Chapter 5

Preparation Strategies for Solid Lipid Nanoparticles

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Abstract

Solid lipid nanoparticles (SLNs) have attracted intense interest as carriers capable of enhancing the solubility, stability, and bioavailability of a broad spectrum of bioactive. Production techniques fall into three broad families-physical, chemical, and biological ("green")-each with distinct advantages, limitations, and scale up considerations. Physical methods use mechanical forces such as high-pressure homogenization, ultrasonication, and membrane contractors to reduce particle size and create stable dispersions. Chemical methods rely on solvent-based processes like solvent emulsification–evaporation, solvent diffusion, microemulsion formation, and solvent injection. Biological methods employ natural materials or bio-inspired processes, including enzyme-mediated lipid modification, biosurfactant-assisted formation, and fermentation-derived lipids. This chapter provides a systematic overview of the major methodologies, clarifies common sources of confusion, and highlights key process parameters that govern particle size, polydispersity, and long term stability.

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1. INTRODUCTION

Solid lipid nanoparticles (SLNs) are the most studied lipid based nanocarrier system that has gained interest over the years. The unique feature of SLNs is their capability to encapsulate both water-soluble and fat-soluble drugs. SLNs offer many benefits including protecting unstable compounds from degradation, delivering orally insoluble active pharmaceutical ingredients (API), enhancing stability, and controlled drug release [1,2]. SLNs systems are made from biocompatible lipids that can remain solid at room and body temperature, dispersed in water with surfactants or emulsifiers. Typical lipid ingredients include triglycerides (glycerol monostearate), partial glycerides, fatty acids (stearic acid), and waxes (cetyl palmitate) [3,4]. As compared to other colloidal drug delivery systems, such as emulsions and polymeric nanoparticles, SLNs offer clear advantages such as excellent biocompatibility, less cytotoxicity, more physical stability, and a simpler scale-up with excipients that may be classified as Generally Recognized as Safe (GRAS) [5,6]. Overall, these benefits are what make SLNs attractive for a variety of pharmaceutical, cosmetic, nutraceutical, and biomedical applications [7,8].

Solid lipid nanoparticles (SLNs) are a well-known lipid-based nanocarrier system and recently become the subject of considerable attention. Because they can encapsulated both water soluble and fat soluble drugs, SLNs have some advantages. First, SLNs can protect unstable compounds from degradation, second, SLNs can improve the oral bioavailability of active pharmaceutical ingredients (API), limits the instability of drugs. Third, SLNs can provide controlled-release [1,2]. SLNs systems consist of solid lipids back at room and body temperatures, and be dispersed in water in the presence of surfactants or emulsifiers. The lipid portion in SLN formulas include triglycerides (such glyceryl