

Valorization Of Punica Granatum Peels: Phytochemical Analysis, Antioxidant Activity And Development Of Herbal Lipsticks

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ABSTRACT

Pomegranate (*Punica granatum L.*) is widely recognized as a medicinally valuable fruit, not only for its edible arils but also for its peel, which is often discarded as waste despite being rich in bioactive compounds. The peel contains significant amounts of polyphenols, flavonoids, tannins, and other secondary metabolites that are known to exert beneficial health effects. The present study focuses on the phytochemical screening and antioxidant evaluation of pomegranate peel extract to highlight its potential as a natural source of therapeutic agent. The antioxidant potential of the extract was assessed through in-vitro method such as Ferric Reducing Antioxidant Power assay. Results indicated that pomegranate peel extract exhibited strong free radical scavenging activity, comparable to standard antioxidants used as references. The presence of high levels of phenolic and flavonoid compounds likely contributes to this activity, thereby validating the medicinal relevance of the peel. Lipstick gives attractive colour, shiny appearance to lips, noticeable fancy look and distinguishing the defects. Due to various adverse effects of available synthetic preparations, the present study was performed to formulate F1 to F6 formulations and to evaluate all the formulations of herbal lipstick, as herbals are less prone to adverse effects. The present study was carried out without side effects and can be used by the several women with satisfaction.

Keywords: Pomegranate Peel, Bioactive Compounds, Phytochemicals, Antioxidants, Herbal Lipstick.

INTRODUCTION

Plants have long been recognized as rich sources of nutrients, therapeutic agents, and bioactive compounds, forming the backbone of traditional medicine and contributing significantly to modern drug discovery. The pharmacological properties of plants are largely attributed to their secondary metabolites, commonly referred to as phytochemicals, including alkaloids, flavonoids, tannins, phenolics, terpenoids, and saponins. These compounds provide defense against environmental stress and pathogens and exhibit diverse biological activities such as antimicrobial, anti-inflammatory, anticancer, and antioxidant effects [1]. In recent years, there has been increasing scientific and industrial interest in plant-derived

bioactive compounds due to their safety, efficacy, and minimal side effects compared to synthetic chemicals. Natural products are being widely explored for applications in pharmaceuticals, nutraceuticals, and cosmetic industries. This shift is largely driven by growing consumer awareness regarding the potential health risks associated with prolonged use of synthetic additives and chemicals [5].

Pomegranate (*Punica granatum L.*) consists of arils, seeds, and peel, with the peel accounting for approximately 40–50% of the total fruit weight and often discarded as agro-industrial waste [2]. However, the peel is a rich source of polyphenolic compounds, including ellagitannins, ellagic acid, gallic acid, catechins, and quercetin, contributing to

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its high antioxidant capacity [3]. Oxidative stress, resulting from an imbalance between reactive oxygen species (ROS) and antioxidant defenses, plays a crucial role in the development of chronic diseases such as cancer, diabetes, and cardiovascular disorders [4]. Although synthetic antioxidants like BHT and BHA are widely used, their potential toxicity has led to increasing interest in natural alternatives [5].



Figure No.1: Pomegranate (*Punica granatum* L.)

Pomegranate peel has emerged as a promising natural antioxidant source with applications in nutraceuticals, pharmaceuticals, and cosmetics [6]. Its phytochemical composition can be evaluated through qualitative and quantitative screening methods. Phytochemical screening and antioxidant evaluation are essential steps in determining the biological potential of plant extracts. Standard qualitative tests help identify the presence of various classes of compounds, while antioxidant assays such as DPPH (2,2-diphenyl-1-picrylhydrazyl), ABTS [2,2'-azino-bis-(3-ethylbenzothiazoline-6-sulfonic acid)], and Ferric Reducing Antioxidant Power (FRAP) provide quantitative insights into their free radical

scavenging ability and reducing potential [7]. These methods are widely accepted for assessing the antioxidant capacity of plant-derived extracts.

Additionally, the bioactive compounds present in pomegranate peel make it suitable for herbal cosmetic formulations, offering both functional and aesthetic benefits [8],[10]. The valorization of agro-industrial waste, such as fruit peels, is an emerging area of research that aligns with the principles of sustainability and circular economy.

Cosmetics are products designed to enhance or alter the appearance of the human body, especially the face. Among cosmetic products, lipsticks are one of the most widely used items globally due to their ability to improve facial aesthetics and boost confidence. Traditionally, commercial lipsticks are prepared using synthetic dyes, pigments, and chemical preservatives, which may cause skin irritation, allergies, or other adverse effects in some users. The use of herbal ingredients in cosmetics is driven by the need for safer, multifunctional products. Pomegranate peel extract is a promising natural ingredient due to its potent biological activities and availability as a low-cost byproduct of the fruit industry. Formulating lipsticks with pomegranate peel extract addresses multiple concerns simultaneously: it provides a natural colorant, antioxidant protection, moisturization, and antimicrobial activity, while reducing reliance on synthetic chemicals. This research aims to develop an herbal lipstick that is not only aesthetically pleasing but also therapeutic, safe, and eco-friendly.

Utilizing pomegranate peel not only reduces environmental waste but also adds economic value by converting a low-cost byproduct into a high-value functional ingredient [6]. This approach supports sustainable development and resource efficiency in both food and cosmetic industries.

MATERIALS AND METHODS:

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Sample Collection:

Fresh pomegranate (*Punica granatum* L.) fruits were obtained from the local market of Pune. The peels were separated, washed thoroughly with sterile distilled water. Using a weighing balance the weight of peels was measured. The peels were then transferred into a tray and kept in a hot air oven at 100°C for 1 hour. The dried peels were ground into fine powder using a mechanical grinder. The powder was then placed in a petri plate and kept under an IR lamp for 1 hour. After an hour, the powder was kept in an air tight container for further use.

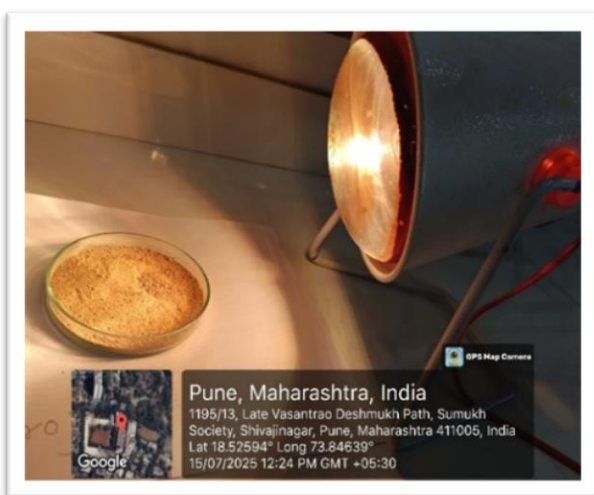


Figure No.2: Drying under IR lamp

Preparation of extract:

10grams of powdered peel material was transferred into a 250mL conical flask and 100mL of distilled water was added. The flask was then placed in rotory shaker at 100 rpm for 24 hours at room temperature. This was done to dissolve the powder, separate large particles and allow the maximum extraction of bioactive compounds. After 24 hours, filtration unit was set up by using a funnel and

Whatman filter paper. The filtered extract was then stored in a refrigerator for further use.

Methodology for phytochemical activity:

Test tubes were taken and each tube was labelled; desired amount of extract was added to all the tubes. Qualitative phytochemical analysis was performed using standard biochemical methods as described further ^[11].

❖ **Test for proteins:**

Biuret's test: The extract was treated with Biuret reagent and gently heated. The appearance of a violet coloration indicated the presence of proteins.

Ninhydrin test: The extract was mixed with Ninhydrin solution and heated. Development of a violet color confirmed the presence of amino acids and proteins.

❖ **Test for carbohydrates:**

Fehling's test: The extract was treated with Fehling's A and B solutions and heated. Formation of a brick-red precipitate indicated reducing sugars.

Benedict's test: Upon heating with Benedict's reagent, a reddish-brown precipitate confirmed carbohydrate presence.

Molisch's test: Addition of Molisch reagent followed by concentrated sulfuric acid produced a violet ring at the interface, indicating carbohydrates.

Iodine test: A blue-black coloration upon addition of iodine solution indicated the presence of starch.

❖ **Test for phenol:**

2 mL of alcohol and 2-3 drops of ferric chloride solution was added to 1 mL of extract, blue-green or black coloration indicated the presence of phenols.

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❖ Test for tannin:

1 mL of distilled water and 2-3 drops of ferric chloride solution was added to 0.5 mL of extract. A black coloration indicated the presence of tannin.

❖ Test for flavonoids:

Alkaline reagent test: The extract was mixed with 2% solution of NaOH. An intense yellow colour was formed which turned colourless on addition of few drops of diluted acid which indicated the presence of flavonoids.

❖ Test for saponins:

1mL of extract was mixed with 5mL of distilled water in a test tube and it was shaken vigorously. The formation of stable foam was taken as an indication for the presence of saponins.

❖ Test for glycosides:

Salkowski's test: 2mL of chloroform was mixed with the extract. Then 2mL of concentrated H_2SO_4 was added carefully and shaken gently. A reddish-brown colour indicated the presence of glycosides.

Keller-kilani test :0.5 mL of extract was mixed with 2ml of glacial acetic acid containing 2-3 drops of 2% solution of $FeCl_3$, then 2mL of concentrated H_2SO_4 was poured into the mixture. A brown ring at the interface indicated the presence of cardiac glycosides.

❖ Test for steroid:

2mL of chloroform was added to the extract. Then 2mL of concentrated H_2SO_4 and acetic acid were added into the mixture. The presence of steroids was indicated by appearance of a greenish coloration in the reaction mixture.

❖ Test for terpenoids:

The extract was mixed in 2mL of chloroform and evaporated. Then 2mL of concentrated H_2SO_4 was

added and heated for about a few minutes. Presence of terpenoids was indicated by a greyish colour at the interface.

❖ Test for alkaloids:

2mL of 1% HCl was mixed with crude extract and then heated gently. After heating, Mayer's and Wagner's reagents were added to the mixture. Precipitate in the reaction mixture which indicated the presence of alkaloids.

FRAP (Ferric Reducing Antioxidant Power) Assay:

The antioxidant capacity of the pomegranate peel extract was evaluated using the Ferric Reducing Antioxidant Power (FRAP) assay. This method is based on the principle that antioxidants present in the sample reduce ferric ions (Fe^{3+}) to ferrous ions (Fe^{2+}) under acidic conditions, resulting in the formation of a colored ferrous-tripyridyltriazine complex. The intensity of the color produced is directly proportional to the reducing power of the sample and, therefore, its antioxidant potential ^[12].

A series of extract concentrations was prepared to assess the concentration-dependent antioxidant activity. To each test sample, 2.5 mL of phosphate buffer (0.2 M, pH 6.6) was added, followed by 2.5 mL of 1% potassium ferricyanide solution. The reaction mixtures were thoroughly mixed and incubated at 50°C for 20 minutes to facilitate the reduction of ferric ions. After incubation, 2.5 mL of 10% trichloroacetic acid (TCA) was added to terminate the reaction, and the mixtures were centrifuged at 3000 rpm for 10 minutes to obtain a clear supernatant.

From the centrifuged mixture, 2.5 mL of the supernatant was transferred to a fresh test tube, and 0.5 mL of ferric chloride solution was added. The formation of a bluish-green color indicated the reduction of ferric ions to ferrous ions, confirming the presence of antioxidant compounds in the

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extract. The absorbance of the produced reaction mixture was measured at 700 nm using a spectrophotometer. An increase in absorbance corresponded to higher reducing power and stronger antioxidant activity ^[12].

Ascorbic acid was used as a standard reference compound (positive control) due to its well-established antioxidant properties, while distilled water served as the negative control. All experiments were carried out in triplicate to ensure reproducibility and accuracy of the results. The FRAP assay is widely used due to its simplicity, reproducibility, and ability to directly measure the electron-donating capacity of antioxidants. However, it primarily reflects the reducing ability of the sample and may not fully represent other mechanisms of antioxidant activity, such as radical scavenging or metal chelation. Therefore, it is often used in combination with other assays to obtain a comprehensive evaluation of antioxidant potential ^{[12],[14]}.

Preparation of herbal lipsticks:

Following ingredients were added as per Table No. 2

Required quantities of Shikakai powder, bees wax, paraffin wax were weighed separately. Paraffin wax and beeswax were melted together by using a double boiling method. This was our first mixture. Shikakai powder was triturated with castor oil, this was our second preparation. Once the waxes turned into a hot liquid, the second mixture and the first mixture were added slowly. To this, required quantity of lemon juice was added and heated properly. Then strawberry essence and vanilla essence were added to the hot mixture. This preparation was poured into the lipstick moulds and cold them by keeping in ice for about 30 minutes. Formulated lipsticks were removed and stored in refrigerator ^[16].

Ingredients	Use	Source
Paraffin wax	Hardness and glossiness	Herbal store in pune
Beeswax	Hardness and glossiness	Herbal store in pune
Castor oil	Blending agent	Herbal store in pune
Shikakai powder	Surfactant	Herbal store in pune
Pomegranate peel extract	Colouring agent	Extracted from pomegranates in laboratory by standard extraction procedure.
Lemon juice	Antioxidant	Squeezed from lemons practically.
Vanilla essence	Preservative	Herbal store in pune
Strawberry essence	Flavoring agent	Herbal store in pune

Table No.1: Ingredients of herbal lipstick

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Sr. no	Ingredients	F1	F2	F3	F4	F5	F6
1.	Paraffin wax	0.10 gm	0.10 gm	0.75 gm	0.65 gm	0.40 gm	0.90 gm
2.	Beeswax	1.10 gm	1.10 gm	1.10 gm	1.10 gm	1.10 gm	1.10 gm
3.	Castor oil	0.70 mL	0.80 mL	0.40 mL	0.60 mL	0.75 mL	0.60 mL
4.	Shikakai powder	0.50 gm	0.50 gm	0.50 gm	0.50 gm	0.50 gm	0.50 gm
5.	Pomegranate peel extract	0.80 mL	0.80 mL	0.80 mL	0.80 mL	0.80 mL	0.80 mL
6.	Lemon juice	0.04 mL	0.04 mL	0.04 mL	0.04 mL	0.04 mL	0.04 mL
7.	Strawberry essence	0.04 mL	0.04 mL	0.04 mL	0.04 mL	0.04 mL	0.04 mL
8.	Vanilla essence	1 drop	1 drop	1 drop	1 drop	1 drop	1 drop

Table No. 2: Formulation Table of Lipsticks containing Herbal Ingredients

Evaluation of synthesized herbal lipsticks:

Following tests were performed as per methods given [16]

- ❖ Organoleptic Properties -The lipsticks were first assessed for organoleptic characteristics like color, odor, and texture.
- ❖ Colour analysis- Colour of each formulated lipstick was checked and noted.
- ❖ Melting Point Analysis- Melting point was studied as it is a critical parameter influencing the stability and usability of lipstick formulations under varying environmental conditions.
- ❖ pH Determination- pH of each formulated lipstick was checked.
- ❖ Mechanical Strength (Breaking Point)- The mechanical strength of the lipsticks was evaluated using the breaking point test, which assesses the resistance of the formulation to applied pressure.
- ❖ Force of Application- The ease of application, an important consumer-related parameter, was assessed by evaluating the force required to apply the lipstick.
- ❖ Skin Irritation Test- The safety of the formulations was evaluated through a skin irritation test. All samples were applied to a small area of skin and observed for any adverse reactions such as redness, itching, or inflammation.
- ❖ Perfume Stability- Fragrance retention or stability was studied as it is an important quality parameter in cosmetic products.
- ❖ Thixotropy and Softening Point- Thixotropic behavior, which reflects the softness and spreadability of the formulation, was evaluated by measuring the depth of penetration.
- ❖ Surface Abnormalities- All formulations were examined for surface defects such as cracking, crystallization, or sweating.

RESULTS AND DISCUSSION:

The present study highlights the significant ability of pomegranate (*Punica granatum* L.) peel extract as a rich reservoir of bioactive compounds with several applications in both antioxidant treatment and cosmetic formulation. The phytochemical screening revealed the presence of major secondary metabolites, including phenolic compounds, flavonoids, tannins, saponins, and glycosides. Phenolic compounds and flavonoids are widely known for their ability to act as potent antioxidants. These compounds exert their effects primarily through free radical scavenging, hydrogen donation, and metal ion chelation, thereby reducing oxidative stress at the cellular level [1],[4]. The presence of tannins further enhances the antioxidant capacity of the extract due to their ability to bind

proteins and metal ions, which contributes to the stabilization of reactive species ^[14].

Test	Compound detected	Observation	Result
Ninhydrin Test	Amino acids/proteins	Very light purple coloration	+
Biuret Test	Proteins	Significant violet coloration	+
Fehling's Test	Reducing sugars	Brick-red precipitate	+
Benedict's Test	Reducing sugars	Reddish-brown precipitate	+
Iodine Test	Carbohydrates	Blue-black coloration	+
Molisch's Test	Carbohydrates	Purple/violet ring at interface	+
Phenol Test	Phenolic compounds	Deep bluish-green coloration	+
Tannin Test	Tannins	Brownish-green precipitate	+
Lead Acetate Test	Flavonoids	Yellow precipitate formation	+
Alkaline Reagent Test	Flavonoids	Intense yellow coloration	+
Saponin Test	Saponins	Persistent froth formation	+
Salkowski's Test	Steroids	Red coloration in lower layer	+
Keller–Killiani Test	Glycosides	Brown ring formation at the interface	+
Terpenoid Test	Terpenoids	Reddish-brown coloration	+

Table No. 3: Phytochemical analysis (+ symbol indicates presence of compound.)

The antioxidant activity of the pomegranate extract was evaluated using the FRAP assay at 700 nm. The absorbance recorded for pomegranate was 0.38, whereas the positive control (ascorbic acid) showed an absorbance of 0.39.

To express the antioxidant capacity in percentage relative to the control, the following formula was applied:

$$\% \text{ antioxidant activity} = (\text{absorbance of sample} / \text{absorbance of control}) \times 100$$

Using this,

$$\% \text{ antioxidant activity} = 0.38 / 0.39 \times 100 = \underline{97.43}$$

This indicates that the antioxidant potential of the pomegranate extract is similar with the standard antioxidant (ascorbic acid) used as the positive control.

The antioxidant activity assessed using the FRAP assay demonstrated a concentration-dependent increase in reducing power, indicating that higher concentrations of the extract exhibit greater electron-donating capacity. This observation is consistent with previous studies reporting that the antioxidant potential of pomegranate peel is strongly correlated with its high polyphenolic content ^{[3],[12],[14]}. It is important to note that antioxidant activity is influenced by multiple mechanisms, including radical scavenging, reducing power, and inhibition of oxidative enzymes. While the FRAP assay provides

valuable insight into the reducing ability of the extract, it represents only one aspect of antioxidant behavior. Therefore, the observed antioxidant activity of pomegranate peel extract can be attributed to the combined effects of its diverse phytochemical composition [7],[14].

In addition to its antioxidant potential, the study also explored the application of pomegranate peel extract in the formulation of herbal lipsticks. The results demonstrated that the extract not only provided natural pigmentation but also contributed to the overall quality and performance of the formulations. The variation in color intensity across different formulations was directly related to the concentration of the extract, which is consistent with the known pigment properties of anthocyanins and other polyphenolic compounds present in pomegranate peel [8],[13].

The herbal lipsticks were successfully prepared using pomegranate peel extract as the natural colorant. Unlike synthetic dyes, which are widely used in commercial lipsticks but often associated with toxicity and allergic responses, the pomegranate peel extract offered a safe, plant-based coloring alternative. Each formulation (F1–F6) was prepared in single-tube quantities to facilitate precise laboratory evaluation. This small-scale production ensured uniformity of ingredients and minimized experimental error while allowing for direct comparison of formulations. All six formulations were smooth in texture and aesthetically acceptable. The variation in shade intensity across formulations was primarily due to the concentration of pomegranate peel extract and the proportion of wax-to-oil ratios. Pomegranate peel is rich in anthocyanins and tannins, which impart a reddish-brown hue. Formulations containing higher amounts of extract (F5 and F6) displayed deeper shades compared to those with smaller amounts (F1 and F2).

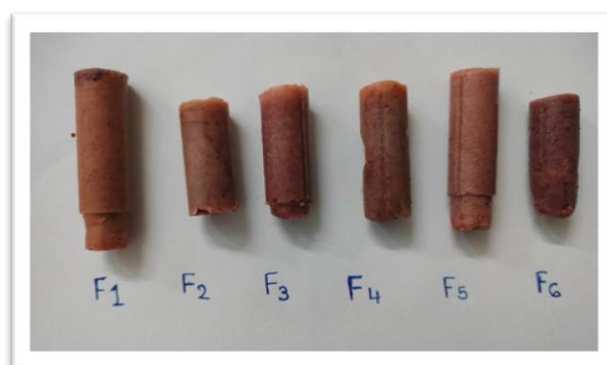


Figure No.3: F1 to F6 herbal lipstick formulations

All samples exhibited an aromatic smell, largely due to the addition of strawberry and vanilla essences, which masked the natural astringency of pomegranate peel. The texture was smooth and uniform across all six formulations. The prepared lipstick formulations exhibited a gradual variation in color intensity depending on the concentration of pomegranate peel extract. Formulations F1 and F2 produced relatively lighter reddish-brown shades, which may be preferred by users seeking a subtle and natural appearance. In contrast, F3 and F4 displayed moderately intense shades, offering a balance between visibility and natural aesthetics. The deepest reddish-brown tones were observed in F5 and F6, closely resembling commercially available synthetic lipsticks. This variation in coloration can be attributed to the presence of anthocyanins and polyphenolic compounds in pomegranate peel extract, which are known to impart rich pigmentation. Similar observations have been reported in earlier studies, confirming the suitability of pomegranate peel as a natural colorant for cosmetic applications [8],[13]. Thus, the extract not only enhances visual appeal but also contributes functional benefits.

The formulations exhibited melting points in the range of 53–64°C. Formulations F1 and F2 showed comparatively lower melting points (53–55°C), indicating a softer consistency and higher susceptibility to deformation under elevated temperatures. F3 and F4 demonstrated moderate thermal stability (59–62°C), while F5 and F6 exhibited higher melting points (62–64°C), suggesting improved structural integrity. The increased melting point in F5 and F6 can be attributed to a higher proportion of wax components, which enhance rigidity and thermal resistance. These

findings indicate that optimal wax concentration is essential for achieving desirable stability in lipstick formulations.

The pH values of all formulations ranged from 6.3 to 6.9, which lies within the acceptable range for products intended for application on the lips. Maintaining a near-neutral pH is essential to prevent irritation, dryness, or discomfort upon application. The observed pH values suggest that the formulations are compatible with the delicate skin of the lips. Comparable findings have been reported in previous studies on herbal lipsticks, indicating that plant-based extracts, including pomegranate peel, do not significantly disrupt the pH balance of cosmetic formulations^{[9],[10]}. This supports the suitability of the extract for safe topical use.

The results indicated that formulations containing higher wax concentrations, particularly F5 and F6, exhibited greater mechanical strength and withstood higher loads before breaking. This suggests that wax content plays a crucial role in determining the structural stability of lipstick formulations. Adequate mechanical strength is essential to ensure durability during handling and application.

Formulations F1 and F2 required comparatively higher effort during application, which may be due to an imbalance in wax-to-oil ratio or lower oil content. In contrast, F5 and F6 demonstrated smoother and more uniform application, indicating an optimal balance between wax, oil, and pigment. These results are consistent with previous studies that highlight the importance of formulation composition in determining spreadability and user acceptability^[15]. Products that offer smooth application are generally preferred by consumers.

None of the formulations exhibited any signs of irritation, indicating that they are safe for topical application. These findings are supported by earlier studies that report the non-toxic and biocompatible nature of pomegranate peel extract, which contains bioactive compounds with antimicrobial and protective properties^{[10],[11]}. This enhances the overall functional value of the formulation.

All formulations maintained their fragrance during the storage period, although F1 and F4 showed slightly better stability. This may be due to lower

concentrations of extract, minimizing interactions between bioactive compounds and volatile fragrance components. The results suggest that the incorporation of pomegranate peel extract does not significantly interfere with perfume stability, making it suitable for use in fragranced cosmetic formulations.

Among the formulations, F5 exhibited the most desirable thixotropic properties, indicating an optimal balance between firmness and ease of application. The softening point of the formulations ranged between 53–58°C, confirming that the products can maintain structural integrity during handling and use. These parameters collectively indicate that F5 achieved the most favorable balance between mechanical strength and usability. Additionally, no surface abnormalities were observed in any of the samples, indicating good formulation stability and uniformity.

Based on the evaluation parameters, all formulations (F1–F6) were found to be stable, safe, and suitable for cosmetic use. A gradual increase in color intensity was observed with increasing concentration of pomegranate peel extract. Among all formulations, F5 demonstrated the best overall performance, exhibiting optimal color intensity, mechanical strength, smooth application, and fragrance stability. Compared to conventional synthetic dyes and other natural colorants, it offers improved safety, stability, and bioactivity. Therefore, it can be considered a promising, eco-friendly alternative for use in lipstick formulations.

The superior performance of F5 highlights the importance of formulation optimization in the development of herbal cosmetic products. The findings of the present study also have broader implications in the context of sustainability and waste utilization. Pomegranate peel, which is typically discarded as agro-industrial waste, can be effectively valorized as a high-value ingredient in cosmetic and pharmaceutical applications. This not only reduces environmental waste but also provides an economical and sustainable alternative to synthetic chemicals^[6].

The dual functionality of pomegranate peel extract as both a colorant and a bioactive agent makes it particularly attractive for use in modern cosmetic formulations^{[8],[9],[10]}. Overall, the results of this study clearly demonstrate that pomegranate peel extract

possesses significant antioxidant activity and can be successfully incorporated into herbal lipstick formulations without compromising product quality. The study not only confirms the functional benefits of the extract but also highlights its potential as a sustainable and safe alternative to conventional synthetic ingredients.

CONCLUSION

The present study successfully demonstrated that pomegranate (*Punica granatum* L.) peel is a rich and valuable source of bioactive compounds with significant antioxidant potential and promising applications in cosmetic formulations. The qualitative phytochemical analysis confirmed the presence of key secondary metabolites, including phenolics, flavonoids, tannins, saponins, and glycosides, which are known to contribute to a wide range of biological activities [2],[3],[8]. The antioxidant activity evaluated using the Ferric Reducing Antioxidant Power (FRAP) assay revealed that the pomegranate peel extract possesses strong reducing capacity, indicating its effectiveness as a natural antioxidant. The observed activity can be attributed to the high concentration of polyphenolic compounds, which play a crucial role in neutralizing reactive oxygen species and preventing oxidative damage [3],[12],[14]. These findings support the potential use of pomegranate peel extract in applications aimed at combating oxidative stress-related conditions.

In addition to its antioxidant properties, the study explored the feasibility of incorporating pomegranate peel extract into herbal lipstick formulations. The results demonstrated that the extract effectively imparted natural coloration and contributed to the overall quality of the formulations. All prepared lipsticks exhibited acceptable physicochemical properties, including suitable melting point, near-neutral pH, adequate mechanical strength, smooth application, and good stability. The absence of skin irritation further confirmed the safety and compatibility of the formulations for topical use [9],[10],[16].

Among the different formulations, F5 was identified as the most optimized formulation, as it achieved an ideal balance between color intensity, structural stability, spreadability, and fragrance retention. This

highlights the importance of optimizing formulation parameters, particularly the ratio of wax, oil, and active ingredient, to achieve desirable product characteristics. The study also emphasizes the potential of utilizing agro-industrial waste, such as pomegranate peel, as a value-added resource. The conversion of this underutilized byproduct into a functional ingredient aligns with the principles of sustainability and waste minimization, offering both environmental and economic benefits [6].

Overall, the findings of this study establish pomegranate peel extract as an effective, safe, and sustainable alternative to synthetic antioxidants and colorants in cosmetic formulations. Future studies may focus on the quantitative estimation of individual phytochemicals, evaluation of long-term stability, and assessment of additional biological activities such as antimicrobial and anti-inflammatory effects. Such investigations would further strengthen the scientific basis for the large-scale utilization of pomegranate peel extract in commercial applications.

REFERENCES

1. Balasundram N, Sundram K, Samman S. Phenolic compounds in plants and agri-industrial by-products: Antioxidant activity, occurrence, and potential uses. Food Chemistry. 2006;99(1):191–203.
2. Singh B, Singh JP, Kaur A, Singh N. Phenolic compounds as beneficial phytochemicals in pomegranate (*Punica granatum* L.) peel: A review. Food Chemistry. 2018;261:75–86.
3. Li Y, Guo C, Yang J, Wei J, Xu J, Cheng S. Evaluation of antioxidant properties of pomegranate peel extract in comparison with pomegranate pulp extract. Food Chemistry. 2006;96(2):254–260.
4. Lobo V, Patil A, Phatak A, Chandra N. Free radicals, antioxidants and functional foods: Impact on human health. Pharmacognosy Reviews. 2010;4(8):118–126.
5. Brewer MS. Natural antioxidants: Sources, compounds, mechanisms of action, and potential applications. Comprehensive Reviews in Food Science and Food Safety. 2011;10(4):221–247.
6. Viuda-Martos M, Fernández-López J, Pérez-Álvarez JA. Pomegranate and its many functional components as related to human health.

- Comprehensive Reviews in Food Science and Food Safety. 2010;9(6):635–654.
7. Sharma A, Sharma S. Evaluation of phytochemical constituents and antioxidant potential of pomegranate peel extract. *Journal of Pharmacognosy and Phytochemistry*. 2019;8(2):345–350.
8. Hasnaoui N, Wathelet B, Jiménez-Araujo A. Pomegranate peel as a valuable source of bioactive compounds: A review. *Journal of Medicinal Plants Research*. 2014;8(5):204–213.
9. Mishra P, Dwivedi S. Formulation and evaluation of lipstick containing herbal ingredients. *Asian Journal of Medical and Pharmaceutical Research*. 2012;2(3):58–60.
10. Sharma P, Singh R, Singh B. Pomegranate peel extract: A natural bioactive ingredient for herbal cosmetics. *International Journal of Green Pharmacy*. 2018;12(3):173–178.
11. Borah R. Tulsi (*Ocimum sanctum*): An excellent source of phytochemicals. *International Journal of Environment, Agriculture and Biotechnology*. 2018;3(5):1732–1738.
12. Benzie IFF, Strain JJ. The ferric reducing ability of plasma (FRAP) as a measure of antioxidant power. *Analytical Biochemistry*. 1996;239(1):70–76.
13. Singh B, Singh JP, Kaur A, Singh N. Phenolic composition and antioxidant potential of pomegranate peel. *Food Chemistry*. 2019;272:313–320.
14. Sreekumar S, Sithul H, Muraleedharan P, Azeez JM, Sreeharshan S. Pomegranate fruit as a rich source of biologically active compounds. *BioMed Research International*. 2014;2014:686921.
15. Deshmukh M, Chavan M, Sutra M, Singh S. Formulation and evaluation of herbal lipstick from pomegranate and beetroot. *International Journal of Pharmacy and Herbal Technology*. 2024;14(1):2253–2260.
16. Rani GS, Pooja G, Harshavardhan V, Madhav BV, Pallavi B. Formulation and evaluation of herbal lipstick from beetroot extract. *Research Journal of Pharmacognosy and Phytochemistry*. 2019;11(3):154–159.

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