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Pharmaceutico-Analytical study of lyophilized *Rasaala*: Comparative culinary science insights from *Bhavaprakasha* and *Kshemakutuhala*

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Abstract
Background: In *Ayurveda, Ahara* (food) is counted among the *Trayopastambhas*, the pillars on which life rests, and classical culinary works such as *Bhavaprakasha* and *Kshemakutuhala*, read together, give a fairly complete picture of Ayurvedic dietetics. *Rasaala* is one such preparation, a curd-based dairy dish mentioned in the *Krutanna Varga* of both texts; it is nutritious but does not keep well, which restricts how useful it can be today. The present work sets out to compare how the two texts approach culinary science and to apply freeze-drying (lyophilization) to the traditional *Rasaala* recipe so as to improve its stability and concentrate its nutritional value.
Methods: Following the *Bhavaprakasha* method, *Rasaala* was made from buffalo curd, sugar, and milk, along with a spice mix of *Ela*, *Lavanga*, *Maricha*, and *Karpura*. The batch was split into two portions: Sample A, kept in its classical, freshly prepared form, and Sample B, which was put through a 63-hour lyophilization cycle at around –74.6°C under a vacuum of 1 Pa. Both samples were then examined for proximate composition, mineral content, the vitamins B2, B5, and B12, microbial load, GC-MS profile, and stability over a two-month accelerated shelf-life trial.
Results: Moisture content dropped markedly after lyophilization, from 48.02% in Sample A to 6.28% in Sample B, which in turn concentrated the nutrients and pushed the energy value up from 216.13 kcal/100 g to 387.87 kcal/100 g. Carbohydrate, protein, fat, and mineral levels (calcium, sodium, potassium) rose in step, and the heat- and light-sensitive vitamins B2, B5, and B12 were largely preserved despite the process. The total aerobic microbial count fell steeply, from 6.3×10^5 CFU/g to 2.1×10^2 CFU/g, and across two months of both accelerated and refrigerated storage the freeze-dried product held its sensory qualities and microbial safety, with no sign of rancidity.
Conclusion: Taken together, the comparison shows that *Bhavaprakasha* and *Kshemakutuhala* complement one another, one leaning toward the therapeutic side of *Ayurvedic* culinary science and the other toward its technical craft. By subjecting *Rasaala* to lyophilization, the study arrived at a product that is stable, nutritionally concentrated, and microbiologically safe, illustrating *Samskara* as a route to value addition and pointing to a workable way of standardizing traditional Ayurvedic *Ahara Kalpanas* through modern food-processing methods.

Keywords: *Ayurveda*, *Rasaala*, culinary science, lyophilization, *Bhavaprakasha*, *Kshemakutuhala*, *Samskara*

Introduction

Ayurveda places *Ahara* (food) among the *Trayopastambhas*, the three supports of life, together with *Nidra* and *Brahmacharya.* It is through suitable food that the body is nourished and the *Doshas* kept in balance, and classical texts consistently stress not just what is eaten but how it is prepared, in what quantity, and whether it suits the individual. References to dietary substances, methods of preparation, and processing techniques appear again and again across *Ayurvedic* literature, which shows how central food is to both preventing and treating disease.

Beyond the core *Ayurvedic* classics, texts written specifically on Indian cooking, such as *Pakadarpana, Soopashastra*, *Bhojanakutuhalam*, and *Kshemakutuhalam,* hold detailed knowledge about ingredients, cooking methods, and how different foods were combined. *Kshemakutuhalam*, written by *Kshemasharma*, focuses almost entirely on culinary science and covers kitchen management, utensils, cooks, and numerous recipe variations under its *Krutanna Varga*. *Bhavamisra's Bhavaprakasha*, by contrast, treats food as part of a wider medical framework, discussing prepared dishes in its own *Krutanna Varga* mainly for their therapeutic and dietary value. Since the two texts date from roughly the same period, they lend themselves naturally to a comparative reading.

One preparation found in both texts is *Rasaala*, a dairy dish built mainly from curd, sugar, and aromatic spices, prized for its flavour and its reputed strength giving qualities. Because it carries so much moisture, though, it is meant to be eaten soon after preparation and spoils quickly, which makes it impractical for everyday modern use. Given that today's lifestyles favour foods that are convenient and keep well, there is room to apply suitable processing methods to such traditional preparations without losing what makes them distinctive.

Lyophilization, or freeze-drying, works by freezing the product and then lowering the pressure around it so that water leaves through sublimation rather than boiling, a low temperature route that spares heat sensitive nutrients while greatly extending shelf life. This study turns that technology on the classical *Bhavaprakasha* recipe for *Rasaala*, examining what changes in its nutritional composition, microbial safety, and shelf-life, and alongside this, builds a comparative picture of the culinary science set out in *Bhavaprakasha* and *Kshemakutuhala*.

AIM

To prepare, modify, and assess the nutritional value of *Rasaala*, with the help of modern food-processing technology.

Objectives

- To prepare Rasala as per *Bhavaprakasha* and lyophilised form.
- To evaluate the effect of lyophilization on the proximate, mineral, vitamin, microbial, and shelf-life characteristics of *Rasaala*.

Materials and Methods

1. Ingredients and Proportions (Bhavaprakasha method)

Table 1: Ingredients and proportions used for the preparation of Rasaala.

Ingredient	Form/Quality	Quantity
Mahisha Dadhi (buffalo curd)	Fresh, unadulterated	400 mL
Sita (sugar)	Powdered	200 g
Mahisha Dugdha (buffalo milk)	Boiled and cooled	~15 mL
Ela (Elettaria cardamomum)	Fine powder	4 g
Lavanga (Syzygium aromaticum)	Fine powder	4 g
Maricha (Piper nigrum)	Fine powder	4 g
Karpura (Cinnamomum camphora)	Fine powder	0.25 g

2. Procedure

2.1 Classical preparation (Sample A)

Fresh buffalo curd (400 mL) was suspended in muslin cloth for 10 hours to drain the whey, yielding a concentrated solid curd mass. Powdered sugar (200 g) was whisked into the curd until fully dissolved, followed by ~15 mL of boiled, cooled buffalo milk to impart a smooth, silky consistency. A finely powdered spice blend of *Ela*, *Lavanga*, *Maricha*, and *Karpura* was sprinkled in and whisked uniformly to obtain a homogeneous, lump-free paste. The preparation was divided into Sample A (retained fresh for analysis) and Sample B (subjected to lyophilization).

2.2 Lyophilization (Sample B)

- **Initial freezing:** Sample B was placed in lyophilizer trays and frozen to approximately –74.6°C to immobilize all water molecules.
- **Primary and secondary drying:** A vacuum pump was engaged to reach ~1 Pa, permitting sublimation of ice crystals.
- **Manual fragmentation:** At the 42-hour mark, the gummy sample was manually fragmented to increase surface area and release bound water.
- **Total cycle time:** The run was completed after 63 hours, yielding a brittle, bone-dry cake.
- **Pulverization and sieving:** The dried cake was pounded in a sterile mortar and sieved to a uniform particle size.
- **Storage:** The resulting powder was stored airtight, protected from light to preserve riboflavin (B2) and B12.

2.3 Analytical Study

Both samples were evaluated at an NABL-accredited, AYUSH-approved laboratory for: (i) proximate and nutritional composition — protein (Kjeldahl method), fat (Soxhlet extraction), moisture (loss on drying), total sugar (Lane-Eynon/Seliwanoff methods), carbohydrate (by difference) and energy (Atwater factors), following FSSAI Manual of Methods of Analysis of Foods; (ii) minerals — calcium, sodium, and potassium by flame photometry; (iii) vitamins — B2 (riboflavin), B5 (pantothenic acid), and B12 (cobalamin) by HPLC; (iv) microbial safety — total aerobic microbial count (IS 5402) and E. coli (IS 5887), with yeast and mould enumerated on acidified potato dextrose agar; (v) volatile and lipid constituents by GC-MS; and (vi) a two-month accelerated stability study under refrigerated (−20°C) and accelerated (40 ± 2°C, 75 ± 5% RH) conditions.

Process and Organoleptic Observations

During deep freezing, sample temperature reached −74.6°C with vacuum pressure maintained near 1 Pa and the material remaining fully frozen. At the 42-hour mark the sample exhibited a rubbery, gummy consistency attributed to bound water held by the high sugar matrix, prompting manual fragmentation to aid drying. In the terminal phase, sample temperature rose gradually from −10°C to 0°C, indicating onset of secondary drying; the material transformed from a gummy matrix into a brittle, porous structure with a clean snapping property, finally yielding a free-flowing, creamish-white granular product rather than a fine powder.

Analytical Results

Nutritional Composition

Table 2: Nutritional composition of Sample A and lyophilized Rasaala (Sample B).

Parameter	Sample A (Bhavaprakasha)	Sample B (Lyophilized)
Energy (kcal/100 g)	216.13	387.87
Total Carbohydrates (g/100 g)	44.02	78.90
Total Sugar (g/100 g)	4.71	8.93
Total Protein (g/100 g)	3.69	7.02
Total Fat (g/100 g)	2.81	4.91
Moisture (g/100 g)	48.02	6.28

Mineral Composition

Table 3: Mineral composition of Sample A and Sample B. Vitamin Content

Parameter	Sample A (Bhavaprakasha)	Sample B (Lyophilized)
Total Mineral Content (g/100 g)	1.46	2.89
Calcium (mg/100 g)	162.07	321.49
Sodium (mg/100 g)	43.82	86.70
Potassium (mg/100 g)	155.40	306.31

Table 4: Vitamin content (B2, B5, B12) of Sample A and Sample B.

Parameter	Sample A (Bhavaprakasha)	Sample B (Lyophilized)
Vitamin B2 – Riboflavin (mg/100 g)	0.12	0.22
Vitamin B5 – Pantothenic acid (mg/100 g)	0.26	0.45
Vitamin B12 – Cobalamin (mg/100 g)	0.33	0.58

Microbial Count

Table 5: Microbial parameters of Sample A and Sample B.

Parameter	Sample A (Bhavaprakasha)	Sample B (Lyophilized)
Total Aerobic Microbial Count (CFU/g)	6.3×10^5	2.1×10^2
Total Yeast & Mould Count (CFU/g)	8	<10

GC-MS – Principal Constituents

Table 6: Principal constituents of lyophilized Rasaala identified by GC-MS (major and moderate peaks).

Compound	Area %	CAS No.	Classification
Isoborneol	75.15	513-23-5	Major
Pentadecanoic acid, 14-methyl-, methyl ester	1.58	5129-60-2	Moderate
(+)-2-Bornanone (Camphor)	1.45	464-49-3	Moderate
Dodecanoic acid, but-3-enyl ester	1.59	0-00-0	Moderate
9,12-Octadecadienoic acid, methyl ester (E,E)-	1.30	2566-97-4	Moderate
9-Octadecenoic acid (Z)-, methyl ester	1.25	112-62-9	Moderate
α-Terpinyl acetate	1.18	80-26-2	Moderate
Dihydrocamphene	1.03	473-15-8	Moderate

Accelerated Shelf-Life Study (*Lyophilized Rasaala*)

Table 7: Shelf-life evaluation of the lyophilized Rasaala over two months.

Parameter	0 Month	2 Months (−20°C)	2 Months (40°C/75% RH)
Colour	Creamish white	Creamish white	Creamish white
Texture	Semi granules	Semi granules	Semi granules
Odour	Lactic smell	Lactic smell	Lactic smell
Total Sugar (%)	8.93	8.87	9.11
Total Protein (%)	7.02	7.03	6.87
Moisture (%)	4.91	4.88	5.02
Total Fat (%)	6.28	6.31	6.00
Rancidity	Not rancid	Not rancid	Not rancid
Total Aerobic Count (CFU/g)	2.1×10^2	1.7×10^2	1.9×10^2
Yeast & Mould (CFU/g)	<10	<10	<10
E. coli	<10	<10	<10

Discussion

Comparative culinary science of *Bhavaprakasha* and *Kshemakutuhala*

Bhavaprakasha situates *Rasaala* within a broader medical framework, giving a single fixed recipe emphasizing therapeutic and dietary relevance, whereas *Kshemakutuhala*, a text devoted specifically to culinary science, records several variations, including honey- and ghee-enriched forms such as *Mochaphala Rasaala*. This reflects two complementary dimensions of classical Indian food science: *Bhavaprakasha* approaches food from a therapeutic and dietetic standpoint, while *Kshemakutuhala* approaches it from a technical, kitchen-science standpoint encompassing utensils, hygiene, and recipe diversity. The *Bhavaprakasha* formulation, being comparatively simple and free of lipid-rich additions such as ghee and honey, was selected for lyophilization owing to its greater expected stability and reproducibility during processing and analysis.

Effect of lyophilization on nutritional composition

Moisture fell from 48.02% to 6.28%, a reduction of 41.74 percentage points, which is the principal driver of the parallel rise seen across every other proximate parameter. As water is removed, the remaining solids become proportionally concentrated: carbohydrate rose from 44.02 to 78.90 g/100 g, protein from 3.69 to 7.02 g/100 g, fat from 2.81 to 4.91 g/100 g, and energy density nearly doubled from 216.13 to 387.87 kcal/100 g. The same concentration effect explains the higher calcium, sodium, and potassium values in Sample B. Vitamins B2, B5, and B12, despite their known heat- and light-lability, were well retained and appeared more concentrated on a per-100 g basis, indicating that the low sublimation temperature of lyophilization is comparatively protective of these micronutrients relative to conventional heat-based drying.

Microbial safety and stability

The steep fall in total aerobic microbial count, from 6.3×10^5 CFU/g in the fresh preparation to 2.1×10^2 CFU/g after lyophilization, corresponds directly to the drastic reduction in water activity that accompanies moisture removal, since most spoilage organisms require free water to proliferate. Over the two-month accelerated stability study, colour, texture, odour, sugar, protein, fat, and moisture all remained within a narrow range, no rancidity developed, and yeast, mould, and E. coli counts stayed below detectable thresholds throughout, indicating that the lyophilized product is both physically and microbiologically stable under both refrigerated and accelerated storage conditions.

GC-MS profile

The chromatographic profile of the lyophilized *Rasaala* was dominated by isoborneol (75.15% area), a terpene alcohol with a characteristic woody, camphor-like note, consistent with the camphor (Karpura) included in the spice blend. Related bicyclic terpenoids such as camphor (Bornanone) and dihydrocamphene appeared as minor co-occurring constituents, while a background of long-chain fatty-acid methyl esters reflects the lipid fraction of the curd and milk base.

Ayurvedic relevance – Samskara

From an Ayurvedic standpoint, lyophilization may be understood as a form of *Samskara*, a processing method that alters the physical form and concentrates the qualities of a substance while preserving its essential composition and identity. The transformation of *Rasaala* from a moist, short shelf-life preparation into a stable, nutrient-dense, ready-to-reconstitute product exemplifies how a modern industrial process can be interpreted within, and validated by, this classical framework, offering a practical route for the value addition and standardization of traditional *Ahara Kalpanas*.

Conclusion

The comparative literary study confirms that *Bhavaprakasha* and *Kshemakutuhala* offer complementary perspectives on Ayurvedic culinary science, the former emphasizing the dietary and therapeutic significance of prepared foods and the latter detailing culinary technique, kitchen science, and recipe variation. Among the formulations common to both texts, the comparatively simple *Bhavaprakasha* recipe for *Rasaala* was selected for practical modification. Lyophilization converted this moisture-rich, short-shelf-life preparation into a stable, nutrient-concentrated, microbiologically safe dried product without loss of its essential composition, remaining stable across a two-month accelerated shelf-life study. The work demonstrates that classical *Ahara Kalpanas* can be prepared, modified, and analysed using contemporary analytical and processing technologies, reaffirming the relevance of the Ayurvedic concept of *Samskara* and providing a practical pathway for the preservation, standardization, and value addition of traditional Ayurvedic diets.

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