The Role and Stability of Emulsions in Ayurvedic Basti Preparations: Methods and Clinical Implications

Dr. Anusree D[1], Prof. Gopesh Mangal[2]
[1]*BAMS, MD (Ay.) Panchakarma Vaidya National Institute of Ayurveda (De Novo), Jaipur*
[2]*BAMS, MD (Ay.), PhD Head of Department, Department of Panchakarma National Institute of Ayurveda (De Novo), Jaipur*

Abstract:-Background: Basti, an important Ayurvedic therapy primarily used for managing Vatavyadhi (Vata-related disorders), leverages emulsions to deliver a combination of oleaginous and aqueous substances directly to the intestines. These emulsions enhance therapeutic effects through localized and systemic absorption.

Objective: This review explores the significance of emulsion stability in Basti preparations, focusing on quality control methods that ensure consistency and efficacy in clinical applications.

Methods: Emulsion stability tests, including the Visual Stability, Centrifugation, Droplet Size Analysis, pH Stability, and Rheology tests, are reviewed to assess their utility in Ayurvedic Basti preparations. Additional methods, such as the Dye Test, Dilution Test, and Conductivity Test, are discussed for emulsion type determination.

Results: Stability tests confirm that maintaining uniform dispersion of active components in emulsions minimizes phase separation, ensuring consistent dosage and therapeutic effects. The role of herbal particulates, temperature, pH, and viscosity on emulsion behavior is emphasized, with recommendations for practitioners on formulation standardization.

Conclusion: Emulsion stability in Basti formulations is vital for achieving reliable therapeutic outcomes and patient safety. Standardized testing provides valuable insights into formulation adjustments, supporting the integration of Ayurvedic practices with modern quality control measures.

Key words: Basti, Emulsion, Emulsion stability, Particle size, Quality control, Standardization

INTRODUCTION

Basti (medicated enema) is considered the most effective therapy for managing Vatavyadhi (disorders related to Vata dosha).[1] It has wide applications in a number of chronic conditions like arthritis, neuro disorders, constipation and several other vata disorders where it facilitates health by restoring homeostasis. It is commonly used to treat a variety of chronic illnesses, including arthritis, neurological problems, constipation, and other Vata-related ailments, by restoring balance and promoting health. Areas of the therapeutic Basti practice go beyond management of Vatavyadhi as it also targets general health of the systems.[2] Basti delivers medication directly into the intestines, where it can be immediately absorbed to achieve both systemic and local therapeutic effects. Medications chosen in Basti use different drugs for a specific purpose depending on the condition of the patient and the intended therapeutic effect. Special kinds of Basti are utilized in cases of nervous disorders, muscular dystrophy, digestive complaints, and metabolic disorders.

Role of Emulsion in Basti preparation

Basti preparations frequently include oil-based Sneha dravyas (oleaginous compounds) combined with aqueous herbal decoctions or extracts, resulting in an emulsion.[3] An emulsion is a combination of two immiscible liquids, such as oil and water, with one distributed in the other in minute droplets using an emulsifier.[4] These emulsions are crucial in Basti because they enable the medicinal oils and herbs to be efficiently mixed and given together. However, these mixes must be stable in order for the active components to be evenly dispersed for optimal dose and therapeutic efficacy.[5] Stable emulsions are necessary because instability, like phase separation (where oil and water layers divide), can compromise the therapeutic effectiveness of Basti. Instability of the emulsion may cause dose to be delivered in such a manner that the efficiency may lower or cause an irritant effect to the intestinal mucous membrane.

Need for Emulsion Testing

Ensuring the stability and quality of Basti emulsions are vital for their safe and successful use. Emulsion testing is essential for quality control, stability evaluation, and overall safety assurance in Basti formulations.[6] Practitioners can use systematic

testing to verify that the emulsion stays homogeneous, with the active components equally distributed, reducing the hazards of phase separation and degradation.

Emulsion tests assess droplet size, phase separation, viscosity, and temperature response—all of which are important markers of emulsion stability.[7-9] These tests aid in determining the appropriate composition and ratios for Basti mixes, as well as alerting practitioners and researchers about best formulation techniques. Ayurveda practitioners can standardize Basti preparations by testing emulsions, resulting in more consistent and reliable treatments and, ultimately, improved patient results.

In a clinical setting, dependable emulsion testing ensures that each delivered dosage is therapeutically efficacious while minimizing variability, hence improving patient safety and efficacy. This quality control component is especially important in modern Ayurveda, where standardized techniques are increasingly recognized for integrating traditional remedies with modern medical standards.

Types of Emulsion Tests

Emulsion tests help determine the stability, homogeneity, and suitability of Basti formulations, ensuring they maintain their therapeutic integrity. The following tests are commonly used in both traditional and modern practices to assess emulsion quality:

1. Visual Stability Test[10-15]

Purpose: The visual stability test is a simple, initial assessment of emulsion stability by visually inspecting the mixture over time.
Method: The emulsion is allowed to stand undisturbed, typically for a period ranging from hours to days. Practitioners observe for any signs of phase separation, such as the formation of separate oil and water layers, which indicates instability. This test is often conducted at room temperature and observed at intervals (e.g., every hour or every day) to track any changes in the emulsion.
Significance: Phase separation or oil floating on top can indicate poor stability and may require reformulation. This test is especially useful for quick and easy quality checks in clinical or laboratory settings.

2. Centrifugation Test[16-19]

Purpose: The centrifugation test is designed to accelerate the separation process to assess the stability of an emulsion more rapidly.

Method: The emulsion sample is subjected to high centrifugal force, typically using a laboratory centrifuge. This force mimics the long-term effects of gravity, causing any unstable emulsions to separate more quickly. The sample is centrifuged for a set time (e.g., 10-30 minutes) at a specific speed, after which it is checked for phase separation.

Significance: This test is a reliable way to predict the long-term stability of the emulsion. If an emulsion separates under centrifugation, it may not be suitable for therapeutic applications where stability is essential.

3. Droplet Size Analysis[20,21]

Purpose: Droplet size analysis measures the size and distribution of the droplets within the emulsion, an indicator of stability.
Method: Using microscopic analysis or laser diffraction techniques, practitioners measure the size of the oil droplets dispersed in the aqueous phase. Stable emulsions tend to have smaller and more uniform droplets, which are less likely to coalesce (combine) and separate.
Significance: Smaller and consistent droplet sizes enhance emulsion stability and improve absorption when administered. This analysis is particularly useful for formulations where precise dosages and even distribution of ingredients are critical.

4. pH Stability Test[22,23]

Purpose: The pH stability test monitors any changes in pH over time, as pH can affect emulsion stability and the therapeutic properties of Basti.
Method: The pH of the emulsion is measured immediately after preparation and then at intervals over a defined period. Any substantial changes in pH can indicate a chemical reaction or degradation within the emulsion, which might impact its stability and effectiveness.
Significance: A stable pH is often associated with emulsion stability and ensures the formulation remains within a safe and effective range for administration. Significant pH fluctuations could require reformulation or addition of pH-stabilizing agents.

5. Rheology and Viscosity Testing (Optional)[24]

Purpose: Rheology and viscosity tests measure the flow properties and thickness of the emulsion, which are critical for the ease of administration and effectiveness of Basti.

Method: The viscosity of the emulsion is measured using a viscometer or rheometer to determine its thickness and flow behavior. Emulsions that are too thick may be difficult to administer, while those that are too thin may not provide the desired retention time in the intestines.

Significance: Consistent viscosity ensures that the emulsion can be administered easily and has the appropriate retention time for effective therapeutic action. Stable viscosity across different batches also contributes to a uniform experience and efficacy for the patient.

Emulsion Tests for Basti Preparations

These tests help determine the type of emulsion (oil-in-water or water-in-oil), assess stability, and ensure consistency in Basti formulations. Here's an overview of each:

Table no 1: Emulsion tests for Basti preparations

Sr No	Name of the test	Purpose	Method	Significance
1	Dye test[25,26]	The dye test is used to find out whether an emulsion is either an oil-in-water (O/W) or a water-in-oil (W/O) type.	The emulsion is treated with methylene blue, a color that dissolves in water. The homogenity of the dispersion throughout the emulsion can indicate if it is oil in water since the continuous phase is water, which will dissolve the dye. It is likely to be water in oil if the dye will not mix and forms droplets.	The Type of emulsion indicates to the practitioner the dispersal and absorption properties that a Basti preparation will have. This test is rapid to confirm the type of emulsion and therefore can impact both therapeutic efficacy as well as storage conditions.
2	Dilution Test[27,28]	The purpose of this test is to determine the type of emulsion. . Its stability after dilution is also checked.	A small amount of water is added to a measured volume of emulsion. If emulsion remains stable and don't break upon addition of water, it's a case of oil in water since water can be added to continuous aqueous phase without breaking the emulsion. The emulsion disintegrates or breaks down when water is added, if it is a water in oil type.	The test ensures that the emulsion type thus prepared meets the requirements of the formulation and tests its tolerance to minor changes in the content of water, which is an important requirement in a clinical setup, wherein the Basti preparation might be tampered with or diluted just before administration.
3	Electrical Conductivity Test[29,30]	The electrical conductivity test distinguishes between types of emulsions by checking the electricity conductivity in an emulsion.	Electrodes are placed in the emulsion; conductivity is measured using a conductivity meter. Emulsions whereby water is the dispersed phase conduct electricity, while oil-in-water emulsions where oil forms the dispersed phase do not.	This test is specially valuable for establishing an oil-in-water emulsion, which is also desirable in Basti preparations wherein the water-based extracts must remain always available to be absorbed. It further provides an added confidence about the uniformity of the emulsion type, which

				directly influences the therapeutic properties of the preparation.
4	Fluorescence Test[31,32]	The fluorescence test is that of distinction between oil-in-water and water-in-oil emulsions based on their interaction with UV light.	The emulsion is exposed to ultraviolet (UV) light. If it fluoresces, or if it glows in appearance, it is likely a water-in-oil emulsion, because oil phases are likely to contain fluorescent materials that would fluoresce under UV illumination. Oil-in-water emulsions characteristically do not fluoresce.	This test ensures that the emulsion structure is as desired, and oil content is finely dispersed in the desired phase. In preparations of Basti, it helps to evaluate the purity and uniformity of oils employed, as fluorescence reveals the presence of certain organic compounds within the formulation.
5	Cobalt Chloride Test[33,34]	Cobalt chloride is a simple, indirect method of determining the type of emulsion by detecting water as a continuous phase.	Cobalt chloride paper, which is blue when dry, is brought in contact with the emulsion. On exposure to water, the paper changes color to pink. If the paper turns pink after being laid on the emulsion, it belongs to the oil-in-water emulsion type as water is the continuous phase in this category. If the paper does not change color at all, then it must be a water-in-oil emulsion.	This test would rapidly ascertain the presence of water as the continuous phase-a critical constituent in Basti preparations, since delivery of water-soluble therapeutic agents would be necessary for absorption and therapeutic effect.

METHODOLOGY OF EMULSION TEST ON BASTI PREPARATIONS

General Procedures

For each emulsion test: Dye Test, Dilution Test, Electrical Conductivity Test, Fluorescence Test, and Cobalt Chloride Test, general procedure necessitates a homogeneous sample. All apparatus applied have to be clean, and tests carried out in controlled environments. Equipment such as dyes, conductivity meters, UV lights, and cobalt chloride paper should be handled precisely, with consistent measurement intervals. Each test indicates the type of emulsion, and here whether Basti is of oil-in-water or water-in-oil type; it's an important indicator to ensure that the Basti preparation is effective as well as stable.

Special Considerations for Ayurvedic Formulations

Multiple herbal ingredients are frequently used in Ayurvedic Basti formulations, which may have an impact on test results. Consider the following particular adaptations:

1. Handling Herbal Particulates: Many Basti formulations contain herbal residues that may interfere with standard emulsion tests. Filtration of these residues before testing may make for improved accuracy.
2. Oil Properties and Temperature Sensitivity: Some medicated oils or ghee thicken or change in consistency at specific temperatures, which may affect the results. Testing always at a constant moderate temperature, close to the human body temperature, may ensure that the results remain dependable.
3. UV Sensitivity of Oils: Some oils will naturally fluoresce with organic compounds that might very well mimic or obscure true emulsion behavior. Adjusting for the lower intensity of UV can prevent interference by such natural fluorescence from affecting the test.

4. pH and Viscosity Adjustments: The pH of some decoctions/ other medicines used in Basti preparation can affect stability as identified through Dilution or Conductivity Tests. Incorporation of pH stabilizers or viscosity regulators could make it possible to formulate for the behaviour of an emulsion and for resultant tests to be more reproducible.
5. Longer Observation Periods: Due to the multi-phase nature of an emulsion of Basti, some tests will need a longer observation time than conventional emulsions to detect stability or phase separation tendencies.

INTERPRETATION OF EMULSION TEST RESULTS

Indicators of Stability

In emulsion testing for Basti preparations, stability is indicated by uniformity in the emulsion's appearance, droplet size, and pH. A stable emulsion remains evenly mixed without phase separation; if the oil and water phases separate shortly after mixing, it suggests instability, which can affect therapeutic delivery. Consistent droplet size is also essential, as variations often signal coalescence, leading to separation. Additionally, a stable pH is crucial in Basti emulsions containing herbal components, as pH fluctuations can compromise emulsion integrity and the intended therapeutic properties of the formulation.

Implications for Clinical Practice

Emulsion test results directly impact clinical decisions for Basti formulations. If instability is observed, practitioners may adjust the oil-to-water ratio or modify mixing techniques to enhance emulsion stability, ensuring consistent delivery of active herbal ingredients. Test outcomes also inform the selection of emulsifying agents; if the emulsion remains unstable, natural emulsifiers like lecithin or mucilaginous extracts may improve stability and therapeutic efficacy. By optimizing these factors, practitioners help ensure that each Basti dose provides uniform therapeutic effects, enhancing both safety and effectiveness in clinical applications.

Clinical Significance of Emulsion Stability in Basti

Emulsion stability in Basti preparations plays a vital role in absorption and bioavailability, as stable emulsions facilitate the effective delivery of therapeutic substances to the colon. A well-formed emulsion allows for uniform dispersion of active ingredients, aiding in their absorption across the mucosal lining, which directly enhances the efficacy of Basti treatments. Stability also ensures consistency in dosage, as each administration delivers a uniform concentration of therapeutic compounds. This consistency is crucial for achieving predictable treatment outcomes, enabling practitioners to maintain the intended therapeutic impact over the course of treatment.

Furthermore, stable emulsions contribute to the safety of Basti therapy by minimizing the risk of irritation or adverse reactions. An unstable emulsion that separates or changes composition may result in inconsistent exposure to certain ingredients, potentially leading to irritation or discomfort in sensitive patients. By ensuring that Basti emulsions remain stable, practitioners can uphold safety standards and improve the overall patient experience. Conducting emulsion stability tests, therefore, supports both the therapeutic efficacy and safety of Ayurvedic Basti preparations, highlighting the importance of standardized formulation practices and rigorous quality control in Ayurveda.

CONCLUSION

In conclusion, performing emulsion stability tests on Basti preparations is essential for maintaining therapeutic consistency and efficacy. Stable emulsions help ensure that therapeutic agents are absorbed properly, contribute to predictable treatment outcomes, and minimize safety risks. This underscores the need for standardized practices and quality control in Ayurvedic formulations, not only to uphold the effectiveness of traditional therapies but also to ensure patient safety and confidence in these treatments.

REFERENCES

[1] Acharya Y T, editor. Commentary Ayurvedadipika of Cakrapanidatta on Charaka Samhita of Agnivesha, Siddhi Sthana; Kalpana Siddhi: Ch. 1, Ver. 38-39. Varanasi: Chaukhamba Surbharati Prakashan, 2014; p.683-684.
[2] Acharya Y T, editor. Commentary Ayurvedadipika of Cakrapanidatta on Charaka Samhita of Agnivesha, Siddhi Sthana; Kalpana Siddhi: Ch. 1, Ver.

40. Varanasi: Chaukhamba Surbharati Prakashan, 2014; p.683-684.

[3] Acharya Y T, editor. Charak Samhita, with 'Ayurved Dipika' commentary by Chakrapani. 3rd edition. Kolbhat Stret, Bombay- (India): The Nirnaya Sagar Press; 1941. pp. 26–28.

[4] David MNV, Akhondi H. Emulsions. [Updated 2023 Jul 30]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK559084/

[5] Khan MF, Sheraz MA, Ahmed S, Haf S. Emulsion separation, classification and stability assessment. J Pharm Pharm Sci. 2014 Dec;2(2):56-62.

[6] Savrikar SS, Lagad CE. Study of Preparation and Standardization of 'Maadhutailika Basti' with special reference to Emulsion Stability. Ayu. 2010 Jan;31(1):1-6.

[7] Mohammed A, Okoye SI, Salisu J. Effect of dispersed phase viscosity on stability of emulsions produced by a rotor stator homogenizer. Int J Sci Basic Appl Res. 2016;25(2):256-267.

[8] Abdurahman HN, Rosli MY, Jemaat Z. Study on demulsification of water-in-oil emulsions via microwave heating technology. J Appl Sci. 2006;6:2060-2066. Available from: https://doi.org/10.3923/jas.2006.2060.2066.

[9] Abd RM, Nour AH, Sulaiman AZ. Kinetic stability and rheology of water-in-crude oil emulsion stabilized by cocamide at different water volume fractions. Int J Chem Eng Appl. 2014;5:204-209. Available from: https://doi.org/10.7763/ijcea.2014.v5.379.

[10] Colucci G, Santamaria-Echart A, Silva SC, Fernandes IPM, Sipoli CC, Barreiro MF. Development of Water-in-Oil Emulsions as Delivery Vehicles and Testing with a Natural Antimicrobial Extract. Molecules. 2020 Apr 30;25(9):05-21

[11] Ahnfelt E, Degerstedt O, Lilienberg E, Sjögren E, Hansson P, Lennernäs H. Lipiodol-based emulsions used for transarterial chemoembolization and drug delivery: Effects of composition on stability and product quality. J Drug Deliv Sci Technol. 2019;53:101-143.

[12] Gu, Y.S., Decker, E.A., and McClements, D.J. (2005). Influence of pH andcarrageenan type on properties of beta-lactoglobulin stabilized oil-in-wateremulsions. Food Hydrocolloids, 19:83–91

[13] Guzey, D. and McClements, D.J. (2006). Influence of Environmental Stresses onO/W Emulsions Stabilized by β-Lactoglobulin–Pectin and β-Lactoglobulin–Pectin–Chitosan Membranes Produced by the Electrostatic Layer-by-LayerDeposition Technique. Food Biophysics, 1:30–40

[14] Ogawa, S., Decker, E.A., and McClements, D.J. (2003). Influence of environ-mental conditions on the stability of oil in water emulsions containing dropletsstabilized by lecithin-chitosan membranes. Journal of Agricultural and FoodChemistry, 51:5522–5527

[15] Velez, G., Fernandez, M.A., Munoz, J., Williams, P.A., and English, R.J. (2003).Role of hydrocolloids in the creaming of oil in water emulsions. Journal ofAgricultural and Food Chemistry, 51:265–269

[16] Mohsin S, Akhtar N, Mahmood T, Khan H, Mustafa R. Formulation and stability of topical water in oil emulsion containing corn silk extract. Trop J Pharm Res. 2016 Jun;15(6):11-15

[17] Taulbee DN, Maroto-Valer MM. Centrifugation. In: Wilson ID, editor. Encyclopedia of Separation Science. Academic Press; 2000. p. 17-40.

[18] Latreille B, Paquin P. Evaluation of emulsion stability by centrifugation with conductivity measurements. J Food Sci. 1990 Nov;55(6):1666-8.

[19] Tea L, Renou F, Benyahia L, Nicolai T. Assessment of the stability of water-in-water emulsions using analytical centrifugation. Colloids Surf A Physicochem Eng Asp. 2021;608:125619

[20] L'Estimé M, Schindler M, Shahidzadeh N, Bonn D. Droplet Size Distribution in Emulsions. Langmuir. 2024 Jan 9;40(1):275-281.

[21] Garg V, Gupta R, Kapoor B, Singh SK, Gulati M. Application of self-emulsifying delivery systems for effective delivery of nutraceuticals. In: Grumezescu AM, editor. Nanotechnology in the Agri-Food Industry: Emulsions. Academic Press; 2016. p. 479-518.

[22] Östbring K, Matos M, Marefati A, Ahlström C, Gutiérrez G. The Effect of pH and Storage Temperature on the Stability of Emulsions

Stabilized by Rapeseed Proteins. Foods. 2021 Jul 18;10(7):1657.

[23] Hao X, Elakneswaran Y, Afrin S, Shimokawara M, Kato Y, Kitamura R, Hiroyoshi N. Role of pH and cations on emulsion formation and stability of crude oils. Geoenergy Sci Eng. 2023;227:211905.

[24] Dzulkarnain I, Yousufi M, Mohyaldinn M. Emulsion rheology applications and measuring techniques in upstream petroleum operations. In: Rheological Measurement Techniques and Analysis Methods. IntechOpen; 2024. doi: 10.5772/intechopen.1005241.

[25] Gawade J, Khude R, Bhosale K, Bhenki A, Bendgude RR. A review on basics of pharmaceutical emulsion. Quest Journals Journal of Research in Pharmaceutical Science. 2024;10(5):24-32

[26] Jaiswal M, Dudhe R, Sharma PK. Nano emulsion: an advanced mode of drug delivery system. 3 Biotech. 2015 Apr;5(2):123-127.

[27] Thakur R, Sharma A, Verma P, Devi A. A review on pharmaceutical emulsion. Asian Journal of Pharmaceutical Research and Development. 2023;11(3):143-147.

[28] Gawade J, Khude R, Bhosale K, Bhenki A, Bendgude RR. A review on basics of pharmaceutical emulsion. Quest Journals Journal of Research in Pharmaceutical Science. 2024;10(5):24-32

[29] Thakur R, Sharma A, Verma P, Devi A. A review on pharmaceutical emulsion. Asian Journal of Pharmaceutical Research and Development. 2023;11(3):143-147.

[30] Guo, A.; Xiong, Y.L. Electrical conductivity: A simple and sensitive method to determine emulsifying capacity of proteins. J. Food Sci. 2021, 86, 4914–4921

[31] Stelmaszewski A. The contribution of fluorescence to measurements of light scattering in oil-in-water emulsions. Oceanologia. 2011;53(2):549-564.

[32] Gawade J, Khude R, Bhosale K, Bhenki A, Bendgude RR. A review on basics of pharmaceutical emulsion. Quest Journals Journal of Research in Pharmaceutical Science. 2024;10(5):24-32

[33] Thakur R, Sharma A, Verma P, Devi A. A review on pharmaceutical emulsion. Asian Journal of Pharmaceutical Research and Development. 2023;11(3):143-147.

[34] Gawade J, Khude R, Bhosale K, Bhenki A, Bendgude RR. A review on basics of pharmaceutical emulsion. Quest Journals Journal of Research in Pharmaceutical Science. 2024;10(5):24-32