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Original Article

Comprehensive GC-MS Profiling and Pharmacological Insights into *Lekhaniya* Mahakashaya for the Management of *Sthaulya* (Obesity)

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ABSTRACT

Background: Obesity (*Sthaulya*) is a major global health concern characterized in Ayurveda by excessive accumulation of *Medo Dhatu* (adipose tissue). Modern anti-obesity medications often present limitations such as adverse effects, high cost, and reduced long-term efficacy. Ayurveda offers holistic alternatives through herbal formulations. *Lekhaniya Mahakashaya*, an Ayurvedic combination of ten herbs known for their *Lekhana* (scraping) and *Medohara* (fat-reducing) properties, is traditionally used to manage Sthaulya. This study investigates the chemical constituents of *Lekhaniya Mahakashaya* using Gas Chromatography-Mass Spectrometry (GC-MS) to evaluate its potential anti-obesity and metabolic benefits. **Objectives:** To analyze the phytochemical profile of *Lekhaniya Mahakashaya* through GC-MS and to explore the metabolic and anti-obesity relevance of its bioactive compounds. **Materials and Methods:** Powdered *Lekhaniya Mahakashaya* was extracted using acetone and analyzed with a Shimadzu GCMS-QP2010SE system. Identification of phytochemicals was based on retention time, molecular weight, and peak area. Physicochemical parameters, including pH and viscosity, and microbiological tests were conducted in accordance with AYUSH quality and safety standards. **Results:** GC-MS analysis identified several bioactive compounds, including dodecanoic acid esters, octadecanoic acid derivatives, myristic acid vinyl ester, and key sesquiterpenes such as curlone and α-turmerone. These compounds are known for their anti-obesity, lipid-lowering, and anti-inflammatory activities. Physicochemical evaluation confirmed that pH, viscosity, and microbial load were within acceptable AYUSH limits, indicating good quality and safety of the formulation. **Conclusion:** The findings support the traditional Ayurvedic use of *Lekhaniya Mahakashaya* in the management of Sthaulya. The presence of multiple bioactive compounds with established metabolic effects underscores its potential as a natural anti-obesity formulation. Further preclinical and clinical studies are recommended to validate these findings and explore its therapeutic applications.

Keywords: GC-MS analysis, Lekhaniya Mahakashaya, Sthaulya (Obesity).

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INTRODUCTION

Obesity (Sthaulya) is a major global health concern, and despite advances in research, modern medicine continues to face challenges in providing long-term, safe, and side-effect-free therapeutic options (Bray and Ryan, 2012). The widespread consumption of inexpensive, energy-dense foods coupled with reduced physical activity has contributed significantly to the rapid rise in obesity rates worldwide (Drewnowski and Specter, 2004). These dietary patterns have become especially common in low-income populations, where calorie-rich but nutrient-poor foods are more accessible (Drewnowski and Specter, 2004).

In Ayurveda, Sthaulya is addressed through specific formulations such as Lekhaniya Dravyas, which possess scraping and fat-reducing actions. Among these, Lekhaniya Mahakashaya has been traditionally described for reducing excessive Medo Dhatu and improving metabolic function. The herbs in this formulation exhibit Laghu (light), Ruksha (dry), Ushna (hot), Tikta (bitter), and Katu (pungent) qualities that help balance deranged metabolism and promote fat reduction (Kakde *et al.*, 2020). Studies highlight the effectiveness of Lekhaniya Mahakashaya in managing Sthaulya due to its Medohara and Lekhana properties, which help reduce adipose tissue and enhance digestive function (Lal *et al.*, 2023).

Globally, obesity rates have nearly tripled over the last four decades. Data from the NCD Risk Factor Collaboration (2017)

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show that childhood and adolescent obesity has risen dramatically between 1975 and 2016. Similarly, global nutrition transition trends reflect increased reliance on high-calorie processed foods, contributing to a pandemic of obesity in developing nations (Popkin *et al*., 2012). Modern biochemical investigations such as GC-MS profiling provide an opportunity to validate traditional Ayurvedic formulations by identifying their active constituents and biological relevance (Preethi *et al*., 2010).

Classical Ayurvedic texts define Sthaulya as the pathological accumulation of Medo Dhatu and Mamsa Dhatu, leading to heaviness, bulkiness, and diminished physical activity relative to body size (Sharma, 2015). Traditional treatments emphasize metabolic regulation and tissue balancing, supported by the use of Medohara and Lekhaniya herbs (Sharma and Dash, 2013). Ayurveda's fundamental principle-"Swasthasya Swasthya Rakshanam, Aturasya Vikara Prashamanam"-highlights preservation of health and management of disease through holistic approaches (Shastri, 2014a). Charaka Samhita further specifies groups of Lekhaniya Dravyas for managing excessive adiposity and metabolic imbalance (Shastri, 2014b; Shastri, 2014c).

The biomedical definition of obesity (BMI ≥ 30 kg/m^2) highlights its significance as a major risk factor for metabolic and chronic disorders (World Health Organization, 2000). Recent WHO data confirm the alarming rise in global obesity, particularly among children and young adults, emphasizing the need for effective preventive and therapeutic strategies (World Health Organization, 2021).

Given these challenges, investigating classical Ayurvedic preparations such as Lekhaniya Mahakashaya through modern analytical tools-including GC-MS-offers a promising pathway for scientific validation and improved understanding of their pharmacological potential in obesity management.

MATERIALS AND METHODS

Sample Preparation

The study utilized a polyherbal formulation containing ingredients of *Lekhaniya Mahakashaya* as referenced in classical Ayurvedic texts procured from Vyas Ayurveda Pvt. Ltd., Harouli, Rajasthan. Exactly 1 g of the powdered sample was taken and extracted using 10 mL of acetone. The mixture was vortexed thoroughly to facilitate extraction and then allowed to stand for an adequate period to ensure complete solubilization of the phytoconstituents. After filtration, 1 µL of the resulting extract was carefully injected into the GC-MS instrument for analysis.

GC-MS Instrumentation and Operating Conditions

The analysis was performed on a Shimadzu GC-MS-QP2010SE system, using helium as the carrier gas. We initially set the column oven temperature at 80.0°C and held it for 2 min to facilitate the initial elution of volatile components. Next, we ramped the temperature to 280.0°C at a rate of 10°C per minute and maintained it for 10 min to elute semi-volatile compounds. Finally, the oven temperature was increased to 330.0°C at a rate of 20°C per minute and held for 5 min to ensure elution of higher boiling point compounds.

The injection temperature was maintained at 280.0°C with the split mode injection with a 10:1 split ratio to regulate the volume of sample entering the column. The flow control mode was set to linear velocity, with a flow rate of 1.50 mL/min for the carrier gas and a total gas flow of 19.5 mL/min. The purge flow was maintained at 3.0 mL/min. The system pressure was kept constant at 24.2 kPa, and the linear velocity of the helium carrier gas was 45.1 cm/sec. Additional parameters such as high-pressure injection, carrier gas saver, and splitter hold were switched off to optimize the analysis.

Mass Spectrometry Parameters

Mass spectrometric detection was performed under the following conditions: the ion source temperature was set at 200.0°C and the interface temperature at 300.0°C, ensuring efficient ionization and transfer of analytes. A solvent cut time of 1.40 min was applied to avoid solvent peak interference. The detector gain mode was adjusted relative to the instrument tuning results, with a detector gain of 0.95 kV. Data acquisition was carried out in full scan mode from 2.00 min to 33.00 min, Having a mass-to-charge ratio (m/z) between 35 and 500. We set the scan speed at 1666 and the event time at 0.30 seconds, which enabled detailed detection and identification of the compounds present in the extract.

Statistical Analysis

GC-MS chromatograms were processed using Shimadzu LabSolutions software. Retention times, peak areas, and compound similarity indices were summarized descriptively. Physicochemical parameters (pH, viscosity) and microbial counts were also reported descriptively. As the study focused on analytical profiling without group comparisons, inferential statistical methods were not applicable.

RESULTS

GC-MS analysis and pharmacological insights in Lekhaniya Mahakashaya

The GC-MS analysis of Lekhaniya Mahakashaya, a traditional Ayurvedic formulation used in the management of Sthoulya (obesity) and Medoroga (dyslipidemia), revealed the presence of a wide spectrum of phytochemicals. Multiple phytocomponents were detected in the acetone extract of Lekhaniya Mahakashaya, including fatty acid esters, sesquiterpenes, and steroid derivatives. The Ayurvedic pharmacodynamic properties of the ingredients of Lekhaniya Mahakashaya are presented in Table 1. The reported

modern pharmacological activities of the ingredients are summarized in Table 2.

These compounds are known for their anti-obesity, lipid-lowering, antioxidant, and anti-inflammatory activities in that Retention time of compound Dodecanoic acid, 1,2,3-propanetriyl ester($C_{39}H_{74}O_6$), aR-Tumerone($C_{15}H_{20}O$), Nootkatone($C_{15}H_{22}O$) mentioned in Figure 1 and Retention time of compound Cinnamyl angelate, E($C_{14}H_{16}O_2$), 9,19-Cycloergost-24(28)-en-3-ol,4,14-dimethyl-, acetate($C_{32}H_{52}O_2$) mentioned in Figure 2, and The GC-MS profiling results are summarized in Table 3, which lists the retention times, peak areas, area percentages, peak heights, and height percentages of all detected phytocomponents in the acetone-extracted Lekhaniya Mahakashaya. Table 4 presents the identified compounds along with their chemical formulas and reported pharmacological activities relevant to metabolic, lipid-modulating, and anti-inflammatory effects. The formulation was shown to have a number of bioactive compounds, including fatty acid esters, sesquiterpenes, triterpenoids, and other plant-based chemicals that are significant for medicine and metabolism.

Dodecanoic acid, 1,2,3-propanetriyl ester was the most common component found, making up more than 21.5% of the overall peak area as mentioned in Figure 3. This molecule is renowned for changing the way lipids break down and lowering the oxidative stress that occurs with inflammation in fat cells. People say that it also stops α-amylase and α-glucosidase, two enzymes that are crucial for breaking down carbs. This proves that it can help with both diabetes and obesity.

The long-chain fatty acid ester octadecanoic acid, 3-[(1-oxohexadecyl) oxy]-2-[(1-oxotetradecyl) oxy] propyl ester. This molecule is known to block enzymes that break down carbohydrates and slow down the process of glycation. Both of these actions help the body control its metabolism better. Myristic acid vinyl ester, which comes from nutmeg (Myristica fragrans), is of particular relevance because it has been demonstrated to protect the liver, reduce inflammation, and act as an antioxidant. Studies have also shown that it can change how cannabis receptors work and switch on AMP-Activated Protein Kinase (AMPK). This could suggest that it helps with lipid metabolism and reducing Metabolic-Associated Fatty Liver Disease (MAFLD). There were modest levels of curlone discovered among the sesquiterpenes. This chemical is renowned for its potential to lower inflammation and modify lipid levels. α-Turmerone is another sesquiterpene in the formula. It is usually produced from Curcuma.

It is recognized for its antioxidant, neuroprotective, and anti-nociceptive effects, which add to the formulation's metabolic benefits. Some medicinal plants' essential oils contain the triterpenoid 24-Norursa-3,12-dien-11-one, which has showed potential in decreasing fat cell growth and modifying lipid profiles. However, further research is needed. In animal tests, cyclocostunolide, which is identical in structure to costunolide, also showed benefits for lowering cholesterol and preventing atherosclerosis by lowering oxidative stress and inflammation. Researchers found that a cinnamyl angelate, which is typically found in essential oils from the Apiaceae family, can lower lipids by blocking the action of lipase, HMG-CoA reductase, and cholesterol esterase. These are all crucial enzymes for breaking down lipids and cholesterol. The sesquiterpene isoaromadendrene epoxide, which is present in Ballota nigra, also makes the recipe more effective against germs. This could assist sustain the balance of gut flora and metabolism.

The GC-MS test shows that *Lekhaniya Mahakashaya* has been utilized in traditional Ayurvedic medicine to treat metabolic disorders and obesity. The many phytochemical parts act together to help manage lipids and carbs, decrease inflammation, and defend against free radicals. We need more pharmacodynamic and clinical studies to back up these old claims.

Table 1: Ingredients of *Lekhaniya* Mahakashaya and its properties.

Sl. No.	Herbal Drug Name	Botanical Name	Family	Main Actions
1.	Mustaka	Cyperus rotundus	Cyperaceae	Deepana, Lekhana, Medoghna
2.	Kushtha	Saussurea lappa	Asteraceae	Lekhana, Shothahara, Krimighna
3.	Haridra	Curcuma longa	Zingiberaceae	Kaphahara, Medohara, Raktashodhaka
4.	Daruharidra	Berberis aristata	Berberidaceae	Lekhana, Jantughna, Raktaprasadana
5.	Vacha	Acorus calamus	Araceae	Medohara, Buddhi-vardhaka, Shodhana
6.	Ativisha	Aconitum heterophyllum	Ranunculaceae	Deepana, Pachana, Jvarahara
7.	Mustard (Shigru)	Moringa oleifera	Moringaceae	Kaphahara, Lekhana, Krimighna
8.	Haritaki	Terminalia chebula	Combretaceae	Tridoshaghna, Medohara, Rasayana
9.	Chitraka	Plumbago zeylanica	Plumbaginaceae	Agnideepana, Medonashaka, Lekhana
10.	Shilajatu	Asphaltum (mineral pitch)	-	Rasayana, Lekhana, Balya

Table 2: **Ingredients of *Lekhaniya Mahakashaya:* modern pharmacological activity.**

Sl. No.	Herbal Drug Name	Botanical Name	Major Phytochemicals	Modern Pharmacological Activities
1.	Mustaka	Cyperus rotundus	Cyperene, flavonoids	Anti-obesity, anti-inflammatory, digestive
2.	Kushtha	Saussurea lappa	Costunolide, dehydrocostus lactone	Anti-inflammatory, antimicrobial, lipolytic
3.	Haridra	Curcuma longa	Curcumin	Antioxidant, hypolipidemic, anti-obesity
4.	Daruharidra	Berberis aristata	Berberine	Lipid-lowering, antidiabetic, hepatoprotective
5.	Vacha	Acorus calamus	β-asarone	CNS stimulant, anti-obesity, antioxidant
6.	Ativisha	Aconitum heterophyllum	Aconitine derivatives	Antipyretic, digestive, immunomodulatory
7.	Shigru	Moringa oleifera	Quercetin, chlorogenic acid	Lipid-lowering, anti-diabetic, antioxidant
8.	Haritaki	Terminalia chebula	Chebulinic acid, gallic acid	Laxative, antioxidant, hypolipidemic
9.	Chitraka	Plumbago zeylanica	Plumbagin	Lipid metabolism enhancer, anti-inflammatory
10.	Shilajatu	Asphaltum (mineral pitch)	Fulvic acid, humic substances	Rasayana, rejuvenator, adaptogen, anti-obesity

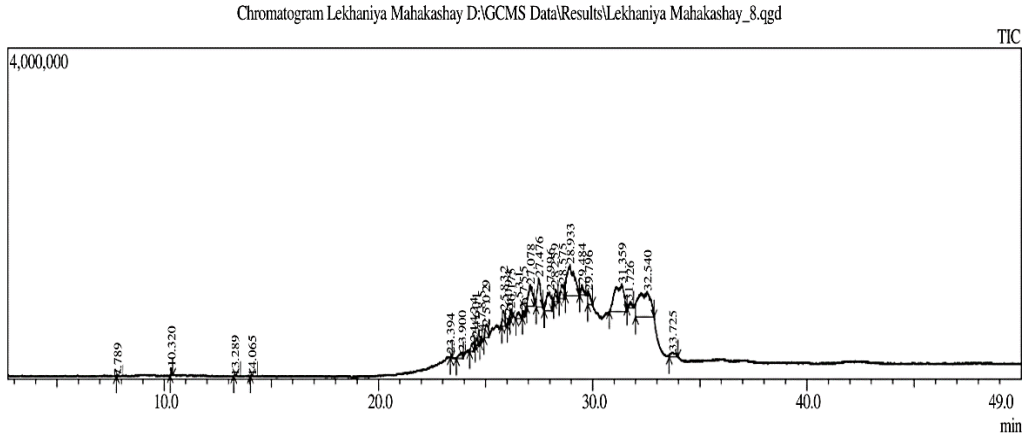


Figure 1: Chromatographic fingerprint of Lekhaniya Mahakashaya obtained through GC-MS analysis, highlighting major phytochemicals with potential anti-obesity activity.

PHYSICOCHEMICAL AND MICROBIOLOGICAL EVALUATION

GCMS Study is done at Amrith Labs in Shimoga, Karnataka, Nisargam Pvt. Ltd., is an AYUSH-approved testing lab. The *Kashaya(syrup)* was a dark reddish-brown color, which suggest its high concentration. It was a little acidic because its pH was 6.32. This is fine for herbal medicines that you swallow. The viscosity was 36.852 cSt and the weight per milliliter was 1.041 g. This means that the fluidity stayed the same and remained safe to use in medication. total amount of solids was 5.15%, while the total amount of sugar was 3.14%. Both of these numbers were good, indicating that the food tasted good and remained fresh for longer.

According to the Ayurvedic Pharmacopoeia of India (API) ii, microbiological testing confirmed that the formulation was safe. The Total Aerobic Microbial Count (TAMC) and the Total Yeast and Mold Count (TYMC) were both less than 10±CFU/gm/mL, which is a healthy range. The regular AYUSH testing procedures were followed; thus, it is likely that harmful bacteria like *Escherichia coli, Salmonella* spp., *Staphylococcus aureus*, and *Pseudomonas aeruginosa* weren't there.

DISCUSSION

GC-MS analysis reveals multiple bioactive compounds that exhibit anti-obesity activity. Cinnamyl angelate from *Angelica archangelica* essential oil suppresses metabolic enzymes such as GST, HMG-CoA reductase, lipase, and cholesterol esterase,

supporting cholesterol and lipid regulation (Abeysekera *et al.*, 2022). Dodecanoic acid esters and octadecanoic acid derivatives regulate carbohydrate metabolism by inhibiting α-amylase and α-glucosidase, thereby reducing postprandial glucose and caloric absorption (Additiya *et al.*, 2024).

Triterpenoids such as 24-norursa-3,12-dien-11-one inhibit adipocyte formation, enhance fat breakdown, improve energy utilization, and modulate lipid metabolism (Al-Yahya *et al.*, 2022; Do, 2023).

Curcumin, a sesquiterpene present in *Curcuma longa* essential oil, improves metabolic health and regulates lipid metabolism, reducing obesity-related risk factors (Ewang-Emukowhate *et al.*, 2014). Turmerones-including α-, β-, and α-turmerone- possess anti-inflammatory and antioxidant properties that contribute to metabolic balance (Kuttan *et al.*, 2007; Xiang *et al.*, 2023).

Cyclocostunolide and costunolide exhibit lipid-lowering, anti-inflammatory, and cardioprotective effects, prevent macrophage uptake of oxidized ldl, improve liver and kidney function, and reduce serum lipid levels (Huang *et al.*, 2023; Rashwan *et al.*, 2019). Isoaromadendrene epoxide from *Ballota nigra* has potent antibacterial activity against pathogens such as *Staphylococcus aureus* and *Enterococcus faecalis* (Majdi *et al.*, 2016).

Nootkatone (nok), a sesquiterpene ketone present in grapefruit and *Alpinia oxyphylla fructus*, improves glucose and lipid metabolism, reduces hepatic fat, activates AMPK and MAPK

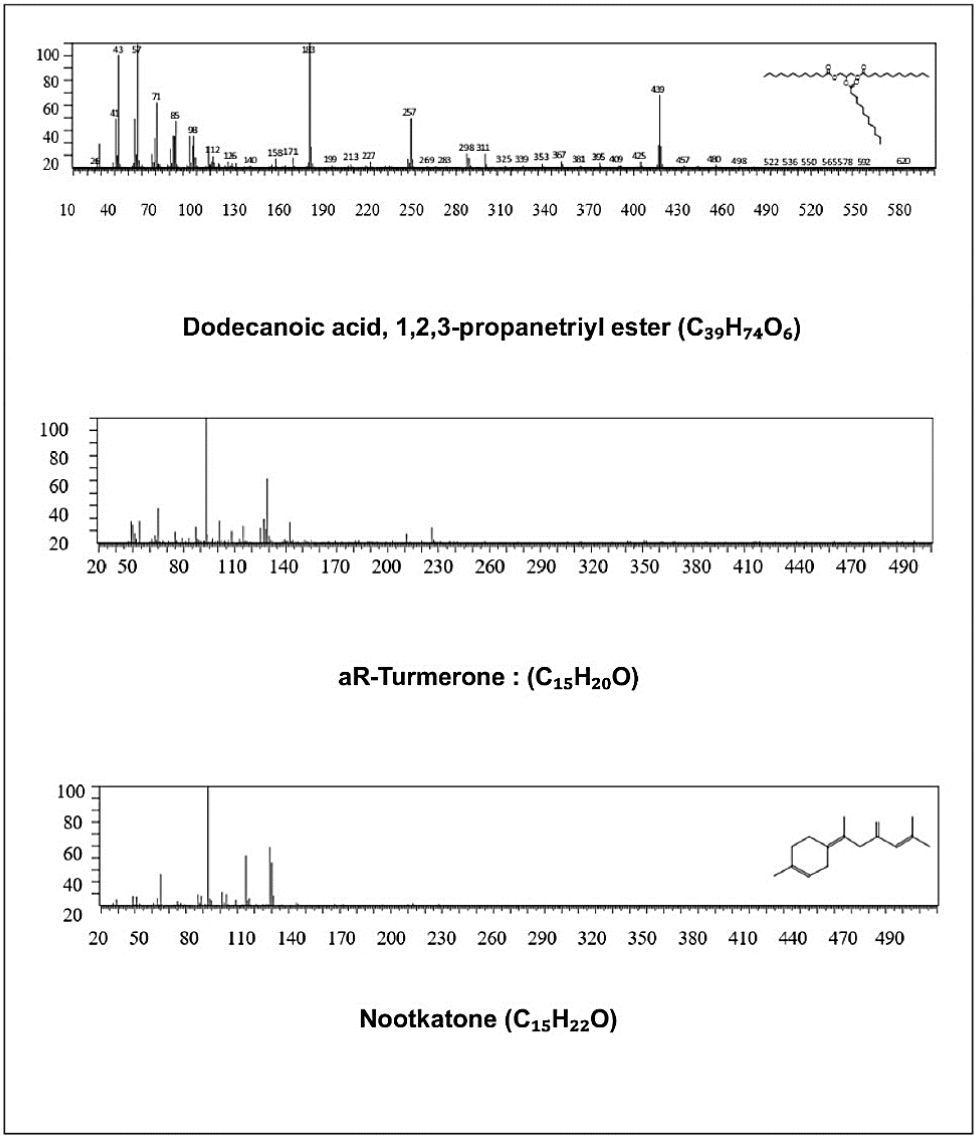


Figure 2: Retention time of compound Dodecanoic acid,1,2,3-propanetriyl ester($C_{39}H_{74}O_6$),aR-Tumerone($C_{15}H_{20}O$), Nootkatone($C_{15}H_{22}O$).

Table 3: Phytocomponents detected in the acetone-extracted *lekhaniya mahakashaya* using GC-MS.

Sl. No.	RT	Area	Area%	Height	Height%	CAS	Name of compound
1.	7.789	44660	0.08	16484	0.43	65-85-0	Benzoic acid
2.	10.32	222576	0.41	95568	2.48	99-76-3	Methylparaben
3.	13.289	54541	0.1	19144	0.5	532-65-0	aR-Turmerone
4.	14.065	32243	0.06	12324	0.32	87440-60-6	Curlone
5.	23.394	68896	0.13	34372	0.89	930591-92-7	24-Norursa-3,12-dien-11-one
6.	23.9	818822	1.5	77433	2.01	538-24-9	Dodecanoic acid, 1,2,3-propanetriyl ester
7.	24.424	944279	1.73	107730	2.8	538-24-9	Dodecanoic acid, 1,2,3-propanetriyl ester
8.	24.601	480337	0.88	81719	2.12	538-24-9	Dodecanoic acid, 1,2,3-propanetriyl ester
9.	24.785	271386	0.5	73574	1.91	538-24-9	Dodecanoic acid, 1,2,3-propanetriyl ester
10.	25.029	1522360	2.79	160767	4.18	538-24-9	Dodecanoic acid, 1,2,3-propanetriyl ester
11.	25.832	1356922	2.49	194166	5.05	538-24-9	Dodecanoic acid, 1,2,3-propanetriyl ester
12.	26.094	362567	0.66	110502	2.87	538-24-9	Dodecanoic acid, 1,2,3-propanetriyl ester
13.	26.175	459812	0.84	100061	2.6	7459-33-8	9,12-Octadecadienoyl chloride, (Z,Z)-
14.	26.531	737927	1.35	86017	2.24	538-24-9	Dodecanoic acid, 1,2,3-propanetriyl ester
15.	26.755	409604	0.75	78793	2.05	538-24-9	Dodecanoic acid, 1,2,3-propanetriyl ester
16.	27.078	3154628	5.78	255831	6.65	538-24-9	Dodecanoic acid, 1,2,3-propanetriyl ester
17.	27.476	3583097	6.57	351654	9.14	538-24-9	Dodecanoic acid, 1,2,3-propanetriyl ester
18.	27.996	3478565	6.38	230348	5.99	538-24-9	Dodecanoic acid, 1,2,3-propanetriyl ester
19.	28.259	961690	1.76	150354	3.91	538-24-9	Dodecanoic acid, 1,2,3-propanetriyl ester
20.	28.575	1743323	3.2	172791	4.49	538-24-9	Dodecanoic acid, 1,2,3-propanetriyl ester
21.	28.933	8624220	15.81	379440	9.86	538-24-9	Dodecanoic acid, 1,2,3-propanetriyl ester
22.	29.484	977670	1.79	129030	3.35	538-24-9	Dodecanoic acid, 1,2,3-propanetriyl ester
23.	29.796	1199410	2.2	155586	4.04	538-24-9	Dodecanoic acid, 1,2,3-propanetriyl ester
24.	31.359	9822839	18.01	333343	8.66	56554-26-8	Octadecanoic acid, 3-[(1-oxohexadecyl)oxy]-2-[(1-oxotetradecyl)oxy]propyl ester
25.	31.726	629767	1.15	75375	1.96	5809-91-6	Myristic acid vinyl ester

Sl. No.	RT	Area	Area%	Height	Height%	CAS	Name of compound
26.	32.54	11733640	21.51	307057	7.98	538-24-9	Dodecanoic acid, 1,2,3-propanetriyl ester
27.	33.725	846945	1.55	58324	1.52	7390-81-0	Oxirane, hexadecyl-
		54542726	100.0	3847787	100.0		

Table 4: Phytocomponents compound activity detected in the acetone-extracted *lekhaniya mahakashaya* using GC-MS.

Sl. No.	Compound name	Compound chemical formula	Pharmacological activity
1.	aR-Turmerone	$C_{15}H_{20}O$	anti-oxidation, anti-inflammation, antilipidemic activity
2.	Curlone	$C_{15}H_{22}O$	Anti-inflammatory effects and lipid-modulating activity
3.	24-Norursa-3,12-dien-11-one	$C_{29}H_{44}O$	anti-oxidation, anti-inflammation, antimicrobial, immunomodulatory,
4.	Dodecanoic acid, 1,2,3-propanetriyl ester	$C_{39}H_{74}O_6$	b5-α reductase inhibitor, antiviral, antibacterial, antifungal
5.	9,12-Octadecadienoyl chloride, (Z,Z)-	$C_{18}H_{31}ClO$	Not known
6.	Octadecanoic acid, 3-[(1-oxohexadecyl) oxy]-2	$C_{51}H_{98}O_6$	Antidiabtetic antiobesity
7.	Myristic acid vinyl ester	$C_{16}H_{30}O_2$	antioxidant, anti-inflammatory, and hepatoprotective
8.	Dodecanoic acid, 1,2,3-propanetriyl ester	$C_{39}H_{74}O_6$	Antidiabetic, anti-obesity,antioxidative
9.	Oxirane, hexadecyl-	$C_{18}H_{36}O$	Adhesive and Anti-microbial
10.	Nootkatone	$C_{15}H_{22}O$	Anti-inflammatory, antilipidemic properties
11.	Cinnamyl angelate, E	$C_{14}H_{16}O_2$	antilipidemic properties
12.	(E)-N-(4-Hydroxyphenethyl)-2-methylbut-2-enamide	$C_{13}H_{17}NO$	Not known
13.	Bicyclo[3.3.1]non-2-en-9-ol, syn- $$ syn-9-Hydroxybicyclo[3.3.1]Non-2-en/ Isophorone	$C_9H_{14}O$	Not known
14.	Isoaromadendrene epoxide	$C_{15}H_{24}O$	Antimicrobial activity
15.	Cyclocostunolide $$ Naphtho[1,2-b]furan-2(3H)-one	$C_{15}H_{20}O_2$	antilipidemic properties

pathways, enhances mitochondrial activity, and stimulates thermogenesis (Yong *et al.*, 2022). Their combined effects on lipid and carbohydrate metabolism, antioxidant activity, and bioavailability enhancement reinforce the formulation's relevance in managing Sthaulya (obesity) and metabolic disorders (Yue *et al.*, 2012). Compounds from *Myristica fragrans*, such as myristicin and myristic acid vinyl ester, modulate cytokine pathways, reduce nitric oxide, activate AMPK, provide hepatoprotective effects, and improve metabolic and liver health (Zhao *et al.*, 2020).

CONCLUSION

Collectively, these bioactive molecules in Lekhaniya mahakashaya validate its classical lekhana (scraping) action by modulating fat metabolism, reducing adipose accumulation, enhancing detoxification, and supporting metabolic balance. The formulation's safety, pharmacological potential, physicochemical properties, and microbial stability align with ayurvedic pharmacopoeia standards, reinforcing its relevance in managing sthaulya (obesity) and metabolic disorders today.

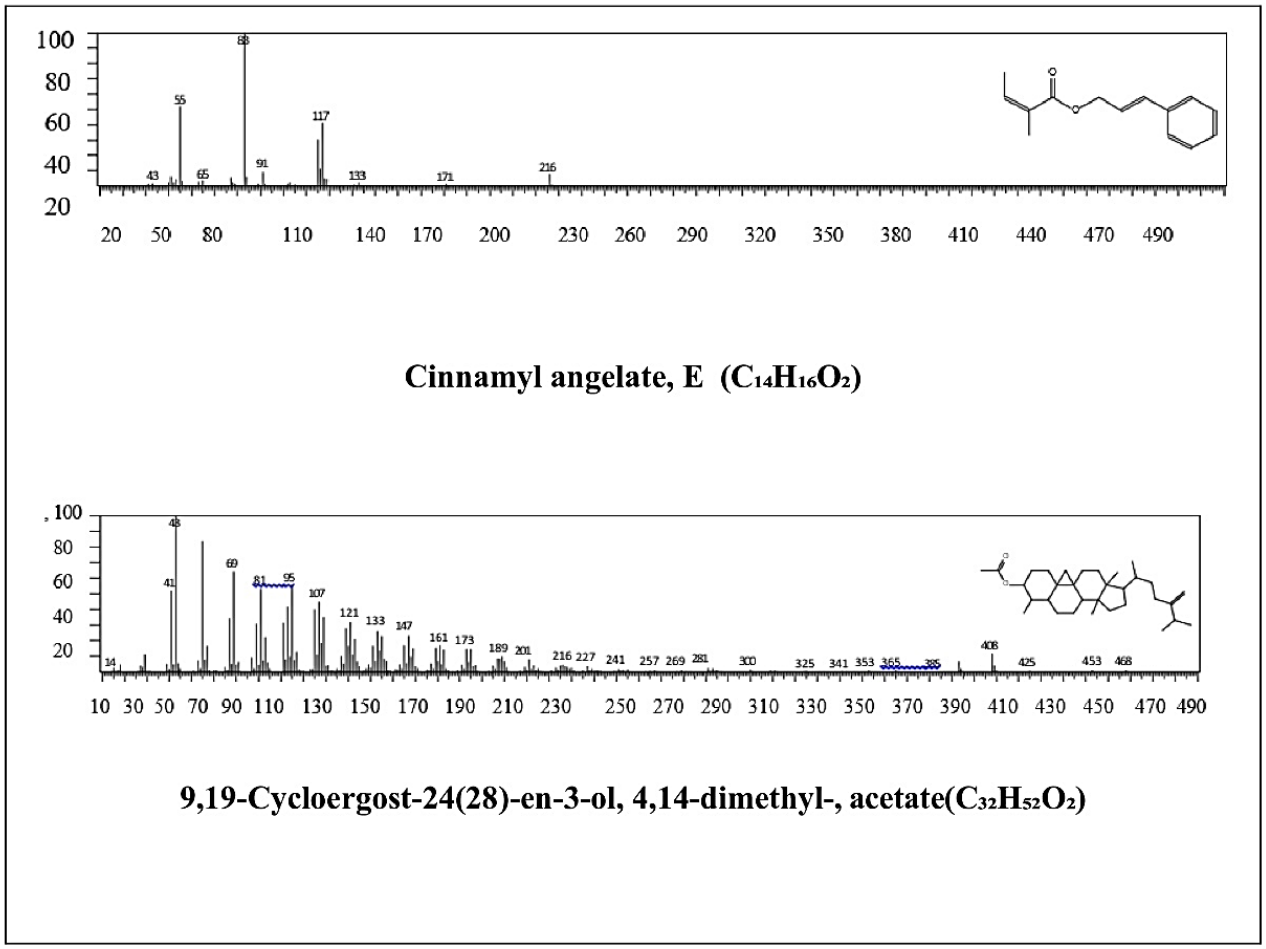


Figure 3: Cinnamyl angelate, E($C_{14}H_{16}O_2$), 9,19-Cycloergost-24(28)-en-3-ol,4,14-dimethyl-,acetate($C_{32}H_{52}O_2$).

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ABBREVIATIONS

α-Amylase: Alpha-Amylase Enzyme; **α-Glucosidase:** Alpha-Glucosidase Enzyme; **AMPK:** AMP-Activated Protein Kinase; **API:** Ayurvedic Pharmacopoeia of India; **AYUSH:** Ayurveda, Yoga and Naturopathy, Unani, Siddha, and Homeopathy; **BMI:** Body Mass Index; **CFU:** Colony-Forming Unit; **GC-MS:** Gas Chromatography-Mass Spectrometry; **GST:** Glutathione S-transferase; **HMG-CoA:** 3-Hydroxy-3-Methylglutaryl-Coenzyme A; **LDL:** Low-Density Lipoprotein; **MAFLD:** Metabolic-Associated Fatty Liver Disease; **NOK:** Nootkatone; **pH:** Potential of Hydrogen; **RT:** Retention Time; **TAMC:** Total Aerobic Microbial Count; **TYMC:** Total Yeast And Mold Count; **UV:** Ultraviolet.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORS CONTRIBUTION

Dr. Raj Joshi (Dr. RJ): Data Collection and Literature Search. **Dr. Raj Joshi (Dr. RJ) and Dr. Ajit Lingayat (Dr. AL):** Writing - Original Draft. **Dr. Raj Joshi (Dr. RJ), Dr. Ajit Lingayat (Dr. AL) and Dr. Santosh Mudakappagol (Dr. SYM):** Reviewing and Editing Approval of Final Manuscript: All authors.

SUMMARY

The GC-MS analysis of *Lekhaniya* Mahakashaya identified important bioactive compound like fatty acid esters, sesquiterpenes, and triterpenoids. Key compounds inhibited enzymes, acted as antioxidants, and activated AMPK. These help break down of fat, decrease and control glucose levels, and elevate inflammation. The physicochemical tests showed that the product was stable, and the microbial tests demonstrated that it

was safe to consume. The results validate its traditional role in treating obesity.

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