. The emulsion was cooled down at room temperature to form lipid particle dispersions.

2.4. Preparation of VCO-SLNs by probe sonicator

The particle size of the pre-emulsion was narrowed down using a probe sonicator (Fisher Scientific Sonic Dismembrator Model 500) at three different amplitudes (30, 50 and 70) while the ultrasonication time was constant at 4 minutes. The emulsion was cooled down at room temperature before stored at refrigerator at 4°C to obtain lipid particle dispersions.

2.5. Particle size analysis

Droplet size was analyzed by dynamic light scattering (DLS) which is also known as photon correlation spectroscopy (PCS). The VCO-SLPs samples were diluted with distilled water to suitable concentration and the mean size and distribution of the droplets was measured by Malvern Zetasizer Nano S (Malvern Instruments, UK). The measurements were repeated in triplicate and the average value was taken. The size distribution reflects the uniformity of particle diameter[7, 8]

III. Results And Discussion

SLNs were successfully produced by using two different techniques; ultrasonicator with different amplitudes and high pressure homogenizer (HPH). Droplet size and size distribution are the most important physical characteristics of SLN. Polydispersity index (PDI) is calculated from a simple two parameter fit to the cumulants analysis. A bigger value of PDI indicates that the sample has very broad size distribution and may contain large particles or aggregates that could be slowly sedimenting. The droplet size parameters and polydispersity index (PDI) were evaluated immediately after the production of VCO-SLNs. Emulsification time and stirring rate during the process of preparations of nanoparticles influenced the particle size and zeta potential[9].

Three amplitudes at 30, 50 and 70 of ultrasonicator provided different intensity sonication which affected the particle sizes for as shown in Table 1. All three different amplitudes showed droplets size range between 113.4 to 276.7 nm with PDI range between 0.336 and 0.441. The smallest droplets size with better PDI of VCO-SLNs was obtained using ultrasonicator at amplitude 30. The time and amplitude during ultrasonicator affect the particle size as longer time and higher amplitude can increase the temperature of SLNs. A study by Zhang et al., (2008) [10] showed that temperature is one of the crucial parameter for the particle size. The problem occurred during ultrasonicator technique is broader particle size distribution ranging into micrometer range which lead to physical instability [11]. Size distributions by intensity of each amplitude were shown as Figure 1 (a), 1 (b) and 1 (c). From the three amplitudes, only ultrasonication with amplitude 30 showed that the particle size was uniformly distributed.

Table 1: Particle size and polydispersity index (PDI) for VCO-SLN using ultrasonication

Technique	Particle size (nm)	Polydispersity index (PDI)
Ultrasonicator		
Amplitude: 30	113.4	0.336
Amplitude: 50	345.4	0.441
Amplitude: 70	276.7	0.386
High pressure homogenizer	289.4	0.680

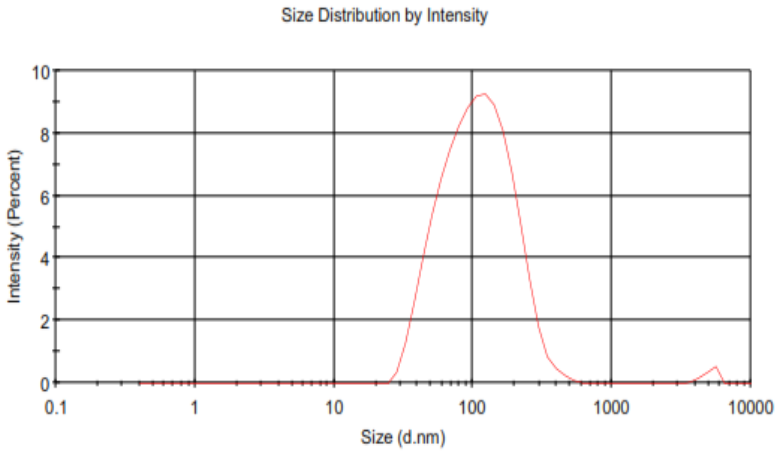

Figure 1 (a): Size distribution by intensity for VCO-SLNs using probe sonicator at amplitude of 30

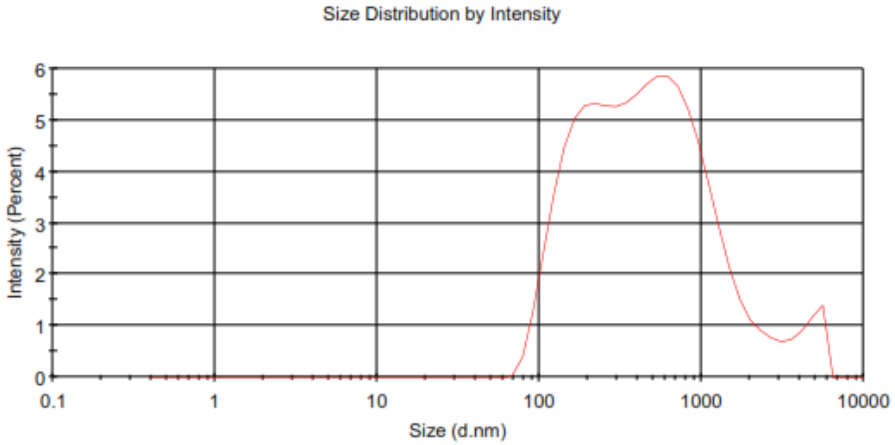

Figure 1 (b): Size distribution by intensity for VCO-SLNs using probe sonicator at amplitude of 50

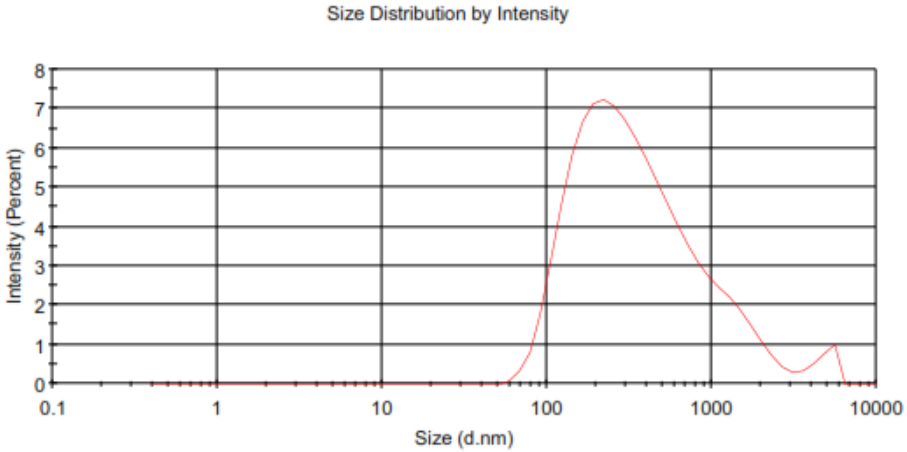

Figure 1 (c): Size distribution by intensity for VCO-SLNs using probe sonicator at amplitude of 70

VCO-SLNs prepared using HPH at 400 bars and six cycles resulted droplets size of 289.4 nm and PDI of 0.680 (Table 1). This result showed that even though the droplets size was quite small but the PDI was high which indicated a broad particle size distribution. The PDI can be improved by increase the stirring rates during the preparation of pre-emulsion but the higher stirring rates did not significantly change the particle size, but slightly improved the PDI [11]. For HPH technique, better products can be obtained after several passes, typically 3 to 5 cycles. Increasing the homogenization leads to an increase of the particle size due to particle coalescence which occurs because of the high kinetic energy of the particles [11]. Figure 2 showed size

distribution by intensity for the preparation of VCO-SLNs using HPH. The size distribution showed that the particle size was not uniformly distributed.

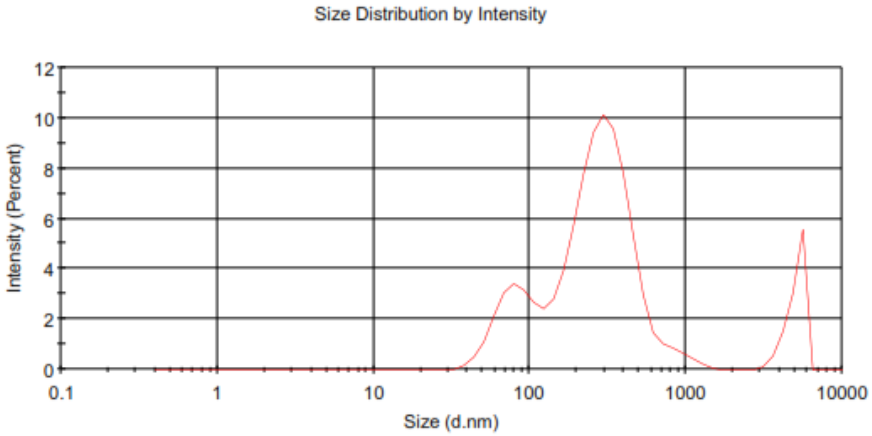

Figure 2: Size distribution by intensity for VCO-SLNs HPH at 400 bars for six cycles

IV Conclusion

This study demonstrates that different techniques in preparation of SLNs can manipulate the physicochemical properties of SLNs. The time, amplitude, stirring rate, temperature, pressure and cycles used during ultrasonication and high pressure homogenizer for the preparation of SLN need to be optimized to get small particle size with good PDI.

References

[1] A. Saupe, T. Rades, Solid lipid nanoparticles inM.R. Mozafari (Ed), Nanocarrier Technologies: Frontiers of Nanotherapy (Netherlands: Springer 2006) 41-50.

[2] S.A. Wissing, R.H. Müller, Cosmetic applications for solid lipid nanoparticles (SLN), International Journal of Pharmaceutics, 254 (1), 2003, 65-68.

[3] S. Utreja, N. Jain, Solid lipid nanoparticles in N.K. Jain (Ed), Advances in controlled and novel drug delivery(New DelhiCBS Publishers2001) 408-425.

[4] R.H. Müller, M. Radtke, S.A. Wissing, Solid lipid nanoparticles (SLN) and nanostructured lipid carriers (NLC) in cosmetic and dermatological preparations, Advanced Drug Delivery Reviews, 54, 2002, S131-S155.

[5] W. Mehnert, K. Mäder, Solid lipid nanoparticles: production, characterization and applications, Advanced Drug Delivery Reviews, 47(2), 2001, 165-196.

[6] E. Ahmad, Preparation and characterization of nanoemulsion with evaluation of its anti-inflammatory and toxicity studies, Universiti Teknologi Malaysia, Johor, 2015.

[7] R. Chouksey, H. Pandey, A. Jain, H. Soni, G. Saraogi, Preparation and evaluation of the self-emulsifying drug delivery system containing atorvastatin HMG-CoA inhibiter, Int J Pharm Pharm Sci, 3 (3), 2011, 147-152.

[8] Y. Zhao, C. Wang, A.H. Chow, K. Ren, T. Gong, Z. Zhang, Y. Zheng, Self-nanoemulsifying drug delivery system (SNEDDS) for oral delivery of Zedoary essential oil: formulation and bioavailability studies, International Journal of Pharmaceutics, 383 (3), 2010, 170-177.

[9] J. Zhang, Y. Fan, E. Smith, Experimental design for the optimization of lipid nanoparticles, Journal of Pharmaceutical Sciences, 98 (5), 2009, 1813-1819.

[10] S. Mukherjee, S. Ray, R.S. Thakur, Solid lipid nanoparticles: A modern formulation approach in drug delivery system, Indian Journal of Pharmaceutical Sciences, 71 (4), 2009, 349-358.

[11] C. Olbrich, A. Gessner, O. Kayser, R.H. Müller, Lipid-drug-conjugate (LDC) nanoparticles as novel carrier system for the hydrophilic antitrypanosomal drug diminazenediaceturate, Journal of Drug Targeting, 10 (5),2002, 387-396.