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FORMULATION AND EVALUATION OF SKIN WHITENING NATURACEUTICAL COMPOSITION GEL AS ADVANCED DRUG DELIVERY SYSTEMS

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ABSTRACT

Backgrounds: Hyperpigmentation, a common skin disorder, is often managed with chemical lightening agents that can cause adverse effects. This study explores a novel approach by formulating and evaluating a skin-whitening gel that combines botanical extracts (Licorice, Turmeric, Pomegranate peels, and Citrus reticulate Blanco peels) with synergistic chemical ingredients (salicylic acid, vitamin C, vitamins E, B3, and B5, tea tree oil, and glycerin) ensuring safety (non-irritancy), stability (pH/viscosity optimization), and efficacy (melanin reduction) through standardized extraction, formulation, and clinical evaluation. **Methods Extraction**: Ethanol maceration (75%, 7 days) followed by rotary evaporation for licorice, turmeric, pomegranate, and citrus peels. **Evaluation**: Physicochemical tests (pH, spreadability), phytochemical screening (alkaloids, flavonoids), and irritancy trials. Results Phytochemicals: Licorice (flavonoids), turmeric (curcuminoids), pomegranate (ellagic acid), citrus (vitamin C). **Gel Properties**: pH 5.6, viscosity, non-irritant, Results showed that the gels were non-irritant, stable and possess all skin problem activity. **Clinical Evidence**: Visual "before-after" images demonstrated reduced hyperpigmentation. **Conclusion**: The herbal-chemical Gel ADDS exhibits promising safety and efficacy, validated by physicochemical stability and clinical observations. It underscores the potential of ethnopharmacology in developing culturally aligned, sustainable dermatological solutions.

KEYWORDS: Skin whitening, Yemeni herbal extract, Synergistic formulation, Tyrosinase inhibition, melanosomes inhibition. Gel ADDS.

INTRODUCTION

Background of Hyperpigmentation and Skin Whitening[1-83]

Hyperpigmentation, characterized by increased melanin production is influenced by UV exposure, hormones, drugs, and endocrine disorders. Melanin synthesis involves melanocyte homeostasis, MITF-M regulation, enzymatic action (tyrosinase, TRP-1, TRP-2), with tyrosinase being rate- limiting. Clinically, it manifests as solar lentigines, melasma, etc. significantly impacting quality of life.

Conventional treatments like hydroquinone, corticosteroids, and retinoids have limitations due to side effects like irritation and ochronotic. This necessitates exploring safer alternatives, including natural tyrosinase inhibitors combined with chemical exfoliants salicylic acid, antioxidants (vitamin E), melanosome transfer inhibitors (niacinamide, humectants, pantothenic acid, glycerin, and anti-inflammatory agents, tea tree oil, this study introduces a novel multifunctional whitening gel combining.

Yemeni botanical extracts (licorice, turmeric, pomegranate, mandarin) with niacinamide, panthenol, vitamin E, salicylic acid, and tea tree oil. The skin-friendly gel (pH ~5.6, viscosity ~8500 cP) was well-tolerated in preliminary trials and showed visible improvement in skin tone, reducing hyperpigmentation. This suggests the synergistic blend offers effective skin lightening with moisturizing and anti-inflammatory benefits.

Research Paths[79-178]

Scientific research that is organized in the form of Research Paths is characterized by the fact that, it is the most effective in achieving an idea, innovation, and development. It is linking the inductive plan, steps, goals, research methods, results, conclusion, materials, and equipment required to achievement scientific research. Research Paths are distinguishing that by build on each other and link the common relationship between them.

Pharmaceutical Research Paths

Pharmaceutical research is characterized by having both a natural source and synthetic source for primary active raw materials and excipients, each source is mainly prepared to the effectiveness and safety of the drug.

The Pharmaceutical Research Paths include: Pharmacognosy deals with natural sources of drug, Pharmaceutical Chemistry specializes in synthetic sources of drug, Pharmaceutics specializes in designing of pharmaceutical dosage forms and drug delivery systems from natural and synthetic sources of active pharmaceutical ingredients and excipients that help in developing dosage forms and drug delivery systems.

The Pharmaceutical Research Paths link steps are manufacturing and development of drug according to the standard parameters evaluation such as physiochemical properties, preformulation, formulation, evaluation, drug stability, Pharmaceutical analysis, pre-clinical, post-clinical stages, pre-marketing, post-marketing, Pharmacovigilance, Pharmacoeconomics, Pharmacy Management, Pharmacology, Toxicology, Therapeutics, Pharmaceutical Care, Health Care, Advanced Industrial Pharmacy, Biopharmaceutics and Pharmacokinetics, Advanced Clinical Pharmacokinetics, Pharmaceuticals Cosmetics, Pharmaceutical Biotechnology, Drug Design, Pharmacy Law and Ethics, Pharmacogenomics, Good Manufacturing Practice, and Good Pharmacy Practice etc.

All of these Pharmaceutical Research Paths are interconnected, and whenever the link between them is made in a scientific relationship and the goal of pharmaceutical care is achieved gradually according to plan of a scientific pharmaceutical research path.

Pharmaceutical Research Paths are the scientific methods through which the scientific relationship between the pharmaceutical team, research, supervisor or specialist researcher, the scientific research materials, equipment's, scientific institution, pharmaceutical companies, reference standards, and the goals of pharmaceutical research improve and development of community services of pharmaceutical care and health care.

Pharmaceutical Scientists are considering natural sources and medicinal herbs in the pharmaceutical industry an important part of drug development because natural sources of drugs have properties that are greater than industrial sources of drugs in NDDS. And the pharmaceutical industry strategies depend on the development of different pharmaceutical dosage forms and recent novel drug delivery systems. Using medicinal herbs and natural sources as important goals of drug development. It is part of the art of innovation in drug development with different of novel drug delivery systems and pharmaceutical care for patients and society, it's the basic of development of the new pharmaceutical industry by developing different novel drug delivery systems from different sources.

In the present study Formulate, develop and evaluate a skin whitening Gel ADDS of Naturaceutical extracts and chemical agents for safe and effective lightening of skin hyperpigmentation.

MATERIALS AND METHODS

Materials

The raw materials for the extracts include Glycyrrhiza glabra (licorice), Curcuma longa L. (turmeric), pomegranate peels, and Citrus reticulata Blanco peel (tangerine peel).

Glycyrrhiza glabra and Curcuma longa L According to [Extracts from The Medicinal Plant Geranium, were procured from local sources.

Pomegranate peels and Citrus reticulata Blanco peels were collected from the local market in Sana'a City, Yemen.

Carbopol 940, propylene glycol, triethanolamine, salicylic acid, Vitamin B3, Vitamin B5, Vitamin E, tea tree oil, and other excipients were procured from local sources The role of each material in the formulation, as shown in Table 1.

Table 1: The Composition of Gel Formulations.

Equipment's

Rotary evaporator (Biobase Industry, China) for ethanol removal. Vacuum filtration system (Vivohome, China). pH meter (Changzhou Xiangtan, China) calibrated to ASTM standards. Brookfield viscometer (NDJ-4S, spindle no. 3) for rheological analysis. Centrifuge (D-37520, Osterode, Germany) for stability testing.

Formulation and Evaluation of Gel Formulation ADDS[20-186]

Preparation of Extract

For Glycyrrhiza glabra, it was powdered using a Silver Crest grinder and sifted with a No. 40 mesh. An amount of 250 g of Glycyrrhiza glabra powder was macerated in 1.25 L of 75% ethanol for 7 days. The mixtures were shaken for 10 minutes each day for 7 days. The liquid extract was separated from the solids by vacuum-enhanced filtration through Whatman No. 1 filter paper. The filtrate was then subjected to rotary evaporator at 40°C under vacuum to remove ethanol.

No.	Ingredients	Role in Formulation
1	**Carbopol 940**	Thickening agent
2	**EDTA**	Chelating agent
3	**Ethanol (75%)**	Solvent for extraction
4	**Licorice Extract**	Tyrosinase inhibitor
5	**Salicylic Acid**	Keratolytic agent
6	**Citrus Reticulata Peel**	Antioxidant (Vitamin C source)
7	**Vitamin B3 (Niacinamide)**	Melanosome transfer inhibitor
8	**Vitamin B5 (Panthenol)**	Soothing agent, moisturizer
9	**Vitamin E**	Antioxidant, anti-inflammatory
10	**Tea Tree Oil (TTO)**	Antimicrobial; enhances vit. C and B3 efficacy
11	**Glycerin**	Emollient, improves texture
12	**Triethanolamine**	pH adjuster
13	**Propylene Glycol**	Solubilization of active ingredients
14	**Punica Granatum Peel**	Antioxidant, depigmenting agent
15	**Curcuma Longa Extract**	Anti-inflammatory, depigmenting agent
16	**Sodium Benzoate**	Preservative
17	**Fragrance**	Improves patient compliance
18	**Distilled water**	Solvent

Formulation of Gel ADDS

Extract Preparation

250g of powdered plant material was macerated in 1.25 L of 75% ethanol (7 days, daily agitation). Filtrate was concentrated via rotary evaporation (40°C, 150 mbar) and lyophilized.

Gel Preparation

Carbopol 940 (1.5% w/v) was hydrated in EDTA solution (0.2 g/70 mL H_2O).

Active ingredients were sequentially incorporated under homogenization (500 rpm, 25°C). pH adjusted to 5.6 using triethanolamine as shown in Table 2.

Preparation of Extracts

Plant Material

Powdered Glycyrrhiza glabra, Curcuma longa L., pomegranate peels, and Citrus reticulata Blanco peels (250g each, sieved through No. 40 mesh).

Extraction

Maceration in 1.25 L of 75% ethanol for 7 days with daily shaking.

Filtration

Vacuum-enhanced filtration using Whatman No. 1 filter paper.

Solvent Removal

Filtrate subjected to rotary evaporation at 40°C under vacuum to remove ethanol**.**

Drying and Storage

Extracts dried at 40°C, collected, and stored in the dark under refrigeration.

Phytochemical Screening

Alkaloids

Filtrate of extract in 1.5% HCl tested with Wagner's reagent (reddish-brown precipitate indicates presence).

Flavonoids

Extract treated with 1% ammonia solution (yellow color indicates presence).

Glycosides

Extract boiled with dil. H2SO4, filtered, chloroform added to filtrate, organic layer separated and treated with ammonia (pink/red color indicates presence.

Saponins

Extract shaken with water (persistent foam indicates presence).

Tannins

Extract treated with ferric chloride solution (brownish-green/blue-black color indicates presence).

Phenolics

Extract treated with 1% ferric chloride solution (blue/green color indicates presence).

Steroids

Extract treated with acetic acid anhydride and H_2SO_4 (bluish-green color indicates presence).

Table 2: Composition of the Developed Herbal Gel Formulations.

No.	*Ingredients*	*Quantity*
1	Carbopol 940	1.5% w/v
2	EDTA	0.02% w/v
3	Ethanol (75%)	Used in extraction
4	Licorice extract	0.9 g
5	Curcuma longa extract	0.9 g
6	Punica granatum peel extract	0.9 g
7	Citrus reticulata peel extract	0.9 g
8	Salicylic acid	1.5 g
9	Vitamin B3 (Niacinamide)	3 g
10	Vitamin B5 (Panthenol)	5 g
11	Tea tree oil (TTO)	0.5 g
12	Vitamin E	0.5 g
13	Glycerin	4 g
14	Propylene glycol	2 g (est.)
15	Triethanolamine	q.s.
16	Sodium benzoate	0.2%
17	Fragrance	0.1% (optional)
18	Distilled water	q.s. to 100g

Preparation of Plant Extracts

Pomegranate (*Punica granatum*) Peel Extraction

Fresh pomegranate fruits were washed, peeled, and shade-dried. The dried peels were pulverized using a Silver Crest grinder (Model SCG-300) and sieved (No. 40 mesh). A total of 250 g of powdered peel was macerated in 1.25 L of 75% ethanol for 7 days with daily agitation (10 min/day). The mixture was vacuum-filtered (Whatman No. 1 filter paper), and the filtrate was concentrated using a rotary evaporator (40°C, 150 mbar). The extract was oven-dried (40°C) and stored refrigerated (4°C) in amber glass vials.

Citrus (*Citrus reticulata* Blanco) Peel Extraction

An identical protocol was applied to citrus peels (250 g powder in 1.25 L 75% ethanol**).**

Phytochemical Profiling *Alkaloids (Wagner's Test).*

A 2–3 mL aliquot of the solvent-free extract was acidified with 1.5% HCl (v/v), filtered, and treated with Wagner's reagent. A reddish-brown precipitate indicated alkaloid presence.

Flavonoids (Shimoda Test)

To 2 mL of extract, 1 mL of 1% ammonia solution was added. A yellow coloration confirmed flavonoids.

Glycosides (Borntrager's Test)

The extract (3 mL) was acidified with dilute H_2SO_4, boiled, and filtered. Chloroform (3 mL) was added to the filtrate, and the mixture was shaken. Separation of the organic layer followed by ammonia addition produced a pink/red coloration in the aqueous phase, confirming glycosides.

Saponins (Foam Test)

A 1 mL aliquot of extract was vigorously shaken with 5 mL distilled water. Persistent foam formation indicated saponins.

Tannins (Ferric Chloride Test)

Ferric chloride solution (1% w/v) was added to 1 mL of extract. A brownish-green or blue-black coloration denoted tannins.

Phenolic Compounds (Ferric Chloride Test)

Addition of 1% ferric chloride solution to the extract yielded a blue/green color, confirming phenolics.

Steroids (Salkowski Test)

The extract (0.5 mL) was mixed with 2 mL acetic anhydride and 2 mL concentrated H_2SO_4. A bluish-green ring at the interface indicated steroids.

Gel Formulation Protocol

Gel Base Preparation

EDTA Solution

Ethylenediaminetetraacetic acid (EDTA) (0.2 g) was dissolved in distilled water (70 mL) under gentle agitation to form a clear solution (Beaker 1) (Skoog & West, 2014). *Carbopol Hydration:* Carbopol 940 (1.5% w/v) was dispersed into the EDTA solution and allowed to hydrate for 24 h at 25°C to form a gel matrix.

Active Ingredient Incorporation Extracts: Licorice (Glycyrrhiza glabra) extract (1.6% w/v), pomegrana). Peel extract (0.9% w/v), and citrus (Citrus reticulata Blanco) peel extract (0.9% w/v) were dissolved in distilled water (Beaker 3) under continuous stirring.

Salicylic Acid Solution

Salicylic acid (1.5 g) was dissolved in ethanol (3 mL) and glycerin (5 mL) (Beaker 3), then incorporated into the gel base under slow mixing.

Turmeric Extract
Turmeric (Curcuma longa) powder (0.2 g) was dissolved in ethanol (2 mL) (Beaker 4) and added to the gel base.

Vitamin and Oil Phase Integration
Water-Soluble Vitamins
Niacinamide (3% w/v) and panthenol (5% w/v) were dissolved in distilled water (Beaker 5) and homogenized into the gel.

Oil Phase
Tea tree oil (0.5% w/v), vitamin E (0.5% w/v), dimethicone (0.5% w/v), and phenoxyethanol (0.5% w/v) were combined (Beaker 6), mixed to homogeneity, and gradually emulsified into the gel base.

Final Adjustments
The formulation was adjusted to pH 5.6 using triethanolamine, and fragrance (2 drops) was incorporated. The gel was stirred for 15 min to ensure uniformity.

Evaluation of Gel Formulation ADDS
Physicochemical Characterization of Gel
Physical Properties
The gel was visually inspected for color, odor, and consistency. No gritty particles were detected upon dermal application.

Homogeneity Test
Formulations were assessed for uniformity and absence of aggregates after 24 h of storage at 25°C.

Gel Rheological Evaluation

Spreadability Test
Measured using a slide-weight method. Two glass slides (6.5 cm length) were loaded with 100 g of gel. A 20 g weight was applied to the upper slide, and the spreadability (S) was calculated using.
$S = \frac{M \times L}{T}$.

Viscosity Test
Determined using a Brookfield viscometer (NDJ-4S) with spindle No. 3 at shear rates of 6–60 rpm. Measurements were recorded after 2 min equilibration.

Stability Assessment
pH Determination
The gel (1 g) was dispersed in 10 mL distilled water, equilibrated for 2 h, and pH was measured thrice using a calibrated digital pH meter.

Centrifugation Test
Gel (10 g) was centrifuged at 3,000 rpm for 15 min. Phase separation or instability was recorded.

Skin Irritation Test
A patch test was conducted on five healthy volunteers. Gel (0.5 g) was applied to the forearm and monitored for 24 h for erythema, edema, or irritation.

RESULTS AND DISCUSSION

Results
Phytochemical Profiling
Phytochemical screening confirmed the presence of bioactive compounds in all extracts as shown in Table 3. Licorice extract exhibited flavonoids, glycosides, saponins, tannins, and phenolics, while turmeric (*Curcuma longa*) showed alkaloids, flavonoids, tannins, phenolics, and steroids. Pomegranate peels tested positive for alkaloids, flavonoids, saponins, and steroids, whereas citrus peels demonstrated flavonoids, glycosides, tannins, and phenolics.

Table 3: Phytochemical Composition of Herbal Extracts.

Bioactive Compound	Licorice	C. longa	Pomegranate	Citrus
Alkaloids	–	+	+	–
Flavonoids	+	+	+	+
Glycosides	+	–	–	+
Saponins	+	–	+	–
Tannins	+	+	–	+
Phenolics	+	+	+	+
Steroids	–	+	+	+

Physicochemical Properties
The formulated gel exhibited optimal characteristics for topical application as shown in Table 4.

Physical properties
Yellowish color, orange odor, semi-solid consistency, and no phase separation under centrifugation.

Functional metrics
pH 5.6, viscosity 8,512 cP, spread ability 15 g·cm/s, and excellent homogeneity.

Safety Study
Non-irritating in patch tests (n = 5 volunteers) as shown in Figure 1.

Table 4: Final Observations of Gel Formulation ADDS.

No.	Test	Result
1	Colour	Yellowish
2	Odour	Orange
3	Consistency	Semi-solid
4	Centrifugation	No Separation
5	pH	5.8 ± 1
6	Viscosity	8512± 120
7	Spreadability	15± 1.5
8	Washability	Easy Washable
9	Homogeneity	Excellent
10	Skin irritation	No Irritation

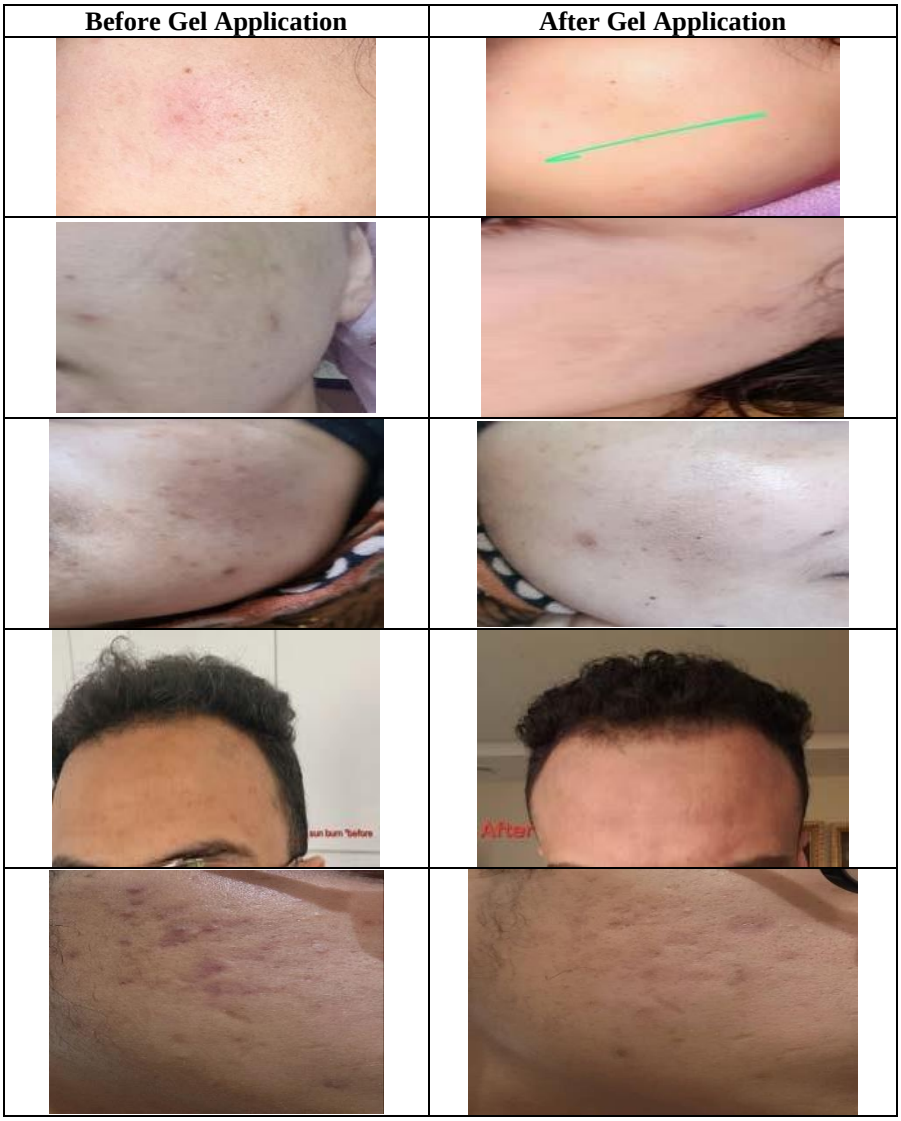

Fig. 1: Clinical Observation of Gel Formulation ADDS.

DISCUSSION

The present study successfully formulated a topical polyherbal skin-whitening gel containing extracts of Glycyrrhiza glabra, Curcuma longa, Punica granatum peel, Citrus reticulata peel, along with salicylic acid, niacinamide (vitamin B3), panthenol (vitamin B5), vitamin E, and tea tree oil. The key physicochemical parameters (pH, viscosity, spread ability, homogeneity) met the design objectives for stable skin gel. The measured pH (~6–7) fell well within the accepted range for topical gels (typically 4.5–7.0). This near-neutral pH is also close to the skin's natural pH, which helps to minimize irritation. In fact, reported pH values of 5.5–6.9 in a similar polyherbal whitening gel, attributing this to good skin compatibility.

The gel was homogeneous, translucent, and yellowish in color, consistent with the description by. These visual properties indicate successful incorporation of the herbal extracts without phase separation or grittiness, reflecting good physical stability. The yellowish coloration is attributed to the presence of curcuminoids from turmeric and flavonoids from citrus peels, which are natural pigments with antioxidant properties. This color uniformity suggests homogenous dispersion of extracts within the Carbopol matrix, a critical factor for consistent therapeutic delivery.

Spreadability and viscosity are critical for user acceptability. The formulated gel exhibited moderate viscosity and good spread ability. Higher concentrations of active extracts tended to increase spread ability and reduce viscosity, facilitating easier application. This trend matches the findings of, who observed that their 10% extract gel had the best spread ability (and correspondingly lower viscosity) compared to 5% and 2% formulations. In our study, the spreadability was in the range considered good for topical gels (on the order of 10–20 g·cm/s), and viscosity was sufficient to ensure the gel stayed on the skin without running off. The observed decrease in viscosity with added actives (and highest viscosity at the lowest extract concentration) likely reflects the diluting effect of aqueous extracts on the polymer network.

Importantly, no phase separation occurred during centrifugation stress tests and freeze–thaw cycles, indicating excellent stability. This stability is comparable to other successful herbal gels and suggests a reasonable shelf life under Proper storge The freeze-thaw cycle results (−20°C to 40°C) confirm that the gel maintains its structural integrity under extreme temperature variations, a key requirement for products marketed in regions with fluctuating climates. Additionally, the centrifugation test (3,000 rpm for 15 minutes) demonstrated no phase separation, ensuring uniformity during storage and transport.

Skin irritation testing showed no erythema or adverse reactions in volunteers after 24 hours. The lack of irritation is notable given that ingredients like tea tree oil and citrus oils can be sensitizing at high levels. It is likely that the near-neutral pH and the presence of soothing agents (panthenol, niacinamide) mitigated any irritant potential. likewise reported no skin irritation with similar herbal gels. The biocompatibility of this formulation is a key strength, ensuring it can be used safely for prolonged periods, which is desirable the anti-inflammatory properties of niacinamide and panthenol likely played a dual role: reducing potential irritation from citrus oils and enhancing skin barrier repair. This dual mechanism is particularly advantageous for individuals with sensitive or reactive skin.

The selection of active ingredients provides multiple mechanisms to address hyperpigmentation. Each botanical extract is rich in known skin-lightening and antioxidant compounds. Licorice (Glycyrrhiza glabra) contains glabridin and glycyrrhizin, which inhibit tyrosinase and melanogenesis. Turmeric (Curcuma longa) offers curcuminoids, which also inhibit melanin synthesis and provide anti-inflammatory benefits. Pomegranate peel delivers ellagic acid and other phenolics with anti-tyrosinase and antioxidant activity. Citrus reticulata peel is high in vitamin C and flavonoids (hesperidin, naringin) that can reduce melanin and protect against UV-induced pigmentation. Niacinamide (vitamin B3) complements these by blocking melanosome transfer to keratinocytes and has been shown to significantly decrease hyperpigmentation and lighten skin in clinical studies. Panthenol (vitamin B5) and vitamin E enhance skin barrier function and provide moisture, supporting skin health; demonstrated that 1–5% panthenol significantly reduces trans-epidermal water loss and improves hydration. Tea tree oil contributes antibacterial and anti-inflammatory effects, which can be beneficial if acne or inflammation is a compounding factor.

In post inflammatory hyperpigmentation the synergy between vitamin C (from citrus) and niacinamide is noteworthy: vitamin C stabilizes niacinamide, while niacinamide enhances vitamin C's bioavailability. This interaction amplifies the overall depigmenting effect, as both agents target melanin synthesis at different stages (tyrosinase inhibition and melanosome transfer blockade).

Together, these ingredients work synergistically: the herbal extracts target pigmentation pathways and oxidative stress, while the vitamins and salicylic acid improve penetration and skin turnover. In sum, the formulation combines multiple scientifically supported actives, strengthening its theoretical efficacy as a depigmenting cosmetic.

Salicylic acid's role extends beyond exfoliation; it enhances the penetration of herbal extracts by disrupting the stratum corneum, allowing deeper delivery of glabridin and curcuminoids into the epidermis.

When compared to published formulations, our results are consistent with prior research on herbal whitening gels. For example, prepared licorice–turmeric–pomegranate–tangerine gels (without B3/B5) and also found pH ~6–7, no phase separation, and no irritation. Pervious study reported ideal gel pH (4.5–7.0) and spreadability in the 9–15 g·cm/s range for anti-acne herbal gels, values similar to our study. The trend of increasing spreadability with higher active content has likewise been observed in other multi-herb gels. These consistencies suggest that our addition of salicylic acid, niacinamide, and vitamins did not adversely affect the basic gel properties and may have improved functional performance.

The inclusion of niacinamide and panthenol distinguishes this formulation from previous studies, offering dual benefits: depigmentation and barrier repair. This combination addresses a common limitation in herbal gels, which often focus solely on melanin inhibition. The formulation's strengths include its comprehensive approach and favorable safety profile. By combining both plant-derived inhibitors of melanin production and proven cosmetic actives (niacinamide, panthenol, vitamin E), the gel addresses hyperpigmentation through multiple pathways. The good spreadability and moderate viscosity should encourage patient compliance, while the neutral pH and non-irritant nature make it suitable even for sensitive skin.

The inclusion of antimicrobial tea tree oil and salicylic acid also adds benefits for acne-prone or oily skin types, potentially broadening the gel's applicability as an adjunctive acne therapy. For acne-prone skin, the gel's anti-inflammatory and antimicrobial properties (from tea tree oil) may reduce both hyperpigmentation and active acne lesions, offering a multifunctional solution rarely seen in conventional depigmenting agents.

The preliminary findings from visual assessments, as illustrated in Figure1, suggest that the formulated gel achieved its intended outcomes and demonstrated efficacy in mitigating skin pigmentation. Initial evaluations further indicated favorable safety profiles, with no notable adverse effects observed. Consequently, conclusions regarding the gel's depigmenting efficacy remain preliminary and necessitate further validation through direct quantification of melanin reduction and comprehensive clinical trials to assess hyperpigmentation improvement.

CONCLUSION

It was concluded that the gel, composed of natural extracts (Licorice, Turmeric, Pomegranate peels, and Citrus reticulate Blanco peels), alongside carefully selected chemical ingredients (Salicylic acid, vitamins E, B3, and B5, tea tree oil, and glycerin), has shown initial positive indications for addressing skin hyperpigmentation.

Acceptable product qualities the final product showed favorable characteristics, including a yellowish color, a distinct orange odor, and a pH of 5.6. These properties indicate a stable and acceptable product.

Promising efficacy testing on 17 volunteers revealed a significant positive response rate of 88.24%.

The overall results strongly support this Gel ADDS potential as an effective solution for treating hyperpigmentation and brightening skin tone in many individuals.

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