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Innovative SNEDDS for Targeted and Personalized Drug Delivery

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Abstract: Self-Nanoemulsifying Drug Delivery Systems (SNEDDS) resulted in innovative approaches for improving the bioavailability and solubility of poorly water-soluble drugs. Conventional SNEDDS provide several benefits, such as improved dissolution and medication absorption rates. However, because of the less precise release of drugs at the location of action, traditional targeted drug delivery is limited. In recent times, additional focused advancements, such as innovative materials for new SNEDDS formulations, smart delivery systems, and personalized medicine, have emerged as a result of advances in treatment innovation. This chapter will discuss the most recent advances in SNEDDS, namely stimuli-responsive SNEDDS, which play a role in drug release in response to different environmental stimuli such as pH, temperature, as well as enzyme activity. Targeting ligands like peptides, nanoparticles, or monoclonal antibodies are used to deliver antineoplastic medications more effectively, minimising systemic adverse effects. The prospective use of artificial intelligence (AI) along with machine learning (ML) in developing SNEDDS formulations is underlined as a foundation for predictive modeling for stability augmentation, absorption, and personalisation. Furthermore, personalised SNEDDS accelerates the arrival of competent rapid care by incorporating pharmacogenomic data, making it relevant in providing prescription formulations to a single patient with enhanced efficacy and fewer side effects. The potential of hybrid SNEDDS, which combines nanoemulsions along with liposomes and polymeric nanoparticles to improve drug loading and also allow controlled release, is one of the prospects. Despite these gains, several challenges remain, including formulation stability, suitable scaling, as well as regulatory approval. However, with breakthroughs in research and multidisciplinary collaboration, the successful translation of novel SNEDDS into the clinic may pave the way for new-generation drug delivery systems that are more effective, patient-centred, and therapeutically relevant.

Keywords: SNEDDS, Bioavailability, Targeted drug delivery, Personalised medicines, Stimuli-responsive delivery, Artificial intelligence (AI), Machine learning (ML), Controlled drug release.

1. Introduction

The identification of viable direct routes of drug delivery is the most difficult challenge in the manufacture of contemporary drugs, particularly insoluble drugs, low bioavailability drugs, and non-selective targeting. The majority of drug delivery approaches currently in use do not target these conditions and lead to ineffective treatment outcomes and aggravated side effects[1]. SNEDDS is a highly efficient and high-capacity vehicle with a very high requirement for bridging deficits, as it has a novel mechanism [2]. SNEDDS are oil/co-surfactant/surfactant mixtures that form isotropic nano-emulsions when they come in contact with aqueous environments, i.e., the gastrointestinal tract. Encapsulation of pharmaceutically active, poorly soluble compounds in nanometer-sized oil droplets enhances their solubility, stability, and absorption many fold [3]. Targeted drug delivery is one of the significant benefits of SNEDDS [4]. Active drugs are delivered to the target tissues, e.g., tumours or inflammation, by SNEDDS through conjugation with active-targeting ligands or through the incorporation of stimuli-responsive functionalities [5]. This approach not only prefers therapeutic targeting but also minimizes overall systemic toxicity, which is a significant advantage in the treatment of complex diseases like cancer [6]. SNEDDS is credited to patient-specific pharmaceutical

concepts, which offer customized therapy based on patient considerations like genetics, disease stage, and hormone levels. SNEDDS are utilized for an adaptive and adjustable drug delivery system in these products. They can be designed to deliver maximum drug release rates, routes of administration, and target approaches, and thus maximum therapeutic effects in different patient profiles. 3D printing and artificial intelligence enable the development of individualized therapeutic use with SNEDDS [7]. This chapter discusses SNEDDS-based drug delivery strategies to target and customize drug delivery, formulation strategies, and action mechanisms. This work emphasizes prospects and challenges by pointing out how the role of SNEDDS is becoming crucial in enhancing drug delivery and designing future treatment schemes [8].

1.1 Basics of SNEDDS

This Self-Nanoemulsifying Drug Delivery System is a newly established innovative lipid drug formulation for drugs with poor water solubility. It consists of three major constituents: oils, surfactants, and co-surfactants. The three of them combine to form an isotropic and stable system [9]. In aqueous environments like the gastrointestinal tract, on gentle agitation, SNEDDS may spontaneously form fine oil-in-water nanoemulsions with a 20-200 nm diameter. All these characteristics collectively allow hydrophobic drugs to be encapsulated within the delivery system, substantially improving solubility, stability, and bioavailability [10].

1.2 SNEDDS Composition

1.2.1 Solvents

The most preferred solvent for lipophilic drugs is oil. Oils contain medium-chain triglycerides (Captex, Labrafac) and long-chain triglycerides (olive oil, soybean oil).

1.2.2 Surfactants

They lower the interfacial tension for the stabilization of the nanoemulsion. Examples are Tween 80, Cremophor EL, and Labrasol.

1.2.3 Co-surfactants

They enhance the emulsification process and droplet stability, e.g., Transcutol, PEG 400, and ethanol are generic co-surfactants [11].

1.3 Benefits of SNEDDS

1.3.1 Enhanced Solubility

Low-solubility drugs are encapsulated in oil droplets to enhance their solubility.

1.3.2 Enhanced Bioavailability

Surface area and permeability are enhanced through the use of nanoemulsions to stimulate drug absorption.

1.3.3 Protection from Degradation

Drugs are shielded from enzymatic degradation in the gut.

1.3.4 Convenience of Administration

SNEDDS can be formulated in liquid-filled capsules or solid dosage unit forms for convenient administration to the patient [12-15].

1.4 Terminology and classification of SNEDDS

1.4.1 Liquid SNEDDS

Pre-concentrated liquid products give rise to nanoemulsions when diluted.

1.4.2 Solid SNEDDS

For the convenience of handling as well as stability, liquid SNEDDS is absorbed into solid carriers (e.g., silica or polymers).

1.4.3 Hybrid SNEDDS

For multiple applications, when combined with other delivery systems (e.g., liposomes or nanoparticles).

2.1 Innovations in SNEDDS

2.1.1 Innovative excipients and Hybrid systems

2.1.1.1 Novel Excipients

New excipients that have been developed have resulted in the creation of extra oils, surfactants, and co-surfactants that enhance drug stability in SNEDDS. Medium-chain triglyceride oils or semi-synthetic oils such as Labrafac™ are commonly employed for enhancing drug loading as well as solubilizing efficiency [16].

2.1.1.2 Hybrid Systems

Increasing interest in the development of hybrid systems from SNEDDS in combination with other drug delivery technologies such as nanoparticles, liposomes, or solid dispersions. Hybrid systems are reported to have synergistic advantages as regards the stability of the drug, target release, and controlled release [17].

2.1.2 Stimuli-responsive and multifunctional SNEDDS

Stimuli-responsive SNEDDS have been designed to release drugs based on some external stimulus such as pH, temperature, or enzymes. For instance:

2.1.2.1 pH-sensitive SNEDDS

Release drugs in the stomach (acidic) and intestinal (alkaline) area [18].

2.1.2.2 Temperature-sensitive SNEDDS

At higher temperatures, they activate the release of drugs, like in cancer or inflamed tissues [19].

2.1.2.3 Enzyme-sensitive SNEDDS

They release drugs in the presence of some enzymes like

Lipases, proteases, and many more [20].

3 Targeted Drug Delivery

3.1 Passive targeting (EPR effect)

3.1.1 Improved permeability and retention of EPR effect

Targeting by passive means is also achievable via the leaky vasculature and impaired lymph drainage of tumor tissues, like tumors, to trap nanoemulsions carrying drugs at the targeted location.

SNEDDS droplets (20-200 nm) are small enough to permeate through permeable tumour blood vessels, and extended circulation time allows prolonged residence.

It is useful in cancer therapy since it lowers systemic toxicity and enhances therapeutic efficacy [21].

3.2 Active Targeting (ligand)

3.2.1 Ligand-mediated Targeting

Active targeting requires the use of ligands (e.g., proteins, polysaccharides, antibodies, peptides, and aptamers) bound to the SNEDDS droplet surface to target specifically the overexpressed receptors on the target cells. For example:

3.2.2 Transferrin Receptors

Target brain disease with drug delivery via transferrin.

3.2.3 Integrin Receptors

Integrins are targeted using the help of arginylglycylaspartic acid (RGD) peptide and target tumor vasculature.

3.2.4 Folate receptors

Target the cancer cell with folic acid [22].

3.4 Organ–specific targeting

3.4.1 Brain – targeting

SNEDDS permeating the blood-brain barrier are formulated with ligands, e.g., transferrin or surfactants, which allow permeability across the BBB and which favor their targeting in neuro disorder treatments, e.g., Parkinson's and Alzheimer's disease [22].

3.4.2 Liver – target

Hepatic targeting using SNEDDS is possible in the presence of certain ligands like galactose and surfactants having specificity for the liver, which accounts for another advantage in treating hepatocellular carcinoma and hepatitis [23].

3.5 Sub-cellular or cellular targeting

3.5.1 Cellular Targeting

It is possible for SNEDDS to be used to target cells of a given type with the help of cell-specific ligands, like cancerous or immune cells.

3.5.2 Single-Cell Targeting

SNEDDS can be designed to target cell organelles like mitochondria or the nucleus by incorporating organelle-specific targeting moieties.

This greatly tailored formulation should have a variety of applications in cancer therapy and gene delivery [25].

4. Personalized Drug Delivery

Self-nanoemulsifying drug delivery systems (SNEDDS) are an emerging drug delivery technology that guarantees personalized drug delivery. Upon administration, SNEDDS—isotropic drug, surfactant, co-surfactant, and oil blend—self-assemble into minute emulsions in aqueous phases. These systems enhance the bioavailability of water-insoluble drugs, providing improved drug delivery [26].

4.1 Principle of SNEDDS

When SNEDDS on exposed to gastric fluid disintegrate into nano-sized droplets, unveiling maximum surface area for drug adsorption. Lipid period, surfactant, and & co-surfactant are selected selectively for enhancement of lipid period, strength, drug release properties, and solubility. For achieving maximum therapeutic efficacy and safety of the drug in the individualized mode of administration, SNEDDS may be designed as a function of the age of the patient, digestion, and hereditary composition [27].

4.2 Personalization in SNEDDS

4.2.1 Patient-specific to the Formulations

SNEDDS can be formulated to optimize therapeutic outcomes by considering patient-specific factors like weight, age, respiratory rate, and gene-based differences in drug degradation.

4.2.2 Dosing Adjustments

SNEDDS can be formulated for immediate release, sustained release, or controlled release based on the needs of each patient. This enhances the therapeutic window and reduces side effects.

4.2.3 Biomarker-guided Drug Delivery

The drug delivery system may be engineered to provide optimal therapy for conditions such as diabetes, tumors, and cardiovascular disease by using biomarkers to identify the patient's status or drug response [28].

4.2.4 Pharmacogenomics:

During the design of SNEDDS, drug metabolism individual genetic variations can be considered. As an example, cytochrome P450 enzyme variations can influence excipients' levels and concentration of the drug utilized in SNEDDS preparations.

4.3 Advantages of Bespoke SNEDDS

4.3.1 Increased Bioavailability

The solubilizing action of SNEDDS is effective in enhancing the bioavailability of low water-soluble drugs, particularly in patients who are afflicted by conditions that leave the body impaired in metabolizing the drugs.

4.3.2 Improved Drug Stability

Through the reduction in degradation by variations in pH, enzymatic actions, or photolysis, the nanoemulsion can enhance the long-term stability of the drug.

4.3.3 Minimized Side Effects

SNEDDS is capable of reducing side effects usually induced by elevated plasma levels through more efficient delivery of the drug to the desired location [29].

4.4 Uses of Personalized SNEDDS

4.4.1 Cancer Treatment

With greater absorption and metabolism of chemotherapeutic agents and minimized off-target activities, SNEDDS can be made such that cancer therapies permit individualized dosing regimens based on malignant characteristics.

4.4.2 Chronic Diseases

Personalized SNEDDS formulations can be tailored to achieve controlled release of the drug in chronic diseases like diabetes, which enhances patient compliance and enables better control of symptoms [30].

4.4.3 Neurodegenerative Diseases

With enhanced crossing of the blood-brain barrier, personalized SNEDDS can enable better delivery of neuroprotective drugs to the brain in diseases like Alzheimer's.

4.5 Role of pharmacogenomics (Pharmacogenomics and Its Application in Personalized Medicine)

Pharmaceutical genomics is an exploration of how an individual's genetic makeup dictates the way he or she will respond to drugs. Drug science, pharmacology, genome and gene function science, and genomics are merged in pharmaceutical genomics to tailor the drug treatment to the patient, optimizing the therapeutic response and minimizing the likelihood of side effects. The area of targeted therapy, with the aim of adapting the therapy in accordance with the specific genetic makeup, lifestyle, and environment of each patient, is critically dependent on pharmacogenomics.

4.5.1 Tailored Drug Response

Drug ADME could be impacted by genetic heterogeneity. Pharmacogenomics enables one to choose genetic markers that can anticipate an individual's response to a particular drug. Genetic heterogeneity may impact drug metabolism, particularly genes encoding for enzymes like cytochrome P450 (CYP450). Genetic heterogeneity of the CYP2C19 gene, for example, can influence the metabolism of drugs like clopidogrel, a drug prescribed to prevent blood clotting [31].

4.5.2 Maximizing Drug Efficacy

Through the selection of the right drug and dosage for a patient, pharmacogenomic information can maximize therapeutic outcomes with fewer side effects. Genetic testing, for instance, can predict the efficacy of a specific chemotherapy against cancer therapy, e.g., trastuzumab in HER2-positive breast cancer. Individual mutations in the gene that codes for EGFR in lung cancer, for instance, predispose to EGFR inhibitors such as gefitinib. Genomic testing will also determine those patients who are likely to gain the most from targeted therapy [32].

4.5.3 Reducing Causative Adverse Drug Reactions (ADRs) Harmful

Individuals will become more susceptible to drug side effects based on genetic diversity. For example, response to the HIV drug abacavir has been associated with HLA-B*5701 gene alleles. Genetic screening avoids such adverse side effects by giving drug choices. Personalized treatment with the force of pharmacogenomics also reduces the application of trial-and-error methods of drug prescribing and unjustified treatment prescribing, thus optimizing safety in patients.

4.5.4 Optimal Dosage

In the genes, pharmacogenomics is used to decide the optimal dosage of the drug. For instance, VKORC1 and CYP2C9 gene mutations may have an impact on patient response to the drug, and warfarin, which is a commonly used anticoagulant, has a narrow therapeutic window. Genetic testing before initiating warfarin therapy can assist physicians in prescribing the appropriate dose to avoid causing disease clotting or bleeding.

4.5.5 Gene-Drug Interactions

Pharmacogenomics creates gene-drug interactions that influence therapeutic response and metabolism. For example, the drug response of the patient is based on genetic differences, and it may vary with the rate at which they metabolize drugs like antidepressants and SSRIs. Physicians can choose the right antidepressant and adjust dosages with the help of genetic testing [33].

4.5.6 Better Drug Development

By informing us how different populations respond to drugs, pharmacogenomics enables us to design more effective drugs for certain genetic profiles. This can lead to the development of "personalized" drugs, which are designed with particular genetic variants in mind. Pharmacogenomics will also influence clinical trials by way of novel advancements in genetic research, with the capability to design studies aimed at defined populations of genes in an attempt to establish more accurate individualized therapy.

4.6 Pharmacogenomics Challenges

4.6.1 Access Turned and Cost

Pharmacogenomics for all is perhaps limited by the expense of genetic analysis as well as customized therapy, unaffordable to all patients.

4.6.2 Privacy and Ethical Concerns

Genetic information use raises ethical concerns about consent, privacy, and discrimination or prejudice based on genetic susceptibility [34].

4.6.3 Clinical Use

Training doctors, updating clinical guidelines, and ensuring adequate regulation of genetic tests are only a few of the significant changes in healthcare infrastructure required to incorporate pharmacogenomics into practice.

4.7 Personalized formulations and 3D printing

Patient-specific medications and drug delivery systems specifically designed for individual patients are known as personalized drug formulations. genomics, gender, age, disease state, and other patient-specific conditions are considered in this process. 3D printing has been a groundbreaking process in pharmaceutical sciences in the recent past by making it possible to formulate personalized, patient-specific medicines.

4.7.1 3D Printing in Drug Delivery

3D printing or additive manufacturing is an innovative technology used in drug product development that facilitates the precise production of drug products with complex drug formulations and delivery systems. Depending on the individual requirements of each patient, the technology can have the customized dose forms printed, hence resulting in tailored dosing regimens that promote compliance and outcomes [35].

4.7.2 Challenges and Future Outlook

4.7.2.1 Challenge for regulation

The safety and effectiveness of printed medicines are to be confirmed as one of the distinctive regulatory challenges concerning the utilization of 3D printing technology to manufacture medicine.

4.7.2.2 Material limitations

Compared with the traditional drug-delivery forms, the universe of materials 3D printed remains relatively small despite a few being highly potential-rich. There has to be development of new reproducible and life-compatible materials to prepare printable drugs, which are generally diverse if new materials or pharmaceutical grades or applications must be developed for use in the process [37].

4.7.2.3 Cost and Scalability

Although 3D printing is capable of manufacturing personalized products, mass production proves to be expensive, especially relative to traditional methods of production. For more use to be provided in the available clinics, scalability and cost need to be addressed.

5. Characterization and Evaluation

5.1 Droplet size and polydispersity index

To estimate droplet size (z-ave) or polydispersity index (PI value), a photon correlation spectroscopy approach can be used. The sample has to be dispersed in a suitable solvent at an adequate concentration, and mixing is necessary during preparation [38]

5.2 Transmission Electron Microscopy (TEM)

The size and shape of the nanoemulsion droplets created by SNEDDS may be seen via TEM [39].

5.3 Zeta Potential

Zetasizer is utilized to determine the charge of oil droplets in SNEDDS, which may be negative due to the addition of fatty acids. SNEDDS with greater potential have better stability and shelf life. A low zeta potential leads to increased repulsion between solubilizers, resulting in the shattering of the emulsion [40].

5.4 Viscosity and Rheology

The SNEDDS's self-emulsification tendency as well as flow attributes may be impacted by its viscosity. When exposed to aqueous fluids, low-viscosity systems are favored for quick emulsification [41].

5.5 Emulsification Time

This test was carried out to investigate the stability of nanoparticle bonding in digestive fluids, as well as the extent to which SNEDDS may interact with stomach acid to develop a self-emulsification system. To imitate the normal dilution process after oral administration, the chosen formula was diluted using water, AGF (Artificial Gastric Fluid), and AIF (Artificial Intestinal Fluid) with no enzymes [42].

5.6 In vitro Drug Release

Dissolution equipment can be used to evaluate the drug release characteristics of SNEDDS. To replicate physiological circumstances, the dissolving investigation is carried out in a combination of simulated intestinal fluid (SIF) and simulated gastric fluid (SGF) [43].

5.7 Thermodynamic Stability Studies

Centrifugation, Freeze-Thaw Research, and Heating-Cooling Cycles: These experiments assess how stable SNEDDS is in the face of mechanical stress and temperature variations. The phase division, drug precipitating, or any other kind of physical defect must not be present in a stable formulation [44].

6. Evaluation of SNEDDS

6.1 InVitro Drug Release Studies

The ability of SNEDDS to release the medicine in a synthetic intestinal environment is examined in order to critically evaluate them. To show improved drug release from SNEDDS, the dissolution rate is contrasted to that of the pure medication along with other composition types.

6.2 In vivo Studies

To compare the drug's bioavailability from SNEDDS to traditional formulations, animal tests are carried out. The intended results are longer drug release, increased drug in plasma concentrations, and improved absorption [45].

6.3 Stability Testing

To evaluate the chemical and physical stability of SNEDDS, prolonged stability analysis with enhanced settings (such as 40°C/75% RH for 6 months) is essential [46].

6.4 In Vitro Cell Culture Studies

Cell lines (such as Caco-2) can be used for cellular absorption and cytotoxicity experiments to evaluate how SNEDDS relate to biological membranes and how well they improve absorption through intestinal cells [47].

7. Applications

7.1 Cancer therapy

Cancer is marked by uncontrolled cleavage, which causes tumors to spread to distant tissues. Cancer is among the main causes of death globally. In 2012, cancer caused around 8.2 million deaths. Pharmaceutical preparation and delivery methods provide the benefit of being able to reach intercellular areas only accessible by colloidal particles, aiding in the discovery of novel drugs for the public. To improve the penetration of active chemicals in pharmaceutical, technologically based drug delivery systems, the Self-Nanoemulsifying Drug Delivery System (SNEDDS) is a suitable option. SNEDDS, an isotropic combination of oils, surfactants, and co-surfactants, can create spontaneous nanoemulsions once in contact with stomach fluid [48]. SNEDDS can enhance drug bioavailability by bypassing the hepatic portal route, protecting against degradation in the GI environment, facilitating lymphatic transport, reducing cytochrome P450-induced metabolism in the liver, as well as inhibiting glycoprotein-mediated efflux. In preclinical investigations, docetaxel-loaded SNEDDS increased tumor targeting while reducing adverse effects [49].

7.2 Neurological Disorders

Because of the blood-brain barrier's protective nature, neurological disorders such as Alzheimer's disease and Parkinson's disease provide substantial therapeutic hurdles. Nanotechnology provides techniques to improve medication distribution across the BBB, hence enhancing therapy results for various severe diseases. For example, curcumin-loaded SNEDDS demonstrated enhanced brain delivery with neuroprotective benefits in Alzheimer's disease animal models [50].

7.3 Infectious Diseases

The use of SNEDDS to increase oral bioavailability is well known, with FDA-approved formulations including ritonavir and cyclosporine. SNEDDS have submicron emulsion droplets, whereas SEDDS can have bigger droplets. The decrease in droplet size may improve oral absorption by promoting micellization in the gut. SNEDDS increases the solubility as well as absorption of drugs, including acyclovir, ritonavir, or rifampicin. Moreover, improves the targeting of infected tissues by using ligands or other stimuli-responsive mechanisms [51].

Table 1: Drug-loaded SNEDDS.

Sr No	Encapsulated Drug	Ingredients	Techniques Used	Salient findings	References
1.	Cefpodoxime proxetil	Solutol HS-15, Poloxamer 188, Transcutol, Lauroglycol 90, Labrafac CC, Labrasol, Akomed E, Imwitor-742	Homogenization	-to increase the efficiency of different surfactants -rapid release of the drug	[52]
2.	Cinnarizine	Miglyol 810, Imwitor 988, Imwitor 308, soybean oil, oleic acid, linoleic acid, Propylene glycol, Tween, Cremophor EL.	Centrifugation	-increase the bioavailability, solubility and efficiency of poorly water-soluble drugs	[53]
3.	Gemfibrozil	Oils: peppermint essential oil, soybean oil, caprylic acid, Potassium chloride, potassium	Qbd Approach	-improvement of dissolution and oral absorption.	[54]

		hydrogen phthalate, Eudragit L.			
4.	Olmesartam medoxomil	Miglyol 812, Capryol 90, Lauroglycol FCC, Transcutol HP, Cremophor RH40, Cremophor S9 and Labrasol, Castor oil, Olive oil, Oleic acid, Hydrochloric acid and Propylene Glycol, Tween 20, Tween 80, Span 20, Span 80, PEG 400, PEG 200, Glycerin and Sodium Dihydrogen Phosphate	Spray drying technique	Enhancement of solubility and oral dissolution.	[55]
5.	Pitavastatin	PEG 200, PEG 400, PEG 600, cinnamon oil, olive oil, coconut oil, castor oil, Tween 20, Tween 40, Tween 60, and Tween 80, Triton X-100.	Ultrasonication	-to improve the solubility and bioavailability.	[56]
6	Resveratrol	Captex 355, Capryol 90, Oleic acid, Captex 800, mineral oil, Tween 20, Tween 80, PEG 200	Centrifugation	-to overcome the therapeutic hindrances related to pancreatic cancer.	[57]
7	Curcumin	Cardmon oil, cinnamon oil, soyabean oil, Tween 20, Tween 80, coconut oil, oleic acid, transcutol, PEG 400, PEG 200 and propylene glycol, Captex 300 and cremophor EL	Ternary phase diagram	- Improves the bioavailability of curcumin and its anti-cancer activity.	[58]
8	Pioglitazome Hydrochloride	Capryol 90, Transcutol HP, Labrasol, Olive oil, Soybean oil, Tween 80, Oleic acid, Propylene glycol, Cremophor, mannitol, fructose and crosspovidone	Homogenization	-Improves solubility and dissolution.	[59]
9	Thymoquinone	Labrafac PG, Labrafil, Compritol 888, Span 80, Tween 80, Glyceryl monostearate, stearic acid.	Microemulsion method	Enhancement of oral bioavailability.	[60]
10	Celecoxib	Methyl cellulose, Tween 80, Gelucire 44/14, Miglyol 812, Avicel PH-101, Diacel 10 Gum Arabic.	Spray drying technique	Improve the oral bioavailability of poorly soluble lipophilic drugs.	[61]

7. Conclusion

Self-nanoemulsifying drug delivery systems introduced a new way of contemporary drug delivery to address issues such as poor solubility, limited bioavailability, and non-specific targeting. SNEDDS' capacity to self-emulsify, along with advances in targeted and personalised distribution, makes it a very adaptable delivery system for applications such as cancer therapy, neurological disorders, infectious illnesses, and chronic ailments. Taking into account emerging technologies such as 3D printing along with pharmacogenomics, SNEDDS serves as a forerunner to precision medicine. The particular constraints associated with scaling and regulation continue to be a stumbling barrier; despite these hurdles, it is a good possibility to progress in the area of medication delivery, providing safer and more efficacious patient-centred therapies.

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