



UTILIZING NATURAL EMULSIFIERS FOR OPTIMIZED PANCHAKARMA PREPARATION: BRIDGING AYURVEDIC PRINCIPLES WITH MODERN PHARMACEUTICAL APPROACHES

Parth kapil¹, Moon^{2*}

¹Third year MD Scholar, Department of Panchakarma, Dr. D. Y. Patil College of Ayurved and Research Centre, Pimpri, Pune 411018, Maharashtra, India, kapilparth@yahoo.in
+919914619277 0009-0003-2722-9606

^{2*}Assistant Professor, Department of Panchakarma, GAC, Patiala, mooncainth@gmail.com
, +919041744223, 0009-0012-2096-615x

Abstract

Background: Nature provides a rich variety of emulsifiers derived from plant, animal, mineral, and microbial sources, enabling the formation of diverse emulsions. Their role is not limited to external applications but extends significantly to the internal biological environment. Emulsifiers are essential components of many medicinal and diagnostic formulations, contributing to their efficacy, bioavailability, and safety. The stability of an emulsion largely depends upon the type of emulsifier used. While synthetic emulsifiers are widely employed in modern pharmaceutical formulations, the biological rhythms and constituents of the human body are inherently aligned with nature, making natural emulsifiers more compatible and synergistic, thereby enhancing therapeutic outcomes.

Objective: This review aims to explore the pharmaceutical and therapeutic actions of natural emulsifiers across different medical applications, with special emphasis on Ayurveda and Panchakarma.

Methods: A comprehensive literature review was conducted using classical Ayurvedic Samhitas, Ayurvedic pharmaceutics textbooks, and standard references of chemistry and modern medical science. Scientific databases such as PubMed, PubChem, Scopus, and Web of Science were searched to identify relevant studies on emulsifiers, emulsions, and their biomedical applications.

Conclusion: This review elucidates the biological, chemical, and physiological significance of emulsions within the human body and their extensive application in Ayurvedic therapeutics, bridging traditional knowledge with modern scientific understanding.

Keywords: Ayurveda; Emulsion Dispersion System; Natural Emulsifiers; Panchakarma; Healthcare

Introduction

An emulsion is defined as a heterogeneous system consisting of two or more immiscible phases, wherein one liquid is dispersed in another with the aid of a stabilizing agent known as an emulsifier.¹ The most commonly observed emulsions are oil-in-water (O/W) and water-in-oil (W/O) systems, prevalent in both natural and industrial processes.¹

Emulsifiers play a crucial role in daily life, ranging from food and cosmetic products to pharmaceutical formulations. In cosmetics, they impart desirable texture and stability, whereas in pharmaceuticals they facilitate the incorporation of lipophilic and hydrophilic constituents, thereby enhancing bioavailability and therapeutic efficacy.⁸

Physiologically, the importance of emulsifiers is evident through endogenous agents such as bile salts, phospholipids, digestive enzymes, and gut microbiota, which facilitate lipid digestion and absorption.¹ Despite extensive application, long-term exposure to synthetic emulsifiers has been associated with gut dysbiosis, inflammation, and metabolic disturbances, prompting concerns regarding their safety.² This necessitates exploration of safer, natural alternatives.

Ayurveda emphasizes nature-based therapeutics and extensively employs emulsion-based formulations. Panchakarma procedures such as basti, ghrita, and lepa represent sophisticated natural emulsion systems designed to enhance drug delivery, tissue penetration, and systemic therapeutic action.^{6,7}

Emulsion Dispersion Systems

Emulsion dispersion systems may include solids, liquids, liquid crystals, and gases, incorporating both hydrophilic and hydrophobic substances. One of the key physicochemical principles governing emulsion formation is the Gibbs–Marangoni effect, which enables mass transfer across immiscible liquid interfaces due to surface tension gradients.³

Emulsifying agents possess amphiphilic properties that allow them to reduce interfacial tension, surround dispersed droplets, and impart stability to emulsions.^{1,3}

Types of Emulsions

- In biological and pharmaceutical contexts, several types of emulsions are recognized:
- Oil-body emulsions, naturally occurring in oil seeds such as soybean, store triglycerides as intracellular droplets.⁹
- Self-emulsifying drug delivery systems (SEDDS) enhance intestinal absorption of lipophilic drugs.⁸
- Blended emulsions, such as soy–cow milk combinations, arise from mixing different emulsion systems.¹
- Double emulsions (W/O/W or O/W/O) are utilized for controlled and sustained drug release.⁸
- Nano-emulsions, characterized by nanometer-sized droplets, offer improved stability and bioavailability.⁹

Properties of Emulsions

Emulsions exhibit several properties beneficial in medical science:

- Antioxidant activity protecting bioactive compounds
- Encapsulation and protection from degradation

- Thermal and pH stability
- Modifiable viscosity and foaming ability
- Controlled and sustained release of active ingredients
- Pickering emulsions, stabilized by solid particles instead of surfactants, demonstrate enhanced long-term stability and reduced toxicity risk.⁴

Functions of Emulsifiers

Emulsifiers modify surface tension, facilitating emulsification, dispersion, wetting, solubilization, and stabilization. In medical applications, they are integral to lipid-based drug delivery systems, vaccines, topical formulations, and parenteral nutrition.⁸

Additionally, emulsifiers interact with proteins, lipids, and polysaccharides, influencing drug release profiles and formulation performance. Certain natural emulsifiers also exhibit antimicrobial activity and enhance transdermal drug permeation.⁹

Drawbacks of Natural Emulsifiers

Natural emulsifiers may be slow-acting and often require higher concentrations. Their susceptibility to microbial contamination necessitates appropriate preservation strategies. Hypersensitivity reactions may also occur in susceptible individuals, emphasizing the need for careful selection and standardization.⁸

Variety of Emulsions in Ayurveda

Sr. No.	Product	Emulsion Type	Dispersed Phase	Continuous Phase	Stabilizing Factor
1	Niruha Basti	O/W	Sesame oil	Decoction	Honey
2	Ksheer Basti	O/W	Ghrita	Ksheerpak	Milk
3	Butter	W/O	Buttermilk proteins	Butter fat	Milk fat globules
4	Shatdhauta Ghrita ⁵	W/O	Ghrita	Ghrita	Water droplets
5	Yapan Basti ⁶	O/W	Ghrita & oil	Ksheerpak	Honey & Saindhava
6	Madhutailika Basti ⁷	O/W	Sesame oil	Decoction	Honey
7	Vaitaran Basti	O/W	Jaggery	Decoction	Honey
8	Lepa	O/W	Oils & fats	Aqueous base	Natural surfactants
9	Polyherbal Bhallatakadi Ghrita	W/O	Water droplets	Fat phase	Ghrita

Discussion

Ayurvedic pharmaceutics demonstrates a refined understanding of emulsion science. Natural emulsifiers such as honey, milk, ghrita, and herbal decoctions not only stabilize formulations but also actively contribute to therapeutic efficacy by enhancing bioavailability and tissue targeting.^{5,6}

Modern pharmaceutical science increasingly acknowledges lipid-based and emulsion-based drug delivery systems as effective therapeutic tools. Integrating Ayurvedic principles with contemporary research offers opportunities for developing safer and more patient-friendly formulations.^{8,9}

Conclusion

The application of emulsions in herbal medicine represents a significant advancement in therapeutic formulation. Natural emulsifiers enhance stability, bioavailability, and therapeutic efficacy while remaining compatible with human physiology. Systematic research and standardization of natural emulsion systems are essential for their optimal utilization in modern healthcare.^{8,9}

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