Design, Development, and Evaluation of a Fermented Rice Water-Based Cosmeceutical Shampoo Enriched with Herbal Bio actives

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***Abstract*—Consumer preferences towards natural and sustainable cosmetics have encouraged research on the development of bio actives from traditional medicines. Fermented rice water, which is an extract of *Oryza sativa* obtained via the fermentation process, has been receiving much attention in cosmetics because of its high content of amino acids, vitamins, minerals, antioxidants, phenolics, and inositol. Fermentation increases the bioavailability of these components, and hence may enhance their efficacy as cosmeceuticals. The main objective of this project was the design and development of a shampoo containing fermented rice water along with other herbal bio actives for use in hair cleansing and conditioning. Fermented rice water has been known to have antioxidant effects and excellent hair conditioning abilities, where inositol has been identified as one of the important components that minimize hair damage.**

***Index Terms*—Fermented rice water, Oryza sativa, Cosmeceutical shampoo, Phytochemical screening, Inositol**

I. INTRODUCTION

Hair serves an important protective and aesthetic function. Increasing exposure to environmental pollutants, chemical treatments, and nutritional deficiencies contributes to hair damage, scalp disorders, and excessive hair shedding. Consequently, consumer preference has shifted toward natural and plant-based cosmetic products. [1]

Fermented rice water has traditionally been used in East Asian countries for hair care. Fermentation increases the concentration and bioavailability of beneficial compounds such as amino acids, vitamins, antioxidants, and inositol. [2] Inositol has been reported to penetrate damaged hair shafts and reduce friction between hair fibers, thereby minimizing breakage and improving hair appearance. Experimental studies on fermented rice water shampoos have reported favorable cleansing, foaming, and conditioning properties. [3]

However, limited scientific literature exists regarding the formulation optimization and comprehensive evaluation of fermented rice water-based cosmeceutical shampoos. Therefore, the present investigation was undertaken to formulate and evaluate a stable herbal shampoo incorporating fermented rice water and selected herbal extracts. [4]

A. Rice Grains (*Oryza sativa* L.)

Oryza sativa L. (Family: Poaceae) is one of the most widely cultivated cereal crops worldwide. Rice grains are rich in carbohydrates, proteins, amino acids, vitamins, minerals, and bioactive compounds such as inositol and phenolic antioxidants. Fermented rice water obtained from rice grains has traditionally been used in hair care owing to its potential conditioning, moisturizing, and hair-strengthening properties. The fermentation process enhances the availability of beneficial metabolites, making rice water a promising ingredient in cosmeceutical formulations.

B. Aloe Vera (*Aloe vera* (L.) Burm.f.)

Aloe vera (Family: Asphodelaceae) is a succulent medicinal plant extensively used in cosmetic and pharmaceutical preparations. The leaf gel contains polysaccharides, vitamins, amino acids, enzymes, minerals, and antioxidants. Aloe vera is known for its moisturizing, soothing, anti-inflammatory, and scalp-

conditioning properties. In hair-care formulations, it helps maintain scalp hydration, reduce irritation, and improve hair softness and manageability.

C. Hibiscus (*Hibiscus rosa-sinensis* L.)
Hibiscus rosa-sinensis L. (Family: Malvaceae) is a flowering shrub traditionally used for promoting hair growth and maintaining scalp health. The flowers and leaves contain flavonoids, anthocyanins, tannins, mucilage, and phenolic compounds. Hibiscus is valued for its antioxidant, conditioning, and nourishing properties and is widely incorporated into herbal shampoos, hair oils, and hair masks to improve hair texture and reduce breakage.

D. Fenugreek (*Trigonella foenum-graecum* L.)
Trigonella foenum-graecum L. (Family: Fabaceae), commonly known as fenugreek, is an annual medicinal herb whose seeds are rich in proteins, amino acids, saponins, alkaloids, flavonoids, and dietary fiber. Fenugreek seeds are traditionally used in hair-care preparations due to their conditioning and moisturizing effects. The presence of mucilage and bioactive compounds helps strengthen hair fibers, improve hair texture, and support overall scalp health.

E. Flax Seeds (*Linum usitatissimum* L.)
Linum usitatissimum L. (Family: Linaceae), commonly known as flax or linseed, is an annual herbaceous plant cultivated for its nutrient-rich seeds. Flax seeds are an excellent source of omega-3 fatty acids (α-linolenic acid), proteins, mucilage, lignans, dietary fiber, vitamins, and phenolic compounds. Due to their high mucilage content, flax seeds form a natural gel when hydrated, making them particularly useful in hair-care formulations such as shampoos, conditioners, serums, and hair gels.

II. MATERIALS AND METHODS

A. Materials
Rice grains (*Oryza sativa*), *Aloe vera* extract, *Hibiscus rosa-sinensis* extract, Fenugreek seed extract, Flax seeds, Sodium benzoate, Citric acid, and distilled water were used.

B. Preparation of Fermented Rice Water
One hundred grams of rice grains were washed and soaked in 300 mL distilled water for 24 h. The soaking medium was filtered and incubated at room temperature (28 ± 2°C) for 72 h to facilitate natural fermentation. The fermented liquid was refrigerated until further use.

C. Formulation of Shampoo (Optimized formula 100mL)

S/n	Ingredients	Quantity in (%)
1.	Fermented rice water	30%
2.	Flax seeds	9%
3.	Aloe vera extract	5%
4.	Hibiscus extract	3%
5.	Fenugreek extract	2%
6.	Sodium benzoate	0.5%
7.	Citric acid	q.s.
8.	Purified water	up to 100%

Fig.1 Fermented Rice water polyherbal Shampoo

D. Evaluation Parameters
- Appearance and homogeneity
- pH determination
- Viscosity measurement
- Surface tension determination
- Foam volume and foam stability
- Wetting time
- Dirt dispersion test
- Percentage solid content
- Conditioning performance
- Stability study

E. Preliminary Phytochemical Screening

Standard qualitative tests were performed for: Alkaloids, Flavonoids, Phenolic compounds, Tannins, Saponins, Terpenoids, Steroids, Glycosides, Steroids, Proteins, Amino acids, Carbohydrates.

III.RESULTS

Table 1. Organoleptic Evaluation

Parameter	Observation
Appearance	Smooth and homogeneous
Color	Pale golden brown
Odor	Mild herbal-fermented aroma
Texture	Viscous liquid
Phase separation	Absent

Table 2. Physicochemical Evaluation

Parameter	Result
pH	5.72 ± 0.06
Viscosity (cP)	4324 ± 85
Surface tension (dynes/cm)	33.4 ± 1.1
Specific gravity	1.024 ± 0.004
Solid content (%)	25.4 ± 0.9

Table 3. Performance Evaluation

Parameter	Result
Foam volume (mL)	164 ± 4
Foam stability (%)	94.5 ± 1.8
Wetting time (s)	11.6 ± 0.8
Dirt dispersion	Excellent
Cleansing ability	Good
Conditioning effect	Good

Table 4. Accelerated Stability Study

Condition	0 Month	3 Months
4°C	Stable	Stable
25°C	Stable	Stable
40°C	Stable	Slight viscosity reduction

No phase separation, microbial growth, or significant pH variation was observed.

Table 5. Phytochemical Screening Test

Sr. No.	Phytochemical Constituent	Test Performed	Observation	Result
1	Alkaloids	Mayer's Test	Cream-colored precipitate	+
2	Alkaloids	Dragendorff's Test	Orange precipitate	+
3	Flavonoids	Shinoda Test	Pink/Red coloration	+++
4	Flavonoids	Alkaline Reagent Test	Intense yellow color	+++
5	Phenolic Compounds	Ferric Chloride Test	Deep blue-green color	+++
6	Tannins	Ferric Chloride Test	Greenish-black color	++
7	Saponins	Foam Test	Persistent froth formation	++
8	Glycosides	Keller-Killiani Test	Brown ring at interface	++
9	Steroids	Salkowski Test	Reddish-brown ring	+
10	Terpenoids	Liebermann-Burchard Test	Green coloration	++
11	Proteins	Biuret Test	Violet coloration	++
12	Amino Acids	Ninhydrin Test	Purple coloration	+++
13	Carbohydrates	Molisch Test	Violet ring formation	+++

IV.DISCUSSION

The formulated shampoo demonstrated physicochemical properties comparable to commercial herbal shampoos. The pH value of 5.72 was within the ideal range for scalp compatibility and minimized cuticular damage. Surface tension reduction indicated effective cleansing performance.

The foam volume and stability obtained in the present study suggest adequate surfactant performance and consumer acceptability. Fermented rice water contributed conditioning effects owing to the presence of inositol and amino acids. Previous investigations have reported that fermented rice water contains higher antioxidant levels than non-fermented rice water and improves hair manageability and strength.

Scientific reviews indicate that rice water may improve elasticity, reduce friction, and decrease breakage through deposition of inositol on the hair shaft, although robust clinical evidence for direct stimulation of hair growth remains limited.

The incorporation of Flax seeds, Aloe vera, Hibiscus, and Fenugreek extracts further enhanced conditioning, moisturization, and antioxidant activity. The accelerated stability study confirmed the physical and chemical stability of the formulation under various storage conditions.

Phytochemical screening of the optimized fermented rice water shampoo revealed the presence of flavonoids, phenolic compounds, amino acids, carbohydrates, proteins, tannins, saponins, glycosides, terpenoids, steroids, and alkaloids. Strong positive reactions were observed for flavonoids, phenolics, amino acids, and carbohydrates, indicating that fermentation enhanced the availability of these bioactive constituents. The presence of these phytochemicals may contribute to the antioxidant, conditioning, and scalp-protective properties of the developed cosmeceutical shampoo.

V. CONCLUSION

A stable and effective fermented rice water-based cosmeceutical shampoo was successfully developed and evaluated. The optimized formulation demonstrated desirable physicochemical properties, satisfactory cleansing efficiency, excellent foaming characteristics, and good stability. The study supports the utilization of fermented rice water as a promising natural cosmeceutical ingredient for modern hair care formulations. Further clinical investigations involving human volunteers are recommended to establish long-term efficacy and consumer benefits.

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