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TECHNOLOGY OF PRODUCTION OF NANOEMULSION BASED ON MANDRAGORA TURCOMANICA ESSENTIAL OIL

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Abstract

This study explores the development of a nanoemulsion formulation derived from Mandragora turcomanica essential oil and its potential applications in the pharmaceutical and cosmetic industries. Nanoemulsions are colloidal systems consisting of fine droplets ranging from 20 to 200 nm in size, which can enhance the solubility, stability, and bioavailability of active compounds. The essential oil of Mandragora turcomanica, known for its pharmacological properties, is encapsulated in a nanoemulsion system to improve its efficacy for potential use in various pharmaceutical, cosmetic, and food applications. In this research, the essential oil was extracted via maceration and the phase inversion temperature (PIT) method was employed to produce essential oil from mandragora turcomanica nano-emulsions. The most suitable nanoemulsion composition was achieved adding 8% Mandragora turcomanica essential oil, 2% Coconut oil , 10% Tween 80 and distilled water.

Key words: Nanoemulsion, Mandragora turcomanica, Essential oil, Surfactants, Antioxidant, Antimicrobial activity, Bioavailability.

1. Introduction

Mandragora turcomanica is a perennial herbaceous plant in the family Solanaceae, native to the Kopet dag mountains in Turkmenistan.Mandragora turcomanica containing tropane alkaloids like atropine, scopolamine, and hyoscyamine. It is known for its bioactive properties, including antioxidant, antimicrobial, and anti-inflammatory effects. Encapsulating Mandragora turcomanica essential oil into a nanoemulsion system can enhance its therapeutic efficacy.This study investigates the technology behind producing a stable nanoemulsion of Mandragora turcomanica essential oil and evaluates its potential in various applications.

Nanoemulsions are typically composed of oil, water, surfactants, and co-surfactants, with droplet sizes in the nanometer range. The use of nanoemulsions for essential oil delivery systems can offer advantages such as improved permeability through biological membranes and controlled release of active ingredients. The purpose of this paper is to explore the technology behind the production of a nanoemulsion from Mandragora turcomanica essential oil.

Nanoemulsions are increasingly recognized as effective delivery systems for active compounds due to their small droplet size, large surface area, and enhanced solubility of hydrophobic substances. The ability to encapsulate essential oils into nanoemulsions is of significant interest for improving the efficacy of volatile compounds in pharmaceuticals, cosmetics, and food industries.

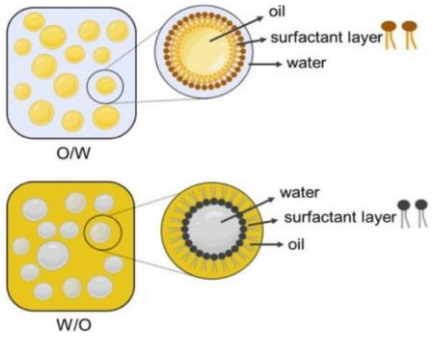

Figure 1 . Oil in water (O/W) and water in oil (W/O) nanoemulsion structure

Nanoemulsion formulation methods are primarily classified into high-energy and low-energy methods. Some examples of high energy methods are high-shear stirring, ultrasonic emulsification and high-pressure homogenization. The most commonly employed low energy methods are the Phase Inversion Temperature method (PIT), the Phase Inversion Composition (PIC) and spontaneous emulsification. Each method has its advantages and shortcomings.

2. Materials and Methods

2.1 Materials

The essential oil of Mandragora turcomanica was obtained through maceration of roots of the plant. Surfactant Tween 80 (polyethylene sorbitan monooleate) were used to stabilize the emulsion and prevent coalescence of the oil droplets. Coconut oil used to increase stability of nanoemulsion .The water phase provides the medium in which the oil droplets are dispersed and stabilized.

2.2 Nanoemulsion Preparation

The nanoemulsion was prepared using the phase inversion temperature method (PIT).Firstly essential oil from mandragora turcomanica and coconut oil blended together , and then surfactant and distilled water were added. All components were mixed together and stirred for to produce a coarse emulsion, and each system was then heated to 15°C . Then, a two-step cooling procedure was performed. Firstly, the temperature was reduced to the PIT to allow a stable microemulsion to form.

Secondly, a rapid cooling step was performed by immersing in an ice bath at 5°C with continuous stirring.

3. Technology of Nanoemulsion Production

Phase inversion temperature (PIT) method is most convenient way of nanoemulsification. It relies on changes in the optimum curvature or solubility of non-ionic surfactants with changing temperature. As the temperature of the emulsions reaches the phase inversion temperature, the interfacial tension drops, allowing the formation of nanodroplets. The system then has to be rapidly cooled to a lower temperature to prevent the droplets from coalescing. The PIT method is based on variations in the hydration feature of non-ionic surfactants when the temperature variation. Therefore, surfactant concentration plays a major role in the foundation of nanoemulsions.

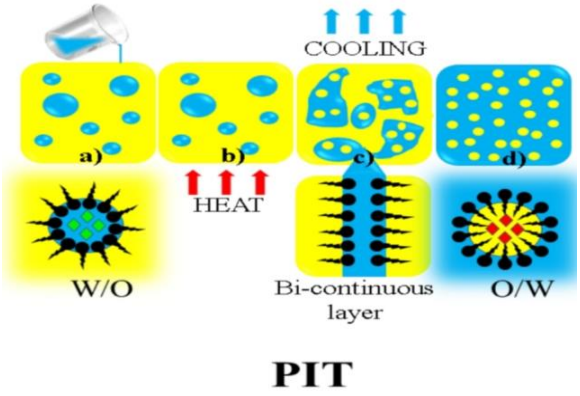

Figure 2 . Phase inversion temperature method

3.3 Stability of nanoemulsion

The stability of the nanoemulsion is crucial for its effectiveness. Several factors influence the stability of the nanoemulsion, including the surfactant concentration, droplet size, and temperature. To evaluate the long-term stability, the nanoemulsion is stored under various conditions, including room temperature and accelerated stability tests. Key indicators of stability include physical appearance (absence of phase separation), particle size distribution, and viscosity.

4. Applications and Advantages of Mandragora turcomanica essential oil Nanoemulsion

Nanoemulsions offer several advantages over conventional emulsions and essential oil formulations. The small droplet size increases the surface area, leading to enhanced bioavailability and absorption of the essential oil's active compounds. This can be particularly useful in pharmaceutical and cosmetic applications, where improved penetration and sustained release of the active ingredients are desired. The incorporation of Mandragora turcomanica essential oil in a nanoemulsion can potentially improve its therapeutic efficacy in treating conditions such as inflammation, microbial infections,

and oxidative stress. Additionally, the nanoemulsion can be used as a topical formulation, providing controlled release of the bioactive compounds directly to the skin.

5. Conclusion

The nanoemulsion prepared from Mandragora turcomanica essential oil demonstrated promising characteristics such as small particle size, stability, and enhanced antioxidant and antimicrobial activities. This formulation could offer a more efficient means of utilizing the therapeutic properties of Mandragora turcomanica essential oil in various applications, particularly in the development of topical pharmaceutical and cosmetic products.

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