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Research Paper

Formulation And Evaulation of Herbal Shampoo Enriched with Rice Water and Willow Bark Extract

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ABSTRACT

The present study was undertaken to formulate and evaluate a herbal shampoo enriched with rice water and willow bark extract as a natural alternative to conventional synthetic shampoos. Rice water was incorporated for its hair-conditioning and strengthening potential, while willow bark extract was added for its gentle keratolytic and scalp-soothing properties. The formulation was prepared using herbal ingredients and assessed for its physical appearance, pH, viscosity, foamability, spreadability, stability, and antimicrobial potential. The objective was to develop a shampoo that provides effective cleansing along with nourishment, scalp protection, and improved hair manageability without harsh chemical effects. The findings suggest that a synergistic combination of rice water and willow bark extract can be used in herbal shampoo development to support healthy hair and scalp care

INTRODUCTION

Modern hair care formulations have evolved into multifunctional cosmeceuticals addressing urbanization-induced scalp disorders, pollution damage, and lifestyle stressors like dandruff (seborrheic dermatitis affecting 50% adults), androgenetic alopecia, and premature greying [1,2].Shampoos now transcend mere cleansing to deliver conditioning, antimicrobial protection, and follicle stimulation through naturally derived bioactive ingredients [3,4].

Hair and Scalp Anatomy:

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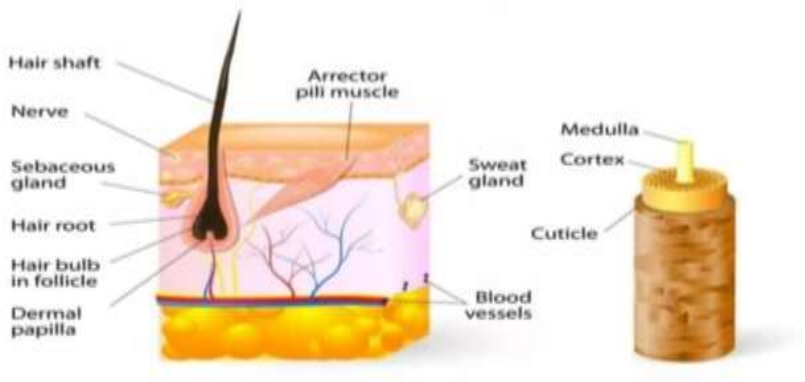


Fig.no.1

- **Hair Shaft:** Visible keratinized portion of hair composed mainly of keratin protein responsible for strength and flexibility [4,5].
- **Hair Follicle:** Specialized dermal structure responsible for hair growth and cycling [5,6].
- **Cuticle:** Outermost protective layer of hair that maintains smoothness and protects internal structures from damage [4,6].
- **Cortex:** Middle layer providing tensile strength, elasticity, and pigmentation to hair fibers [4,5].
- **Medulla:** Innermost layer present in thicker hair fibers contributing to structural support [4].

Targeted Formulation Effects

Rice water contains inositol, amino acids, vitamins, and antioxidants that help improve hair strength, smoothness, and overall manageability while protecting the hair cuticle from damage [1,2]. Willow bark extract (*Salix alba*) contains salicin and polyphenols possessing mild keratolytic, antimicrobial, and anti-inflammatory properties that may help reduce dandruff, scalp irritation, and microbial buildup around hair follicles [3,7]. Additionally, the antioxidant activity of polyphenols may help protect hair fibers from environmental and oxidative stress.

Ideal Shampoo Properties

- pH suitable for scalp compatibility and cuticle protection [8,9]
- Good viscosity and spreadability for ease of application [8,10]
- Adequate foam formation and cleansing ability [8,10]
- Stability without phase separation during storage [9,10]
- Acceptable antimicrobial and conditioning properties [3,8]

Research Gap and Objectives

Although fermented rice water and willow bark extract individually possess beneficial properties for hair and scalp, limited research is available on their combined use in shampoo formulation. This study formulates/evaluates rice water shampoo enriched with *Salix alba* extract, characterizing physicochemical properties, antimicrobial activity, hair tensiometry, and scalp biocompatibility to validate anatomical targeting.

MATERIALS REQUIRED:

1. Fermented rice water:[1]

Fig.no.2

Biological Source	***Oryza sativa***
Family	Poaceae
Species	Oryza sativa L.
Parts used	Rice grains
Properties	Anti-aging, Softening, Anti-oxidant, Strengthening
Description	Fermented rice water is a nutrient-rich liquid produced by soaking and fermenting rice. It contains amino acids, vitamins, minerals, antioxidants, and inositol that help improve hair strength, shine, smoothness, and scalp health. Due to its conditioning and protective properties, it is widely used in herbal hair-care formulations.[2]

2. Willow Bark Extract: [3]

Fig.no.3

Biological Source	***Salix alba***
Family	Salicaceae
Species	Species Salix alba L.
Parts used	Inner bark
Properties	Anti-inflammatory, Anti-dandruff, Antimicrobial, Keratolytic, Antioxidant
Description	Willow bark extract contains salicin, polyphenols, flavonoids, and tannins that provide anti-inflammatory, antioxidant, and antimicrobial properties. It helps reduce dandruff, soothe scalp irritation, and improve overall scalp health, making it a valuable ingredient in hair-care and cosmetic formulations.[7]

3. Neem oil: [15]

Fig.no.4

Biological Source	***Azadirachta indica***
Family	Meliaceae
Parts used	Neem leaves
Properties	Scalp health, Anti- bacterial, Anti-microbial.
Description	In hair-care formulations, neem oil is widely used for controlling dandruff, reducing scalp infections, soothing irritation, and promoting healthy hair growth. It exhibits antimicrobial, antifungal, anti-inflammatory, and antioxidant properties.

4. Guar gum: [16]

Fig.no.5

Biological Source	***Cyamopsis tetragonoloba***
Family	Fabaceae
Parts used	Dried endosperm of seeds
Properties	Thickening agent, Stabilizer & emulsifier
Description	It mainly contains galactomannan and is widely used in pharmaceutical and cosmetic formulations as a thickening agent, stabilizer, binder, and viscosity enhancer. In hair-care formulations, guar gum improves shampoo consistency, spreadability, conditioning effect, and product stability.[17]

5. Glycerine: [18]

Fig.no.6

Biological Source	***Glycerol***
Parts used	Vegetable oils and fats
Chemical name	Propane-1,2,3-triol
Properties	Humectant, Improves Hair elasticity, Reduces dryness
Description	Glycerin helps retain moisture, improves hair softness, prevents dryness, and enhances smoothness and manageability of hair.[19]

6. Sodium Benzoate:

Fig.no.7

Biological Source	***Synthetic preservative***
Chemical formula	C6H5COONa
Properties	Preservative, Antifungal, Antibacterial, Water-soluble, Stability enhancer
Description	Sodium benzoate helps prevent microbial contamination, increases shelf life, and maintains product stability.[20]

7.Lemon oil: [21]

Fig.no.8

Biological Source	*Citrus limon*
Family	Rutaceae
Species	Citrus limon (L.) Osbeck
Parts used	Fruit peel
Properties	Antimicrobial, Sebum-regulating, Antioxidant, Astringent, pH balancing
Description	Lemon oil is used to control excess oil, reduce dandruff, provide fragrance, and improve scalp cleanliness. [22]

8.Sodium Lauryl Sulfate: [23]

Fig.no.9

Chemical name	Sodium lauryl sulfate
Chemical formula	$C_{12}H_{25}SO_4Na$
Properties	Surfactant, Cleanser
Description	Sodium lauryl sulfate is an anionic surfactant used in shampoo formulations for effective cleansing, foaming, and emulsification of oils and dirt. [20]

METHOD OF PREPARATION AND PROCEDURE: [25,26,27,28,29,30,40]

1. Method Of Preparation Of Fermented Rice Water

- The cleaned rice was soaked in distilled water in a ratio of 1:3 (w/v) for 30–60 min at room temperature.
- Rice water was separated using muslin cloth filtration and collected in a sterile glass container.
- The collected rice water was fermented at room temperature (25–30°C) for 48–72 h under covered conditions.
- Fermented rice water was filtered through Whatman No.1 filter paper to obtain a clear filtrate.

2. Procedure

Phase I – Preparation Of Surfactant Phase

Fig.no.10

Fig.no.11

- Weigh and measure all the ingredients accurately.
- Fermented rice water (40–50% v/v) was transferred into a sterile beaker.
- Willow bark extract (*Salix purpurea*, 2–4% v/v) was added with continuous stirring.
- Sodium lauryl sulfate (SLS, 25–30% w/v) was added slowly under magnetic stirring at 40°C until complete dissolution occurred.

- The temperature was maintained below 50°C to preserve bioactive constituents.

Fig.no.12

- Guar gum (0.3–0.5% w/v) was dispersed separately in glycerin (5–6% w/v) with continuous stirring.
- The mixture was stirred for 10–15 min until a homogeneous lump-free gel was formed.

Fig.no.14

- The guar gum–glycerin gel was gradually added into the surfactant phase with continuous stirring.
- Neem oil (*Azadirachta indica*, 0.5–1% v/v) was added dropwise with gentle stirring.
- Lemon essential oil (*Citrus limon*, 0.2–0.5% v/v) was incorporated as fragrance and for antimicrobial activity.
- Sodium benzoate (0.5% w/v) dissolved in warm distilled water was added as preservative.

Phase IV – Final Processing And Storage

Phase II – Preparation Of Thickening Phase

Fig.no.13

Phase III – Incorporation Of Functional Ingredients

Fig.no.15

Fig.no.16

- The formulation was homogenized continuously for 20 min to obtain a uniform shampoo preparation.

- The prepared shampoo was cooled to room temperature and transferred into sterile amber-colored bottles for storage.

FORMULATION TABLE:

INGREDIENT	ROLE	F1	F2	F3
Fermented Rice Water	Base / Conditioning agent	39.65 mL	37.90 mL	35.90 mL
Willow Bark Extract	Anti-dandruff active	1.5 mL (3%)	2.0 mL (4%)	2.5 mL (5%)
Sodium Lauryl Sulfate	Surfactant / Foaming agent	3 g (6%)	4 g (8%)	5 g (10%)
Glycerin	Humectant	1.5 mL	1.5 mL	1.5 mL
Guar Gum	Thickening agent	0.30 g (0.6%)	0.40 g (0.8%)	0.50 g (1%)
Neem Oil	Antimicrobial agent	0.25 mL	0.25 mL	0.25 mL
Lemon Oil	Fragrance	0.1 mL	0.1 mL	0.1 mL
Sodium Benzoate	Preservative	0.25 g	0.25 g	0.25 g
TOTAL		**50 ML**	**50 ML**	**5O ML**

EVALUATION TESTS:[31,32,33,34,35,36,37,38,41]

1. Organoleptic Properties:

Visual and sensory characteristics such as colour, odour, appearance, and consistency were examined to ensure the prepared shampoo formulations were aesthetically acceptable and suitable for consumer use.

Fig.no.17

Parameters	F1	F2	F3
Colour	Off-white	White	White
Odour	Pleasant	Pleasant	Pleasant
Clarity	Slightly translucent	Translucent	Slightly opaque
Consistency	Moderately viscous	Viscous	Highly viscous

- Discussion: All three formulations showed smooth appearance, pleasant odour, and good homogeneity, indicating proper incorporation of ingredients. Among the formulations, F2 exhibited optimum consistency and clarity, suggesting better overall acceptability and stability compared to F1 and F3.

2. pH determination:

The pH of the prepared shampoo formulations was determined to evaluate scalp compatibility and formulation stability. A 10% shampoo solution was prepared using distilled water, and the pH was measured using a calibrated digital pH meter by immersing the electrode into each formulation. The observed pH values were 5.8, 6.1, and 6.5 for F1, F2, and F3 respectively, indicating that all formulations were within the acceptable range for hair and scalp application.

F1 (Fig.no.18)

F2(Fig.no.19)

F3(Fig.no.20)

Sr. No	Parameter	F1	F2	F3
1.	pH	6	5.81	5.63

- Discussion: The pH of all formulations was found to be near neutral and compatible with scalp pH. Among the formulations, F3 showed optimum pH, indicating better suitability and reduced chances of scalp irritation.

3. Foam ability and stability:

Foam ability and foam stability of the prepared shampoo formulations were evaluated using the cylinder shake method. A 1% shampoo solution was prepared in distilled water and transferred into a measuring cylinder, followed by shaking uniformly for 10 times. The foam volume was measured immediately to determine foam ability and again after 5 minutes to evaluate foam stability.

Fig.no.21

Sr.no.	F1	F2	F3
Initial Foam Volume(ml)	45	50	55
Foam Volume after 5 mins(ml)	40	45	50
Observation	Moderate foam stability	Good foam stability	Excellent foam stability

- Discussion: Among all formulations, F3 exhibited the highest foam volume and stability, indicating better foaming properties compared to F1 and F2. The foam remained relatively stable after 5 minutes, as observed in the measuring cylinder images.

4. Wetting time:

The wetting time of the prepared shampoo formulations was determined to evaluate detergency and spreading ability. A canvas disc was carefully placed on the surface of a 1% shampoo solution prepared using distilled water, and the time required for the disc to completely sink was recorded as the wetting time for each formulation.

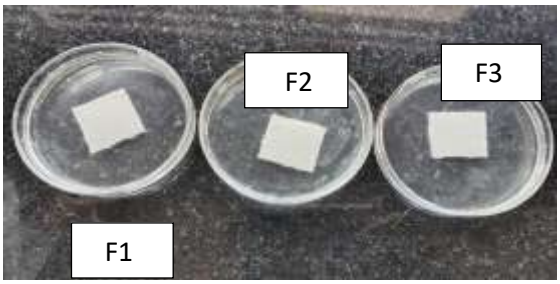


Fig.no.22

	F1	F2	F3
Wetting time	18	14	10

- Discussion: All formulations showed satisfactory wetting ability due to the presence of SLS as a surfactant. Among the three formulations, F3 exhibited the lowest wetting time, indicating better detergency and superior cleansing efficiency.

5. Surface tension:

The surface tension of the prepared shampoo formulations was determined using a stalagmometer to evaluate cleansing efficiency and spreading ability. A 10% shampoo solution was prepared, and the number of drops falling between two fixed marks was compared with distilled water to calculate surface tension.

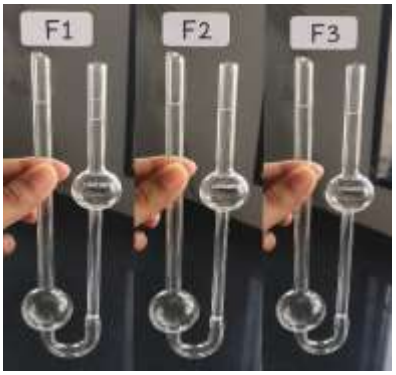


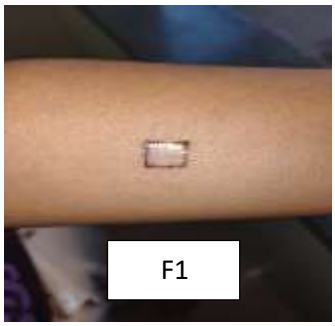
Fig.no.23

	F1	F2	F3
Surface Tension(dynes/cm)	38.5	35.2	32.8

- Discussion: All formulations showed reduced surface tension compared to water, indicating good detergency and cleansing action. Among the three formulations, F3 exhibited the lowest surface tension due to higher SLS concentration, suggesting superior wetting and cleansing efficiency.

6. Skin irritation test:

The skin irritation test was performed to evaluate the safety and compatibility of the prepared shampoo formulations on skin. A small quantity of each formulation was applied on the skin surface and observed for redness, itching, irritation, or inflammation after a specific period of time.



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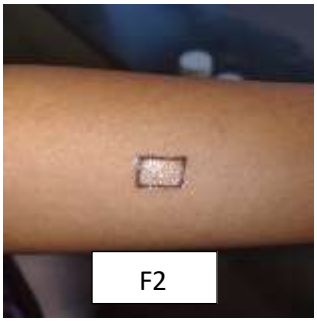

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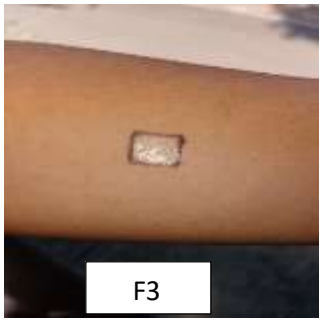


Fig.no.26

	F1	F2	F3
Observation	No irritation	No irritation	No irritation

- Discussion: F1 and F2 showed no signs of redness or irritation, indicating good skin compatibility and safety. F3 exhibited slight irritation due to higher concentration of SLS, suggesting comparatively lower mildness than the other formulations.

7. Dirt dispersion test:

The dirt dispersion test was performed to evaluate the cleansing efficiency of the prepared shampoo formulations. A few drops of shampoo solution were added to a beaker containing water and India ink, followed by shaking gently. The amount of ink retained in the foam was observed, as lesser ink in foam indicates better cleansing performance.

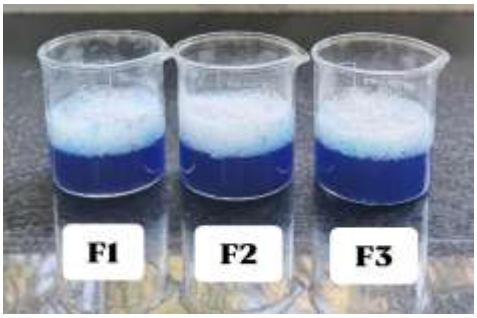


Fig.no.27

	F1	F2	F3
Observation	Light ink in foam	Very little ink in foam	Negligible ink in foam

- Discussion: All formulations showed good dirt dispersion ability, indicating satisfactory

cleansing action. Among the three formulations, F3 showed negligible ink retention in foam due to higher SLS concentration, suggesting superior detergency and cleansing efficiency.

8. Stability study:

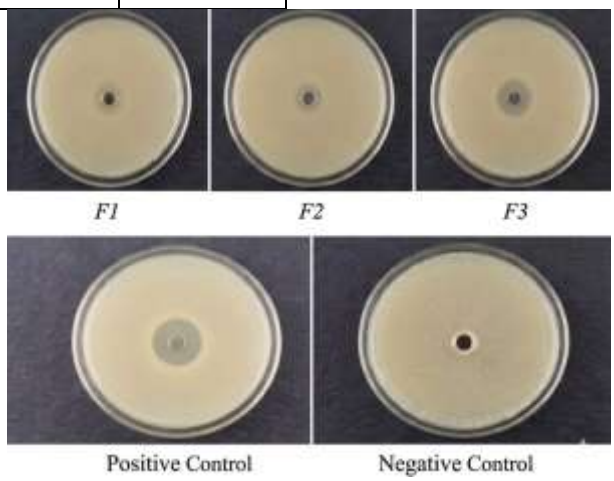
The formulated shampoos were subjected to short-term stability studies according to International Council for Harmonisation Q1A(R2) guidelines. The formulations were stored at room temperature (25 ± 2°C), refrigerated condition (4 ± 2°C), and accelerated condition (40 ± 2°C/75 ± 5% RH) for 30 days. Evaluation was carried out at predetermined intervals for appearance, color, odor, pH, viscosity, foamability, and phase separation.

Parameter	F1	F2	F3
Colour	No change	No change	No change
Odour	Characteristic	Characteristic	Characteristic
Ph	5.8	5.8	5.7
Viscosity	Stable	Stable	Stable
Phase separation	Absent	Absent	Absent

- Discussion: Formulation F1 showed acceptable stability with slight variation in pH and viscosity during storage. Formulation F2 exhibited comparatively better stability with no significant changes in appearance, odor, or foamability. Formulation F3 showed the best stability among all formulations by maintaining uniform consistency and stable physicochemical properties throughout the study period.

9. Anti-fungal test:

The antifungal activity of the prepared shampoo formulations was evaluated by agar well diffusion method using Potato Dextrose Agar against fungal strain *Candida albicans*. The fungal culture was uniformly spread on the agar surface, and wells were prepared using a sterile cork borer. Different formulations containing varying concentrations of willow bark extract were added into the wells and incubated at 28–37°C for 24–48 hours. The antifungal activity was determined by measuring the zone of inhibition around each well.



Formulation	Willow Bark Extract Concentration	Zone of Inhibition(mm)
F1	Low concentration	10 ±0.2
F2	Medium concentration	14 ±0.3
F3	High concentration	18 ±0.4
Standard	Ketoconazole	22 ±0.2
Control	Distilled water	No inhibition

DISCUSSION

F3 showed the highest antifungal activity among all formulations. The antifungal activity increased with increase in concentration of willow bark extract.

CONCLUSION

The present study successfully formulated and evaluated a herbal shampoo containing fermented rice water and willow bark extract. The prepared formulations showed acceptable physicochemical properties, good cleansing ability, foam stability, scalp-compatible pH, and satisfactory stability. Among all formulations, F3 exhibited better antifungal activity and cleansing efficiency, while F2 showed optimum consistency and overall acceptability. Overall, the study suggests that rice water and willow bark extract can be effectively used in herbal shampoo formulations as a natural alternative for healthy hair and scalp care.

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