ORIGINAL ARTICLE

Pharmaceutical and physicochemical study of *Vasa* and *Palasha Kshara*

Shobhnath Yadav[1], Ashish Verma[1], B. J. Patgiri[2], P. K. Prajapati[3],

[1]PhD(APS) Scholar, Institute for Post Graduate Teaching & Research in Ayurveda, Gujarat Ayurved University, Jamnagar, Gujarat, India, [2]I/C HOD, Department of Rasashastra & Bhaishajya Kalpana, Institute for Post Ayurveda, Gujarat Ayurved University, Jamnagar, Gujarat, India, [3]Director, Institute for Post Ayurveda, Gujarat Ayurved University, Jamnagar, Gujarat, India

Abstract

Background: In *Upanishad* (*Vedanta*), the use of word "*Kshara*" is found but nothing has been described in detail. *Vasa Adhatoda Vasica (leen)* and *Palash Kshara* (*Butea monosperma Lam.*) is a prestigious and potential herbal formulation of *Ayurveda*. In *Sushruta Samhita Vasa* and *Palash Kshara* are mentioned for various aliments of disease such as *Palash Kshara*: Useful in *Agnimandhya*, *Gulma*, *Plihayakritvriddhi*, *Mutrakruccha*, *Anah*, *Grahni*, *Visuchika*, *Sarkara* and *Vasa Kshara*: Useful in *Gulma*, *Kasa*, *Svasa*, *Grahni*, *Arsa*, *Ajirna*, *Aruchi*, *Asmari*, *Sarkara*. However, there is a lack of scientific work on related to Pharmaceutical and physicochemical Study of *Vasa* and *Palash Kshara.* **Objective:** To prepare and physicochemically evaluate *Vasa* and *Palasha Kshara.* **Materials and Methods:** *Vasa* and *Palasha Kshara* was prepared as per *Ayurvedic* text and characterized by organoleptic characters, physico-chemical parameters, qualitative chemical tests, and various modern analytical techniques, *viz*., Fourier transform infrared (FTIR) spectroscopy, inductively coupled plasma atomic emission spectroscopy (ICP-AES) analysis. **Results:** This study clearly revealed that percentage yield of *Palasha Kshara* and *Vasa Kshara* obtained from completely dried stems of *Palsash* and Panchanga of *Vasa* are 2.28 and 9.39, respectively. *Palasha* and *Vasa Kshara* showed the presence of sodium, potassium, chloride, and carbonate ions. Sulfate ions were not detected in *Palash Kshara* while phosphate ions in *Vasa Kshara*. **Conclusion:** The FTIR study of *Palash Kshara* indicates the presence of alkyl, corbonyl or ester and halide group. FTIR report of *Vasa Kshara* showed the presence of alkyl, carboxylic or nitro-aliphatic compound, trisubstituted alkenes, and cis-disubstituted alkenes. The detection of heavy metal - Hg and Cd was not detected by the results obtained from ICP-AES.

Key words: Fourier transform infrared, inductively coupled plasma atomic emission spectroscopy, *Palasha Kshara*, *Sushruta Samhita, Vasa Kshara*

INTRODUCTION

Ksharas are the derivatives of plant drug *ashes* in the form of solutions, powder or crystals, all of which have the basic quality of being alkaline. According to *Sushruta*, the substance is called *Kshara*, because it causes *Ksharana* to *Mamsa,* etc. *Dhatus.*[1] *Acharya Charaka* has mentioned 18 parts of herbal plants which can be used in medicinal purpose and *Kshara* is one among them.[2] *Sushruta* has narrated *Kshara* in scope of *Shalyatantra.*[3] *Astanga samgraha* and *Ashtanga hridaya* deals with types of *Kshara*. Varieties and method of preparation of *Kshara* are described by *Acharya Sharangadhara.*[4] *Acharya Yadavaji Trikamaji*[5] and *Rasataranginikar*[6] have described the method of preparation, varieties, properties, application, and doses of *Kshara*. *Kshara* is also included as an ingredient in many formulations.

Vasa Kshara is one of the important *Ksharas*. It is an alkali extracted from the water soluble ash of *Vasa panchanga*.

In clinical practice, it is used in *Swasa*, *Kasa*, *Gulma*, *Udararoga*, *Switra,* etc.[7] In the treatment of *Mutraghat*, *Kshara* of *Tila*, *Kadali*, *Palasa*, *Apamarga*, and *Yava* are advised to be consumed with sheep's urine is good for both gravel and

Address for correspondence:
Shobhnath Yadav, PhD Scholar, Ayurvedic Pharmaceutical Sciences, Department of Rasashastra & Bhaishajya Kalpana, Institute for Post Graduate Teaching & Research in Ayurveda, Gujarat Ayurved University, Jamnagar - 361 008, Gujarat, India.
E-mail: shobhnathbhuims@gmail.com

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stone.[8] *Palash Kshara*, a reputed preparation of *Ayurveda*, valued for the treatment of anthelmintic antiimplantation, antiovulatory, abortificient, antilaprotic, antigout, antiestrigenic, spasmogenic, antifungal, antispasmodic, hypotensive, astringent, alterative, aphrodisiac, antiasthmatic, and bactericidal.[9] Pharmacological activities of *Vasa* antispasmodic, hypotensive, bronchodilator, respiratory stimulents, hypoglycemic, uterine stimulant, antiviral, anti-insect, and juvenile hormone mimicking, expectorant, antiseptic, antibacterial.[10] None of the work presents the elemental and structural characterization of *Vasa* and *Palasha Kshara* formulation which is an essential requirement to discuss the therapeutic value of preparations. The present study aims to study the composition and the structure of *Vasa* and *Palasha Kshara* formulation using various techniques, *viz*., Fourier transform infrared spectroscopy (FTIR) and inductively coupled plasma-mass spectroscopy (ICP-MS).

MATERIALS AND METHODS

Vasa and *Palasha Kshara* was subjected to evaluate the organoleptic and physicochemical characters such as the determination of foreign matter,[11] determination of loss on drying at 105°C,[11] determination of ash value,[12] determination of acid insoluble ash,[12] determination of alcohol soluble extractive,[13] determination of water soluble extractive,[13] determination of pH using pH-meter,[11] determination of refractive index,[14] determination of specific gravity,[14] determination of alkalinity,[15] and qualitative chemical tests.[16] For the quantitative determination of heavy metals in *Vasa* and *Palasha Kshara* in parts per million (ppm), an ICP-MS, PerkinElmer ELAN-6000 was used. The IR spectrum in the low-frequency region (50-400/cm) was recorded on a Bruker IFS 66 V/S vacuum Fourier transform interferometer; whereas the spectra from 400 to 4000/cm region were recorded (SAIF Sicart) using FTIR spectrophotometer (Spectrum RXI, PerkinElmer). For IR spectra, powdered samples were mixed in KBr to make translucent pellet and spectrum was recorded.

Collection of Drugs

The fresh *Vasa Panchanga* and *Palash* was collected from the surrounding areas of village Vasai, situated about 25 km away from Jamnagar in the month of October to November. The fresh drug was cleaned with water and allowed to dry in sunlight. After complete drying, the *Vasa Panchanga* and *Palash* were subjected to ash preparation. The drug *Vasa* and *Palash* was authenticated in the Department of Pharmacognosy.

Preparation of Ash - for Preparation *Vasa* and *Palash* Ash

First of all, 56 kg fresh vasa whole plant and 37 kg fresh *Palasha* stem was collected and kept for drying. After complete drying, 22 and 19 kg weight was found of *Vasa* and *Palasha*. Dried stem was taken in a big iron pan and burned completely. After self-cooling, the ash was collected [Table 1].

Preparation of *Ksharajala*

In classic, only one time washing process is mention during preparation of *Kshara* in various ratio of water and ash of the plant, i.e. 1:4, 1:6, 1:8. But due to onetime washing process, it is difficult to prepared large scale level. Hence, present study has been attempt to repetition of washing process minimum 3 times in same ash used and also find out the any physic-chemical changes occur or not after each processing [Table 2].

Preparation of *Vasa* and *Palasha Kshara*

Prepared the vasa and *Palasha Kshara* as per the reference *Sushruta Samhita*. First dried stem of *Palash* and whole part of *Vasa* was taken in separately a big iron pan and burned completely and after self-cooling, it passes through Sieve no. 40. Then, this ash is dissolved in 6 times of water in an earthen pot and rubbed with hands properly for some time. Then, these contents are kept as it is without any disturbance for one night. Next day, the clean supernatant liquid was decanted through the outlet of specially prepared vessel with open the tap. Then, it was filtered through seven folded cotton cloth that 1st dissolving. The same procedure repeated more 2 times with adding same quantity of water in remaining ash residue. Total 3 times dissolving, filtration and evaporation process was repeated.[17] VA_1: *Vasa Kshara* Sample A 1st time wash, VA_2: *Vasa Kshara* Sample A 2nd time wash, PA_1: *Palash Kshara* sample A 1st time wash and PA_2: *Palash Kshara* Sample A 2nd time wash.

Observation and Result of Ash

Palasha stem and *Vasa Panchanga* were burned quickly due to complete drying. Then it burn after complete, after self-cooling, the whitish gray colored ash was obtained. About

Table 1: Result obtained during preparation of *Vasa* and *Palasha* ash

Plant material	Fresh (weight) kg	After dried (weight) kg	Weight of ash kg	Weight of ash in %	Percentage loss
Vasa (whole part)	56	22	3.67	6.57	93.44
Palasha (stem)	37	19	4.18	11.29	88.71

6.59% found in *Vasa* ash and 11.29% found in *Palasha* ash. There was 6 h time taken for the formation of ash [Table 1].

Observation and Result of *Ksharajala*

Observation and result obtained during the preparation of *Vasa* and *Palasha Ksharajala* [Tables 3-6].

Observation and Result of *Vasa Kshara*

Dried *Vasa Panchanga* was subjected to the burning in a big iron pan. After self-cooling, the ash was collected and sieving through sieve No. 40. *Vasa Panchanga* was burnt quickly due to complete drying. The color of ash was gray colored after shelf cooling. The ash was taken in a steel vessel and 6 times water was added w/v. The mixture of ash and water was rubbed with hand to mix properly and kept overnight for the settlement of insoluble particles. Next day, supernatant liquid was decanted through saline tube and filtered through seven-folded cotton cloth. The *Ksharajala* was taken in steel vessel and heated over the gas stove till the entire water portions get evaporated. Finally, a dull white colored *Kshara* was obtained. Then, *Kshara* was powdered and stored in air tight glass container [Table 7].

Table 2: Details abbreviations of different samples of *Kshara*

Abbreviations
VA_1: *Vasa Kshara* Sample A (1st time dissolve)
VA_2: *Vasa Kshara* Sample A (2nd time dissolve)
VA_3: *Vasa Kshara* Sample A (3rd time dissolve)
VB_1: *Vasa Kshara* Sample B (1st time dissolve)
VB_2: *Vasa Kshara* Sample B (2nd time dissolve)
VB_3: *Vasa Kshara* Sample B (3rd time dissolve)
VC_1: *Vasa Kshara* Sample C (1st time dissolve)
VC_2: *Vasa Kshara* Sample C (2nd time dissolve)
VC_3: *Vasa Kshara* Sample C (3rd time dissolve)
PA_1: *Palash Kshara* Sample A (1st time dissolve)
PA_2: *Palash Kshara* Sample A (2nd time dissolve)
PA_3: *Palash Kshara* Sample A (3rd time dissolve)
PB_1: *Palash Kshara* Sample B (1st time dissolve)
PB_2: *Palash Kshara* Sample B(2nd time dissolve)
PB_3: *Palash Kshara* Sample B (3rd time dissolve)
PC_1: *Palash Kshara* Sample C (1st time dissolve)
PC_2: *Palash Kshara* Sample C (2nd time dissolve)
PC_3: *Palash Kshara* Sample C (3rd time dissolve)

Observation and Result of *Palash Kshara*

Dried *Palasha* stems were cut into the small pieces subjected to the burning in a big iron pan. The color of *ash* was whitish gray colored after shelf cooling after self-cooling the ash was collected and sieving through sieve No. 40. The ash was taken in a steel vessel and 6 times water was added w/v. The mixture of ash and water was rubbed with hand to mix properly and kept overnight for the settlement of insoluble particles. Next day, supernatant liquid was decanted through saline tube and filtered through seven folded cotton cloth. The *Ksharajala* was taken in steel vessel and heated over the gas stove till the entire water portions get evaporated. Finally, a pinkish white colored *Kshara* was obtained. Then, *Kshara* was powdered and stored in air tight glass container Pieces of *Palasha* stem were kept fire quickly due to complete drying. The color of ash was whitish gray colored after shelf cooling pieces of *Palasha* stem were kept fire quickly due to complete drying. The color of ash was whitish grey colored after shelf cooling [Table 8].

DISCUSSION

Vasa Kshara and *Palash Kshara* are mentioned in classical literature and their uses are also mentioned. *Vasa Kshara* is used in the *Swasa*, *Kasa*, etc., and *Palash Kshara* is used in the *Mutrakruccha*, *Agnimandhya,* etc. It is also used in the preparation of *Kshara Sutra*. Chemically, *Vasa Kshara* is composed of sodium, potassium, chloride, sulfate, carbonate, etc., and *Palash Kshara* is also composed of potassium, carbonate, sulfate, phosphate, etc. Alkali or caustics have been in use in Indian medicine since very early times. General properties of alkalis include light, warm, acrid, and moistening. They are digestives and increases appetite, reduce Kapha, destroy intestinal worms, and heal wounds.

Table 3: Result obtained during preparation of *Vasa Ksharajala*

Parameters	Batches								
	VA_1	VA_2	VA_3	VB_1	VB_2	VB_3	VC_1	VC_2	VC_3
Volume of ash taken (L)	1	-	-	1	-	-	1	-	-
Weight of ash taken (g)	456	-	-	456	-		456	-	-
Volume of water taken (L)	6	6	6	6	6	6	6	6	6
Ksharajala obtained in ml (after filtration)	4795	5915	5940	4825	5940	5960	4810	5945	5975
Percentage of *Ksharajala* obtained in v/v	79.91	98.58	99.0	80.41	99.0	99.33	80.17	99.08	99.58
Percentage of *Ksharajala* loss in v/v	20.09	1.42	1.00	19.59	1.00	0.77	19.83	0.92	0.42

Table 4: Quantity of *Ksharajala* taken in different batches

Ingredients	Batches								
	VA_1	VA_2	VA_3	VB_1	VB_2	VB_3	VC_1	VC_2	VC_3
Vasa Ksharajala (ml)	4795	5915	5940	4825	5940	5960	4810	5945	5975

Table 5: Result obtained during preparation of *Palash Ksharajala*

Parameters	Batches								
	PA_1	PA_2	PA_3	PB_1	PB_2	PB_3	PC_1	PC_2	PC_3
Volume of ash taken (L)	1	-	-	1	-	-	1	-	-
Weight of ash taken (g)	513	-	-	513	-		513	-	-
Volume of water taken (L)	6	6	6	6	6	6	6	6	6
Ksharajala obtained in ml (after filtrations)	4875	5930	5955	4780	5925	5960	4850	5940	5935
Percentage of *Ksharajala* obtained in v/v (%)	81.25	98.83	99.25	79.66	98.75	99.33	80.83	99.00	98.91
Percentage of *Ksharajala* loss in v/v (%)	18.75	1.17	0.75	20.34	1.25	0.77	19.17	1.00	1.09

Table 6: Details of *Ksharajala* taken for evaporation

Ingredients	Batches								
	PA_1	PA_2	PA_3	PB_1	PB_2	PB_3	PC_1	PC_2	PC_3
Palasha Ksharajala (ml)	4875	5930	5955	4780	5925	5960	4850	5940	5935

Table 7: Result obtained during evaporation of *Vasa Ksharajala*

Parameters	Batches								
	VA_1	VA_2	VA_3	VB_1	VB_2	VB_3	VC_1	VC_2	VC_3
Volume of *Ksharajala* taken for evaporation (ml)	4795	5915	5940	4825	5940	5960	4810	5945	5975
Time required for evaporation of *Ksharajala*	3.14	4.25	4.30	3.22	4.33	4.25	3.17	4.29	4.37
Kshara obtained in w/v (g)	80.1	41.8	12.3	73.6	37.9	10.8	78.3	39.1	11.9
Percentage of *Kshara* obtained w/v	17.56	9.16	2.70	16.14	8.31	2.36	17.17	8.57	2.61

Table 8: Result obtained during evaporation of *Palasha Ksharajala*

Parameters	Batches								
	PA_1	PA_2	PA_3	PB_1	PB_2	PB_3	PC_1	PC_2	PC_3
Volume of *Ksharajala* taken for evaporation (ml)	4875	5930	5955	4780	5925	5960	4850	5940	5935
Time required for evaporation of *Ksharajala* (h: min)	3.8	4.23	4.27	3.13	4.19	4.22	3.12	4.24	4.27
Kshara obtained in w/v (g)	19.7	9.8	6.8	18.9	9.2	6.4	19.2	9.4	6.3
Percentage of *Kshara* obtained w/v (%)	3.84	1.91	1.32	3.68	1.79	1.24	3.74	1.83	1.23

The carbonate or potash is pungent, soft, and light, it helps discharge of urine. It is recommended for intestinal obstruction (Anaha), anemia, asthma, and enlargement of spleen. Its internal administration is said to dissolve urinary calculi. Refined matron (*Sarji-Kshara*, carbonate of soda) is very similar in action to the carbonate of potash.

Historical review suggested that references of both *Vasa* and *Palash* are available from *Samhitas*, description of both are found in many chapters. Almost all the *Nighantus* have mentioned about the both plants. *Raja nighantu* quotes four varieties *viz*., (1) Rakta, (2) Pitta, (3) Sweta, and (4) Nila. Another verity of *Palash*, "*latapalash"* (*Butea superba*) is also available at present. In the *Bhavprakash Nighantu* two varieties of *Vasa* are given: (1) Rakta pushpa adusa and (2) Krushna pushpa adusa. P.V. Sharma reported that *Justacia gendarussa* Linn. is being used as *Krishna Vasa*. Dr. Desai quoted *Justicia picta* Linn. as Rakta pushpa *Vasa*. After the preparation of ash, it was sieved through 40# to remove the unproper burn of materials. The percentage of ash of *Palash* ash (11.29%) was found more as comparison to *Vasa* ash (6.57%). It may be due to more fibers material of content in *Palash*. Ash and water were taken volumetrically by keeping the constant weight for respective samples. All

samples were prepared by taking 6 parts of water to ash, but yet there is a difference in % yield of *Ksharajala*. The average time required for evaporation of *Ksharajala* was 3.17-4.30 (h.min). The maximum temperature required was 100°C. Initially, *Ksharajala* of *Palash* was whitish color, while it was yellowish color in *Vasa Ksharajala*. Aggregation, vapors, and creaking sound were increased proportionally with increasing the temperature.

Color of the *Vasa Ksharajala* was changed from yellowish to brownish gradually as temperature raise, whereas whitish to grayish in *Palash Ksharajala*. *Kshara* was started sticking to the vessel in final stage and bumping was observed. It was stirred continuously to prevent bumping and sticking at final stage. Finally, a dull white color, brownish color of *Kshara* was obtained from *Palash* and *Vasa*, respectively. The average percentages of *Palash Kshara* obtained in 1st soaking 3.75%, whereas in *Vasa Kshara* were found 16.95%. Percentages of *Kshara* obtained gradually decreased from sample 1st soaking to 3rd time dissolving. It may be due to water solubility material may be gradually decrease in successive dissolving. The % w/w of *Kshara* was calculated with respect to weight of ash taken. The finally percentage of *Kshara* was found more in *Vasa Kshara*, i.e., 16.95% whereas it was found 3.75% in *Palasha Kshara*. It may be due to more water soluble material more in *Vasa* ash as comparison to *Palasha* ash which is supported by analytical study. There was a vast difference in the physico-chemical value between the *Palash* and *Vasa*. The ash value of *Palash* was 17.3% while *Vasa* were almost half value as 9.18% and same difference was seen in the extractive value also. The results obtained in physico-chemical analysis were found under the limits of Ayurvedic Pharmacopoeia of India. Limit of detection was found more in *Palash Kshara*, i.e., 3.012, while it was found less in *Vasa Kshara*, i.e., 2.61 it may due to more moisture content in the *Palash Kshara*. The remaining parameters were found similar in both final products. The qualitative tests of both samples were found sodium, potassium, chloride, and carbonate. But the sulfate was present in only *Vasa Kshara* and phosphate was present in only *Palash Kshara*.

Evaluation of organoleptic characters of *Palasha* and *Vasa Kshara* such as color, taste, and touch [Table 9]. The data of physic chemical parameter such as loss on drying, ash value, and acid insoluble ash values, etc., were recorded [Table 10]. Qualitative tests for various ions present in the *Kshara* [Table 11]. Modern analytical techniques were used

Table 9: Organoleptic characteristics of *Vasa* and *Palasha Kshara*

Characteristics	Observation	
	Palash Kshara	***Vasa Kshara***
Colour	Whitish	Brownish
Taste	Salty	Salty
Touch	Crystalline	Crystalline

Table 10: Value of physic-chemical parameter of the *Vasa* and *Palasha Kshara*

Parameters	Samples					
	PA_1	PA_2	Average value	VA_1	VA_2	Average value
Loss on drying (%w/w)	3.042	2.983	3.012	2.594	2.638	2.616
Ash value (% w/w)	94.24	93.96	94.1	93.97	94.46	94.21
Acid insoluble ash (% w/w)	0.30	0.24	0.27	0.19	0.21	0.2
pH	9.8	9.6	9.7	10.2	9.9	10.05
Alkalinity (ml)	16.9	17.1	17	16.8	16.7	16.75

Table 11: Results of qualitative tests for various ions present in the *Kshara*

Qualitative tests	Samples			
	PA_1	PA_2	VA_1	VA_2
Tests for sodium	+	+	+	+
Tests for potassium	+	+	+	+
Test for chloride	+	+	+	+
Test for carbonate	+	+	+	+
Test for sulphate	–	–	+	+
Test for phosphate	+	+	–	–

to observe the effect of the procedure employed in processing of *Vasa* and *Palasha Kshara*. Whereas ICP atomic emission spectroscopy (ICP-AES) was used to detect elements As and Pb in trace (ppm) amount. While Hg and Cd was not detected chemical compositions of *Vasa* and *Palasha Kshara*. Trace metal composition of *Vasa* and *Palasha Kshara* using ICP-AES has been listed [Table 12]. Concentration of heavy metals was found 0.02, 0.053, 0.158, and 0.039 ppm for As in sample of PA_1, PA_2, VA_1, and VA_2 and 0.038, 0.119, 0.077, and 0.107 ppm for Pb in sample of PA_1, PA_2, VA_1, and VA_2, which were well within the safe limits recommended by the WHO.[18] Thus, the additional element present in the drug is clearly due to the herbal origin. FTIR spectrum of *Vasa* and *Palasha Kshara* in the region from 400 to 4000/cm is shown in Table 13. The peaks obtained in FTIR study of *Palasha* and *Vasa Kshara* in different regions for different sample of *Vasa* (VA_1,VA_2) and *Palasha* (PA_1,PA_2) *Kshara* [Table 14]. For hydrogen stretching region 3700 to 2700/cm, there was 4 peak (3517.23, 3479.2, 2926.80, 2856.55) and 2 peak (3423.40, 2926.22) found for sample *Palasha* (PA_1 and PA_2) *Kshara* and for same stretching region the obtained peak from two sample of *Vasa Kshara* (VA_1 - 3464.71, 3389.34 and VA_2 - 3421.37) which indicate the presence of the organic compounds in the formulation. These arise probably from the usage of the source of herbs. In finger print region between 1500 and 700/cm maximum 8 peak show in sample no PA_1 - 1464.41, 1413.53, 1386.97, 114.62, 982.37, 878.97, 780.29, 617.83. *Palasha* and *Vasa Kshara* with related type of bond and assigned functional group by the study of peaks obtained in FTIR. The bond N-H primary ammine shows in different peak obtained from different sample of *Vasa* and *Palasha Kshara* sample in between 3400 and 3500/cm peaks. Aliphatic amine (C-N) shows often overlapped peak −1023.24 in samples VA_1.

CONCLUSIONS

The text in which most detail description of *Kshara* is found mentioned includes *Sushruta Samhita* and *Rasatarangini*. Percentage yield of *Palash Kshara* and *Vasa Kshara* obtained from completely dried stems of *Palsash* and *Panchanga* of *Vasa* are 2.28 and 9.39, respectively. Percentage yield of *Kshara* is more in the first wash of ash then decreases in other subsequent two wash. As the obtained pH value of *Palash Kshara* (10) is greater than *Vasa Kshara* (9.5), it can be concluded that *Palash Kshara* possesses more corrosive property than *Vasa Kshara*. *Palash Kshara* and *Vasa Kshara*

Table 12: Results obtained from ICP-AES

Samples metals	Metals detected in ppm			
	As	Hg	Pb	Cd
PA_1	0.02	ND	0.038	ND
PA_2	0.053	ND	0.119	ND
VA_1	0.158	ND	0.077	ND
VA_2	0.039	ND	0.107	ND

ND: Not detected, ICP-AES: Inductively coupled plasma atomic emission spectroscopy

Table 13: Peaks obtained in FTIR study of *Palasha* and *Vasa Kshar* in different regions

Peak region	Sample	Number of peaks	Obtained peak
Hydrogen stretching region 3700-2700/cm	*Palash*-1	4	3517.23, 3479.2, 2926.80, 2856.55
	Palash-2	2	3423.40, 2926.22
	Vasa-1	2	3464.71, 3389.34
	Vasa-2	1	3421.37
Triple bond region 2700-1950/cm	*Palash*-1	1	2085.97
	Palash-2	1	2085.29
	Vasa-1	1	2314.80
	Vasa-2	-	-
The double bond region between 1950 and 1550/cm	*Palash*-1	2	1632.50, 1558.62
	Palash-2	2	1651.23, 1568.83
	Vasa-1	2	157036
	Vasa-2	2	1632.18, 1571.15
The fingerprint region between 1500 and 700/cm	*Palash*-1	8	1464.41, 1413.53,1386.97, 114.62, 982.37, 878.97, 780.29, 617.83

FTIR: Fourier transform infrared

Table 14: Peaks obtained in FTIR study of *Palash* and *Vasa Kshar* with related type of bond and assigned functional group

Peak	Found in	Actual peak	Bond	Type of bond	Specific type of bond	Appearance
3400-3500 cm^{-1}	*Palash*-1	3479.2	N–H	Primary amines	Any	Strong
	Palash-2	3423.40				
	Vasa-1	3464.71				
	Vasa-2	3421.37				
2925 cm^{-1}	*Palash*-1	2926.80	C–H	Alkyl	Methylene	Medium to strong
	Palash-2	2926.22				
2850 cm^{-1}	*Palash*-1	2856.55	C–H	Alkyl	Methylene	Medium to strong
1625 cm^{-1}	*Palash*-1	1632.50	C=O	Carboxylic acids/derivates	Esters and lactones	Influenced by conjugation and ring size (as with ketones)
	Palash-2	1651.23				
	Vasa-2	1632.18				
1450 cm^{-1}	*Palash*-1	1464.41	C–C	Aromatic C=C	Any	Weak to strong (usually 3 or 4)
	Palash-2	1415.37				
1380 cm^{-1}	*Palash*-1	1386.97	C–H	Alkyl	Methyl	Weak
	Palash-2	1389.01				
1040 cm^{-1}	*Vasa*-1	1062.06	C–O	Alcohols	Primary	Strong, broad
	Vasa-2	1060				
1020 cm^{-1}	*Vasa*-1	1023.24	C–N	Aliphatic amines	Any	Often overlapped
800-840 cm^{-1}	*Palash*-2	851.59	C–H	Vinyl	Trisubstituted alkenes	Strong to medium
	Vasa-1	864.37				
	Vasa-2	858.49				
670-700 cm^{-1}	*Palash*-1	670.40	C–H	Vinyl	Cis-disubstituted alkenes	Strong
	Vasa-1	669.73				
	Vasa-2	671.43				

FTIR: Fourier transform infrared

are highly alkaline in nature with average alkalinity value 17 and 16.75. Qualitative tests for various ions present in the *Palash Kshara* and *Vasa Kshara* showed the presence of sodium, potassium, chloride, and carbonate ions. Sulfate ions were not detected in *Palash Kshara* while phosphate ions in *Vasa Kshara*. The FTIR study of *Palash Kshara* indicates the presence of alkyl, corbonyl or ester and halide group. FTIR report of *Vasa Kshara* showed the presence of alkyl, carboxylic or nitro-aliphatic compound, trisubstituted alkenes, and cis-disubstituted alkenes.

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