Pharmacogn. Res., 2026; 18(4):1112-1116.
https://www.phcogres.com

Review Article

Phytochemical Insights into Ayurvedic Taila Therapy for Spasticity in Cerebral Palsy: A Narrative Review with GC-MS Support

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ABSTRACT

Sahacharadi Taila, a classical Ayurvedic medicated oil, is traditionally prescribed for neuromuscular stiffness and Vata-dominant disorders. Understanding its pharmacological relevance through modern analytical techniques can bridge Ayurvedic principles and biomedical science, particularly in the context of spastic Cerebral Palsy (CP). A narrative review was conducted integrating Ayurvedic literature, contemporary biomedical evidence, and phytochemical data derived from documented GC-MS analyses of Sahacharadi Taila and comparable oils. The author's unpublished analytical dataset (2025) was cross-referenced with PubMed- and Scopus-indexed studies to validate constituent profiles. Comparative analyses included Ksheerabala Taila, Mahamasha Taila, Balaswagandhadi Tailam, and Dhanwanthari Taila. GC-MS profiling of Sahacharadi Taila revealed the predominance of lauric, oleic, and linoleic acids, eugenol, sterols, and tocopherols-compounds known for antioxidant, anti-inflammatory, and neuromodulatory actions. Similar lipid-sterol-phenolic motifs were observed across other tailas, supporting their therapeutic roles in rigidity, spasticity, and neuromuscular dysfunction. These bioactive groups correspond to the Snigdha (unctuous), Mridu (soft), and Sukshma (penetrative) qualities described in Ayurveda, reflecting their potential to pacify aggravated Vata and restore tissue flexibility. The convergence of GC-MS findings and Ayurvedic theory provides a strong mechanistic rationale for the use of Sahacharadi Taila in spastic CP. Shared phytochemical patterns across related oils affirm the scientific plausibility of medicated oil therapy as an integrative, evidence-based approach to managing neuromuscular disorders.

Keywords: Antioxidant activity, Ayurveda, GC-MS analysis, Phytochemical profiling, Spastic cerebral palsy.

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Received: 13-04-2026;
Revised: 28-05-2026;
Accepted: 08-07-2026.

INTRODUCTION

Cerebral Palsy (CP) is a group of permanent disorders of movement and posture caused by non-progressive disturbances in the developing brain, leading to activity limitations and secondary musculoskeletal complications (Surveillance of Cerebral Palsy in Europe [SCPE], 2002). It remains the most common cause of chronic childhood disability, with a global prevalence estimated between 2 and 3 per 1,000 live births, and a higher burden in low- and middle-income countries due to perinatal asphyxia, prematurity, and infection-related insults (SCPE, 2002). Among its clinical subtypes, spastic cerebral palsy accounts for nearly 70-80% of all cases, manifesting as hypertonia, clonus, and restricted joint mobility secondary to upper motor neuron lesions (Matthews and Balaban, 2009).

Conventional management of spasticity primarily includes physiotherapy, botulinum toxin injections, oral muscle relaxants such as baclofen and diazepam, and in severe cases, orthopedic or neurosurgical interventions. While effective in reducing tone, these interventions are often limited by transient efficacy, adverse effects, cost, and the need for repeated administration (Matthews and Balaban, 2009). From an Ayurvedic perspective, this condition can be correlated with Snayugata Vikara Vatavyadhi, where imbalance of Vata and Kapha doshas produces features such as Sthambha, Kampa, Sula, and Akshepa (Shastri, 2011; Sharma and Dash, 2016; Tewari, 2020). Classical texts also describe manifestations including Cesta Nasa, Lala Srava, Mukatwa, Ardita, Pangu, Jadatwa, Hata-ekapaksha, Mukha Vakrata, and Lalasrava, many of which are clinically evident in children with cerebral palsy. The Ayurvedic features of Sthambha and Sankocha closely parallel spasticity, wherein velocity-dependent loss of

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DOI: 10.5530/pres.20260243

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stretch reflex leads to limb stiffness (Sharma and Dash, 2016; Tewari, 2020).

The use of medicated oils, administered internally or externally, forms a cornerstone of Ayurvedic management of Vata disorders. Oils such as Ksheerabala Taila, Mahamasha Taila, Balaswagandhadi Taila, Dhanwanthari Taila, and Sahacharadi Taila are traditionally indicated in paralysis, muscular stiffness, and spastic conditions (Bhinde *et al.*, 2014). Their therapeutic rationale lies in restoring Snigdha and Mridu guna, counteracting the Ruksha and Sita attributes of aggravated Vata.

Recent advances in analytical chemistry, particularly Gas Chromatography-Mass Spectrometry (GC-MS), have enabled phytochemical profiling of these oils, revealing complex mixtures of fatty acids, sterols, terpenoids, and phenolic compounds with established anti-inflammatory, neuromodulatory, and antioxidant properties (Sah, 2021; Harini *et al.*, 2023). Among these formulations, Sahacharadi Taila-containing *Barleria prionitis* and other synergistic herbs-demonstrates a distinctive GC-MS fingerprint rich in lauric acid, oleic acid, linoleic acid, and eugenol, compounds implicated in neuronal modulation, membrane stabilization, and muscle relaxation (Sharma and Sinha, 2020).

This narrative review synthesizes classical Ayurvedic descriptions and contemporary biochemical evidence on medicated oils used in spastic cerebral palsy, with particular emphasis on Sahacharadi Taila. By integrating GC-MS findings with Ayurvedic pharmacological concepts, the review aims to contextualize taila therapy within an integrative framework for managing neuromuscular spasticity.

MATERIALS AND METHODS

Review Design

This narrative review integrates classical Ayurvedic literature, contemporary biomedical research on spastic cerebral palsy, and phytochemical evidence from documented GC-MS analyses of traditional medicated oils. The narrative approach accommodates heterogeneity in formulations and analytical methodologies while enabling synthesis across textual, experimental, and clinical domains.

Sources of Information

Ayurvedic data were compiled from authoritative classical texts and contemporary commentaries describing medicated oils indicated in Vata-dominant and neuromuscular disorders (Sharma and Dash, 2016; Tewari, 2020). Oils included Ksheerabala Taila, Mahamasha Taila, Balaswagandhadi Tailam, Dhanwanthari Taila, and Sahacharadi Taila (Bhinde *et al.*, 2014; Bhat and Pandit, 2020).

Phytochemical data were obtained from published GC-MS studies characterizing volatile and semi-volatile constituents of Ayurvedic oils, including fatty acids, sterols, tocopherols, phenolics, and terpenoids (Sah, 2021). GC-MS data on Sahacharadi Taila were additionally derived from an original unpublished analytical dataset generated by the authors (2025), cross-referenced with published studies to ensure consistency (Harini *et al.*, 2023; Sharma and Sinha, 2020).

Search Strategy

Literature relating to Ayurvedic management of neuromuscular rigidity, GC-MS profiling of classical tailas, and biomedical mechanisms of spasticity was reviewed. Priority was given to sources elucidating therapeutic indications, chemical composition, and mechanistic relevance to spastic cerebral palsy.

Eligibility Criteria

Sources were included if they described medicated oils indicated for Vata disorders or spasticity, reported identifiable GC-MS constituents, or provided classical descriptions correlatable with modern biochemical pathways.

GC-MS Analytical Framework

Published GC-MS workflows were reviewed to contextualize phytochemical findings, encompassing sample preparation, chromatographic separation, mass spectral analysis, and compound identification through reference libraries such as NIST and Wiley (Sah, 2021).

RESULTS

GC-MS analysis of Sahacharadi Taila revealed a chemically rich formulation comprising fatty acids, phenolic compounds, esters, terpenoids, and sterols. Lauric acid, oleic acid, linoleic acid, and eugenol were consistently identified, forming a bioactive matrix with neuromodulatory, antioxidant, and anti-inflammatory potential (Sharma and Sinha, 2020; Harini *et al.*, 2023). These properties align with traditional indications for stiffness, impaired mobility, and neuromuscular dysfunction (Bhinde *et al.*, 2014).

Comparative analysis demonstrated shared phytochemical patterns across oils. Ksheerabala Taila showed hexadecanoic acid, tocopherols, and phytosterols supportive of neuroprotection (Singh *et al.*, 2019). Mahamasha Taila contained aromatic esters and benzoic acid derivatives associated with analgesic and anti-spasmodic actions (Duraipandiyan and Ignacimuthu, 2017). Balaswagandhadi Tailam exhibited vitamin E homologs and sterols consistent with anti-inflammatory and nutritive effects (Pandey and Gupta, 2021). Dhanwanthari Taila showed fatty-acid profiles aligned with musculoskeletal analgesia (Tiwari *et al.*, 2022). A comparative summary of the GC–MS constituents and their therapeutic relevance across the reviewed Ayurvedic oils is presented in Table 1.

The GC–MS analysis of Sahacharadi Taila produced a well-resolved total ion chromatogram, demonstrating the presence of multiple

volatile and semi-volatile phytochemical constituents shown in Figure 1. Individual compounds were identified based on their retention times and corresponding mass spectral fragmentation patterns. Representative mass spectral data illustrating compound identification are shown in Figure 2, confirming the presence of characteristic bioactive constituents detected in the formulation.

DISCUSSION

The phytochemical patterns observed demonstrate coherence between classical Ayurvedic indications and biochemical activities. Fatty acids, sterols, tocopherols, and phenolics contribute to membrane stabilization, antioxidant protection, and modulation of inflammation and muscle tone, paralleling Ayurvedic concepts of Snigdha, Mridu, and Sukshma guna (Sharma and Dash, 2016). Sahacharadi Taila's distinctive eugenol content may offer additional neuromodulatory benefits relevant to spastic cerebral palsy (Sharma and Sinha, 2020).

The convergence of classical textual knowledge and GC-MS evidence underscores the value of analytical chemistry in validating traditional therapeutics. While these findings support the integrative use of medicated oils, further pharmacodynamic and clinical studies are required to establish efficacy and optimize application in pediatric spasticity.

Table 1: Comparative GC-MS Profiles of Ayurvedic Oils Used in Neuromuscular/Vata Conditions.

Taila Name	Key GC-MS Constituents	Therapeutic Relevance
Ksheerabala Taila	n-Hexadecanoic acid; 15-Hydroxypentadecanoic acid; Hexadecanoic acid esters; γ-Tocopherol; γ-Sitosterol.	Used in neuromuscular pain, paralysis, myalgia, Vata disorders.
Mahamasha Taila	n-Hexadecanoic acid; n-Decanoic acid; 2,6-Difluoro-3-methylbenzoic acid; 2,3-Dichlorophenyl ester; propane; 2-methoxy-2-methyl-.	Applied in paralysis, muscle stiffness, Vata rigidity.
Balaswagandhadi Tailam	Tetradecanedioic acid; Octadecanoic acid; β-Eudesmol trimethylsilyl ether; 1-Heptatriacotanol; Vitamin E; Campesterol; γ-Sitosterol.	Indicated in muscle weakness, neuralgia, arthritic pain.
Dhanwanthari Taila	Glycidyl palmitoleate; Oleic acid; Hexadecanoic acid derivatives.	Used for musculoskeletal pain relief and inflammation.
Sahacharadi Taila	Lauric acid; Eugenol; Oleic acid; Linoleic acid; and additional neuromodulatory and antioxidant compounds.	Employed in spasticity, stiffness; modern GC-MS supports its therapeutic use.

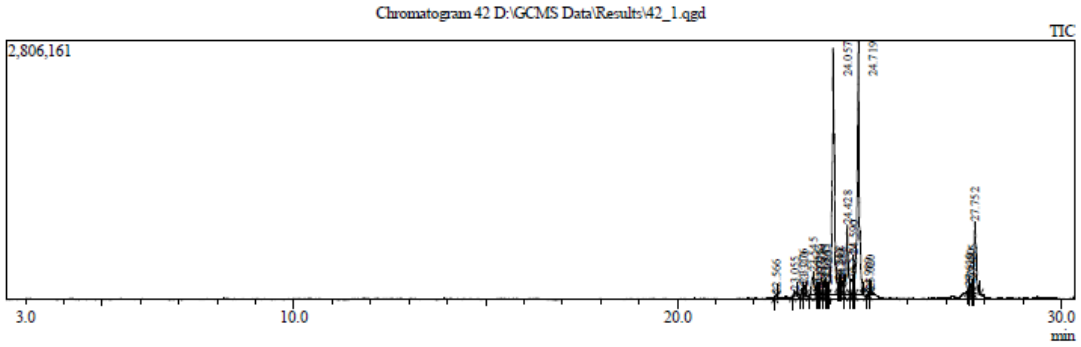

Figure 1: Chromatogram 42.

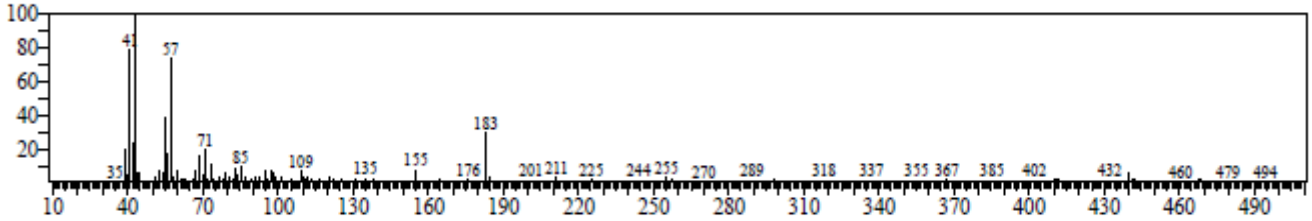

Figure 2: Line#:1 R.Time:22.565(Scan#:4014) MassPeaks:304. RawMode:Averaged 22.560-22.570(4013-4015) BasePeak:43.05(3767). BG Mode:Calc. from Peak Group 1 - Event 1 Scan.

FUTURE DIRECTIONS AND RESEARCH GAPS

Future studies should focus on pharmacodynamic validation, standardized GC-MS profiling across batches, and well-designed clinical trials evaluating functional outcomes in children with spastic cerebral palsy. Integrating biochemical markers with clinical spasticity scales may further strengthen the translational relevance of Ayurvedic taila therapy.

CONCLUSION

This review highlights strong concordance between Ayurvedic pharmacology and GC-MS findings of Sahacharadi Taila and related medicated oils. The presence of fatty acids, sterols, phenolics, and tocopherols provides a biochemical rationale for their traditional use in neuromuscular stiffness and spasticity. Sahacharadi Taila, distinguished by eugenol and diverse fatty acids, shows particular promise for spastic cerebral palsy, affirming the scientific plausibility of Ayurvedic taila therapy as an integrative approach to neuromuscular rehabilitation.

ACKNOWLEDGEMENT

We would like to express our heartfelt gratitude to faculties of department of Kaumarabhritya KLE Shri BMK Ayurveda Mahavidyalaya Belagavi, Karnataka for their support and guidance.

ABBREVIATIONS

CP: Cerebral palsy; **GC-MS:** Gas chromatography-mass spectrometry; **SCPE:** Surveillance of Cerebral Palsy in Europe; **NIST:** National Institute of Standards and Technology; **Wiley:** Wiley Registry of Mass Spectral Data.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS

Dr. Jeeru Ojaswini Reddy conceptualized the study, performed the literature review, and drafted the manuscript.

Dr. Jain Aditi ajay contributed to Ayurvedic interpretation and manuscript revision. Dr. Akshay Manik Khot provided critical review and supervision.

All authors approved the final manuscript.

SUMMARY

This narrative review explores the scientific basis of Ayurvedic medicated oil (taila) therapy in the management of spasticity in cerebral palsy, with particular emphasis on Sahacharadi Taila. Spastic cerebral palsy, the most common subtype of CP, is characterized by muscle hypertonia, stiffness, and restricted mobility, and conventional treatments often provide only temporary relief with notable limitations.

The review integrates classical Ayurvedic concepts of Vata-dominant neuromuscular disorders with modern phytochemical evidence generated through Gas Chromatography-Mass Spectrometry (GC-MS). Traditional descriptions of conditions such as *Snayugata Vikara Vatavyadhi* and features like *Sthambha* and *Sankocha* are correlated with the clinical and neurophysiological manifestations of spasticity.

GC-MS profiling of Sahacharadi Taila demonstrates a predominance of fatty acids (lauric, oleic, linoleic acids), phenolic compounds (eugenol), sterols, and tocopherols, all of which possess documented anti-inflammatory, antioxidant, and neuromodulatory properties. Comparative analysis with other commonly used Ayurvedic oils-Ksheerabala Taila, Mahamasha Taila, Balaswagandhadi Tailam, and Dhanwanthari Taila-reveals shared lipid-phenolic phytochemical patterns that support their traditional use in neuromuscular and Vata-related conditions.

The convergence of Ayurvedic pharmacological principles such as *Snigdha*, *Mridu*, and *Sukshma* qualities with GC-MS-derived biochemical mechanisms provides a coherent mechanistic rationale for taila therapy in spastic cerebral palsy. Overall, the review affirms the scientific plausibility of Ayurvedic medicated oils as integrative adjuncts in the management of neuromuscular spasticity, while highlighting the need for further pharmacodynamic and clinical studies to strengthen translational application.

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Cite this article: Reddy JO, jain AA, khot AM. Phytochemical Insights into Ayurvedic Taila Therapy for Spasticity in Cerebral Palsy: A Narrative Review with GC-MS Support. Pharmacog Res. 2026;18(4):1112-6.