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Review Article

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"TAILA AND *GHRITA* AS LIPID-BASED DRUG-DELIVERY SYSTEMS: TRADITIONAL RATIONALE AND MODERN PHARMACOLOGICAL PERSPECTIVES"

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ABSTRACT

Introduction: In Ayurveda, *Taila* (medicated oils) and *Ghrita* (medicated clarified butter/ghee) are canonical lipid-based dosage forms used to deliver therapeutic agents systemically and locally. Classical pharmaceutics *(Bhaishajya Kalpana)* attribute to these vehicles abilities such as deep tissue penetration (*sroto abhyantara*), nourishment (*dhatu poshana*), and targeted action to lipid-rich tissues (neurological, reproductive, bone). Modern pharmacology recognizes lipid carriers (oils, liposomes, lipid emulsions) as efficient vehicles for enhancing solubility, lymphatic uptake, bioavailability, and tissue targeting. **Methods:** This narrative integrative review synthesizes classical Ayurvedic texts (*Charaka*, *Sushruta*, *Ashtanga Hridaya*, *Rasashastra* sources) and contemporary literature (pharmaceutics, pharmacokinetics, lipid-based drug delivery, and clinical reports). Databases searched included PubMed, Scopus, Web of Science, and Ayurvedic pharmacopeia resources (1950–2025). Eligible studies included formulation science, *in vitro/in vivo* pharmacokinetics, mechanistic reports, and clinical observations of medicated oils/*ghritas*. **Results:** Classical preparation processes *(Sneha Paka* for *Taila* and *Sneha–Paka* with dairy base for *Ghrita*) incorporate herbal *kalka* (paste) and aqueous decoctions to generate oil/ghee matrices enriched with both lipophilic and polar bioactives. Mechanistically, lipid matrices enhance extraction of lipophilic constituents, favor chylomicron formation and intestinal lymphatic transport (bypassing first-pass metabolism), improve CNS penetration for certain lipophiles, and provide sustained depot effects on topical application. Medicated *ghrita* shows advantages in delivery of lipophilic neuroactive molecules and systemic nourishment, whereas medicated oils excel for transdermal/arthritic and local administration. Preclinical and human pilot studies report improved tissue levels, enhanced therapeutic outcomes in neurodegeneration, wound healing, and musculoskeletal disorders, and acceptable safety when prepared under standardized protocols. **Discussion:** *Taila* and *Ghrita* combine centuries of pharmaceutic refinement with principles analogous to modern lipid-based delivery platforms (phytosomes, lipid nanoparticles, self-emulsifying systems). Key gaps include rigorous pharmacokinetic profiling in humans, standardized manufacturing (SOPs, marker assays), and mechanistic elucidation (lymphatic transport quantitation, BBB penetration studies). **Conclusion:** *Taila* and *Ghrita* are traditional lipid-based delivery systems with plausible and demonstrable modern pharmacological advantages. Integrative research that standardizes preparations and applies contemporary pharmaceutics will enable evidence-based deployment of these formulations in modern therapeutics.

KEYWORDS: Drug delivery, *Ghrita*, lipid carrier, *Taila*, lipid-based

INTRODUCTION

Ayurvedic pharmaceutics has long recognized formulation as central to therapeutic action.[1] Among classical dosage forms, *Taila* (medicated oil) and *Ghrita* (medicated ghee) are widely used across therapeutic domains — from topical management of musculoskeletal disorders to systemic *rasayana* therapy for neurodegenerative and metabolic conditions.[2-3] Their selection in classical texts is guided by *guna* (qualities), *anupana* (vehicle), and *srotas* (channels), reflecting empirical observations of differential tissue targeting and systemic effects.[4]

Modern pharmaceutics treats lipids as privileged vehicles for drug delivery because they improve solubility of hydrophobic compounds, facilitate lymphatic transport, and enable modulation of absorption kinetics.[5] Contemporary lipid-based systems (liposomes, solid lipid nanoparticles, self-emulsifying drug delivery systems) exploit these same mechanisms to enhance bioavailability, reduce first-pass metabolism, and target tissues. Viewed through this lens, *Taila* and *Ghrita* can be conceptualized as traditional lipid vehicles with unique processing-induced properties (herbal-derived surfactants/biocapping, Maillard/thermal transformation products) that influence pharmacokinetics and pharmacodynamics.[6-7]

This review examines *Taila* and *Ghrita* as lipid-based drug-delivery systems. It integrates classical preparation principles and indications with contemporary mechanistic pharmacology, preclinical and clinical evidence, and regulatory/quality considerations.[8-9] The objectives are to (i) describe traditional preparation and rationales that influence delivery properties, (ii) summarize modern evidence on pharmacokinetics and tissue targeting, (iii) compare *Taila* vs *Ghrita* for specific therapeutic niches, and (iv) identify research gaps and practical pathways for standardization and translational development.[10]

MATERIALS AND METHODS

Search strategy and sources

A narrative integrative review was undertaken (search period: 1950–2025). Electronic databases searched were PubMed, Scopus, Web of Science, and the AYUSH Research Portal.[11] Classical sources consulted included *Charaka Samhita, Sushruta Samhita, Ashtanga Hridaya, Sharangdhara Samhita,* and *Rasashastra* texts (e.g., *Rasa Ratna Samuccaya, Rasatarangini*). Search terms combined traditional and modern keywords, for example: *"Taila,"* "medicated oil," "Ayurvedic *ghrita*," "medicated ghee," "lipid-based drug delivery," "intestinal lymphatic transport," "phytosome," and "medicated oil pharmacokinetics."[12]

Inclusion and exclusion criteria

Included were: pharmaceutics papers describing *Sneha Paka/ghrita* preparation; analytical studies (HPTLC/HPLC/GC-MS) comparing decoction, oil, and *ghrita*; in vitro/animal studies demonstrating lymphatic transport, brain uptake, transdermal permeation, or altered bioavailability;[13] clinical pilot trials or observational studies reporting therapeutic outcomes with *Taila/Ghrita;* and review articles on lipid carriers. Excluded were anecdotal reports without analytical or pharmacological data and non-translated classical commentaries where method detail was absent.[14]

Data extraction and synthesis

Data extraction covered formulation methods (ingredients, ratios, processing temperatures), physicochemical analyses (fatty acid profile, solubilized phytoconstituent spectra), pharmacokinetic endpoints (plasma/tissue levels, lymphatic recovery), pharmacodynamic outcomes (efficacy signals), safety/toxicity, and standardization approaches. Thematic synthesis was used to reconcile classical rationales with mechanistic data.[15]

OBSERVATION AND RESULTS

1. Classical formulation principles: *Sneha Paka* and *Ghrita Paka*

Ayurvedic pharmaceutics describes *Sneha* (oleaginous preparations) as vehicles that impart *sneha* (unctuousness), *sthairya* (stability), and *balya* (strengthening). Two principal processes are used:

- ***Taila* (oil) *Sneha Paka*:** oil is boiled with herbal decoction and herbal paste *(kalka)* until aqueous phase evaporates and oil becomes saturated with herbal principles. Common carriers: sesame oil *(til taila)*, coconut oil, or other fixed oils chosen for *virya* and absorption attributes.
- ***Ghrita* (ghee) *Sneha Paka*:** ghee (clarified butter) is used instead of oil or is prepared by processing oil/ghee with decoction and *kalka.*

Ghrita preparations use dairy fat, imparting unique saturated/unsaturated lipid profiles and may include fermentation steps *(kshira* or milk infusion).

Classically, choice of vehicle is disease- and tissue-specific: *Taila* for local application (*Abhyanga, Anuvasana Basti*), and *Ghrita* for internal administration aimed at deeper tissues (brain, bone marrow) and rejuvenation (*rasayana*). Processing cycles, temperature control, and repeated trituration *(bhavana)* are stated to modulate therapeutic potency and safety.

2. Physicochemical transformations during *Sneha Paka*

Modern analyses show the *Sneha Paka* process is not mere mixing: it is a complex extraction, emulsification and thermal transformation sequence.

- **Extraction:** Lipophilic phytoconstituents (triterpenes, sterols, essential oil fractions) preferentially partition into the lipid phase. Some polar constituents undergo thermal hydrolysis to more lipophilic aglycones, increasing their oil-solubility.
- **Emulsification:** During processing, vegetable lecithins, saponins, and proteins from the kalka/decoction act as natural surfactants, creating stable micro/nano-emulsions within the oil/ghee matrix, enhancing dispersion.
- **Thermal and Maillard reactions:** Controlled heating induces Maillard-like and other thermal modification products, which can change pharmacology (e.g., increased antioxidant or immunomodulatory activity in some cases).
- **Lipid composition:** *Ghrita* has a complex mix of triglycerides, short-chain fatty acids, and conjugated fatty acids that affect melting point, lymphatic uptake potential, and organ distribution.

3. Mechanistic parallels with modern lipid-based systems

A. Enhanced solubility and absorption of lipophiles

Like phytosome or lipid nanoparticle systems, *Taila/Ghrita* improves solubility of poorly water-soluble bioactives, enabling higher intestinal absorption. Lipid solubilization often increases dissolution rate and GI residence.

B. Lymphatic transport and first-pass avoidance

Lipid vehicles stimulate chylomicron formation; large lipophilic drug–lipid complexes are taken up via intestinal lymphatics, bypassing hepatic first-pass metabolism. This has been observed for other lipid formulations and is plausibly active with medicated *ghritas*/oils—explaining enhanced systemic levels of lipophilic actives.

C. CNS penetration

Lipid carriers can facilitate blood–brain barrier (BBB) access for selected lipophilic agents. Classical use of *ghrita* for *medhya* (neuropsychiatric) conditions aligns with modern findings that lipid vehicles promote brain delivery of certain phytochemicals.

D. Transdermal and local depot effects

Topical *Taila* applications, often with friction *(Abhyanga),* increase local temperature, enhance skin permeability, and create oil depots that release actives slowly — analogous to contemporary transdermal lipid matrices.

E. Immunomodulation and anti-inflammatory activity

Lipid matrices can alter pharmacodynamics by modifying local cytokine milieu and cell membrane composition; some medicated *ghritas* show modulation of inflammatory markers in preclinical models.

4. Comparative therapeutic niches: *Taila vs Ghrita*

- ***Taila* (Topical / Local / Panchakarma routes):** Preferred for musculoskeletal disorders (arthritis, sprains), dermatologic conditions (oil massages for localized disorders), and as an external medium for medicated enemas *(Anuvasana/Anuvasana Basti).* Advantages: ease of application, high local concentration, thermal modulation enhancing permeation.
- ***Ghrita* (Internal / Systemic / *Rasayana*):** Preferred for chronic degenerative and neurological conditions (memory disorders, neurodegeneration), pediatric and geriatric nourishment, and post-partum rejuvenation. Advantages: systemic nourishment, lymphatic uptake, potential BBB penetration, and palatability for long-term internal therapy.

5. Evidence from analytical, preclinical and

clinical studies

Analytical studies: HPTLC/GC-MS profiling of *Taila/Ghrita* formulations demonstrate enrichment of lipophilic marker compounds (e.g., arjunolic acid in *Arjuna ghrita*; bacosides in *Brahmi ghrita*) not present in corresponding aqueous decoctions. Particle-size analyses reveal micro-/nano-emulsion structures stabilised by natural surfactants.

Pharmacokinetic and mechanistic reports: Animal studies report higher plasma/tissue levels of lipophilic phytoconstituents after lipid-vehicle administration than with aqueous extracts. Lymphatic recovery studies in rodents (using labeled lipids) show significant chylomicron-associated transport of co-administered lipophiles, consistent with first-pass bypass.

Preclinical efficacy: *Taila* shows wound-healing, anti-inflammatory, and analgesic effects in topical models. *Ghrita* formulations demonstrate neuroprotective and hepatoprotective trends in rodent studies. Many studies are pilot and heterogeneous in methodology.

Clinical observations and pilot trials: Small randomized and observational studies (pilot RCTs / case series) report symptomatic benefit in osteoarthritis with medicated oils (*Abhyanga* + localized *Taila* therapy), cognitive improvement with medicated *ghrita (Brahmi ghrita*), and improved wound healing when medicated oils are used. Safety data from standardized *ghrita* preparations indicate good tolerability when prepared under quality controls; caloric load and lipids must be considered in metabolic patients.

6. Pharmaceutical development and standardization issues

- **SOPs and batch consistency:** Variability in raw materials, decoction strength, heating duration, and *kalka* ratios causes batch heterogeneity. Developing validated SOPs with in-process controls (temperature, time, ratio) and chemical fingerprints (HPLC/HPTLC markers) is critical.
- **Quality control:** Testing should include fatty acid profile, marker compound quantification, microbial limits, peroxide value (rancidity), and absence of contaminants (pesticide residues, heavy metals).
- **Formulation modernization:** Opportunities include microencapsulation of medicated oil fractions, self-emulsifying *ghrita* formulations, and combining traditional *Sneha Paka* with modern excipients to improve stability and targeted delivery.

DISCUSSION

Taila and *Ghrita* are traditional lipid-based delivery platforms that remarkably anticipate several modern drug delivery principles. Classical selection of vehicle (oil vs ghee), processing steps *(Sneha Paka, bhavana),* and administration routes (topical, internal, enema) represent a nuanced pharmaceutic logic for targeting tissues and modulating therapeutic kinetics. Modern pharmacology confirms several of these rationales: lipid matrices enhance solubilization and lymphatic transport, facilitate CNS uptake for selected lipophiles, and provide depot and transdermal effects.[16]

Therapeutic implications. For hydrophobic plant actives (withanolides, arjunolic triterpenes, curcuminoids), *Taila/Ghrita* processing increases oil-phase loading and possibly oral bioavailability. The observed clinical efficacy of *ghrita* for cognitive and rejuvenative purposes may be partially explained by improved brain exposure to lipophilic neuroactives and systemic nutrient delivery via lymphatics. *Taila* remains unmatched for localized musculoskeletal delivery, combining mechanical (massage) and pharmacological (lipid depot) effects.[17]

Limitations and research gaps. Despite promising mechanistic congruence, high-quality human pharmacokinetic data are scarce. Most studies are small, heterogeneous in methods, and often lack standardization of formulations. Quantitative demonstrations of lymphatic uptake of specific Ayurvedic phytochemicals after *ghrita* or *taila* administration in humans are missing. The caloric load of *ghrita* is a practical limitation in metabolic disease; dose optimization and alternative lipid matrices (low-calorie phospholipid vehicles) can be explored. Safety concerns arise mainly from non-standard preparations (oxidation/rancidity, microbial contamination, inconsistent herb selection).[18]

Translational prospects. Integrative research pathways include (1) establishing GMP-grade SOPs for *Sneha Paka* with defined marker assays; (2) pharmacokinetic studies using labeled

phytochemicals to measure lymphatic transport and tissue distribution; (3) head-to-head clinical trials comparing aqueous decoctions, medicated oil/*ghrita*, and modern lipid carriers (phytosomes) for the same phytochemical; and (4) formulation innovations (self-emulsifying *ghrita*, nano-emulsions) that preserve traditional processing benefits while meeting regulatory standards.[19]

Regulatory and educational aspects. To gain acceptance in mainstream pharmaceutics, *Taila* and *Ghrita* must be subjected to modern quality, safety, and efficacy frameworks. Ayurvedic pharmacopeial standards (Ayurvedic Pharmacopoeia of India) provide a starting point, but harmonized international monographs, validated analytical methods, and pharmacovigilance are needed.[20]

CONCLUSION

Taila and *Ghrita* are sophisticated traditional lipid-based drug delivery systems that combine empirical pharmaceutic wisdom with mechanisms now well understood in modern pharmaceutics. Through *Sneha Paka* and *Ghrita Paka*, Ayurveda creates lipid matrices that extract, stabilize, and deliver bioactive phytoconstituents in ways that enhance solubility, promote lymphatic transport, facilitate CNS access for lipophiles, and create local depots for sustained release. *Taila* is especially suited for topical and local musculoskeletal therapy and for routes such as medicated enemas, while *Ghrita* is tailored for systemic nourishment, rejuvenation, and neuro-targeted therapy.

To translate these advantages into evidence-based clinical tools requires robust standardization (SOPs, analytical fingerprints), quantitative pharmacokinetic studies (including lymphatic transport and brain uptake), and well-designed clinical trials. Modern formulation science (emulsions, phytosomes, lipid nanoparticles) can learn from and be synergistically combined with traditional *Sneha Paka* to develop hybrid formulations that meet contemporary safety, stability, and regulatory requirements while preserving the therapeutic rationale of *Taila* and *Ghrita*.

In summary, *Taila* and *Ghrita* exemplify a centuries-old lipid delivery platform with clear contemporary relevance. With rigorous research and standardized production, these formulations could provide culturally congruent, pharmaceutically sound lipid-based therapies for a range of acute and chronic conditions.

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