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Research Article

FORMULATION AND EVALUATION OF HERBAL MELIACEAE BLEACH POWDER FOR COSMETIC APPLICATION

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Abstract

The increasing consumer preference for safer and naturally derived cosmetic products has accelerated research into herbal alternatives to conventional synthetic skincare formulations. Chemical bleaching agents commonly used in cosmetic applications often produce adverse dermatological effects including irritation, dryness, erythema, hypersensitivity, and disruption of the skin barrier with prolonged use. Herbal cosmetic formulations offer a promising alternative due to their favorable safety profile, multifunctional therapeutic properties, and environmental compatibility (1,2). The present study aimed to formulate and evaluate a herbal cosmetic bleach powder using Azadirachta indica (Neem), a medicinal plant belonging to the Meliaceae family, as the principal active ingredient. The formulation incorporated neem powder along with multani mitti, turmeric powder, and sandalwood powder to provide cleansing, antimicrobial, anti-inflammatory, soothing, and mild skin-enhancing effects. The herbal bleach powder was evaluated for organoleptic properties, pH, particle size distribution, bulk density, tapped density, angle of repose, moisture content, washability, and stability. The prepared formulation exhibited acceptable physicochemical characteristics including greenish-brown appearance, pleasant herbal odor, fine texture, average pH of 6.6, bulk density of 0.50 g/mL, tapped density of 0.62 g/mL, angle of repose of 33°, and moisture content of 6%. Stability studies demonstrated no significant changes in physical characteristics over the study period. The results suggest that the developed neem-based herbal bleach powder is a stable, skin-compatible, and cosmetically acceptable alternative to synthetic bleaching formulations.

Keywords: Herbal bleach powder, Azadirachta indica, neem, herbal cosmetics, Meliaceae, cosmetic formulation, skin care

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Introduction

The cosmetic industry has experienced a significant transformation in recent decades due to increasing consumer awareness regarding product safety, dermatological compatibility, and long-term health implications associated with synthetic cosmetic ingredients. Skin, being the largest organ of the human body, serves as a critical protective barrier against environmental aggressors including microbial pathogens, ultraviolet radiation, pollutants, and chemical irritants. In addition to its protective role, the skin contributes to thermoregulation, immunological defenses, sensory perception, and metabolic functions such as vitamin D synthesis (3).

The maintenance of healthy skin has both physiological and psychological significance. Various internal and external factors including ultraviolet exposure, pollution, hormonal imbalance, stress, microbial infection, and aging contribute to dermatological concerns such as hyperpigmentation, acne, irritation, dryness, and uneven skin tone. As a result, cosmetic products designed to improve skin appearance and function have gained widespread popularity (4).

Among cosmetic preparations, skin bleaching products are commonly used to improve complexion, reduce pigmentation, and enhance skin appearance. Conventional bleaching products generally rely on oxidizing chemical agents such as hydrogen peroxide and ammonia, which act by chemically altering melanin pigments. Although these products may provide rapid visible results, their long-term use is frequently associated with adverse effects including erythema, irritation, contact dermatitis, skin barrier disruption, hypersensitivity, and increased photosensitivity (5).

These limitations have encouraged the development of safer and more sustainable herbal cosmetic alternatives. Herbal cosmetics, often classified as cosmeceuticals, combine cosmetic and therapeutic benefits using plant-derived bioactive compounds. Such formulations frequently exhibit antimicrobial, antioxidant, anti-inflammatory, soothing, and skin-protective properties while minimizing the adverse effects associated with synthetic products (6).

Azadirachta indica (Neem), a member of the Meliaceae family, is among the most extensively studied medicinal plants used in traditional dermatological applications. Neem contains biologically active compounds including azadirachtin, nimbin, nimbidin, quercetin, tannins, and flavonoids that exhibit potent antimicrobial, antioxidant, anti-inflammatory, and skin-protective activities (7,8). These pharmacological properties make neem a suitable candidate for cosmetic skincare formulations.

Additional herbal ingredients can further enhance formulation performance. Multani mitti (Fuller's earth) is recognized for its oil-absorbing and cleansing effects, turmeric contributes anti-inflammatory and antioxidant properties, while sandalwood provides cooling and soothing benefits (9,10).

The present study was undertaken to formulate and evaluate an herbal cosmetic bleach powder using neem as the principal active ingredient and to assess its physicochemical properties, stability, and cosmetic suitability.

Materials and Methods

The present study involved the development of a neem-based herbal cosmetic bleach powder using natural herbal ingredients selected for their therapeutic and cosmetic benefits. Fresh leaves of *Azadirachta indica* were collected from a suitable local source and authenticated for botanical identity as belonging to the Meliaceae family. The collected leaves were thoroughly washed to remove dust, foreign matter, and surface contaminants, followed by shade drying at room temperature for 7–10 days to preserve thermolabile phytoconstituents. After complete drying, the leaves were pulverized using a mechanical grinder and passed through sieve number 60 to obtain uniform particle size.

Additional herbal ingredients including multani mitti, turmeric powder, and sandalwood powder were procured from reliable local suppliers and visually inspected for quality. All herbal ingredients were dried where necessary, finely powdered, and sieved individually to ensure uniform consistency.

The final formulation consisted of neem powder (30 g), multani mitti (30 g), turmeric powder (20 g), and sandalwood powder (20 g), each selected according to its functional role in the formulation. Neem served as the antimicrobial active component, multani mitti as the cleansing and adsorbent agent, turmeric as the anti-inflammatory and skin-enhancing component, and sandalwood as the soothing and cooling agent.

The formulation was prepared by accurately weighing all powdered ingredients using an analytical balance. Uniform mixing was achieved using the geometric dilution method in a mortar and pestle to ensure homogeneous distribution of ingredients and minimize segregation. The final herbal bleach powder was stored in a clean, dry, airtight container until evaluation.

The prepared formulation was evaluated using standard physicochemical methods appropriate for cosmetic powder formulations. Organoleptic evaluation was performed by visual and sensory assessment of color, odor, texture, and flow characteristics. The pH was determined by preparing a 1% aqueous dispersion of the powder and measuring it using a calibrated digital pH meter.

Particle size distribution was assessed through sieve analysis using multiple sieve grades to determine powder uniformity. Bulk density and tapped density were measured to evaluate packing and compressibility characteristics. Flow properties were further assessed using angle of repose measurements.

Moisture content was determined by drying the sample in a hot air oven at 105°C until constant weight was obtained. Washability was assessed by mixing the powder with water to prepare a paste, applying it topically, and evaluating ease of removal and residue formation.

Stability studies were conducted over 30 days under standard storage conditions, during which physical parameters including color, odor, and texture were monitored for changes

Results

The formulated herbal Meliaceae bleach powder was successfully prepared and evaluated for physicochemical suitability as a cosmetic topical formulation. The results demonstrated that the developed formulation possessed acceptable cosmetic, stability, and handling characteristics appropriate for routine skin application.

Organoleptic evaluation revealed that the prepared formulation exhibited a **greenish-brown color**, which is consistent with the incorporation of neem and associated herbal ingredients. The powder possessed a **pleasant characteristic herbal odor**, indicating acceptable sensory properties for cosmetic application. The texture was observed to be **smooth, fine, and free-flowing**, suggesting appropriate particle uniformity and favorable handling characteristics.

The pH of the herbal bleach powder, determined using a 1% aqueous dispersion, showed values of **6.5, 6.7, and 6.6**, with an average pH of **6.6**. This value falls within the acceptable skin-compatible range, suggesting suitability for topical cosmetic application without significant risk of irritation or barrier disruption.

Particle size analysis demonstrated that the majority of particles (**65%**) were retained on sieve number 60, while **10%** were retained on sieve number 40, **20%** on sieve number 80, and **5%** passed into the collection pan. These findings indicate relatively uniform particle distribution, which is essential for smooth application and consistent skin coverage.

Bulk density and tapped density measurements were recorded as **0.50 g/mL** and **0.62 g/mL**, respectively. These values indicate acceptable packing characteristics and moderate compressibility, appropriate for powdered cosmetic formulations.

Flow properties assessed by angle of repose demonstrated measurements of **32°, 34°, and 33°**, with an average of **33°**. This indicates good powder flowability, supporting ease of handling, packaging, storage, and consumer application.

Moisture content analysis showed an initial sample weight of **5 g**, with a final dried weight of **4.7 g**, corresponding to a moisture content of **6%**. This relatively low moisture level supports improved product stability and reduced susceptibility to microbial contamination.

Washability testing indicated favorable consumer usability characteristics. The formulation demonstrated **good spreadability**, **easy removal**, and **absence of residual deposits after washing**, suggesting convenience during routine use.

Stability assessment conducted over a **30-day observation period** demonstrated no significant changes in physical parameters including color, odor, and texture, indicating acceptable short-term storage stability.

Discussion

The present study successfully demonstrated the formulation and evaluation of a neem-based herbal cosmetic bleach powder intended as a safer alternative to conventional synthetic bleaching products. The findings support the growing interest in herbal cosmetic formulations that combine therapeutic plant-derived bioactivity with acceptable cosmetic functionality (1,2).

The organoleptic properties of the prepared formulation indicate good cosmetic acceptability. Consumer compliance with topical cosmetic products is strongly influenced by sensory attributes such as appearance, odor, texture, and ease of handling. The observed greenish-brown color reflects the natural composition of neem and associated herbal ingredients, while the pleasant herbal odor enhances acceptability. The free-flowing and fine powder characteristics further indicate favorable manufacturing and handling properties (11).

The measured pH of 6.6 is particularly relevant for dermatological compatibility. Human skin typically maintains a mildly acidic surface environment that

supports barrier integrity, microbiological defense, and physiological homeostasis (3). Cosmetic formulations with excessively acidic or alkaline pH may disrupt the skin barrier and provoke irritation. The near-neutral pH observed in the present formulation suggests adequate compatibility for topical use and supports its intended cosmetic application (12).

Particle size distribution is a critical determinant of topical powder performance. Uniform particle size contributes to improved spreadability, better skin adherence, enhanced cleansing performance, and greater consumer comfort (13). The predominance of particles retained on sieve number 60 suggests an appropriate balance between fine texture and practical usability, reducing the likelihood of coarse abrasive effects or excessive airborne dispersion.

Flow properties, as demonstrated by the angle of repose and density measurements, were also satisfactory. An angle of repose of 33° generally reflects good flowability, which is advantageous for product packaging, dispensing, and user handling (14). The difference between bulk density and tapped density suggests moderate compressibility without excessive caking, further supporting formulation practicality.

Moisture content is a major determinant of formulation stability, especially in herbal powder systems. Elevated moisture levels may encourage microbial growth, clumping, chemical degradation, and reduced shelf life. The observed moisture content of 6% falls within acceptable limits for dry herbal powder formulations and contributes positively to product stability (15).

The washability findings are particularly important for cosmetic convenience. Products that leave persistent residues may reduce consumer satisfaction and potentially contribute to pore occlusion or skin discomfort. The easy removal and residue-free behavior observed in this study indicate favorable practical usability.

The stability results further strengthen the formulation's suitability. The absence of significant physical changes over the study period suggests acceptable short-term product integrity under normal storage conditions. Powder dosage forms inherently offer greater physicochemical stability compared with aqueous or semisolid systems because of their reduced susceptibility to hydrolytic degradation and microbial contamination (16).

The inclusion of neem as the principal active component provides strong pharmacological rationale. Neem has well-documented antimicrobial, anti-inflammatory, antioxidant, and dermatoprotective properties attributable to bioactive constituents such as azadirachtin, nimbin, nimbidin, flavonoids, and tannins (7,8). These properties support the potential utility of the formulation not only for cosmetic cleansing and mild skin enhancement but also for maintaining skin hygiene and reducing microbial burden.

The complementary herbal ingredients further enhance formulation performance. Multani mitti contributes oil absorption and cleansing, turmeric provides antioxidant and anti-inflammatory effects, and sandalwood contributes soothing and cooling benefits (9,10). The combination of these ingredients likely contributed synergistically to the observed formulation performance.

Unlike synthetic bleaching agents that rely on aggressive oxidative mechanisms, the present herbal powder functions through milder natural mechanisms including adsorption, cleansing, exfoliation, and antimicrobial action. This approach reduces the likelihood of irritation while promoting broader skin-supportive effects (5).

Limitations of the Study

Despite the encouraging findings of the present investigation, certain limitations should be acknowledged. The study primarily focused on basic physicochemical evaluation appropriate for preliminary cosmetic formulation assessment, and advanced analytical characterization such as phytochemical quantification, particle morphology analysis, and instrumental rheological assessment was not performed. Although antimicrobial activity was referenced in the thesis discussion, detailed microbiological experimental data, including organism-specific inhibition measurements, were not comprehensively documented in the evaluated dataset. The stability study was limited to short-term observation over 30 days, which does not provide sufficient evidence regarding long-term shelf life or accelerated environmental stability. Clinical testing involving human volunteers was not conducted under controlled dermatological conditions, limiting conclusions regarding real-world cosmetic efficacy, irritation potential, skin brightening performance, and long-term safety. Additionally, quantitative efficacy endpoints such as reduction in pigmentation, sebum control, or objective skin compatibility measurements were not instrumentally assessed. Future studies should incorporate advanced analytical testing, extended stability evaluation, microbiological validation, and controlled clinical investigations to establish stronger scientific evidence for commercial application.

Conclusion

The present study successfully formulated and evaluated a herbal cosmetic bleach powder using *Azadirachta indica* as the principal active ingredient. The developed formulation demonstrated acceptable physicochemical, cosmetic, and stability characteristics suitable for topical skin application.

The herbal bleach powder exhibited favorable organoleptic properties, skin-compatible pH, satisfactory particle size distribution, good flow behavior, acceptable moisture content, convenient washability, and short-term physical stability. These characteristics indicate that the formulation meets essential quality requirements expected of a topical cosmetic powder.

The incorporation of neem, along with multani mitti, turmeric, and sandalwood, provided a rational herbal formulation strategy combining cleansing, antimicrobial, anti-inflammatory, and soothing benefits. Compared with conventional synthetic bleaching formulations, the present herbal preparation offers a potentially safer and more natural cosmetic alternative.

The findings support the growing role of herbal cosmetic science in developing effective plant-based skincare products. With further analytical refinement, clinical validation, and long-term stability assessment, the formulation may have potential for larger-scale cosmetic application and commercial development.

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