Recent Trends in Pharmaceutical Technology & Industries
Volume 6, Issue 2 - 2024, Pg. No. 5-7
Peer Reviewed Journal

Review Article

Basics of Pharmaceutical Emulsion: A Review

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How to cite this article:
Neeraj P, Sohal T. Basics of Pharmaceutical Emulsion: A Review. *Rec Trends Pharm Tech Indl* 2024 6(2): 5-7.

Date of Submission: 2024-08-17
Date of Acceptance: 2024-09-21

A B S T R A C T

Emulsions are biphasic systems consisting of two immiscible liquids, where one liquid is dispersed in the form of droplets within the other with the help of an emulsifying agent to ensure stability. They are widely used in pharmaceutical formulations for both oral and topical applications. This review provides an overview of the types of emulsions—oil-in-water (o/w), water-in-oil (w/o), multiple emulsions, and microemulsions—highlighting their structural characteristics, preparation methods, and pharmaceutical significance. Common preparation techniques such as the dry gum and wet gum methods are discussed in detail. The article also outlines various tests for identifying the type of emulsion and provides guidelines for packaging, labelling, and storage. Advantages of emulsions include improved drug solubility, taste masking, and enhanced absorption, while limitations such as instability and short shelf-life are also addressed. This review serves as a concise reference for understanding the formulation and application of emulsions in pharmaceutical sciences.

Keywords: Emulsion, Microemulsion, Multiple Emulsion, Emulsifying Agents, Drug Delivery, Pharmaceutical Formulation, Emulsion Stability

Introduction

Definition

An emulsion is a biphasic liquid dosage form composed of two immiscible liquids—typically oil and water—where one liquid (known as the dispersed phase) is finely divided into droplets and uniformly dispersed throughout the other liquid (the continuous phase). Due to the inherent immiscibility of the two phases, emulsions are thermodynamically unstable, requiring the presence of one or more emulsifying agents (surfactants) to reduce interfacial tension and stabilize the system.

Types of Emulsions

Oil-in-Water (O/W) Emulsion

- In this type of emulsion, oil is dispersed as fine droplets throughout the water phase, which acts as the continuous phase.
- Emulsifying agents used are typically hydrophilic (e.g., acacia, Tween 80).
- Pharmaceutical applications: Commonly used for oral administration of oil-soluble drugs and for topical formulations like creams and lotions due to their non-greasy feel and ease of washability with water.

Water-in-Oil (W/O) Emulsion

- Here, water droplets are dispersed in oil, which forms the continuous phase.
- Lipophilic emulsifiers (e.g., Span 80) are used to stabilize these emulsions.
- Applications: Primarily used for topical preparations, especially in cold creams and certain medicated ointments, where hydration and barrier formation are desired. Some antiseptic agents also show improved efficacy in w/o emulsions.

Multiple Emulsions

1. These are complex systems involving more than two phases. They can be:

- Water-in-Oil-in-Water (W/O/W): Water droplets trapped in oil globules, which are further dispersed in water.
- Oil-in-Water-in-Oil (O/W/O): Oil droplets dispersed in water globules, which are themselves dispersed in oil.

2. These systems are used in controlled drug delivery, prolonged release, and targeted therapy due to their ability to encapsulate active ingredients in inner phases.

Microemulsions

Microemulsions are thermodynamically stable, transparent or translucent dispersions of two immiscible liquids (typically oil and water) stabilized by a surfactant and often a co-surfactant. Unlike conventional emulsions, microemulsions have droplet sizes typically in the range of 10–100 nanometers (nm), making them optically clear and more stable over time. Thermodynamically stable (unlike normal emulsions which are kinetically stable but thermodynamically unstable).

Clear or translucent appearance due to extremely small droplet size.

Form spontaneously when the right composition of oil, water, surfactant, and co-surfactant is used.

Low interfacial tension between oil and water phases due to the presence of both surfactant and co-surfactant.

Can solubilize both hydrophilic and lipophilic drugs.

Oil-in-water Emulsion

In pharmaceutical emulsions, one phase is usually water and the other is an oil, fat or waxy substance. Systems in which oil is the dispersed or discontinuous phase and water is the continuous phase are termed as oil- in- water. Oil–in–water emulsions are also useful for preparation for external use such as creams, lotions and liniments since they provide a totally non-greasy feeling to the product and can easily be washed off from the skin. (Fig: 1)

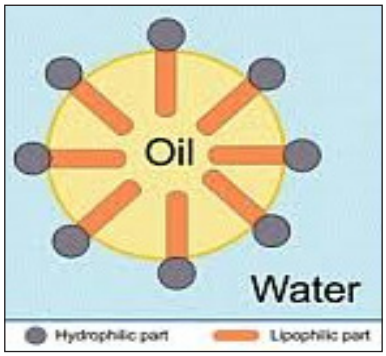

Figure 1.Emulsion O/W (Oil / Water)

Water-in-oil Emulsion

Water-in-oil emulsions are those in which oil forms the continuous or external phase while water is the dispersed or discontinuous phase. Such emulsions are mostly used externally as creams and lotions. Certain medicaments such as antiseptics are more effective when used in the form of w/o emulsions. (Fig: 2)

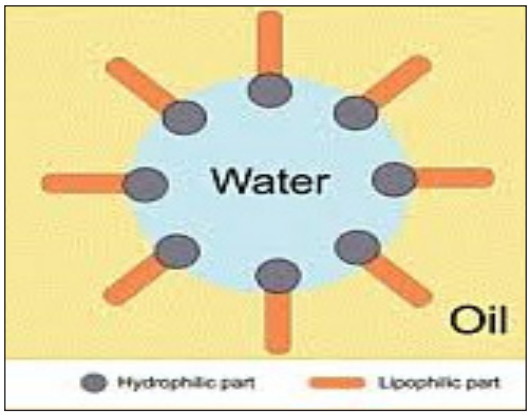

Figure 2.Emulsion O/W (Water / Oil)

Multiple emulsions

In addition to the two types of emulsions discussed above there are certain complex, multiple emulsions in which the oil-in-water or water-in-oil emulsions are dispersed in another liquid medium. Thus, an oil-in-water-in-oil emulsion consists of very small droplets of oil dispersed in the water globules of a water-in-oil emulsion and a water-in-oil-in-water emulsion consists of droplets of water dispersed in the oily phase of an oil-in-water emulsion. (Fig: 3)

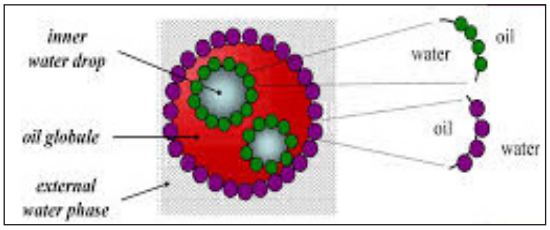

Figure 3.Multiple emulsions

Micro emulsions

Normal emulsions generally contain globules ranging from 0.1 to 100 micrometres

in diameter. Micro emulsions are emulsion that contain globules having a diametres of less than 0.1 micrometer. Droplets of such dimensions cannot refract light and, as a result, are invisible to the naked eye. (Fig: 4)

Preparation of Emulsions

- **Dry Gum Method:** In this method the oil or the blend of oils is taken in a dry mortar and thoroughly triturated with the required quantity of acacia using a pestle. This

is followed by the addition of the required quantity of water and its trituration to form the primary emulsion. The trituration is continued until a characteristic 'cracking' sound is produced and a thick white cream is formed.

- **Wet Gum Method:** In this method the calculated quantity of gum is first triturated with a small quantity of water to form a mucilage. The required quantity of oil is then added gradually in small portions with rapid trituration to form a thick primary emulsion.

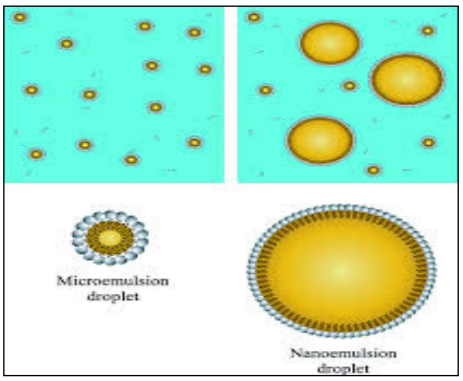

Figure 4.Micro emulsions

Tests for Identification of Emulsion Types

- **Dilution test:** emulsion can be diluted only with external phase
- **Dye test:** water or oil soluble dyes
- **$CoCl_2$/filter paper test:** filter paper impregnated with $CoCl_2$ and dried (blue) changes to pink when o/w emulsion is added
- **Fluorescence:** some oils fluoresce under UV light
- **Conductivity:** for ionic o/w emulsions (O/w emulsions conduct electric current)

Packaging, Labelling and Storage of Emulsions

Oral emulsion is usually packed in well filled bottles having an air-tight closure. Light sensitive products may be packed in amber coloured bottles. If the preparation is quite viscous, a wide mouthed bottle or jar may be used. Emulsions for external use such as applications, liniments and lotions are generally packed in amber fluted bottles or plastic containers.

Emulsion should preferably be stored in a cool place but the refrigerator should be avoided since this may damage the product. The containers of emulsions should be labelled to indicate that these should be shaken thoroughly before use.

Advantages

- To solubilise hydrophobic or oil soluble drugs
- To enhance drug absorption through
- To enhance topical absorption of drugs
- To mask the disagree able taste and odour of drugs
- To enhance palatability of nutrient oils

Disadvantages

- Less stable as compared to other dosage forms
- Possesses short shelf-life
- Creaming, cracking (breaking), flocculation and phase inversion are common problems observed during storage of emulsion.

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