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Analytical Evaluation and Chromatographic Profiling of *Nilikadya Taila*: A Classical Ayurvedic Formulation for Hair Care

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ABSTRACT

Background: *Sneha Kalpana* (medicated oleaginous preparations) is a specialized pharmaceutical method in Ayurveda designed to extract lipid and water-soluble active principles into a fatty medium. *Nilikadya Taila* is a renowned polyherbal formulation mentioned in the *Sharangdhar Samhita (Madhyama Khanda)*, primarily indicated for *Kesh-Sthirikara* (hair strengthening) and *Akala Palitya* (premature graying of hair). However, scientific documentation of its quality standards and analytical profile is currently lacking.

Objectives: The present study aimed to standardize the pharmaceutical preparation of *Nilikadya Taila* and establish its quality control parameters through physicochemical analysis and Thin Layer Chromatography (TLC).

Methods: The oil was prepared following the classical *Sneha Paka* methodology using seventeen authenticated herbs as *Kalka* (paste), *Tila Taila* (sesame oil) as the base, and a mixture of *Triphala Kwatha* and *Bhringaraja Swarasa* in a 1:4:16 ratio. The finished product was evaluated for physicochemical parameters and TLC profiling using pre-coated Silica Gel G F_{254} plates (Merck KGaA, Germany) on the unsaponifiable matter of the oil.

Results: The prepared oil exhibited a medallion yellow-to-green color with a typical herbal odor. Physicochemical analysis revealed a Specific Gravity of 0.9133, Acid Value of 1.261, Saponification Value of 194.81, Iodine Value of 75.59, and Unsaponifiable Matter of 1.5188%. TLC profiling revealed nine distinct spots with Rf values ranging from 0.03 to 0.991, confirming the successful incorporation of phytoconstituents.

Conclusion: The established physicochemical parameters and TLC fingerprint provide a scientific basis for the quality control and standardization of *Nilikadya Taila*, thereby ensuring its therapeutic efficacy.

Key Words *Nilikadya Taila, Sneha Kalpana, Standardization, TLC Fingerprinting, Physicochemical analysis*

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INTRODUCTION

Sneha Kalpana, or oleaginous preparations, refers to the process of preparing various medicated oils and *ghee*-based formulations. These preparations are valued in

RESEARCH ARTICLE

Ayurveda for their therapeutic effectiveness and relatively longer shelf life. As one of the most frequently prescribed dosage forms, *Sneha Kalpana* plays an important role in daily clinical practice due to its broad applicability across all age groups and a wide range of diseases. Such formulations are considered superior to many other dosage forms because they enhance the absorption of both fat-soluble and water-soluble active constituents within a single preparation[1].

Nilikadya Taila is a well-known polyherbal formulation mentioned in the classical *Ayurvedic* text, *Sharangdhar Samhita (Madhyama Khanda*, Chapter 9, Verses 158–161). It is traditionally formulated to nourish the hair and manage various scalp-related conditions. The preparation follows the classical *Sneha Paka* process, using *Tila Taila* (sesame oil) as the base lipid or *Sneha Dravya*. Seventeen medicinal herbs are incorporated in the form of a fine paste (*Kalka*), including powerful ingredients such as *Neelika* (*Indigofera tinctoria*), *Bhringaraja* (*Eclipta alba*), *Triphala*, and *Ayoraja* (iron filings/bhasma). To facilitate better extraction of bioactive components, *Triphala Kwatha* (decoction) and *Bhringaraja Swarasa* (fresh juice) are used as the liquid media (*Drava Dravya*) during the heating process. Therapeutically, *Nilikadya Taila* is recognized for strengthening hair roots (*Kesh-Sthirikara*) and is widely indicated in conditions such as *Akala Palitya* (premature graying of hair) and *Darunaka* (dandruff). It also exhibits beneficial effects in managing disorders like *Upajihwaka* (adenoid-related conditions)[2].

MATERIALS AND METHODS

Collection of Raw Material

The raw materials used for the preparation of *Nilikadya Taila* and their details are given in Table 1.

Table 1 Composition of *Nilikadya Taila*

S.N.	Name of Drug	Botanical Name	Family	Quantity
		KALKA DRAVYA		
1	*Nilika* [3]	*Indigofera tinctoria Linn.*	Fabaceae	75g (1 part) [4.41g each]
2	*Ketaki kanda* [4]	*Pandanus tectorius Soland Ex Parkino*	Pandanaceae	
3	*Bhringaraja* [5]	*Eclipta alba Hask.*	Compositae	
4	*Kurantaka (sahacara)* [6]	*Barleria prionitis*	Acanthaceae	
5	*Arjun pushpa* [7]	*Terminalia arjuna Wight. And Avn.*	Combretaceae	
6	*Beejaka (asana) pushpa* [8]	*Pterocarpus marsupium Linn.*	Leguminosae	
7	*Tagara* [9]	*Valerian wallichii Dc.*	Valerianaceae	
8	*Kamala* [10]	*Nelumbo nucifera*	Nymphaeaceae	
9	*Loha Bhasma*	*Ferrum*		
10	*Priyangu* [11]	*Callicarpa macrophylla Vaul.*	Verbenaceae	
11	*Dadima twak* [12]	*Punica granatum Linn.*	Punicaceae	
12	*Krishna tila* [13]	*Sesamum indicum Linn.*	Pedaliaceae	
13	*Guduchika* [14]	*Tinospora cordifolia Willd Meris.*	Menispermaceae	

RESEARCH ARTICLE

14	*Haritaki* [15]	*Terminalia chebula Retz.*	Combretaceae	
15	*Vibhitaki* [16]	*Terminalia belerica Roxb.*	Combretaceae	
16	*Amlaki* [17]	*Emblica officinalis Gaertn*	Euphorbiaceae	
17	*Padma panaka (swamp at the roots of kalka)*	*Nelumbo nucifera*	Nymphaeaceae	
		SNEHA DRAVYA		
18	*Tila Taila*	*Sesamum indicum Linn.*	Pedaliaceae	300 ml (4 parts)
		DRAVA DRAVYA		
19	*Triphala Kwatha*	—	—	1200 ml (16 parts) [600 ml each]
20	*Bhringaraja Swarasa*	*Eclipta alba Hask.*	Compositae	

Method of Preparation

The manufacturing of *Nilikadya Taila* followed the classical guidelines of *Sneha Kalpana*, adhering to the standard pharmaceutical ratio for medicated oils. The process was executed using a systematic combination of herbal paste (*Kalka*), base oil (*Sneha*), and liquid media (*Drava*) in a specific proportion of 1:4:16[18].

Formulation Ratio: The process utilized 1 part of herbal paste (*Kalka*), 4 parts of *Tila Taila* (base sesame oil), and 16 parts of liquid media (*Drava Dravya*), which included *Triphala Kwatha* and *Bhringaraja Swarasa*.

Initial Heating: Initially, a measured quantity of *Tila Taila* was poured into a wide-mouthed stainless-steel vessel and heated over a moderate flame (*Mandagni*).

Addition of Ingredients: Once the oil reached the required temperature indicated by the appearance of mild fumes, the previously prepared *Kalka* (paste) of the seventeen herbal ingredients was added slowly. This was immediately followed by the gradual addition of the liquid media (*Triphala* decoction and *Bhringaraja Swarasa*)[19].

Controlled Processing: Throughout the pharmaceutical procedure, a consistent mild heat was maintained to ensure the slow extraction of active phytoconstituents into the lipid medium. Continuous stirring was performed using a spatula to prevent the herbal paste from adhering to the bottom of the vessel and to maintain uniform heat distribution.

***Siddhi Lakshana* (Completion Tests):** The heating process continued until the moisture was completely evaporated, as confirmed by the *Sneha Siddhi Lakshanas*. These included the formation of a perfect wick when the paste was rolled between fingers (*Vartivat*) and the absence of a crackling sound when the paste was exposed to a direct flame[20].

Filtration and Storage: Upon achieving the *Madhyama Paka* stage, the vessel was removed from the heat. The medicated oil was filtered through a sterile muslin cloth while still warm to ensure maximum recovery. The final *Nilikadya Taila* was measured and stored in an airtight, amber-colored glass container to protect it from light-induced oxidation.

The step-by-step photographic documentation of the preparation process is given in Figure 1.

RESEARCH ARTICLE

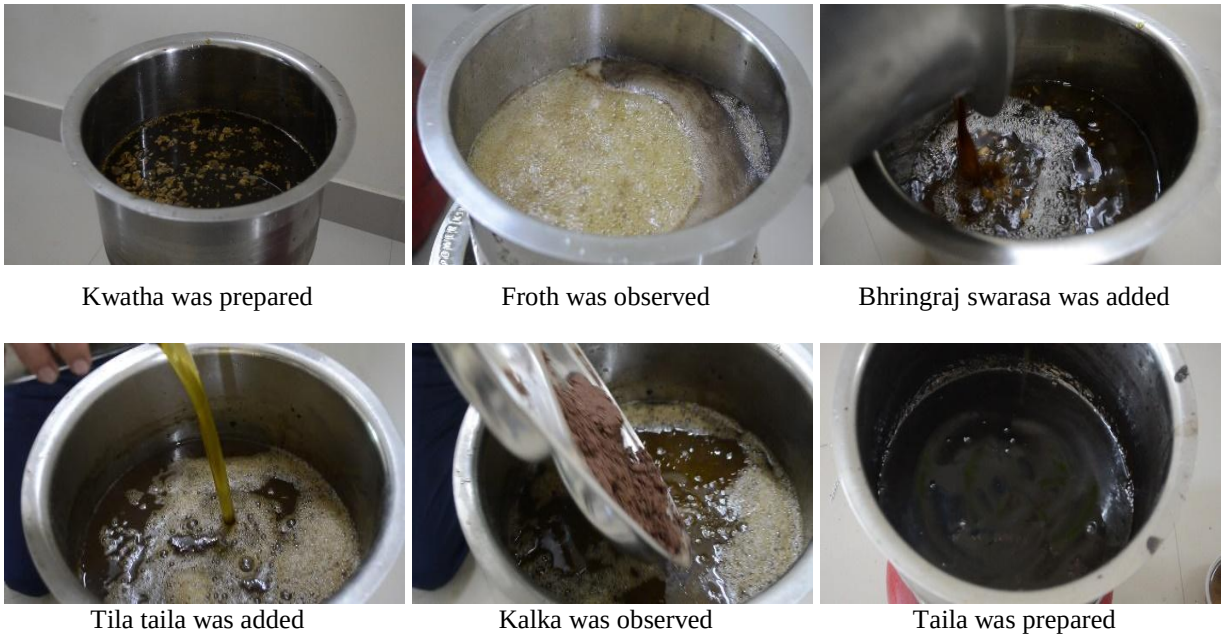

Figure 1 Preparation of *Nilikadya Taila*

Analytical Study

The analytical evaluation of *Nilikadya Taila* was conducted to establish quality standards and ensure the consistency of the formulation. The study was divided into organoleptic examination, physicochemical analysis, and chromatographic profiling.

Organoleptic Evaluation

The sensory characteristics of the finished oil were documented. This included a systematic examination of its color, odor, and texture. The oil exhibited a characteristic herbal aroma and a stable medallion yellow-to-green color, typical of its botanical ingredients. Organoleptic characters are presented in Table 3.

Physicochemical Parameters

To establish the chemical standards and stability profile, the oil was analyzed for the following quantitative parameters, results of which are presented in Table 4.

Refractive Index: To assess the optical density and purity of the medium[21].

Specific Gravity: To measure the density of the medicated oil relative to water[22].

Acid Value: To quantify free fatty acids and assess the shelf-life stability[22].

Saponification Value: To determine the average molecular weight of fatty acids present[24].

Iodine Value: To measure the degree of unsaturation in the lipid content[25].

Unsaponifiable Matter: To quantify the non-fatty substances, including phytosterols and active herbal constituents[26].

Thin Layer Chromatography (TLC) Profiling

TLC was performed to create a phytochemical fingerprint of the formulation. The chromatographic fingerprints visualized at 254 nm and 366 nm are illustrated in Figure 2 and Figure 3, respectively.

RESEARCH ARTICLE

Sample Preparation: The sample for the TLC study was prepared by isolating the unsaponifiable matter of *Nilikadya Taila*.

Stationary Phase: The chromatographic separation was executed using high-grade pre-coated Silica Gel G F_{254} aluminum plates (Merck KGaA, Germany). These plates were selected to ensure a uniform layer thickness and high-resolution reproducibility of the separated spots.

Mobile Phase: A specific solvent system comprising Toluene: Ethyl Acetate: Acetic Acid in the volumetric ratio of 8:2:0.2 (v/v) was employed. This mobile phase was optimized to achieve distinct separation of the phytoconstituents without tailing.

Visualization: After the development of the chromatogram, the plates were air-dried and visualized under UV light at 254 nm and 366 nm to detect fluorescent compounds. The Retardation factor (Rf) values were calculated for each visible spot to establish a reference standard for the formulation.

RESULTS AND DISCUSSION

The preparation of *Nilikadya Taila* involved a systematic heating process, during which distinct changes were observed in the color and consistency of the formulation.

Color Transformation: The most significant change observed was the chromatic transition of the oil. The base *Tila Taila* (sesame oil) was initially pale yellow. However, upon adding the herbal paste (*Kalka*) and liquid media and subjecting it to mild heat, the oil gradually began to absorb the botanical pigments. By the end of the process, the formulation attained a stable yellow-to-green color, attributed to the effective infusion of chlorophyll and other water-soluble active principles from herbs like *Neelika* and *Bhringaraja*.

Consistency and Frothing: As the boiling continued, the moisture content evaporated, and the formulation shifted from a watery mixture to a dense, viscous oily consistency. Towards the final stage of *Paka* (cooking), the appearance of foam (*Phenodgama*) was observed on the surface, which is a classical sign of completion for medicated oils.

***Siddhi Lakshana*:** The endpoint was confirmed when the herbal paste could be rolled into a wick (*Vartivat*) without sticking to the fingers, and the oil produced no crackling sound (*Shabda Hani*) when exposed to fire, indicating the complete absence of moisture.

The quantity of taila taken and the loss during preparation are given in Table 2.

Table 2 Quantity of taila taken and loss

Taila	Quantity
Total tila taila taken	300 ml
Obtained taila	260 ml
Loss	40 ml

A comprehensive analytical investigation of *Nilikadya Taila* was conducted, encompassing organoleptic evaluation, physicochemical parameters, and Thin Layer Chromatography (TLC) profiling. The consolidated quantitative

RESEARCH ARTICLE

results are systematically presented in Table 3 and Table 4.

Table 3 Organoleptic characters of *Nilikadya Taila*

Sr. No.	Particulars	Nilikadya Taila
1	Color	Yellow to green
2	Smell	Characteristic herbal smell
3	Touch	Oily

Table 4 Physicochemical parameters of *Nilikadya Taila*

S.NO	PARAMETERS	TEST 1	TEST 2	TEST 3	MEAN
1	Specific Gravity	0.9098	0.9160	0.9141	0.9133
2	Acid Value	1.248	1.278	1.257	1.261
3	Saponification Value	195.07	194.58	194.79	194.81
4	Iodine Value	72.82	75.85	78.11	75.59
5	Refractive Index	1.468	1.468	1.468	1.468
6	Unsaponifiable Matter	1.5027	1.5369	1.5717	1.5188

Furthermore, the chromatographic fingerprints visualized at 254 nm and 366 nm are illustrated in Figure 2 and Figure 3, respectively.

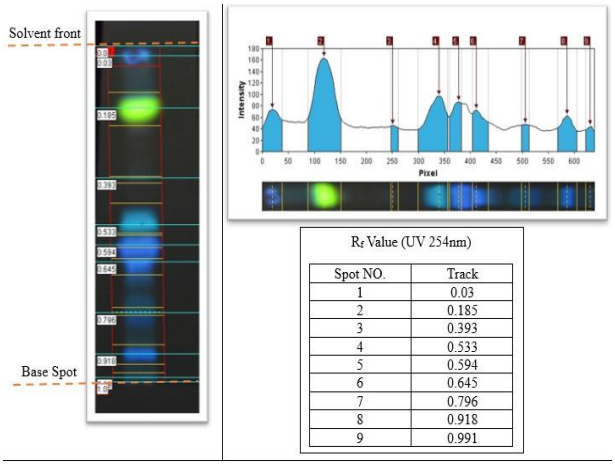

Figure 2 TLC Chromatogram of *Nilikadya Taila* at UV 254 nm

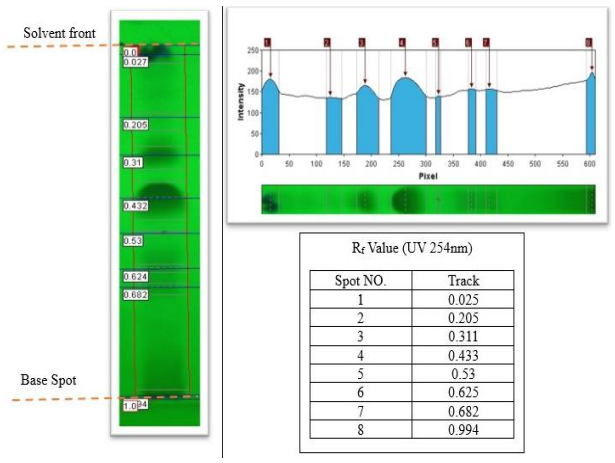

Figure 3 TLC Chromatogram of *Nilikadya Taila* at UV 366 nm

The present study demonstrates that *Nilikadya Taila* can be prepared following classical *Sneha Kalpana* principles while meeting contemporary pharmaceutical quality and analytical standards. The formulation consistently exhibited a yellow-to-green coloration and characteristic herbal aroma, indicative of effective extraction of pigment-rich and aromatic constituents from herbs such as *Neelika* and *Bhringaraja* into the sesame oil base. This organoleptic stability serves as a practical marker of appropriate *Paka*, corroborated by similar pharmaceutico-analytical findings in other Ayurvedic oil preparations.

A single batch was prepared, with physicochemical parameters assessed in triplicate to ensure analytical reproducibility and reduce random error. The mean specific gravity (0.9133) reflects a slight increase relative to plain *Tila Taila*, suggesting successful incorporation of dissolved and suspended phytoconstituents from the *Kalka* and *Drava Dravyas* into the lipid matrix. The low acid value (1.261) indicates minimal free fatty acid content, favorable for

RESEARCH ARTICLE

oxidative stability and extended shelf life. The saponification value (194.81) aligns with expected molecular weights of triglycerides in sesame oil-based formulations. The iodine value (75.59) denotes a moderate degree of unsaturation, implying preservation of beneficial unsaturated fatty acids post-processing. The unsaponifiable matter (1.5188%) signifies enrichment with non-glyceride bioactive compounds such as phytosterols and triterpenoids.

(TLC) profiling of the unsaponifiable fraction revealed multiple distinct spots with reproducible R_f values at 254 nm and 366 nm, confirming diverse phytoconstituent presence. The consistency of chromatographic bands across replicates validates the method's robustness and suitability as a reference identity profile for routine quality control. Establishing such fingerprints is critical for polyherbal Ayurvedic formulations, where therapeutic efficacy arises from synergistic compound spectra rather than isolated markers. Combined with physicochemical data, the TLC results affirm that the prepared *Nilikadya Taila* satisfies both classical *Sneha Siddhi* criteria and modern analytical benchmarks.

From an Ayurvedic perspective, the formulation integrates *Tila Taila* with *Keshya, Rasayana*, and *Raktaprasadana* agents including *Neelika, Bhringaraja, Triphala, Guduchi*, and *Loha Bhasma*, traditionally indicated for hair strengthening (*Kesh-Sthirikara*), prevention of premature graying (*Akala Palitya*), and dandruff reduction (*Darunaka*). While pharmacological and clinical evaluations were beyond this study's scope, establishing a stable, reproducible physicochemical and chromatographic profile constitutes a foundational step towards evidence-based validation of these traditional uses.

Limitations include the study's confinement to a single laboratory batch with triplicate analyses, absence of accelerated stability testing, microbial assessments, and correlation of TLC bands with quantified markers via HPTLC or HPLC. Additionally, comparisons with other classical hair oil formulations or marketed *Nilikadya Taila* products were not conducted, which could have enhanced the external validity of the proposed standards. Addressing these aspects in future research will refine quality specifications and elucidate links between chemical profiles, pharmacological activity, and clinical efficacy.

CONCLUSION

The study successfully standardized the preparation of *Nilikadya Taila* using a single batch processed according to classical *Sneha Paka* methodology, and characterized this batch through triplicate physicochemical and chromatographic evaluations. Consistent organoleptic findings, low acid value, suitable specific gravity, appropriate saponification and iodine values, and a measurable proportion of unsaponifiable matter collectively indicate that the formulation obtained is stable, well-processed, and pharmaceutically acceptable. The

RESEARCH ARTICLE

TLC fingerprint, with reproducible Rf values across repeated analyses, offers a practical chromatographic identity profile that can be adopted as a reference standard in routine quality control of *Nilikadya Taila*. Taken together, these parameters provide a scientifically grounded framework for the standardization and quality assurance of this classical haircare formulation in both academic and industrial settings. Incorporation of these quality markers into production protocols will support the manufacture of consistent, safe, and reliable *Nilikadya Taila*, and lays the groundwork for further pharmacological and clinical research aimed at substantiating its traditional claims in hair and scalp disorders.

RESEARCH ARTICLE

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RESEARCH ARTICLE

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