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Research Article

Preliminary pharmaceutico - analytical analysis and FTIR evaluation of Bhallataka (Semecarpus anacardium) before and after purification using Narikela jala (Coconut water) as shodana media

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Abstract

Bhallataka (*Semecarpus anacardium* Linn), commonly known as Indian marking nut, is a poisonous plant that is therapeutically used after proper *shodhana* (purification) in Ayurveda, an Indian system of medicine. Therapeutically, it is used extensively in the management of many diseases like *Arshas* (piles), *Arbuda* (cancer), etc. According to the Drugs and Cosmetics Act (India), 1940, it is mentioned in Schedule E-1 drugs (Poisonous drugs). The fruits of *bhallataka* (*Semecarpus anacardium* Linn) have their own poisonous property, and the oily fraction in the pericarp of the fruit is responsible for the toxic nature of the drug. Therefore, it should be used therapeutically only after proper *shodhana* (purification); as injudicious use of *ashuddha* (impure) *bhallataka* may result in toxic effects. It is hazardous to humans due to its irritant property, causing symptoms like burning sensation of the skin, blister formation, ulcer, and so on. Various *shodhana* (purification) methods are mentioned in the Ayurvedic literature. *Bhallataka shodana* was done as per the reference, and preliminary analytical study, phytochemical evaluation, and FTIR analysis were conducted to understand the impact of *shodhana* (purification) on *bhallataka* (*Semecarpus anacardium* Linn). These obtained pharmaceutical standards can be taken as a reference for further research to know the impact of *shodhana* on *ashuddha* (impure) *bhallataka* and to compare the physicochemical parameters of *ashuddha* (impure) *bhallataka* and *shuddha* (pure) *bhallataka* (*Semecarpus anacardium* Linn)**.**

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Introduction

Bhallataka (*Semecarpus anacardium* Linn, Family: Anacardiaceae) is distributed in the sub-Himalayan region, tropical, and central parts of India. It is commonly known as marking nut, dhobi nut, etc., with vernacular names such as *Bhallataka* (marking nut) or *bhilwa* (another local name). Its high therapeutic applicability is found in the traditional and folklore systems of medicine (1,2). The word *bhallataka* was mentioned around the 4th century B.C. Many formulations related to Ayurveda (Indian system of medicine) contain *bhallataka* as an ingredient. *Acharya Charaka* (the great sage of Ayurveda) has mentioned 10 different formulations of *bhallataka*, especially for the purpose of *rasayana* (rejuvenation) (3). Various chemical and phytochemical analyses on the nut reveal the presence of bhilwanols (specific chemical compounds), bhilwanoids (another type of compounds), tannins, amino acids, etc (4). *Bhallataka* is mentioned in Schedule E1 drugs as per the Drugs and Cosmetics Act 1940, which means it is listed as a poisonous substance. Hence, it is necessary to therapeutically use *bhallataka* only after proper *shodhana* (purification) procedures.

Shodhana (purification/processing) is the method adopted in Ayurveda (Indian system of medicine) to purify poisonous medicinal plants, metals, and minerals, etc. *Shodhana* is a process by which unwanted impurities are removed by adopting various pharmaceutical methods such as boiling, washing, frying, etc, in specific media, thereby minimizing the toxicity of the substance. The *shodhana* procedure not only minimizes toxicity but also increases the therapeutic efficacy of the substance (5).

Ayurveda emphasizes the selection of genuine and quality drugs for therapeutic use. The selection criteria of individual herbal drugs differ from drug to drug (6). Before subjecting *bhallataka* to the *shodhana* (purification) procedure, good quality fruits should

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be selected. It is reported that *bhallataka* fruits that are sunk in water should be selected for therapeutic use, while those floating on the surface of water are not useful for therapeutic purposes (7). The Ayurvedic Pharmacopoeia of India holds standards for various other Ayurvedic formulations. Although *bhallataka shodhana* (purification) is one of the commonly practiced procedures involving various *shodhana* (purification) media, there is a lack of basic physicochemical and chromatographic analytical data for *bhallataka shodhana* (purification) using *narikela jala* (coconut water) as *shodhana* (purification) media.

This attempt reveals the changes that occur in impure *bhallataka* and the changes that occur in *bhallataka* after the *shodhana* (purification) procedure using *narikela jala* (coconut water) as *shodhana* (purification) media. It is crucial to contribute towards the study of analytical data of pure and impure *bhallataka* of *Ayurvedic* formulation, and that is the main core of the study. Although classical Ayurvedic texts emphasize *shodhana* (purification) of *Bhallataka (Semecarpus anacardium)* to reduce toxicity and improve efficacy, comprehensive physicochemical and chromatographic analyses comparing *Ashoditha* (impure) and *Shoditha* (purified) *Bhallataka*, particularly using *Narikela Jala* (coconut water) are lacking. Most studies focus on phytochemical screening or toxicity, with limited data on FTIR profiles, extractive and ash values, and other analytical parameters before and after purification. This gap restricts understanding of chemical changes during *Narikela Jala shodhana*, highlighting the need for detailed scientific validation of this purification process**.**

Materials and Methods

Pharmaceutical part

The purification of *bhallataka* took place at the *Rasashastra* and *Bhaishajya kalpana* laboratory of KAHER's Shri BMK Ayurveda Mahavidyalaya, Belagavi. The raw drug of *bhallataka*, were obtained from the GMP certified KLE Ayurveda Pharmacy in Belagavi, while the fresh *narikela jala* (coconut water) was sourced from the local market of Belagavi. The authenticity of *bhallataka* was verified by the Drug Testing Laboratory of the same institution.

Fruits of *bhallataka* were taken and added in water to selected *prashastha phala* (good variety of fruits) those that are sunken are good variety and are taken for further processing. The thalamus part of the fruit was removed and cut into 2 halves. These *bhallataka* were made as *pottali* (drug material tied in a cloth) and hung in *dola yantra* containing 12 liters of freshly collected *narikela jala* (coconut water) as purification media. The process of swedana (purification method) was carried out over mild fire for 1 *yama* (3 hours) (8). Later the fruits were taken out and washed with warm water. Then, it was spread on clean stainless-steel plate and kept for drying in shade for three days for upto 8 hours a day. It is later stored in an air tight container after complete drying.

Inference for end point of completion of *shodhana* process

The end point of the *Shodhana* of *Bhallataka* (*Semecarpus anacardium* Linn) using *Narikela Jala* (coconut water) was determined based on, completion of the specified *Swedana* time duration 1 *Yama* (3 hours) During shodhana, drug undergoes changes in its physical, chemical and biological characters. Notable changes in organoleptic characteristics like loss of irritant odour, softening of outer pericarp and reduction in oily exudation. Colour changes from deep black to brownish-black. This can be inferred from changes noted in terms of colour, smell, touch, appearance (9).

Figure 1 *Bhallataka shodhana*

a) Pre-*shoditha* half cut fruits of *bhallataka*
b) *Narikela jala* (coconut water)
c) Adding of *Narikela jala* (coconut water)
d) S*hodhana* process
e) End process of *shodhana (swedana)*
f) *Shoditha bhallataka*

Observations

Room temperature – 24^0 C

Table 1: Total quantity of ingredients

Drug Name	Latin name	Family	Part used	Qty taken
Bhallataka	*Semecarpus anacardium* Linn	Anacardiaceae	Fruit	2500 gm
Narikela Jala	*Cocos nucifera* Linn	Arecaceae	Juice	13.3 Liters

Table 2: Organoleptic characters and pH before and after purification

Obs.	*Bhallataka*				*Narikela Jala*			
	Colour	Touch	Odour	Weight	Colour	Touch	Odour	pH
Before	Dirty black	Rough skin with sticky oil	Pungent, irritant odour	2500gm	Turbid white	Water like	Fresh	4.67
After	Shiny brownish black	Soft pericarp and Sticky	Pungent and irritant odour reduced	2490 gm	Turned muddy brown, black froth	Sticky	Pungent	5.25
Note - Test for pH was conducted using a calibre pH meter as per mentioned procedure of Ayurvedic pharmacopeia of india (10).								

Results

Pharmaceutical part: The temperature during the process of *shodhana* (purification) gradually increased during the preparation, as shown in Table 3. The total processing time for the *bhallataka* was three hours. From 2500 gm of Pre-*shoditha bhallataka* (unpurified marking nut) added, the final yield of shoditha bhallataka (purified marking nut) obtained was 2490gms. During the beginning of the process 12 liters of *narikela jala* (coconut water) was added later during the process of *swedana* (purification procedure) the evaporated *narikela jala* (coconut water) in the mud pot was compensated by adding *narikela jala*

(coconut water) 5 times to maintain the level during the process of *swedana* (purification) which was around 1.5 liter. Although classical texts have not highlighted addition of *shodhana dravya* during the *shodhana* process practically it is followed to ensure the maintenance of *pottali* in contact with *shodhana dravya*. Evaporation occurs during the *shodhana* process resulting in evaporation and insufficient *shodhana dravya*, this is compensated by gradual addition of liquid to maintain the contact of *pottali* and *shodhana dravya.*

Table 3: Temperature, pH at different time intervals and quantity of *narikela jala* (coconut water) added

S.no	Time	Temperature of boiling *narikela jala*	Qt of *narikela jala* added in between the process	pH
The procedure was started at 0:15 min				4.67
1	0:30 min	41 ^{0}C	-	-
2	1:00 Hr	76.4 ^{0}C	250 ml	4.67
3	1:30 Hr	89 ^{0}C	100 ml	-
4	2:00 Hr	91.5 ^{0}C	750 ml	4.93
5	2:30 Hr	94 ^{0}C	200 ml	-
6	3:00 Hr	98.1 ^{0}C	250 ml	-
7	3:30 Hr	100.2 ^{0}C	-	5.25

Note

a) Temperature was measured using a thermocouple instrument by placing it inside the boiling *narikela jala* for periodic monitoring. The addition of *Narikela jala* was synchronized with temperature control measures, ensuring uninterrupted *Swedana* efficacy.

b) *Narikela jala* was added in divided doses, allowing sufficient time for thermal equilibrium to be restored. This method ensured that the progressive increase in temperature was maintained without significant fluctuations, facilitating uniform processing conditions. Since temperature was recorded at intervals, it indicates that the temperature was closely monitored. The consistent rise in temperature throughout the multiple additions of *Narikela Jala* indicates a combination of precise heating control, incremental liquid addition, and continuous thermal monitoring to maintain the required temperature range during the process.

c) Usually coconut water boils at 100^{0}C at under normal atmospheric pressure (11).

Table 4: Physico-chemical analysis of *Pre-shoditha bhallataka* (unpurified) and *Shoditha bhallataka* (Purified)

S.no	Name of the test	API Standards	Observed results	
			Pre-shoditha bhallataka	***Shoditha bhallataka***
1	Foreign matter	Not more than 1%	Nil	Nil
2	Loss on drying	NA	8.641%	12.086%
3	Ash value	Not more than 4 %	2.599%	2.534%
4	Acid insoluble ash	Not more than 0.5%	0.247%	0.181%
5	Water insoluble ash	NA	1.465%	1.501%
6	Water soluble extractive	Not less than 5%	8.974%	8.707%
7	Alcohol soluble extractive	Not less than 11%	39.663%	28.726%
8	pH value	NA	6.42	5.5

Analytical part

The physico-chemical analysis of the Pre-*shoditha* (unpurified) and *shoditha bhallataka* (Purified) was conducted at Central Research Facility of KAHER's Shri BMK Ayurveda Mahavidyalaya, Belagavi.

Note: The above mentioned physico-chemical analysis were conducted according to the procedure mentioned in Ayurvedic pharmacopeia of india (12).

Table 5: Preliminary phytochemical screening of *shoditha* (Purified) and *Pre-shoditha bhallataka* (unpurified)

S.no	Tests	***Shoditha bhallataka***		***Pre-shoditha bhallataka***	
		Water	**Alcohol**	**Water**	**Alcohol**
1	**Carbohydrates** (Molisch's Test)	+	+	+	+
2	**Reducing sugars** (Benedict's Test)	+	+	+	-
3	**Monosaccharides** (Barfoed's Test)	+	+	+	-
4	**Pentose sugar** (Bial's Test)	-	-	-	-
5	**Non reducing sugar** (After hydrolysis + Benedict's test)	-	-	-	+
6	**Hexose sugar** (Seliwanoff's Test)	-	-	-	-
7	**Proteins** (Biuret Test)	+	-	-	-
8	**Amino acids** (Ninhydrin Test)	-	-	-	-
9	**Steroids** (Salkowski's Test)	-	-	-	-
10	**Flavonoids** (Shinoda Test)	+	+	-	+
11	**Alkaloids** (Mayer's reagent)	-	-	-	+
12	**Tannins** (Ferric chloride Test)	+	+	+	+
Test for glycosides					
13	**Cardiac glycosides** (Keller–Killiani Test)	+	-	+	+
14	**Anthraquinone glycosides** (Borntrager's Test)	+	-	-	-
15	**Saponin glycosides** (Froth Test)	+	-	-	-

Table 6: Preliminary phytochemical findings of *shoditha* and *Pre-shoditha bhallataka*

S.no	Tests	Observation	Findings
1	**Carbohydrates**	Violet ring at junction	Present in both samples (water & alcohol)
2	**Reducing sugars**	Brick-red precipitate	Absent in pre-*shoditha* alcohol extract
3	**Monosaccharides**	Red precipitate within 2–3 min	Absent in pre-*shoditha* alcohol extract
4	**Pentose sugar**	Bluish-green colour	Absent in all extracts-extracts
5	**Non-reducing sugar**	Brick-red precipitate after acid hydrolysis	Present only in pre-*shoditha* alcohol extract.
6	**Hexose sugar**	Cherry red colour for ketohexoses	Absent in all samples-extracts
7	**Proteins**	Violet or pink colour	Present in purified water extract only
8	**Amino acids**	Blue or purple colour	Absent in all samples-extracts
9	**Steroids**	Red colour in chloroform layer	Absent in all samples-extracts
10	**Flavonoids**	Pink to red colour	Absent in pre-*shoditha* water extract
11	**Alkaloids**	White precipitate	Present in pre-*shoditha* alcohol extract only
12	**Tannins**	Blue-black or green precipitate	Present in all samples-extracts
Test for glycosides			
13	**Cardiac glycosides**	Blue-green colour	Present in water extract for *shoditha* and both alcohol extracts in pre -*shoditha*
14	**Anthraquinone glycosides**	Pink to red color in ammonia layer	Absent in all samples-extracts
15	**Saponin glycosides**	Persistent froth	Present only in water extract of *shoditha bhallataka.*

For preliminary phytochemical screening of *Shoditha* (purified) and *Pre-shoditha* (unpurified) *Bhallataka,* two types of extracts are typically prepared:

Water Extract: 5 grams of powdered *Ashoditha/shoditha bhallataka* is boiled or macerated in 100 ml of distilled water for a duration of 24 hrs. This is later filtered and used for water-soluble phytochemical screening.

Alcoholic Extract: 5 grams of powdered *Ashoditha/shoditha bhallataka* is soaked in 100 ml of ethanol (usually 95%) for 24 hours. Then filtered, and used for alcohol-soluble phytochemical screening.

Need for water and alcohol extract preparation was to identify phytoconstituents based on its solubility as few compounds (e.g., tannins, sugars, proteins) are water-soluble. Others compounds such as alkaloids, flavonoids, steroids, glycosides are more soluble in alcohol.

The above mentioned phytochemical screening methodology, preparations of extractions observations were adopted as per standard phytochemical procedures protocol mentioned in the text Practical Pharmacognosy by Khandelwal KR (13).

TLC Analysis

Table 7: Specifications of *Pre-shoditha bhallataka* and *Shoditha bhallataka* test samples and their mobile phases

S.no	Drug Tested	Extraction media	Test Solution	Mobile Phase
1	*Pre-shoditha bhallataka* (unpurified)	Ethanol	5gm in 100 ml of ethanol	Toluene : Ethyl acetate (7:3)
2	*Shoditha bhallataka* (purified)	Ethanol	5 mg in 100 ml of ethanol	Toluene : Ethyl acetate (7:3)

Table 8: TLC results of *Pre-shoditha bhallataka* and *Shoditha bhallataka*

Sample	Mobile phase	Rf values
Pre-shoditha bhallataka extract of ethanol	Toluene: Ethyl acetate (7: 3)	Short wave: 0.06, 0.18, 0.43, 0.56, 0.57, 0.81, 0.91 Long wave: 0.42, 0.52 Day Light: 0.06, 0.41, 0.51, 0.57, 0.81, 0.93
Shoditha bhallataka extract of ethanol	Toluene: Ethyl acetate (7: 3)	Short wave: 0.11, 0.29, 0.48, 0.70, 0.82, 0.87 Long wave: 0.42, 0.56, 0.76 Day Light: 0.32, 0.45, 0.58, 0.68, 0.74

Note: The methodology adopted for the above TLC aligns with the standard protocol as per Ayurvedic pharmacopoeia of India (14).

Fig 7: TLC- Pre-*shoditha Bhallataka*

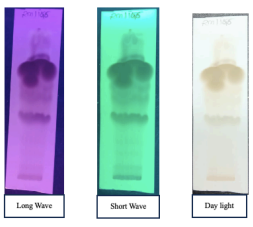
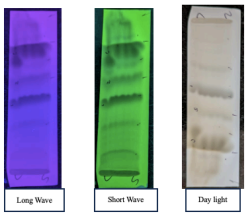


Fig 8: TLC- *Shoditha Bhallataka*



Inference: Urushiol's (catechol derivatives responsible for toxicity) generally exhibit Rf values in the range of 0.05–0.15 in non-polar solvent systems such as toluene:ethyl acetate (7:3) ratio (15). The absence of Rf bands at 0.06 and 0.18 in the *Shoditha bhallataka* may indicate successful detoxification and removal of urushiol's during the *Shodhana* process (16). Rf values in the range of 0.42–0.56 noted in both the samples of unpurified *bhallataka* and purified *bhallataka*, may represent bioactive but

safe constituents, such as bhilawanols or phenolic acids, which are retained after detoxification (17).

FTIR Analysis

FTIR analysis was performed using a Bruker Alpha II spectrophotometer based on the principle of molecular vibration, employing ATR (Attenuated Total Reflectance) technique. The spectra were recorded in terms of wavenumber (cm^{-1}) versus percentage transmittance using OPUS software. This analysis was conducted at KLE College of Pharmacy, Belagavi.

Procedure: Solid sample kept in an IR cell and run out 48 scans over the sample with an IR beam. Sample undergoing molecular vibration on the absorbance of a beam of light. Vibrational frequencies will be measured in the term of wavenumbers (Cm-1) versus percentage transmittance. Wavenumbers in the term cm-1 is an indication of a functional group at different positions. Fig.9 FTIR finding-Pre-shoditha bhallataka.

Figure 9: FTIR finding-Pre-*shoditha bhallataka*

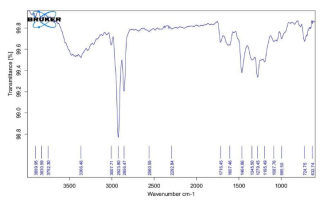


Figure 10: FTIR Finding-Shoditha bhallataka

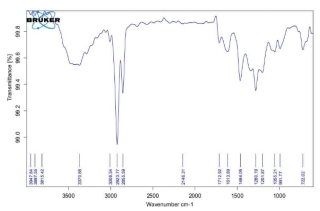


Table 09: Interpretation of *Pre-shodita bhallataka* (unpurified) fruit sample

S.no	Wavenumber cm^{-1}	Peak intensity	Stretching vibration	Probable functional group	Reference ranges
1	3899.95,3830.59 3752.30	Weak	O-H stretch	Alcohol	3900–3200 (m)
2	3366.46	Medium	N-H stretch	Amine	3400-3200
3	3007.71	Strong	C-H stretch	Aromatic	3100–2900
4	2923.80 2856.47	Strong	C-H	Aliphatic	2800-2900
	2560.55	Weak	O-H	Carboxylic acid	3200 – 2500
5	2292.84	Weak	C-N	Nitrile	2300–2240
6	1716.45	Strong	C=O stretch	Carboxyl Group	1730–1700 (s)
7	1607.46	Medium	C=C	Aromatic	1600–1475 (w-m)
8	1464.86	Medium	C=C	Aromatic	1600–1475 (w-m)
9	1345.50	Medium	NO2	Nitro	1390 – 1300
10	1279.45	Medium	C-C	Aromatic or Aliphatic	1450 and 1375 (m)
11	1195.49	Medium	C-O stretch	Alcohol, Ether, Ester, Carboxylic Acid, Anhydride	1300–1000 (s)
12	1087.76 995.50	Medium	C-O stretch	Alcohol, Ether, Ester, Carboxylic Acid, Anhydride	1300–1000 (s)
13	1087.76, 995.50	Strong	C-N OR C-O	Amine	1250–1000 (m-s)
14	724.75, 632.74	Weak	C-H Bend	Aromatic	900–690 (s)
15	724.75, 632.74	Weak	C-H Bend OR C-Cl	Aromatic OR Halide	900–690 (s) or 800–600 (s)

Table: 10 Interpretation of *Shodita bhallataka* (purified) fruit sample

S.no	Wavenumber cm^{-1}	Peak intensity	Stretching vibration	Probable functional group	Reference ranges
1	3947.84, 3897.55 3815.42	Weak	O-H stretch	Alcohol	3900 - 3200 (m)
2	3370.88	Medium	N-H stretch	Amine	3400 - 3200
3	3008.54	Strong	C-H stretch	Aromatic	3100 - 2900
4	2923.77, 2855.59	Strong	C-H	Aliphatic	2800 - 2900
5	2146.31	Weak	C°C stretch	alkyne	2250 - 2100
6	1712.92	Strong	C=O stretch	Carboxyl Group	1730 - 1700 (s)
7	1613.89	Medium	C=C	Aromatic	1600 -1475 (w-m)
8	1464.05	Medium	C=C	Aromatic	1600 - 1475 (w-m)
9	1280.19, 1201.87	Medium	C-C	Aromatic or Aliphatic	1450 and 1375 (m)
10	1055.21 991.77	Medium	C-O stretch	Alcohol, Ether, Ester, Carboxylic Acid, Anhydride	1300 - 1000 (s)

11	1055.21 991.77	Strong	C-N OR C-O	Amine	1250 -1000 (m-s)
12	722.02	Weak	C-H Bend	Aromatic	900 - 690 (s)
13	722.02	Weak	C-H Bend OR C-Cl	Aromatic OR Halide	900 - 690 (s) or 800–600 (s)

Inference: The FTIR spectrum of *pre-shoditha* (unpurified) *bhallataka* reveals the presence of alcohols, carboxylic acids, esters, aromatic rings, amines, and nitriles, which are consistent with urushiol-like catechol derivatives, the known toxic allergens responsible for contact dermatitis. Notably, toxic functional groups such as nitriles (C≡N) and strong nitro or halide signals, which were present in the unpurified sample, are absent in *shoditha bhallataka*, suggesting successful detoxification of reactive (18). In pre-*shoditha bhallataka* the peaks observed in the regions corresponding to aromatic hydrocarbons (3100–2900 cm^{-1}), nitriles (2290 cm^{-1}), and carboxylic acids (1700–2500 cm^{-1}) indicate the presence of highly reactive and potentially dermotoxic compounds. The emergence of new signals, like the alkyne stretch, further supports chemical transformation during the *shodhana*, possibly due to thermal or chemical hydrolysis (19).

These findings scientifically validate the requirement for *Shodhana* (purificatory process) of *Bhallataka* to detoxify such irritants prior to therapeutic application and also enhances the safety and therapeutic efficacy of *bhallatalka*

Discussion

The analysis of *Pre-shoditha* (unpurified) and *Shoditha Bhallataka* (purified) provides significant insights into the chemical composition as well as the organoleptic characteristics of these two different forms of the medicinal fruit, *Semecarpus anacardium* Linn. The differences observed between the two preparations reflect the effects of purification processes on the chemical constituents and the overall quality.

Organoleptic Characteristics: Before purification, *Preshoditha bhallataka* (unpurified) displayed a "dirty blackish brown" colour with rough and sticky texture, indicative of impurities and presence of undesirable compounds. The pungent odour was characteristic of unprocessed plant materials. Post-purification, the colour of *Shoditha Bhallataka* (purified) transformed into a shiny black, reflecting enhanced aesthetic quality likely due to the removal of extraneous materials. The touch remained sticky, and the pungent odour and irritant odour was reduced, suggesting that some of the volatile compounds which are contributing to this strong smell were removed during purification. The slight decrease in weight from 2500 g to 2490 g indicates the loss of water and impurities, which aligns with expectations from a purification process.

The pH change from 4.67 to 5.25 is notable; it indicates an increase in acidity after purification, possibly due to the concentration of organic acids during the process. Coconut water is naturally mildly acidic due to organic acids like citric and ascorbic acid. (20). Gradual increase in pH during boiling indicates loss of acidity and possible neutralization by phytochemicals released from *bhallataka* (21). The pH change reflects a reduction of irritant compounds like urushiol, which are acidic in nature (22). Impurities are eliminated during *Shodhana.*

Temperature and Processing: The temperature observations noted throughout the processing of *Bhallataka* show a gradual increase, peaking at 100.2 °C by the end of the process. This thermal regulation is crucial for effectively extracting and transforming the active components within the plant matrix. The addition of *Narikela Jala* (coconut water) five times in between during the *dola yantra swedana* to maintain consistency also illustrates an adaptive processing technique. The use of coconut water not only assists in the extraction of soluble constituents but also potentially contributes beneficial phytochemicals that enhance the therapeutic properties of the *shoditha bhallataka* (purified).

Physico-Chemical Analysis: The results from the physico-chemical analysis reveal significant differences between *Shoditha* (purified) and *Preshoditha* (impure) *Bhallataka* (marking nut), reflecting the purification's effectiveness. The absence of foreign matter in both forms indicates a high level of cleanliness and adherence to standards, which is very critical for pharmaceutical preparations. The loss on drying values indicates moisture retention; *Shoditha Bhallataka* (purified) showed a loss of 8.641% compared to 12.086% for *Preshoditha Bhallataka* (unpurified). The lower moisture content in *Shoditha* (purified) suggests better stabilization during the processing, which may enhance shelf-life and storage stability of the drug.

Ash values provide insight into the mineral content of the samples. Both forms remain within acceptable limits as per API (Ayurvedic Pharmacopoeia of India) standards, but *Shoditha Bhallataka* (purified) showed slightly lower values. The acid-insoluble ash was also lower in *Shoditha Bhallataka* (purified) indicating reduced inorganic impurities.

Phytochemical Screening: The significant observation was disappearance of alkaloids indicating detoxification. Alkaloids that are present in the sample of Pre-*shoditha bhallataka* (alcohol extract) but these alkaloids are absent in *shoditha bhallataka*, which indicates removal of urushiols (a toxic catechol alkaloids responsible for irritant effects) through *shodhana* procedure (23). Presence of Reducing Sugars and Presence of Flavonoids in *Shoditha bhallataka* (both water & alcohol extracts). But are absent in Pre-*shoditha bhallataka* (water extract). This reveals better release or extraction of flavonoids post purification (24). Absence of Non-Reducing Sugars and Alkaloids in *shoditha bhallataka*. Indicates removal of complex sugars and toxic elements during *shodhana* procedure (25). Presence of Cardiac and Saponin Glycosides in *Shoditha bhallataka*. Suggests that therapeutic constituents are retained or enhanced after *shodhana*. (26)

TLC Analysis: The TLC (Thin Layer Chromatography) analysis provided further differentiation between the two preparations. *Preshoditha Bhallataka* (unpurified) exhibited six spots with various Rf values, indicating a rich profile of phytochemicals. In contrast, *Shoditha Bhallataka* (purified) had five spots, suggesting that certain compounds may have been removed or transformed during purification. The solvent system of Toluene: Ethyl acetate (7:3) proved effective for separating constituents, which is crucial for understanding the chemical diversity present in each preparation. Pre-*shoditha Bhallataka* showed more Rf bands, indicating the presence of a greater number of chemical constituents, including possible irritants or unstable compounds (27). *Shoditha Bhallataka* showed fewer and cleaner Rf bands, suggesting the removal of toxic or unwanted compounds during the purification process. Emergence of new Rf bands in the

Shoditha bhallataka sample (e.g., Rf 0.29, 0.70, 0.87) may suggest chemical transformation or hydrolysis of parent compounds due to interaction with coconut water during *Shodhana* process. (28).

Loss of certain Rf bands (e.g., Rf 0.06, 0.18, 0.91) in purified samples may correlate with the removal of urushiol-like toxic compounds, which are known to be present in Pre - *shoditha Bhallataka* (29). The Rf values common to both extracts (e.g., Rf 0.42) likely indicate stable phytoconstituents retained after purification Rf ranges around 0.40–0.80 may indicate presence of phenolics, flavonoids, or bhilawanol-type compounds, which may be bioactive but less toxic, and retained after purification (30).

FTIR Analysis: The presence of O-H stretches confirms alcohols in both samples, while the N-H stretches signify amines. The aromatic C-H stretches are consistent with the presence of bioactive phenolic compounds. The detection of aliphatic C-H stretches suggests the presence of long-chain fatty acids, which may contribute to the oiliness observed. The notable presence of a weak C≡C stretch in *Shoditha Bhallataka* (purified) indicates alkynes, which are less common in many plant materials, suggesting unique chemical transformations during the *shodhana* (purification) process. The strong C=O stretch indicates the carboxyl groups prevalent in both preparations, vital for their medicinal properties (31). *Shoditha bhallataka* preserves important bioactive functional groups like alcohol (O-H), amine (N-H), carboxyl (C=O), and aromatic structures, maintaining therapeutic efficacy while minimizing harmful effects. Various studies have explored the chemical composition and detoxification of *Bhallataka* through various analytical techniques. For instance, Sharma et al. (2018) reported the presence of phenolic compounds and aliphatic acids using FTIR, highlighting functional groups similar to those observed in both Pre-*shoditha* and *Shoditha* samples in this study. (32)

Unlike previous studies which mainly focused on phytochemical screening or toxicity assays, this study provides a detailed comparative FTIR analysis showing the emergence of alkyne groups (C≡C) in *Shoditha Bhallataka*, suggesting unique chemical transformations noted during *shodhana* that have not been extensively documented earlier. This comparison underscores the significance of purification in detoxifying *Bhallataka* while retaining or modifying bioactive groups necessary for its therapeutic efficacy. (33)

Conclusion

The comprehensive analysis of *Shoditha* (purified) and Pre-*shoditha* (impure) *Bhallataka* (*Semecarpus anacardium* Linn) elucidates significant transformations in physical, chemical, and phytochemical properties due to the purification process. The results underscore the importance of traditional methods like *shodhana* (purification) in enhancing the therapeutic efficacy of medicinal plants while ensuring safety and quality of the drug. The observations made through organoleptic characteristics, temperature regulation, and detailed physico-chemical and phytochemical analyses provide a robust framework for understanding the impact of the *purification* process on the medicinal properties of *Bhallataka*. These findings could pave the way for future research aimed at optimizing traditional purification techniques for enhanced therapeutic outcomes.

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