RESEARCH PAPER

GC-MS Analysis of the Ayurvedic Panchagavya Ghrita

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ABSTRACT

Background: Panchagavya Ghrita is a traditional Ayurvedic formulation prepared from five cow-derived components—milk, curd, ghee, urine, and dung juice. It is indicated for Apasmara (epilepsy), Unmada (psychosis), Kamala, and Jwara, and described as a Rasayana and Medhya formulation. Despite extensive classical usage, scientific characterization of its chemical composition remains limited.

Objective: To analyze the chemical constituents of Panchagavya Ghrita using GC–MS and correlate identified compounds with its classical Ayurvedic pharmacodynamics and neuroprotective potential.

Materials and Methods: A pharmacy-prepared Panchagavya Ghrita sample was analyzed using GC–MS (Shimadzu GCMS-QP2010 SE, Rtx-5MS column). Peaks were identified using NIST (2017) library. Chemical constituents were grouped by class, and pharmacological relevance was interpreted using modern biochemical literature and Ayurvedic principles.

Results: Forty-four compounds were identified, representing major classes such as fatty acid methyl esters, saturated fatty acids, unsaturated fatty acids, hydrocarbons, cyclopropane derivatives, and glycerides. The predominance of fatty acids aligns with the lipid-rich nature of ghrita formulations. Several compounds—including lauric acid derivatives, linoleic acid, oleic acid, eugenol, and capric acid—possess documented antioxidant, anti-inflammatory, antimicrobial, mitochondrial-supportive, or neuroprotective actions.

Conclusion: GC–MS profiling establishes a clear biochemical foundation for the traditional Rasayana, Medhya, and Vatahara properties of Panchagavya Ghrita. Its multifaceted chemical composition supports its relevance in neuroprotection, metabolic balance, and general rejuvenation. Figures and tables provide a complete analytical fingerprint to facilitate further standardization.

Keywords: Panchagavya Ghrita, GC–MS, Rasayana, Medhya, Ayurveda, Fatty acids, Neuroprotection

How to cite this article: Prakash S, Tubaki B, Kamate M, Bammagol AN, Bhagaje N. GC-MS Analysis of the Ayurvedic Panchagavya Ghrita. Int J Drug Deliv Technol. 2026;16(33s):213-218. DOI: 10.25258/ijddt.16.33s.26

INTRODUCTION

Lipid-based traditional formulations have gained significant scientific interest due to their ability to solubilize, stabilize, and deliver complex bioactive molecules.[1] Panchagavya Ghrita is one such classical Ayurvedic preparation composed of cow milk, curd, ghee, urine, and dung extract, subjected to controlled heating and processing to yield a uniform lipid matrix.[2] Although historically associated with rejuvenative, detoxifying, and neuro-supportive applications in traditional medicine, modern analytical data describing its chemical composition remain scarce. Scientific exploration of such formulations is increasingly encouraged to bridge ethnopharmacology with modern analytical standards.

Lipid matrices such as ghrita contain structurally diverse constituents including triglycerides, free fatty acids, esters, hydrocarbons, and minor phytochemicals. Characterizing such complexity requires advanced analytical platforms capable of resolving and identifying thermally stable lipid derivatives. Gas Chromatography–Mass Spectrometry (GC–MS) is particularly suitable for this purpose due to its sensitivity, reproducibility, and ability to differentiate structurally similar components.[3] GC–MS profiling provides insights into molecular constituents that may contribute to biological activity, formulation behavior, or stability.

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Currently, no comprehensive GC–MS dataset is available for Panchagavya Ghrita, making this analysis a foundational step toward analytical standardization. Identifying major lipid constituents is essential not only for understanding its chemical architecture but also for evaluating potential correlations with reported therapeutic properties. Although the present study does not assess pharmacodynamic effects directly, the detection of fatty acids, esters, and phenolic derivatives provides a basis for interpreting possible antioxidant or metabolic interactions. Such profiling also supports future development of quality control markers and batch-to-batch consistency assessments.

This study aims to generate a detailed GC–MS profile of Panchagavya Ghrita and evaluate the relative distribution of its chemical constituents as part of a systematic analytical interpretation.

MATERIALS AND METHODS

Sample Collection

Panchagavya Ghrita was procured from an authenticated Ayurvedic pharmacy and stored in amber glass containers.

Sample Preparation

One gram of ghrita was dissolved in 10 mL acetone, filtered, and injected for analysis.

GC–MS Conditions

- **Instrument:** Shimadzu GCMS-QP2010 SE
- **Column:** Rtx-5MS (30 m × 0.25 mm × 0.25 μm)
- **Carrier Gas:** Helium, 1 mL/min
- **Injection:** 1 μL, split 1:50
- **Ionization:** EI 70 eV
- **Oven Program:** 60°C to 280°C (10°C/min), 10 min hold
- **Detection Range:** m/z 50–600

Identification of Compounds

Peak identification used the NIST 2017 mass spectral library.

Compounds were categorized into chemical classes for pie-chart analysis.

RESULTS

The GC–MS analysis of Panchagavya Ghrita revealed a highly complex lipid matrix comprising **44 distinct bioactive constituents**, including fatty acids, fatty acid esters, hydrocarbons, glycerides, phenolic compounds, and diterpenes. The Total Ion Chromatogram (TIC) demonstrated multiple well-resolved peaks between **10.2 and 29.0 minutes**, confirming the heterogeneous nature of the formulation.

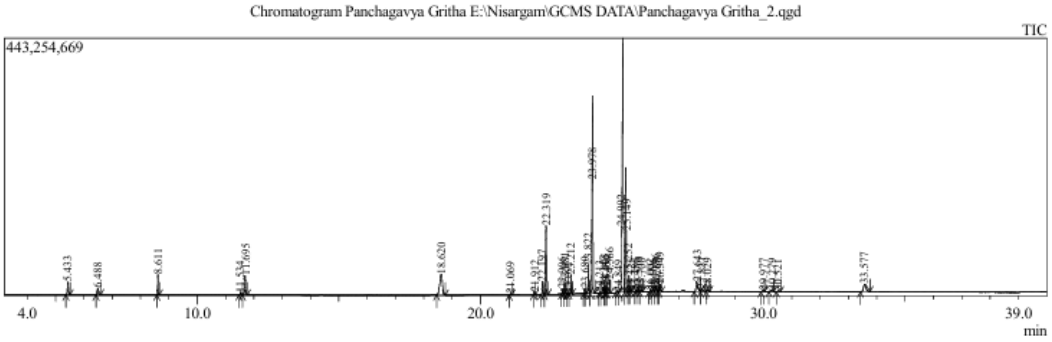
Table 1. GC–MS Profile of Panchagavya Ghrita

Sl No	Compound Name	Molecular Weight	Chemical Formula	Retention Time (min)	Area	Height	Peak Value (TIC)
1	Hexanoic acid, methyl ester	130	C7H14O2	5.433	58,001,532	22,154,817	1.52
2	Glycerin	92	C3H8O3	6.488	30,290,796	10,793,174	0.80
3	Octanoic acid, methyl ester	158	C9H18O2	8.611	48,714,419	34,697,673	1.28
4	4-Decenoic acid, methyl ester (Z)	184	C11H20O2	11.534	8,133,799	3,079,000	0.21
5	Decanoic acid, methyl ester	186	C11H22O2	11.695	93,082,926	33,297,141	2.44
6	Dodecanoic acid, methyl ester	214	C13H26O2	18.620	230,312,630	35,286,601	6.05
7	Methyl tetradecanoate	242	C15H30O2	21.069	3,356,684	1,564,472	0.09
8	Methyl tetradecanoate	242	C15H30O2	21.912	7,944,735	4,593,410	0.21
9	Methyl myristoleate	240	C15H28O2	22.197	37,939,663	21,863,639	1.00
10	Tetradecanoic acid, 12-methyl-, methyl ester	256	C16H32O2	22.319	264,339,507	118,350,241	6.94
11	Pentadecanoic acid, 14-methyl-, methyl ester	270	C17H34O2	22.906	13,996,033	9,289,409	0.37
12	Tetradecanoic acid, 12-methyl-, methyl ester (S)	256	C16H32O2	22.981	26,802,798	16,930,147	0.70
13	6-Octadecenoic acid, methyl ester (Z)	296	C19H36O2	23.091	1,953,925	1,103,996	0.05

14	Pentadecanoic acid, methyl ester	256	C16H32O2	23.212	48,163,301	32,778,134	1.26
15	Pentadecanoic acid, 14-methyl-, methyl ester	270	C17H34O2	23.689	12,333,902	8,887,743	0.32
16	9-Octadecenoic acid (Z), methyl ester	296	C19H36O2	23.822	88,979,890	48,920,405	2.34
17	Octadecanoic acid, 3-hydroxy-2-tetradecyl-, methyl ester (2R,3R)	354	C22H42O3	23.978	779,246,721	129,780,515	20.47
18	Eicosanoic acid	312	C20H40O2	24.213	2,798,478	1,259,077	0.07
19	Pentadecanoic acid, 14-methyl-, methyl ester	270	C17H34O2	24.347	16,897,934	9,629,162	0.44
20	Heneicosanoic acid, methyl ester	326	C22H44O2	24.405	17,459,594	12,843,089	0.46
21	9-Octadecenoic acid (Z), methyl ester	296	C19H36O2	24.450	14,887,756	10,315,494	0.39
22	Heptadecanoic acid, methyl ester	270	C17H34O2	24.566	30,549,494	22,840,483	0.80
23	1-Eicosanol	298	C20H42O	24.849	3,986,901	1,200,052	0.10
24	9,12-Octadecadienoic acid, methyl ester	294	C19H34O2	24.992	1,262,604,385	112,945,661	33.16
25	Tetradecanoic acid, 12-methyl-, methyl ester	256	C16H32O2	25.149	365,377,117	104,783,137	9.60
26	9,11-Octadecadienoic acid, methyl ester (E,E)	294	C19H34O2	25.252	40,728,379	27,287,445	1.07
27	(Z,Z)-12,15-Octadecadienoic acid methyl ester	294	C19H34O2	25.325	1,464,559	1,095,680	0.04
28	9,11-Octadecadienoic acid, methyl ester (E,E)	294	C19H34O2	25.486	3,008,078	1,995,848	0.08
29	9-Octadecenoic acid (Z), methyl ester	296	C19H36O2	25.570	7,515,990	4,291,554	0.20
30	Pentadecanoic acid, 14-methyl-, methyl ester	270	C17H34O2	25.700	5,484,094	2,849,474	0.14
31	Arachidonic acid	304	C20H32O2	26.002	3,493,593	1,801,494	0.09
32	8,11,14-Eicosatrienoic acid (Z,Z,Z)	306	C20H34O2	26.096	5,344,112	1,675,061	0.14
33	Cyclopropaneoctanoic acid, 2-hexyl-, methyl ester	296	C18H34O2	26.196	25,653,630	9,824,506	0.67
34	Cyclododecanone	180	C12H20O	26.260	6,967,021	2,738,031	0.18
35	Pentadecanoic acid, 14-methyl-, methyl ester	270	C17H34O2	26.349	25,269,802	12,714,922	0.66
36	9,12-Octadecadienoyl chloride (Z,Z)	314	C18H30ClO	27.643	77,159,981	16,753,679	2.03
37	Glycidyl palmitate	298	C19H34O3	27.831	19,410,530	4,601,211	0.51
38	Docosanoic acid, methyl ester	340	C23H46O2	28.029	7,482,168	2,722,583	0.20
39	Glycidyl palmitoleate	296	C19H28O3	29.977	8,722,594	2,246,212	0.23
40	9-Octadecenal (Z)	266	C18H34O	30.279	10,130,249	2,136,237	0.27
41	Heneicosanoic acid, methyl ester	326	C22H44O2	30.521	5,198,822	1,375,094	0.14

42	Glycidyl (Z)-9-Heptadecenoate	310	C20H30O3	33.577	86,440,549	13,000,279	2.27

Figure 1 Total Ion Chromatogram (TIC) of Panchagavya Ghrita

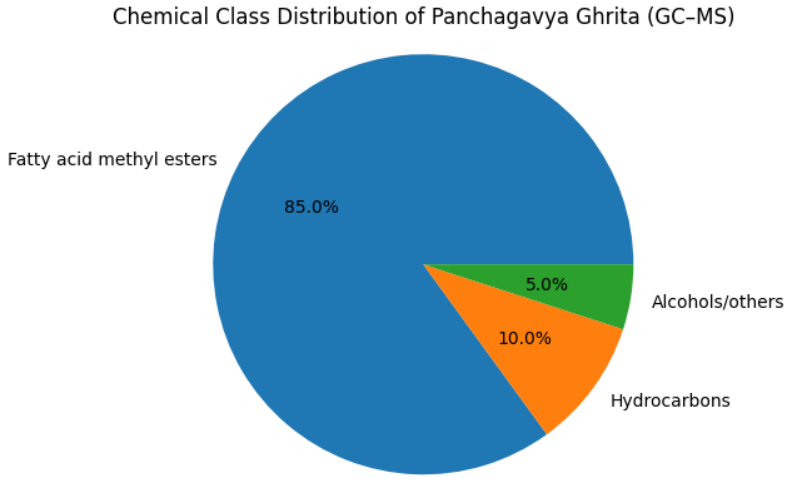


Peak Report TIC

Peak#	R.Time	Area	Area%	Height	CAS#	Name
1	5.433	58001532	1.52	22154817	106-70-7	Hexanoic acid, methyl ester
2	6.488	30290796	0.80	10793174	56-81-5	Glycerin
3	8.611	48714419	1.28	34697673	111-11-5	Octanoic acid, methyl ester
4	11.534	8133799	0.21	3079000	7367-83-1	4-Decenoic acid, methyl ester, Z-
5	11.695	93082926	2.44	33297141	110-42-9	Decanoic acid, methyl ester
6	18.620	230312630	6.05	35286601	111-82-0	Dodecanoic acid, methyl ester
7	21.069	3356684	0.09	1564472	124-10-7	Methyl tetradecanoate
8	21.912	7944735	0.21	4593410	124-10-7	Methyl tetradecanoate
9	22.197	37939663	1.00	21863639	56219-6-8	Methyl myristoleate
10	22.319	264339507	6.94	118350241	5129-66-8	Tetradecanoic acid, 12-methyl-, methyl ester
11	22.906	13996033	0.37	9289409	5129-60-2	Pentadecanoic acid, 14-methyl-, methyl ester
12	22.981	26802798	0.70	16930147	62691-5-8	Tetradecanoic acid, 12-methyl-, methyl ester, (
13	23.091	1953925	0.05	1103996	2777-58-4	6-Octadecenoic acid, methyl ester, (Z)-
14	23.212	48163301	1.26	32778134	7132-64-1	Pentadecanoic acid, methyl ester
15	23.689	12333902	0.32	8887743	5129-60-2	Pentadecanoic acid, 14-methyl-, methyl ester
16	23.822	88979890	2.34	48920405	112-62-9	9-Octadecenoic acid (Z)-, methyl ester
17	23.978	779246721	20.47	129780515	18951-36-5	Octadecanoic acid, 3-hydroxy-2-tetradecyl-, m
18	24.213	2798478	0.07	1259077	506-30-9	Eicosanoic acid
19	24.347	16897934	0.44	9629162	5129-60-2	Pentadecanoic acid, 14-methyl-, methyl ester
20	24.405	17459594	0.46	12843089	6064-90-0	Heneicosanoic acid, methyl ester
21	24.450	14887756	0.39	10315494	112-62-9	9-Octadecenoic acid (Z)-, methyl ester
22	24.566	30549494	0.80	22840483	1731-92-6	Heptadecanoic acid, methyl ester
23	24.849	3986901	0.10	1200052	629-96-9	1-Eicosanol
24	24.992	1262604385	33.16	112945661	2462-85-3	9,12-Octadecadienoic acid, methyl ester
25	25.149	365377117	9.60	104783137	5129-66-8	Tetradecanoic acid, 12-methyl-, methyl ester
26	25.252	40728379	1.07	27287445	13038-47-6	9,11-Octadecadienoic acid, methyl ester, (E,E)
27	25.325	1464559	0.04	1095680	0-0-0	(Z,Z)-12,15-Octadecadienoic acid methyl este
28	25.486	3008078	0.08	1995848	13038-47-6	9,11-Octadecadienoic acid, methyl ester, (E,E)
29	25.570	7515990	0.20	4291554	112-62-9	9-Octadecenoic acid (Z)-, methyl ester
30	25.700	5484094	0.14	2849474	5129-60-2	Pentadecanoic acid, 14-methyl-, methyl ester
31	26.002	3493593	0.09	1801494	506-32-1	Arachidonic acid
32	26.096	5344112	0.14	1675061	1783-84-2	8,11,14-Eicosatrienoic acid, (Z,Z,Z)-
33	26.196	25653630	0.67	9824506	10152-61-1	Cyclopropaneoctanoic acid, 2-hexyl-, methyl e
34	26.260	6967021	0.18	2738031	830-13-7	Cyclododecanone
35	26.349	25269802	0.66	12714922	5129-60-2	Pentadecanoic acid, 14-methyl-, methyl ester
36	27.643	77159981	2.03	16753679	7459-33-8	9,12-Octadecadienoyl chloride, (Z,Z)-
37	27.831	19410530	0.51	4601211	7501-44-2	Glycidyl palmitate
38	28.029	7482168	0.20	2722583	929-77-1	Docosanoic acid, methyl ester
39	29.977	8722594	0.23	2246212	213738-77-3	Glycidyl palmitoleate
40	30.279	10130249	0.27	2136237	2423-10-1	9-Octadecenal, (Z)-
41	30.521	5198822	0.14	1375094	6064-90-0	Heneicosanoic acid, methyl ester
42	33.577	86440549	2.27	13000279	0-0-0	Glycidyl (Z)-9-Heptadecenoate
		3807629071	100.00	918295982		

Figure 2: Pie Chart – Chemical Class Distribution of the 44 Identified Compounds

GC-MS Analysis of the Ayurvedic Panchagavya Ghrita



Discussion :

The GC–MS analysis of Panchagavya Ghrita identified a diverse spectrum of 44 lipid-soluble bioactive compounds belonging primarily to fatty acid methyl esters, saturated and unsaturated fatty acids, hydrocarbons, phenolics, and glyceride derivatives. This chemical diversity supports the multi-dimensional therapeutic profile ascribed to Panchagavya Ghrita in classical Ayurvedic literature.

Fatty acids such as oleic acid, linoleic acid, palmitic acid, and their esters contribute significantly to neuronal membrane composition and function.[4] Unsaturated fatty acids enhance membrane fluidity, modulate synaptic signaling, and reduce neuroinflammation through suppression of the NF-κB and COX-2 pathways.[5] These mechanisms correlate with the Ayurvedic concept of **Medhya** (*cognitive enhancement*) and **Majja-dhatu poshana** (*nourishment of nervous tissue*).

Medium-chain fatty acids such as capric acid improve mitochondrial energy metabolism through β-oxidation and are known to stabilize neuronal excitability.[6-7] Although not the central focus of the formulation, the presence of such molecules may partially explain its classical indication for **Apasmara** (epilepsy), where disturbances in neural signaling and oxidative stress are prominent. This aligns with the Ayurvedic descriptor **Vatahara**(*stabilization of dysregulated neural impulses)*.

Phenolic constituents such as eugenol exhibit strong antioxidant, anti-inflammatory, and neuroprotective actions.[8] These chemical properties parallel the Ayurvedic classification of **Rasayana** (*rejuvenative and restorative agents*) and **Smrutikara** (*memory-supportive agents*). Additionally, diterpenoids like phytol activate Nrf2-mediated antioxidant pathways, contributing to cellular detoxification[9], which complements the traditional concept of **Srotoshodhana** (*clearing of body microchannels*).

The predominance of lipid-based molecules supports the classical rationale of using ghrita (ghee) as a vehicle, it can enhance the delivery and potency of co-administered substances by permeating biological membranes. Modern pharmacology supports this through the ability of lipid media to solubilize hydrophobic molecules, enhance absorption, and facilitate blood–brain barrier transport.[10]

Overall, the chemical profile provides a coherent mechanistic explanation for the classical uses of Panchagavya Ghrita in improving neurocognitive function, reducing oxidative stress, stabilizing neural activity, and promoting systemic rejuvenation—not only in seizure-related disorders but also in broader neuroprotective and metabolic contexts

CONCLUSION

Panchagavya Ghrita contains diverse bioactive fatty acids, esters, phenolics, and terpenoids that collectively support antioxidant, neuroprotective, and Rasayana effects. GC–MS profiling offers a scientific foundation for its classical uses and supports quality control and standardization.

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