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Impact of formulation parameters on physical characteristics of spray dried nanoemulsions and their reconstitutions

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Nanoemulsion as small droplet dispersion allows them to uniformly deposit on substrates, increases the rate of bioavailability, absorption and has a better uptake. Although it is generally accepted that nanoemulsions are stable for years, Oswald ripening which can damage nanoemulsion has been reported [1]. In this study, converting nanoemulsion as liquid formulation into solid powders was attempted by using spray drying method. The obtained powders were then characterized, reconstituted and compared to the initial nanoemulsion.

Oil in water nanoemulsions containing various oil compositions of vegetable oil (1%–5%) with constant surfactant concentration of a hydrophobic surfactant, Span® 85, 0.5% w/v and hydrophilic surfactant, Tween® 80, 0.5% w/v were prepared by high pressure homogenization technique. The primary emulsion was prepared by Ultraturrax high-speed homogenizer of 12,000 rpm for 3 min, 5 min and 7 min. It was then subjected to high-pressure homogenizer of 1000 bar for 6 cycles at different temperatures (40 °C, 50 °C and 60 °C) [1]. Optimized nanoemulsion had the lowest oil composition of 1% w/v with an average diameter of 110 nm. Nanoemulsion droplets were spherical in shape when characterized by transmission electron microscope (Fig. 1A). Stability evaluation was carried out at 4 °C and at ambient temperature for 3 months. During the storage period, nanoemulsion was stable with no phase separation or creaming. Maltodextrin was used as carrier during spray drying as it is of low cost and has neutral aroma and low viscosity at high solid concentrations [2]. Nanoemulsion was loaded with two different concentrations of maltodextrin, 3% and 5%, under magnetic stirring for 15 minutes. Two different inlet temperatures of 110 °C and 130 °C and pump rates of 20% and 30% were varied to analyze the effect of parameters on particle size [3]. Spray dried powders were then reconstituted with purified water to analyze the particle size compared with the nanoemulsion before spray drying. The morphological appearances and thermal behavior of spray dried powders were analyzed by scanning electron microscopy and differential scanning calorimetry, respectively [2]. The highest spray dried powder yield of 57% was obtained with the formulation containing 3% of maltodextrin at the inlet temperature of 110 °C and pump rate of 20% with the spherical powder size of 1–2 μm (Fig. 1B). However, increasing the concentration of maltodextrin had not much effect on spray dried yield. Among

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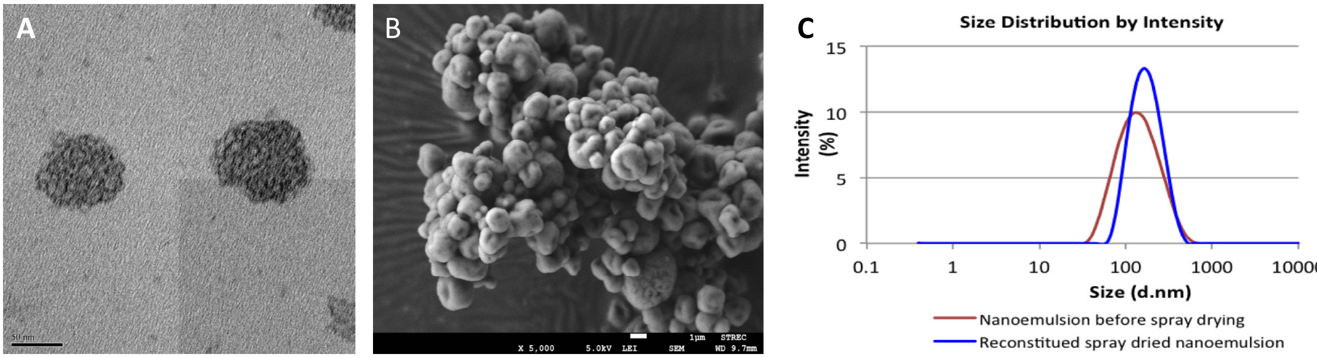

Fig. 1 – TEM of nanoemulsion with the lowest oil composition (A), SEM of spray dried powders (B), size distribution data of nanoemulsion before spray drying and reconstituted spray dried nanoemulsion (C).

all the formulations, nanoemulsion spray dried at 110 °C and pump rate of 30% containing 3% of maltodextrin had achieved the smallest particle size after reconstitution with an average diameter of 158 nm with narrower size distribution (Fig. 1C) and zeta potential of –16.43 mV. Increasing the inlet temperature to 130 °C or decreasing the pump rate to 20% had increased the particle size to 180 nm after reconstitution. It could be concluded that at optimum spray drying condition, spherical powder of nanoemulsion could be obtained and rendered slightly larger size but narrower size distribution than the initial formulation.

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