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PHARMACOGNOSTICAL AND PHARMACEUTICAL ANALYSIS OF *SHULADWIPAGHNI VATI*: A HERBOMINERAL FORMULATION

Sathi E. D.*[1], Sanila V. K.[2]

[1]PG Scholar, Department of Rasashastra and Bhaishajya Kalpana, Govt. Ayurveda College, Kannur, Kerala.
[2]Associate Professor, Department of Rasashastra and Bhaishajya Kalpana, Govt. Ayurveda College, Kannur, Kerala.

***Corresponding Author: Sathi E. D.**

PG Scholar, Department of Rasashastra and Bhaishajya Kalpana, Govt.Ayurveda College, Kannur, Kerala.

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ABSTRACT

Background: Herbomineral formulations are widely used in traditional medicine and are considered beneficial for managing chronic diseases when properly processed. Owing to their combined herbal and mineral constituents, such formulations often exhibit significant anti-inflammatory and antioxidant properties. *Shuladwipaghni vati* is one such formulation that comprises ingredients individually known for these therapeutic potentials, suggesting its possible role in chronic inflammatory conditions. Systematic evaluation of its pharmacognostical characteristics and pharmaceutical processing is essential to establish standardisation parameters and provide a scientific basis for further research. **Methods**: *Shuladwipaghni vati* was prepared using authenticated and genuine raw drugs. As part of pharmacognostical evaluation, for herbal drugs, macroscopical and microscopical evaluation was performed, and for mineral drugs, XRD analysis was conducted. In pharmaceutical evaluation, physicochemical analysis and instrumental analysis were carried out. **Results**: The microscopic features of herbal drugs were compared with the standards of individual drugs mentioned in the Ayurvedic Pharmacopoeia of India. Mineral identification was performed using XRD analysis. HPTLC revealed 9 peaks at ultraviolet 254 nm and 7 peaks at ultraviolet 366 nm, indicating a diverse range of phytoconstituents. ICP-OES heavy metal analysis detected cadmium (0.06 ppm) and mercury (0.19 ppm) within permissible limits of the Ayurvedic Pharmacopoeia of India. XRD analysis confirmed the presence of Sulphur, Halite, Boron, and Magnesium sulphite hydrate. FTIR showed peaks indicating OH, C=O, C-H, and C-O stretching. ICP-MS analysis detected Mg (0.29%), K(0.69%), Ca(0.08%), Mn(74.04 ppm), Cu (113.28 ppm), Zn (21.53 ppm), and Fe(96.22 ppm). **Conclusion**: The findings establish a scientific baseline for standardisation and future research on *Shuladwipaghni vati*.

KEYWORDS: *Shuladwipaghni vati*, Standardisation, Pharmacognostical evaluation, Pharmaceutical evaluation, Physicochemical analysis, Instrumental analysis, Ayurvedic Pharmacopoeia of India.

1. INTRODUCTION

Ayurveda emphasises a comprehensive and customised approach to health and illness, of which herbomineral formulations are an integral part of its extensive pharmacopoeia. These formulations enhance medicinal efficacy, bioavailability, and targeted action through plant-derived compounds combined with processed minerals and metals. They are systematically described in numerous renowned classical texts.

Shuladwipaghni vati is one such herbomineral formulation mentioned in various classical textbooks. It is described in the ***Shula prakarana*** of *Vaidya Chinthamani*, comprising six herbal and four mineral ingredients.[1] It is also referenced in other textbooks such as ***Vaidya Rahasya*** and ***Bharat Bhaishajya Ratnakara***, where it is referred to as ***Shulagajakesari gutika***. According to *Vaidya Rahasya*, ***Vidanga*** is mentioned in place of ***Vida lavana***.

The major ingredient of this formulation is processed ***Kupeelu*** (**Strychnous nuxvomica Linn.**), which has been proven to possess anti-inflammatory activity.[2] Purified ***Chitraka*** (**Plumbago zeylanica Linn.**) exhibits

anti-arthritic activity through its methanolic extract.[3] Chebulanin, the chemical constituent of ***Haritaki*** (**Terminalia chebula Retz**.), significantly suppressed the progression and development of Rheumatoid Arthritis in collagen-induced arthritis mice by decreasing arthritis indices.[4] Published review studies on ***Sunti*** (**Zingiber officinale Roscoe**) demonstrate its anti-inflammatory, antioxidant, and immunomodulatory properties.[5] The piperine content of ***Maricha*** (**Piper nigrum Linn**.) has proven anti-inflammatory and anti-arthritic activities.[6] An in vitro study on the ethanolic extract of ***Hingu*** (**Ferula asafoetida Linn**.) showed anti-inflammatory activity.[7] ***Gandhaka*** (**Sulphur**)-containing compounds are proven to possess anti-inflammatory properties.[8] An in vitro study on ***Tankana*** (**Borax**) powder demonstrated anti-inflammatory activity.[9] Thus, most ingredients of this formulation have demonstrated anti-inflammatory and antioxidant activities. Therefore, it may be useful in managing many chronic inflammatory conditions of the present era that require long-term treatment.

Despite the documented individual properties of its ingredients, the complete herbomineral formulation *Shuladwipaghni vati* lacks systematic pharmacognostical and pharmaceutical standardisation. This absence of a scientific baseline hinders its validation, quality control, and potential for integration into evidence-based practice. This emphasises the importance of undertaking pharmacognostic and pharmaceutical evaluation of this formulation as a foundational step for further research.

2. MATERIALS AND METHODS

2.1. Collection and Authentication of Raw Drugs

The raw drugs were procured from authenticated vendors of Kerala. The examination of macroscopic and microscopic features of herbal drugs was conducted at the Department of Dravya Guna Vijnana, Government Ayurveda College, Kannur, and authenticated as per the Ayurvedic Pharmacopoeia of India (API). The examination of macroscopic features of mineral drugs was conducted by the Department of Rasashastra and Bhaishajya Kalpana, and crystal identification was performed using the XRD technique at SAIF, Cochin.

2.2. Method of Preparation of *Shuladwipaghni Vati*

2.2. A. Prerequisite Procedures

2.2. A.1. Purification of *Kupeelu*[10]

The following method was selected based on a published study that demonstrated a significant reduction in strychnine and brucine content.

Materials required: Cow's urine, Cow's milk, Cow's ghee, Stainless steel vessel, tray.

i. Soaking in Cow's urine: Five hundred grams of cleaned and dried authenticated raw seeds of *Kupeelu* were kept in 1 L of cow's urine in a stainless-steel tray for 7 days. Urine was replaced with fresh urine every morning at 6 am. Seeds were taken out, monitored, and then washed with hot water.

ii. Boiling in Cow's milk: After the above procedure, the seeds were placed in a cloth bundle and suspended in a steel vessel. Cow's milk was poured up to half of the vessel, and the bundle was immersed by tying it to a rod placed horizontally over the mouth of the vessel. It was then kept on an induction stove at 100°C for three hours. Sufficient quantity of cow's milk was added as needed until completion of the *swedana* (boiling) procedure. After completion, the seeds were removed and washed with hot water. The external covering and sprout were removed using a knife.

iii. Frying in ghee: The cotyledons were dried, fried in ghee, then powdered and stored in an airtight container.

Figure 1: Raw Kupeelu seeds.

Figure 2: Nimajjana (soaking) of Kupeelu in Gomutra (cow's urine)

Figure 3: Boiling Kupeelu in milk.

Figure 4: Kupeelu after removal of cotyledons.

Figure 5: *Kupeelu* after frying in ghee.

2.2. A.2. Purification of *Gandhaka*[11]

Materials required: Mud pot, mortar and pestle, cow's milk, cloth, thread, cow's ghee, cow dung cakes, *sharava* (earthen lid), mud.

Procedure: A sufficient quantity of cow's milk was taken in a mud pot smeared internally with cow's ghee, and its mouth was tied with a cloth. Coarse powder of 100 g. *Gandhaka* was spread upon this cloth and covered with a broad and large *sharava*, and the joints were sealed with mud. Cow dung cakes were spread upon the *sharava* and ignited. The *Gandhaka*, melted by the heat of the fire, trickled down through the cloth into the milk inside the vessel and solidified. The purified *Gandhaka* was then collected and washed with lukewarm water.

Figure 6: Powdering of Gandhaka.

Figure 7: Milk taken in mud pot.

Figure 8: Pot tied with cloth.

Figure 9: Powdered Gandhaka spread over cloth.

Figure 10: Another Sharava placed over it and sealed with mud.

Figure 11: Placed inside the pit.

Figure 12: Covered with cow dung.

Figure 13: Burning process.

2.2. A.3. Purification of *Tankana*[12]
Materials required: Iron vessel, stainless steel spoon
Procedure: Thirty grams of *Tankana* were coarsely powdered and taken in a wide-mouthed iron vessel. The vessel was placed over the stove and heated with continuous stirring using a stainless-steel spoon until the water content evaporated, indicated by cessation of the hissing sound.

2.2. A.4. Purification of *Chitraka*[13]
Materials required: Weighing balance, lime powder, stainless steel vessel.

Preparation of *Choornodaka*: Twenty-one grams of lime powder was dissolved in 5.04 L of water and kept undisturbed for 9 hours. One hundred grams of *Chitraka* roots were washed, cut into small pieces, and kept immersed in the *Choornodaka*. When the water turned pink, it was discarded. The process was repeated until the white colour of *Choornodaka* remained unchanged. The central cylindrical portion was then removed, dried, and powdered.

2.2. A.5. Purification of *Hingu*[14]
Materials required: Cow's ghee, a wide-mouthed iron vessel.

Thirty grams of *Hingu* were fried in sufficient quantity of ghee until it attained a golden yellow colour.

2.2.B. Preparation of *Shuladwipaghni Vati* - Main Procedure
Requirements: Weighing balance, mixer grinder, spoon, sieve (mesh No. 120), steel vessels, airtight containers, ziplock covers, mortar, pestle.

Table 1: Composition of *Shuladwipaghni Vati.*

Sl.No.	Sanskrit Name	Scientific Name / Mineral Composition	Quantity
1	Purified *Gandhaka*	Sulphur	18g
2	Purified *Tankana*	Borax	18g
3	Purified *Kupeelu*	Strychnous nuxvomica Linn	162g
4	*Maricha*	Piper nigrum Linn.	18g
5	*Pathya (Haritaki)*	Terminalia chebula Retz.	18g
6	*Sunti*	Zingiber officinale Roscoe	18g
7	Purified *Hingu*	Ferula asafoetida Linn.	18g
8	Purified *Chithraka*	Plumbago zeylanica Linn.	18g
9	*Vida lavana*	Black salt (processed)	18g
10	*Saindhava*	Rock salt	18g

Eighteen grams each of purified *Gandhaka*, purified *Tankana*, *Haritaki*, *Sunti*, purified *Hingu*, *Maricha*, purified *Chitraka*, *Saindhava*, and *Vida lavana* were taken and powdered separately. To the above mixture, 162 g of finely powdered purified *Kupeelu* was added and mixed homogenously. For the *bhavana* (levigation) process, a sufficient quantity of water was added to the combined powder mixture to form a paste. This was then ground in a *khalva yantra* (mortar and pestle) for one day until a homogeneous consistency was achieved, after which *vati* (tablets) of 125 mg were prepared.

Figure 14: Prepared *Shuladwipaghni Vati.*

2.3. Pharmacognostical Evaluation

The evaluation of herbal drugs was carried out based on their macroscopic and microscopic characteristics. Mineral drugs were identified through macroscopic examination and X-ray diffraction (XRD) analysis. Macroscopic evaluation included assessment of the raw drug's colour, odour, size, shape, texture, and other physical attributes. Microscopic evaluation involved examination of transverse sections of the herbal drugs under a microscope. For *Hingu*, macroscopic examination was performed. All evaluations were conducted in accordance with the API.

2.4. Pharmaceutical Evaluation

Shuladwipaghni vati was prepared using authenticated herbal and mineral drugs at the Rasashastra and Bhaishajya Kalpana laboratory and then subjected to physicochemical and instrumental analysis.

2.4.1. Physicochemical Analysis and Instrumental Analysis

An analytical study involves assessment of the formulation for ensuring consistency, efficacy, and safety, which authenticates the prepared formulation. Analysis of *Shuladwipaghni Vati* was performed at the QA department of Aryavaidyashala, Kottakkal, Malappuram. Instrumental analysis was conducted at SAIF, Cochin.

Table 2: List of Physicochemical Parameters and Instrumental Analysis.

Physicochemical parameters	Instrumental analysis
• pH value • Loss on drying • Total-ash value • Water-soluble extractive • Alcohol soluble extractive	• HPTLC • ICP OES analysis for heavy metals • ICP -MS • XRD • FTIR • SEM-EDS

3. RESULTS

3.1. Pharmacognostical Analysis

Macroscopic and microscopic evaluation results of individual herbal drugs confirmed their authenticity, and the crystalline structure of mineral drugs proved their identity.

Table 3: XRD Analysis Results of Individual Mineral Drugs.

Mineral	Compound name	S-Q
Gandhaka	Sulphur	100 %
Tankana	Na2 B4 O 5(OH)4(H2O)8	100%
Saindava	NaCl	100%
Vida lavana	NaCl KCl	63.9% 36.1%

These results revealed the authenticity of mineral drugs used in the formulation. The sample of *Vida Lavana* used contained both NaCl and KCl, addressing the existing controversy regarding its composition.

3.2. Pharmaceutical Analysis

Table 4: Organoleptic Characters of *Shuladwipaghni Vati* Powder.

Characters	Observations
Colour	Dark brown
Odour	Pungent
Taste	Bitter, Astringent

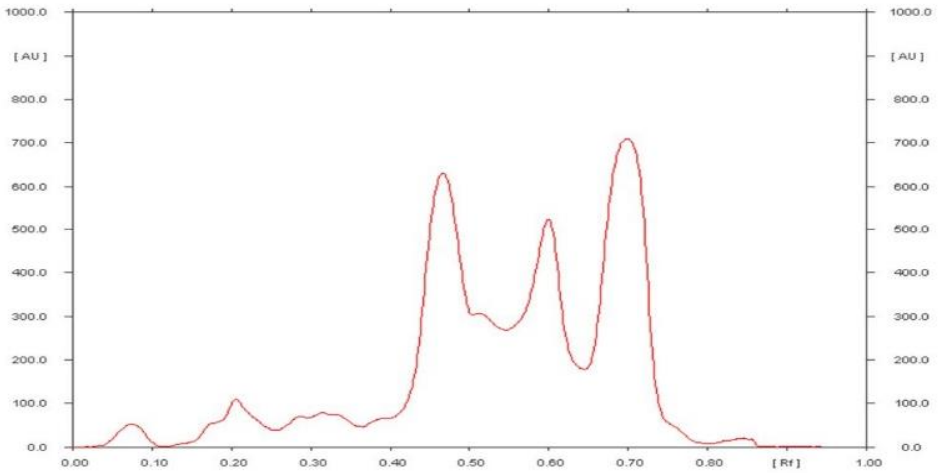
Table 5: Physicochemical Parameters of *Shuladwipaghni Vati.*

Parameter	Result	Unit
Appearance	Dark brown	-
Loss on drying	8.87	%w/w
pH	7.75	
Total Ash	17.85	%w/w
Water-soluble extractive	85.42	%w/w
Alcohol soluble extractive	40.22	%w/w

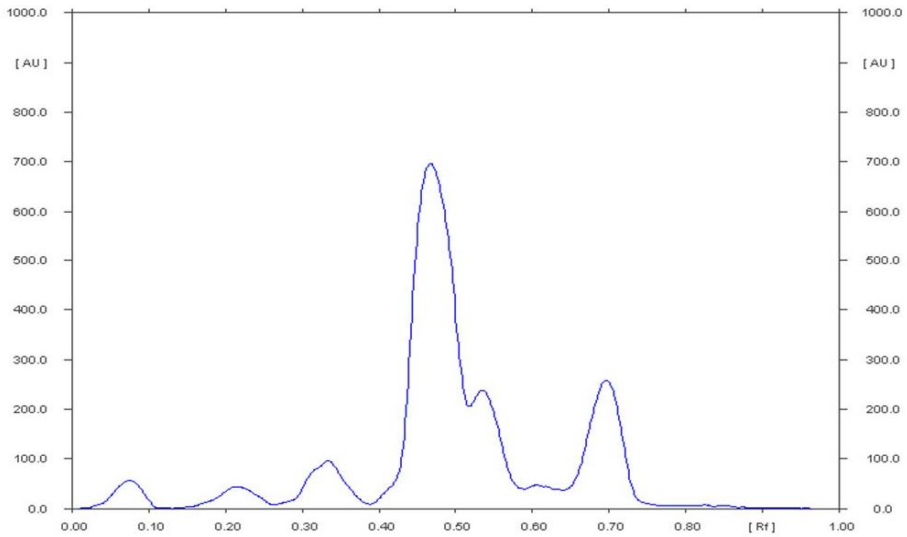
Table 6: ICP-OES Analysis of Heavy Metals in *Shuladwipaghni Vati.*

Heavy metal	Quantity present(ppm)	API Permissible Limit (ppm)
Arsenic	nil	3.0
Cadmium	0.06	0.3
Lead	nil	10.0
Mercury	0.19	1.0

HPTLC



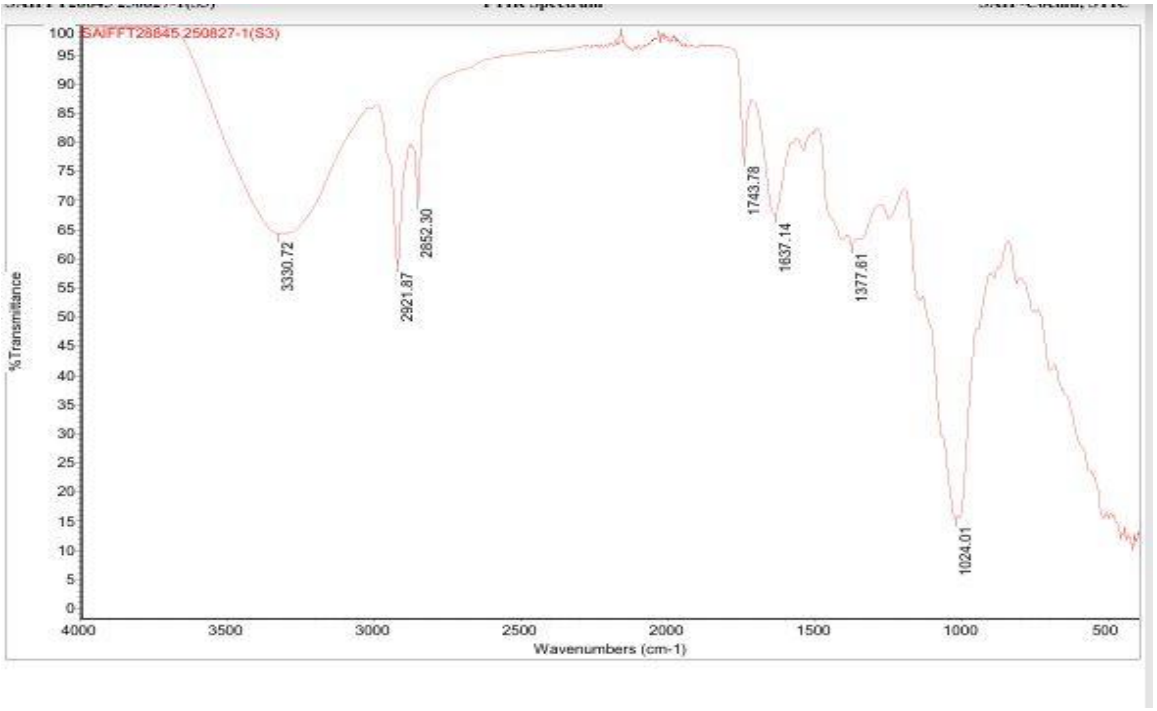
Graph 1: HPTLC Overview Graph of *Shuladwipaghni Vati* Sample at 254 nm.



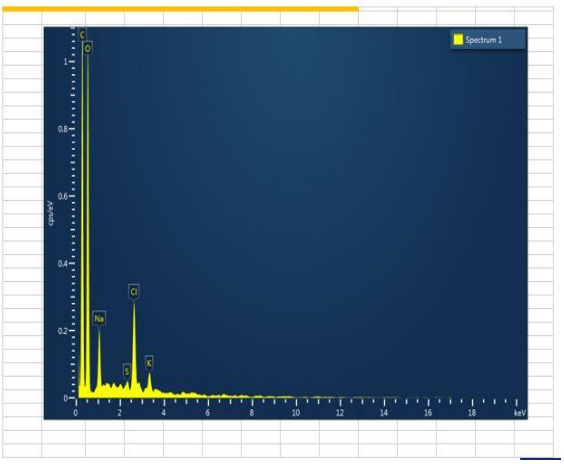
Graph 2: HPTLC Overview Graph of *Shuladwipaghni Vati* Sample at 366 nm.

Table 7: Rf Values and Number of Peaks at 254 nm and 366 nm.

At 254 nm		At 366 nm	
No.of peaks	**Rf value**	**No.of spots**	**Rf Value**
9	0.07 0.21 0.29 0.31 0.47 0.51 0.60 0.70 0.86	7	0.08 0.21 0.33 0.47 0.54 0.61 0.70

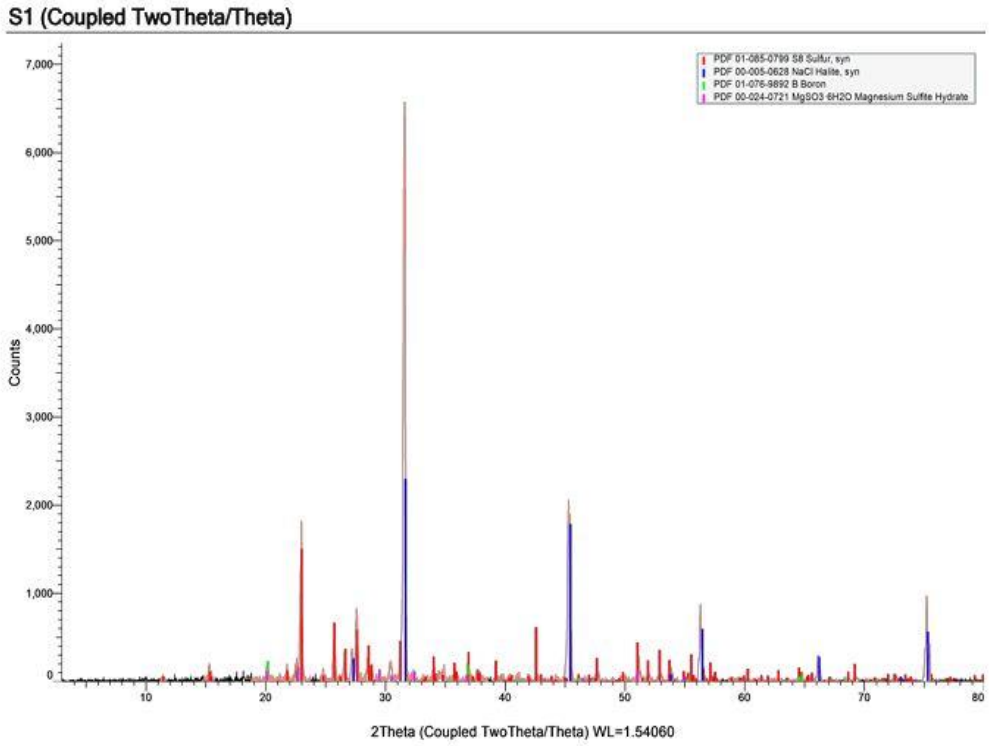


Graph 3: FTIR Spectrum of *Shuladwipaghni Vati.*



Element	Line Type	Wt%	Atomic %
O	K series	73.77	83.54
Na	K series	11.38	8.97
S	K series	0.93	0.52
Cl	K series	10.8	5.52
K	K series	3.12	1.45
Total:		100	100

Graph 4: SEM-EDS Analysis Result of *Shuladwipaghni Vati.*



Graph 5: XRD Analysis Result of *Shuladwipaghni Vati.*

Pattern List #1

Index	Name	Compound Name	Formula	Quality	S-Q	Lattice	Space Group	a
1	PDF 01-085-0799	Sulfur, syn	S8	Indexed	40.4%	Orthorhombic	Fddd (70)	10.48000 Å
2	PDF 00-005-0628	Halite, syn	NaCl	Star (*)	29.9%	Cubic	Fm-3m (225)	5.64020 Å
3	PDF 01-076-9892	Boron	B	Blank	24.0%	Tetragonal	P-4n2 (118)	8.79790 Å
4	PDF 00-024-0721	Magnesium Sulfite Hydrate	MgSO3·6H2O	Star (*)	5.7%	Rhombo.H.axes	R3 (146)	8.83850 Å

b	c	alpha	beta	gamma	Z	Volume	Density
12.92000 Å	24.54999 Å				16.00	3324.11 Å³	2.050 g/cm³
					4.00	179.43 Å³	2.168 g/cm³
	5.03700 Å				50.00	389.88 Å³	2.302 g/cm³
	9.08000 Å				3.00	614.29 Å³	1.723 g/cm³

Table 8: ICP-MS Analysis Results of *Shuladwipaghni Vati.*

Sl.No.	Element	Concentration
1	Magnesium (Mg)	0.29 %
2	Potassium (K)	0.69 %
3	Calcium (Ca)	0.08 %
4	Manganese (Mn)	74.04 ppm
5	Copper (Cu)	113.28 ppm
6	Zinc (Zn)	21.53 ppm
7	Iron (Fe)	96.22 ppm

4. DISCUSSION

4.1. Pharmacognostical Study

Pharmacognostical evaluation ensures the identity, purity, and quality of crude drugs used in the formulation. Microscopic and macroscopic analyses were performed to confirm the authenticity of ingredients. Macroscopic features of herbal and mineral ingredients were compared with textual references. Microscopic features of herbal ingredients were evaluated as per the API. XRD analysis of mineral drugs (Table 3) confirmed their authenticity, with the *Vida Lavana* sample showing a composition of both NaCl (63.9%) and KCl (36.1%), which addresses the classical controversy regarding its precise mineral composition.

4.2. Pharmaceutical Study

4.2.1. Organoleptic Characters

The organoleptic evaluation of *Shuladwipaghni vati* powder (Table 4) revealed a fine, dark brown powder with a pungent odour and intense bitter-astringent taste, characteristic of its constituent herbs and minerals.

4.2.2. Physicochemical Parameters

Loss on drying: The formulation showed 8.87% w/w loss on drying (Table 5), indicating relatively low moisture content. This suggests good stability and suitability for safe storage and long-term use, as lower

moisture content minimises the risk of microbial growth and chemical degradation.

pH: The pH of a 1% aqueous solution was 7.75, indicating mild alkalinity. This is within an acceptable range and suggests proper processing. A mildly alkaline pH may help neutralise acidity and promote a balanced internal environment, potentially reducing inflammation triggered by acidosis.

Total Ash: The total ash value of 17.85% w/w reflects the significant mineral content of this herbomineral formulation, which is consistent with its composition and considered acceptable.

Water-soluble extractive: The high water-soluble extractive value of 85.42% w/w indicates the presence of substantial hydrophilic bioactive components such as tannins, glycosides, and sugars. This suggests good aqueous extractability of active constituents.

Alcohol-soluble extractive: The alcohol-soluble extractive value of 40.22% w/w suggests the presence of alcohol-soluble phytochemicals, including alkaloids, flavonoids, and essential oils. The combination of high water and alcohol extractives indicates a broad spectrum of both polar and non-polar bioactive compounds.

4.2.3. HPTLC Analysis

HPTLC analysis of *Shuladwipaghni vati* revealed 9 peaks at 254 nm and 7 peaks at 366 nm (Table 7). At 254 nm, which primarily detects conjugated double bond systems and aromatic compounds, the presence of 9 distinct peaks suggests a diverse range of phenolic compounds, flavonoids, and other UV-absorbing phytoconstituents. These compounds are often associated with anti-inflammatory and antioxidant activities, supporting potential mechanisms of action. The 7 peaks observed at 366 nm confirm the presence of multiple fluorescent phytoconstituents, further indicating phytochemical diversity. The characteristic Rf values established can serve as a fingerprint for future quality control and authentication of the formulation.

4.2.4. Heavy Metal Analysis (ICP-OES)

ICP-OES analysis (Table 6) detected cadmium at 0.06 ppm and mercury at 0.19 ppm, both well within the permissible limits specified by the Ayurvedic Pharmacopoeia of India (Cadmium: 0.3 ppm, Mercury: 1.0 ppm). Arsenic and lead were below detectable limits (<0.01 ppm). These findings are significant as they confirm the efficacy of the classical *Shodana* (purification) processes in rendering the mineral components safe for therapeutic use. The absence of toxic heavy metals within harmful ranges supports the safety profile of the formulation when prepared according to traditional methods.

4.2.5. XRD Analysis

XRD analysis revealed crystalline phases corresponding to Sulphur (S_8, 40.4%), Halite (NaCl, 29.9%), Boron (24.0%), and minor Magnesium Sulphite Hydrate (5.7%). Elemental sulphur is traditionally recognised for its role in reducing joint pain and stiffness through anti-inflammatory mechanisms. The NaCl crystalline phase confirms the electrolyte-rich profile also observed in EDS analysis. Boron is well-documented to improve bone strength, reduce inflammatory mediators, and enhance antioxidant enzyme activity. Magnesium sulphite hydrate may further contribute to redox regulation and detoxification pathways.

4.2.6. FTIR Analysis

The FTIR spectrum revealed major functional groups supporting the pharmacological potential of *Shuladwipaghni vati*. The peak around 3320 cm^{-1} indicates –OH stretching of phenols or alcohols, suggesting antioxidant potential. Bands at 2920–2850 cm^{-1} correspond to C–H stretching of alkanes, while absorption near 1637 cm^{-1} indicates C=O stretching (carbonyl groups), which may be associated with bioactive organic components. The strong band near 1024 cm^{-1} is characteristic of C–O stretching in polysaccharides or glycosidic bonds, often linked with immunomodulatory and anti-inflammatory activity. Collectively, these functional groups suggest the presence of compounds that could scavenge free radicals, stabilise oxidative stress, and mitigate inflammatory cascades.

4.2.7. SEM-EDS Analysis

SEM–EDS results confirmed the elemental composition of *Shuladwipaghni vati*, showing high oxygen content (73.77 wt%), along with sodium (11.38 wt%), chlorine (10.8 wt%), potassium (3.12 wt%), and trace sulphur (0.93 wt%). The presence of Na and Cl confirms the dominance of mineral salts like NaCl, while potassium and sulphur suggest additional bioactive mineral components. These mineral ions are known to contribute to electrolyte balance, anti-inflammatory activity, and antioxidant defence. The significant oxygen content reflects oxidised compounds, possibly contributing to redox balance and free-radical scavenging.

4.2.8. ICP-MS Analysis

Elemental analysis by ICP-MS (Table 8) demonstrated the presence of essential macroelements (Mg 0.29%, K 0.69%, Ca 0.08%) and trace elements (Mn 74.04 ppm, Cu 113.28 ppm, Zn 21.53 ppm, Fe 96.22 ppm), all above detection limits, confirming analytical reliability. Potassium was the predominant macroelement, supporting electrolyte balance and neuromuscular function, while magnesium and calcium contribute to enzymatic activity and structural roles. Among trace elements, copper and iron were relatively higher, suggesting potential hematinic and metabolic benefits, whereas zinc and manganese support antioxidant and immune functions. The combined presence of these

physiologically important minerals indicates possible nutritional and therapeutic relevance of the formulation. However, the comparatively higher copper and iron levels underscore the critical importance of adhering to the classical dosage regimen and necessitate further sub-chronic toxicity studies to establish a comprehensive long-term safety profile.

5. CONCLUSION

The pharmacognostic and pharmaceutical analysis of *Shuladwipaghni vati* demonstrated acceptable quality parameters and indicated promising antioxidant and anti-inflammatory potential. The study established comprehensive standardisation parameters, including organoleptic characters, physicochemical constants, HPTLC fingerprint profiles, and elemental composition. Heavy metal analysis confirmed the safety of the formulation, validating the efficacy of traditional purification (*Shodana*) procedures. XRD, FTIR, and SEM-EDS analyses provided detailed insights into the mineral composition and functional groups contributing to therapeutic activity. These findings support its classical indications and provide baseline standards for identification, quality control, and authentication. Further experimental and clinical studies are required to substantiate its therapeutic efficacy, making this study a foundational step for future research on *Shuladwipaghni vati*.

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