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FORMULATION AND EVALUATION OF ANTI-POLLUTION POLYHERBAL SHAMPOO ENRICHED WITH POMEGRANATE PEEL EXTRACT

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ABSTRACT

Environmental pollution is one of the major causes of hair and scalp damage. Daily exposure to dust, smoke, dirt, and harmful pollutants may lead to dryness, dullness, irritation, oxidative stress, and premature ageing of hair.[1] The present study was carried out to formulate and evaluate an anti-pollution polyherbal shampoo enriched with pomegranate peel extract using natural ingredients. The formulation contained pomegranate peel extract, activated charcoal, reetha extract, amla extract, glycerin, guar gum, sodium chloride, citric acid, sodium benzoate, lemon oil, and Sodium Lauryl Sulphate (SLS). Pomegranate peel was used for its antioxidant and anti-ageing properties, while activated charcoal was added for deep cleansing and anti-pollution activity.[2] The prepared shampoo was evaluated for parameters such as physical appearance, pH, viscosity, wetting time, dirt dispersion, foaming ability, foam stability, cleansing action, stability, skin irritation, and antimicrobial activity. The formulation showed good cleansing ability, stable foam formation, suitable viscosity, and scalp-friendly pH. No irritation was observed during the study.[3] The results suggest that the developed shampoo can be used as a safe and effective herbal alternative to synthetic shampoos for protection against pollutionrelated hair damage.[4]

KEYWORDS: Polyherbal shampoo, pomegranate peel, activated charcoal, anti-pollution,

herbal cosmetics, antioxidant.

INTRODUCTION

Hair comes in contact with environmental pollutants such as dust, smoke, chemicals, and ultraviolet radiation every day. Continuous exposure to these pollutants may damage the scalp and hair, causing dryness, roughness, irritation, excessive oiliness, hair fall, and premature ageing. Due to increasing environmental pollution and changing lifestyles, there is a growing demand for hair care products that not only cleanse the scalp but also protect hair from pollution-related damage.[5]

Most commercial shampoos mainly focus on cleansing, dandruff control, and improving cosmetic appearance. However, long-term use of synthetic shampoos may sometimes lead to dryness, scalp irritation, and damage to natural hair texture. Herbal shampoos are considered safer and more eco-friendly because they contain naturally derived ingredients with fewer side effects.[6]

In the present study, an anti-pollution polyherbal shampoo was formulated using pomegranate peel extract and activated charcoal as major active ingredients. Pomegranate peel is rich in antioxidants such as flavonoids, tannins, and ellagic acid, which may help reduce oxidative stress and premature ageing of hair. Activated charcoal has excellent adsorption properties and helps remove dirt, toxins, excess oil, and pollution particles from the scalp.[7]

Other herbal ingredients such as reetha and amla were also added to improve cleansing, nourishment, and conditioning properties. The study mainly focused on developing a herbal shampoo that provides cleansing, anti-pollution protection, antioxidant activity, and better scalp health.[8]

Scientific Basis of Polyherbal Shampoo Formulation

Fig 1: Scientific basis of polyherbal shampoo.

Scalp Cleansing: Proper cleansing helps remove dirt, sweat, and excess oil from the scalp, which supports healthy and clean hair.

Hair Conditioning: Conditioning agents help make hair softer, smoother, and easier to manage while reducing dryness.

Oil Balance: Controlling excess oil on the scalp helps prevent greasiness without removing natural moisture completely.

Hair Protection: Herbal ingredients rich in antioxidants may help protect hair from environmental damage and dullness.

Scalp Nourishment: Natural plant extracts provide nourishment to the scalp and help maintain healthy hair roots.[9]

Role of Herbal Ingredients in the Formulation

Amla is known for its antioxidant content, which may help improve hair strength and overall hair texture. Reetha works as a natural cleansing agent because it contains saponins that help remove dirt and oil from the scalp. Pomegranate peel contains natural compounds with antioxidant and antimicrobial activity that may help keep the scalp healthy. Activated charcoal helps in deep cleansing by removing impurities and excess sebum. Glycerine helps retain moisture and prevents dryness, while guar gum improves the thickness and smoothness of the shampoo.[10]

Expected Properties of Herbal Shampoo

- Mild cleansing action suitable for regular use
- Good foaming ability

- Easy application and spreadability
- Stable and uniform formulation
- Improved softness and smooth feel of hair
- Objective of the Study

The present study aims to prepare and evaluate a polyherbal shampoo using natural ingredients for effective hair and scalp care. The formulation is evaluated for parameters such as pH, foamability, viscosity, stability, and cleansing performance to determine its overall quality and effectiveness.

AIM AND OBJECTIVES

Aim

- The present study aimed to formulate and evaluate an anti-pollution polyherbal shampoo enriched with pomegranate peel extract for safe, effective, and natural hair care.

Objectives

- To prepare a polyherbal shampoo using natural ingredients.
- To provide anti-pollution and anti-ageing benefits to hair and scalp.
- To achieve effective cleansing of dirt and excess oil from the scalp.
- To reduce oxidative stress caused by environmental pollution.
- To improve scalp health and hair texture naturally.
- To evaluate the formulation for pH, viscosity, foaming ability, stability, and safety.

MATERIALS AND METHODS

Materials

The ingredients used in the preparation of the anti-pollution polyherbal shampoo are listed below.

Pomegranate Peel Extract as an Anti-Ageing and Antidandruff Agent

- Pomegranate peel (Punica granatum) has been used traditionally for treating various scalp and skin problems. It is rich in natural compounds that are highly beneficial for hair health.
- It contains antioxidants, flavonoids, and tannins, which help in protecting the hair from damage caused by free radicals. This makes it very useful in preventing premature ageing of hair.

- It helps in strengthening hair roots, improving scalp condition, and reducing inflammation.
- Pomegranate peel also shows good anti-dandruff and antifungal activity, helping to reduce itching and control dandruff effectively.

Characteristics	Description
Common name	Pomegranate peel
Biological name	Punica granatum
Biological source	Dried peel of punica granatun
Family	Lythraceae
Major constituents	Punicalagin, Ellagic acid, Tannis, Flavonoids
Uses	Antioxidant and antimicrobial agent

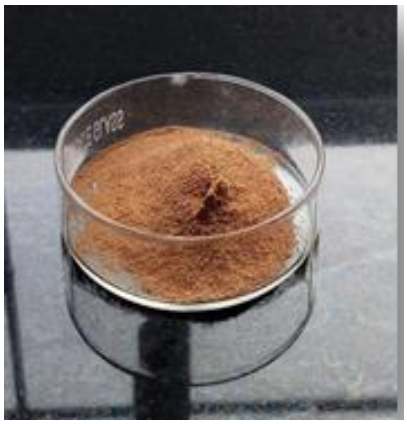

Fig. 2: Dried pomegranate peel powder.

Activated charcoal as an anti-pollution agent

- Activated charcoal is well known for its deep cleansing ability. It works by absorbing dirt, oil, and toxins from the scalp.
- It is especially useful in removing pollution-related impurities like dust and smoke particles that stick to the hair.
- It helps in keeping the scalp clean, fresh, and free from buildup.
- Regular use helps in maintaining a healthy scalp environment and improves overall hair quality.

Characteristics	Description
Common name	Activated charcoal
Biological name	Activated carbon
Biological source	Carbon-rich plant materials
Family	-
Major constituents	Activated carbon
Uses	Detoxifying and anti-pollution agent

Fig. 3: Activated charcoal powder.

Reetha Extract as a Natural Cleansing Agent

- Reetha (Sapindus mukorossi) is a natural ingredient that acts as a gentle cleanser.
- It contains saponins, which help in producing mild foam and cleaning the scalp effectively.
- It removes dirt and oil without damaging the natural balance of the hair.

Characteristics	Description
Common name	Reetha
Biological name	Sapindus mukorossi
Biological source	Fruits of sapindus mukorossi
Family	Sapindaceae
Major constituents	Saponins
Uses	Natural cleansing and foaming agent

Fig. 4: Reetha (Sapindus mukorossi).

Sodium Lauryl Sulfate (SLS) as a Surfactant

- SLS is used to enhance the cleansing action of the shampoo.
- It helps in producing foam and removing oil and dirt from the hair.
- It also helps in spreading the shampoo evenly during use.

Characteristics	Description
Common name	Sodium Lauryl Sulphate
Chemical formula	$C_{12}H_{25}SO_4Na$
Category	Synthetic surfactant
Major constituents	Sulphate compounds
Uses	Cleansing and foaming agent

Fig. 5: Sodium Lauryl Sulphate.

Amla Extract as a Nourishing Agent

- Amla (Phyllanthus emblica) is rich in vitamin C and nutrients that are good for hair.
- It helps in strengthening hair roots, promoting hair growth, and improving hair texture.
- It also adds natural shine to the hair.

Characteristics	Description
Common name	Amla
Biological name	Phyllanthus emblica
Biological source	Fruits of Phyllanthus emblica
Family	Phyllanthaceae
Major constituents	Vitamin c, gallic acid,tannis
Uses	Hair strengthening and antioxidant agent

Fig. 6: Amla (Phyllanthus emblica).

Glycerin as a Moisturising Agent

- Glycerin helps in retaining moisture in the hair and scalp.
- It prevents dryness and keeps the hair soft and smooth.

Characteristics	Description
Common name	Glycerin
Chemical name	Glycerol
Chemical formula	C_3 H_8 O_3
Category	Humectant
Uses	Moisturizing agent

Fig. 7: Glycerine.

Guar Gum as a Thickening Agent

- Guar gum is used to give the shampoo a proper thickness.
- It improves the texture and makes the formulation smooth and easy to apply.

Characteristics	Description
Common name	Guar gum
Biological name	Cyamopsis tetragonobola
Biological source	Seeds of Cyamopsis tetragonoloba
Family	Fabaceae
Major constituents	Galactomannan
Uses	Thickening and stabilizing agent

Fig. 8: Guar Gum powder.

Sodium Chloride as a Viscosity Modifier

- Sodium chloride helps in adjusting the thickness of the shampoo.
- It ensures the product is neither too thick nor too thin.

Characteristics	Description
Common name	Sodium chloride
Chemical formula	Nacl
Category	Inorganic compound
Uses	Viscosity enhancer

Fig. 9: Sodium chloride Citric Acid as a pH Adjusting Agent.

- Citric acid helps in maintaining the pH of the shampoo suitable for the scalp

Characteristics	Description
Common name	Citric acid
Chemical formula	C_6 H_8 O_7
Category	Organic acid
Uses	pH adjusting agent

Fig. 10: Citric Acid.

Sodium Benzoate as a Preservative

- Sodium benzoate prevents microbial growth in the shampoo.
- It helps increase the product's shelf life.

Characteristics	Description
Common name	Sodium benzoate
Chemical formula	$C_7\ H_5\ NaO_2$
Category	Preservative
Uses	Prevents microbial growth

Fig. 11: Sodium Benzoate.

Lemon Oil as a Fragrance and Conditioning Agent

- Lemon oil gives a pleasant and fresh fragrance to the shampoo

Characteristics	Description
Common name	Lemon oil
Biological name	Citrus limon
Biological source	Peel oil of citrus limon
Family	Rutaceae
Major constituents	Limonene, citral
Uses	Fragrance and refreshing agent

Fig. 12: Lemon oil.

Purified Water as a Base

- Purified water acts as the base of the formulation.
- It helps in mixing all ingredients properly and forming a uniform shampoo.

Characteristics	Description
Common name	Distilled water
Chemical formula	H_2 O
Category	Vehicle/solvent
Uses	Used for proper mixing of ingredients

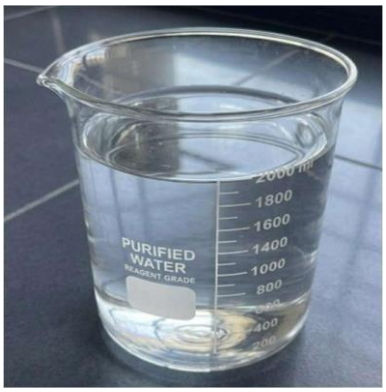

Fig. 13: Distilled water.

Methods

Extraction of Herbal Ingredients

The raw materials, namely pomegranate peel (Punica granatum), reetha (Sapindus mukorossi), and amla (Phyllanthus emblica), were first cleaned, dried, and coarsely powdered. The extraction was carried out using a simple boiling method. The powdered materials were added to distilled water and heated for about 15–20 minutes. This helps in releasing the active components present in the herbs into the water.

After boiling, the mixture was allowed to cool slightly. It was then filtered using a funnel, filter paper, and a conical flask to separate the liquid extract from the solid residue. The clear filtrate obtained was collected and used as the herbal extract for further shampoo formulation. The extracts were stored properly in clean containers until use.

Fig. 14: Extraction of herbal ingredients.

- **Preparation of Base**

A suitable quantity of purified water was taken in a clean beaker. Sodium Lauryl Sulfate (SLS) was added slowly with continuous stirring so that it would dissolve properly without forming too much foam.

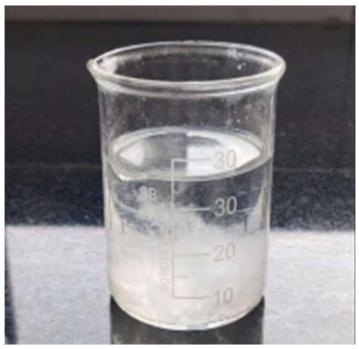

Fig 15: Preparation of base.

- **Addition of Herbal Extracts**

The prepared extracts of pomegranate peel, reetha, and amla were then added slowly into the base while stirring continuously to get a uniform mixture.

- **Incorporation of Active Ingredient**

Activated charcoal was added to the mixture and mixed well so that it spreads evenly throughout the formulation.

Fig. 16: Incorporation of active ingredients.

- **Addition of Moisturising Agent**

Glycerin was added to help keep the hair and scalp moisturised and prevent dryness.

- **Adjustment of Thickness**

Guar gum was added slowly with continuous stirring to increase the thickness and give a smooth consistency. A small amount of sodium chloride was then added to further adjust the

viscosity.

- **pH Adjustment**

Citric acid was added in small quantity to adjust the pH of the shampoo so that it is suitable for scalp use.

- **Addition of Preservative**

Sodium benzoate was added to prevent microbial growth and to increase the shelf life of the shampoo.

- **Addition of Fragrance**

Lemon oil was added at the final stage to give a pleasant and refreshing fragrance.

- **Final Mixing and Storage**

The mixture was stirred properly until a smooth and uniform shampoo was formed. The prepared shampoo was then transferred into a clean container, labelled, and stored for further evaluation.

Fig. 17: Prepared polyherbal shampoo.

Formulation Table for 50 ml Anti-Pollution Polyherbal Shampoo

Sr. No.	Ingredients	Function	Quantity for 50 ml
1	Pomegranate peel	Antioxidant, antimicrobial agent	5 ml
2	Activated charcoal	Anti-pollution, detoxifying agent	1 g
3	Reetha extract	Naturalsurfactant, cleansing agent	10 ml
4	Amla extract	Hair nourishing and conditioning agent	5 ml
5	Sodium lauryl sulphate	Foaming and cleansing agent	8 ml
6	Glycerin	Humectant and moisturising agent	2 ml
7	Guar gum	Thickening agent	0.5 g
8	Sodium chloride	Viscosity enhancer	1 g
9	Citric acid	Ph adjuster	q.s.

10	Sodium benzoate	Preservative	0.25 g
11	Lemon oil	Fragrance and scalp refreshing agent	2-3 drops
12	Distilled water	Vehicle	q.s. to 50 ml

Evaluation of herbal shampoo

To evaluate the prepared formulation, quality control tests, including visual assessment and physicochemical controls such as pH, density, viscosity, surface tension, foam volume, foam

1. Physical appearance / Visual inspection

The formulated herbal shampoo, as shown in Figure, is dark brown to black in colour due to charcoal. It has a pleasant odour from the herbal ingredients and shows good foam-producing ability.

2. pH

The pH of the formulated shampoo was found to be 6, which lies within the ideal range of 5 to 7.8. The shampoo is acid-balanced and close to the natural pH of the scalp. Maintaining this pH helps improve hair quality, reduces irritation and supports scalp health. Mild acidity also helps in tightening the hair cuticle, thereby improving shine.

3. Viscosity

Viscosity plays an important role in determining the stability of shampoo, ease of pouring and spreading on hair. The viscosity of the formulated shampoo was found to be around 50 millipoise, which is suitable for easy application and good consistency.

4. Percentage of solid contents

If the shampoo contains too many solids, it becomes difficult to apply and rinse off. The percentage of solid content was found to be around 24%, indicating that the shampoo can be easily washed out and has good consistency.

5. Dirt dispersion

A good quality shampoo should keep dirt in the water and not in the foam. The amount of ink observed in the foam was light, which indicates that the prepared formulation has good cleansing ability.

Fig. 18: Comparison of the dirt dispersion test.

6. Action

The cleansing action was tested using a white cotton cloth stained with oil and dirt. The cloth was treated with the shampoo solution and then rinsed with water. The results showed that the shampoo effectively removed oil and dirt from the cloth. The cloth appeared clean after washing, indicating good cleansing ability of the formulation.

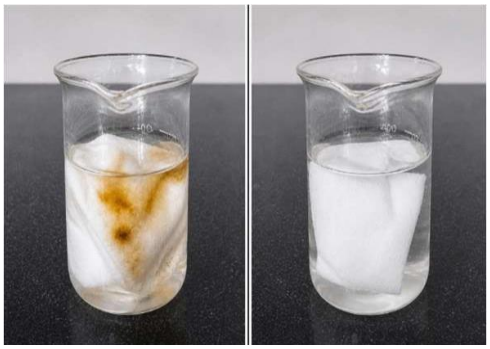

Fig. 19: Before washing (stained cloth) After washing).

7. Surface tension

Reduction in surface tension is one of the main mechanisms responsible for cleansing action. The decrease in surface tension compared to water indicates good detergent property. The formulated shampoo showed reduced surface tension, confirming its effectiveness.

8. Foaming ability and foam stability

Foam formation is important for user satisfaction, even though it is not directly related to cleansing. The formulation produced stable foam (Figure-7) with only a slight decrease in volume over time, indicating good foam stability.

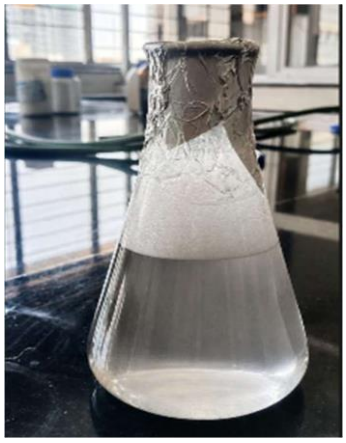

Fig. 20: Foam height.

9. Wetting time

Wetting ability depends on the surfactant concentration and is used to evaluate shampoo performance. The canvas disc method is a simple and reliable test for this purpose. The wetting time of the herbal shampoo was found to be 120–180 seconds, indicating good wetting ability.

10. Skin irritation test

The skin irritation test showed that the shampoo does not cause any irritation or harmful effects. This is mainly due to the use of natural ingredients, which are generally safer compared to synthetic chemicals that may cause inflammation or irritation.

11. Stability study

The stability study indicated that the formulation remained chemically and physically stable during storage. No major changes in colour, odour or consistency were observed over a period of four weeks at room temperature (25–30°C).

12. Microbiological examination

The microbiological count of the formulated shampoo was found to be within acceptable limits (below 10^2 CFU/ml), indicating that the shampoo is safe for use.

13. Anti-microbial activity

The results showed that the formulated shampoo has moderate antimicrobial activity, especially against Gram-negative bacteria, with less effect on Gram-positive bacteria. The zone of inhibition ranged from 0.1 to 0.3 cm, indicating the presence of active herbal components like pomegranate peel.

Fig. 21: Antimicrobial activity.

Table: Results

S. No.	Parameters	Observation
1	Physical appearance	Dark brown to black, opaque
2	pH	6
3	Percentage of solid contents	24%
4	Wetting time	120-180 sec
5	Viscosity	~50 millipoise
6	Dirt dispersion	Light
7	Cleaning action	Good
8	Surface tension	Reduced compared to water
9	Foam ability and stability	Good, stable
10	Skin irritation	Nil
11	Microbiological count	$<10^2$ CFU/ml
12	Antimicrobial activity	Moderate

DISCUSSION

The shampoo showed a suitable scalp pH and good cleansing action. Activated charcoal effectively removed dirt and pollutants, while pomegranate peel extract provided antioxidant benefits. The formulation produced stable foam, good cleansing performance, and remained stable without changes in colour, odour, or consistency.

CONCLUSION

The formulated herbal shampoo was stable, safe, and effective with good cleansing and antioxidant properties. It supports the use of herbal ingredients as a better alternative to synthetic shampoos.

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