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Research Article

A Review on Nanoemulsion-Based Drug Delivery Systems for Enhancing Bioavailability

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ABSTRACT

Nanoemulsion-based drug delivery systems have emerged as a promising approach to improve the solubility, stability, and bioavailability of poorly water-soluble drugs. Nanoemulsions are isotropic, thermodynamically stable systems composed of oil, water, surfactants, and co-surfactants, with droplet sizes ranging between 20–200 nm. These systems provide enhanced drug absorption, targeted delivery, and improved therapeutic efficacy. The present review highlights formulation techniques, characterization methods, advantages, limitations, and applications of nanoemulsions in pharmaceutical sciences.

INTRODUCTION

In recent years, the pharmaceutical industry has focused on improving drug delivery systems to overcome limitations associated with conventional dosage forms. Many drugs suffer from poor aqueous solubility, leading to reduced bioavailability and therapeutic efficacy.

Nanoemulsions are advanced drug delivery systems designed to address these challenges. They consist of nano-sized droplets stabilized by surfactants, offering improved solubility and permeability of drugs. These systems have gained attention due to their ability to enhance drug absorption and provide targeted delivery.

2. CONCEPT OF NANOEMULSION

Nanoemulsions are colloidal dispersions of two immiscible liquids stabilized by surfactants. They can be categorized into:

- Oil-in-Water (O/W)
- Water-in-Oil (W/O)
- Bicontinuous systems

Droplet size typically ranges from 20 to 500 nm, which plays a crucial role in drug delivery efficiency.

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3. ADVANTAGES OF NANOEMULSION

1. Improved drug solubility
2. Enhanced bioavailability
3. Controlled and sustained release
4. Protection of drugs from degradation
5. Targeted drug delivery
6. Reduced toxicity

Nanoemulsions provide better absorption due to their small droplet size and large surface area.

4. FORMULATION COMPONENTS

4.1 Oil Phase

- Solubilizes lipophilic drugs

4.2 Surfactants

- Reduce interfacial tension
- Stabilize nanoemulsion

4.3 Co-surfactants

- Enhance flexibility of interfacial film

4.4 Aqueous Phase

- Continuous phase in O/W nanoemulsion

5. METHODS OF PREPARATION

5.1 High-Energy Methods

- High-pressure homogenization
- Ultrasonication
- Microfluidization

5.2 Low-Energy Methods

- Phase inversion temperature method
- Spontaneous emulsification

These methods ensure formation of stable nano-sized droplets.

6. CHARACTERIZATION OF NANOEMULSION

1. Droplet size analysis
2. Zeta potential measurement
3. Viscosity determination
4. Drug content analysis
5. Stability studies

7. APPLICATIONS

7.1 Oral Drug Delivery

Improves absorption of poorly soluble drugs

7.2 Topical Delivery

Enhances skin penetration

7.3 Ocular Delivery

Provides improved drug retention and bioavailability

7.4 Parenteral Delivery

Used for targeted therapy

8. LIMITATIONS

1. Stability issues under extreme conditions
2. High surfactant concentration may cause toxicity
3. Costly manufacturing process

9. FUTURE PROSPECTS

Nanoemulsion systems are expected to play a major role in:

- Targeted drug delivery
- Personalized medicine
- Cancer therapy
- Gene delivery systems

Recent research focuses on combining nanoemulsions with advanced technologies for improved therapeutic outcomes.

10. CONCLUSION

Nanoemulsion-based drug delivery systems offer a promising approach to overcome limitations of conventional drug formulations. Their ability to enhance solubility, stability, and bioavailability makes them highly valuable in modern pharmaceutical research. Continued

advancements in nanotechnology will further expand their applications in drug delivery.

REFERENCES

1. Tadas A., et al. Enhancing Drug Delivery with Nanoemulsion, 2025.
2. Chatzidaki M.D., et al. Advances in Nanoemulsion Drug Delivery, 2025.
3. Nagar M., Review on Nano-emulsion Drug Delivery System.
4. ScienceDirect Review on Ophthalmic Nanoemulsions.
5. Khan M.H., et al. Nanoemulsion Formulation and Applications.

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