Chapter 6

Characterization Techniques of Solid Lipid Nanoparticles

K. Snekha[1], R. Susmitha[1], V. Sabitha[1], P. Gokulram[1], N. Selvasudha[1]*
[1]Kamarajar College of Pharmacy, Chidambaram, Tamilnadu, India

Abstract
Solid lipid nanoparticles (SLNs) have emerged as a promising nanocarrier system for drug delivery. Since they can encapsulate both hydrophobic and hydrophilic drugs and have the potential for controlled release. The main methods and variables used in the characterization of SLNs are thoroughly covered in this chapter. The significance of comprehending the physicochemical characteristics of SLNs, such as particle size, zeta potential, surface morphology, and crystalline structure, is covered at the outset. A number of analytical methods are thoroughly examined, including X-ray diffraction (XRD), differential scanning calorimetry (DSC), scanning and transmission electron microscopy (SEM/TEM), dynamic light scattering (DLS), and Fourier-transform infrared spectroscopy (FTIR). Methods for assessing drug encapsulation efficiency, *in vitro* release profiles, and stability under various storage conditions are also covered in this chapter. This chapter seeks to assist researchers in maximizing formulation and guaranteeing quality control in both academic and industrial contexts by providing insights into the approaches and difficulties in SLN characterization.

Keywords: Nanocarrier, Characterization, Particle size, Encapsulation efficiency, SEM

***Author for Correspondence:** *Email:* nkselvasudha@gmail.com

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1. INTRODUCTION

As a cutting-edge drug delivery technology, SLNs have potential uses in the fields of clinical medicine, research, cosmetics, pharmaceuticals, and other applied sciences. SLN is an effective carrier system to overcome solubility and stability issues. SLNs composed of lipid, surfactant, co-surfactants and active pharmaceutical ingredients (API). Lipids used in SLNs biocompatible and biodegradable lipids, offering controlled drug release, enhanced penetration, and improved stability. Various formulation techniques like solvent diffusion method are efficient approach for preparing SLNs due to its simplicity and ability to yield nanoparticles with higher drug loading capacity. Improved DDS have been made possible by the development of colloidal drug delivery systems including nanoparticles, liposomes, and miscelles where they are characterized to ensure the quality control of these particles. The creation of a reliable, secure DDS with the required qualities must be the primary goal driving the characterisation process. Particle size, size distribution, kinetics, zeta potential, lipid modification polymorphism, coexistence of other colloidal structures, such as micelles, liposomes, super cooled melts, drug nanoparticles, time scale of distribution processes, drug content, *in vitro* drug release, and surface morphology, are among the significant parameters that are also assessed for the SLNs [1]. One of the most difficult areas of research in pharmaceutical sciences is accessing the target organ and ensuring accessibility to the place of delivery. Compared to conventional delivery systems, nanoparticles have many advantages due to their unique features, which include small particle size, huge surface area, and capability. SLNs with size ranging from 10 to 1000 nm appear to be particularly promising colloidal drug carriers. As an alternative to lipid emulsion, liposomes, and polymeric nanoparticles, solid lipid nanoparticles have been the trialed out for the past decade [2]. Lipophilic medications like camptothecin can also have their sustained release enhanced. Drugs like cyclosporine can have their bioavailability increased by using SLN [3]. Solid biodegradable lipids make up the matrix of solid lipid nanoparticles, which are aqueous colloidal dispersions. SLNs have the