Section A -Research paper

# Solid Lipid Nanoparticles: an Effective Carrier for Anti Helminthic Drugs

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**Abstract:**

Compared to traditional formulations, solid-lipid nanoparticles (SLNs) are a novel type of nanosystems that are used to deliver medication to specific sites more effectively and bioavailablely. SLNs are easier to biodegrade, less toxic, and have less negative consequences. They are also more biocompatible. Drugs that are hydrophilic, hydrophobic, or lipophilic can be added to SLNs to improve their chemical and physical stability in harsh conditions. Incorporating poorly soluble medicines, biologicals, proteins, and other anti helminthic agents into solid-lipid nanoparticles (SLNs) can improve their therapeutic efficacy, bioavailability, and target specificity. Anti helminthic medications based on SLNs are now effective against severe helmenthic infections that are resistant to drugs. A special focus on helminthic infections is placed on the importance of SLNs in the delivery of classical anti helminthic drugs, as well as their preparation, physicochemical characteristics, structure, and sizes, composition, and drug entrapment efficacy.

**Keywords:** Anti Helminthic drugs, Nanoparticles, SLNs.

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## Introduction:

About 40% of the medications in development are thought to have solubility issues. More medications that are poorly water-soluble are being discovered as a result of the increased usage of high throughput screening techniques **(1).**

As a result, it is clear that clever technological formulation methods are required to increase the bioavailability of such poorly soluble medications. Developing innovative formulation techniques and drug delivery methods to address the solubility issues of these therapeutic candidates, which are frequently accompanied by low oral bioavailability, is the pharmaceutical industry's greatest challenge **(2).**

The transfer of medication powders into the size range between typically 1 and 10 μm is known as micronization, and it is such a ubiquitous formulation strategy to boost oral bioavailability. Today's medications, however, are frequently so poorly soluble that micronization is insufficient. The bioavailability issues of very weakly soluble pharmaceuticals of the biopharmaceutical specification class II are not sufficiently resolved by the increase in surface area, and consequently by the corresponding rise in dissolution velocity ***(3).***

The logical next step after micronization was nanonization. Since the 1990s, the business Nanosystems has promoted using nanocrystals (rather than microcrystals) to increase oral bioavailability and to employ nanocrystals mixed in water (nanosuspensions) to administer drugs intravenously or through the lungs **(4).**

Nanotechnology is the science including particles with a core either polymeric, metallic or lipid in nature and size less than 100 nm **(5)** with specific physicochemical and biological activities **(6)** which facilitate transporting drugs into the target tissue due to the large surface area and small size structure **(7).** These particles are further divided as Nano carriers and Nano drugs **(8).** Nano medicine has been employed to overcome limitations of traditional drugs **(9).** Nanoparticles (NPs) were also used for medical applications as they were proved to have anti-inflammatory and anti-microbial activities **(10)** against viruses, bacteria and helminthes **(11).** The drugs or actives can either be integrated in the core matrix or attached to the surface of nanoparticles that have a high surface/volume ratio **(12).**

**History of NPs birth:**

Although the production of nanosized particles had occurred in several ways in ancient times and hundreds of years ago, nanomedicine as a modern science was first confirmed in the nineties of the last century only. Nanomedicine is a clue science of the 21st century. NPs are synthetic and complex molecules with specified chemical structures that were synthesized firstly in the early of 1980s ***(*2).**

These nanomaterials are nanosized polymers and are assembled from branch units. The surface of a synthetic nanomaterial has numerous chain ends, which can be tailored to complete specific chemical functions. This property could also be helpful for catalytic uses. Nanomaterials show some remarkably improved chemical and physical properties compared to traditional polymers. New functionalities and properties of matter are observed in a wide range of applications ***(*1).**

Nanotechnology provides important new tools expected to have the most impact on many areas in medical sciences. Polymer coated functioned metal NPs have recently appeared as an active and novel field of advanced research. For example, silver is an important accessible metal, and its NPs are superior to other nanosized metal particles for their antimicrobial effects ***(*13).**

However, their stability is a serious problem with polar terminal groups like hydroxyl groups or amine are usually used for their stabilization. Three-dimensional nanomaterials may be useful for drug delivery and first have been applied in in vitro diagnostics for heart muscle damage, ophthalmic surgery, microbicide activity against HIV-1, cancer treatment, targeting tumor cells, gene therapy and few last decades parasitology ***(*14).**

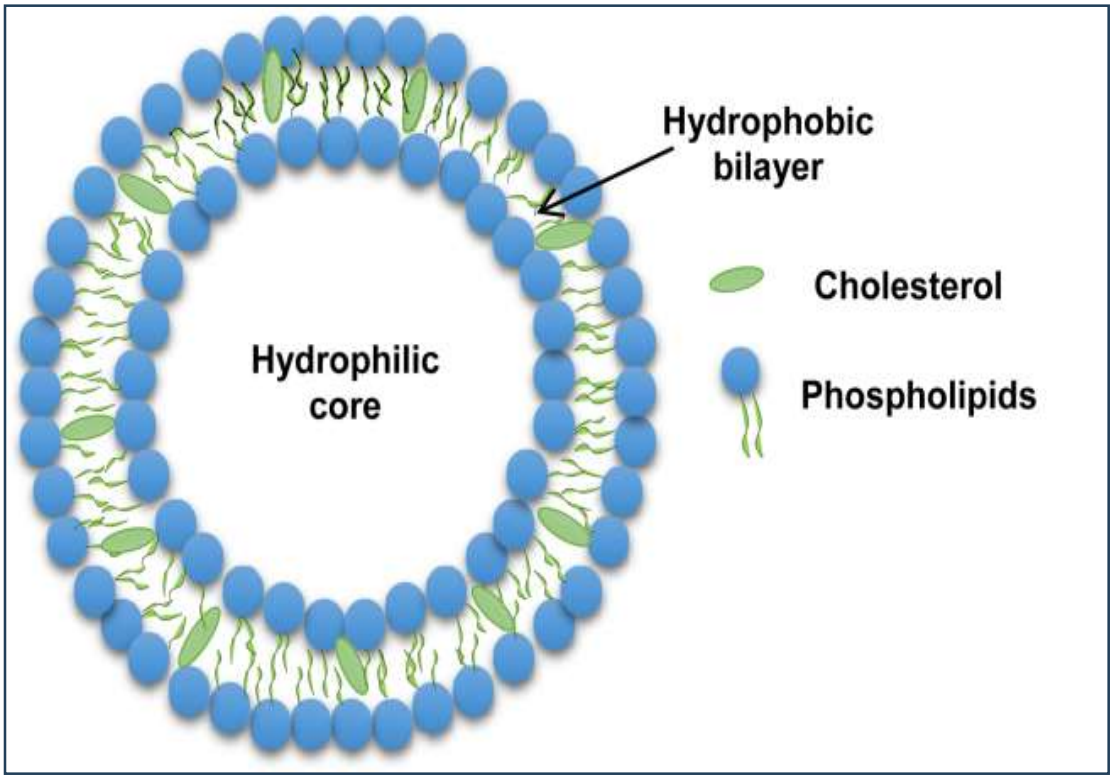


**Figure (1):** Schematic representation of liposomes ***(*15).**

**Types of NPs:**

N Ps can be classified into inorganic and organic depending on the material used. The first one includes MNPs, quantum dots (QDs), carbon-based nanostructures (CBNs), and mesoporous silica NPs (MSNs). At the same time, liposomes and micelles, dendrimers, and polymeric NPs represent the organic ones **(16).**

Among the different types of nano-carriers, solid lipid nanoparticles (SLNs) are at the forefront of the potential application in oral drug delivery systems **(17).**

- Solid lipid nanoparticles:

Solid lipid nanoparticles (SLNs) were reported in 1991 as an unconventional carrier system to typical colloidal carriers such as emulsions, microemulsions, self micro-emulsifying drug delivery system, micellar systems, liposomes, polymeric microparticles and nanoparticles **(18).**

SLNs are effortlessly made nanoparticles composed of biodegradable polymers of high stability devoid of significant toxicity as well as commercially economic and could incorporate wide variety of drugs for effective targeting. SLNs are novel lipid-based formulations constituted exclusively of biodegradable lipids such as highly purified triglycerides, monoglycerides, complex glyceride mixtures, hard fats or even waxes, which turn solid at room temperature **(19).** Solid lipid nanoparticles are nanometre-sized particles that range from 50 to 200 nm and made of solid hydrophobic core which are suspended in aqueous phase containing surfactant. The drug is dissolved or dispersed in solid core contains the solid high melting fat matrix. Both kinds of lipophilic or hydrophilic therapeutics and diagnostics could be incorporated into the SLN **(20).** SLNs not only unite the advantages of emulsion, liposomes and solid polymeric nanocarriers together but also eliminate few of their disadvantages. Major advantages included are biocompatibility and biodegradability, avoidance of drug leakage, stability against coalescence, nontoxicity, hydrolysis, physical stability and being an excellent carrier for lipophilic drugs **(21).** Lipid emulsion and liposomes are entirely different. Oil core made of a neutral lipid, covered by monolayer of amphiphilic lipid, makes lipid emulsion, whereas liposomes are bilayer lipid vesicles made of amphiphilic phospholipid having an interior aqueous cavity **(22).** On the other hand, SLNs are designed from solid lipids and stabilized with an aqueous suspension of emulsifying agents. They look a lot like nanoemulsion; the only difference is that liquid lipid is replaced with a solid lipid, hence providing an outstanding opportunity for controlled drug release as solid lipid lowers the movement of encapsulated drug drastically compared to liquid oil phase **(23).** Also, encapsulation in solid lipids improves the stability of incorporated chemically sensitive lipophilic ingredients in contrast to liquid lipids of nanoemulsion.

**Advantages of SLNs:**

(a) Suitable for controlled drug release and drug targeting.

(b) Suitable for delivery of both hydrophilic and lipophilic drugs.

(c) Reduced toxicity compared to polymeric nanoparticles as SLNs are made of biocompatible lipids.

(d) Provide protection to labile drugs from chemical, photochemical and oxidative degradation.

(e) Water-based technology (organic solvents can be avoided).

(f) SLN could be administered through various routes such as oral, pulmonary, intravenous, ophthalmic and dermal **(24).**

**Disadvantages of SLN:**

The disadvantages of SLNs are particle growth, unpredictable gelation tendency and unexpected dynamics of polymeric transitions **(25).** Also there is poor stability in acidic environments, a strong tendency to aggregate during the drying process, and a low loading capacity. **(26).**

O/W nano-emulsions produce solid lipid nanoparticles (SLNs), which are made up of the lipid phase and surfactant. They are made by dispersing active chemicals and melting lipid molecules in an aqueous media with an emulsifier ***(*27).**

One or a combination of solid lipids are employed to solidify the lipid phase using the emulsifier partially or completely. The physiological lipid-like triglycerides or saturated fatty acids are part of the lipid phase in SLNs. As they provide excellent encapsulation efficiency, stability, loading capacity, and target-specific release qualities, SLNs outperform other lipid-based nanosystems in these areas **(28).**

Both lipophilic and hydrophilic molecules are better protected from environmental stress by SLNs. Higher bioavailability, a delayed release profile, and flexible application are all characteristics of SLNs. In contrast to other lipid-based nanosystems, the manufacture of SLNs is straightforward, scalable, affordable, and suitable for industrial use **(1).**

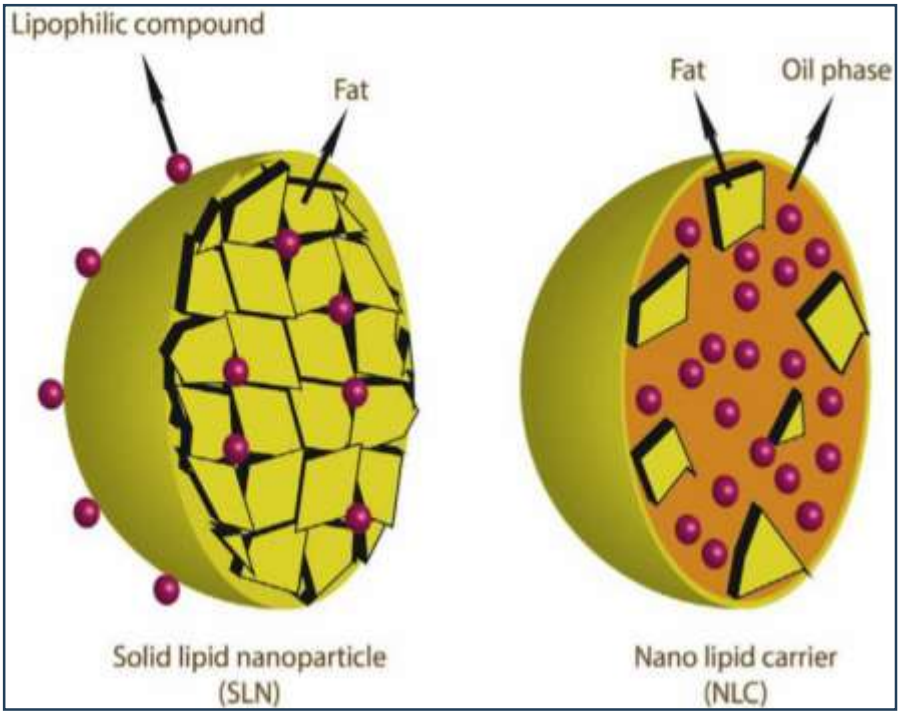


**Figure (2):** Engineered Solid Lipid Nanoparticles and Nanostructured Lipid Carriers ***(29).***

**Nanoparticle-based diagnosis for many diseases:**

There are many nanoparticles, particularly fluorescent nanoparticles, metallic nanoparticles, and magnetic nanoparticles, which have been successfully utilized for the diagnosis of infectious diseases. The most used metallic nanoparticles in the diagnosis applications are gold and silver nanoparticles. The gold nanoparticles are the first nanomaterials as nanodiagnostics for the detection of DNA **(4).**

The changes in the color of gold nanoparticles in solution from red to blue have been demonstrated after DNA-guided aggregations, which make them ideal nanomaterials for nanodiagnostics because of their unique color changes and other chemical and physical properties. Many different molecules, such as antibodies, antigens, and enzymes, could be conjugated with gold nanoparticles as electrochemical labels, optical probes, and signal transfer amplifiers for the diagnosis of various diseases **(13).**

Magnetic nanoparticles are nanocarriers that have been successfully applied in many biomedical applications, such as bioimaging, cancer therapy, and nanodiagnostics. Iron oxide nanoparticles are used in order to detect many different infecting pathogens, such as viruses, bacteria, and helminthes, and for early diagnosis of malaria **(28).**

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