Applications of Banana and Orange peel extracts in formulation of herbal skin products

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Abstract: The herbal face pack formulation reveals promising results in the comprehensive test such as physicochemical analysis, irritancy, and stability tests. The following emphasizes analyzed by physicochemical test analysis, ANOVA test analysis, and irritancy test analysis on various skin types and stability test at room temperature cum 50°C. The physicochemical results of pH were neutral 6.82, moisture content 2.4%, acceptable ash percentage 83 ± 0.315 %, particle size 21.3 ± 2.9 µm. The ANOVA test shows a variation in the quality of the product with the changes in formulation and method of processing. The irritancy test performed on various skin types indicated no allergic types, which means product is safe for use. The stability test results showed no change in color and texture at 50°C; however, at room temperature, color and texture changed for face pack. In conclusion, herbal face pack is an effective and reliable product with a potential of improvise by quality in terms of stability and texture by changing the processing and formulations techniques.

Keywords: caffeine, total phenolic content, total flavonoid content, antioxidant activity

INTRODUCTION

Trend for all things natural has sparked the discovery of botanicals (David et al., 2015), often recognised not just as earthly holistic ingredients but environmentally friendly solutions too and these (Carolan, 2015), banana and orange peel extracts are increasingly being sought after by the personal care industry because of its bioactive compounds that have multiple benefits for skin health (Bhavani et al., 2023; Maqbool et al., 2023).

Since banana pesticides are full of antioxidants, vitamins and minerals; any cosmetic which contains these pesticide rich peels will be great for skin (Muhammad et al., 2018). Orange peels are also very high in vitamin C, flavonoids and essential oils which provide them with antioxidant and anti-inflammatory properties (Nazir et al., 2022). Though available, these peels are not properly used in the cosmetics industry (Barbulova et al., 2015).

There are individual studies in literature on banana and orange peels but no one has combined both for skincare until now (Bhavani et al., 2023). In particular, more in-depth research is warranted that measures the physicochemical properties as well as antioxidant (Siddique et al.) capacities and efficacies of these extracts in skincare formulations (Matias et al., 2023; Michalak, 2023).

The present research concentrates on formation and appraisal of herbal skin products by inclusion of banana peel extract and orange peel extract (Adeel et al., 2022). These included quantification of the bioactive components curcumin (Sahne et al., 2017), berberine, resveratrol as well as anthocyanin's and phenolic acids via UV-Vis spectrophotometry (Jaldappagari et al., 2013; Toma et al., 2024). The presence of these well-known chromophores in the extracts is consistent with their brown color and bioactivities displayed on various microbes (Agarwal et al., 2023; Muhammad et al., 2024).

Excellent properties of the formulated products were observed. The face pack had a pH of 6.82 near-neutral suitable for skin application and moisture value was found to be 2.4% making it adequately wet compatible with physical stability. The results showed that the extracts have marked antioxidant effects as evidenced by calibration curve prepared with standard solutions of ascorbic acid indicating a high Total Antioxidant Activity (TAA). Data were processed and explored via ANOVA or similar statistical tests to assure that the results can be reproduced reliably (Mannino et al., 2023) (Garcia-Amezquita et al., 2018). In vivo testing also supported the formulas' safety and efficacy on human skin, without adverse reactions.

Such structure implied that banana and orange oil were plausible to be great candidate in herbal exposition products of skin-care. This research also contributes to the validation of these natural ingredients for potential commercial use, by showing their efficacy and stability. The reuse and recycle of waste from agricultural sources adds value to the product, in this way aligning with consumer choice for environment friendly products created sustainably that are good rather than harmful. With the extracts successfully merged, it represents innovative green chemistry in natural skincare solutions, catering to consumers who are increasingly demanding non-toxic and sustainable beauty alternatives.

MATERIALS AND METHO

Sample Collection

Banana and Orange fruits were gathered randomly from several places of the Faisalabad Food Market. Healthy peels were handpicked from post harvested for defects and contaminant free peel. Thereafter, the samples were

immediately transported to the laboratory where they underwent processing and analysis in order to preserve their bioactive constituents for product formulation and evaluation studies (AyeshaTariq et al.; Noureen et al.).

Peel Extraction

Mature bananas (*Musa cavendish*) and unripe oranges (*Citrus sinensis L. cv*. "Bollo") were purchased from a local market in Faisalabad. Banana peels that are 2 cm long were sliced lengthwise and subjected to vacuum drying at ambient pressure in the range of 60,80, and 100°C (until constant weight) with mass checks conducted intermittently spaced during microwave coring. Orange peels were cut into segments of 4 cm × 0.35 cm and dried convectively at a temperature of70 °C for five hours. Samples were further packed in polyethylene bags and kept at room temperature protected from light during 24 h prior to analysis (Noor et al.).

Formulation of Herbal Face Pack

For the herbal face pack measure how much you need to be used, sieved for regular texture and purity. Take 15% Multani Mitti (Calcium Bentonite), 15% turmeric (Curcuma longa), 10% sandalwood (Santalum album), 5 % saffron(Crocus sativus) and mix it, add milk powder as well which is also in the quantity of about a good percentage i. e., around or more than to get that smooth consistency followed by rice flour(Oryza sativa) orang peel powder(Citrus sinensis) banana, peels(Musa acuminata). Make sure each ingredient is tested and good, especially turmeric, saffron or milk powder. First combine the sieved Multani Mitti and turmeric, next add sandalwood,saffron,milk powder,rice flour, orange peel power, banana peen powder. Combine into a clean mixing container and mix well until homogenized to ensure full incorporation for easy application (Alvi et al.).

Mixing and Storage

Quality-assured and cost-effective dried powdered ingredients of this herbal face pack. Store the face pack in an airtight container at 25°C, Keep it away from direct sunlight. Always consider the texture, scent, color and skin compatibility. The product undergoes patch tests and efficacy tests on pore reduction as well as skin whitening Quality checks and quick feedback allows for improving the script thus ensuring that it produces better results every time (Noureen et al.).

Banana Serum Formulation

Banana serum formula starts with selection of either Hyaluronic Acid 1-2% (to hydrate), or Jojoba Oil at 5%, which is quite matter to the touch. Baby Banana Cream contains 5-10% of banana extract, the main active ingredient in Table 1 to promote skin elasticity and wrinkle improvement. A 1-3 percent vitamin C derivative also helps to brighten and stabilize the mixture, as does a second metal salt manganese gluconate (0.5 - 1 percent) with added anti-inflammatory benefits. 0.5% preservatives, and 0.1% thickeners for product stability and texture. The serum is formulated with a low pH (~5.5) for better ingredient activity and the same acidity as healthy skin. It is demarcated for the stability testing and verifying that the properties of serum remain intact over a period (Hafeez, Mansha, et al., 2021).

Table 1: Formulation gradients of Banana serum

Ingredient	Target %	Brightening Focus	Oily Skin	Dry Skin	Soothing Focus
Banana Extract	5-10%	10%	5%	7.5%	5%
Vitamin C Derivative (Sodium Ascorbyl Phosphate)	1-3%	3%	1%	2%	1%
Base (Hyaluronic Acid or Jojoba Oil)	1-2% or 5%	1% (Hyaluronic Acid)	1% (Hyaluronic Acid)	2% (Hyaluronic Acid)	1% (Hyaluronic Acid)
Manganese Gluconate	0.5-1%	0.5%	0.5%	0.75%	1%
Preservatives	0.5%	0.5%	0.5%	0.5%	0.5%
Thickener (Xanthan Gum)	0.1%	0.1%	0.1%	0.1%	0.1%

Orange Serum Formulation

When developing a functional skincare serum, you will first need to carefully select the appropriate base ingredients along with active compounds that target particular skin problems. For lighter hydration, use water-based (80% distilled H_2O + 10% glycerin). For more moisture that's still non-greasy, oil-based (70 % grapeseed seed oil by volume + 20 % Sunflower seed Oil) main actives are the 5-10% Orange Peel Extract to provide antioxidants (F Hafeez et al., 2022), a vitamin C derivative at 1-3%, and then for some light

exfoliation effects - 0.5-2% Citric Acid. Stabilize with 0.5% preservatives and thicken using 0.1 xanthan gum Formulate to suit various skin types and have the desired outcomes making sure that the formulations remain at or near a slightly acidic pH (about 5.0) for good efficacy and safety performance.

Table 2: Formulation gradients of Orange serum

Ingredient	Target %	Oily Skin	Dry Skin	Antioxidant Focus	Exfoliation Focus
Base (Water or Oil Blend)	80-90%	Distilled Water (80%) + Glycerin (10%)	Grapeseed Oil (70%) + Jojoba Oil (10%)	Distilled Water (80%) + Glycerin (10%)	Distilled Water (80%) + Glycerin (10%)
Orange Peel Extract	5-10%	5%	7.5%	10%	5%
Vitamin C Derivative (Ascorbic Acid Glucoside)	1-3%	2%	1%	3%	1%
Citric Acid	0.5-2%	0.5%	1%	1%	2%
Preservatives	0.5%	0.5%	0.5%	0.5%	0.5%
Thickener (Xanthan Gum)	0.1%	0.1%	0.1%	0.1%	0.1%
Soothing Agent (Allantoin)	0.1%	-	0.5%	-	0.5%

Herbal Pack Evolution

Phytochemical Properties

Provisional phytochemical properties, such as Total Phenolic Compounds (TPCs) and the Total Antioxidant Activity (TAA), were performed by standardized methodologies reported elsewhere Oliveira et al. Each extraction and analysis was performed in triplicate (Hafeez, Zahoor, et al., 2021).

Sample Extraction

Samples (3g fresh or 0.45 g dried) were extracted with 20 ml of methanol, homogenized and the supernatants obtained by centrifugation at a speed of4°C5,000 rpm for l0 min and then filtered through a Whatman tissue paper no analysis was done in the same day (Freeha Hafeez et al., 2022).

Total Phenolic Compounds

Total polyphenols were estimated by the oxidation of phenolics with Folin–Ciocalteu reagent. OD at 750nm was measured using a UV/vis spectrophotometer and the results are presented as mg of gallic acid equivalent per g of dried weight in dry basis (Khushnood et al.).

Physiochemical Evolution

The pH, 2.4% moisture content; ash value of the herbal face pack formulation was found to be 6.82 and 83 ±0.315 respectively with mean particle size of (21.3±2·9µm), as per standard guidelines for qualitative parameters extracted from ingredients so that proper efficacy, safety and consistency can be ensured based on reference protocols frameworks (Shoaib et al.).

Irritancy Test

On their left hand, participants labeled a 1 cm^2 area and then applied the face pack. Every day the skin reaction quality observation is performed, which is examination of redness (erythema), and swelling/edematous lesion as well irritation based on comments of participants for 24 h after using (Noreen et al., 2022).

Stability Test

The formulation samples were stored in glass vials at 25 °C and room temperature for one month. Stability and compatibility of the development were evaluated long-term with regular assessment for color, odor, pH changes in consistency or overall feel (Nazeer et al., 2023).

Characterization

Extract absorption spectra are analyzed using UV-Vis spectroscopy Differences in color of curcumin, berberine resveratrol anthocyanins and phenolic acids (Iftikhar et al., 2023). The establishment of product standards that explain the pH, viscosity in terms of surface properties and interactions as well as particle size, moisture contents ensure physicochemical parameters. Total antioxidant activities were determined by ascorbic acid standards and ABTS solution, in mg of ascorbic acid equivalent per 100g. Data was analyzed with ANOVA, Tukey's test and non-parametric tests using SPSS basket version. Safety and efficacy of herbal skin products are tested in living organisms using methods like; In vivo testing.

RESULTS

Yield Extract

yields of the banana and orange extracts were identified by utilizing methanol, ethanol, ethyl acetate, chloroform and n-hexane as solvent. At 12.3% ± 0.2%, methanol had the best extraction efficiency for banana extract, followed by n-hexane at 6.1% ± 0.3%, ethanol at 11.8% ± 0.3%, ethyl acetate at 9.5% ± 0.4%, and chloroform at 8.2% ± 0.5%. Methanol generated the largest amount of orange extract, 14.5% ± 0.3%, followed by ethanol (13.8 ± 0.4%), ethyl acetate (11.2 ± 0.5%), chloroform (9.7% ± 0.6%), and n-hexane (7.2% ± 0.4%). All these indicate the vital role of choice of solvent in maximizing extraction efficiency for herbal skincare formulations.

Table 3: Extract yield in different solvents

Sr. No.	Solvent	Yield of Orange Extract (%)	Yield of Banana Extract (%)
3	Chloroform	9.7 ± 0.6	8.2 ± 0.5
2	Ethanol	13.8 ± 0.4	11.8 ± 0.3
3	Ethyl Acetate	11.2 ± 0.5	9.5 ± 0.4
1	Methanol	14.5 ± 0.3	12.3 ± 0.2
5	n-Hexane	7.2 ± 0.4	6.1 ± 0.3

Effect of Bioactive Compounds

Table 4 chloroform had the greatest total phenolic content (88.20 ± 0.50 mg GAE/g) among orange peel extracts, followed by n-hexane (75.90 ± 0.40 mg GAE/g), methanol (26.15 ± 0.30 mg GAE/g), ethyl acetate (82.50 ± 0.70 mg GAE/g), and ethanol (14.02 ± 0.18 mg GAE/g). Furthermore, at 55.30 ± 0.65 mg QE/g, chloroform exhibited the greatest total flavonoid concentration. It was followed by ethanol (9.85 ± 0.14 mg QE/g), n-hexane (42.15 ± 0.50 mg QE/g), methanol (15.20 ± 0.25 mg QE/g), and ethyl acetate (48.60 ± 0.85 mg QE/g).

Significant variations are seen in the total flavonoid concentration of banana peel extracts prepared in different solvents at 45°C. The greatest flavonoid concentration was found in ethyl acetate, at 13.02 ± 0.16 mg QE/g. Methanol came in second at 12.45 ± 0.09 mg QE/g, followed by n-hexane at 12.75 ± 0.14 mg QE/g, ethanol at 12.85 ± 0.12 mg QE/g, and chloroform at 12.95 ± 0.09 mg QE/g. These findings demonstrate how the choice of solvent affects extraction efficiency.

Ethanol also had the highest efficiency of extracting phenolic compounds from sweet orange peels and was followed by methanol, acetone, water, petroleum ether (raw sample), and hexane. This unequivocally confirms methanol, ethanol and water as excellent polar solvents in comparison to hexane or petroleum ether predominantly used organic solvent for a successful recovery of bioactive compounds from citrus peels.

Table 4: Total phenolic content (TPC) and total flavonoid content (TFC) of orange peel and banana peel extracts at 45°C

Solvent	Orange peel		Banana Peel	
	Total Phenolic Content (mg GAE/g)	Total Flavonoids Content (mg QE/g)	Total Phenolic Content (mg GAE/g)	Total Flavonoid Content (mg QE/g)
Methanol	26.15 ± 0.30	15.20 ± 0.25	24.15 ± 0.20	12.45 ± 0.09
Ethanol	14.02 ± 0.18	9.85 ± 0.14	13.02 ± 0.16	12.85 ± 0.12
Ethyl Acetate	82.50 ± 0.70	48.60 ± 0.85	81.03 ± 0.91	13.02 ± 0.16
Chloroform	88.20 ± 0.50	55.30 ± 0.65	86.12 ± 0.83	12.95 ± 0.09
n-Hexane	75.90 ± 0.40	42.15 ± 0.50	73.89 ± 1.15	12.75 ± 0.14

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successful recovery of bioactive compounds from citrus peels.

Antioxidant Activity

Table 5 reveals the influence of temperature on bioactive constituents in orange peel extract. Total phenolics and flavonoids exhibited progressive increases from 35 to 60 °C, as shown by changes in DPPH-RSA together with ABTS RSA (Antioxidant activities). The highest levels of total flavonoids (14.85 ± 0.18 mg QE/g) and phenolics (29.20 ± 0.25 mg QE/g), as well, obtained at an immersion in a water methanol bath for a duration with the temperature stability being fixed no higher than +45 °C were similar to maximum antioxidant activity against ABTS-RSA How did you calculate this table if it is not caused by adoption (%)DPPH -RSA (% inhibition)). These results indicate that the optimization of temperature is an important factor in increasing bioactive compounds content in orange peel extract, which may have significant health-promoting properties.

Table 5: Temperature effect on bioactive compounds in orange peel extracts

Temperature (°C)	Total Phenolics (mg GAE/g)	Total Flavonoids (mg QE/g)	ABTS-RSA (% inhibition)	DPPH-RSA (% inhibition)	α-Glucosidase (% inhibition)
35	25.45 ± 0.20d	14.15 ± 0.10c	84.10 ± 0.30d	78.20 ± 0.60c	73.40 ± 0.75c
40	27.10 ± 0.30c	14.50 ± 0.15b	85.20 ± 0.70c	79.60 ± 0.40b	74.10 ± 0.50b
45	29.20 ± 0.25b	14.85 ± 0.18a	87.00 ± 0.75b	81.00 ± 0.80a	74.80 ± 1.00b
50	28.90 ± 0.50b	14.75 ± 0.12a	86.40 ± 0.60b	80.80 ± 0.55a	74.50 ± 0.85b
55	28.70 ± 0.75b	14.65 ± 0.20b	86.70 ± 0.70b	80.60 ± 0.50a	74.60 ± 0.90b
60	26.35 ± 0.40d	14.70 ± 0.08b	86.10 ± 0.50b	80.00 ± 0.45b	73.80 ± 0.40c

This study was conducted to find out the changes in bioactive compounds, as well as antioxidant properties and α-glucosidase inhibitory potential of banana peel extracts upon extraction temperature (Dave et al., 2022). Changes in total phenolic and flavonoid contents, DPPH-RSA, ABTS-RSA, as well as α-glucosidase inhibition by varying the temperature from 35 to ~60 °C were considerable (Table 6). These findings exhibited highest values at 45 °C for Phenolic content (24.15 ± 0.20 mg GAE/g) and Flavonoid content reached it maximum value also at same temperature level (13.02±0,16 % w/w). This shifting of maximum DPPH-RSA and ABTS-RSA activity to 45 °C (81.03 ± 0.91% and 86.12 ± 0.83%, respectively). The inhibition of α-Glucosidase was somehow temperature dependent, and 45°C showed the highest activity % (73.89 ±1.15%). This further confirms 45°C as the best temperature to boost extraction of bioactive compounds and antioxidant power in banana peel extracts (Goyal et al., 2022). Values are presented as mean ± standard error (n = 3). Means followed by different lowercase letters in the same column differ significantly at $P < 0.05$.

Table 6: Temperature effect on bioactive compounds in banana peel extracts

Temperature (°C)	Total Phenolics (mg GAE/g)	Total Flavonoids (mg QE/g)	DPPH-RSA (% inhibition)	ABTS-RSA (% inhibition)	α-Glucosidase (% inhibition)
35	20.75 ± 0.18d	12.45 ± 0.09c	83.92 ± 0.24d	77.85 ± 0.73c	72.33 ± 0.92c
40	22.30 ± 0.30c	12.85 ± 0.12b	84.65 ± 0.79c	79.21 ± 0.42b	73.14 ± 0.61b
45	24.15 ± 0.20b	13.02 ± 0.16a	86.12 ± 0.83b	81.03 ± 0.91a	73.89 ± 1.15b
50	23.80 ± 0.40b	12.95 ± 0.09a	85.34 ± 0.63b	80.75 ± 0.56a	73.56 ± 0.92b
55	23.78 ± 0.60b	12.75 ± 0.14b	85.68 ± 0.72b	80.05 ± 0.49a	73.67 ± 0.95b
60	21.65 ± 0.32d	12.80 ± 0.04b	85.12 ± 0.57b	79.38 ± 0.45b	72.75 ± 0.31c

Physiochemical Analysis

Table 7 Physicochemical examination of herbal face pack formulation Being an acidic base, it had a pH of 6.79 which was near-neutral leading us to the conclusion that it must be used topically. After drying, the moisture percentage was 2.4%, which confirmed acceptable hydration status. Ash 83

±0.317%. There is a lesser amount of ash %, within normal ranges so that show the components are good in quality. The mean particle size was 21.4 ± 2.8μm obeying the application needs The tests like pH, loss of drying (LOD), Ash value and Particle size analysis were performed by following the standard protocols to ensure that all critical quality attributes are built into during formulation for its uniformity, purity (quality attribute) performance(effectiveness), safety.

Table 7: Physiochemical evaluation parameters

Sr. No.	Parameters	Value
1	pH	6.79
2	Moisture Content	2.4%
3	Ash Percentage	82 ± 0.317%
4	Particle Size	21.4 ± 2.8 μm

ANOVA Analysis

Table 8 ANOVA results for herbal face pack formulations and processing techniques full size table moreover, the formulation variation with 2 df and an SS of 125.6 led to a MS:62.8, F-value:5.21 (p = 0), pointing again that there were differences between sources in this field as well last table(supplement)(LS). Variation due to processing method was 32.8, SS =98.3, and df=3 (p-value;0.028, f value: 3.84) which indicates different results. TRUE The error term varied randomly with an MS of 2.37 and SS = 56.9 (df=24). These results also represent in Figure 1 suggest that the physicochemical properties of herbal face pack were significantly affected by both types of formulation and processing methods.

Table 8: ANOVA analysis of herbal face pack

Source of Variation	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F-value	p-value
Formulation	125.6	2	62.8	5.21	0.015
Processing Method	98.3	3	32.8	3.84	0.028
Error	56.9	24	2.37		
Total	280.8	29			

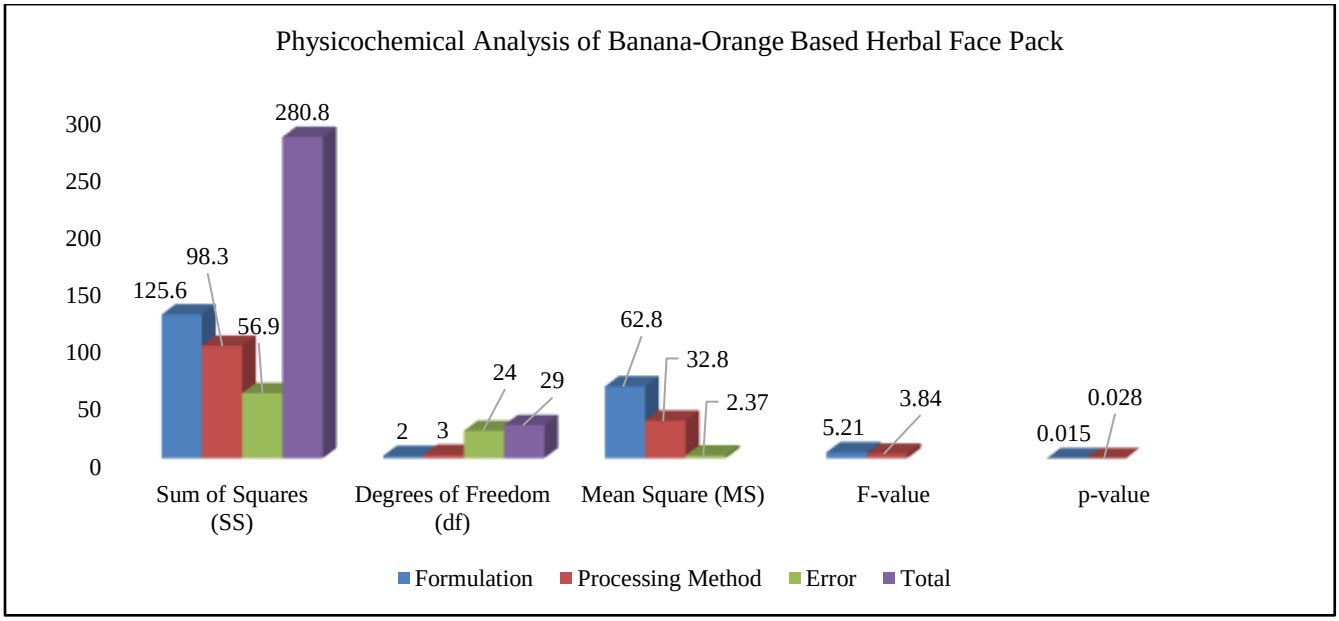

Figure 1: Physicochemical analysis of Banana-Orange based herbal face pack

Irritancy Test (vivo analysis)

The test subjects were therefore selected to represent a range of skin types and sensitivities. Simply did not use any skincare products for 24 hours before the test. The herbal face pack was manually applied to clean, dry skin on the forearm or behind the ear and participant were advised not wash this area &/or apply other products for 48-72 hours. Table 9 Sites were inspected for erythema, edema, pruritis, pain or patient reported allergic reaction (such as Dystonia), and Irritancy for each symptom, the observations were noted. The results demonstrated zero irritancy and allergenicity from the herbal face pack.

Table 9: Test for Banana Orange-Based herbal face pack

Sr. No.	Parameter	Observation
1	Allergy	None
2	Burning	None
3	Itching	None
4	Redness	None
5	Sensitivity	None
6	Swelling	None

Room temperature and 50°C Stability test (Table 10) The color of the product turned a little at room temperature but was stable at 50°C, and there was no smell change in either temperature. No significant changes were registered at room temperature, opposite to 50°C with a decrease in the degree of smoothness and texture from glutinous rice flour added starches as compared to no added ones. pH did not significantly vary under both conditions: at room temperature mean value was 6.92 ± SD =0.12 and for heated samples it decreased just below six point nine due maximum variation unforeseen standard deviation equation could provide (they are around zero).

Table 10: Stability test of herbal face pack

S. No	Parameter	Room Temperature	50°C
1	Color	Stable	Slight change
2	Odor	No change	No change

3	Texture	Slight change	Significant change
4	Smoothness	No change	Slight change
5	pH	6.92 ± 0.12	6.87 ± 0.13

CONCLUSION

According to the data furnished through all these analyses, herbal face pack has exhibited both positive and negative results. Physiochemical evaluation suggested skin-friendly nature of the face pack with nearly neutral pH, appropriate moisture content and stable particle size confirming acceptable formulation quality. ANOVA analysis showed significant differences both for formulation, and processing methods indicating that a fine tuning of these parameters might improve the product. There was no significant increase in the allergenic reaction while atopic patch test confirmed that it is safe for multiple types of skin. The stability test proved that product is stable which compared to odor and pH at different temperatures, where color & texture have more stability in higher temperature while less change found on room temperature. In conclusion, the herbal face pack is efficacious and safe although technical modifications in formulation and processing could improve its stability as well as attributes.

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REFERENCES

Adeel, S., Habiba, M., Kiran, S., Iqbal, S., Abrar, S., & Hassan, C. M. (2022). Utilization of colored extracts for the formulation of ecological friendly plant-based green products. *Sustainability*, *14*(18), 11758.

Agarwal, H., Bajpai, S., Mishra, A., Kohli, I., Varma, A., Fouillaud, M., . . . Joshi, N. C. (2023). Bacterial pigments and their multifaceted roles in contemporary biotechnology and pharmacological applications. *Microorganisms*, *11*(3), 614.

Alvi, K. I., Suleman, M., Batool, F., Iqbal, S., Hafeez, F., Afzal, A., . . . Bilal, M. Hydrothermal Green Synthesis of Silver Doped Molybdenum Nanocomposites Using Citrus Limetta Extract for Photo Catalytic Properties.

AyeshaTariq, M. S., Hafeez, F., Sana, K., Zafar, A., & Khan, I. A. A biodegradable approach for efficient and economical spectrophotometric assay for the Platelet aggregation inhibitor Clopidogrel.

Barbulova, A., Colucci, G., & Apone, F. (2015). New trends in cosmetics: By-products of plant origin and their potential use as cosmetic active ingredients. *Cosmetics*, *2*(2), 82-92.

Bhavani, M., Morya, S., Saxena, D., & Awuchi, C. G. (2023). Bioactive, antioxidant, industrial, and nutraceutical applications of banana peel. *International Journal of Food Properties*, *26*(1), 1277-1289.

Carolan, M. (2015). Affective sustainable landscapes and care ecologies: Getting a real feel for alternative food communities. *Sustainability Science*, *10*, 317-329.

David, B., Wolfender, J.-L., & Dias, D. A. (2015). The pharmaceutical industry and natural products: historical status and new trends. *Phytochemistry Reviews*, *14*, 299-315.

Garcia-Amezquita, L. E., Tejada-Ortigoza, V., Heredia-Olea, E., Serna-Saldívar, S. O., & Welti-Chanes, J. (2018). Differences in the dietary fiber content of fruits and their by-products quantified by conventional and integrated AOAC official methodologies. *Journal of Food Composition and Analysis*, *67*, 77-85.

Hafeez, F., Mansha, A., Zahoor, A. F., Ali, K. G., Khan, S. G., & Naqvi, S. A. R. (2021). Facile green approach towards the synthesis of some phenyl piperazine based dithiocarbamates as potent hemolytic and thrombolytic agents. *Pakistan Journal of Pharmaceutical Sciences*, *34*.

Hafeez, F., Zahoor, A., Irfan, M., Kamal, S., & Ahmad, S. (2022). Facile one-pot approach to the synthesis of alkyl piperazine-1-carbodithioates as hemolytic and thrombolytic agents. *Russian Journal of Organic Chemistry*, *58*(6), 884-890.

Hafeez, F., Zahoor, A. F., Rasul, A., Ahmad, S., & Mansha, A. (2021). Synthesis and anticancer evaluation of 2-oxo-2-(arylamino) ethyl 4-phenylpiperazine-1-carbodithioates. *Pak. J. Pharm. Sci*, *34*(1), 353-357.

Hafeez, F., Zahoor, A. F., Rasul, A., Mansha, A., Noreen, R., Raza, Z., . . . El-Hiti, G. A. (2022). Ultrasound-assisted synthesis and in silico modeling of methanesulfonyl-piperazine-based dithiocarbamates as potential anticancer, thrombolytic, and hemolytic structural motifs. *Molecules*, *27*(15), 4776.

Iftikhar, R., Parveen, I., Mazhar, A., Iqbal, M. S., Kamal, G. M., Hafeez, F., . . . Ahmadipour, M. (2023). Small organic molecules as fluorescent sensors for the detection of highly toxic heavy metal cations in portable water. *Journal of Environmental Chemical Engineering*, *11*(1), 109030.

Jaldappagari, S., Balakrishnan, S., Hegde, A. H., Teradal, N. L., & Narayan, P. S. (2013). Interactions of polyphenols with plasma proteins: insights from analytical techniques. *Current drug metabolism*, *14*(4), 456-473.

Khushnood, M., Hafeez, F., Suleman, M., Noor, T., Siddique, S., Bakar, A., & Bano, R. Formulation and Evaluation of Strawberry Extract/Oil infused anti-aging and anti-pigmenting Face serum.

Mannino, G., Serio, G., Gaglio, R., Maffei, M. E., Settanni, L., Di Stefano, V., & Gentile, C. (2023). Biological Activity and Metabolomics of Griffonia simplicifolia Seeds Extracted with Different Methodologies. *Antioxidants*, *12*(9), 1709.

Maqbool, Z., Khalid, W., Atiq, H. T., Koraqi, H., Javaid, Z., Alhag, S. K., . . . Afifi, M. (2023). Citrus waste as source of bioactive compounds: Extraction and utilization in health and food industry. *Molecules*, *28*(4), 1636.

Matias, M., Martins, A., Alves, C., Silva, J., Pinteus, S., Fitas, M., . . . Murray, P. (2023). New insights into the dermocosmetic potential of the red seaweed Gelidium corneum. *antioxidants*, *12*(9), 1684.

Michalak, M. (2023). Plant extracts as skin care and therapeutic agents. *International Journal of Molecular Sciences*, *24*(20), 15444.

Muhammad, A., Mohammed, I., & Ameh, M. (2018). banana (Musa sapientum L) in Sokoto Metropolis. *J Appl Biotechnol Bioeng*, *5*(3), 172-182.

Muhammad, M., Basit, A., Majeed, M., Shah, A. A., Ullah, I., Mohamed, H. I., . . . Ghanaim, A. M. (2024). Bacterial pigments and their applications. In *Bacterial Secondary Metabolites* (pp. 277-298). Elsevier.

Nazeer, U., Mushtaq, A., Zahoor, A. F., Hafeez, F., Shahzadi, I., & Akhtar, R. (2023). Cloke–Wilson rearrangement: a unique gateway to access five-membered heterocycles. *RSC advances*, *13*(50), 35695-35732.

Nazir, A., Itrat, N., Shahid, A., Mushtaq, Z., Abdulrahman, S. A., Egbuna, C., . . . Toloyai, P.-E. Y. (2022). Orange peel as source of nutraceuticals. In *Food and Agricultural byproducts as important source of valuable nutraceuticals* (pp. 97-106). Springer.

Noor, T., Afzal, I., Hafeez, F., Suleman, M., Siddique, S., & Khushnood, M. Incorporation of Cocoa Extracts into Herbal Skin Care Products.

Noreen, R., Aziz, H., Hafeez, F., Kamal, S., Zahoor, A. F., Parveen, B., & Akhtar, R. (2022). Facile synthesis, antibacterial and protease inhibition studies of β-amino alcohols prepared via ring opening of epoxides. *Pakistan Journal of Pharmaceutical Sciences*, *35*.

Noureen, A., Afzal, I., Hafeez, F., Iqbal, M., & Suleman, M. Development, Formulation and evaluation of anti aging gel utilizing Allium Cepa Extracts Asifa Noureen1, Iqra Afzal1, Freeha Hafeez1, Mateen Iqbal1, Muhammad Suleman1, Bisma1.

Sahne, F., Mohammadi, M., Najafpour, G. D., & Moghadamnia, A. A. (2017). Enzyme-assisted ionic liquid extraction of bioactive compound from turmeric (Curcuma longa L.): Isolation, purification and analysis of curcumin. *Industrial crops and products*, *95*, 686-694.

Shoaib, M., Suleman, M., Hafeez, F., Ahmad, M., & Mumtaz, N. Synthesis and Cytotoxic Evaluation of Functionalized Aryl-halo Amide Derivatives.

Siddique, S., Hafeez, F., Suleman, M., Khushnood, M., & Manzoor, B. Phytochemical and antioxidant Study of Ficus carica species available in Faisalabad region.

Toma, L., Deleanu, M., Sanda, G. M., Barbălată, T., Niculescu, L. Ș., Sima, A. V., & Stancu, C. S. (2024). Bioactive Compounds Formulated in Phytosomes Administered as Complementary Therapy for Metabolic Disorders. *International Journal of Molecular Sciences*, *25*(8), 4162.