International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2024: 7.101

Analytical Study of Different Samples of Naveena Guda, Purana Guda, and Suryatapi Guda

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Abstract: ***Background: In Ayurveda, Guda (jaggery) is used both as a dietary sweetener and as a pharmaceutical base. Classical texts describe Naveena Guda (fresh jaggery) as Kaphakara and Agnimandyakara, whereas Purana Guda (aged jaggery) is considered Laghu, Anabhishyandi, and Hridya, making it therapeutically superior. However, procuring Purana Guda is difficult due to prolonged storage requirements and risk of contamination. Abhavaprakarana of Bhaishajya Ratnavali mentions that Suryatapi Guda (sun-exposed jaggery) attains properties similar to Purana Guda. This study aimed to analytically compare Naveena, Purana, and Suryatapi Guda to evaluate whether Suryatapi Guda can serve as a substitute for Purana Guda. Methods: Guda samples were collected from five districts of Karnataka and categorized into three groups: Naveena (fresh), Suryatapi (sun-exposed for 12 hours: 4 hours/day for 3 days), and Purana (stored for one year). Organoleptic evaluation and analytical assessment of physicochemical parameters (moisture, ash values, pH, extractive values, sugar profile), phytochemical constituents, and inorganic mineral content were performed. Statistical analysis included ANOVA/Kruskal–Wallis test, Mann–Whitney U test, and effect size (η^2) was done. Results: No significant differences were found for between Suryatapi and Purana Guda texture, fracture, alcohol-soluble extract, reducing and non-reducing sugars, and thermolabile phytochemicals. Significant differences were noted for taste, odour, moisture, water-soluble extract, total sugar, and minor minerals (Na, NO_3^-, Cl^-). Highly significant differences were observed for colour, total ash, acid-insoluble ash, pH, and major minerals (Ca, Mg, K, Fe, PO_4^{3-}, SO_4^{2-}). Conclusion: Suryatapi Guda demonstrates analytical characteristics comparable to Purana Guda in several key parameters and can be considered a suitable partial substitute when Purana Guda is unavailable.***

Keywords: Guda, jaggery, Naveena, Purana, Suryatapi, analytical study

1. Introduction

Ayurveda, the ancient Indian system of medicine, emphasizes a holistic approach to health through the maintenance of balance among body, mind, and spirit. Rooted in the Vedas and elaborated in classical treatises such as Charaka Samhita, Sushruta Samhita, and Ashtanga Hridaya, Ayurvedic pharmaceutics utilizes a wide range of substances derived from plant, mineral, and animal sources for both dietary and therapeutic purposes.[1,2,3]Within this system, the concept of Pratinidhi Dravya (substitute drugs) plays a vital role, enabling continuity of treatment when the primary drug (Pradhana Dravya) is unavailable, difficult to procure, or economically inaccessible.[1,4]

The principle of substitution is well documented in Ayurvedic texts, particularly under Abhava Pratinidhi Dravya described in Charaka Samhita, Sushruta Samhita, and Bhaishajya Ratnavali.[1,2,4] Selection of a substitute is governed by specific criteria, including similarity in Rasa (taste), Guna (qualities), Veerya (potency), and Vipaka (post-digestive effect), along with the ability to perform comparable Karma (therapeutic action). Availability and ease of procurement are also essential considerations, ensuring practical applicability without compromising therapeutic efficacy.[5]

Among commonly used Ayurvedic substances, Guda (jaggery) occupies a unique position due to its dual role as Ahara (diet), Aushadha (medicine), and Anupana (adjuvant). Prepared from sugarcane juice through boiling and solidification, Guda is not merely a sweetening agent but a nutritionally rich substance containing carbohydrates, essential minerals, vitamins, and bioactive compounds.[6] Classical texts describe Guda as pacifying Vata and Pitta doshas and recommend its use in conditions such as anemia, digestive disorders, and respiratory ailments.[1,5] It also serves as a base in several Ayurvedic formulations, particularly avaleha preparations.[4]

Ayurvedic literature classifies Guda based on age and processing. Naveena Guda (fresh jaggery) is characterized as moist, heavy, and potentially Kaphakara when consumed excessively. In contrast, Purana Guda (aged for at least one year) is described as lighter, drier, and therapeutically superior, possessing enhanced digestive and detoxifying properties.[1,5] However, the procurement of Purana Guda is often challenging

due to prolonged storage requirements and the risk of contamination or deterioration.[5]

To address this limitation, Ayurvedic pharmaceutics recognizes Suryatapi Guda, a processed form in which Naveena Guda is exposed to sunlight for approximately four yamas (12 hours) to simulate the properties of Purana Guda. Although not explicitly named in early classical texts, this practice is described in the Abhava Prakarana of Bhaishajya Ratnavali as a method to impart characteristics such as reduced moisture, improved stability, and enhanced therapeutic suitability.[4] The term Suryatapi denotes transformation through solar exposure, reflecting the Ayurvedic principle of modifying substances using natural elements.

Despite its practical importance, limited scientific evidence exists to validate whether Suryatapi Guda truly resembles Purana Guda in terms of physicochemical, phytochemical, and mineral composition. Establishing such equivalence is essential for ensuring standardization, quality control, and broader application in pharmaceutical formulations.

Therefore, the present study entitled "Analytical Study of Different Samples of Naveena Guda, Purana Guda, and Suryatapi Guda" was undertaken to comparatively evaluate their organoleptic, physicochemical, phytochemical, and inorganic parameters, with the objective of assessing the suitability of Suryatapi Guda as a substitute for Purana Guda.

2. Review of Literature

Guda

Guda (jaggery) is a classical Ayurvedic substance prepared by concentrating and solidifying the juice of Ikshu (Saccharum officinarum Linn.). Unlike refined sugar, Guda retains natural molasses, minerals, and phytoconstituents, making it both a nutritive sweetener (Ahara) and a medicinal substance (Aushadha).[1,5] In Ayurvedic pharmaceutics, Guda is extensively used as a base in formulations such as Avaleha, Modaka, Gutika, and Leha, and also serves as an Anupana (vehicle) to enhance drug palatability, stability, and bioavailability.[4]

Ayurvedic Properties (Rasapanchaka), According to classical texts, Guda predominantly possesses:Rasa (Taste): Madhura, Guna (Qualities): Guru, Snigdha, Virya (Potency): Sheeta, Vipaka (Post-digestive effect): Madhura, Dosha Karma: Pacifies Vata and Pitta while potentially aggravating Kapha if consumed in excess.[1,5]

These attributes explain its nourishing (Brimhana), strengthening (Balya), and rejuvenating effects. Therapeutically, Guda is indicated in Daurbalya (weakness), Pandu (anemia), Kasa (cough), Shwasa (dyspnea), Mutrakriccha (dysuria), and digestive disorders. Its mild laxative and demulcent action supports gastrointestinal health, while its calorific value makes it useful in conditions of fatigue and emaciation.

Types of Guda

Ayurvedic literature classifies Guda based on age and processing, recognizing significant differences in therapeutic suitability:[6,9]

1) Naveena Guda (Fresh Jaggery): Naveena Guda refers to freshly prepared jaggery with higher moisture content. It is described as Guru (heavy), Snigdha (unctuous), and Abhishyandi (tending to obstruct channels). Excessive consumption may aggravate Kapha and reduce digestive fire (Agnimandya). Although nutritionally rich, it is considered less suitable for medicinal preparations due to its poor shelf stability and potential to cause fermentation and microbial growth.[7.9]
2) Purana Guda (Aged Jaggery): Purana Guda is jaggery that has been stored for at least one year under proper conditions. Classical texts describe it as Laghu (light), Anabhishyandi (non-obstructive), Hridya (cardiotonic), and more conducive to digestion. The aging process reduces moisture, improves stability, and enhances therapeutic qualities, making Purana Guda the preferred form for pharmaceutical use. It is considered superior in disorders of Vata and Pitta, and in chronic conditions requiring sustained nourishment without metabolic burden.[6,8,9]
3) Suryatapi Guda (Sun-exposed Jaggery): Suryatapi Guda is a modified form of Naveena Guda obtained by exposing fresh jaggery to sunlight, traditionally for about four yamas (approximately 12 hours). Although not always explicitly named in early classics, its preparation is described in the Abhava Prakarana of Bhaishajya Ratnavali, where it is recommended as a practical substitute when Purana Guda is unavailable. Solar exposure reduces moisture content, improves texture, and alters physicochemical properties, thereby imparting characteristics similar to aged jaggery.[10]

From a pharmaceutics perspective, Guda acts as: A binding agent in solid formulations, preservative base that enhances shelf life, and bioavailability enhancer that improves drug absorption.[11]

Chemically, Guda contains sucrose, reducing sugars, minerals (Ca, Mg, K, Fe), organic acids, and minor phytoconstituents, all of which vary with processing and storage. Differences in moisture, ash values, pH, sugar profile, and mineral content influence its stability, therapeutic action, and suitability for medicinal use.[12,13]

3. Materials and Methods

Study Design

The present study was designed as a comparative analytical investigation to evaluate three forms of jaggery (Guda), namely Naveena Guda (fresh), Suryatapi Guda (sun-exposed) and Purana Guda (aged). The study comprised three phases:

a) Procurement of freshly prepared jaggery from five geographic locations,
b) Controlled preparation of Suryatapi and Purana Guda from the same source material, and

c) Systematic analytical evaluation through organoleptic, physicochemical, phytochemical, and inorganic parameters.

Collection and Authentication of Samples

Freshly prepared jaggery (Naveena Guda) was collected during the month of May from sugarcane farmers/manufacturers in five districts of Karnataka:

S1: Bidar, S2: Kalburgi, S3: Bengaluru, S4: Mandya, S5: Mysuru

All samples were authenticated by faculty members of the Department of Dravyaguna, Taranath Government Ayurvedic Medical College, Ballari.

Preparation of Trial Samples

Each freshly collected jaggery sample was divided into three equal portions for preparation of the study groups:

- Naveena Guda (N): One-third of each sample was retained in its original fresh state and subjected to immediate analysis.
- Suryatapi Guda (S): One-third portion of each sample was exposed to direct sunlight for a total of 12 hours, distributed as 4 hours per day for three consecutive days. The samples were placed in open trays under hygienic conditions, ensuring uniform exposure and protection from dust and moisture.
- Purana Guda (P): One-third portion of each sample was stored in airtight inert glass containers under shade at room temperature for one year to simulate traditional aging.

This resulted in 15 analytical samples: S1N–S5N, S1S–S5S, and S1P–S5P.

1) Analytical Evaluation

a) Organoleptic Evaluation

All samples were examined macroscopically for the following sensory parameters: Colour, Taste, Odour, Texture and Fracture. Observations were recorded by direct visual, tactile, and organoleptic assessment.

b) Physicochemical Evaluation

All physicochemical tests were conducted according to the standard operating procedures of the Ayurvedic Pharmacopoeia of India (API).

- Determination of Moisture Content (Loss on Drying)
- Determination of Total Ash
- Determination of Acid-Insoluble Ash
- Alcohol-Soluble Extractive Value
- Water-Soluble Extractive Value
- Determination of Sugar Profile: Reducing Sugars, Total Sugars and Non-reducing Sugars

c) Phytochemical Evaluation

- Secondary Metabolites: Ethanolic extracts were screened using standard qualitative tests to evaluate Alkaloids, Glycosides, Flavonoids, Triterpenoids, Saponins, Tannins, Phenols, Steroids and glycosides
- Primary Metabolites: Chemical tests were carried out for Carbohydrates, Reducing sugars, Starch, Proteins, Quinones

2) Inorganic Constituent Analysis

Ash of each sample was treated with 50% v/v HCl, filtered, and the filtrate was subjected to qualitative tests for mineral ions: Calcium, Magnesium, Sodium, Potassium, Iron, Sulphate, Phosphate, Chloride, Carbonate, Nitrate

Statistical Analysis

All analytical data were statistically analyzed using ANOVA/Kruskal–Wallis test, followed by Mann–Whitney U test for inter-group comparisons. Effect size (η^2) was calculated to determine the magnitude of differences among Naveena, Suryatapi, and Purana Guda.

4. Results

The analytical evaluation of Naveena, Suryatapi and Purana Guda was performed using organoleptic, physicochemical, phytochemical and inorganic parameters. Results are presented in terms of comparative similarity and difference among the three forms.

1) Organoleptic Characters

a) Naveena Guda: Light to deep dark brown colour, sweet taste, characteristic sugarcane odour, soft–sticky–moist texture and uneven, pliable fracture with moist interior.
b) Suryatapi Guda: Brown to deep darker brown colour, moderately sweet taste, pleasant caramel-like odour, moderately firm and slightly dry texture, and granular, uneven fracture.
c) Purana Guda: Dark to deep darker brown colour, sweet with slight bitterness, pleasant earthy odour, hard, brittle and non-sticky texture, and sharp-edged fracture with dry crystalline interior.

2) Physicochemical Parameters

a) Moisture Content (%)

Sample	Naveena	Suryatapi	Purana
S1	2.5	2.8	1.0
S2	2.5	3.0	1.5
S3	6.0	3.2	2.0
S4	2.5	2.9	2.5
S5	5.0	3.5	3.0

Naveena shows the highest moisture, Purana the lowest, and Suryatapi is intermediate. Moisture values of Suryatapi are closer to Purana.

b) Total Ash (%)

Sample	Naveena	Suryatapi	Purana
S1	1.85	2.0	1.0
S2	3.7	2.2	2.0
S3	3.5	2.5	2.5
S4	3.0	2.3	2.8
S5	2.5	2.8	3.0

Total ash values are comparable among Suryatapi and Purana, with only minor variation. Thus, overall inorganic residue is similar between Suryatapi and Purana Guda.

c) Acid-Insoluble Ash (%)

Sample	Naveena	Suryatapi	Purana
S1	0.5	0.6	0.5
S2	1.75	1.2	0.7
S3	1.2	1.0	0.9
S4	1.1	0.8	0.8
S5	1.75	1.0	1.0

Acid-insoluble ash decreases from Naveena → Suryatapi → Purana. Suryatapi and Purana show very similar values.

d) Alcohol-Soluble Extract (%)

Sample	Naveena	Suryatapi	Purana
S1	35.0	15.0	9.0
S2	32.0	14.0	14.0
S3	68.0	18.0	11.5
S4	42.0	16.0	12.0
S5	49.2	19.0	8.8

Alcohol-soluble components are highest in Naveena, markedly reduced in Suryatapi, and lowest in Purana. Suryatapi values are closer to Purana than Naveena.

e) Water-Soluble Extract (%)

Sample	Naveena	Suryatapi	Purana
S1	30.0	55.0	98.2
S2	43.0	60.0	95.0
S3	28.0	65.0	75.0
S4	38.0	62.0	70.0
S5	53.0	68.0	60.0

Water-soluble extract shows a clear increase from Naveena → Suryatapi → Purana. Suryatapi exhibits intermediate but closer similarity to Purana.

f) pH

Sample	Naveena	Suryatapi	Purana
S1	6.2	7.6	7.8
S2	6.0	7.5	8.2
S3	6.5	7.8	7.9
S4	6.1	7.9	8.5
S5	6.3	8.0	8.8

Naveena is slightly acidic, whereas Suryatapi and Purana are neutral to alkaline. The pH of Suryatapi is very close to Purana, demonstrating chemical similarity.

g) Sugar Profile (%)
Total Sugar

Sample	Naveena	Suryatapi	Purana
S1	64.0	69.0	71.55
S2	61.0	65.0	67.43
S3	60.0	62.0	65.37
S4	61.0	63.0	69.49
S5	70.0	73.0	79.80

Pattern: Purana > Suryatapi > Naveena

h) Reducing Sugar

Sample	Naveena	Suryatapi	Purana
S1	38.0	59.0	67.16
S2	37.0	53.0	64.56
S3	36.0	50.0	59.35
S4	38.0	52.0	59.35
S5	48.0	63.0	74.97

Pattern: Purana > Suryatapi > Naveena

i) Non-Reducing Sugar (Sucrose)

Sample	Naveena	Suryatapi	Purana
S1	26.0	10.0	4.39
S2	24.0	12.0	2.87
S3	24.0	12.0	6.02
S4	23.0	11.0	6.02
S5	22.0	10.0	4.86

Suryatapi consistently shows values closer to Purana, indicating that solar treatment mimics biochemical changes of aging.

3. Phytochemical Profile

Compound	Naveena	Suryatapi	Purana
Carbohydrates	+	+	+
Proteins	+	–	–
Saponins	+	+	+
Flavonoids	+	+	–
Terpenoids	+	+	–
Alkaloids	+	+	–
Phenols	+	+	–
Glycosides	–	+	–
Tannins	±	±	–
Starch	+	+	+

Suryatapi retains most phytochemicals found in Naveena, while Purana contains only carbohydrates, saponins and starch. Thus, Suryatapi is chemically intermediate, showing partial similarity to Purana.

4. Inorganic Mineral Profile

Element	Naveena	Suryatapi	Purana
Calcium	+	+	+
Magnesium	+	+	+
Potassium	+	+	±
Iron	+	+	+
Sulphate	+	+	±
Phosphate	±	±	±
Sodium	±	–	–
Chloride	±	–	–
Nitrate	±	±	–

Major minerals (Ca, Mg, K, Fe, SO_4^{2-}, PO_4^{3-}) are similar in Suryatapi and Purana, with only minor variation in Na, NO_3^- and Cl^-.

5. Discussion

Organoleptic Characteristics
Distinct yet progressive changes were observed across Naveena, Suryatapi and Purana Guda in colour, taste, odour, texture and fracture.

Colour gradually deepened from light brown (Naveena) to dark brown (Suryatapi) and deep dark brown (Purana), attributable to caramelization and Maillard reactions involving reducing sugars and amino acids. Ātapa initiated surface browning, while Kāla promoted internal uniformity.

Taste evolved from purely sweet (Naveena) to moderately sweet (Suryatapi) and slightly bitter (Purana), possibly due to oxidation and degradation of sugars into aldehydes and ketones. Odour changed from fresh sugarcane-like to caramel-like and then earthy, reflecting volatilization and oxidation of aromatic compounds.

Texture hardened progressively from soft and sticky to firm and brittle due to moisture loss and sugar crystallization. Fracture patterns similarly changed from pliable to granular and finally to sharp-edged crystalline.

Overall, Suryatapi Guda closely resembled Purana Guda in colour, odour, texture and fracture, though it retained slightly higher sweetness, indicating an intermediate stage of transformation (Madhyama Pāka Avasthā).

Physicochemical Parameters

Moisture Content
Moisture decreased from Naveena to Suryatapi and was lowest in Purana Guda. This reflects progressive dehydration through Ātapa (surface drying) and Kāla (gradual internal loss of bound water), corresponding to a shift from Snigdha to Rūkṣa Guna. Suryatapi and Purana Guda exhibited nearly similar moisture levels, supporting functional similarity.

Total Ash and Acid-Insoluble Ash
Total ash and acid-insoluble ash values were almost identical in Suryatapi and Purana samples. These parameters represent inorganic mineral content and refractory siliceous matter, which are chemically stable and unaffected by either sunlight or aging. This confirms that Ātapa and Kāla do not alter the mineral backbone of Guda, resulting in close comparability between Suryatapi and Purana.

Alcohol-Soluble Extract
Alcohol-soluble extract decreased from Naveena to Suryatapi and was lowest in Purana Guda. These extracts include volatile and semi-volatile phytoconstituents such as phenols, flavonoids and terpenoids. Ātapa likely induces mild volatilization and oxidation, while prolonged Kāla promotes further degradation and polymerization. Suryatapi Guda showed intermediate values, reinforcing its position as a partial substitute.

Water-Soluble Extract
A progressive change in water-soluble extract was observed from Naveena to Purana, with Suryatapi occupying an intermediate position. This may be attributed to oxidation, polymerization and mild caramelization of polar compounds such as sugars, tannins and mineral salts. Suryatapi Guda exhibited values closer to Purana, suggesting that solar exposure can replicate aging-induced changes.

pH
pH increased from mildly acidic in Naveena to neutral-alkaline in Suryatapi and Purana Guda. Reduction of organic acids and relative enrichment of alkaline mineral salts (especially potassium and calcium) during Ātapa and Kāla processing likely account for this shift. The small variation between Suryatapi and Purana indicates a similar acid–base equilibrium, relevant to improved stability and digestibility.

Sugar Profile
The transformation of sugars provides key biochemical evidence of aging.
Total Sugar: Purana > Suryatapi > Naveena
Increased total sugar in Purana reflects moisture loss, concentration of solids and gradual breakdown of complex carbohydrates into simpler sugars.
Reducing Sugar: Purana > Suryatapi > Naveena
Progressive hydrolysis of sucrose into glucose and fructose occurs under mild heat, sunlight and storage. Suryatapi shows partial inversion, while Purana exhibits the highest degree.
Non-Reducing Sugar (Sucrose): Naveena > Suryatapi > Purana
Decreasing sucrose content from Naveena to Purana confirms continued inversion during solar exposure and aging.
These trends demonstrate that Suryatapi Guda undergoes biochemical changes similar to Purana Guda, though to a lesser extent.

Phytochemical Profile
Naveena Guda showed the widest spectrum of phytochemicals, including proteins, flavonoids, phenols, terpenoids, tannins and glycosides, reflecting a fresh and chemically active matrix associated with Guru–Snigdha Guna.

Suryatapi Guda retained several stable phytochemicals while showing partial reduction of thermolabile compounds, indicating that solar heat enhances shelf life without complete loss of bioactive constituents.

Purana Guda retained mainly carbohydrates, saponins and starch, signifying degradation and polymerization of reactive molecules over time, resulting in a more inert and stable composition.

Thus, Suryatapi Guda represents a transitional chemical state, supporting uttarottara Laghu and Rūkṣa Guna from Naveena to Purana.

Inorganic Elements
Major minerals (calcium, magnesium, potassium, iron and phosphates) were consistently present across all samples. Minor ions such as sodium, chloride and sulphate showed variation.

Suryatapi Guda demonstrated mineral stabilization likely due to dehydration and reduction of volatile impurities, while Purana Guda exhibited further refinement, retaining essential stable elements. The mineral pattern of Suryatapi was largely comparable to Purana, supporting their functional equivalence.

Suryatapi Guda can be considered a suitable and partial substitute for Purana Guda, as it mimics most physicochemical and compositional changes produced by natural aging through controlled Ātapa saṃskāra. This offers a time-efficient, cost-effective and Ayurvedically justified method for preparing therapeutically appropriate Guda in modern pharmaceutical practice.

6. Conclusion

Suryatapi Guda is physically and chemically closer to Purana Guda than to Naveena Guda across most functional parameters. Although it does not replicate all phytochemical changes produced by long-term aging, Suryatapi Guda can be considered a suitable and partial substitute for Purana Guda in Ayurvedic pharmaceutical preparations when aged jaggery is unavailable.

7. Future Scope and Recommendations

Targeted phytochemical quantification: Quantitative estimation of key compounds (phenolics, flavonoids, alkaloids and glycosides) to map the kinetics of phytochemical loss during Ātapa and Kāla.

Controlled storage studies: Evaluation of samples stored under defined conditions (darkness, sunlight, controlled humidity and temperature) with time-course analysis (0, 1, 3, 6 months and 1 year).

Bioactivity correlation: Assessment of antioxidant, antimicrobial and anti-inflammatory activities to determine the clinical relevance of observed chemical changes.

8. Limitations

Sample size and representativeness: Analysis was limited to five samples per group; inclusion of larger datasets across seasons and geographical regions would improve generalizability.

Qualitative phytochemical screening: Presence/absence tests lack quantitative resolution; advanced analytical techniques (HPLC, LC-MS, GC-MS) are needed for precise profiling.

Storage condition variability: Environmental parameters such as humidity, temperature, container type and light exposure during aging were not fully standardized, which may influence the effects attributed to Kāla.

Acknowledgement
I would like to express my sincere gratitude to Dr. Sampat Kumar Bellamma Dept. of Dravyaguna TGAMC Ballari for his support, guidance, and encouragement. Special thanks to Praveen Kumar

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