Journal of Ayurveda & Holistic Medicine

https://jahm.co.in eISSN-2321-1563

ORA – Analytical study

Pharmaceutical Analysis and Gas Chromatography-Mass Spectrometry (Gc-Ms) Profiling of Phytoconstituents in *Jatamansyadi Taila* for Potential Use in Neurobehavioral and Neurodevelopmental Conditions

[1]Mithila R. Nadig, [2*]Azizahmed I Arbar, [3]Veena K.H, [4]Anantamati N Bammagol, [5]Sonu Prakash, [6]Tejaswini Yarazarvimath

ABSTRACT:

Background*: Jatamansyadi Taila* is a unique *Ayurveda* formulation mentioned in *Sushruta Samhita* derived from *Aparajithayoga,* mentioned in *Amanushopasarga Pratisedha Adhyaya* of *Uttarasthana*. It is indicated in the management of *Manasa rogas like Unmada* (neurobehavioral disorders)*, Apasmara*(epilepsy) and *Graha doshadi sarva vikaras* (psychosis & psychosomatic disorders) with a principal focus of this study being on *Unmada roga* (neurobehavioral disorders). This relatively unexplored formulation is prepared based on the principle of *Yukti by* selecting specific drugs from the *Yoga*. **Aim**: To understand the potential therapeutic efficacy of identified phytoconstituents and its underlying mechanisms in managing neurobehavioral conditions. **Materials & Methods:** *Jatamansyadi Taila* was tested for its safety and suitability for administering in patients using parameters such as physicochemical parameters, organoleptic characteristics and microbial limit test. Instrumental analysis using GC-MS was carried out to detect the presence of phytoconstituents in *Jatamansyadi Taila*. **Results & Discussion:** GC-MS analysis revealed 32 phytoconstituents, among which ten showed major peak areas reported as 1,6,10-Dodecatrien-3-ol, 3,7,11-trimetl , Asarone , 1,3a-Ethano(1H)inden-4-ol, Octadecanoic acid, 3-[(1-oxohexadecyl, Hexadecanoic acid, 2-[(1-oxododecyl), 9-Octadecen-1-ol, (Z)- Myristic acid vinyl ester ,Stigmasta-3,5-diene, Glycerol 2-acetate 1,3-dipalmitate and (+)-Sesamin. Among these, several constituents possess neuroprotective actions supporting *Ayurveda's* approach in managing neurobehavioral disorders. **Conclusion**: The present study provides preliminary analytical data of *Jatamansyadi Taila* on organoleptic, physicochemical and microbial parameters. As this formulation is not mentioned either in the Ayurvedic Pharmacopoeia of India (API) or in the Ayurvedic Formulary of India (AFI), thus the outcomes of *Jatamansyadi Taila* serve as preliminary analytical benchmarks for future standardization. Furthermore, this study helps in contributing to the validation of classical *Ayurveda's* approach in managing various neurobehavioral conditions.

KEYWORDS: *Jatamansyadi Taila,* Pharmaceutical analysis*,* Phytoconstituents, Neurobehavioral conditions, GC-MS, *Ayurveda*

CTRI Reg no.-CTRI/2024/05/067151 (https://ctri.nic.in/Clinicaltrials/pmaindet2.php?EncHid=OTU5NDU=&Enc=&userName=)

IEC Clearance: BMK/22/PG/KB/3

RECEIVED ON: 14-06-2025

REVISED ON: 25-09-2025; 01-11-2025

ACCEPTED ON: 12-11-2025

Access This Article Online:

Quick Response Code:

Website Link: https://jahm.co.in

DOI Link: https://doi.org/10.70066/jahm.v13i10.2082

Corresponding Author Email: azizarbar.kaher@kleayurworld.edu.in

CITE THIS ARTICLE AS

Mithila R. Nadig, Azizahmed I Arbar, Veena K.H, Anantamati N Bammagol, Sonu Prakash, Tejaswini Yarazarvimath. Pharmaceutical Analysis and Gas Chromatography-Mass Spectrometry (Gc-Ms) Profiling of Phytoconstituents in *Jatamansyadi Taila* for Potential Use in Neurobehavioral and Neurodevelopmental Conditions. *Journal of Ayurveda and Holistic Medicine (JAHM).*2025;13(10):26-39.

1. INTRODUCTION

Neurobehavioral or neurodevelopmental conditions like attention deficit hyperactivity disorder (ADHD) and others are not explicitly mentioned in *Ayurveda* texts. In *Ayurveda,* these conditions can be understood under the description of *Manasa Rogas* (disorders of mind). *Manasa Rogas* are mental disorders characterized by disturbance in cognitive functions, emotional regulation and behavior. [1] Conventional medicine is widely opted but has potential side effects when used in the long term. Consequently, there is a growing interest for indigenous treatment approaches that imparts fewer or zero side effects. *Ayurveda* system of medicine describes such formulations that help alleviate symptoms of *Manasa rogas.* One such formulation is *Jatamansyadi Taila*, a medicated oil that is indicated in the management of *Manasa rogas* that includes conditions like *Unmada* (neurobehavioral disorders), *Apasmara* (epilepsy) and *Graha doshadi sarva vikaras* (psychosis & psychosomatic disorders). In this study, it primarily focuses on *Unmada roga* (neurobehavioral disorders). [2]

The formulation is prepared following the principle of *Sneha Kalpana* where "*Sneha*" basically refers to an unctuous substance, while "*Kalpana*" is a preparation process where decoctions or pastes are processed with unctuous bases either in *taila* (oil) or g*hṛita* (ghee) form. [3] *Taila* constitutes an oily portion where water soluble active principles of medicines are extracted into medicinal base oil. [4] To obtain *Jatamansyadi Taila* five medicinal drugs namely, *Jatamamsi* (*Nardostachys jatamansi* DC.), *Vacha* (*Acorus calamus* Linn), *Guduchi* (*Tinospora cordifolia* Miers.), *Durva* (*Cynodon dactylon* Linn) and *Ashwagandha* (*Withania somniferum* Dunal) were subjected to *Sneha kalpana* preparation process. This formulation is derived from *Aparajithayoga*, as mentioned in *Amanushopasarga Pratisedha Adhyaya* of *Uttarasthana* in *Sushruta Samhita.* The term '*Aparajit*' (unable to conquer) signifies that it doesn't *parajit* (conquer) the *roga* (disease) but eradicates it temporarily thus this *yoga* (formulation) has been named as '*Aparajithayoga'*. It may be administered in the form of *paana* (internal administration), *abhyanga* (massage), *nasya* (nasal administration) or *anjana* (collyrium). In this study, *Jatamansyadi Taila* was prepared by selecting ingredients based on the principle of *Yukti* (logical reasoning) for its application as a *taila* in the form of *Pratimarsha Nasya* (micro-instillation of medicine into nostrils) a type of *snehana nasya* using small dose for the management of *Unmada*.

2. AIMS & OBJECTIVES

Aim of the study: To understand the potential therapeutic efficacy of identified phytoconstituents and its underlying mechanisms in the management of neurobehavioral conditions.

Objectives of the study:

1. To determine organoleptic characteristics (color, form, odor) and physicochemical parameters (saponification value, iodine value, refractive index, acid value and specific gravity).
2. To check for safety of the oil with microbial limit test
3. To analyze phytoconstituents of *Jatamansyadi Taila* in managing neurobehavioral disorders.

3. MATERIALS AND METHODS

Sources of Raw Material

The raw drugs used for the preparation of *Jatamansyadi Taila* include *Jatamamsi* (root)*, Vacha* (root), *Guduchi* (stem)*, Durva* (root)*,* and *Ashwagandha* (root). These were collected from the GMP certified KLE Ayurveda Pharmacy, Khasbag, Belagavi, Karnataka.

Authentication and Analysis of drugs

All the mentioned raw drugs authentication and analysis were done in accordance with the institutional and national ethical guidelines in Central Research Facility (AYUSH approved ASU Drug Testing Laboratory) of KAHER'S Shri BMK Ayurveda Mahavidyalaya, Shahapur, Belagavi, Karnataka, 590003.

Preparation of *Jatamansyadi Taila*

Jatamansyadi Taila was prepared as per the classical reference of general method of preparation of *taila* from *Sharangdhar Samhita,* [5] at GMP certified KLE *Ayurveda* Pharmacy at Khasbag, Belagavi.

Method of Preparation

Table 1: Ingredients and Proportions of *Jatamansyadi taila*

Drug	Latin name	Parts used	Quantity
Jatamamsi	*Nardostachys jatamansi* DC.	*Moola* (Root)	125 grams (Total quantity=*kalka* is 1/4th part of *Sneha* (Each 25 grams)
Vacha	*Acorus calamus* Linn.	*Moola* (Root)	
Guduchi	*Tinospora cordifolia* Miers.	*Kanda* (Stem)	
Durva	*Cynodon dactylon* Linn	*Moola* (Root)	
Ashwagandha	*Withania somniferum* Dunal	*Moola* (Root)	
Murchita Tila Taila	*Sesamum indicum* Linn.	*Beeja* (Seed)	500 ml (1 part)
Jala	-	-	2000 ml (4 parts)

Table 2: *Ayurveda* Parameters

Drug (Sanskrit Name)	***Rasa*** **(taste)**	***Guna*** **(property)**	***Virya*** **(potency)**	***Vipaka*** **(biotransformed taste)**	***Doshaghnata*** **(*dosha* pacifying action), *Rogaghnata* (Disease alleviating) and *Karmas* (therapeutic action)**	***Prabhava*** **(specific action)**
Jatamamsi	*Tikta* (bitter), *Kashaya* (astringent)	*Laghu* (light)	*Shita* (cold)	*Katu*	*Tridoshahara* (pacifying all 3 *doshas - vata, pitta, kapha), Medhya* (intellect promoting)*, Nidrajanana* (sleep inducing)	*Bhutaghna* (severe psychiatric diseases) and *Manasa-doshahara* (anti-psychotic)
Vacha	*Katu* (pungent)*, Tikta*	*Laghu, Tikshna* (sharpness)	*Ushna* (hot)	*Katu*	*Kaphavatahara* (pacifies *vata* and *kapha dosha), Sanjnyasthapana* (restores consciousness), *Unmadahara*	*Medhya*
Guduchi	*Tikta, Kashaya*	*Laghu*	*Ushna*	*Madhura* (sweet)	*Tridoshashamaka, Rasayana* (rejuvenating), *Medhya*	-

Durva	*Kashaya, Madhura, Tikta*	*Laghu*	*Shita*	*Madhura*	*Kaphapittashamaka,Bhutaroga* (psychosomatic disorders), *Medhya, Unmada, Manasaroga*	-
Ashwagandha	*Tikta, Kashaya*	*Laghu*	*Ushna*	*Madhura*	*Vatakaphapaha, Balya* (nourishing), *Rasayana*	-

Standard operating procedures were followed for the preparation of the *taila.* Preparation of *Jatamansyadi Taila* was prepared as per the general method of *sneha kalpana* preparation, i.e. the *kalka* is 1/4th part with respect to quantity of *sneha*, 1 part of *sneha* and 4 parts of *drava dravya* (water). *Murchita Tila Taila* (*MTT*) was taken in a wide mouthed stainless-steel vessel in the quantity specified in Table 1 and heated over *madhyam agni* (moderate flame). Following this, required quantity of water was added. Once the mixture was adequately heated and faint fumes began to appear, the *kalka dravya* comprising of *Jatamamsi, Vacha, Durva, Guduchi*, and *Ashwagandha* prepared in *yavakuta* (bolus) form was added. Continuous stirring with *darvi* (spoon) was performed to ensure uniform mixing of the *kalka dravya* into the oil. It took total six hours for preparation. [6] *Sharangadhara* describes *madhyama paka* (moderately cooked stage) to be *sarvakarmasu,* suitable for various therapeutic applications. [7] This stage is said to be achieved when the *kalka* becomes soft and non-sticky due to complete evaporation of water content, but does not exude any *sneha* upon pressing. The *taila siddhi lakshanas* (proper indicators of oil processing) observed include: *vartivat sneha kalka* (the ability to roll the *kalka* in between the fingers into a wick), *shabdahino agni nikshipta* (no crackling sound on heating), *phenodgama* (frothing at the end of processing)*, gandha utpatti* (emergence of characteristic odour) and *varna utpatti* (orange colour of the oil). These features confirm proper transformation of the oil. *Rasa utpatti* was not tested for this preparation as the oil is intended solely for external purpose. After processing, the lukewarm oil was filtered and the residual *kalka* was squeezed using a clean cloth to extract the maximum amount of oil and minimize loss, carefully done to prevent contamination of the oil. The final product was poured into airtight containers and stored properly. The pictorial representation of the sequential stages of the preparation methods is shown in Figure 1.

Figure 1: Sequential Stages in the Preparation of *Jatamansyadi Taila*

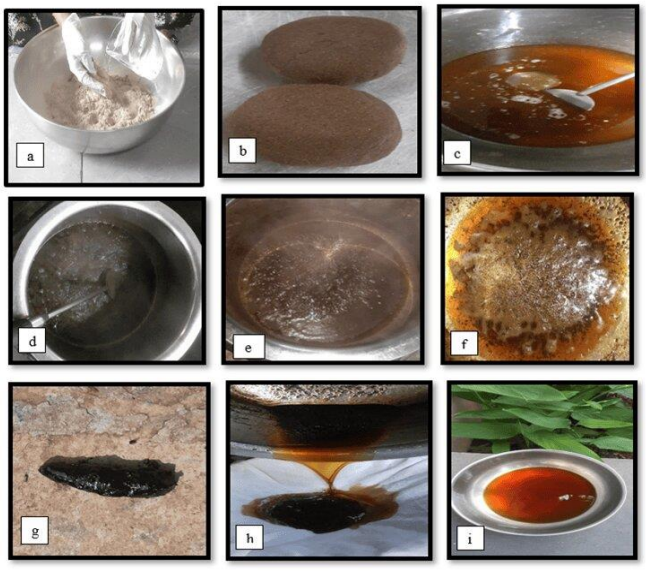

Figure 1: a) Mixing of *Kalka* powders, b) *Kalka* in bolus form, c) *Kalka* in *MTT,* d) Observation of Dark Brown colored *taila,* e) Changed to Light brown colored *taila,* f) Appearance of froth during processing f) Formation of *Varti*, g) Filtration of prepared *taila* and h) Orange colored *Jatamansyadi Taila* obtained.

Analytical Study

Pharmacognostical study of *Jatamansyadi Taila* was analyzed for the organoleptic parameters like form, color and odor. Physicochemical analysis of *Jatamansyadi Taila* like refractive index, acid value, iodine value, saponification value and specific gravity was carried out using standard procedures in accordance with the Ayurveda Pharmacopeia of India (API) [8] *Jatamansyadi Taila* was analyzed for Specific Micro-Organism (Qualitative) and Microbial limit test (Quantitative). Place of analytical study was carried out at Central Research Facility (AYUSH approved ASU Drug Testing Laboratory Lic no.TL-8/2011) of KAHER'S Shri B.M. Kankanawadi Ayurveda Mahavidyalaya, Belagavi, Karnataka, 590003.

GC-MS Analysis

The GC-MS analysis of *Jatamansyadi Taila* was performed using a Shimadzu GCMS-QP 2010SE system. Place of GC-MS analysis carried out was at Amrith Labs, Nisargam Pvt Ltd. at Shimoga, Karnataka. One gram of sample was taken which was extracted using ten milliliters of acetone after which one microliter of the extract was injected. The injection temperature was calibrated at 280°C placed in split mode with a split ratio of 10:0. Purge flow was 3.0 mL/min and a linear velocity was 45.1 cm/sec and the column flow rate was stabilized at 1.50 mL/min.

Oven Temperature

Rate	Temperature (°C)	Hold Time (minutes)
-	80	2
10	280	10
20	330	5

The ion source temperature was set at 200°C and interface temperature at 300°C. The solvent cut time noted was 1.40 minutes, minimizing solvent interference and the detector gain mode was set relative to the tuning result with a gain of 0.95 kV.

Mass Spectrometry, Group 1- Event 1 details:

Start time: 2 min	Scan Speed: 1666
End time: 33 min	Start m/z: 35
ACQ mode: Scan	End m/z: 500
Event time: 0.30 sec	Sample inlet: GC

These conditions set allowed for precise separation and identification of the analytes.

Compound identification was carried out using the NIST 2020 Mass Spectral Library (NIST20), including the NIST20R, NIST20M1, and NIST20M2 libraries for accurate matching of spectra to known phytochemicals.

4. RESULTS

The pharmaceutical analysis of *Jatamansyadi Taila* was carried out in accordance with the established standards to ensure its quality, safety profile and therapeutic effectiveness. At CRF of KAHER's Shri BMK Ayurveda Mahavidyalaya, Belagavi, quality control procedures were performed.

Observations and results of analytical study

Initially oil was orange in color before adding *Kalka* & d*rava dravya*. After its boiling, it turned into dark brown color. Second day, after heating, oil turned from brown to slightly golden brown and then returned to original color. Third day, oil produced characteristic odor indicating that active constituents of the *kalka* were well incorporated into the oil. *Kalka* achieved proper consistency as it could be rolled between the fingers to form a wick. At this stage of *Madhyama Paka,* fire was put off. It took forty minutes for the *taila* to reach lukewarm stage. Obtained quantity of oil is mentioned in Table 3, organoleptic and physico-chemical parameters are provided in Table 4 and 5. Details of specific micro-organism and microbial limit are mentioned in Table 6.

Table 3: Quantity of *Taila* taken and loss

Total *Tila Taila* taken	500ml
Total obtained	450ml
Loss	50 ml

Table 4: Organoleptic characters of *Jatamansyadi taila*

Particulars	***Jatamansyadi taila***
Form	Oil (liquid)
Color	Orange
Odor	Characteristic

Table 5: Physico- chemical parameters of *Jatamansyadi taila*

Parameters	**Result**
Refractive index at 40 degrees Celsius	1.486
Acid Value	4.347
Iodine value	82.485
Saponification Value	80.859
Specific gravity	0.920

Table 6: Tests for Specified Micro-Organism (Qualitative) and Microbial limit (Quantitative)

Specified Micro-Organism (Qualitative)	**Limits**	**Results**
Escherichia coli	Absent/100ml	Absent
Staphylococcus aureus	Absent/100ml	Absent
Pseudomonas aeruginous	Absent/100ml	Absent
Salmonella abony	Absent/100ml	Absent
Microbial limit (Quantitative)		
Total Bacterial count	30-300cfu/ml *	No growth
Total Fungal count	10-100cfu/ml	No growth

*cfu=colony forming units

Graph 1. GC-MS Chromatogram with Peaks obtained in *Jatamansyadi Taila*

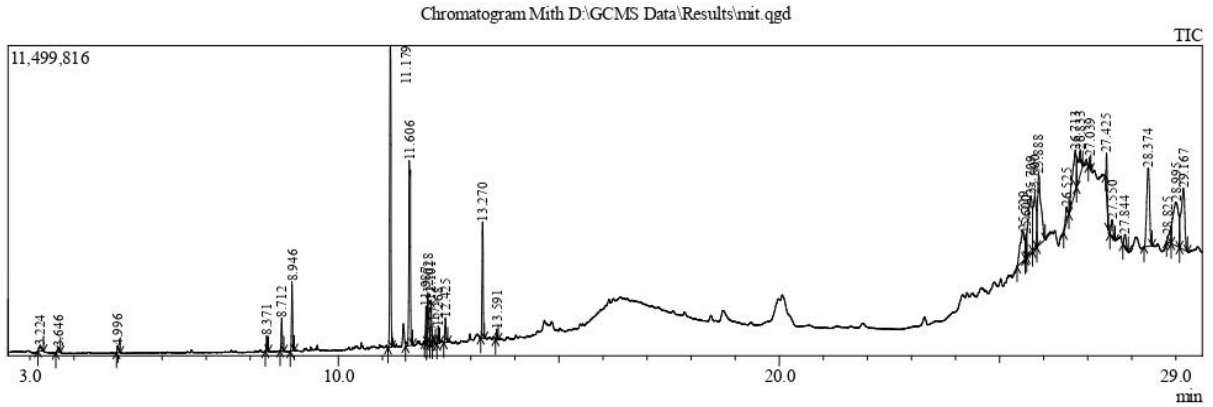

Figure 2: Chemical compounds identified through GCMS Analysis

Peak Report TIC

Peak#	R.Time	I.Time	F.Time	Area	Area%	Height	Height%	A/H	Mark	Name
1	3.224	3.180	3.305	665677	0.37	158132	0.28	4.21	MI	Octane
2	3.646	3.590	3.695	577646	0.32	189114	0.34	3.05	MI	2-Pentanone, 4-hydroxy-4-methyl-
3	4.996	4.965	5.045	561328	0.31	236096	0.42	2.38	MI	2-Heptenal, (E)-
4	8.371	8.340	8.410	849949	0.47	567740	1.01	1.50		2-Decenal, (E)-
5	8.712	8.675	8.760	1942008	1.07	1210101	2.16	1.60		2,4-Decadienal, (E,E)-
6	8.946	8.905	8.995	3843425	2.12	2557843	4.57	1.50		2,4-Decadienal, (E,E)-
7	11.179	11.125	11.215	21667724	11.96	11180105	19.98	1.94		1,6,10-Dodecatrien-3-ol, 3,7,11-trimetl
8	11.606	11.520	11.685	17312048	9.56	6852829	12.24	2.53	V	Asarone
9	11.987	11.955	12.005	2019417	1.12	1335312	2.39	1.51		11,14-Eicosadienoic acid
10	12.028	12.005	12.075	3805815	2.10	1834419	3.28	2.07	V	Undec-10-ynoic acid, dodecyl ester
11	12.101	12.075	12.130	2623942	1.45	1604666	2.87	1.64	V	aR-Turmerone
12	12.175	12.130	12.200	627455	0.35	175942	0.31	3.57	V	.alpha.-Cadinol
13	12.268	12.235	12.300	940230	0.52	617366	1.10	1.52		1.6-Farnesadiene-3.10.11-triol, acetate
14	12.425	12.385	12.480	1756276	0.97	906943	1.62	1.94		Curlone
15	13.270	13.225	13.310	7346223	4.06	4302697	7.69	1.71		1,3a-Ethano(1H)inden-4-ol, octahydro-
16	13.591	13.560	13.625	575835	0.32	380681	0.68	1.51		Spirojatamol
17	25.529	25.395	25.580	7686652	4.24	1111675	1.99	6.91		Octadecanoic acid, 3-[(1-oxohexadecyl
18	25.600	25.580	25.615	1770494	0.98	865612	1.55	2.05	V	Eicosanoic acid, 2-[(1-oxohexadecyl)o
19	25.709	25.615	25.750	13485527	7.45	2114001	3.78	6.38	V	Hexadecanoic acid, 2-[(1-oxododecyl)
20	25.800	25.750	25.845	9696879	5.35	2016194	3.60	4.81	V	Hexadecanoic acid, 2-[(1-oxododecyl)
21	25.888	25.845	26.035	14359376	7.93	2626740	4.69	5.47	V	9-Octadecen-1-ol, (Z)-
22	26.525	26.450	26.575	1956828	1.08	526818	0.94	3.71		.beta.-Sitosterol acetate
23	26.713	26.575	26.745	10165738	5.61	1547930	2.77	6.57		Myristic acid vinyl ester
24	26.833	26.745	26.885	5529006	3.05	883677	1.58	6.26	V	Eicosanoic acid, 2-[(1-oxohexadecyl)o
25	27.039	27.010	27.065	628197	0.35	399766	0.71	1.57		Hexadecanoic acid, 1-tetradecyl-1,2-et
26	27.425	27.400	27.465	2233210	1.23	1624040	2.90	1.38		Octadecanoic acid, 3-[(1-oxododecyl)c
27	27.550	27.500	27.620	1988251	1.10	637931	1.14	3.12		Stigmasta-5,22-dien-3-ol, acetate, (3.b
28	27.844	27.795	27.920	1578574	0.87	480352	0.86	3.29		Stigmasta-3,5-diene
29	28.374	28.280	28.460	13179447	7.28	2891241	5.17	4.56		Stigmasta-3,5-diene
30	28.825	28.790	28.890	1963468	1.08	240082	0.43	8.18		Glycerol 2-acetate 1,3-dipalmitate
31	28.995	28.890	29.080	14499982	8.01	1620307	2.90	8.95	V	Glycerol 2-acetate 1,3-dipalmitate
32	29.167	29.080	29.265	13276574	7.33	2271864	4.06	5.84	V	(+)-Sesamin
				181113201	100.00	55968216	100.00			

Table 7: High Area % identified Phytochemicals in *Jatamansyadi Taila* Based on GCMS Analysis

SR. NO	Name Of the Compound	Mol. Formula	Mol. Weight	Rt. Time (Min)	Peak Area %	Pharmacological Properties*
1	1,6,10-Dodecatrien-3-ol, 3,7,11-trimetl	C15H26O	222	11.179	11.96	Anti-Oxidant, Skin-penetration enhancer Anti-nociceptive and Anti-Inflammatory
2	Asarone	C12H16O3	208	11.606	9.56	Neuroprotective, Antioxidant, Anti-Inflammatory and Antiapoptotic
3	1,3a-Ethano(1H)inden-4-ol, octahydro-2,2,4,7a-tetramethyl-	C15H26O	222	13.270	4.06	Anti-Inflammatory And Neuroprotective activities.
4	Octadecanoic acid, 3-[(1-oxohexadecyl)oxy]-2-[(1-oxotetradecyl)oxy]propyl	C51H98O6	806	25.529 And 27.425	4.24 +1.23= 5.47	Neuroprotective.

	ester					
5	Hexadecanoic acid, 2-[(1-oxododecyl)	C47H90O6	750	25.709 and 25.800	7.45 + 5.35 = 12.80	Anti-inflammatory.
6	9-Octadecen-1-ol, (Z)-	C18H36O	268	25.888	7.93	Skin permeation/ penetration enhancers.
7	Myristic acid vinyl ester	C16H30O2 C16H30O2	254	26.713	5.61	CNS depressant and Anxiolytic
8	Stigmasta-3,5-diene	C29H48	396	27.844 and 28.374	7.28	Refining byproduct.
9	Glycerol 2-acetate 1,3-dipalmitate	C37H70O6	610	28.825 and 28.995	1.08 + 8.01=9.09	Lowers Intracranial pressure.
10	(+)-Sesamin	C20H18O6	354	29.167	7.33	Antioxidative, anti-inflammatory, anti-proliferative and anti-hypertensive

*Pharmacological activities listed in the table have been compiled and adapted from the following sources: Chan et al. [9], Balakrishnan et al. [10], GC et al. [11], Wang et al. [12], Aparna et al. [13], Kovacik et al. [14], Contreras CM et al. [15], Cert et al.16], Frank et al. [17], and Dossou et al. [18]

5. DISCUSSION

Basis of Selection of drugs in *Jatamansyadi Taila* Formulation:

The therapeutic rationale behind selecting the ingredients of *Jatamansyadi Taila* is based on the *Ayurveda* principles of *Yukti*. Although its reference is found in the *Sushruta Samhita,* the formulation is further supported by the concept of *Yukti* elaborated in *Charak Samhita Sutrasthana* particularly in *Shad virechana shatashritiya adhyaya*. [19] This principle ensures the inclusion of herbs with synergistic actions, addressing the root cause. The drug selection was based on earlier studies. For illustration, Kalpesh Panara et al. in his study demonstrated the neuroprotective effects of *Jatamamsi*. [20] Clinically, it was observed that children diagnosed with ADHD showed reduction in hyperactivity, restlessness and anger. Similarly, *Vacha* , [21] *Guduchi*, [22] *Durva*, [23] and *Ashwagandha* possess neuroprotective effects. *Ashwagandha* has phytoconstituents such as sitoindosides and withaferin which offers CNS-modulating effects on memory and learning by increasing GABA (Gamma-amino butyric acid) inhibitory neurotransmitter, deficient in neurodevelopmental disorders.[24] Although, combined action of these drugs in the formulation needs thorough analysis.

Discussion on Physico- chemical parameters of *Jatamansyadi taila*:

The refractive index of *Jatamansyadi Taila* (1.486), is relatively high suggesting increased viscosity, unsaturated compounds that may predispose to oxidative deterioration. [25] Obtained iodine value is

82.485, indicating a moderate degree of unsaturation. According to standard classifications, oils having iodine values lesser than hundred are mentioned to be non-drying, which improves shelf stability and reduces susceptibility to oxidative rancidity. [26] This classification suggest that *Jatamansyadi Taila* is suitable for long-term therapeutic use. While specific gravity of *Jatamansyadi Taila* is reported as 0.920, which is lower than that of water. This suggests favorable application and absorption characteristics. [27] As the value is within the normal range and usually observed in high quality medicinal oils, it is most likely the formulation is not adulterated and is favorable for topical application. An acid value of 4.347 suggests a modest amount of free fatty acids, which could be the consequence of hydrolysis produced by heat or due to extended storage. This acid value is within safe limits but still oil must be safely stored to prevent oxidation. The saponification value obtained is 80.859 indicates presence of short-chain fatty acids indicating quick absorption potentially helping the active compounds to reach the target area more efficiently. Altogether the physico-chemical parameters of this formulation suggest its safety and suitability for the therapeutic purpose.

Discussion on GCMS analysis and identified Key Phytoconstituents:

GC-MS identifies various bioactive compounds. [28] In *Jatamansyadi taila,* GC-MS analysis revealed thirty-two phytoconstituents based on their names, retention times and peak areas as shown in Figure 2. Among these thirty-two, ten compounds exhibited higher area percentages. Their pharmacological actions can be inferred from previously conducted researches, presented in Table 7. Graphical representation of Total ion chromatogram is presented in Graph 1, where x-axis depicts retention time while y-axis represents the peak height. Essential phytoconstituents are identified such as Asarone that exhibits neuroprotective effects by mitigating oxidative stress and neuroinflammation and activates various neuroprotective signaling pathways. Octadecanoic acid (stearic acid), aid in protecting the brain tissue against damage caused by oxygen-glucose deprivation (OGD) or oxidative stress (H_2O_2) that may occur due to several physiological and environmental factors. It acts by activating a specific pathway in the brain known as the phosphatidylinositol 3-kinase (PI3K) pathway, which is critical for cell survival and protection. Many evidences have been reported that fatty acids can directly or indirectly influence signaling pathways inside cells in various ways so this might help in protecting neurons from damage showing neuroprotective actions. While farnesol (1,3a-Ethano(1H) inden-4-ol, octahydro-2,2,4,7a-tetramethyl) modulates $GABA_A$ receptors, highlighting its role in CNS regulation. Interestingly, Hexadecanoic acid, 2-[(1-oxododecyl)-] compound was observed at two different retention times, [13] adding 7.45% and 5.35% to the total ion chromatogram. This reoccurrence could be due to existence of structural isomers, stereoisomers and thermal breakdown. Moreover, Its cumulative presence (12.80%) compared to the rest nine phytoconstituents suggest it to be a major phytoconstituent potentially contributing outrightly to its observed pharmacological activities. Similarly, Octadecanoic acid and Glycerol 2-

acetate 1, 3-dipalmitate both are present at two different retention times. There is limited research on glycerol 2-acetate 1,3-dipalmitate in neurobehavioral disorder but research on related lipids such as glyceryl 1,3-dipalmitate and 1,3-dipalmitoyl-2-oleoylglycerol have shown neuroprotective and antioxidant. Owing to their structural similarity, glycerol 2-acetate 1,3-dipalmitate may also demonstrate comparable actions on the CNS. [29]

Discussion on probable mode of action based on *Ayurveda* understanding

Unmada manifests mainly in *alpa sattva* (weaker inborn disposition) person where vitiated *doshas* afflicts the heart, the seat of *buddhi* (intellect) and it lodges in the *manovaha srotas* (channels responsible for mental functioning) and blocks normal functions of *manas*.[30] Thus, the treatment must incorporate drugs that can enhance *sattva guna* (mental clarity). *Jatamansyadi taila,* enriched with some *medhya* drugs will help bring such effect. *Jatamamsi,* [31] *Vacha,* [32] *Guduchi,* [33] *Durva,* [34] and *Ashwagandha's Ayurveda* parameters is detailed in Table 2., [35] where breaking of pathogenesis can be understood by *rogaghnata* and *prabhava.* For instance, *Jatamamsi,* a *medhya* drug which exhibits *bhutaghna* and *manasadoshahara prabhava* may alleviate *manasa doshas* (*rajas* and *tamas* - mental *doshas*). Here, *prabhava* refers to specific actions that cannot be justified by its known pharmacological attributes like *rasa, guna, virya* and *vipaka*. [36] *Vacha* exhibits *medhya prabhava* and additionally has *pramathi* (clears morbid *doshas* accumulated in the *srotas*) action. [37] This helps in *dosha* elimination and enhances the action of other concurrently administered drugs, aiding optimized *dosha shamana* (pacification). As the five drugs are processed in *MTT, Tila taila* includes *ushna virya, hima sparsha* (cold to touch), *vyavayi guna* (quick action), *vata-kaphahara* action and is *buddhidam* (intellect promoting) and *medhyam* (nootrophic). [38] To augment its therapeutic value, *Sneha murchana*, (purification processing technique) is employed. This procedure gets rid of unwanted characteristics.[39] It enhances *virya* of the *sneha* and incorporates active principles from the *murchana dravyas*. The resultant *MTT* serves as a base oil. [40] Altogether, formulation predominantly consists of *tikta rasa* while *kashaya rasa* observed in four drugs indicates both *pitta* and *kapha dosha shamana*. *Tikta rasa* possess *lekhana* property, aiding *srotoshodhana* and removes *avarana* of the *doshas* in the *manovaha srotas*. [41] *Ushna virya* will help in *dosha vilayana* (liquefication) and act as *vata-kapha dosha shamana*.[42] Also, by virtue of *manasdoshahara prabhava* of *Jatamamsi*, *manasadoshas* will be alleviated. As a whole, the formulation demonstrates *tridoshahara* properties, while most drugs predominantly show *vata-kapha hara* effects, the inclusion of *pittahara* drugs like *Guduchi* and *Durva* pacifies *pitta dosha* as well. Thus, *Rasa-Panchaka* of *Jatamansyadi Taila* includes *tikta* and *kashaya rasa, laghu guna, ushna virya* and *madhura vipaka* pacifying the three *doshas*.

Limitation of the study

One significant drawback of GC-MS technology is that only a limited number of volatile and thermally stable chemicals can be analyzed.

6. CONCLUSION

This study has generated preliminary data on the pharmacognosy and physicochemical parameters of *Jatamansyadi Taila*. Moreover, it confirms that *Jatamansyadi Taila* is analytically stable and safe for use as evidenced by its acceptable organoleptic, physicochemical parameters and compliance with microbial safety standards. In the absence of its existing standards in API or AFI, these findings can only provide valuable preliminary analytical benchmarks that may serve as a baseline for future analytical substantiation. Consequently, the GC-MS identified phytoconstituents indicates potential neuroprotective properties supporting the formulation's traditional use in neurodevelopmental disorders such as ADHD and other such related disorders.

Abbreviations with expansions:

GC-MS- Gas Chromatography-Mass Spectrometry

NIST- National Institute of Standards and Technology

ACQ- Acquisition mode

m/z-Mass to charge ratio

min-minute

API- Ayurvedic Pharmacopoeia of India

AFI- Ayurvedic Formulary of India

CNS- Central Nervous System

Authors Details:

[1]MD Scholar, Department of Kaumarabhritya, Shri BMK Ayurveda Mahavidyalaya Postgraduate Studies and Research Centre, A Constituent unit of KLE Academy of Higher Education and Research Centre, Deemed to be University, Shahapur, Belagavi-590003, Karnataka, India

[2*]Professor and HOD, Department of Kaumarabhritya, Shri BMK Ayurveda Mahavidyalaya Postgraduate Studies and Research Centre, A Constituent unit of KLE Academy of Higher Education and Research Centre, Deemed to be University, Shahapur, Belagavi-590003, Karnataka, India

[3,4]Associate Professor, Department of Kaumarabhritya, Shri BMK Ayurveda Mahavidyalaya Postgraduate Studies and Research Centre, A Constituent unit of KLE Academy of Higher Education and Research Centre, Deemed to be University, Shahapur, Belagavi-590003, Karnataka, India

[5,6]Assistant Professor, Department of Kaumarabhritya, Shri BMK Ayurveda Mahavidyalaya Postgraduate Studies and Research Centre, A Constituent unit of KLE Academy of Higher Education and Research Centre, Deemed to be University, Shahapur, Belagavi-590003, Karnataka, India

Authors Contribution:

Conceptualization and Analytical management: MRN, AIA, VKH, SP

Data collection and literature search: MRN, TY

Writing – original draft: MRN

Reviewing & editing: MRN, VKH, ANB

Approval of final manuscript: All authors

Acknowledgements: Sincere gratitude is expressed to Dr. Veena B Kupati, Associate Professor, Department of Rasashastra & Bhaishajya Kalpana, for her valuable guidance on the analytical aspects of the article. The authors also acknowledge the Central Research Facility at KAHER's Shri B. M. Kankanawadi Ayurveda Mahavidyalaya, Belagavi; the GMP-certified KLE Ayurveda Pharmacy at Khasbag, Belagavi; and Nisargam Pvt. Ltd., Shimoga, along with its technical team, for their timely support and technical assistance.

Declaration of Generative AI

The authors declare this manuscript was written without the use of generative artificial intelligence tools. All the content, including text generation, data analysis and references was developed and reviewed by the author without assistance from AI technologies.

Conflict of Interest – The authors declare no conflicts of interest.

Source of Support – The authors declare no source of support.

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