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# A Comparative Physicochemical and Phytochemical Analysis of *Churna* and *Sodhita Churna* of The Rhizome of *Zingiber officinale* Rosc.

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**ABSTRACT:** *Zingiber officinale* Rosc. (*Nagara*) is a widely used medicinal rhizome in Ayurvedic formulations, valued for its digestive and anti-inflammatory properties. The present investigation undertakes a comprehensive comparative phytochemical and physicochemical evaluation of *Churna* (powder) and *Sodhita Churna* (purified powder) prepared from the dried rhizome of *Zingiber officinale* Rosc. Physicochemical parameters including ash values, moisture content, pH, fibre content, volatile oil content, tannins, phenols, total sugars and reducing sugars were systematically determined for both samples. Extractive values (cold water and alcohol soluble) and successive solvent extractives (petroleum ether, cyclohexane, acetone, alcohol) were quantitatively assessed. Preliminary phytochemical screening of cold-water extracts and solvent fractions was performed to characterize major secondary metabolites and identify differences induced by purification. *Sodhana* (purification) produced notable quantitative modifications in *Nagara* (*Zingiber officinale* Rosc.). *Sodhita Churna* exhibited reduced total ash, water-insoluble ash, crude fibre, tannins, phenols, and sugar content, suggesting removal of non-essential or extraneous components during purification. Volatile oil was present only in *Churna*, indicating partial loss of thermo-labile constituents. Ash analysis demonstrated similar mineral radical profiles in both samples. Phytochemical tests confirmed the presence of alkaloids, saponins, carbohydrates, proteins, steroids, and tannins in both samples, with selective reduction of phenolic constituents in *Sodhita Churna*. The findings demonstrate that the *Sodhana* process significantly modulates the physicochemical and phytochemical characteristics of *Nagara* (*Zingiber officinale* Rosc.), enhancing purity while altering certain bioactive fractions.

**KEYWORDS:** *Zingiber officinale* Rosc., *Nagara Churna, Sodhita Nagara Churna*, physicochemical analysis, phytochemical screening.

## INTRODUCTION

*Nagara*, a classical synonym for *Sunthi* (*Zingiber officinale* Rosc.), is a well-established medicinal plant known since Vedic times. Although widely used as a culinary spice and nutraceutical, its primary significance

in Ayurveda lies in its therapeutic application. The rhizome (*kandha*) is the main medicinally useful part of the plant, employed in both its forms- *Ardraka* (fresh rhizome) and *Sunthi* (dried rhizome). Classical texts describe both forms under the same botanical identity, *Zingiber officinale* Rosc.[1]

*Nagara* is extensively referenced in various samhitas and nighantus for its *katu rasa* (pungent taste), *laghu* (light) and *snigdha* (unctuous) qualities, *ushna veerya* (hot potency), and *madhura vipaka* (sweet post-digestive effect). It is appreciated for actions such as *kaphavata samana*, *deepana* (enhancing digestive fire), *pachana* (aiding digestion of undigested food)*, sophaghna,* (reducing oedema) and *grahi* (absorbing excess fluid from the bowels*).*[2,3] Phytochemical investigations conducted in previous studies have reported that *Zingiber officinale* Rosc. contains a rich spectrum of bioactive constituents, including gingerols, shogaols, paradols, zingerone, volatile oils (such as zingiberene), and various phenolic compounds.[4] These constituents are primarily responsible for its recognized activities such as anti-inflammatory, antioxidant, digestive, carminative, and immunomodulatory effects. Despite its therapeutic value, *Nagara* is considered *teekshna* in potency, and its sharpness is attributed mainly to gingerols, bioactive constituents known for their irritant and pungent nature.

In Ayurvedic literature, the quality, safety, and efficacy of a drug are enhanced through specific processing techniques known as *sodhana*. This procedure is believed to reduce undesirable irritants, improve palatability, and modify the physicochemical nature of the raw material. For *Nagara*, traditional purification methods are described to attenuate excessive pungency and enhance therapeutic suitability. Despite its long-standing traditional use, scientific validation of *sodhana*-induced transformations in the physicochemical and phytochemical profile of *Nagara* remains limited.

Physicochemical standardization is essential to ensure the identity, purity, quality, and safety of herbal drugs. Parameters such as foreign matter, ash values, extractive values, moisture content, volatile oil content, fibre percentage, pH, phenolics, tannins, and sugars provide critical insights into the composition and stability of the raw drug. Similarly, phytochemical screening enables the identification of major functional groups, supporting both analytical consistency and therapeutic interpretation.

Comparative analysis of *Asodhita* and *sodhita Nagara Churna* offers an opportunity to understand how traditional purification modifies the drug at a chemical level. Evaluating changes in extractive values, key phytoconstituents, and physicochemical parameters can help establish scientific evidence for the Ayurvedic rationale of sodhana. Moreover, the study provides essential baseline data for standardization, as no earlier reports have documented the analytical profile of *sodhita Nagara.*

In this context, the present study aims to assess and compare the physicochemical characteristics, extractive values, and phytochemical constituents of *Nagara Churna* before and after *sodhana*, thereby elucidating the impact of purification on the qualitative and quantitative attributes of the drug. This investigation contributes to bridging classical Ayurvedic principles with modern analytical science and supports the development of validated standards for processed herbal drugs.

## MATERIALS AND METHODS

### Collection of the Drug

The fresh rhizomes of *Zingiber officinale* Rosc. were cultivated in the home garden. Harvesting was carried out when the plant's leaves turned yellow and the plant began to dry. The rhizomes were carefully dug out, with the buds and roots meticulously removed. They were then thoroughly washed with clean water to remove any soil, followed by soaking overnight. The identification of the collected drug specimen was done by the faculty of the Department of Dravyaguna Vigyana, Government Ayurveda College, Tripunithura, and plant authentication has been done at St. Albert's College (Autonomous), Ernakulam, Department of Botany, with a voucher number of 602.

**Preparation of *Nagara churna* (Powder of dried rhizomes of *Zingiber officinale* Rosc.)**

The outer skin of the fresh rhizomes of *Zingiber officinale* Rosc. was carefully removed by scraping with bamboo splits. The peeled rhizomes were then dried under sunlight, with frequent turning to ensure uniform drying.[9] Once completely dried, the rhizomes were powdered using a pulveriser and subsequently sieved through an 85-mesh sieve. The powdered drug (Figure 1) was stored in clean airtight bottles.

**Preparation of *Sodhita Nagara churna* (Powder of purified dried rhizomes of *Zingiber officinale* Rosc.)**

*Nagara* (*Zingiber officinale* Rosc.) was subjected to *sodhana* (purification) by immersing it in *Churnodaka* (lime water/Calcium hydroxide solution) for half *yama* (1.5 hours). After the soaking period, the sample was thoroughly washed with *Kanjika* (fermented sour gruel) then dried under sunlight.[5] Once completely dried, the purified rhizomes were powdered using a pulveriser, and the powdered drug was then sieved using a mesh size of 85. The powdered drug (Figure 2) was stored in clean airtight bottles.

**Reagents and Apparatus Required**

Concentrated and dilute hydrochloric acid, xylene, concentrated and dilute sulfuric acid, concentrated and dilute nitric acid, sodium hydroxide solution, lead acetate solution, sodium oxalate, potassium permanganate, anhydrous sodium carbonate, petroleum ether, cyclohexane, acetone, alcohol, Fehling's solution A&B, chloroform water, Dragendorff's reagent, Mayer's reagent, Wagner's reagent, neutral ferric chloride, magnesium ribbon, methylene blue reagent, sodium bicarbonate solution and copper sulfate, catechol, Folin Ciocalteu phenol reagent. Silica crucible, round bottom flask, conical flask, standard flask, Dean and stark's apparatus, Clevenger's apparatus, Soxhlet apparatus, Bunsen burner, water condensers, hot air oven, muffle furnace, heating mantle, glass beakers, glass beads, petri dishes, test tubes, glass lids, measuring jars, funnel, glass rods, watch glass, burettes, pipettes, Whatman filter paper.

**Procedure**

**Determination of the Physicochemical Parameters**

The physicochemical properties such as foreign matter, total ash, acid-insoluble ash, water-insoluble ash, moisture content, volatile oil content, fibre content, tannin content, total sugar, reducing sugar, phenol content, pH, and qualitative analysis of ash were separately evaluated in the *Asodhita* and *sodhita churna* of *Nagara* (*Zingiber officinale* Rosc.). The ash obtained from each sample was subjected to qualitative analysis to detect the presence or absence of acid radicals such as carbonate, phosphate, sulphate, and chloride, as well as the basic radical potassium. The cold and hot water-soluble extractive values and cold and hot alcohol-soluble extractive values of both *Asodhita* and *sodhita churnas* of *Nagara* were estimated in the study. In addition, successive solvent extraction was performed using the solvents petroleum ether, cyclohexane, acetone, and alcohol to determine the extractive profile of each sample.

**Phytochemical Parameters**

Phytochemical constituents such as alkaloids, saponins, flavonoids, tannins, steroids, phenols, carbohydrates, and proteins were screened to detect their presence or absence in *Asodhita* and *sodhita churna* of *Nagara* (Zingiber officinale Rosc.). Further, the petroleum ether, cyclohexane, acetone, and alcohol extracts of both test samples were subjected to qualitative phytochemical analysis to detect the presence of steroids, alkaloids, flavonoids, and phenols.

## RESULTS

**Physicochemical and Preliminary Phytochemical Evaluation**

The physicochemical and preliminary phytochemical evaluation of *Asodhita* and *sodhita churna* of *Nagara* (*Zingiber officinale* Rosc.) was carried out separately to assess the impact of the *sodhana* (purification) process on the quality of the drug.

**Determination of Physicochemical Parameters**

Physicochemical parameters were estimated for *Asodhita* and *sodhita Nagara churna* separately. The observations are listed in Table 1.

**Qualitative Analysis of Ash**

Qualitative analysis of ash of *Asodhita and sodhita Nagara churna* were assessed separately, as shown in Table 2

**Determination of Extractive Values (Water Soluble and Alcohol Soluble)**

Hot water-soluble and alcohol-soluble extractive values of *Asodhita and sodhita Nagara churna* were assessed separately and are listed in Table 3.

**Determination of Successive Solvent Extractive Values**

Successive solvent extraction of A*sodhita and sodhita Nagara churna* was performed using petroleum ether, cyclohexane, acetone, and alcohol. The extractive values obtained are given in Table 4.

**Determination of the Phytochemical Constituents**

**Qualitative analysis**

The results obtained in qualitative analysis of *Asodhita and sodhita Nagara churna* were assessed separately. The results are summarized in Table 5.

**Qualitative analysis of successive solvent extractives**

Results obtained from the qualitative analysis of successive solvent extractives in petroleum ether, cyclohexane, acetone, and alcohol of *Asodhita Nagara churna* was shown in Table 6 and *sodhita Nagara churna* was shown in table 7

## DISCUSSION

**Determination of Physicochemical Parameters**

In the present study, the physicochemical characteristics of *churna* (powder) and *Sodhita Churna* (purified powder) of dried rhizome of Zingiber officinale Rosc.) were evaluated. *Sodhita Nagara Churna* was scientifically analysed for the first time in the present study; therefore, no direct published references exist for comparison.

Foreign matter was absent in *asodhita* and *sodhita nagara churna* which indicates the purity of the samples. Total ash indicates the overall amount of inorganic matter present in a drug sample. Acid-insoluble ash shows contamination with earthy materials like sand and silica. Water insoluble ash is the portion of the total ash that remains undissolved when the ash of a crude drug is treated with water.

The total ash (5.87%) and acid-insoluble ash (1.8%) values of *Asodhita Nagara Churna* closely correspond with the standards reported in the Ayurvedic Pharmacopoeia of India[1] and previous studies,[4, 5] validating the authenticity of the drug. Water-insoluble ash (3.62%) was also within the acceptable range reported in earlier literature.[4, 5] Total ash (4.93%), acid-insoluble ash (1.35%), and water-insoluble ash (2.56%) were all lower in *Sodhita Churna* compared to the unprocessed powder, indicating effective removal of inorganic and earthy impurities during sodhana. Moisture content in *asodhita churna* and *sodhita churna* was found to be 2%, which falls within permissible limits and suggests adequate stability and minimal microbial risk. Moisture content remained constant at 2%, suggesting that purification did not compromise stability.

Volatile oil content in *Asodhita Nagara Churna* was determined as 2%, aligning well with previously published data on ginger rhizomes,[4, 5] confirming the presence of essential components such as gingerols and shogaols. A notable finding was the complete absence of volatile oil in *Sodhita Churna*. Soaking the drug in lime water (*Curnodaka)* exposes it to a strongly alkaline medium, which hydrolyzes and neutralizes volatile terpenoids while also facilitating their leaching. Subsequent drying promotes further evaporation, resulting in an undetectable volatile oil content, supports the traditional objective of *sodhana*, which aims to reduce

*teekshnatva* and enhance tolerability. The crude fibre content (8.78%) in *asodhita churna* was higher, reflecting proper processing and supporting the drug's digestive benefits. In *sodhita churna*, Crude fibre decreased to 5.76%, possibly due to partial removal of fibrous components, thereby improving digestibility. Phenolic content (2.1%) and tannin content (1.31%) in *asodhita churna* were indicating substantial polyphenolic compounds associated with antioxidant and hepatoprotective properties. But Polyphenols declined (phenols: 1.09%, tannins: 1.04%) in *sodhita churna*, indicating selective alteration of chemical constituents. In *asodhita churna*, reducing sugars (5.98%) and total sugars (8%) were within the ranges documented in earlier studies while Carbohydrate content decreased (reducing sugars: 4.78%, total sugars: 5.68%) in *sodhita churna* likely due to leaching during purification.

The pH of *Nagara Churna* was assessed both qualitatively and quantitatively. Both powders turned blue litmus red, confirming its acidic nature, and the *asodhita churna* measured pH value of 6.17 was similar or slightly lower than values reported in previous work.[4] In *sodhita churna,* the pH increased slightly to 6.30, shifting towards neutrality.

Qualitative ash analysis of both *Asodhita Churna and Sodhita Churna* revealed the presence of carbonate, phosphate, chloride, and sulphate radicals, along with potassium as the major basic radical. Since these constituents were present in both forms, it can be inferred that purification did not significantly alter the mineral composition of the drug.

**Determination of Extractive Values**

Extractive values of drugs are important parameters for assessing quality, purity, and presence of adulteration. In the present study, the cold water-soluble and cold alcohol-soluble extractive values of *Asodhita Churna* were 16.13% and 3.79%, respectively, whereas in *sodhita Churna*, these values were 15.30% and 5.21%, respectively. The hot water-soluble and hot alcohol-soluble extractives of *Asodhita Choorna* were 22.3% and 12.86%, while in *sodhita Choorna*, they were 21.1% and 10.06%, respectively. In both *Churnas*, the water-soluble extractive values were higher than the alcohol-soluble extractives under cold conditions, indicating that a majority of active phytoconstituents are extracted in water. Hot alcohol extractive values were higher than cold alcohol extractives, and hot water extractive values were higher than cold water extractives in both *Churnas*. Unlike the cold extractive pattern, the trend of increased alcohol-soluble extractives in *sodhita Churna* was not preserved in hot extracts. This is because hot extraction is far more exhaustive, enabling extensive solubilization of polysaccharides, starch, mucilage, phenolics, essential oils, and resinous constituents from both samples. Under such intense extraction conditions, the subtle compositional differences produced by *sodhana* become less apparent, leading to relatively comparable hot water and hot alcohol extractive values in both Churnas. Thus, the influence of sodhana is more prominently reflected in cold extraction profiles than in hot extractions.

Successive extraction with solvents of increasing polarity, from non-polar to more polar, is used to extract various compounds of a wide range of polarity. In the present study, the successive solvent extractive values of *Asodhita* and *sodhita churna* were 0.96% and 0.72% in petroleum ether, 1.19% and 1.02% in cyclohexane, 1.63% and 1.22% in acetone, and 0.43% and 0.22% in alcohol, respectively. The successive solvent extractive values were lower in the sodhita Churna, indicating the removal of volatile, non-polar, and lipophilic constituents during the purification process. The maximum extractive values were obtained in acetone for both *Churnas*, reflecting the better solubility of semi-polar phytoconstituents in this solvent. As no published references are available for the successive solvent extractive values of Sodhita *Churna*, the current findings may serve as valuable baseline data for future studies and standardization efforts.

**Determination of Phytochemical Constituents**

Phytochemical screening of aqueous extracts of *Nagara Churna* indicated the presence of alkaloids, saponins, carbohydrates, proteins, steroids, tannins, and phenols. In *Sodhita Churna*, all constituents remained present

except phenols, which were absent in the ferric chloride test, suggesting a reduction in phenolic compounds due to purification. Flavonoids were not detected in either sample. Ginger naturally contains minimal flavonoids, and the *sodhana* process may have contributed to degradation of trace flavonoid compounds, resulting in an undetectable level during qualitative analysis.

Successive solvent extract analysis revealed that alkaloids were present in all solvent extracts (petroleum ether, cyclohexane, acetone, and alcohol) of both *churna* and *sodhita churna,* indicating their stability during purification. Flavonoids were absent in all extracts of both samples. Phenolic compounds were widely distributed across all extracts of *churna* but were absent in the petroleum ether and alcohol extracts of *sodhita churna*, though retained in cyclohexane and acetone extracts. Steroids were detected in the petroleum ether, cyclohexane, and acetone extracts of both samples but absent in alcohol extracts.

Overall, *sodhana* resulted in a selective decrease in phenolic constituents while retaining major phytochemical groups such as alkaloids, tannins, carbohydrates, proteins, steroids, and saponins. The phytochemical results for *Nagara Churna* align with earlier research, whereas this is the first scientific report on *Sodhita Nagara Churna*, contributing new information on how purification modifies its phytochemical profile

## CONCLUSION

The present study provides a comprehensive comparative evaluation of *Asodhita Nagara churna* and *Sodhita Nagara churna*, highlighting the chemical and qualitative changes brought about by the traditional *sodhana* process. Purification in lime water resulted in a marked reduction in total ash, acid-insoluble ash, water-insoluble ash, crude fibre, and hot water/alcohol-soluble extractives, indicating the effective removal of inorganic impurities, fibrous material, and pungent principles such as gingerols. The absence of volatile oil in *sodhita churna* further supports the classical purpose of *sodhana* in reducing *teekshnatva* and enhancing the tolerability of the drug. Although a general decrease in phenolic content was noted. Major phytochemical constituents including alkaloids, carbohydrates, tannins, proteins, saponins, and steroids were retained, confirming that essential therapeutic components remain intact. Extractive value analysis revealed that water-soluble constituents predominated in both samples, while *sodhita churna* consistently showed lower yields, reflecting selective leaching during purification. As this is the first scientific documentation of *Sodhita Nagara Churna*, the findings serve as valuable baseline data for future research and support the Ayurvedic rationale that *sodhana* modifies the physicochemical and phytochemical profile of *Nagara*, potentially improving its safety and therapeutic applicability.

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**Figure 1: Powder of dried rhizome of *Zingiber officinale* Rosc.**

**Figure 2: Powder of Purified dried rhizome of *Zingiber officinale* Rosc.**

**Table no. 1: Physicochemical Characteristics of *Asodhita churna* and *Sodhita churna* (powder and Purified Powder) of *Nagara* (Dried Rhizome of *Zingiber officinale* Rosc.)**

| Sl. No. | Parameters | *Asodhita churna* | *Sodhita churna* |
|---|---|---|---|
| 1. | Foreign matter | Nil | Nil |
| 2. | Total ash | 5.87% | 4.93% |
| 3. | Acid Insoluble Ash | 1.8% | 1.35% |
| 4. | Water Insoluble Ash | 3.62% | 2.56% |
| 5. | Moisture Content | 2% | 2% |
| 6. | Volatile oil | 2% | Nil |
| 7. | Crude fibre | 8.78% | 5.76% |
| 8. | Tannin Content | 1.31% | 1.04 % |

| | | | |
|---|---|---|---|
| 9. | Total sugar | 8% | 5.68% |
| 10. | Reducing sugar | 5.98% | 4.78 |
| 11. | Phenol | 2.1% | 1.09% |
| 12. | pH | 6.17 | 6.30 |

**Table No: 2 Qualitative analyses of ash of *Asodhita churna* and *Sodhita churna* (powder and purified powder) of *Nagara* (dried rhizome of *Zingiber officinale* Rosc.)**

| **Sl. No.** | **Experiment** | ***Asodhita churna*** | ***Sodhita churna*** |
|---|---|---|---|
| **Acid Radicals** | | | |
| 1. | Carbonate | + | + |
| 2. | Phosphate | + | + |
| 3. | Chloride | + | + |
| 4. | Sulphate | + | + |
| **Basic Radicals** | | | |
| 5. | Potassium | + | + |

**Table No: 3 Extractive values of *Asodhita churna* and *Sodhita churna* (powder and purified powder) of *Nagara* (dried rhizome of *Zingiber officinale* Rosc.)**

| **Sl. No.** | **Type of Extractives** | ***Asodhita churna*** | ***Sodhita churna*** |
|---|---|---|---|
| 1. | Cold water soluble | 16.13% | 15.30% |
| 2. | Hot water soluble | 22.3% | 21.1% |
| 3. | Cold alcohol soluble | 3.79% | 5.21% |
| 4. | Hot alcohol soluble | 12.86% | 10.06% |

**Table No: 4 Successive solvent extractives value of *Asodhita churna* and *Sodhita churna* (powder and purified powder) of *Nagara (dried rhizome of Zingiber officinale* Rosc.*)***

| **Sl. No.** | **Solvents** | ***Asodhita churna*** | ***Sodhita churna*** |
|---|---|---|---|
| 1. | Petroleum ether | 0.96% | 0.72% |
| 2. | Cyclohexane | 1.19% | 1.02 % |
| 3. | Acetone | 1.63% | 1.22% |
| 4. | Alcohol | 0.43% | 0.22% |

**Table No: 5 Qualitative phytochemical analysis of cold-water extract of *Asodhita churna* and *Sodhita churna* (powder and purified powder) of *Nagara (*dried rhizome of *Zingiber officinale* Rosc.*)***

| **Sl. No.** | **Experiment** | ***Asodhita churna*** | ***Sodhita churna*** |
|---|---|---|---|
| 1. | Test for Alkaloids | | |
| | Dragendroff's test | + | + |
| | Meyer's test | + | + |
| 2. | Test for flavonoids | - | - |
| 3. | Test for Saponins | + | + |

| | | | |
|---|---|---|---|
| 4. | Test for Carbohydrates | | |
| | Fehling's test | + | + |
| | Benedict's test | + | + |
| 5. | Test for proteins | + | + |
| 6. | Test for Phenols | | |
| | Ferric Chloride test | + | _ |
| | Lead Acetate test | + | + |
| 7. | Test for Steroids | + | + |
| 8. | Test for Tannins | | |
| | Ferric Chloride test | + | + |
| | Lead Acetate test | + | + |

**Table No: 6 Qualitative phytochemical analysis of successive solvent extracts of *Asodhita churna* (powder) of *Nagara (dried rhizome of Zingiber officinale* Rosc.*)***

| **Sl. No.** | **Experiment** | **Extracts** | | | |
|---|---|---|---|---|---|
| | | **Petroleum ether** | **Cyclohexane** | **Acetone** | **Alcohol** |
| 1. | Test for Alkaloids | | | | |
| | Dragendroff's test | + | + | + | + |
| | Meyer's test | + | + | - | + |
| 2. | Test for flavonoids | - | - | - | - |
| 3. | Test for Phenols | | | | |
| | Ferric Chloride test | + | + | + | + |
| | Lead Acetate test | + | + | + | + |
| 4. | Test for Steroids | + | + | + | - |

**Table No: 7 Qualitative Phytochemical Screening of Successive Solvent Extracts of *Sodhita churna* (Purified Powder) of *Nagara* (Dried Rhizome of *Zingiber officinale* Rosc.)**

| **Sl. No** | **Experiment** | **Extract** | | | |
|---|---|---|---|---|---|
| | | **Petroleum ether** | **Cyclohexane** | **Acetone** | **Alcohol** |
| 1. | Test for Alkaloids | | | | |
| | Dragendroff's test | + | + | + | + |
| | Meyer's test | + | + | - | + |
| 2. | Test for flavonoids | - | - | - | - |
| 3. | Test for Phenols | | | | |
| | Ferric Chloride test | - | + | + | - |
| | Lead Acetate test | + | + | + | - |
| 4. | Test for Steroids | + | + | + | - |