



### Research Article

## Phytochemical Analysis and GC-MS Profiling of Bioactive Compounds in Prasaranyadi Taila

Yashraj Doshi<sup>1\*</sup>, Rajashekhar V Sanapeti<sup>2</sup>, Nidhi Narvekar<sup>3</sup>

1. PG Scholar, Department of Panchakarma, KAHER'S Shri B.M. Kankanwadi Ayurveda Mahavidyalaya Shahapur, Belgavi, Karnataka. India.
2. HOD, Department of Panchakarma, KAHER'S Shri B.M. Kankanwadi Ayurveda Mahavidyalaya Shahapur, Belgavi, Karnataka. India.
3. PG Scholar, Department of Panchakarma, KAHER'S Shri B.M. Kankanwadi Ayurveda Mahavidyalaya Shahapur, Belgavi, Karnataka. India.

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### Abstract

Herbal formulations are composed of a wide range of phytochemicals many of which are responsible for their therapeutic benefits. Although without advanced analytical studies the precise bioactive components often remain unidentified. Gas Chromatography–Mass Spectrometry (GC–MS) is valuable technique in this regard as it enables separation, detection as well as characterization of volatile and semi-volatile compounds in such preparations. It is also helpful in connecting pharmacological activity of herbal formulation to its bioactive compounds hence combining traditional knowledge with modern scientific evidence. One such classical preparation is *Prasaranyadi Taila* a traditional Ayurvedic herbal oil described in the classical Ayurvedic literature in *Chakradatta*. Traditionally the oil is used in the management of *Vata-Vyadhi* (Pathological conditions due to *Vata* vitiation) for both therapeutic and preventive purpose. Additionally, it demonstrates anti-inflammatory, analgesic, anti-rheumatic and nerve tonic properties making it especially beneficial in conditions involving musculoskeletal and neuromuscular disorders. Objective of current study to analyze *Prasaranyadi Taila* through Gas Chromatography Mass Spectrometry (GCMS) for the identification of its bioactive compounds and to correlate their pharmacological actions with those described in classics thereby supporting evidence-based Ayurveda. The analysis was performed following standard protocol with Thermo GC Trace Ultra Version 5.0 and Thermo MS DSQ II equipment. This revealed 43 compounds including Phytol, Hexadecanoic acid (Palmitic acid), Oleic acid, Squalene, Linoleic acid, 1,2-Benzenedicarboxylic acid diethyl ester (Diethyl phthalate) and Stigmasterol. These phytochemicals suggest that the formulation may possess properties such as pain relief associated with nerve disorders, anti-inflammatory effects, antioxidant, antimicrobial and inhibition of pro-inflammatory mediators.

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## Introduction

Healing benefits of Ayurvedic medicines are well documented in classical texts; however, many formulations still lack scientific validation as a result, remain under-recognized. Understanding the phytochemical profile of medicinal plants is crucial not only for identifying potential bioactive compounds but also for uncovering new economic sources of complex chemical substances and explaining the basis of traditional remedies.(1) As a result rigorous evaluation and standardization of Ayurvedic formulations have become an important scientific discipline especially since many phytochemicals exhibit complementary or overlapping

mechanisms of action.(2) To confirm reliability and efficacy of these formulations must be evaluated using modern analytical techniques such as GCMS, antioxidant assays, Chromatography (HPLC, HPTLC, GC), Spectroscopy (IR NMR), Mass spectroscopy (MS), DNA barcoding.(3) Current study concentrates on GCMS analysis of *Prasaranyadi Taila* an Ayurvedic herbal formulation that has traditionally been used to treat various *Vata* and *Vata-Kapha* disorders. It is indicated in conditions such as eighty types of *Vata rogas*, *Kubja Vata*, *Stimitavata*, *Gridhrasi* (sciatica), *Pangu Vata* (paraplegia), *Ardita Vata* (facial palsy), *Hanu Stambha* (tetanus), *Prishtha Stambha* (back stiffness), *Griva Stambha* (neck pain/cervical spondylosis) and *Siro Stambha*.

The *Prasaranyadi Taila* used in the present study was prepared according to the classical reference of *Chakradatta* (*Vatavyadhi Chikitsa*). (4) The formulation consisted of *Prasarani* (*Paederia foetida* Linn.) whole plant/stem bark (5 kg) for the preparation of *Kashaya*. The *Kalka dravyas* comprised *Chitraka* (*Plumbago*

### \* Corresponding Author:

#### Yashraj Doshi

PG Scholar, Department of Panchakarma, KAHER'S Shri B.M. Kankanwadi Ayurveda Mahavidyalaya Shahapur, Belgavi, Karnataka. India.

Email Id: [yashraj15@gmail.com](mailto:yashraj15@gmail.com)

zeylanica Linn.) root bark (50 g), *Pippalimula* (*Piper longum* Linn.) root (50 g), *Yashtimadhu* (*Glycyrrhiza glabra* Linn.) root (50 g), *Saindhava* (Rock Salt) (50 g), *Bala* (*Sida cordifolia* Linn.) root and leaves (50 g), *Shatapushpa* (*Anethum sowa* Roxb.) seeds (50 g), *Devadaru* (*Cedrus deodara* (Roxb.) G.Don) heartwood (50 g), *Rasna* (*Alpinia calcarata* Roscoe) root and leaves (50 g), *Gajapippali* (*Piper chaba* Hunter) fruit and root (50 g), *Prasarani* (*Paederia foetida* Linn.) whole plant (50 g), *Bhallataka* (*Semecarpus anacardium* Linn.) fruit (50 g), and *Jatamansi* (*Nardostachys jatamansi* (D.Don) DC.) root (50 g). The *Sneha Dravyas* included *Murchita Tila Taila* (*Sesamum indicum* Linn.) seed oil (3.2 L), *Dadhi* (curd) (3.2 L), *Kanjika* (fermented gruel) (3.2 L), and *Gokshira* (cow's milk) (6.4 L). These ingredients were processed following the classical *Sneha Paka* procedure to prepare the *Prasaranyadi Taila* used in the study. GCMS analysis of *Prasaranyadi Taila* was performed to identify its bioactive constituents ensure standardization and purity verify presence of phytochemicals associated with its therapeutic effects and produce reliable data for research and quality control. Additionally, microbial limit testing was carried out to ensure safety of oil and phytoconstituents were assessed in relation to its effectiveness in managing *Vata*-dominant disorders.

## Materials and methods

### Collection of drugs

All *churna* (Powders) viz. *Prasarini churna*, *Bhallataka churna*, *Jatamansi churn*, *Chitraka churna*, *yashtimadhu churna*, *Pippalimool churna*, *Bala churna*, *Shatapushpa churna*, *Rasna churn*, *Deodara churn*, *Gajapippali churna*, *Saindhav Lavan* were procured from reputed GMP-certified pharmacy of KLE Society and Ayurved Pharmacy.

### Authentication of drugs

Authentication of all individual drugs, *Murchita Tila Taila* and final formulation *Prasaranyadi Taila* was performed at Central

Research Facility, Shri B.M. Kankanwadi Ayurvedic Mahavidyalaya, Belagavi.

### Preparation of Prasaranyadi Taila

*Prasaranyadi Taila* was prepared following the classical method of *Taila* preparation described in *Chakradatta* and formulation was manufactured at GMP-certified KLE Ayurveda Pharmacy, Khasbag, Belagavi. Standard operating procedures were carefully adhered to during the preparation of the *Taila* as per AFI. (4) The process started with the preparation of the *Kwatha* (decoction). For this purpose, 5 kg of *Prasarini* was mixed with 12.8 litre of water and boiled until the volume was reduced to 3.2 litre. To the prepared decoction, 3.2 litre of *Murchita Tila Taila* was added, followed by 3.2 litre each of *Dadhi* and *Kanji* and 6.4 litre of cow's milk (*Gokshira*). All *Kalka* ingredients, namely *Chitraka Churna*, *Pippalimool Churna*, *Yashtimadhu Churna*, *Saindhava Churna*, *Bala Churna*, *Shatapushpa Churna*, *Devadaru Churna*, *Rasna Churna*, *Gajapippali Churna*, *Prasarini Churna*, *Jatamansi Churna*, and *Bhallataka Churna*, were added at 50 g each.

Mixture was then boiled over moderate flame until complete oil was achieved. This stage is attained when *kalka* becomes soft and non-sticky as result of complete evaporation of water, however, no oil oozes out on pressure. *Taila siddhi lakshanas* was attained. (5) *lakshanas* (signs of proper oil processing) included *vartivat sneha kalka* (paste can be rolled between the fingers like a wick), *shabdahino agni nikshipta* (Burning without sound), *phenodgama* (Froth formation), *gandha utpatti* (Odour formation) and *varna utpatti* (appearance of the typical orange colour). These parameters confirm that the oil has been successfully converted. Whole procedure took 8 hours to complete. After completion warm oil was filtered and the remaining *kalka* was squeezed through a clean cloth to recover maximum oil without causing contamination. Final product was then transferred into airtight containers and stored accurately. (4,6)

### Ayurveda Parameters of all the drugs used to prepare the oil

Table 1: shows all the Ayurveda parameters of drugs used to prepare the *Prasaranyadi Taila*

| Drug                | Rasa                           | Guna                                 | Virya        | Vipaka         | Doshaghnata               | Karma                                                       |
|---------------------|--------------------------------|--------------------------------------|--------------|----------------|---------------------------|-------------------------------------------------------------|
| <i>Prasarini</i>    | <i>Tikta</i>                   | <i>Guru, Sara</i>                    | <i>Ushna</i> | <i>Katu</i>    | <i>Vata kapha shamaka</i> | <i>Vrushya, Balya</i>                                       |
| <i>Chitrakamool</i> | <i>Katu</i>                    | <i>Laghu, Tikshna</i>                | <i>Ushna</i> | <i>Katu</i>    | <i>Kaphavata hara</i>     | <i>Dipan, pachana, Vataghna</i>                             |
| <i>Pippalimool</i>  | <i>Katu</i>                    | <i>Laghu, ruksha</i>                 | <i>Ushna</i> | <i>Katu</i>    | <i>Kaphavata hara</i>     | <i>Dipan, Pachan, Swas-kasa, Udarrognashaka</i>             |
| <i>Yashtimadhu</i>  | <i>Madhura</i>                 | <i>Guru, Snigdha</i>                 | <i>Shita</i> | <i>Madhura</i> | <i>Pittavata hara</i>     | <i>Vranashtotha, VIsaghna, keshya, shukrala</i>             |
| <i>Shatapushpa</i>  | <i>Katu</i>                    | <i>Laghu, Tikshna</i>                | <i>Ushna</i> | <i>Katu</i>    | <i>Vata kapha hara</i>    | <i>Hrudya, Agnidipaka, Pachaka</i>                          |
| <i>Devdaru</i>      | <i>Tikta</i>                   | <i>Laghu, Snigdha</i>                | <i>Ushna</i> | <i>Katu</i>    | <i>Vata kapha hara</i>    | <i>Vatanulomaka, Swedajanana,</i>                           |
| <i>Rasna</i>        | <i>Tikta</i>                   | <i>Guru</i>                          | <i>Ushna</i> | <i>Katu</i>    | <i>Kaphavata hara</i>     | <i>Shothahara, Swasahara, Vata shoolhara</i>                |
| <i>Varuna</i>       | <i>Kashaya, Madhura, tikta</i> | <i>Laghu, ruksha</i>                 | <i>Ushna</i> | <i>Katu</i>    | <i>Kaphavata hara</i>     | <i>Samsrana, mutrajanana, Mutrashmari</i>                   |
| <i>Pippali</i>      | <i>Katu</i>                    | <i>Laghu, Tikshna</i>                | <i>Ushna</i> | <i>Madhura</i> | <i>Vata kapha hara</i>    | <i>Dipana, Rasayan, Vrushya</i>                             |
| <i>Jatamansi</i>    | <i>Tikta, Kashaya</i>          | <i>Shita, Laghu</i>                  | <i>Shita</i> | <i>Katu</i>    | <i>Tridosha g hna</i>     | <i>Vatanuloman, Vednasthapana, Medhya, Vatanadi shamaka</i> |
| <i>Bhallataka</i>   | <i>Madhura, Kashaya</i>        | <i>Laghu</i>                         | <i>Ushna</i> | <i>Madhura</i> | <i>Vata kapha hara</i>    | <i>Rasayan, Medhya, Vajikara, Vatanadi balya</i>            |
| <i>Godugdha</i>     | <i>Madhura</i>                 | <i>Snigdha</i>                       | <i>Shita</i> | <i>Madhura</i> | <i>Vatapitta shamaka</i>  | <i>Jaranashaka, sarvarogahara</i>                           |
| <i>Tila taila</i>   | <i>Madhura, Kashaya</i>        | <i>Guru, Sthira, Vishada, Vikasi</i> | <i>Ushna</i> | <i>Madhura</i> | <i>Vata-kaph nashaka</i>  | <i>Balakaraka, Vrushya,</i>                                 |

### Physicochemical parameter

Physicochemical assessment involved analyzing saponification value, iodine value, refractive index, acid value, rancidity and viscosity of formulation along with phytochemical such as alkaloid, tannin, terpenoid, glycoside, flavonoid, saponin, total phenol and test for micro-organisms which was carried out at Central Research Facility of Kankanwadi Ayurveda Mahavidyalaya, Belagavi.

### Phytochemical Screening of *Prasaranyadi Taila*

Phytochemical study was conducted at Ayush approved lab- Amrith Lab, Nisargam Private Limited, Shimoga, Karnataka.

### Test specific Micro-organisms (Qualitative): (7), (8)

The micro-organisms used for the tests were sourced from stock culture and restored on Nutrient Agar Slants. The incubation of whole culture was done for 18 to 24 hrs at 37°C.

To attain the isolated colonies a complete loop of culture stripped on the suitable culture media (Nutrient Agar, MacConkey Agar, or selective media). For the subculture incubation was done for 24 hrs at 37°C.

Identification of colony morphology with the help of size, shape, colour, elevation and margins were monitored and documented.

For the staining purpose smears were produced from the fresh cultures and observed under the microscope to ascertain the gram reaction and morphology.

Biochemical tests identification was done for *E. coli*, *S. aureus*, *P. aeruginosa*, *S. abony*.

### Quantitative: (9, 10)

#### Total aerobic microbial count

The plate count method was used to determine the total aerobic microbial count. For this 1ml of pretreated sample were transported to a sterile petri dish by adding the 15 mL of molten Casein Soybean Digest Agar maintained at below 45°C. The contents were graded completely and permitted to freeze. Then, the incubation of plates was carried out for 5 days at 30-35°C. Once the incubation was completed the formed colonies were computed and results were prepared as colony-forming units (CFU) per gram of sample.

#### Total yeast and mold count

The plate count method was used to determine the total aerobic microbial count. For this 1ml of pretreated sample were transported to a sterile petri dish by adding the 15 mL of Sabouraud Dextrose Agar supplemented with antibiotics maintained at below 45°C. The contents were graded completely and permitted to freeze. Then, the incubation of plates was carried out for 5 days at 20-25°C. Once the incubation was completed the formed colonies were computed and results were prepared as colony-forming units (CFU) per gram of sample.

### Gas chromatography-mass spectroscopic analysis of *Prasaranyadi Taila*: (11)

GCMS is performed at Amrith Lab, Nisargam Private Limited, Shimoga, Karnataka.

A 1-gram sample was extracted using 10 mL of acetone and 1 µL of obtained extract was injected into Shimadzu GC-MS system (GCMS-QP 2010SE) installed with capillary column (40 m length, 0.22 mm internal diameter) and helium as the carrier gas.

Analysis was carried out under the following conditions: the column oven temperature was maintained at 80 °C, the injector temperature was set at 280 °C and split injection mode was applied. The flow was regulated in linear velocity mode with a pressure of 24.2 kPa, a total flow rate of 19.5 mL/min, a column flow of 1.50 mL/min, a linear velocity of 45.1 cm/s and purge flow of 3.00 mL/min. Split ratio was fixed at 10:1, while the high-pressure injection, carrier gas saver and splitter hold functions were switched off.

Oven temperature was maintained initially at 80 °C with 2 minute hold then increased at a rate of 10 °C/min to 280 °C where it was maintained for 10 minutes. It was further raised at 20°C/min to 330 °C followed by 5 minute hold. The ion source temperature was adjusted to 200°C and the interface temperature was fixed at 300 °C. A solvent cut time of 1.40 minutes was applied. The detector was operated in gain mode relative to tuning with detector gain of 0.95 kV + 0.00 kV and the threshold was set to zero

**Table 2: The Ms table is as follows**

|                   |         |
|-------------------|---------|
| Start time        | 2.00min |
| End time          | 3.00min |
| ACQ Mode          | Scan    |
| Event time        | 0.30sec |
| Scan Speed        | 1666    |
| Start m/z         | 35.00   |
| End m/z           | 500.00  |
| Sample Inlet unit | GC      |

Chemical constituents were identified by comparing their mass spectra and retention indices with data available in the NIST and Wiley libraries. Detected compounds were matched with reference information and the identified components were systematically arranged in a table.

## Results

**Table 2: Organoleptic characters of *Prasaranyadi Tail***

| Test   | Results         |
|--------|-----------------|
| Form   | Tail            |
| Colour | Brownish yellow |
| Odour  | Pleasant        |

**Table 3: Physicochemical standards of *Prasaranyadi Tail***

| Test                 | Limits         | Results                    |
|----------------------|----------------|----------------------------|
| Saponification value | 190 to 200     | 198.69                     |
| Iodine value         | 80 to 90       | 86.924                     |
| Refractive index at  | 1.457 to 1.461 | 1.460                      |
| Acid value           | 3 to 6         | 4.214                      |
| Rancidity            | NA             | Negative                   |
| Viscosity            | -              | 58.092x10 <sup>-6</sup> cp |

**Table 4: Phytochemical screening of *Prasaranyadi Taila***

| Parameter    | Results |
|--------------|---------|
| Alkaloid     | 109µg/g |
| Tannin       | Absent  |
| Terpenoid    | Absent  |
| Glycosides   | Absent  |
| Flavonoids   | 63µg/g  |
| Saponin      | Absent  |
| Total phenol | 129µg/g |

## Test specific microorganism (Qualitative)

Table 5: Test for microorganism

| Name of microorganism | Results |
|-----------------------|---------|
| E. coli               | Absent  |
| P. aureus             | Absent  |
| P. aeruginosa         | Absent  |
| S. abony              | Absent  |

## Microbial limit test (Quantitative)

Table 6: Test for the Microbial limit

| Organism              | Results   |
|-----------------------|-----------|
| Total bacterial count | No growth |
| Total fungal count    | No growth |

Table 7: GC-MS spectral analysis of Prasarnyaadi Tail

| Sr.No. | RT (min) | Peak area % | Name of compound                               | MF                                                             | MW g/mol | RI    | CAS         | Activity [SP1]                                      |
|--------|----------|-------------|------------------------------------------------|----------------------------------------------------------------|----------|-------|-------------|-----------------------------------------------------|
| 1      | 10.081   | 0.57        | Cycloheptasiloxane, tetradecamethyl-           | C <sub>14</sub> H <sub>42</sub> O <sub>7</sub> Si <sub>7</sub> | 518      | 1447  | 107-50-6    | Artifacts, Antibacterial, antifungal, antitumor (7) |
| 2      | 11.508   | 1.86        | 1,6,10-Dodecatrien-3-ol, 3,7,11-trimethyl-, (E | C <sub>15</sub> H <sub>26</sub> O                              | 222.37   | 1564  | 40716-6-3   | Antioxidant, anti-inflammatory                      |
| 3      | 12.543   | 1.85        | Cyclooctasiloxane, hexadecamethyl-             | C <sub>16</sub> H <sub>48</sub> O <sub>8</sub> Si <sub>8</sub> | 593.23   | 1654  | 556-68-3    | Artifacts, Antifungal (8)                           |
| 4      | 13.273   | 0.28        | aR-Turmerone                                   | C <sub>15</sub> H <sub>20</sub> O                              | 216.32   | 1660  | 532-65-0    | Anti-inflammatory                                   |
| 5      | 13.948   | 0.27        | 1(2H)-Naphthalenone, octahydro-4a,8a-dimet     | C <sub>12</sub> H <sub>20</sub> O                              | 180.29   | 1615  | 1803-39-0   | Anti-inflammatory                                   |
| 6      | 16.177   | 0.77        | Cyclononasiloxane, octadecamethyl-             | C <sub>18</sub> H <sub>54</sub> O <sub>9</sub> Si <sub>9</sub> | 667.39   | 1860  | 556-71-8    | Antimicrobial, anti-inflammatory                    |
| 7      | 20.752   | 0.57        | Octasiloxane, 1,1,3,3,5,5,7,7,9,9,11,11,13,13, | C <sub>6</sub> H <sub>48</sub> O <sub>7</sub> Si <sub>8</sub>  | 577.2    | 1710  | 19095-24-0  | Artifacts                                           |
| 8      | 22.608   | 0.54        | Heptasiloxane, hexadecamethyl-                 | C <sub>16</sub> H <sub>48</sub> O <sub>6</sub> Si <sub>7</sub> | 533.15   | 1437  | 541-01-5    | Anti microbial, anti-inflammatory                   |
| 9      | 22.915   | 0.54        | 14-Octadecenal                                 | C <sub>18</sub> H <sub>34</sub> O                              | 266.46   | 2007  | 56554-89-3  | -                                                   |
| 10     | 22.960   | 0.61        | 5-(3-Methoxyphenyl)-1,3,4-thiadiazol-2-ylami   | C <sub>9</sub> H <sub>9</sub> N <sub>3</sub> OS                | 207.25   | 1811  | 247109-15-5 | Antibacterial, anti-inflammatory, analgesic         |
| 11     | 23.065   | 0.43        | Z-8-Pentadecen-1-ol acetate                    | C <sub>7</sub> H <sub>32</sub> O <sub>2</sub>                  | 268.4    | 1752  | 0-00-0      | -                                                   |
| 12     | 23.235   | 0.75        | Silane, chlorodiethylheptyloxy-                | C <sub>11</sub> H <sub>25</sub> ClOSi                          | 236.85   | 1765  | 0-00-0      | Anti microbial                                      |
| 13     | 23.401   | 0.51        | (2R,3R,4aR,5S,8aS)-2-Hydroxy-4a,5-dimethy      | C <sub>15</sub> H <sub>24</sub> O <sub>2</sub>                 | 236.35   | ~1685 | 66884-74-0  | Antioxidant and anti-inflammatory                   |
| 14     | 23.864   | 0.79        | Cyclononasiloxane, octadecamethyl-             | C <sub>18</sub> H <sub>54</sub> O <sub>9</sub> Si <sub>9</sub> | 667.39   | 1860  | 556-71-8    | Artifacts                                           |
| 15     | 24.030   | 1.71        | 1-Hydroxy-3-(octanoyloxy)propan-2-yl decan     | C <sub>21</sub> H <sub>40</sub> O <sub>5</sub>                 | 372.54   | ~2580 | 177717-46-3 | -                                                   |
| 16     | 24.140   | 3.13        | 1-Hydroxy-3-(octanoyloxy)propan-2-yl decan     | C <sub>21</sub> H <sub>40</sub> O <sub>5</sub>                 | 372.54   | ~2580 | 177717-46-3 | -                                                   |
| 17     | 24.165   | 1.23        | Oxalic acid, isohexyl undecylester             | C <sub>22</sub> H <sub>42</sub> O <sub>4</sub>                 | 370.57   | 2420  | 0-00-0      | Antioxidant                                         |
| 18     | 24.210   | 3.85        | Glycidyl palmitate                             | C <sub>19</sub> H <sub>36</sub> O <sub>3</sub>                 | 312.49   | ~2320 | 7501-44-2   | -                                                   |
| 19     | 24.295   | 1.48        | Octahydropyrano[3,2-b]pyridin-6-one            | C <sub>8</sub> H <sub>13</sub> NO <sub>2</sub>                 | 155.19   | ~1870 | 0-00-0      | Anticancer, antibacterial                           |

|    |           |       |                                                 |                                                                 |        |       |             |                                                          |
|----|-----------|-------|-------------------------------------------------|-----------------------------------------------------------------|--------|-------|-------------|----------------------------------------------------------|
| 20 | 24.400    | 0.79  | Spiro(3,7,9-trioxabicyclo[4.3.0]nonane)-5,2'-o  | C <sub>17</sub> H <sub>32</sub> O <sub>7</sub>                  | 348.4  | 1900  | 0-00-0      | -                                                        |
| 21 | 24.475    | 0.45  | Liguloxide                                      | C <sub>15</sub> H <sub>26</sub> O                               | 222.37 | ~1680 | 0-00-0      | Anti inflammatory, anti microbial                        |
| 22 | 24.530    | 0.47  | Ethanone, 1-(2-ethyl-3,3-dipropylcyclopropyl)   | C <sub>15</sub> H <sub>28</sub> O                               | 224.39 | ~1820 | 0-00-0      | -                                                        |
| 23 | 25.025    | 0.45  | Trimethylsiloxycitrostadienol                   | C <sub>9</sub> H <sub>14</sub> O <sub>7</sub>                   | 234.20 | ~2140 | 17774-68-4  | -                                                        |
| 24 | 25.216    | 0.60  | Cyclononasiloxane, octadecamethyl-              | C <sub>18</sub> H <sub>54</sub> O <sub>9</sub> Si <sub>9</sub>  | 667.39 | 1860  | 556-71-8    | Artifacts                                                |
| 25 | 26.179    | 1.93  | Glycidyl (Z)-9-Heptadecenoate                   | C <sub>20</sub> H <sub>36</sub> O <sub>3</sub>                  | 324.51 | ~2280 | 0-00-0      |                                                          |
| 26 | 26.887    | 0.45  | Cyclononasiloxane, octadecamethyl-              | C <sub>18</sub> H <sub>54</sub> O <sub>9</sub> Si <sub>9</sub>  | 667.39 | 1860  | 556-71-8    | antimicrobial, antioxidant                               |
| 27 | 27.589    | 5.99  | (E)-7-Benzylidene-1-azabicyclo[3.2.1]octan-5    | C <sub>14</sub> H <sub>17</sub> N                               | 211.30 | ~2100 | 0-00-0      |                                                          |
| 28 | 28.690    | 0.41  | Di-n-decylsulfone                               | C <sub>20</sub> H <sub>42</sub> O <sub>2</sub> S                | 346.61 | ~2460 | 111530-37-1 | Antagonistic, Antifungal, Antimicrobial, Anthelmintic(9) |
| 29 | 28.804    | 0.76  | Acrylic acid, (1,7,7-trimethyl-2-neopentylbicy  | C <sub>13</sub> H <sub>20</sub> O <sub>2</sub>                  | 208.3  | ~1980 | 0-00-0      | Anti inflammatory, cell apoptosis                        |
| 30 | 28.905    | 0.68  | Decanedioic acid, 3,6-dimethyl-, dimethyl este  | C <sub>14</sub> H <sub>26</sub> O <sub>7</sub>                  | 258.35 | ~1860 | 5024-28-2   | Anti inflammatory and anti oxidant                       |
| 31 | 29.063    | 0.58  | Heptasiloxane, hexadecamethyl-                  | C <sub>16</sub> H <sub>48</sub> O <sub>6</sub> Si <sub>7</sub>  | 533.15 | 1437  | 541-01-5    | Anti- oxidant , anti inflammatory                        |
| 32 | 29.095    | 0.32  | Methyl 2-tetradecyloxiranecarboxylate           | C <sub>18</sub> H <sub>34</sub> O <sub>3</sub>                  | 298.47 | ~2105 | 0-00-0      | Antibacterial and anti-inflammatory                      |
| 33 | 31.885    | 0.65  | Cyclononasiloxane, octadecamethyl-              | C <sub>18</sub> H <sub>54</sub> O <sub>9</sub> Si <sub>9</sub>  | 667.39 | ~1860 | 556-71-8    | Anti-inflammatory                                        |
| 34 | 33.675    | 0.41  | 4,4-Bis(dichlorofluoromethyl)-1,2-oxathietane   | C <sub>4</sub> H <sub>2</sub> Cl <sub>4</sub> F <sub>4</sub> OS | 311.9  | ~2210 | 22721-88-6  | -                                                        |
| 35 | 33.825    | 0.43  | Cholest-4-en-26-oic acid, 3-oxo-, methyl ester  | C <sub>28</sub> H <sub>44</sub> O <sub>3</sub>                  | 428.65 | ~3250 | 53481-64-4  | -                                                        |
| 36 | 33.860    | 1.36  | Ethyl 3-((2S,5S)-7-pivaloyl-1-oxa-7-azaspiro[   | C <sub>20</sub> H <sub>35</sub> NO <sub>3</sub>                 | 333.5  | ~2340 | 0-00-0      | -                                                        |
| 37 | 33.935    | 0.89  | 6-Hydroxy-9-oxa-bicyclo[3.3.1]nonan-3-one       | C <sub>8</sub> H <sub>12</sub> O <sub>3</sub>                   | 156.18 | ~1920 | 0-00-0      | -                                                        |
| 38 | 33.980    | 1.15  | (1S,2R,5R)-2-Methyl-5-((R)-6-methylhept-5-e     | C <sub>15</sub> H <sub>26</sub> O                               | 222.37 | ~1580 | 58319-05-4  | -                                                        |
| 39 | 34.064    | 1.63  | Octadecane, 1,1'-[1,3-propanediylbis(oxy)]bis   | C <sub>39</sub> H <sub>80</sub> O <sub>2</sub>                  | 581.1  | ~2600 | 17367-38-3  | -                                                        |
| 40 | 34.129    | 0.84  | Octadecanoic acid, 2,3 bis[(1-oxotetradecyl)o   | C <sub>50</sub> H <sub>98</sub> O <sub>6</sub>                  | 795.3  | ~3100 | 56846-96-9  | Anti-inflammatory                                        |
| 41 | 3eto4.190 | 0.56  | 1-Butanone, 3-methyl-1-[2,3,5-trihydroxy-4-(3   | C <sub>19</sub> H <sub>26</sub> O <sub>4</sub>                  | 318.4  | ~1750 | 520-40-1    | -                                                        |
| 42 | 35.451    | 55.87 | 3-(Octanoyloxy)propane-1,2-diyl bis(decanoat    | C <sub>31</sub> H <sub>58</sub> O <sub>6</sub>                  | 526.79 | ~3450 | 82426-88-8  | Anti-inflammatory                                        |
| 43 | 38.990    | 0.56  | Cholest-5-en-3-ol (3.beta.)-, carbonochloridate | C <sub>28</sub> H <sub>45</sub> ClO <sub>2</sub>                | 449.11 | ~3280 | 7144-08-3   | -                                                        |

[illegible]

Mass spectrum of the sample showing relative intensity versus m/z. The base peak is at m/z 41. Other significant peaks are labeled at m/z 27, 43, 55, 69, 81, 93, 107, 109, 121, 136, and 161. The chemical structure of the sample is shown as a branched alkene with a hydroxyl group (HO).

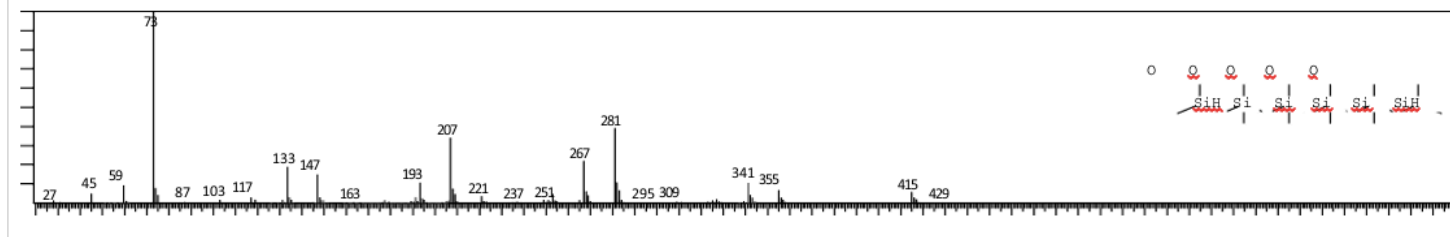
The mass spectrum shows relative intensity on the y-axis (0 to 100) and m/z on the x-axis (40 to 240). The base peak is at m/z 88. Other significant peaks are labeled at m/z 55, 91, 105, 119, 132, 143, 159, 173, 183, 201, and 216.

The chemical structure is 4-methyl-2-methyl-3-penten-2-one, represented by the SMILES string: CC(=O)C(C)=CC(C)c1ccc(C)cc1. It consists of a 4-methylphenyl group attached to a 3-methyl-2-penten-2-one side chain.

Mass spectrum of compound 10. The x-axis represents the mass-to-charge ratio ( $m/z$ ) and the y-axis represents relative intensity. The base peak is at  $m/z$  429. Other labeled peaks include  $m/z$  73, 147, 221, 355, and 401. A chemical structure of compound 10 is shown on the right.

Mass spectrum of the sample. The x-axis represents the mass-to-charge ratio (m/z) and the y-axis represents relative intensity. The base peak is at m/z 78. Other significant peaks are labeled at m/z 45, 59, 117, 147, 191, 207, 221, 281, 295, 325, 341, 429, and 517. A chemical structure of a siloxane chain is shown on the right.

**Image 6: Name of compound:** GC–MS mass spectrum of an identified phytochemical as Hexasiloxane, 1,1,3,3,5,5,7,7,9,9,11,11-dodecamethyl displaying its usual electron-impact fragmentation pattern with clear major and minor ion peaks. The molecular structure shown on the right helps confirm the compound's identity based on matching with NIST/Wiley spectral libraries.



## Discussion

Medicinal plants have for a long time acted as fundamental sources of modern drug discovery, with most therapeutic agents originating from their bioactive constituents. Variation of phytochemicals present in these plants offers significant therapeutic benefits against a wide range of diseases. Therefore extraction, characterization and analysis of plant materials are essential for standardizing and improving herbal formulations as well as for ensuring their quality and safety. Such research also aids in identifying possible toxic effects thereby protecting both humans and animals from naturally occurring poisons.

### GC-MS Analysis of *Prasaranyadi Taila*

The objective of this study was to identify the bioactive compounds present in *Prasaranyadi Taila* using Gas Chromatography Mass Spectroscopy (GCMS). The identified compounds along with their retention times (RT), molecular formulas and relative concentrations (peak area %), indicated the presence of a total of 43 phytochemical constituent. Most of these compounds possess anti-inflammatory, antimicrobial and antioxidant, analgesic properties.

Among the identified constituents, several compounds including 1,6,10-dodecatrien-3-ol, 3,7,11-trimethyl-(E),  $\alpha$ -turmerone, heptasiloxane derivatives, cyclononasiloxane, di-n-decylsulfone, acrylic acid, dimethyl esters of decanedioic acid, methyl 2-tetradecyloxiranecarboxylate, octadecanoic acid derivatives and glycerol tri-esters exhibit notable anti-inflammatory, antimicrobial and antioxidant activities.

1. Nerolidol (1,6,10-dodecatrien-3-ol, 3,7,11-trimethyl-(E)) (15), (16)

Compound exhibits strong antioxidant activity by neutralizing reactive oxygen species (ROS) and preventing oxidative damage to lipids, proteins and DNA. It shows potent antimicrobial effects against *Staphylococcus aureus* (FDA 209P) including both MSSA and MRSA strains with MIC values ranging from 512 to >1024  $\mu$ g/mL. Its mechanism involves disruption of bacterial cell membranes resulting in leakage and cell lysis. It also interferes with gene pathways related to bacterial virulence and reveals anti-inflammatory activity.

2. Ar- Turmerone: (17)

It decreases nitric oxide levels by inhibiting iNOS and COX-2 resulting in strong anti-inflammatory effects and reduced adenoma formation. It significantly reduces the expression of iNOS, MMP-9, COX-2, IL-6, IL-1 $\beta$ , TNF- $\alpha$  and MCP-1 in  $\alpha$ -activated microglial cells, indicating possible benefits in neuroinflammatory conditions. The compound also exhibits therapeutic benefits in an imiquimod-induced psoriasis model in BALB/c mice.

3. (2R,3R,4aR,5S,8aS)-2-Hydroxy-4a,5-dimethyl: (18)

It exhibits anti-inflammatory and antioxidant activity and also precise mechanism of action remains unclear.

4. 2-tetradecyloxiranecarboxylate: (19)

It acts by blocking the oxidation of free fatty acids which in turn contributes to its antibacterial and anti-inflammatory effects.

5. 3-(Octanoyloxy)propane-1,2-diyl bis(decanoate): (20)

It suppresses inflammation by inhibiting COX-2 and reducing key cytokines like TNF- $\alpha$  and IL-6. It also decreases oxidative stress by downregulating NOX-2 thus limiting reactive oxygen species production. And act as anti-inflammatory.

6. Octadecanoic acid, 2,3-bis[(1-oxotetradecyl)]: (21)

It exhibits antiinflammatory activity by suppressing the production of key proinflammatory cytokines such as TNF- $\alpha$ , IL-6 and IL-1 $\beta$ .

7. Decanedioic acid, 3,6-dimethyl-, dimethyl ester: (22)

This compound exhibits anti-inflammatory and antioxidant activity. It acts through regulation of hepatic metabolic pathways reducing de novo lipogenesis and enhancing fatty-acid  $\beta$ -oxidation which collectively reduces liver fat accumulation, inflammation and fibrosis.

8. Methyl 2-tetradecyloxiranecarboxylate: (23)

The compound acts by inhibiting mitochondrial  $\beta$ -oxidation of long-chain fatty acids leading to changes in cellular energy pathways including glucose utilization and overall energy production. It combined ability to impede fatty acid breakdown while also showing potential blood glucose lowering effects distinguishes it from other metabolic compounds.

9. Cyclononasiloxane, octadecamethyl-

It inhibits free fatty acid oxidation hence contributing to its antibacterial and anti-inflammatory properties.

10. Along with above components Heptasiloxane, hexadecamethyl Silane, chlorodiethylheptyloxy-(2R,3R,4aR,5S,8aS)-2-Hydroxy-4a,5-dimethyl-Cyclononasiloxane, octadecamethyl, Liguloxide and Di-n-decylsulfone also have demonstrated anti-inflammatory, antioxidant, antimicrobial and antifungal activities while their precise mechanisms of action remain unclear.

These conclusions show strong correspondence with therapeutic indications described in classical Ayurvedic literature. *Prasaranyadi Taila* contains ingredients known for their *vatahara* and *kaphahara* properties. Traditionally *Prasaranyadi Taila* is prescribed for various *Vata* disorders especially *Kubja* (sciatica)

owing to its *vedanasthapana* (analgesic), *sothahara* (anti-inflammatory) and *krimighna* (antimicrobial) actions. As described in the literature this formulation is particularly effective in conditions caused by aggravated *Vata* which can be correlated with several modern clinical disorders having similar pathology. Presence of potent bioactive compounds validate traditional claims indicating that formulation exhibits anti-inflammatory, antioxidant and antimicrobial activities with modern scientific understanding.

## Conclusion

GCMS analysis of the Ayurvedic formulation *Prasarnyaadi Taila* identified 43 bioactive compounds most of which show anti-inflammatory, antimicrobial, antioxidant and antifungal activities. These results provide evidence based scientific basis for Ayurvedic principles as biological actions of these constituents align with therapeutic effects described in therapeutic literature. This confirms that formulation has significant anti-inflammatory potential and supports its traditional use.

**Conflict of Interest:** NA

**Funding:** NA

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