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Original Article

GC-MS Analysis of *Dhanwanthari Taila*: Identification of Bioactive Compounds Supporting its Analgesic and Anti-Inflammatory Potential in Chronic Low Back Pain

Ramesh Shivappa Killedar[1], Pradeep Shahjirao Shindhe[1,*], Vijay Kage[2], Raj Joshi[1]

[1]Department of Shalya Tantra, KAHER'S Shri B M Kankanawadi Ayurveda Mahavidyalaya, Shahapur, Belagavi, Karnataka, INDIA.
[2]Department of Orthopedic physiotherapy, Institute of Physiotherapy, Belagavi, Karnataka, INDIA.

ABSTRACT

Background: The scientific validation of traditional Ayurvedic formulations is crucial for integrating them into modern therapeutic practices. *Dhanwanthari Taila*, a widely used Ayurvedic medicated oil, is traditionally used for pain management, particularly in musculoskeletal disorders like Chronic Low Back Pain (CLBP). **Aim and Objectives:** This study utilizes Gas Chromatography-Mass Spectrometry (GC-MS) to analyze the chemical composition of *Dhanwanthari Taila*, aiming to establish correlations between its bioactive compounds and its therapeutic effects in pain relief. **Materials and Methods:** A sample (100 mL) of *Dhanwanthari Taila* was procured from KLE GMP certified Ayurveda Pharmacy and subjected to GC-MS analysis using standard analytical protocols to identify its bioactive components. **Results and Discussion:** The analysis identified key bioactive compounds, including Glycidyl palmitoleate, Oleic acid, 1-Decyne, 3-Tridecene, and Hexadecanoic acid derivatives, which are known for their anti-inflammatory and analgesic properties. The high concentration of Glycidyl palmitoleate suggests its potential contribution to the oil's therapeutic efficacy. These findings align with the traditional use of *Dhanwanthari Taila* in alleviating pain, inflammation, and stiffness, supporting its role in managing CLBP and related conditions. **Conclusion:** The presence of these bioactive molecules validates the therapeutic application of *Dhanwanthari Taila* as an effective pain-relieving formulation. Further research is essential to explore its clinical efficacy and potential integration into conventional pain management strategies.

Keywords: *Dhanwanthari Taila*, GC-MS, Chronic Low Back Pain, Analgesic, Anti-Inflammatory.

Correspondence:
Dr. Pradeep Shahjirao Shindhe
Professor and HOD, Department of Shalya Tantra, KAHER'S Shri B M Kankanawadi Ayurveda Mahavidyalaya, Shahapur, Belagavi- 590003, Karnataka, INDIA.
Email: pshindhe@gmail.com

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INTRODUCTION

Chronic Low Back Pain (CLBP), defined as pain persisting for more than three months, is a growing issue across all age groups.[1] Low back pain impacts 619 million people globally and is projected to increase to 843 million by 2050.[2,3] In India, it accounts for 8% of years lived with disability.[2,3] The prevalence is 50% higher in women than in men.[2,3] The biopsychosocial model is widely recognized for managing non-specific CLBP, emphasizing a multidisciplinary approach to treatment.[4,5] It is essential to comprehend how Ayurvedic medicines work in order to incorporate these therapeutic modalities into conventional medical practice.[6] Ayurveda, offers many treatment options for CLBP like herbal formulations, external therapies, and lifestyle modifications.[7] Among these, *Dhanwanthari Taila*, a classical medicated oil, has been extensively used in Ayurvedic practice for musculoskeletal disorders.[8] Enriched with potent anti-inflammatory and analgesic compounds, it is traditionally applied through massage (*Abhyanga*), therapeutic enema (*Basti*), and warm oil streaming (*Dhara*).[8] Understanding the therapeutic benefits of Ayurvedic treatments can provide an alternative and complementary approach to managing chronic pain effectively.[9] Hence the GC-MS study was undertaken to analyze the chemical composition of *Dhanwanthari Taila*, aiming to establish correlations between its bioactive compounds and its therapeutic effects in pain relief.

MATERIALS AND METHODS

Dhanwanthari Taila was procured from a GMP certified standard Ayurvedic pharmacy KLE Belagavi and was subjected to GC-MS analysis following standard procedures. *Dhanwanthari Taila* was prepared as per the reference of *Vaidya Yogaratnavali taila prakarana*.[10] The method of *taila* preparation is provided in supplementary material.

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Study conduction

The GC-MS study was conducted by Amrith Private Lab, Nisargam Private Limited, Shivamogga, Karnataka.

Instrument

The GC-MS instrument, Shimadzu model QP 2010SE, is widely used for precise qualitative and quantitative analysis in various applications, offering high sensitivity and reliability.

Sample Preparation

Dhanwanthari Taila was procured from GMP certified KLE Ayurveda Pharmacy, a trusted supplier of genuine Ayurvedic products. The preparation for analysis involved several steps:

Preparation

The formulation was thoroughly inspected and homogenized to ensure uniformity before extraction.

Acetone Extraction

A 1 mL sample was diluted with 9 mL of acetone.

Analysis

GC-MS Analysis to analyze the filtered acetone extract (1 µL), gas chromatography-mass spectrometry was use.

Chromatography and Mass Spectrometry Method

The analysis was conducted using a Shimadzu GCMS-QP-2010SE instrument with helium as the carrier gas. A 1 mL sample was diluted with 9 mL of acetone, and 1 µL of the extract was injected. The instrument parameters were set as follows: The column oven temperature was maintained at 80.0°C, while the injection temperature was set at 280.0°C. The injection mode was split, with a split ratio of 10.0. The flow control mode was linear velocity, operating at a pressure of 24.2 kPa. The total flow rate was 19.5 mL/min, with a column flow of 1.50 mL/min and a linear velocity of 45.1 cm/sec. The purge flow was kept at 3.0 mL/min. Additionally, high-pressure injection, carrier gas saver, and splitter hold functions were disabled. The column temperature program was as follows: Initially, the temperature was held at 80.0°C for 2.00 min. It was then increased to 200.0°C at a rate of 10.00°C/min and maintained for 5.00 min. Subsequently, it was further raised to 280.0°C at a rate of 5.00°C/min and held for 3.00 min. The ion source temperature was set at 200.0°C, with an interface temperature of 280.0°C. The solvent cut time was established at 1.40 min. For detection, the detector gain mode was adjusted relative to the tuning result, with a detector gain of 0.95 kV +0.00 kV and a threshold of 0. The MS table settings were as follows: The analysis commenced at 2.00 min and concluded at 33.00 min. The acquisition mode was set to scan, with an event time of 0.30 sec. The scan speed was 1666, covering a mass range of 35.00 to 500.00 *m/z*. The sample inlet unit utilized was the GC-MS system.

RESULTS

Gas Chromatography-Mass Spectrometry (GC-MS) analysis of *Dhanwanthari Taila* identified several bioactive compounds known for their potential therapeutic effects (Table 1 and Figure 1).

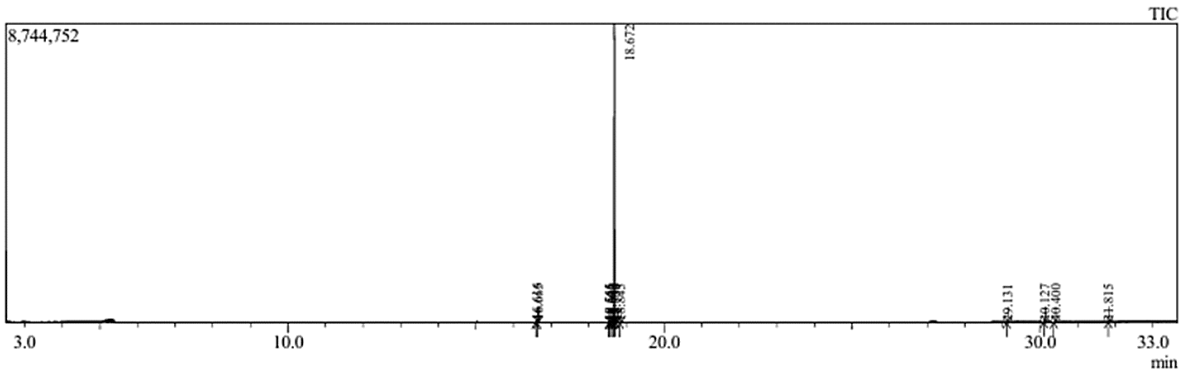
Table 1: Phytocomponents detected in the acetone-extracted *Dhanwantari Taila* using GC-MS.

Peak	R Time	I.Time	F.Time	Area	Area%	Height	Height%	CAS	Name
1	16.616	16.585	16.635	82209	0.83	55982	0.62	463-11-6	1-Fluorooctane
2	16.665	16.635	16.675	36719	0.37	40701	0.45	463-11-6	1-Fluorooctane
3	18.541	18.535	18.545	11570	0.12	27787	0.31	2769-64-4	Butane, 1-isocyano-
4	18.565	18.545	18.58	45223	0.46	27175	0.3	0-00-0	Z-1,9-Hexadecadiene
5	18.6	18.58	18.625	39792	0.4	23547	0.26	764-93-2	1-Decyne
6	18.64	18.625	18.66	27406	0.28	15197	0.17	41446-53-1	3-Tridecene, (Z)-
7	18.672	18.66	18.77	9536447	96.5	8729328	96.84	213738-77-3	Glycidyl palmitoleate
8	18.704	18.7	18.71	2116	0.02	11623	0.13	52965-57-8	7,8-Dioxabicyclo[4.2.2]decane
9	18.73	18.71	18.76	31367	0.32	23594	0.26	52338-90-6	1,2:4,5:9,10-Triepoxydecane
10	18.845	18.82	18.875	33321	0.34	25123	0.28	0-00-0	4-Heptadecyl-1,2,5-oxadiazol-3-amine
11	29.131	29.11	29.145	7243	0.07	7424	0.08	112-80-1	Oleic Acid
12	30.127	30.1	30.14	8176	0.08	10564	0.12	51067-85-7	Methyl 2-hydroxydodecanoate
13	30.4	30.365	30.415	14231	0.14	12272	0.14	38954-75-5	Oxirane, [(tetradecyloxy) methyl]-
14	31.815	31.81	31.845	6203	0.06	3953	0.04	761-35-3	Hexadecanoic acid, 1-(hydroxymethyl)-1,2-ethanediyl ester

The major constituents detected were 1-Fluorooctane (Ret. Time: 16.616 min, 0.83% and 16.665 min, 0.37%), 1-Isocyanobutane (Ret. Time: 18.541 min, 0.12%), Z-1,9-Hexadecadiene (Ret. Time: 18.565 min, 0.46%), 1-Decyne (Ret. Time: 18.6 min, 0.4%), 3-Tridecene (Ret. Time: 18.64 min, 0.28%), Glycidyl palmitoleate (Ret. Time: 18.672 min, 96.5%), 7,8-Dioxabicyclo[4.2.2] decane (Ret. Time: 18.704 min, 0.02%), 1,2:4,5:9,10-Triepoxydecane (Ret. Time: 18.73 min, 0.32%), 4-Heptadecyl-1,2,5-oxadiazol-3-amine (Ret. Time: 18.845 min, 0.34%), Oleic Acid (Ret. Time: 29.131 min, 0.07%), Methyl 2-hydroxydodecanoate (Ret. Time: 30.127 min, 0.08%), Oxirane, [(tetradecyloxy)methyl]- (Ret. Time: 30.4 min, 0.14%), and Hexadecanoic acid, 1-(hydroxymethyl)-1,2-ethanediyl ester (Ret. Time: 31.815 min, 0.06%) (Supplementary material). The high presence of Glycidyl palmitoleate suggests its significant role in the formulation, potentially contributing to its therapeutic benefits. Oleic Acid and Hexadecanoic acid derivatives are well-documented for their anti-inflammatory (Table 2) and analgesic properties, which may help alleviate chronic back pain. Additionally, 1-Decyne and 3-Tridecene have reported bioactivities that could enhance pain relief and reduce inflammation. These compounds collectively support the traditional use of *Dhanwantari Taila* for managing chronic back pain, reinforcing its role as an effective natural medication.

DISCUSSION

The GC-MS analysis of *Dhanwanthari Taila* reveals a complex chemical profile where several key bioactive compounds may underlie its longstanding use in Ayurvedic pain management and anti-inflammatory therapies. For instance,1-Fluorooctane inhibit choroidal neovascularization Membrane Interaction Alters membrane fluidity and permeability, Oxidative Stress (Table 2).[11] 1 -Fluor octane integrates into lipid bilayers, disrupting lipid packing and increasing membrane fluidity and permeable.[12] This disruption impairs receptor clustering and reduces ROS production, ultimately dampening VEGF-driven angiogenesis and inhibiting choroidal neovascularization.[13,14] 1-Isocyanobutane (C_5H_9N) is a butyl derivative featuring an isocyano group at the 1-position. Studies have reported that it exhibits antibacterial, antimalarial, antifouling, and anti-algal activities, making it a promising candidate for eco-friendly coatings and antimicrobial applications.[15,16] Z-1,9-Hexadecadiene ($C_{16}H_{30}$) has been reported to exhibit anti-inflammatory activity (Table 2), suggesting its potential as a natural bioactive agent for pharmaceutical and coating applications.[17,18] 1-Decyne ($C_{10}H_{18}$) has been reported as a metabolite in the volatile fraction of the marine brown alga *Dictyota dichotoma*, exhibiting bioactivity.[19,20] 3-Tridecene ($C_{13}H_{26}$) has been shown to possess good antioxidant activity (Table 2) in a DPPH assay, suggesting it may serve as an effective natural free radical scavenger.[21,22] Glycidyl palmitoleate ($C_{19}H_{34}O_3$) has been reported to augment neuronal levels by modulating enzymes that control endocannabinoid signaling, suggesting therapeutic potential in neurodegenerative



Peak Report TIC

Peak#	R.Time	I.Time	F.Time	Area	Area%	Height	Height%	CAS#	Name
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8	18.704	18.700	18.710	2116	0.02	11623	0.13	52965-57-8	7,8-Dioxabicyclo[4.2.2]decane
9	18.730	18.710	18.760	31367	0.32	23594	0.26	52338-90-6	1,2:4,5:9,10-Triepoxydecane
10	18.845	18.820	18.875	33321	0.34	25123	0.28	0-00-0	4-Heptadecyl-1,2,5-oxadiazol-3-
11	29.131	29.110	29.145	7243	0.07	7424	0.08	112-80-1	Oleic Acid
12	30.127	30.100	30.140	8176	0.08	10564	0.12	51067-85-7	Methyl 2-hydroxydodecanoate
13	30.400	30.365	30.415	14231	0.14	12272	0.14	38954-75-5	Oxirane, [(tetradecyloxy)methyl
14	31.815	31.810	31.845	6203	0.06	3953	0.04	761-35-3	Hexadecanoic acid, 1-(hydroxyn
				9882023	100.00	9014270	100.00		

Figure 1: GC MS of *Dhanwantari taila*.

Table 2: Pharmacological Activity of compounds found in *Dhanwanthari Taila*.

Sl. No.	Molecules	Chemical compound	Medicinal role
1	1-Fluorooctane	$C_8H_{17}F$	Inhibit choroidal neovascularization Membrane Interaction Alters membrane fluidity and permeability, Oxidative Stress.
3	Butane, 1-isocyano-	C_5H_9N	Antibacterial, antimalarial, antifouling, and anti-algal activities
4	Z-1,9-Hexadecadiene	$C_{16}H_{30}$	Anti-inflammatory
5	1-Decyne	$C_{10}H_{18}$	Metabolite
6	3-Tridecene, (Z)-	$C_{13}H_{26}$	Good antioxidant activity using a DPPH assay
7	Glycidyl palmitoleate	$C_{19}H_{34}O_3$	Therapeutic potential to augments neuron level, manipulate a subset of enzymes that control eCB signaling
8	7,8-Dioxabicyclo [4.2.2] decane	$C_8H_{14}O_2$	No activity reported
10	1,2:4,5:9,10-Triepoxydecane	$C_{10}H_{16}O_3$	Stimulatory, diuretic, an tipsychotic, anti-inflammatory, antidiarrheal, abortifacient, antitussive, and anti-asthmatic activity.
11	4-Heptadecyl-1,2,5-oxadiazol-3-amine	$C_{19}H_{37}N_3O$	No activity reported
12	Oleic Acid	$C_{24}H_{46}O_2$	Acidifier, acidulant, arachidonic acid inhibitor increase aromatic amino acid decarboxylase activity and inhibit the production of uric acid
13	Methyl 2-hydroxydodecanoate	$C_{13}H_{26}O_3$	No activity reported
14	Oxirane, [(tetradecyloxy)methyl]-/ Hexadecanoic acid, methyl Ester	$C_{17}H_{34}O_2$	Antioxidant, Anti - bacterial and Anti-fungal, Anti-inflammatory
15	Hexadecanoic acid, 1-(hydroxymethyl)-1,2-ethanediyl ester	$C_{35}H_{68}O_5$	Anticancer activity
16	9-Octadecenoic acid (Z)	$C_{37}H_{70}O_5$	Anticancer and antioxidant properties
17	Tetradecane	$C_{14}H_{29}F$	antibacterial and antifungal.
18	Ether, 6-methylheptyl vinyl	$C_{10}H_{20}O$	Anticancer Activity, anti-proliferative,
19	13-Docosenoic acid methyl ester	$C_{23}H_{44}O_2$	Antibacterial
20	1-Nonyne	C_9H_{16}	Antioxidant
21	9-Decen-1	$C_{10}H_{20}O$	Potential Anticancer Agent

conditions.[23,24] 1,2:4,5:9,10-Triepoxydecane ($C_{10}H_{16}O_3$) has been reported to exhibit multiple pharmacological activities-including stimulatory, diuretic, antipsychotic, anti-inflammatory (Table 2), antidiarrheal, abortifacient, antitussive, and anti-asthmatic effects-which supports its potential as a multifunctional therapeutic agent.[25,26] Oleic Acid ($C_{24}H_{46}O_2$) has been reported to act as an acidifier/acidulant, inhibit arachidonic acid production, enhance aromatic amino acid decarboxylase activity, and reduce uric acid formation, indicating its therapeutic potential in modulating eicosanoid and purine metabolism.[27,28] Methyl palmitate (hexadecanoic acid, methyl ester; $C_{17}H_{34}O_2$) has been reported to exhibit antioxidant, antibacterial, anti-fungal, and anti-inflammatory activities, which supports its potential therapeutic applications.[29,30] Hexadecanoic acid, 1-(hydroxymethyl)-1,2-ethanediyl ester ($C_{35}H_{68}O_5$), a diester of glycerol with palmitic acid (glyceryl dipalmitate), has been reported to exhibit anticancer activity by inducing apoptosis and inhibiting tumor cell proliferation.[31,32] 9-Octadecenoic acid (Z) derivative ($C_{37}H_{70}O_5$) has been reported to exhibit anticancer and antioxidant activities, indicating its potential as a therapeutic agent for cancer treatment and free radical scavenging.[29,33] Tetradecane derivative ($C_{14}H_{29}F$) has been reported to exhibit both antibacterial and antifungal activities, indicating its potential as a bioactive agent for controlling microbial growth.[34,35] Ether, 6-methylheptyl vinyl ($C_{10}H_{20}O$) has been observed to exhibit anticancer and antiproliferative effects, highlighting its potential as a chemotherapeutic candidate.[36,37] 3-Docosenoic acid methyl ester ($C_{23}H_{44}O_2$) is a long-chain unsaturated fatty acid methyl ester that exhibits antibacterial activity by integrating into and disrupting bacterial cell membranes, impairing essential functions and leading to cell death. This mechanism supports its promise as a natural antimicrobial agent with potential applications in food

preservation, pharmaceuticals, and eco-friendly coating.[38,39] 1-Nonyne (C_9H_{16}) is a terminal alkyne that has been found to possess antioxidant properties. Its mode of action is thought to involve free radical scavenging, where 1-nonyne interrupts lipid peroxidation chain reactions, thereby protecting cellular membranes from oxidative damage. This property makes it a promising candidate for natural antioxidant formulations in food preservation, cosmetics, and pharmaceuticals.[40,30] 9-Decen-1 ($C_{10}H_{20}O$) has been reported to exhibit potential anticancer activity by inhibiting cell proliferation and inducing apoptosis in tumor cells, suggesting its promise as a novel chemotherapeutic agent.[41,42], *Dhanwanthari Taila* is a well-known Ayurvedic formulation extensively used for relieving chronic back pain. Its unique blend of medicinal herbs and oils provides deep tissue penetration, reducing inflammation, improving circulation, and alleviating muscle stiffness. Traditionally, it has been applied through therapies like *Abhyanga* (therapeutic massage), *Pizhichil* (oil bath therapy), and *Kati Basti* (localized oil pooling) to address back pain caused by *Vata* imbalances. The bioactive compounds present in the oil exhibit anti-inflammatory, analgesic, and neuromuscular benefits, which help in managing conditions like lumbar spondylosis, sciatica, and muscle spasms. By nourishing the joints and strengthening musculoskeletal structures, *Dhanwanthari Taila* supports mobility and overall spinal health. Classical Ayurvedic texts highlight its role in promoting nerve function and easing pain, while modern studies reinforce its efficacy in pain management. This holistic approach makes it a valuable remedy for those seeking natural and long-term relief from back pain.

CONCLUSION

Dhanwanthari Taila has long been valued for its ability to relieve chronic back pain. Its rich blend of natural ingredients helps reduce inflammation, ease discomfort, and support overall spinal health. Used in Ayurvedic therapies like massages and targeted treatments, it promotes deep absorption and provides lasting relief for back and nerve-related pain. Scientific research continues to highlight its effectiveness, making it a trusted, time-tested remedy for improving mobility and enhancing quality of life.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

RT: Retention Time; **GC-MS:** Gas Chromatography combined with Mass Spectrometry.

SUMMARY

Dhanwanthari Taila has shown significant potential in managing chronic back pain due to its diverse bioactive components. Its application in traditional therapies helps alleviate discomfort, enhance mobility, and support musculoskeletal health. The presence of anti-inflammatory and analgesic compounds contributes to its effectiveness in reducing pain and promoting recovery. Scientific studies further reinforce its therapeutic value, highlighting its role as a natural solution for long-term pain relief.

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