Data Article

Optimization of solid lipid nanoparticles prepared by a single emulsification-solvent evaporation method

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A B S T R A C T

This data article contains the data related to the research article “Characterization, biorecognitive activity and stability of WGA grafted lipid nanostructures for the controlled delivery of rifampicin” (Pooja et al. 2015) [1]. In the present study, SLN were prepared by a single emulsification-solvent evaporation method and the various steps of SLN preparation are shown in a flow chart. The preparation of SLN was optimized for various formulation variables including type and quantity of lipid, surfactant, amount of co-surfactant and volume of organic phase. Similarly, effect of variables related to homogenization, sonication and stirring processes, on the size and surface potential of SLN was determined and optimized.

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1. Experimental design, material and methods

Solid lipid nanoparticles (SLN) i.e. lipid nanoparticles with solid matrix is the most fascinating carrier for oral drug delivery because of their excellent biocompatibility, high drug loading, long-term stability and feasibility for large scale production [1–5]. In this study, solid lipid nanoparticles (SLN) were prepared by a single emulsification-solvent evaporation method. Fig. 1 presents the various steps of preparation of SLN. Various formulation parameters (Table 1) and process variables (Table 2) were optimized on the basis of their effect on particle size, polydispersity index and zeta potential.

![Single emulsification-solvent evaporation method](image)

**Fig. 1.** Flow chart representing the preparation of solid lipid nanoparticles.
These parameters included type and quantity of lipid and surfactant, quantity of co-surfactant, volume of organic phase, homogenization speed and time, sonication time, stirring speed and time. Formulations were prepared by changing one parameter at a time while keeping other parameters constant.

1.1. Optimization of formulation variables

1.1.1. Type and quantity of lipids

Three different lipids viz. glyceryl monostearate (GMS), tristearin and tripalmitin were used as lipid matrix. The particle diameter (PD), polydispersity index (PDI) and zeta potential (ZP) were measured using a Zetasizer NanoZS (Malvern, UK). The lipid showing minimum PD and PDI was selected and used in three different quantities (80, 100 and 120 mg).

1.1.2. Type and concentration of surfactants

The type and concentration of surfactant affect the particle size as well as stability of nanoparticles. At low concentration, surfactant will not be sufficient to cover the surface of nanoparticles resulting into increased particle size due to particle aggregation. High concentration of surfactant may lead to bridging between nanoparticles and may also cause toxicity. Therefore, three different surfactants (Tween®80, Poloxomer 188 and polyvinyl alcohol) were evaluated at three different concentrations (1%, 1.5% and 2% w/v).

1.1.3. Volume of organic phase

The organic solvent is used to dissolve the lipids and chloroform was used in this study in varying volumes (1–5 mL). The formulation showing good particle size with minimum volume of solvent was selected.

| Table 1 | Optimization of various formulation parameters for the preparation of solid lipid nanoparticles. |
|---------|---------------------------------------------------------------------|
| Formulation | Variable | PD (nm) | PDI | ZP (mV) |
| **Type of lipid** | | | | |
| F1 | GMS | 100 | 55.53 ± 2.4 | 0.23 ± 0.04 | −23.2 ± 2.1 |
| F2 | Tristearin | 100 | 157.5 ± 5.3 | 0.35 ± 0.11 | −26.9 ± 2.3 |
| F3 | Tripalmitin | 100 | 119.5 ± 3.9 | 0.43 ± 0.08 | −23.1 ± 1.9 |
| **Quantity of lipid (mg)** | | | | |
| F4 | GMS | 80 | 49.28 ± 3.1 | 0.27 ± 0.09 | −21.8 ± 1.6 |
| F5 | GMS | 100 | 55.53 ± 2.4 | 0.23 ± 0.04 | −23.2 ± 2.1 |
| F6 | GMS | 120 | 55.09 ± 3.7 | 0.30 ± 0.02 | −29.7 ± 2.3 |
| **Type and concentration of surfactant (%w/v)** | | | | |
| F7 | Tween 80 | 1 | 66.67 ± 2.5 | 0.36 ± 0.12 | −31.8 ± 2.4 |
| F8 | Tween 80 | 1.5 | 55.53 ± 2.4 | 0.23 ± 0.04 | −23.2 ± 2.1 |
| F9 | Tween 80 | 2 | 133.2 ± 5.6 | 0.27 ± 0.08 | −26.6 ± 2.3 |
| F10 | Poloxomer 188 | 1 | 61.4 ± 4.4 | 0.38 ± 0.09 | −29.9 ± 2.3 |
| F11 | Poloxomer 188 | 1.5 | 65.7 ± 3.9 | 0.40 ± 0.12 | −26.4 ± 2.1 |
| F12 | Poloxomer 188 | 2 | 64.9 ± 2.8 | 0.39 ± 0.10 | −23.5 ± 2.5 |
| F13 | PVA | 1 | 120.92 ± 6.1 | 0.15 ± 0.09 | −32.0 ± 1.9 |
| F14 | PVA | 1.5 | 108.84 ± 4.3 | 0.20 ± 0.07 | −26.6 ± 2.4 |
| F15 | PVA | 2 | 102.86 ± 4.8 | 0.21 ± 0.11 | −24.5 ± 1.8 |
| **Volume of organic solvent (mL)** | | | | |
| F15 | CHCl₃ | 1 | 48.91 ± 2.4 | 0.36 ± 0.11 | −19.6 ± 1.4 |
| F16 | CHCl₃ | 2 | 52.81 ± 1.9 | 0.21 ± 0.07 | −24.3 ± 2.6 |
| F17 | CHCl₃ | 3 | 55.53 ± 2.4 | 0.23 ± 0.04 | −23.2 ± 2.1 |
| **Quantity of co-surfactant (mg)** | | | | |
| F16 | lecithin soy | 20 | 52.81 ± 1.9 | 0.21 ± 0.07 | −24.3 ± 2.6 |
| F18 | lecithin soy | 30 | 47.54 ± 2.3 | 0.21 ± 0.09 | −25.5 ± 1.8 |
| F19 | lecithin soy | 40 | 50.32 ± 3.1 | 0.28 ± 0.10 | −28.6 ± 2.4 |

GMS: Glyceryl monostearate; PVA: Polyvinyl alcohol; PD: Particle diameter, PDI: Polydispersity index; ZP: Zeta potential.

These parameters included type and quantity of lipid and surfactant, quantity of co-surfactant, volume of organic phase, homogenization speed and time, sonication time, stirring speed and time. Formulations were prepared by changing one parameter at a time while keeping other parameters constant.
1.1.4. Quantity of co-surfactant

Lecithin soy was used as co-surfactant which act as internal emulsifier and favors to particle size reduction and stability. Lecithin soy was used at different concentration (20, 30 and 40) to get a formulation having small particle size, less PDI with good zeta potential and stability.

1.2. Optimization of process variables

1.2.1. Homogenization speed and time, sonication time and stirring speed and time

The organic phase was poured in aqueous surfactant phase and homogenized at different speed (5000, 8000 and 11000 rpm) for different time (3, 4, 5 and 6 min) to get course emulsion. Then this course emulsion was sonicated for different time period to get a nanoemulsion. Finally formulation was stirred to evaporate the organic solvent and to get the nanoparticles. The formulation was stirred at different speed (800, 1000, and 1200 rpm) and for different time period (1, 2 and 3 h) for optimization.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.dib.2015.11.038.

Table 2
Optimization of various process variables for preparation solid lipid nanoparticles.

| Formulation | Variable | PD (nm) | PDI  | ZP (mV) |
|-------------|----------|---------|------|---------|
| Homogenization speed (rpm) |          |         |      |         |
| F20         | 5000     | 64.67 ± 4.8 | 0.56 ± 0.03 | –27.5 ± 2.5 |
| F18         | 8000     | 47.54 ± 2.3  | 0.21 ± 0.09 | –25.5 ± 1.8 |
| F21         | 11000    | 44.43 ± 3.1  | 0.26 ± 0.03 | –26.5 ± 2.1 |
| Homogenization time (min) |          |         |      |         |
| F22         | 3        | 157.92 ± 5.7  | 0.45 ± 0.05 | –30.3 ± 3.1 |
| F23         | 4        | 76.21 ± 3.9   | 0.28 ± 0.07 | –25.8 ± 2.8 |
| F21         | 5        | 44.43 ± 3.1   | 0.26 ± 0.03 | –26.5 ± 2.1 |
| F24         | 6        | 71.23 ± 4.8   | 0.29 ± 0.11 | –23.9 ± 2.7 |
| Sonication time (min) |          |         |      |         |
| F25         | 5        | > 500      | –   | –       |
| F26         | 10       | 135.45 ± 6.7 | 0.32 ± 0.13 | –27.1 ± 2.9 |
| F21         | 15       | 44.43 ± 3.1  | 0.26 ± 0.03 | –26.5 ± 2.1 |
| F27         | 20       | 49.89 ± 2.8  | 0.24 ± 0.09 | –25.8 ± 2.6 |
| Stirring speed (rpm) |          |         |      |         |
| F28         | 800      | 59.02 ± 3.9  | 0.25 ± 0.05 | –20.1 ± 1.9 |
| F21         | 1000     | 44.43 ± 3.1  | 0.26 ± 0.03 | –26.5 ± 2.1 |
| F29         | 1200     | 67.82 ± 4.2  | 0.27 ± 0.02 | –22.9 ± 2.5 |
| Stirring time (h) |          |         |      |         |
| F30         | 1        | 69.48 ± 4.5  | 0.42 ± 0.07 | –28.4 ± 2.7 |
| F31         | 2        | 57.37 ± 5.1  | 0.31 ± 0.05 | –26.4 ± 1.8 |
| F21         | 3        | 44.43 ± 3.1  | 0.26 ± 0.03 | –26.5 ± 2.1 |
| F32         | 4        | 61.34 ± 3.8  | 0.25 ± 0.09 | –26.2 ± 2.5 |
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