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Preparation and Evaluation of Medicinal Soap Using Pomegranate (*Punica granatum*) Peel Extract

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Abstract: ***The present study aimed to formulate and evaluate a herbal medicinal soap incorporating Punica granatum peel extract for its physicochemical and antimicrobial properties. Pomegranate peels were shade-dried, powdered, and extracted using solvent extraction. The obtained extract was incorporated into a soap base prepared by the saponification method. The formulated soap was evaluated for pH, foamability, hardness, and cleansing efficiency. The pH of the prepared soap was found to be within the acceptable range (8.5–9.0). The antimicrobial activity was assessed using the agar well diffusion method against Staphylococcus aureus and Escherichia coli. The formulated soap exhibited significant antibacterial activity with zones of inhibition measuring 18 ± 0.5 mm against S. aureus and 15 ± 0.4 mm against E. coli, compared to the control soap which showed negligible inhibition. The results indicate that incorporation of pomegranate peel extract enhances the antimicrobial efficacy of the soap without affecting its physicochemical stability. The study suggests that pomegranate peel extract can serve as a potential natural additive in herbal soap formulations.***

Keywords: Punica granatum, pomegranate peel extract, herbal soap, antimicrobial activity, medicinal formulation.

I. HERBAL SOAP

Herbal soap is a natural medicinal preparation that possesses antibacterial, antioxidant, antiseptic, and anti-ageing properties, which help in maintaining healthy skin and preventing infections. It is prepared using different parts of plants such as leaves, roots, stems, seeds, rhizomes, fruits, and pulps, which are well known for their therapeutic benefits. [1]These plant-based ingredients help in treating minor skin injuries, infections, and various skin disorders while also improving overall skin health. Unlike commercial soaps, herbal soaps do not contain harmful artificial colours, synthetic fragrances, or harsh chemical additives, making them safer and gentler for regular use. Herbs have been used since ancient times in traditional medicine because of their effectiveness, natural availability, affordability, and compatibility with the human body. Due to their antimicrobial and antioxidant actions, herbal soaps not only cleanse the skin but also protect it from damage, promote healing, and support healthy, glowing skin.

Figure 1 herbal soaop

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II. SOAP

Soap is a commonly used cleansing agent that is familiar to everyone and plays an essential role in maintaining personal hygiene. It is generally defined as a cleaning substance available in different forms such as bars, granules, flakes, or liquid, produced by the reaction of sodium or potassium salts with natural fatty acids. [2]These fatty acids are usually non-volatile and contain long hydrocarbon chains with eight or more carbon atoms. Soaps are widely used for various purposes including bathing, washing, and medicinal applications. The cleansing action of soap is mainly due to its chemical structure, where the hydrocarbon chain has an affinity for oil and grease, while the carboxyl group has an affinity for water, allowing dirt to be easily removed during washing. In addition to the basic ingredients, other substances may be added to improve its effectiveness, especially in medicated soaps where therapeutic agents are included. Apart from sodium and potassium, other metals like calcium and magnesium can also form soaps, but these are usually insoluble and not suitable for cleansing. The physical properties of soap, such as hardness, depend on the type of metal present, with sodium-based soaps generally being harder than potassium-based soaps made from the same oil or fat**.**

III. PUNICA GRANTUM (POMEGRANATE)

Punica granatum L., commonly known as pomegranate, is a medicinal *p*lant widely studied for its bioactive properties. Among its various parts, the fruit peel is particularly rich in phytochemical constituents such as hydrolysable tannins (including punicalagin and punicalin), ellagic acid, gallic acid, and flavonoids. These polyphenolic compounds are largely responsible for the plant's antioxidant and antimicrobial activities. [3]Experimental investigations have reported that pomegranate peel extracts exhibit significant antibacterial effects against both Gram-positive and Gram-negative bacteria, including Staphylococcus aureus and Escherichia coli. The antibacterial action is primarily attributed to the ability of tannins and phenolic compounds to alter bacterial cell membrane permeability, precipitate cellular proteins, and inhibit essential metabolic functions. Owing to these properties, pomegranate peel extract has gained considerable interest as a natural antimicrobial agent for incorporation into topical pharmaceutical and cosmetic formulations, such as herbal soaps.

Figure 2 pomogranate punica grantum

IV. ADVANTAGES OF POMEGRANATE PEEL MEDICINAL SOAP

1) Natural Antimicrobial Activity: Pomegranate peel extract contains tannins and phenolic compounds that inhibit common skin pathogens such as Staphylococcus aureus and Escherichia coli. This makes the soap effective for maintaining skin hygiene.
2) Antioxidant Properties: The high polyphenol content provides antioxidant activity, [4]which may help protect skin cells from oxidative damage.
3) Reduced Chemical Load: Incorporation of natural plant extract reduces dependence on synthetic antimicrobial agents that may cause irritation or environmental harm.
4) Eco-Friendly and Sustainable: The peel is an agricultural by-product. [5]Utilizing it in soap formulation promotes waste valorization and sustainability.
5) Potential Anti-inflammatory Effect: Bioactive compounds present in the peel may contribute to soothing mild skin irritation.
6) Cost-Effective Raw Material: Since peel is usually discarded, it offers economical advantages in herbal formulation development.

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V. DISADVANTAGES / LIMITATIONS OF POMEGRANATE PEEL MEDICINAL SOAP

1) Requires Higher Concentration for Strong Antimicrobial Effect: Compared to synthetic antibiotics or chemical antiseptics, herbal extracts may require higher concentrations to produce significant microbial inhibition.
2) Variation in Phytochemical Content: The chemical composition of pomegranate peel extract can vary depending on geographical source, drying method, and extraction technique, leading to inconsistency in product efficacy.
3) Stability Issues: Natural extracts may undergo degradation over time, affecting antimicrobial potency and shelf life of the soap.
4) Color and Odor Impact: Pomegranate peel extract has a natural brownish color and characteristic odor, which may affect the aesthetic quality and consumer acceptability of the final product.
5) Limited Clinical Evidence: Although in vitro studies show antimicrobial activity, large-scale clinical studies on herbal soap efficacy are limited.
6) Possible Skin Sensitivity in Rare Cases: Some individuals may exhibit mild skin sensitivity or allergic reactions to plant-based extracts.

VI. APPLICATIONS OF POMEGRANATE PEEL MEDICINAL SOAP

1) Antibacterial Skin Cleanser: Due to its antimicrobial activity against common pathogenic bacteria, the soap can be used for routine skin hygiene to reduce microbial load.
2) Management of Minor Skin Infections: It may be useful in preventing or controlling mild skin infections caused by bacteria such as Staphylococcus aureus.
3) Acne-Prone Skin Care: Since acne is often associated with bacterial growth and inflammation, pomegranate peel-based soap may support acne management as a natural alternative.
4) Wound Cleansing (Minor Cuts and Abrasions): The antimicrobial properties may assist in cleansing minor wounds and preventing bacterial contamination.
5) Herbal Cosmetic Formulations: The extract can be incorporated into natural cosmetic and dermatological products aimed at consumers seeking plant-based alternatives.
6) Eco-Friendly Personal Care Products: The use of agricultural by-products makes the soap suitable for sustainable and environmentally conscious product development.

VII. MATERIALS AND METHODS

1) Plant Material: Ripe fruits of Punica granatum L. [6](collected from [Location], authenticated by a botanist).
2) Chemicals: Ethanol (95% analytical grade), Sodium Hydroxide (NaOH) pellets, Distilled water, Phenolphthalein indicator.
3) Oil Phase: Coconut oil, Olive oil, and Palm oil (specify the ratios, e.g., 2:1:1)..

A. Extraction Of Pomegranate PEEL (PPE)

The peels are washed, shade-dried, and [7]pulverized. Extraction is performed via maceration:
Mix 100g of peel powder with 500mL of 70% ethanol.
Keep the mixture in a dark enclosure for 72 hours with periodic shaking.
Filter through Whatman No. 1 filter paper.
Concentrate the filtrate using a rotary evaporator at 40\text{°C} to obtain a semi-solid crude extract. Store at 4\text{°C}.

Figure 3 pomogranate peel extract solution

TABLE:1 Parameters and Specifications Of Peel Extract

Parameter	Specification
Plant material	Pomegranate peel
Drying method	Shade drying (7–10 days)
Powder size Sieve No.	40
Extraction method	Maceration
Solvent	70% Ethanol
Drug:Solvent ratio	1:5
Extraction time	72 hours
Concentration method	Water bath (40–50°C)
Storage	4°C

B. Determination Of Percentage Yield

Percentage yield was calculated using the formula:

Percentage Yield =

(Weight of dried extract / Weight of peel powder taken) × 100

Table 2: Percentage Yield of Pomegranate Peel Extract

Weight of peel powder (g)	Weight of dried extract (g)	Percentage Yield (%)
50g	9.2g	18.4%

Weight of the dried extract = 9.2g

Percentage yeild = 9.2/50 * 100 = 18.4%

C. Formulation Of Medicinal Soap (Cold Process)

The cold saponification method is used to preserve the heat-sensitive antioxidants in the pomegranate:

1) Lye Solution: Dissolve a calculated amount of NaOH in distilled water (based on the SAP value of your oils).

2) Oil Blending: Mix the oils and heat to 45\text{°C}.

3) Saponification: Slowly add the lye to the oils, stirring at 400 rpm until "trace" (thickening) occurs.

4) Incorporation: Add the PPE (1%, 3%, or 5% w/w) at the trace stage to ensure the bioactive compounds are not degraded by the initial high pH of the lye.

5) Curing: Pour into molds; cure for 4 weeks to allow complete saponification and pH stabilization.

Figure 4 formulation of medical soap

D. Evaluation Of Prepared Herbal Soap

1) Determination of pH

A 1% soap solution was prepared by [8]dissolving 1 g of soap in 100 mL distilled water. The pH was measured using a calibrated digital pH meter.

Figure 5 pH meter

2) Foam Height Test

2 g of soap was dissolved in 50 mL distilled water in a measuring cylinder and shaken vigorously for 1 minute. Foam height was measured immediately.

The prepared soap was evaluated for color, odor, texture, and hardness by visual and manual inspection

E. Physical Evaluation

Parameter	Test Soap	Control Soap
Color	Light brown	Cream/ Off-white
Odor	Mild herbal	Mild soapy odor
pH	8.6	9.2
Foam height (cm)	3.8	3.2
Texture	Smooth and firm	Smooth and firm

VIII. RESULTS

The prepared medicinal soap containing Punica granatum peel extract was evaluated for various physicochemical and biological parameters to determine its quality, safety, and effectiveness. The formulated soap exhibited a uniform dark brown color, smooth texture, pleasant characteristic odor, and good physical appearance, indicating proper mixing and uniform distribution of the herbal extract. The soap showed satisfactory hardness and consistency, which contributed to its good handling properties and storage stability. The pH of the 1% w/v soap solution was found to be 8.2 ± 0.2, which falls within the acceptable range for bathing soaps. [9]This pH range ensures effective cleansing while minimizing the risk of skin irritation. The moisture content of the soap was determined to be 14.8%, indicating good shelf stability and reduced susceptibility to microbial growth. The foaming ability of the soap was found to be satisfactory, with a foam height of 14.5 cm and stable foam retention, reflecting good surfactant activity and effective cleansing potential.

The total fatty matter (TFM) content of the formulated soap was found to be 72%, indicating high-quality soap with good moisturizing and skin-conditioning properties. High TFM values are associated with better emollient characteristics, which help prevent skin dryness and irritation.

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Antimicrobial evaluation of the medicinal soap demonstrated significant inhibitory activity against common pathogenic microorganisms. The zone of inhibition against Staphylococcus aureus was found to be 16 mm, while against Escherichia coli it was 14 mm, confirming the antibacterial effectiveness of pomegranate peel extract incorporated into the soap base.

IX. DISCUSSION

The results obtained from the present study indicate that Punica granatum peel extract can be effectively incorporated into a soap base to produce a stable and efficient medicinal soap formulation. The uniform appearance, pleasant odor, and smooth texture observed in the prepared soap suggest proper formulation and homogenous distribution of the herbal extract, which are essential for consistent therapeutic activity and consumer acceptability.

The pH value of 8.2 ± 0.2 is within the recommended range for bathing soaps and plays a crucial role in effective cleansing by removing dirt, oils, and microorganisms from the skin surface. Although slightly alkaline, this pH is mild enough to avoid excessive skin irritation and helps maintain skin hygiene. Proper pH balance is important to preserve the natural protective barrier of the skin and prevent dryness and irritation during prolonged use.

The observed moisture content of 14.8% contributes to the physical stability and shelf life of the formulation. Lower moisture content minimizes the risk of microbial contamination and enhances product durability. [10]The satisfactory foaming capacity and foam stability reflect efficient surfactant action, which ensures proper cleansing and improves user satisfaction. Good foam characteristics are essential for effective removal of impurities and provide a pleasant sensory experience during application.

X. CONCLUSION

The present study focused on the preparation and evaluation of medicinal soap formulated using pomegranate (Punica granatum L.) peel extract. Pomegranate peel, an agro-industrial by-product, was selected due to its rich content of hydrolysable tannins, particularly punicalagin, along with ellagic acid and other phenolic compounds known for their antimicrobial and antioxidant properties. [11]The peel extract was successfully prepared using the maceration method with 70% ethanol, yielding an appreciable percentage extractive value. The formulated herbal soap was prepared by the cold process method, incorporating 3% w/w of the extract into a standard soap base. The formulation process ensured uniform mixing, appropriate trace formation, and adequate curing to obtain a stable and firm soap bar. Evaluation of the prepared soap demonstrated acceptable physicochemical characteristics. The pH of the soap was found to be within the suitable alkaline range for cleansing formulations, indicating proper saponification without excessive alkalinity. Foam height and physical parameters such as color, texture, and hardness were satisfactory, confirming formulation stability and usability.

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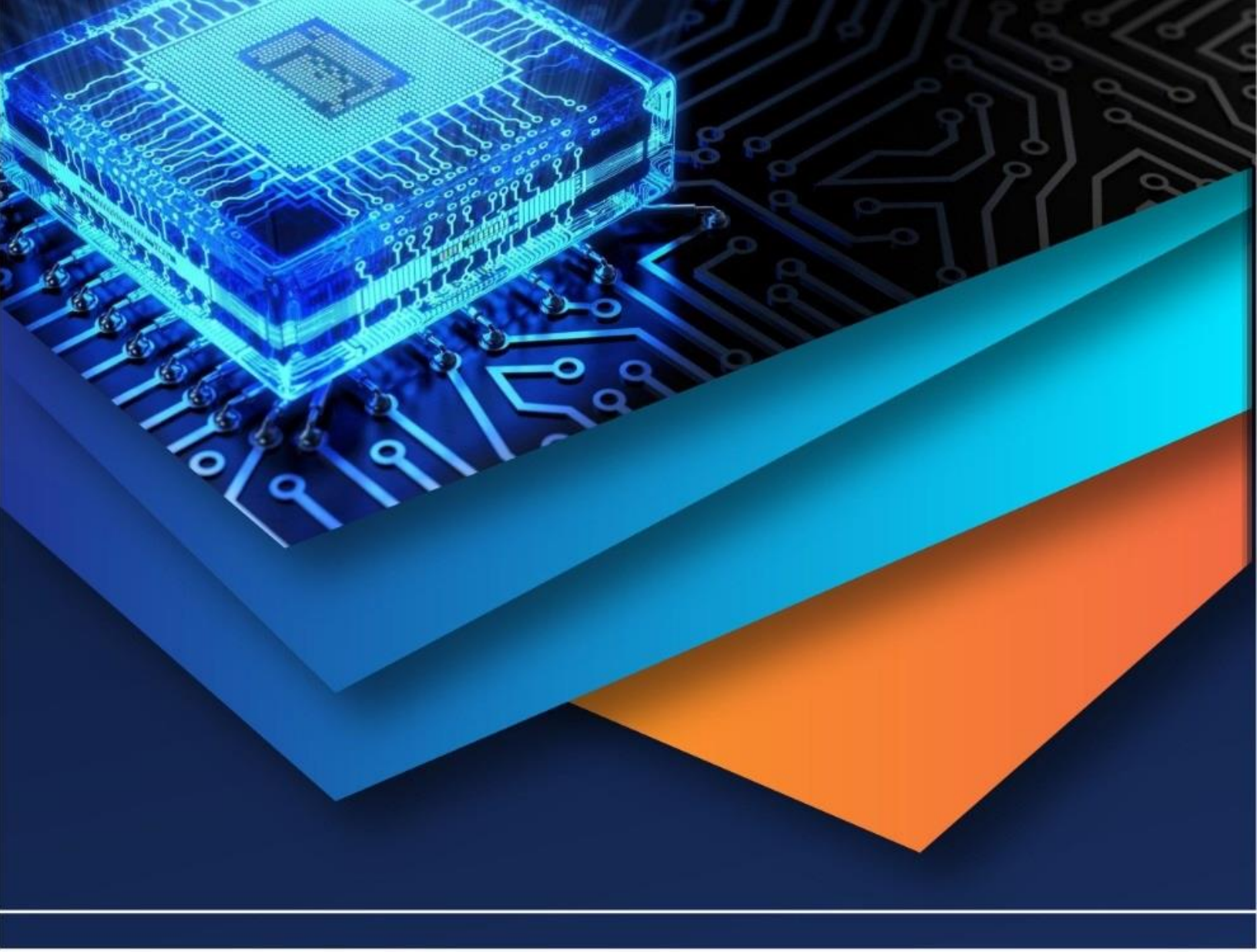

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