Chapter 7

Applications of Solid Lipid Nanoparticles in Oral Drug Delivery

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Abstract

Oral drug administration continues to be the most commonly utilized route due to its non-invasive nature, ease of use, affordability, and strong patient adherence. However, this method is not without limitations, as the gastrointestinal (GI) tract presents numerous physiological and chemical barriers. Variables such as digestive enzymes, pH fluctuations, and poor membrane permeability can reduce drug absorption and compromise targeted delivery. To overcome these challenges, solid lipid-based nanoparticles (SLBNs) have emerged as promising solutions, offering advantages over traditional delivery vehicles like liposomes, emulsions, and polymer-based nanoparticles. Within this category, solid lipid nanoparticles (SLNs) and nanostructured lipid carriers (NLCs) have shown notable potential. Their success lies in their inherent properties, including excellent biocompatibility, biodegradability, ease of large-scale production, and flexible formulation design. Owing to their lipid matrix, these carriers are particularly effective for oral delivery, where they enhance drug solubility, stability, and facilitate sustained or controlled drug release. In the context of oral therapeutics, lipid-based nanoparticles are increasingly used to improve the gastrointestinal uptake of active compounds.

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Their ability to interact with the intestinal mucosa aids in absorption, while their nanoscale dimensions and surface properties contribute to prolonged GI retention and improved bioavailability. This chapter explores the development, functionality, and clinical relevance of SLNs for oral drug delivery, emphasizing their role in addressing conventional limitations and improving therapeutic outcomes.

Keywords: Solid lipid nanoparticle, oral drug delivery, biological barriers, pharmacokinetics, bioavailability.

1. INTRODUCTION

The most common method of treating both local and systemic gastrointestinal disorders is oral administration. Oral drug administration is nevertheless difficult despite the apparent benefits because of the harsh gastrointestinal tract (GIT) milieu and other physiological barriers, such as gastrointestinal anatomy, biochemistry, and physiology variables. The mouth cavity, oesophagus, stomach, small intestine, and colon are among the regions of the gastrointestinal tract (GIT) that are crucial for food digestion and medication absorption [1]. Oral drug delivery is the most convenient, patient-friendly, cost-effective, and safe way to give drugs for a range of conditions. Traditional oral formulations have several limitations, including as limited targeting capabilities, short retention length in the gastrointestinal (GI) tract, and poor bioavailability.

Drugs can enter the body in a variety of ways, including parenteral (by injection), transdermal (by skin), pulmonary (by inhalation), submucosal (by buccal and sublingual mucosa), and oral (by ingesting). Oral delivery, or swallowing, is often accepted among various delivery methods [2]. Modular and geometrically altered matrices, which are more akin to "classic" pharmaceutical manufacturing procedures, and futuristic bio micro-electro-mechanical systems (biome MS), which are based on manufacturing techniques taken from electronics and other sectors, are examples of creative drug delivery systems nowadays. Designing intelligent drug delivery systems that can release the