Formulation of Skin Bleach Using Fruit and Vegetable Peels

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ABSTRACT

The increasing demand for sustainable and plant-based cosmetic formulations has promoted the exploration of agro-waste materials as potential sources of bioactive compounds. The present study investigates the extraction of phytochemicals from selected fruit and vegetable peels, namely pomegranate (*Punica granatum*), orange (*Citrus sinensis*), tomato (*Solanum lycopersicum*), and carrot (*Daucus carota*), and their application in the formulation of a herbal face cream. The combined peel powder was subjected to Soxhlet extraction using ethanol, followed by preliminary phytochemical screening, antioxidant evaluation using DPPH radical scavenging assay, antimicrobial activity assessment by agar well diffusion method, and chromatographic analysis using High Performance Liquid Chromatography (HPLC). Phytochemical analysis confirmed the presence of phenolics, flavonoids, tannins, and other secondary metabolites. The extract exhibited significant antioxidant activity, indicating strong free radical scavenging potential. Antimicrobial studies demonstrated inhibitory effects against *Escherichia coli* and *Staphylococcus aureus*. HPLC chromatograms recorded at 214 nm and 280 nm revealed multiple peaks corresponding to UV-active phenolic and flavonoid compounds indicating effectiveness to be used as a skin bleach.

Keywords: Agro-waste valorization, Peel extract, Phytochemicals, Antioxidant activity, Antimicrobial activity, HPLC analysis.

INTRODUCTION

Fruit and vegetable peels, commonly regarded as agro-waste, represent an abundant and underutilized source of valuable phytochemicals. Several studies have demonstrated that peels contain higher concentrations of polyphenols, flavonoids, tannins, carotenoids, and other antioxidant compounds compared to their edible portions (Mo *et al.*, 2022). These bioactive constituents exhibit significant antioxidant, antimicrobial, anti-inflammatory, and anti-aging properties, making them promising candidates for cosmetic applications.

Pomegranate peel (*Punica granatum*) is known to contain high levels of ellagic acid, punicalagin, and hydrolyzable tannins, which possess strong free radical scavenging and antimicrobial activity. Orange peel (*Citrus sinensis*) is rich in flavonoids such as hesperidin and vitamin C, contributing to skin brightening and antioxidant protection. Tomato peel (*Solanum lycopersicum*) contains lycopene and phenolic compounds that protect against oxidative stress and UV-induced damage. Carrot peel (*Daucus carota*) is a source of beta-carotene and polyphenols, known for their skin rejuvenating properties (Das *et al.*, 2021).

Antioxidants neutralize these free radicals, thereby protecting skin cells and delaying premature aging. Therefore, incorporation of antioxidant-rich plant extracts into topical formulations is scientifically justified.In addition to antioxidant protection, antimicrobial activity is an essential parameter in cosmetic development. Microbial contamination not only reduces product shelf life but may also cause skin infections. Plant-derived

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bioactive compounds can inhibit the growth of pathogenic microorganisms such as *Staphylococcus aureus* and *Escherichia coli*, enhancing both product safety and therapeutic value.

The present study focuses on the extraction of bioactive compounds from selected fruit and vegetable peels, evaluation of their phytochemical, antioxidant, and antimicrobial properties, and formulation of a herbal face cream containing 3% combined peel extract. It demonstrated the potential of agricultural waste materials as valuable sources of natural cosmetic ingredients, promoting sustainability and scientific innovation in herbal product development.

MATERIALS AND METHODS

1. Collection and Preparation of Plant Materials

Fresh pomegranate (*Punica granatum*), orange (*Citrus sinensis*), tomato (*Solanum lycopersicum*), and carrot (*Daucus carota*) peels were shade dried, powdered and sieved through 40 mesh to obtain fine powder.

2. Preparation of Combined Peel Extract (Soxhlet Extraction)

25 g of mixed peel powder dissolved in 95% ethanol in a ratio of 15:1 (solvent:solid) and extracte using Soxhlet apparatus. The concentrated extract was stored in an amber bottle at 4°C until further analysis.

3. Phytochemical Screening

The combined extract was subjected to qualitative phytochemical tests to identify the presence of major secondary metabolites. **Alkaloids (**Mayer's, Dragendorff's, and Wagner's test) **Flavonoids** (Alkaline reagent test) **Tannins** (Ferric chloride test**) Phenols(**Ferric chloride test).

4. Antioxidant Activity (DPPH Assay)

The antioxidant activity of the combined extract was evaluated using the DPPH radical scavenging method. A 0.1 mM DPPH solution was prepared in methanol. One milliliter of extract solution was mixed with 1 mL of DPPH solution and incubated in the dark for 30 minutes. The absorbance was measured at 517 nm using a UV-Visible spectrophotometer. Ascorbic acid was used as standard. The percentage inhibition was calculated using the formula:

$$\% \text{ Inhibition} = \frac{[(\text{absorbance of Control} - \text{absorbance of Sample})]}{\text{absorbance of Control}} \times 100$$

5. Antimicrobial Activity (Agar Well Diffusion Method)

The antimicrobial activity was evaluated using the agar well diffusion method against *Escherichia coli* and *Staphylococcus aureus*. Mueller–Hinton agar plates were prepared and inoculated with bacterial culture. Wells were made using a sterile cork borer, and 50 µL of extract was added into each well. Plates were incubated at 37°C for 24 hours. The zone of inhibition was measured in millimeters. Gentamicin was used as positive control.

Formulation And Evaluation

Phase A & B

The face cream was formulated using an oil phase consisting of stearic acid (0.6 g), cetyl alcohol (0.8 g), and coconut oil (2.4 mL) phase A, which was combined with an aqueous phase containing glycerin (1 mL), propylene glycol (0.38 mL), and distilled water (14 mL) phase B, to obtain a stable oil-in-water emulsion.

Phase C & D

The active phase A&B incorporated combined peel extract (0.6 mL) phase C into the base formulation, followed by the addition of methyl paraben (0.1 g) as preservative and vanilla essential oil (0.05 mL) phase D

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as fragrance. The final pH was adjusted to 6.0 using citric acid and sodium hydroxide solution to ensure formulation stability and dermal compatibility.

Cream Preparation Procedure

1. Heat Phase A ingredients in a beaker until melted at 70°C.

2. Heat Phase B ingredients to 70°C.

3. Slowly add Phase B to Phase A with continuous stirring to form an emulsion.

4. Cool the emulsion to 45°C.

5. Add Phase C (combined peel extract) and mix thoroughly.

6. Add Phase D (methyl paraben, vanilla essential oil, pH adjuster) and stir.

7. Cool to room temperature (25°C) with gentle stirring.

8. Check pH (6.0), texture, and viscosity.

Evaluation

The formulated face cream exhibited a skin-compatible pH of 6.0 with smooth and uniform consistency, indicating good formulation stability. It showed easy spreadability with a non-greasy feel and pleasant aroma, making it suitable for topical cosmetic application.

RESULTS AND DISCUSSION

1. Phytochemical Screening

Phytochemical constituent	Test performed	Result
Alkaloids	Mayer's,Dragendorff's, Wagner's	Present
Flavonoids	Alkaline reagent	Present
Phenols	Ferric chloride	Present
Tannins	Ferric chloride	Present

Table 1. Phytochemical Screening Test

2. DPPH Radical Scavenging Activity

The antioxidant activity of the combined peel extract was evaluated using the DPPH assay. The extract demonstrated strong radical scavenging activity in a dose-dependent manner.

Concentration of sample(µg/mL)	% Inhibition (Mean ± SD)
Ascorbic Acid (100 µg/mL)	95 ± 0.9
20	28 ± 1.2
40	45 ± 1.5
60	58 ± 1.4
80	68 ± 1.3
100	78 ± 1.6

Table 2. DPPH Radical Scavenging Activity

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3. Antimicrobial Activity

The combined peel extract exhibited significant antibacterial activity against both Gram-positive and Gram-negative bacterial strains. The activity increased in a concentration-dependent manner.

Sample (50 µL)	Concentration (µg/ml)	*E.coli* (mm)	*S.aureus* (mm)
Gentamicin (Positive Control)	20 µg/ml	22 ± 0.3	24 ± 0.4
Combined Peel Extract	25 µg/ml	9 ± 0.5	10 ± 0.6
Combined Peel Extract	50 µg/ml	12 ± 0.4	14 ± 0.5
Combined Peel Extract	100 µg/ml	16 ± 0.6	18 ± 0.7

Table 3. Zone of Inhibition of Combined Peel Extract

Hplc Analysis

HPLC analysis of the combined peel extract was carried out using a C18 reversed-phase column with detection at 214 nm and 280 nm. Multiple peaks were observed, indicating the presence of various UV-active bioactive compounds.

Peak	Retention time	Area %	Height	Probable Compound Class
1	1.585	19.89%	2119.95	phenolic
2	1.749	24.81%	2054.19	flavonoid
3	17.080	6.43%	222.84	flavonoid aglycone
4	18.430	7.26%	557.52	flavonoid

Table 4. HPLC Peak Profile of Combined Peel Extract (214 nm)

Peak	Retention time	Area %	Height	Probable Compound Class
1	1.586	6.77%	907.76	phenolic
2	1.748	28.22%	2858.62	flavonoid
3	17.081	9.42%	232.65	flavonoid aglycone
4	18.431	9.06%	491.30	flavonoid

Table 5. HPLC Peak Profile of Combined Peel Extract (280 nm)

Physical Evaluation of Formulated Face Cream

The prepared herbal face cream appeared as a smooth, pale yellow semi-solid formulation with uniform consistency. The color of the cream is attributed to the presence of natural phytoconstituents extracted from the combined fruit and vegetable peels. (Mo *et al*., 2022). The formulation exhibited a pleasant odor due to the addition of essential oil. No phase separation, grittiness, or lump formation was observed, indicating proper emulsification and uniform distribution of ingredients. Das *et al*. (2021).

Homogeneity

The formulated cream was found to be homogeneous upon visual and tactile evaluation. It appeared smooth and free from coarse particles or phase separation, indicating proper mixing of the combined peel extract within the cream base. The uniform consistency suggests good formulation stability and even distribution of active constituents.

pH Determination

The pH of the formulated cream was found to be 6.0, which falls within the normal physiological skin pH range. This indicates good skin compatibility and suggests a reduced risk of irritation upon topical application.

Spreadability

The formulation exhibited good spreadability upon application. It spread uniformly without excessive drag, indicating appropriate viscosity and a stable oil–water balance within the emulsion system.

Stability, Functional Study

The formulated cream remained physically stable when stored under room temperature and refrigerated conditions. No significant changes in color, odor, consistency, or phase separation were observed during the study period, confirming the physical stability of the formulation.

The incorporation of the combined peel extract endowed the cream with antioxidant and antimicrobial properties. The presence of phenolic and flavonoid compounds, confirmed through phytochemical screening and HPLC analysis, supports the observed biological activity. These antioxidant constituents may help neutralize free radicals and reduce oxidative stress induced skin damage, while antimicrobial compounds may contribute to minimizing microbial contamination and promoting skin health.

CONCLUSION

The combined peel extract was rich in phenolics and flavonoids and exhibited significant antioxidant and antimicrobial activity. HPLC analysis further supported the presence of bioactive constituents responsible for these effects. The formulated cream demonstrated good physical stability, appropriate pH, smooth texture, and satisfactory spreadability.

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REFERENCES

1. Abbas KA, Mohamed A, Abdulamir AS, Abbas HA. 2008. A review on supercritical fluid extraction as new analytical method. Am J Biochem Biotechnol 4:345–53.
2. Abd-Talib N, Mohd-Setapar SH, Khamis AK. 2014. The benefits and limitations of methods development in solid phase extraction: mini review. J Teknol 69:69–72.
3. Ade-Omowaye BIO, Angersbach A, Taiwo KA, Knorr D. 2001. Use pulsed electric field pre-treatment to improve dehydration characteristics of plant based foods. Trends Food Sci Technol 12:285–95.
4. Afifi MM. 2011. Enhancement of lactic acid production by utilizing liquid potato wastes. Intl J Biotechnol Biochem 5:91–102.
5. Jalal, H.; Pal, M. A.; Ahmad, S. R.; Rather, M.; Andrabi, M.; Hamdani, S. Physico-chemical and functional properties of pomegranate peel and seed powder. J. Pharm. Innov. 2018, 7, 1127−1131.
6. Mo, Y.; Ma, J.; Gao, W.; Zhang, L.; Li, J.; Li, J.; Zang, J.Pomegranate peel as a source of bioactive compounds: A mini review on their physiological functions. Front. Nutr. 2022, 9, 887113.
7. Charalampia, D.; Koutelidakis, A. E. From Pomegranate Processing By-Products to Innovative value added Func-tional Ingredients and Bio-Based Products with Several Applications in Food Sector. BAOJ. Biotechnol. 2017, 3, 210.
8. Romelle, F. D.; Rani, A.; Manohar, R. S. Chemical composition of some selected fruit peels. Eur. J. Food Sci. Technol. 2016, 4, 12−21.
9. Ahmed, M.; Ali, A.; Sarfraz, A.; Hong, Q.; Boran, H. Effect of freeze-drying on apple pomace and pomegranate peel powders used as a source of bioactive ingredients for the development of functional yogurt. J. Food Qual. 2022, 2022, 3327401.
10. Das, A. K.; Nanda, P. K.; Chowdhury, N. R.; Dandapat, P.; Gagaoua, M.; Chauhan, P.; Pateiro, M.; Lorenzo, J. M. Application of pomegranate by-products in muscle foods: oxidative indices, colour stability, shelf life and health benefits. Molecules. 2021, 26, 467.

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11. Das, A. K.; Nanda, P. K.; Chowdhury, N. R.; Dandapat, P.; Gagaoua, M.; Chauhan, P.; Pateiro, M.; Lorenzo, J. M. Application of pomegranate by-products in muscle foods: oxidative indices, colourstability, shelf life and health benefits. Molecules. 2021, 26, 467.
12. Rowayshed, G.; Salama, A.; Abul-Fadl, M.; Akila-Hamza, S.; Emad, A. M. Nutritional and chemical evaluation for pomegranate (Punica granatum L.) fruit peel and seeds powders by products.Middle East J. Appl. Sci. 2013, 3, 169−179.
13. Ranjitha, J.; Bhuvaneshwari, G.; Terdal, D.; Kavya, K. Nutritional composition of fresh pomegranate peel powder. Int. J.Chem. Stud. 2018, 6, 692−696.