Overview on Review Article of a Lansoprazole Drug

Title: Solid Lipid Nanoparticle for Lansoprazole drug.

Rahul Sharma[1], Dr. Alok Mahor[2]

[1] Author, [2]Assistant Professor

Bundelkhand University, Institute of pharmacy BU (Jhansi) India 284128.

Abstract:

Solid lipid nanoparticles (SLNs) are an important class of noncolloidal drug delivery systems. This review covers several aspects of SLNs, including morphology, structural characteristics, preparation methods, and characterisation techniques. SLNs are essential for enhancing the medicinal effectiveness of medications in a variety of categories. SLNs are currently being used for cancer treatment, infectious diseases, diabetes, cardiovascular disease, central nervous system problems, and cosmeceuticals, among other things. Enhanced pharmacokinetics, controlled drug release, surface modification potential, increased penetration through biological barriers, resistance to chemical degradation, and the ability to encapsulate numerous therapeutic compounds at once are just a few of its noteworthy benefits. This review also highlights current research developments in the field of SLNs.Solid lipid nanoparticles (SLNs) have gained popularity since the 1990s and have become an inventive medication delivery technology. These nanoparticles can be made of different solid lipids, including fatty acids, waxes, and glycerides, and they can be stabilized using a wide range of surfactants. Scholars from all over the world are interested in them because of their originality and versatility. Compared to other colloidal carriers such as emulsions, liposomes, and polymeric nanoparticles, SLNs have many benefits. The number of research organizations creating SLN formulations and production methods customized for certain purposes is constantly growing.

Keywords: Solid lipid nanoparticles, carrier system, nanomedicine, biocompatibility, nanotechnology.

Introduction: -

First presented in 1991, solid lipid nanoparticles (SLNs) provide a novel substitute for conventional colloidal carriers such as emulsions, liposomes, and polymeric micro and nanoparticles [1]. Made of solid lipids, these nanoparticles have attracted a lot of interest as an innovative colloidal drug carrier for intravenous use, offering an alternative particulate carrier system. SLNs are usually composed of nanometre-sized spherical solid lipid particles that are dispersed in an aqueous surfactant solution or water. They typically consist of a monolayer of phospholipids covering a solid hydrophobic core. The medication is either dissolved or distributed in a high melting fat matrix inside this solid core. This fat matrix has embedded hydrophobic phospholipid chains, which allow SLNs to transfer lipophilic and hydrophilic medications or diagnostics with equal efficacy.While avoiding some of its disadvantages, SLNs combine the advantages of polymeric nanoparticles, fat emulsions, and liposomes. Excellent biocompatibility, non-toxicity, resistance to coalescence, drug leakage, hydrolysis, biodegradability, physical stability, and appropriateness as carriers for lipophilic medicines are just a few of the many benefits they have to offer. There are some significant distinctions between liposomes and lipid emulsions. A lipid emulsion's basic structure consists of an amphiphilic monolayer of lipids surrounding a neutral lipophilic oil core. On the other hand, liposomes are made up of an aqueous compartment enclosed by an outer bilayer made of molecules that are amphiphilic, like phospholipids.

Preparation of SLNs.

High-pressure homogenization.

Solid Lipid Nanoparticles (SLN) can be prepared by high-pressure homogenization (HPH), which is a dependable method. Homogenizers of various sizes are reasonably priced and available from a variety of

manufacturers. HPH produces particles that are submicron in size by exposing the particles to high shear stress and cavitation compulsion. Parenteral nutrition uses this technique to produce nano emulsions. During HPH, a liquid is forced through a small opening that is usually only a few microns wide at high pressures (between 100 and 2,000 bar). The fluid moves quickly and at a high speed over a small distance as a result. According to Wolfgang and Karsten (2001), homogenization can convert even high lipid concentrations into nano dispersions. The production of SLN involves the use of both hot and cold homogenization processes, each requiring a preliminary stage.

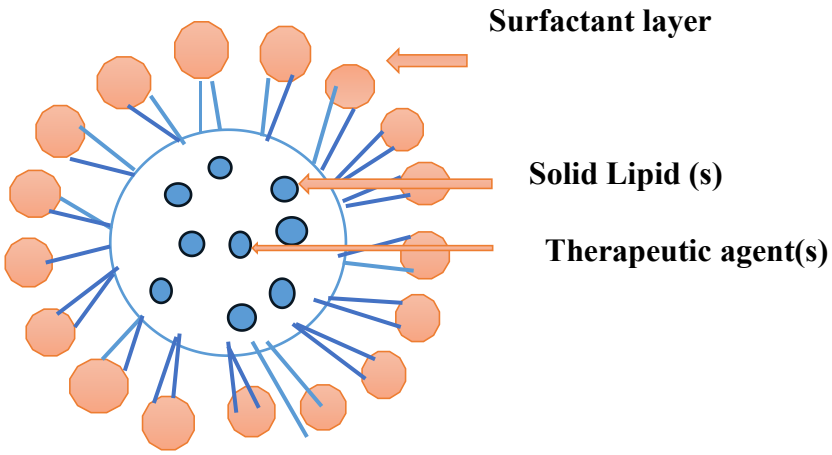


Fig.1- structure of SLNs

Hot homogenization: -

This procedure efficiently homogenizes an emulsion by selecting temperatures above the lipid's melting point. Utilizing an aqueous surfactant, the medication and lipid are mixed at the same temperature. A hot pre-emulsion is then prepared using high shear mixing machines to create an oil-in-water type emulsion. Upon cooling, the product undergoes lipid crystallization, initiating the formation of Solid Lipid Nanoparticles (SLNs). To achieve optimal SLNs, typically 3-5 cycles of homogenization at pressures ranging between 500 and 1,500 bar are necessary. It's crucial to note that High-Pressure Homogenization (HPH) leads to a rise in temperature. As pressure or cycle count increases, there's a tendency for particle size to increase due to attractive forces between particles. The process concludes with cooling the nano emulsion to room temperature, promoting lipid recrystallization and facilitating nanoparticle formation. This entire process is essential for producing SLNs with the desired properties and characteristics. In summary, this method offers an efficient means of homogenizing emulsions, enabling the creation of SLNs suitable for various applications. However, careful control of parameters such as pressure, temperature, and cycle count are necessary to ensure the desired particle size and distribution.

Cold homogenization.

This technique was created to overcome the difficulties posed by heat homogenization. High temperature-induced rapid degradation, drug loss into the aqueous phase during homogenization, and the complex crystallization process leading to unanticipated polymorphic alterations of lipid structures are some of these issues. Solubilizing the medication in the lipid melt is the first stage in this process, which is similar to hot homogenization. Subsequent stages, however, differ; to attain a homogenous distribution inside the lipid matrix, the drug-containing melt is quickly chilled using either liquid nitrogen or solid carbon dioxide. Using a ball mill, the solidified mixture is next finely ground into dust, usually producing particles with diameters between 50 and 100 µm. To start the manufacture of SLN, this fine dust is mixed with a chilled aqueous surfactant and put through a process called High-Pressure Homogenization, or HPH. However, cold homogenization usually produces a wider size dispersion and bigger particle sizes than hot homogenization procedures. Viability to cold homogenization is decreased by.

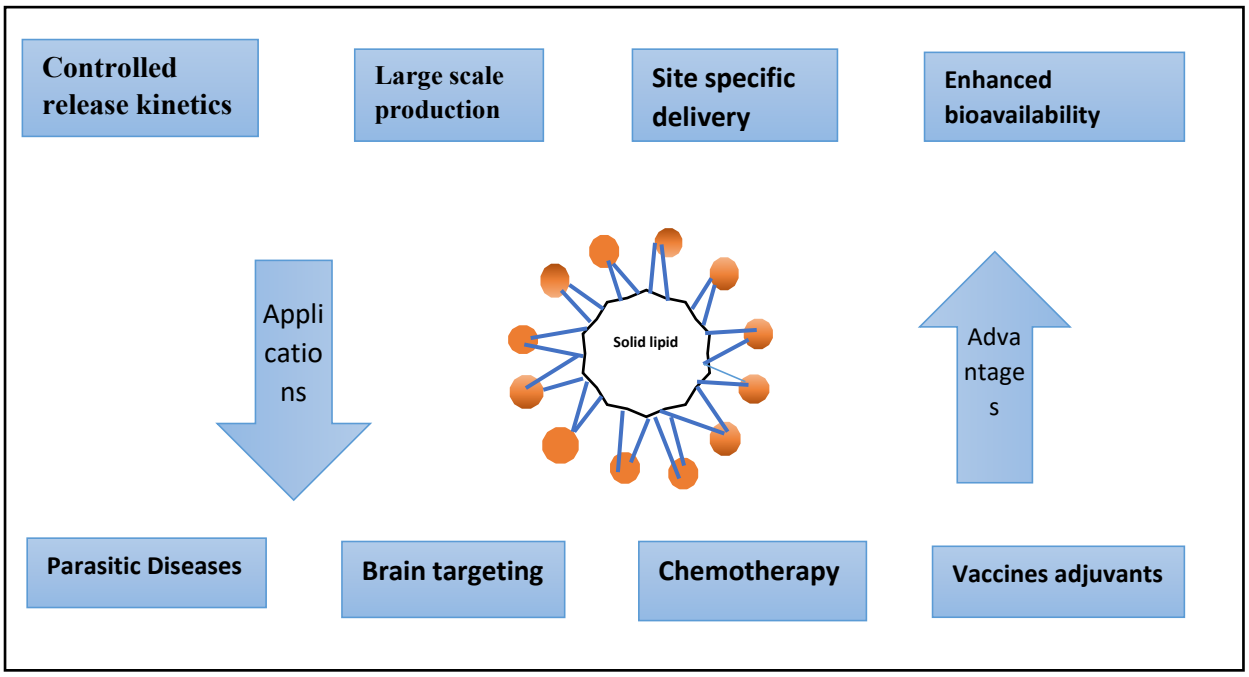


Fig.2- Representation of advantages and applications SLNs formulation.

Ultrasonication: -

SLN can also be produced through high-speed stirring or sonication, as noted. The equipment needed for this approach is commonly found in most laboratories. However, a significant drawback is the wider particle size distribution, often extending into the micrometer range, which contributes to physical instability. Issues such as particle agglomeration during storage and the potential for metal contamination are notable concerns associated with this method**.**

Solvent emulsification–evaporation: -

This approach involves dissolving the hydrophobic medication and lipophilic substance in water-immiscible organic solvents such as chloroform, toluene, or cyclohexane. The mixture is then emulsified into an aqueous phase using a high-speed homogenization technique. The coarse emulsion that is produced is quickly run through a microfluidizer. A rotary evaporator with mechanical agitation at room temperature and low pressure is used to extract the organic solvent. This technique's capacity to avoid heat stress makes it possible to incorporate extremely thermolabile medications, which is one of its main advantages.

Supercritical fluid (ScF): -

This process is a rather sophisticated way to produce SLNs. Because supercritical fluids have special thermophysical properties that can be precisely controlled by small pressure changes, using this technique has several advantages. This procedure is solvent-free, in contrast to standard methods. Pressure increases improve the fluid's density and its capacity to dissolve substances at a steady speed. Supercritical fluid is a special kind of fluid that occurs above its critical temperature and pressure. It has features that are halfway between those of a liquid and a gas, including enhanced diffusivities, gas-like viscosity, and density similar to that of a liquid.

Microemulsion: -

By maximizing the concentration of microemulsion, Gasco and associates invented SLN formulations. The external and internal phases of these microemulsions are usually made up of water, butanol or sodium mono cetyl phosphate as emulsifiers, low-melting fatty acids like stearic acid, and emulsifiers like polysorbate 20 or 60. The composition of the microemulsion determines the dilution process when the heated microemulsion is diffused into cold water (2°C–3°C). It is noteworthy that this process can produce

submicron diameters without the need for extra energy. Choose solvents that easily dissolve into the aqueous phase (more lipophilic solvents are used for larger particle sizes) is an important step in the manufacturing of nanoparticles.

Spray drying: -

Spray drying is an often more economical technique than lyophilization for turning an aqueous dispersion into a medication. But because of things like high temperatures, shear stresses, and partial melting of the particles, there's a chance of particle aggregation. For best results in spray drying, recommended choosing lipids having a boiling point greater than 70°C. The best results were obtained when 1% of SLNs were added to a trehalose in water solution or to mixes containing 20% ethanol and water and trehalose.

a)-Double emulsion: -

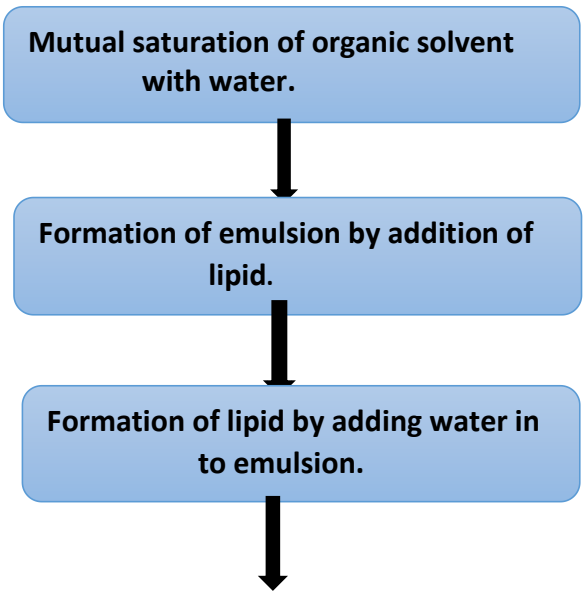
This method uses a solvent emulsification-evaporation process to create hydrophilic-loaded SLNs. The medication is first added to a liquid melt after being dissolved in aqueous-based solutions. The primary emulsion is stabilized by adding a stabilizer. The aqueous phase, which normally contains a hydrophilic emulsifier, is where this primary emulsifier is disseminated.Using poly (lactic-co-glycolic acid) (PLGA) is essential to the initial emulsification process of water-in-oil (w/o) emulsions. It has been observed that loading capacity, w/o emulsion stability, and encapsulation efficiency all improve with increasing PLGA concentration. Nevertheless, PLGA has no effect on the size of the SLN particles, and the zeta potential noticeably decreases with increasing PLGA concentration.

b)-Static light scattering (SLS): -

This technique, also known as Fraunhofer diffraction, entails obtaining the scattered light pattern from a particle solution and evaluating it using an electromagnetic equation. It is used as a quick and approximative method to describe particle distributions.

Emulsification solvent-diffusion: -

Organic solvents with partial miscibility with water, such as methyl acetate, ethyl acetate, isopropyl acetate, butyl lactate, and benzyl alcohol, are commonly used in this procedure. Water and the organic solvent are first saturated to create thermodynamic equilibrium between the two phases. The process of creating an oil-in-water (o/w) emulsion involves dissolving the medicine and lipid in a saturated aqueous solvent, then agitating the mixture to emulsify into the organic phase. In order to encourage solvent diffusion into the exterior phase, the emulsion is subsequently diluted with water at a ratio of 1:5 to 1:10. Lipid deposition causes the spontaneous development of solid-liquid nanolayers (SLNs) upon solvent evaporation. Lastly, lyophilization or vacuum distillation are used to eliminate the solvent.



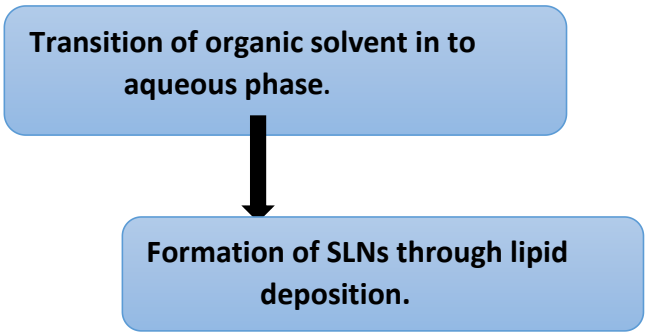


Fig.03- Emulsification solvent-diffusion technique for the manufacturing of SLNs.

Solvent injection: The process entails rapidly injecting the lipid matrix-solvent mixture into an aqueous phase that contains surfactants after it has been dissolved in an organic solvent (see Figure 7). This method is simple, flexible, and effective for acquiring sentinel lymph nodes. But using organic solvents could lead to losses.

SLN Overview: -

Solid Lipid Nanoparticles (SLN) were initially developed in the 1990s. With a melting point usually exceeding 40°C, which guarantees they stay solid at body temperature, SLN offer a potential colloidal system made up of lipids that are physiologically well-tolerated. According to and these lipids form a solid core that is encircled by non-toxic surfactants and occasionally cosurfactants, which help to stabilize the nanoparticles in dispersions. The size range of SLN is usually 50–1000 nm. The main goal behind SLN's creation was to create a biocompatible platform that could incorporate many pharmacological compounds with different chemical properties. Furthermore, these nanoparticles are intended to decrease drug deterioration during the administration procedure and function as a method for regulated drug release.Within the lipid core of SLN, the medication dissolves. The surface area of these nanoparticles allows medications to be released from the system when it is exposed to an aqueous media. Targeted delivery of pharmacological molecules and their therapeutic efficacy can be improved by using SLN to increase tissue and cellular penetration.

The Purpose of Developing SLN: -

Nanoscale drug delivery techniques have been developedto tackle the concerns listed below.

- Drug concentrations that are low or unstable are generally the result of oral drug delivery being hampered by issues such rapid metabolism, poor absorption, and excretion.
- Drugs' poor solubility is another major obstacle, especially when they are injected intravenously as aqueous solutions.
- Moreover, a significant amount of toxicity is shown by several prescription medications. While potentially lowering toxicity or side effects, turning these medications into SLN can enhance their targeted delivery.
- It has been proposed that SLN provide the benefits of several colloidal carriers without sacrificing their disadvantages.

Advantages of SLN: -

- Compared to other carriers, this one has a higher drug loading capacity.
- It can move medication molecules that are lipophilic or hydrophilic.
- It has outstanding biodegradability and biocompatibility.
- The size of production can be increased.
- It has the potential to raise the bioavailability of adsorbed active ingredients.

- The system can be lyophilized or sterilized.
- Compared to the manufacturing of other nanoparticles, the production cost is comparatively lower.
- No waste is produced during the production process that could endanger the environment or public health.

Disadvantages of SLN: -

- The particle size may increase during storage.
- The polymeric transition during storage is feasible to result in drug repulsion.
- It has a low loading capacity for hydrophilic drugs.

Type of SLN and Models of Drug Incorporation IntoSLN: -

Various parameters, such as the manufacturing process, processing temperature, and chemical composition of the formulation, affect the arrangement of pharmaceuticals within Solid Lipid Nanoparticles (SLN). There are three main approaches to incorporating drugs into SLN.

SLN Type 1: Homogenous matrix model: -

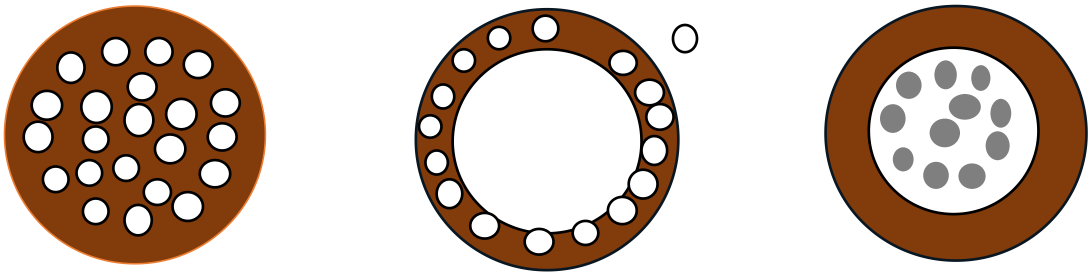
The existence of amorphous groups or the uniform dispersion of the active component within the lipid core are characteristics of a solid solution model, also known as a homogeneous matrix model. High-pressure homogenization (HPH) or cold homogenization methods carried out at temperatures beyond the melting point of the lipids are used to create this model. The goal of this method is to distribute the pharmacological ingredient uniformly at the molecular level without the use of surfactants or solubility-enhancing chemicals.homogenization process according to reported that there is a notable interaction between the medicinal molecule and lipid component.

SLN Type 2: Drug-enriched shell model: -

Heat induction is used in a homogenization procedure to create. This concept states that a solid lipid core forms when the lipid reaches its recrystallization temperature. The oil-in-water (o/w) nano emulsion experiences lipid precipitation when the dispersion temperature drops, which raises the drug concentration in the liquid lipid phase. Within the solid lipid nanoparticle's outer shell, which is still liquid, the medication has a tendency to accumulate. As a result, when the outer shell solidifies, a significant portion of the medication becomes enclosed in it, this earlier strategy frequently resulted in burst drug release and dose dumping. This problem was frequently experienced when liquid lipid contents were low.

SLN Type 3: Drug-enriched core model: -

Drug precipitation takes place in SLN type 3 prior to lipids resolidifying. This phenomenon happens when the drug concentration in the lipids becomes close to the solubility saturation point, which causes the drug to be incorporated into the lipids at a high concentration. The medication in the liquid lipid in the nano emulsion becomes supersaturated upon cooling. Lipid solidification therefore happens subsequent to medication precipitation. A membrane-like structure is formed as the temperature decreases and the lipid recrystallizes around the drug-enriched core. This strategy works best for medications that need to have an extended-release profile within a certain amount of time.



Homogenous matrix **Drug-enriched shell** **Drug- enriched core**

Fig.04- Drug incorporation model of SLN: Homogenous matrix of solid solution (left), drug-enriched shell (middle); and drug-enriched core(right).

Stability of SLN: -

The components of the lipid matrix, the surfactants, and the storage environment all have an impact on the stability of SLN. To guarantee the long-term stability of solid lipid nanoparticles (SLN), it is essential to ascertain the ideal surfactant concentrations as well as regulate temperature and light exposure. According, these factors are essential for both storage and the whole SLN manufacturing process.

Lipids undergo a polymorphic transition from a less stable to a more stable crystal state when they are being stored. This shift is contingent upon the lipids' molecular makeup. For example, triglycerides show different crystal forms as α (alpha), β′ (beta prime), and β (beta). After being rapidly cooled during SLN, lipids go through a phase shift from the relatively unstable α modification to the more stable β modification when stored.

Characterization of SLNs: -

Solid lipid nanoparticles (SLNs) are a flexible drug delivery nanocarrier technology with distinctive properties. Biocompatible lipids make up SLNs, which are normally solid at room temperature. Their range of nanometers makes drugs more effective by facilitating cellular absorption and biodistribution. The encapsulated pharmaceuticals are stabilized and protected from degradation by the solid lipid matrix.

Moreover, SLNs provide regulated release kinetics, which permits continuous medication administration. Their functionalization is made possible by their programmable surface characteristics, which enable targeted distribution to particular cells or tissues. All things considered, SLNs show promise as additives in pharmaceutical formulations, providing a versatile way to improve medication distribution and treatment results.

Particle size and distribution: -

Solid lipid nanoparticles (SLNs) have an average diameter of 100–300 nanometers and a uniform particle size distribution, usually spanning from 50 to 1000 nanometers. This consistency guarantees the stability and effective encapsulation of medications. SLNs can be made to attain particular size ranges by adjusting formulation factors, which makes precise drug administration possible.

SLNs are attractive carriers for a variety of therapeutic drugs with enhanced pharmacokinetic profiles and therapeutic results because of their narrow size distribution, which improves bioavailability and cellular uptake.

Zeta potential: -

Solid lipid nanoparticles (SLNs) are one type of nanoparticle whose stability and colloidal behavior are influenced by zeta potential, a measure of surface charge. Higher absolute zeta potential values of SLNs show stronger electrostatic repulsion, which prevents particle aggregation.

Typically, these values range from -30 to +30 mV. Long-term circulation in biological systems and efficient medication administration depend on its stability. Furthermore, surface functionalization can be used to modify zeta potential, enabling targeted delivery and regulated release of medicines.

Electron microscopy: -

A concentrated electron beam is employed in electron microscopy, a potent imaging method, to expose minute details of materials at nanoscale resolution. Researchers in many domains, including materials science, biology, and nanotechnology, can benefit from the visualization of the ultrastructure of materials and biological specimens made possible by modern technologies such as the Transmission Electron Microscope (TEM) and Scanning Electron Microscope (SEM).

By revealing hidden structures and paving the way for advancements across a wide range of scientific fields, this ground-breaking approach transforms our knowledge of the microcosm.

Atomic force microscopy (AFM).

Using an atomic-level sharp probe, Atomic Force Microscopy (AFM) is a high-resolution imaging technique that examines surfaces. AFM produces remarkably precise topographic maps by identifying minute forces between the probe and material. Biological samples and other materials can be precisely examined down to the nanoscale scale by scientists using this non-destructive technique.

Surface Analysis, Molecular Manipulation, and Nanoscale Characterization are just a few of the domains in which AFM finds applications in Nanotechnology, Materials Science, and Biology.

Dynamic light scattering (DLS).

The size and dispersion of particles in a solution can be measured non-invasively using dynamic light scattering (DLS). DLS offers important insights into the size distribution, aggregation, and stability of macromolecules and nanoparticles in solution by examining the variations in scattered light brought on by the Brownian motion of particles.

For the characterization of proteins, polymers, and nanoparticles, this technique is frequently used in the domains of colloid science, medicine, and biotechnology. DLS is a useful technique for understanding the behavior of particles in a variety of applications since it provides quick and precise data.

Differential scanning calorimetry (DSC).

The thermal analysis method known as differential scanning calorimetry (DSC) is used to examine the heat flow related to chemical and physical changes in materials as a function of temperature. DSC gives important information regarding phase transitions, including melting, crystallization, glass transitions, and chemical processes, by measuring the heat absorbed or released by a sample in relation to a reference material.

This technique is frequently used in the fields of materials science, pharmacology, and food science to better understand material behavior, characterize thermal properties, and optimize processing settings. These results enable improvements in quality control and product development.

Acoustic methods.

Acoustic methods are a group of approaches that use sound waves to examine systems and materials. These techniques include acoustic microscopy, acoustic spectroscopy, and ultrasound imaging. High-frequency sound waves are used in ultrasound imaging to provide images of inside body structures that assist in diagnosis.

Using an analysis of the interaction between sound waves and materials, acoustic spectroscopy can be used to quantify qualities such as viscosity and elasticity. Sound waves are used in acoustic microscopy to show minute details in materials. These adaptable methods have uses in non-destructive testing, materials science, medicine, and many other domains.

Nuclear magnetic resonance (NMR).

Molecular structure and dynamics can be better understood by using Nuclear Magnetic Resonance (NMR) spectroscopy, a potent analytical method that takes advantage of the magnetic characteristics of atomic nuclei. NMR uncovers important details about chemical environments, molecule interactions, and molecular mobility by exposing a sample to radiofrequency radiation and a strong magnetic field.

This allows NMR to identify the absorption and emission of electromagnetic radiation by nuclei. NMR, which is widely employed in chemistry, biochemistry, and medicine, makes it possible to identify substances, determine molecular structures, and examine biological processes. As such, it is essential to expanding our knowledge of the molecular world.

Applications of SLN.

SLN for Parenteral Application.

Parenteral applications could benefit greatly from the use of Solid Lipid Nanoparticles (SLN). SLNs are characterized by improved stability and sustained drug release due to their size range of 10 to 1000 nm. With the help of this cutting-edge delivery technology, medications that are both hydrophilic and hydrophobic can be effectively delivered to their intended locations.

SLNs are a desirable alternative for a range of therapeutic applications in the field of parenteral administration since they also show biocompatibility and are simple to surface-modify for targeted delivery.

SLN for Nasal Application.

Solid Lipid Nanoparticles (SLNs) offer an attractive option for application in the nasal cavity. Their tiny size (10–1000 nm) guarantees effective nasal mucosa penetration, accelerating the absorption of drugs. With their regulated release, SLNs improve the therapeutic efficacy and drug bioavailability.

They are adaptable for drug delivery through the nose because they can encapsulate a wide variety of medications, both hydrophobic and hydrophilic. Additionally, SLNs may be customized for focused distribution and are biocompatible, which holds great promise for improvements in nasal therapeutic administration.

SLN for Respiratory Application.

The pulmonary uses of solid lipid nanoparticles (SLNs) show great potential. SLNs provide improved drug stability and prolonged release, with diameters usually ranging from 10 to 1000 nm. When it comes to respiratory administration, SLNs excel at precisely administering drugs to targeted locations inside the lungs, enhancing the effectiveness of the prescription.

They are especially useful in treating respiratory disorders including lung infections or asthma because of their biocompatibility and ability to encapsulate a wide range of drugs. Moreover, the potential of SLNs in pulmonary drug delivery systems can be increased by customizing them for targeted distribution. The future of respiratory treatments appears bright, given the adaptability and efficacy of SLNs.

SLN for Ocular Application.

Innovative medication delivery techniques employed in ocular applications are Solid Lipid Nanoparticles (SLNs). For eye illnesses, they improve the regulated release and absorption of medicinal medicines. SLNs, which are made of solid lipids, are biocompatible and shield medications against deterioration. Their compact size makes it possible for them to enter and stay in ocular tissues more effectively. SLNs are versatile because they can encapsulate both lipophilic and hydrophilic medications. This nanotechnology offers a promising substitute for traditional eye drop formulations, improving the effectiveness of therapies for ailments like inflammation, retinal diseases, and glaucoma.

SLN for Rectal Application.

Solid Lipid Nanoparticles (SLNs) are becoming a more viable option for rectal medication administration. Improved stability of encapsulated pharmaceuticals, controlled drug release, and increased bioavailability are just a few benefits they provide. Sensitive medications can be shielded from gastrointestinal tract degradation by SLNs, which are made of biocompatible and biodegradable lipids. They can be used for both local and systemic therapy because of their tiny size, which guarantees good absorption through the rectal mucosa.

Different medications, such as analgesics, antiretrovirals, and anti-inflammatory medicines, can be delivered via SLNs efficiently, making them a good substitute for conventional rectal formulations. When treating rectal and systemic illnesses, this technique improves patient compliance and therapeutic efficacy.

SLN for Topical application.

Solid Lipid Nanoparticles (SLNs) have many advantages and are very effective for topical medication administration. By improving the stability and bioavailability of medications, these nanoparticles provide regulated and prolonged release. SLNs, which are made of biocompatible lipids, offer delicate skin a non-irritating substrate while preventing the breakdown of active substances. They are perfect for treating skin disorders like psoriasis, eczema, and acne because of their small size, which allows for deeper skin penetration. Antioxidants, anti-inflammatory medications, and antimicrobials are just a few of the therapeutic agents that SLNs can encapsulate to improve patient outcomes and treatment efficacy for dermatological conditions.

SLN in Cancer chemotherapy.

One important idea in cancer chemotherapy is the Sentinel Lymph Node, or SLN, especially for malignancies like melanoma and breast cancer. The initial lymph node or lymph nodes that cancer cells are likely to disseminate from the main tumour must be located, removed, and examined. By reducing the necessity for extensive lymph node excision, SLN biopsy helps minimize surgical complications by assessing the amount of cancer dissemination. By adjusting treatment to the patient's unique cancer stage, an accurate assessment of the SLN can help improve patient outcomes when choosing chemotherapy and other therapies.

Oral SLN in antitubercular chemotherapy.

To increase the effectiveness of oral medications including rifampicin, isoniazid, and pyrazinamide, oral SLN (Solid Lipid Nanoparticles) is a novel drug delivery technique utilized in antitubercular treatment. These nanoparticles give the medications more stability and bioavailability, resulting in greater absorption in the gastrointestinal tract and regulated release. The frequency of dose can be decreased and side effects can be minimized by encasing the medications in SLNs, which greatly increases patient compliance. By sustaining therapeutic medication levels over prolonged periods of time, this targeted delivery method also aids in the overarching success of tuberculosis treatment, helping to overcome drug resistance.

SLN for potential agriculture application.

Solid Lipid Nanoparticles (SLNs) have potential uses in agriculture, particularly in terms of enhancing fertilizer and pesticide distribution and effectiveness. Active substances can be encapsulated by SLNs, which will shield them from environmental deterioration and provide a controlled release. With this tailored delivery system, the environmental impact is reduced, the dosage needed for agrochemicals is decreased, and their effectiveness is increased. Furthermore, SLNs can be engineered to release their payload in reaction to particular stimuli, including alterations in pH or moisture content, which maximizes the time and effectiveness of applying fertilizers or pesticides. This creative method may result in more productive and sustainable farming methods.

Result And Discussion.

The performance of the medication was improved when lansoprazole was added to Solid Lipid Nanoparticles (SLNs). Lansoprazole was stabilized and made more bioavailable by the SLNs, which also prevented stomach breakdown and ensured a regulated release. As a result, there was a longer therapeutic response and less frequent doses. Furthermore, the SLN formulation reduced lansoprazole's usual side effects when taken orally. Better absorption and a more constant plasma concentration were demonstrated by the encapsulated medication, suggesting a more effective delivery mechanism. All things considered, the research showed that SLNs are a viable strategy for maximizing lansoprazole therapy, providing improved efficacy and patient compliance.

Conclusions: -

Solid Lipid Nanoparticles (SLNs) act as colloidal drug carriers, merging the benefits of polymeric nanoparticles, fat emulsions, and liposomes. They offer numerous advantages, such as the ability to incorporate both lipophilic and hydrophilic drugs, enhanced physical stability, cost-effectiveness, and ease of scale-up and manufacturing. SLNs can be produced using advanced techniques and are particularly effective for site-specific and sustained drug release. Nanoparticles have been widely utilized in drug discovery, delivery, diagnostics, and other medical applications. Since their introduction in the early 1990s, SLNs have gained significant attention, and the future is promising for their continued research and development, likely leading to many patented formulations.

References: -

[1]. Paliwal R, Rai S, Vaidya B, et al. Effect of lipid core material on characteristics of solid lipid nanoparticles designed for oral lymphatic delivery. Nanomedicine: Nanotechnology, Biology and Medicine. 2009;5(2):184–191.

[2]. Cortesi R, Esposito E, Luca G, et al. Production of lipospheres as carriers for bioactive compounds. Biomaterials. 2002; 23:2283–2294.

[3]. Paliwal R, Paliwal SR, Agrawal GP, et al. Biomimetic solid lipid nanoparticles for oral bioavailability enhancement of low molecular weight heparin and its lipid conjugates: in vitro and in vivo evaluation. Mol Pharm. 2011;8(4):1314–1321.

[4]. Battaglia L, Serpe L, Mentone E, et al. Methotrexate-loaded SLNs prepared by coacervation technique: in vitro cytotoxicity and in vivo pharmacokinetics and biodistribution. Nanomedicine. 2011;6(9):1561–1573..

[5]. Essaghraoui A, Belfkira A, Hamdaoui B, et al. Improved dermal delivery of cyclosporine a loaded in solid lipid nanoparticles. Nanomaterials. 2019;9(9):1204.

[6]. Shilpi S, Vimal VD, Soni V. Assessment of lactoferrin-conjugated solid lipid nanoparticles for efficient targeting to the lung. Prog Biomatter. 2015;4(1):55–63.

[7]. Valdes SA, Ahirani RF, Rodriguez A, et al. A solid lipid nanoparticle formulation of 4-(N)-docosahexaenoic 2′, 2′-difluorodeoxycytidine with increased solubility, stability, and antitumor activity. Int J Pharm. 2019; 12:118609.

[8]. Esposito E, Sugianto M, Drechsler M, et al. Lipid nanostructures for antioxidant delivery: a comparative preformulation study. Beilstein J Nanotechnology. 2019;10(1):1789–1801.

[9]. Garg NK, Singh B, Jain A, et al. Fucose decorated solid-lipid nanocarriers mediate efficient delivery of methotrexate in breast cancer therapeutics. Colloids Surf B Bio interfaces. 2016; 146:114–126.

[10]. Paliwal R, Rai S, Vyas SP. Lipid drug conjugate (LDC) nanoparticles as autolymphotrophs for oral delivery of methotrexate. J Biomed Nanotechnology. 2011;7(1):130–131.

[11]. Cho HJ, Park JW, Yoon IS, et al. Surface-modified solid lipid nanoparticles for oral delivery of docetaxel: enhanced intestinal absorption and lymphatic uptake. Int J Nanomedicine. 2014; 9:495–504.

[12]. Du B, Yan Y, Li Y, et al. Preparation and passive target of 5-fluorouracil solid lipid nanoparticles. Pharm Dev Technol. 2010;15(4):346–353.

[13]. Pandey R, Sharma S, Khullar GK. Oral solid lipid nanoparticle-based antitubercular chemotherapy. Tuberculosis. 2005;85(5–6):415–420.

[14]. Jenning V, Gorla SH. Encapsulation of retinoids in solid lipid nanoparticles (SLN). J Microencapsulate. 2001;18(2):149–158.

[15]. Padois K, Cantini C, Berthold V, et al. Solid lipid nanoparticles suspension versus commercial solutions for dermal delivery of minoxidil. Int J Pharm. 2011;416(1):300–304.

[16]. Woznick-Frackowiak H, Cal K, Stefano ska J, et al. Roxithromycin loaded lipid nanoparticles for follicular targeting. Int J Pharm. 2015;495(2):807–815.

[17]. Talpur R, Cox K, Duvic M. Efficacy and safety of topical tazarotene: a review. Expert Open Drug Metab Toxicon. 2009;5(2):195–210.

[19]. Souto EB, Doktorovova S, Gonzalez-Mira E, et al. Feasibility of lipid nanoparticles for ocular delivery of anti-inflammatory drugs. Curr Eye Res. 2010;35(7):537–552.

[20]. Kakkar V, Kaur IP. Evaluating potential of curcumin loaded solid lipid nanoparticles in aluminum induced behavioral, biochemical and histopathological alterations in mice brain. Food Chem Toxicon. 2011;49(11):2906–2913.

[21]. Kakkar V, Singh S, Singla D, et al. Exploring solid lipid nanoparticles to enhance the oral bioavailability of curcumin. Mol Nutra Food Res. 2011;55(3):495–503. 23. Qi C, Chen Y. Huang JH, et al. Preparation and characterization of catalase-loaded solid lipid nanoparticles based on soybean phosphatidylcholine. J Sci Food Agric. 2012;92(4):787–793.

[22]. Qi C, Chen Y, Huang JH, et al. Preparation and characterization of catalase-loaded solid lipid nanoparticles based on soybean phosphatidylcholine. J Sci Food Agric. 2012;92(4):787–793.

[23]. Wissing SA, Kayser O, Muller RH. Solid lipid nanoparticles for parenteral drug delivery. Adv Drug Deliv Rev. 2004;56(9):1257–1272.

[24]. Mukherjee S, Ray S, Thakur RS. Solid lipid nanoparticles: a modern formulation approach in drug delivery system. Indian J Pharm Sci. 2009 Jul;71(4):349–358.

[25]. Muller RH, Mader K, Gorla S. Solid lipid nanoparticles (SLN) for controlled drug delivery - a review of the state of the art. Eury J Pharm BioPharma. 2000;50(1):161–177. •• An excellent review article describing the basic concepts of SLNs.

[26]. Marengo E, Cavalli R, Caputo O, et al. Scale-up of the preparation process of solid lipid nanospheres part I. Int J Pharm. 2000;205(1–2):3–13.

[27]. Rostam Abadi H, Failsafe SR, Jafari SM. Nanoencapsulation of carotenoids within lipid-based nanocarriers. J Control Release. 2019; 298:38–67.

[28]. Anand A, Sugumaran A, Narayanasamy D. Brain targeted delivery of anticancer drugs: prospective approach using solid lipid nanoparticles. IET Nanobiotechnology. 2019;13(4):353–362.

[29]. Talegaonkar S, Bhattacharyya A. Potential of lipid nanoparticles (SLNs and NLCs) in enhancing oral bioavailability of drugs with poor intestinal permeability. AAPS Pharm SciTech. 2019;20(3):121.