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Comparative, Pharmaceutical and Analytical study of *Vaikranta Druti* prepared by two distinct techniques

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Abstract

Vaikranta(Tourmaline), is a complex boron silicate mineral, which is classified as a *Ratna Dravya* (precious stone drug) in the Ayurvedic pharmacopoeia. Conversion into *Druti* (semi-fluid bioavailable state) is mandatory before therapeutic use. Classical texts suggest two different preparatory routes; however, indexed literature lacks a systematic analytical comparision.

To prepare *Vaikranta Druti* (VD) by (i) the *Dolayantra Swedana* (Purification) method of *Rasa Ratna Samucchaya* 4/ 76 (VD-1) and (ii) the sequential alkali-acid method of *Anubhuta yoga Shtakam* (VD-2), and also to compare their pharmaceutical and analytical profiles.

Both the samples undergone organoleptic evaluation (like colour, odour, taste and consistency) with physio-chemical tests (like pH, loss on drying, total ash, acid insoluble ash, water soluble extractive, specific gravity, refractive index) X-ray diffraction (XRD), and Energy dispersive X-ray spectroscopy (EDS).

VD-1 was dark brownish-black, viscous, and near-neutral pH (6.8 ± 0.12), having sharp XRD peaks (~118,000 counts at $2\theta \approx 32°$) that confirmed preserved crystallinity, as well as higher sodium (Na 4.88 at.%) and chloride (Cl 3.60 at.%) by EDS. VD-

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2 was pale yellowish-brown, less viscous, acidic pH (4.2 ± 0.09), elevated carbon (C 47.55 at.%), broader XRD peaks with a prominent low-angle reflection (~57,000 counts at $2\theta \approx 14°$), higher loss on drying (11.76%) and water-soluble extractive (24.91%), indicating greater structural deconstruction.

The two methods produce analytically and pharmaceutically distinct *Druti* preparations. The differential physico-chemical, crystallographic and elemental profiles provide objective evidence for method-specific standardisation and form baseline data for pharmacopoeial monograph development.

Key words : *Vaikranta*; Tourmaline; *Druti*; *Rasa Ratna Samucchaya*; *Anubhuta Yoga Shatakam*; XRD; EDS; physico-chemical standardisation

***R**asashastra* (Ayurvedic alchemy and iatrochemistry) employs a diverse range of mineral, metal, and gemstone-based formulations to treat diseases refractory to botanical medicines alone. Among these, *Ratna Dravyas* (precious stone drugs) hold a unique therapeutic position.[1] *Vaikranta*, identified in modern mineralogy as Tourmaline—a complex boron silicate of the general formula $NaFe_3^{2+}Al_6(BO_3)_3Si_6O_{18}(OH)_4$ [5] —is one of the most therapeutically referenced *Ratna* drugs in classical *Rasa* texts.

Classical texts features *Vaikranta* with *Medhya* (cognitive-enhancing), *Rasayana* (rejuvenative), *Chakshushya* (ophthalmotonic) and therapeutic effects in *Kustha* (skin disorders), *Prameha* (metabolic disorders), *Vatarakta* (gout), and *Krimi* (infections).[3,4] However, raw Tourmaline in its *Ashudda* (unpurified) state is considered pharmacologically inert and potentially harmful for internal use. Classical processing—*Shodhana* (purification) and *Druti* preparation (transformation to semi-liquid form)—are mandatory requirement to render the mineral biocompatible and therapeutically active.

The term '*Druti*' represents a specific pharmaceutical end-state of a *Ratna* or *Loha* (metal) in which the material is transformed into a semi-fluid, reactive preparation through processing with specific media—signifying *Paka Siddhi* (pharmaceutical completion) in *Rasashastra* practice.[5] Two principal classical references describe distinct *Druti* preparation procedures for *Vaikranta*: (i) *Rasa Ratna Samucchaya* (RRS) 4/76, employing botanical-mineral media in *Dola Yantra Swedana* for seven days; and (ii) *Anubhuta Yoga Shatakam* (AYS), prescribing sequential alkaline soaking followed by *Chanakamla* (hydrochloric acid) treatment.[6]

Despite clinical relevance, a rigorous multi-parameter comparative study with modern analytical validation remains absent from indexed literature. The present study

addresses this gap through organoleptic assessment, eight standard physico-chemical tests, XRD phase analysis, and EDS elemental characterisation of both preparations.

Objectives :

1. To prepared *Vaikranta Druti* by the classical *Dolayantra Swedana* method as referenced in *Rasa Ratna Samucchaya* 4/76 (VD-1).
2. To prepare *Vaikranta Druti* by the sequential Alkali-acid method as per *Anubhuta Yoga Shatakam* (VD-2).
3. To evaluate and compare organoleptic properties of both preparations.
4. To perform physico-chemical standardization tests (pH, loss on drying, total ash, acid-insoluble ash, water-soluble extractive, specific gravity, and refractive index) on both preparations.
5. To perform XRD analysis for phase identification and crystallographic characterization of both samples.
6. To perform SEM-EDS analysis for elemental composition profiling of both samples.
7. To compare findings and establish a baseline for pharmacopoeial standardization of *Vaikranta Druti*.

Raw material procurement and authentication:

Raw *Vaikranta* (Tourmaline) specimens were taken from verified mineral suppliers and were confirmed through visual mineral identification. The botanical materials, *Ketaki Swarasa* (expressed juice of Pandanus odoratissimus Roxb.) *Suvarnapushpi* (dried pods of Cassia fistula L.) *Saindhava Lavana* (Rock salt), and *Sauvarchala Lavana* (Black salt), were sourced from a licensed Ayurvedic raw materials supplier and verified by a pharmacognosy expert. *Trikshara* (*Yavakshara*, *Sarjikakshara*, *Tankanakshara*) were prepared in-house as per classical methods. *Chanakamla* (analytical grade hydrochloric acid, 35–37% v/v) was sourced commercially and diluted to approximately 10% v/v.

Vaikranta Shodhana (pre-purification):

Prior to *Druti* preparation, raw *Vaikranta* was subjected to classical *Shodhana* (purification). The mineral was heated to red-hot condition and quenched sequentially in *Triphala Kwatha* (decoction of three fruits), *Gomutra* (cow's urine), *Takra* (buttermilk), *Kanji* (fermented grain water), and *Kulatha Kwatha* (horse gram decoction) for seven cycles. The *Shodhita Vaikranta* was then powdered to fine *Churna* (powder, ≤ 100 mesh) for both methods.

VD-1 :

Classical reference

(Rasa Ratna Samucchaya 4/76) :

Ketaki Swarasa (juice of *Pandanus odoratissimus*), *Saindhava* (rock salt), *Suvarnapushpi* (*Cassia fistula*) and *Indragopa* (a type of insect) are taken in equal quantity, ground well to make a ball. *Vaikranta Churna* is kept inside the ball and subjected to *Swedana* (steaming) in *DolaYantra* for seven days to obtain *Vaikranta Druti*.[1]

Ingredients

Ingredient	Botanical/source name	Part used	Quantity
Ketaki Swarasa	*Pandanus odoratissimus* Roxb.	Fresh juice	Equal parts
Saindhava Lavana	Rock salt (NaCl)	Crystal/powder	Equal parts
Suvarnapushpi	*Cassia fistula* L.	Pod pulp	Equal parts
Indragopa	Insect (Red velvet mite)	Whole insect	Equal parts

Procedure :

All four ingredients were ground together to form a homogeneous paste and shaped into a *Pinda* (ball). The *Shodhita Vaikranta Churna* was encased within the *Pinda*. The *Pinda* was suspended in a *Dola Yantra* (swing apparatus) over a vessel containing *Amladravya* (acidic medium—*Kanji*) and water. Continuous *Swedana* (steam processing) was administered for seven days with daily replenishment of the liquid medium. The resulting fluid *Druti* (VD-1) was filtered through fine muslin and stored in an airtight glass container.

VD-2: Anubhuta Yoga Shatakam method

Classical reference

Anubhuta Yoga Shatakam method

The *Churna* (powder) of the gem is placed in a solution prepared from three *Ksharas* (alkalis—*Yavakshara*, *Sarjikakshara*, *Tankanakshara*) and two *Lavanas* (salts—*Sauvarchala*, *Saindhava*) for three days, and then carefully soaked in *Chanakamla* (hydrochloric acid) overnight for five days. This processed gem material is called *Druti* by scholars.[12]

Ingredients

Ingredient	Modern identity	Phase	Duration
Yavakshara	Potassium carbonate	Phase 1 (alkaline)	3 days
Sarjikakshara	Sodium carbonate	Phase 1	3 days
Tankanakshara	Borax ($Na_2 B_4 O_7 \cdot 10H_2 O$)	Phase 1	3 days
Sauvarchala Lavana	Sochal salt (black salt)	Phase 1	3 days
Saindhava Lavana	Rock salt (NaCl)	Phase 1	3 days
Chanakamla	Dilute hydrochloric acid (10% v/v)	Phase 2 (acid)	5 nights

Procedure :

Phase 1 (alkaline processing, 3 days): *Vaikranta Churna* was immersed in the aqueous solution of *Trikshara* combined with *Dvilavana* at ambient temperature, with gentle stirring twice daily. Phase 2 (acid processing, 5 nights): The material was air-dried and soaked in dilute *Chanakamla* (HCl) overnight for five consecutive days with daily monitoring. The resulting *Sadhita Ratna Dravya* (VD-2) was

filtered, washed with distilled water to near-neutral residual acidity, and stored for analysis.

Analytical methods :

Organoleptic evaluation :

Colour, odour, taste, and consistency were noted by a panel of three trained observers following WHO guidelines for sensory evaluation of herbo-mineral preparations.[7] Consensus values are reported.

pH determination :

A 1% w/v aqueous solution of each sample was prepared in freshly boiled and cooled double-distilled water. pH was measured at 25 ± 2°C using a calibrated digital pH meter (Mettler-Toledo S220, ± 0.01 pH units) standardised with pH 4.0, 7.0, and 9.2 buffer solutions. Results are expressed as mean ± SD (n = 3).

Loss on drying (LOD) :

One gram (1.000 ± 0.001 g) of each sample was accurately weighed in a pre-tared porcelain crucible and dried at 105 ± 2°C until constant weight (successive difference d" 0.5 mg at 30-min intervals). LOD is expressed as percentage weight loss (n = 3, mean ± SD) per Ayurvedic Pharmacopoeia of India (API) guidelines.[2]

Total ash content :

Two grams of each oven-dried sample were incinerated in a pre-weighed silica crucible at 600 ± 25°C for six hours until constant weight and absence of carbonaceous residue. Total ash is expressed as percentage of dry weight (n = 3) per API/IP standards.[8,9]

Acid-insoluble ash (AIA) :

Total ash was boiled with 25 mL of dilute HCl (10% v/v) for 5 minutes. The insoluble material was filtered (Whatman No. 42), washed with hot distilled water until chloride-free (confirmed by $AgNO_3$ test), and ignited at 600°C to constant weight. AIA is expressed as percentage of original sample weight.

Water-soluble extractive :

Five grams of each powdered sample were macerated with 100 mL distilled water in a stoppered conical flask for 18 hours (shaking frequently during the first 6 hours), then filtered (Whatman No. 1). Twenty-five millilitres of filtrate were evaporated to dryness on a water-bath at 70°C and dried at 105°C to constant weight. The extractive value is expressed as percentage w/w of air-dried drug per API methodology.[2]

Specific gravity :

Specific gravity of the liquid *Druti* samples was determined using a calibrated glass pycnometer (10 mL) at 25 ± 0.1°C in a thermostatically controlled water-bath. Specific gravity = (mass of sample-filled pycnometer − empty pycnometer) / (mass of water-filled pycnometer − empty pycnometer). Results are expressed as mean ± SD (n = 3).

Refractive index :

Refractive index was measured at

25±0.1°C using an Abbe refractometer calibrated with distilled water (n = 1.3330 at 25°C). Three readings per sample were averaged.

X-ray diffraction (XRD) :

Powder XRD was performed using a Bruker D8 Advance diffractometer with Cu-Kα radiation (λ = 1.54060 Å), Ni filter, and a LYNXEYE detector (40 kV, 40 mA). Scanning range: 2θ = 10°–80°; step size 0.02°; count time 0.5 s/step. Phase identification used the ICDD PDF-4+ database. Crystallite size was estimated via the Scherrer equation: $D = K\lambda/(\beta \cos\theta)$, where K = 0.94, β = full width at half maximum (FWHM) in radians.[8]

Scanning Electron Microscope-Energy dispersive X-ray spectroscopy (SEM-EDS):

EDS was performed using an Oxford Instruments X-MaxN 80 detector integrated with a JEOL JSM-7600F field emission SEM at 15 kV. Samples were sputter-coated with gold (Au) to prevent charging; Au signals are excluded from mineralogical interpretation. Elemental maps were acquired at ×500 magnification over multiple regions; data are reported as mean atomic percentage (at.%) and weight percentage (wt. %).

Statistical analysis :

All determinations were performed in triplicate (n = 3). Results are expressed as mean ± SD. Between-group significance was assessed using Student's unpaired t-test (two-tailed); $p < 0.05$ was considered significant. Data were analysed using Graph Pad Prism v9.0.

Organoleptic properties and physico-chemical parameters :

Organoleptic and physico-chemical profiles of VD-1 and VD-2 are presented in Table 1. All eight physico-chemical parameters showed statistically significant differences ($p < 0.05$) between the two preparations.

Table-1. Organoleptic and physico-chemical parameters of VD-1 and VD-2

Parameter	VD-1 (RRS method)	VD-2 (AYS method)
Colour	Dark brownish-black, translucent	Pale yellowish-brown, opaque
Odour	Characteristic aromatic (*Ketaki*)	Pungent, faintly acidic
Taste	Astringent, slightly salty	Astringent, mildly bitter
Consistency	Semi-fluid, viscous	Slightly fluid, less viscous
pH (1% aqueous solution)	6.8 ± 0.12	4.2 ± 0.09
Loss on drying (%)	8.42 ± 0.31	11.76 ± 0.44
Total ash (%)	72.14 ± 0.62	68.39 ± 0.55
Acid-insoluble ash (%)	1.82 ± 0.08	2.47 ± 0.11
Water-soluble extractive (%)	18.34 ± 0.27	24.91 ± 0.35
Specific gravity	1.342 ± 0.004	1.289 ± 0.006
Refractive index (25°C)	1.4821 ± 0.0012	1.4634 ± 0.0009

Values expressed as mean ± SD (n = 3). VD-1: *Vaikranta Druti* by *Rasa Ratna Samucchaya* method; VD-2: *Vaikranta Druti* by *Anubhuta Yoga Shatakam* method.

VD-1 exhibited a dark brownish-black translucent appearance with characteristic aromatic notes of *Ketaki* (*Pandanus*), while VD-2 was pale yellowish-brown with a faint residual acid odour. The pH of VD-1 (6.8 ± 0.12) was near-neutral, whereas VD-2 showed markedly acidic pH (4.2 ± 0.09). Loss on drying was higher in VD-2 (11.76 ± 0.44%) than VD-1 (8.42 ± 0.31%), indicating greater moisture retention. Total ash was higher in VD-1 (72.14 ± 0.62%) versus VD-2 (68.39 ± 0.55%), and acid-insoluble ash was slightly higher in VD-2 (2.47 ± 0.11%). Water-soluble extractive was significantly higher in VD-2 (24.91 ± 0.35%) compared to VD-1 (18.34 ± 0.27%; $p < 0.001$). Specific gravity was higher in VD-1 (1.342 ± 0.004) and refractive index was also higher in VD-1 (1.4821 ± 0.0012) compared to VD-2.

XRD analysis :

XRD diffractograms of VD-1 (Figure 1) and VD-2 (Figure 2) were recorded over $2\theta = 10°–80°$ using Cu-Kα radiation ($\lambda = 1.54060$ Å). Both patterns confirm the tourmaline mineral phase.

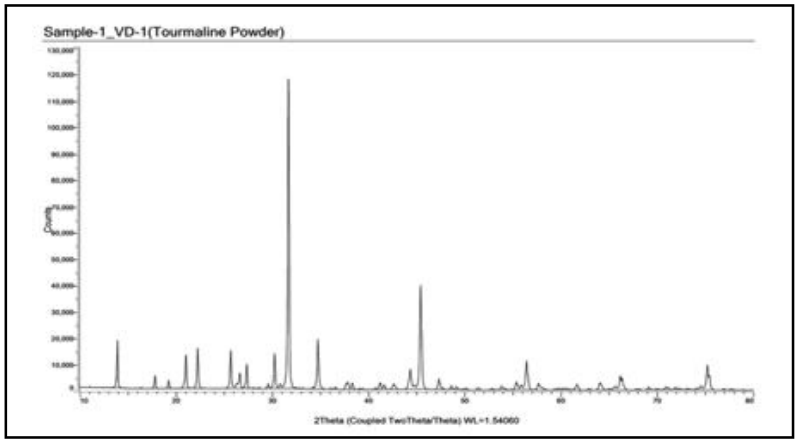

Figure 1. XRD pattern of VD-1 (*Vaikranta Druti – Rasa Ratna Samucchaya* method)

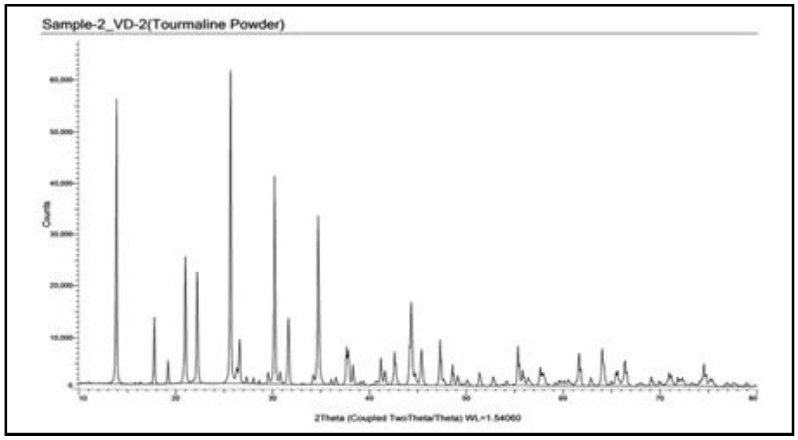

Figure 2. XRD pattern of VD-2 (*Vaikranta Druti – Anubhuta Yoga Shatakam* method)

VD-1 (Figure 1) shows clearly defined, high-intensity peaks. The main peak at $2\theta \approx 32°$ (~118,000 counts) corresponds to primary reflection planes of Rhombohedral tourmaline structure (space group R3m). There is also a secondary major peak at $2\theta \approx 46°$ (~40,000 counts) and cluster between 20° and 25°. The narrow FWHM values indicate large, well-ordered crystalline domains, with an estimated size which is greater than 50nm according to Scherrer equation.this represents the preservationof the bulk crystallinity. VD-2 (figure 2) shows a very different profile.

A significant low-angle peak at $20° \approx 14°$ (~57,000 counts)-which is not present in VD-1 – suggesting the formation of new mineral phases or expanded-layer silicate products from Kshara treatment. The main tourmaline peak shifts to $2\theta \approx 26°$(~61,000 counts), with secondary peakes at approximately 30° (~41,000 counts) and approximately 38° (~34,000 counts). Broader peak widths suggest a smaller crystalline size and increased lattice microstrain, which is consistent with some amorphization from sequential alkaline-cid processing.

EDS elemental analysis :

EDS data for both samples are presented in Tables-2 and 3. Elements C, O, Na, Al, Si, Cl, K, Fe, and Au were detected in both samples. Au signals originate from sputter-coating and are excluded from mineralogical interpretation.

Table-2. EDS elemental analysis – VD-1 (*Rasa Ratna Samucchaya* method)

Element	Signal type	Atomic %	Wt%	Wt% Sigma
C	EDS	38.11	—	—
O	EDS	41.67	—	—
Na	EDS	4.88	—	—
Al	EDS	4.78	—	—
Si	EDS	5.20	—	—
Cl	EDS	3.60	—	—
K	EDS	0.24	—	—
Fe	EDS	1.34	—	—
Au	EDS	0.18	—	—
Total (at. %)		**100.00**		
C	EDS	—	26.04	1.91
O	EDS	—	37.92	1.10
Na	EDS	—	6.38	0.25
Al	EDS	—	7.33	0.25
Si	EDS	—	8.31	0.27
Cl	EDS	—	7.25	0.25
K	EDS	—	0.53	0.07
Fe	EDS	—	4.25	0.24
Au	EDS	—	1.99	0.30
Total (wt.%)			100.00	

Table-3. EDS elemental analysis – VD-2 (*Anubhuta Yoga Shatakam* method)

Element	Signal type	Atomic %	Wt%	Wt% Sigma
C	EDS	47.55	—	—
O	EDS	41.35	—	—
Na	EDS	1.27	—	—
Al	EDS	3.85	—	—
Si	EDS	4.35	—	—
Cl	EDS	0.49	—	—
K	EDS	0.14	—	—
Fe	EDS	0.90	—	—
Au	EDS	0.10	—	—
Total (at.%)		**100.00**		
C	EDS	—	36.14	1.27
O	EDS	—	41.86	0.92
Na	EDS	—	1.85	0.12
Al	EDS	—	6.57	0.19
Si	EDS	—	7.73	0.21
Cl	EDS	—	1.10	0.07
K	EDS	—	0.35	0.05
Fe	EDS	—	3.18	0.17
Au	EDS	—	1.21	0.21
Total (wt.%)			**100.00**	

Na content was 3.84-fold higher in VD-1 (4.88 at.%) versus VD-2 (1.27 at.%), and Cl was 7.35-fold higher in VD-1 (3.60 at.%) versus VD-2 (0.49 at.%), confirming *Saindhava*-mediated surface enrichment in VD-1. Carbon content was much higher in VD-2 at 47.55 at.% compared to VD-1 at 38.11 at.%. This aligns with the addition of the organic *Kshara* matrix. Iron levels were greater in VD-1 at 1.34 at.% and 4.25 wt.% than in VD-2 at 0.90 at.% and 3.18 wt.%.

Organoleptic and physio-chemical findings:

The variations in colour indicate distinct chemical changes. The dark brownish-black colour of VD-1 comes from the formation of iron-tannate complexes. This occurs when *Indragopa* and *Ketaki Swarasa* reat with surface iron sites of tourmaline under hydrothermal conditions. The lighter colour of VD-2 indicates that some chromophore metal ions(Fe^{2+} /Fe^{3+}) were partially leached out during acid treatment. This is in line with its lower EDS iron content.

The near-neutral pH of VD-1 (6.8) confirms its biocompatibility for internal use, which is an important criterion in *Ayurveda* for *Druti*. The acidic pH of VD-2(4.2), even after washing, shows that there are still acidic mineral leachates from *Chanakamla* treatment. Clinical formulations made from VD-2 may need to be paired with alkaline excipients.

The water-soluble extractive value of VD-2 is significantly higher at 24.91%, compared to 18.34% for VD-1 ($p<0.001$). This difference is important for pharmacokinetics. The greater water-soluble content suggests tht mineral speciesb dissolve better in the body's water-based environment.this might mean VD-2 is more available for absorption. VD-2 also has a higher loss on drying at 11.76%, indicating that it absorbs moisture easily. This may be due to interactions between *Sarjikashara* ($Na_2\ CO_3$) and *Tankanakshara* (borax) that creat hydrated salt phases.

Total ash values (68-72%) confirms the mineral content of both preparations. The slightly higher acid-insoluble ash of VD-2 (2.47%) aligns with silica (SiO_2) enrichment after acid leaching. Silica does not dissolve in the acid and remains in the ash residue when more soluble parts are removed by HCl. The Higher specific gravity (1.342) and refractive index (1.4821) of VD-1 suggest a denser, more mineral-rich, homogeneous liquid dispersion.

XRD findings :

The VD-1 pattern, which indicates a maximum at $2\theta \approx 32°$(~118,000 counts), is a characteristic of the major tourmaline phase. The Dolayantra Swedana process, operating through mild vapour-phase hydrothermal conditions at ≤ 100°C, provides physiochemical activation at the surface without affecting the bulk framework of the silicate network. This is in accordance with the Ayurvedic principle of *Mridu swedana,* or gentle steaming, to make the mineral reactive without altering its inherent framework.[11]

The XRD pattern of VD-2 also shows a new low–angle diffraction peak at around ~14° 2θ, implying a substantial structural change. Successive pH treatments of high alkaline *Kshara* and strong acid HCl cause desilication(removal of SiO_2) and possible intercalation of Na^+, K^+, and CO_3^{2-} ions from *Kshara*. Phyllosilicates, Sodium silicates, or Chloride compounds could be responsible for these XRD changes.[10] This also fits with the *Ayurvedic* theory of *Virada* or dissolution/ deconstruction of a material, as per the *Anubhuta yoga* reference. More structural changes in VD-2 could make it more reactive and bioavailable but also more variable in terms of its formulation.

EDS Findings :

The EDS results verify that the two Druti preparations have distinctly different elemental fingerprints. In VD-1, the high levels of (4.88 at.%, 6.38 wt.%) and Cl (3.60 at.%, 7.25 wt.%) directly point to the interaction of Saindhava Lavana in the solution allows the ion-exchange/adsorption of Saindhava's NaCl with the tourmaline's surface. This results in the enrichment of sodium choride. This confirms that the classical *Saindhava*-attributed properties like *Deepana* (digestive stimulant), *Pachana* (digestive), and electrolyte-replenishing effects.[9]

The higher content of carbon in VD-2 (47.55 at.%) compared to VD-1 is a result of the inclusion of organic-carbon from plant-based *Kshara* like *Yavakshara* and *Sauvarchala lavana*. Alkali-derived carbonate ions may interact with surface aluminium and silicon sites to form aluminosilicate-carbonate surface

complexes. The Iron content is also found to be lower in VD-2 (0.90 at.%) than VD-1 (1.34 at.%), indicating partial dissolution of surface-bound iron species during the HCl treatment in phase 2. The Iron content is significant in *Ratna* preparations, which is bioactive component, and its selective dissolution may influence the *Raktavardhaka* activity of the *Ayurvedic* medicine. Therefore, VD-1 may be described as a '*Saindhava*-enriched, iron-retentive, high-sodium/chloride' containing preparation, and VD-2 as a '*Kshara*-enriched, iron-depleted, high-carbon' containing preparation—each carrying distinct elemental profiles with potential differential therapeutic implications.

Correlation with the Classical text intent:

Rasa Ratna Samucchaya 4/76 specifies a procedure of *Dolayantra Swedana* for seven days. Our results show that this procedure has the desired effect of activating the surface of the mineral without compromising the crystallographic structure of the mineral. The use of *Ketaki Swarasa* (which is flavanoid-based, and slightly acidic), *Saindhava*, and *Suvarna Pushpi* illustrates the powerful medium for surface mineral chemistry providing the scientific accuracy of classical *Rasashastra*.[6]

The sequential approach of *Anubhuta yoga* results in a greater degree of structural modification, as reflected in our XRD and EDS analysis results. The term '*Sadhita*' (Perfected) used for VD-2 in the classical text correlates well with the greater degree of prosessing of the minerals reflected in our analytical results. The greater degree of water-soluble extract of VD-2 could also be a reflection of what the classical text intended by "more dissolution", a key feature of *Druti* preparation. Both the methods fulfill their classical criteria but produce different pharmaceutical products, strongly advocating for the method-specific clinical applications.

Limitations :

This study is limited by the absence of in-vitro dissolution tests, FTIR spectroscopy, ICP-MS trace elements profiling, In-vivo pharmacological/toxicological validation. The physio-chemical properties were initial standardization results and need to be validated in several centers before inclusion in an Ayurvedic pharmacopoeial monograph.

The current study provides the first detailed multi-parameter pharmaceutical and analytical comparison of *Vaikranta Druti* prepared using two different methods. VD-1 prepared using the Rasa Ratna Samucchaya procedure results in a near-neutral, dense, high total ash preparation with well-preserved tourmaline crystallinity and *Saindhava*-enriched Na/Cl elemental profile. Whereas VD-2 prepared using the *Anubhuta Yoga* procedure results in an acidic, more hygroscopic preparation with a significantly higher water-soluble extractive, partially crystallographic deconstruction, and a high carbon, low iron profile enriched in *Kshara*. The eight physio-chemical parameters give rise to a set of reproducible and objectively distinguishable fingerprints for each of the methods, which is suitable for inclusion in the Pharmacopoeia. Hence these findings confirm that the two methods of *Druti* are not pharmaceutically interchangeable and establish a scientifically validated foundation for the method-specific standardization, formulation guidelines, and

quality control of *Vaikranta Druti* in *Rasashastra* practice.

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