

Analytical Standardization and Fatty Acid Profiling of Brahmi Ghrita: A Physicochemical Evaluation of a Classical Ayurvedic Medicated Ghee

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ABSTRACT

Background: Brahmi Ghrita is a classical Ayurvedic medicated ghee widely used as a Medhya Rasayana for cognitive and neurological disorders. Standardization and analytical evaluation are essential to ensure the quality, purity, and therapeutic reliability of herbal formulations.

Objective: To evaluate the physicochemical parameters and fatty acid profile of prepared Brahmi Ghrita through analytical standardization.

Materials and Methods: Brahmi Ghrita was prepared according to the guidelines of the Ayurvedic Formulary of India (AFI) in the Rasashastra Department under expert supervision. The prepared sample was analyzed at Patanjali Research Foundation, Haridwar (Report No. PRF/2025/0029). Physicochemical parameters including acid value, peroxide value, iodine value, saponification value, refractive index, and density were assessed. Fatty acid profiling was carried out using GC-FID analysis.

Results: The analytical study showed acid value 0.37, peroxide value 0.95 meq/kg, iodine value 19.86, saponification value 357.83, refractive index 1.4618, and density 0.8919 g/mL, indicating good stability and low oxidative degradation. GC-FID analysis identified major fatty acids including palmitic acid (29.68%), stearic acid (9.88%), myristic acid (9.22%), oleic acid (8.79%), linoleic acid (2.08%), and butyric acid (2.82%).

Conclusion: The analytical parameters confirmed the quality and stability of Brahmi Ghrita. The presence of biologically important fatty acids supports its therapeutic potential and validates its classical Ayurvedic utility.

Keywords: Brahmi Ghrita, Analytical Standardization, Physicochemical Analysis, GC-FID, Fatty Acid

Profile, Ayurvedic Formulation

INTRODUCTION

Ayurvedic formulations require proper standardization and quality control to ensure safety, efficacy, and reproducibility. Brahmi Ghrita is a classical medicated ghee described in Ayurvedic texts as a Medhya Rasayana, commonly indicated in disorders affecting cognition and mental functions. Ghrita-based formulations possess unique lipid-mediated drug delivery properties that enhance the absorption and bioavailability of herbal constituents.

Analytical evaluation of Ayurvedic formulations through physicochemical testing and chromatographic profiling plays an important role in validating traditional claims and establishing pharmaceutical standards. Parameters such as acid value, peroxide value, iodine value, and saponification value are important indicators of purity, stability, rancidity, and quality of lipid-based preparations.

Fatty acid profiling further helps in identifying biologically active constituents that may contribute to therapeutic activity. Therefore, the present study was undertaken to evaluate the analytical parameters and fatty acid composition of prepared Brahmi Ghrita.

MATERIALS AND METHODS

Preparation of Brahmi Ghrita

The formulation was prepared in the Rasashastra Department according to the guidelines mentioned in the Ayurvedic Formulary of India (AFI). Raw drugs were authenticated prior to use. Preparation included:

- Preparation of Kalka
- Preparation of Kwatha
- Addition of Go Ghrita
- Heating according to Sneha Paka Siddhi Lakshana
- Filtration and storage in airtight containers

Analytical Study

The prepared sample of Brahmi Ghrita was analyzed at Patanjali Research Foundation, Haridwar (Report No. PRF/2025/0029).

Sample Details

| Parameter | Details |
|---------------------------|--------------------|
| Sample Described as | Brahmi Ghrit |
| Sample Quantity | 50 g |
| Sample Code | PRF/CHIN/1025/1409 |
| Date of Receipt of Sample | 17/10/2025 |
| Analysis Start Date | 30/10/2025 |
| Analysis Completion Date | 07/11/2025 |
| Test Report Date | 07/11/2025 |

Parameters Evaluated

- Colour

- Odor
- Acid value
- Iodine value
- Peroxide value
- Saponification value
- Refractive index
- Density

Fatty acid composition was analyzed using Gas Chromatography–Flame Ionization Detection (GC-FID).

RESULTS

Organoleptic and Physicochemical Parameters of Brahmi Ghrita

| S. No. | Test Parameter | Method | Result |
|--------|----------------------|------------------|----------------------|
| 1 | Colour | Organoleptic | Dark yellow granular |
| 2 | Odor | Organoleptic | Characteristic |
| 3 | Acid value | IS: 548 | 0.37 |
| 4 | Iodine value | IS: 548 | 19.86 |
| 5 | Peroxide value | IS: 548 | 0.95 meq/kg |
| 6 | Saponification value | IS: 548 | 357.83 |
| 7 | Refractive index | By refractometer | 1.4618 |
| 8 | Density | In-house | 0.8919 g/mL |

The obtained values indicate low oxidative degradation and good stability of the formulation.

Fatty Acid Profile

| Fatty Acid | Percentage |
|---------------|------------|
| Palmitic Acid | 29.68% |
| Stearic Acid | 9.88% |
| Myristic Acid | 9.22% |
| Oleic Acid | 8.79% |
| Linoleic Acid | 2.08% |
| Butyric Acid | 2.82% |

DISCUSSION

Standardization and analytical evaluation of Ayurvedic formulations are essential for ensuring quality assurance, reproducibility, safety, and therapeutic efficacy. In classical Ayurvedic pharmaceuticals, Ghrita Kalpana is considered one of the most effective dosage forms because of its unique ability to absorb lipid-soluble active constituents and deliver them to deeper tissues, including the central nervous system. However, despite their extensive therapeutic use, many traditional formulations lack comprehensive scientific validation. Therefore, the present analytical study was undertaken to establish the physicochemical profile and fatty acid composition of Brahmi Ghrita using modern analytical parameters.

The organoleptic examination of the prepared formulation revealed a dark yellow granular appearance with characteristic odor, indicating proper processing and successful completion of Sneha Paka.

Organoleptic parameters are considered the preliminary indicators of quality assessment in Ayurvedic pharmaceuticals and are useful for identifying deviations in preparation, storage, or raw material quality. The granular consistency observed in the formulation may be attributed to the herbal lipid interactions occurring during processing.

The acid value of Brahmi Ghrita was found to be 0.37, which is significantly low and reflects minimal hydrolytic decomposition of triglycerides. Acid value represents the amount of free fatty acids liberated due to hydrolysis and is one of the most important indicators of lipid deterioration. Increased acid value generally indicates rancidity, poor storage conditions, microbial degradation, or prolonged exposure to moisture and heat. The low acid value observed in the present study indicates that the formulation was prepared under proper pharmaceutical conditions using high-quality raw materials and controlled heating procedures. It also confirms the freshness and stability of the lipid base.

From a pharmaceutical perspective, maintaining a low acid value is important because free fatty acids generated during rancidity may reduce therapeutic efficacy and alter the organoleptic properties of medicated ghee. The obtained result therefore validates the pharmaceutical acceptability of the prepared sample.

The peroxide value of the formulation was observed to be 0.95 meq/kg, indicating very low oxidative rancidity and minimal lipid peroxidation. Peroxide value measures the concentration of peroxide compounds formed during oxidation of fats and oils. Oxidative degradation of lipids results in the formation of reactive oxygen species and secondary toxic metabolites, which may adversely affect the quality and safety of the formulation.

The low peroxide value obtained in this study suggests excellent oxidative stability of Brahmi Ghrita. This stability may be attributed to the naturally high saturated fatty acid content of ghee along with the antioxidant phytoconstituents present in Brahmi and other herbal ingredients. Antioxidant compounds such as bacosides, flavonoids, and phenolic constituents present in Brahmi are known to inhibit free radical generation and lipid peroxidation.

Oxidative stress is considered one of the major mechanisms involved in neurodegenerative and neurodevelopmental disorders. Therefore, the low peroxide value not only indicates pharmaceutical stability but may also indirectly support the therapeutic potential of the formulation in neurological conditions.

The iodine value of the prepared formulation was found to be 19.86. Iodine value represents the degree of unsaturation of fatty acids present in fats and oils. Lower iodine values indicate higher saturation, whereas higher values indicate increased unsaturation and susceptibility to oxidation. The moderate iodine value observed in the present study reflects the presence of both saturated and unsaturated fatty acids in balanced proportions.

Unsaturated fatty acids such as oleic acid and linoleic acid identified in the formulation are biologically important because they contribute to neuronal membrane fluidity, neurotransmitter function, cellular signaling, and inflammatory regulation. Essential fatty acids are necessary for normal brain development and cognitive function. Thus, the iodine value indirectly reflects the neurobiological significance of the fatty acid composition of Brahmi Ghrita.

The saponification value of the formulation was found to be 357.83, which is comparatively high and indicates the predominance of lower molecular weight fatty acids. Saponification value represents the amount of alkali required to hydrolyze fats and is inversely proportional to the average molecular weight of fatty acids.

A high saponification value is considered beneficial in lipid-based formulations because lower molecular weight fatty acids are more readily digestible and absorbable. This property may facilitate faster metabolism and improved bioavailability of the formulation. In Ayurvedic terms, this correlates with the Sukshma and Vyavayi properties of Ghrita, which enable rapid systemic distribution and penetration into minute channels.

The refractive index of 1.4618 obtained in the study confirms the purity and homogeneity of the formulation. Refractive index is an important physicochemical parameter used to assess the identity and quality of lipid-based substances. Significant deviation in refractive index may indicate adulteration or degradation. The observed value lies within acceptable limits for medicated ghee preparations and supports the pharmaceutical integrity of the sample.

Similarly, the density value of 0.8919 g/mL further supports the consistency and uniform composition of the formulation. Density determination is useful in standardizing manufacturing processes and ensuring reproducibility between batches.

GC-FID analysis of Brahmi Ghrita revealed the presence of several important fatty acids including palmitic acid, stearic acid, myristic acid, oleic acid, linoleic acid, and butyric acid. The chromatographic profiling provides a scientific basis for understanding the pharmacological potential of the formulation.

Palmitic acid was identified as the major fatty acid constituent with a concentration of 29.68%. Palmitic acid is a saturated fatty acid that contributes to the structural stability and oxidative resistance of lipid formulations. Its predominance may partly explain the low peroxide value and enhanced shelf stability of the formulation.

Stearic acid (9.88%) and myristic acid (9.22%) were also identified in considerable amounts. These saturated fatty acids are important for maintaining physicochemical stability and preventing rapid oxidative deterioration. Moreover, saturated fatty acids in ghee are known to improve lipid absorption and facilitate transport of fat-soluble phytoconstituents.

Oleic acid constituted 8.79% of the fatty acid profile. Oleic acid is a monounsaturated fatty acid with established anti-inflammatory, antioxidant, and neuroprotective properties. It contributes to membrane fluidity and neuronal signaling and has been associated with improved cognitive functions and reduced neuroinflammation.

Linoleic acid was present at 2.08%. Although present in smaller quantities, linoleic acid is an essential polyunsaturated fatty acid with significant physiological importance. It plays an important role in maintaining neuronal membrane integrity, synaptic transmission, inflammatory modulation, and cellular metabolism.

Scientific studies have demonstrated altered fatty acid metabolism and deficiency of essential fatty acids in various neurodevelopmental disorders. Therefore, the presence of linoleic acid in Brahmi Ghrita may contribute to its beneficial role in improving neuronal function and maintaining neurochemical balance.

The presence of butyric acid (2.82%) is particularly noteworthy because of its established pharmacological and neurobiological significance. Butyric acid is a short-chain fatty acid naturally present in cow ghee and is widely recognized for its anti-inflammatory, antioxidant, immunomodulatory, and gut-protective effects.

Modern research indicates that butyrate acts as a histone deacetylase inhibitor and influences gene expression related to neuronal survival, neuroplasticity, and immune regulation. It also improves mitochondrial function and reduces oxidative stress, which are important mechanisms in neurological disorders.

Another important aspect of butyric acid is its role in regulating the gut-brain axis. Gut microbiota dysbiosis and reduced levels of beneficial short-chain fatty acids have been implicated in several neurodevelopmental and psychiatric disorders. Butyrate helps maintain intestinal epithelial integrity, reduces gut inflammation, and modulates communication between the gut and brain through neural, endocrine, and immune pathways.

The presence of butyric acid in Brahmi Ghrita therefore provides scientific support for its traditional use in conditions affecting cognition, memory, behavior, and mental functions.

From an Ayurvedic perspective, Brahmi Ghrita is categorized as a Medhya Rasayana and is indicated in disorders involving impairment of Smriti, Buddhi, Dhi, Dhriti, and Manas. Ghrita is described in classical texts as Smritivardhaka, Agnivardhaka, Balya, and Vata-Pitta Shamaka. It nourishes Majja Dhatu and enhances mental functions.

The lipid medium of Ghrita acts as an excellent carrier for delivering active herbal constituents across biological membranes. Modern pharmacological studies suggest that lipid-based formulations may cross the blood-brain barrier more efficiently, thereby improving central nervous system delivery.

The concept of Samskara Anuvartana described in Ayurveda explains that Ghrita acquires and potentiates the pharmacological properties of the drugs processed within it. Thus, processing of Brahmi in Ghrita enhances its therapeutic efficacy and bioavailability.

The presence of biologically active fatty acids identified through GC-FID analysis scientifically validates these classical Ayurvedic concepts. The synergistic interaction between herbal phytoconstituents and lipid components may contribute to antioxidant, neuroprotective, anti-inflammatory, and cognitive-enhancing activities.

Therefore, the present analytical report successfully establishes the standardization profile of Brahmi Ghrita through objective scientific parameters. The favorable physicochemical values, oxidative stability, and presence of pharmacologically important fatty acids collectively support the pharmaceutical quality and therapeutic relevance of the formulation.

CONCLUSION

The present analytical study established the standardization profile of Brahmi Ghrita through physicochemical evaluation and fatty acid analysis. The formulation showed good stability with low oxidative degradation. GC-FID profiling confirmed the presence of biologically important fatty acids including palmitic acid, oleic acid, linoleic acid, and butyric acid. These findings support the quality, purity, and potential therapeutic value of the formulation.

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