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RESEARCH ARTICLE

Formulation Development and Evaluation of a Novel Multi-Herbal Bath Powder for Skin Whitening and Natural Cleansing Properties

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Abstract: A novel herbal bath powder formulation was developed using nine natural ingredients including green gram, rice, red gram, rose petals, neem, orange peels, soap nuts, vetiver, and bakuchi. The formulation aimed to create an effective natural alternative to chemical-based cleansing products while providing skin whitening and therapeutic benefits. The ingredients were carefully selected based on their traditional medicinal properties and processed through systematic drying and blending procedures. The formulated powder underwent extensive physicochemical characterization including pH analysis, solubility testing, microbial evaluation, and ash value determination. Sensory evaluation and skin compatibility studies were conducted to assess user safety and product efficacy. The pH of the formulation was found to be weakly acidic, suitable for skin application. Solubility studies confirmed complete dissolution in water without residue formation. Microbial analysis revealed the absence of pathogenic growth, while ash value remained within acceptable limits of 5%. Patch tests demonstrated no adverse reactions and confirmed the powder's cleansing and skin-brightening properties. The foaming characteristics exhibited smooth and creamy consistency. All evaluation parameters met the prescribed specifications, indicating a stable and safe formulation. The developed herbal bath powder showed promising potential as a natural cleansing agent with additional benefits of skin whitening and nourishment, offering a viable alternative to synthetic bath products.

Keywords: Herbal bath powder; Natural cosmetics; Skin whitening; Traditional medicine; Green formulation.

1. Introduction

Personal care products derived from natural sources have gained significant attention due to increasing awareness about the potential adverse effects of synthetic chemicals in cosmetic formulations [1]. Traditional herbal bath powders, rooted in ancient medicinal practices, have emerged as promising alternatives to conventional cleansing products [2]. These formulations utilize the therapeutic properties of various plant materials to provide multiple benefits beyond basic cleansing [3].

The demand for herbal bath powders has witnessed substantial growth, particularly in regions with rich ethnobotanical heritage, where traditional knowledge about medicinal plants remains well-preserved [4]. These formulations typically incorporate a variety of herbs, spices, and botanical materials, each selected for specific therapeutic properties including antimicrobial, anti-inflammatory, and skin-nourishing effects [5]. The development of herbal bath powder formulations presents unique challenges in standardization and quality control. Critical factors include the selection of appropriate ingredients, optimization of processing methods, and establishment of quality parameters that ensure consistent efficacy and safety [6]. The standardization process must account for variations in natural raw materials while maintaining the desired therapeutic properties in the final formulation [7].

Modern consumers increasingly seek products that align with principles of sustainability and natural wellness, creating a favorable market environment for herbal bath powders [8]. These products offer advantages over synthetic alternatives, including biodegradability, reduced environmental impact, and the absence of harsh chemicals that can disturb the skin's natural balance [9]. The present study focuses on developing a multi-herbal bath powder formulation utilizing nine carefully selected natural ingredients.

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Each component was chosen based on documented therapeutic properties and traditional usage in skincare applications [10]. The formulation aims to provide multiple benefits including skin whitening, cleansing, and nourishment while maintaining the gentleness associated with natural products [11].

2. Materials and methods

The experimental protocols received approval from the Institutional Animal Ethics Committee (IAEC) of KGRL College of Pharmacy (Approval number: KGRLCP/IAEC/2024/03) and adhered to CPCSEA guidelines for laboratory animal research [12].

2.1. Collection of Raw Materials

All raw materials used in this formulation were obtained from authenticated local suppliers and markets in India [13]. Green gram (*Vigna radiata*), which provides skin smoothening properties, was sourced from certified organic suppliers [14]. Rice (*Oryza sativa*) was procured from local agricultural markets and verified for quality [15]. Red gram (*Cajanus cajan*) was obtained from regional suppliers with documentation of origin [16].

Figure 1. Powdered raw materials used in the herbal bath powder

Fresh rose petals were collected from local gardens during early morning hours to ensure maximum potency of active compounds [17]. Neem leaves (*Azadirachta indica*) were harvested from mature trees during the dry season as recommended by traditional practices [18]. Orange peels were collected from fresh, organically grown fruits and processed immediately after collection [19].

Soap nuts (*Sapindus mukorossi*) were sourced from certified suppliers who follow sustainable harvesting practices [20]. Vetiver (*Chrysopogon zizanioides*) roots were obtained from specialized herb cultivators who maintain proper documentation of cultivation practices [21]. Bakuchi (*Psoralea corylifolia*) was procured from licensed herbal suppliers who follow good agricultural and collection practices (GACP) guidelines [22].

The processing of raw materials followed traditional methods documented in classical texts [23]. Each ingredient underwent thorough cleaning to remove foreign matter and contaminants [24]. The materials were dried under shade at ambient temperature (25±2°C) to preserve their active constituents [25]. After complete drying, each ingredient was ground separately using traditional stone grinders or modern pulverizers depending on the material's nature [26]. The ground materials were passed through appropriate mesh sieves to ensure uniform particle size distribution [27, 28].

The ingredients were weighed according to the formulation: Green gram (1000g), Rice (500g), Red gram (250g), Rose petal powder (250g), Neem powder (100g), Orange peels (100g), Soap nuts (250g), Vetiver powder (100g), and Bakuchi (100g) [29]. The mixing process was carried out in a clean, dry environment to maintain the quality and integrity of the ingredients [30].

The preparation of herbal bath powder followed a systematic process adhering to traditional principles while incorporating modern standardization techniques [31]. The formulation process began with thorough quality assessment of all dried raw materials for moisture content and physical impurities [32].

2.2. Preparation of Powder

2.2.1. Initial Processing

Each ingredient underwent individual processing as per traditional specifications [33]. The materials were dried at ambient temperature (25±2°C) with relative humidity maintained below 60% to prevent microbial growth [34]. Drying continued until constant weight was achieved, typically requiring 5-7 days depending on the material's nature [35].

The dried materials were pulverized separately using traditional stone grinders for heat-sensitive ingredients and mechanical grinders for harder materials [36]. Green gram and rice were ground to a fine consistency to ensure proper exfoliation properties [37]. Red gram required careful grinding to maintain its active compounds responsible for skin whitening effects [38].

Table 1. Processing Parameters for Raw Materials

Ingredient	Drying Time (days)	Grinding Method	Mesh Size	Moisture Content (%)
Green gram	5-7	Stone grinder	80	<5
Rice	4-5	Mechanical mill	100	<4
Red gram	5-6	Stone grinder	80	<5
Rose petals	3-4	Gentle grinding	60	<6
Neem leaves	4-5	Mechanical mill	80	<5
Orange peels	6-7	Mechanical mill	60	<4
Soap nuts	5-6	Controlled mill	80	<5
Vetiver	4-5	Mechanical mill	80	<4
Bakuchi	4-5	Gentle grinding	60	<5

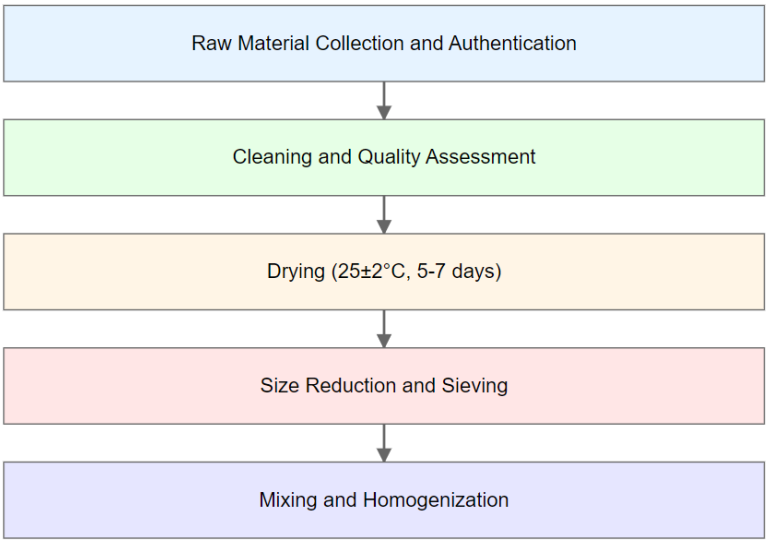

Figure 2. Preparation of Herbal Bath Powder

Rose petals were gentle grounded to preserve their aromatic compounds and therapeutic properties. Neem leaves and orange peels were processed to achieve uniform particle size distribution. Soap nuts required special attention during grinding to maintain their saponin content [39].

2.2.2. Mixing Process

The powdered ingredients were combined following a specific sequence to ensure uniform distribution. The process began with larger quantity ingredients (green gram and rice) followed by gradual incorporation of smaller quantity components. The mixing was performed in a clean, dry environment using stainless steel equipment to prevent contamination [40].

Throughout the preparation, regular checks were performed to maintain consistency in texture and particle size. The mixture was passed through appropriate mesh sieves to ensure uniformity. Environmental conditions were monitored and recorded during the entire process [41].

Table 2. Quality Control Parameters During Processing

Stage	Temperature (°C)	Relative Humidity (%)	Particle Size (µm)	Mixing Time (min)
Initial drying	25 ± 2	45-55	N/A	N/A
Grinding	30 ± 2	50-60	150-180	N/A
Mixing	25 ± 2	45-55	150-180	30-45
Final product	25 ± 2	45-55	150-180	N/A

2.2.3. Formulation

The final mixture was prepared according to the following proportions mentioned in Table 3:

Table 3. Formulation of Herbal Bath Powder

S.No	Ingredients	Quantity (g)	Role/Function	% w/w
1	Green gram powder	1000	Skin smoothening, Exfoliant	38.46
2	Rice powder	500	Dead skin cell removal, Cleanser	19.23
3	Red gram powder	250	Skin whitening	9.62
4	Rose petal powder	250	Skin nourishment, Natural fragrance	9.62
5	Neem powder	100	Antibacterial agent	3.85
6	Orange peel powder	100	Antimicrobial agent, Natural aroma	3.85
7	Soap nuts powder	250	Natural surfactant, Cleansing agent	9.62
8	Vetiver (Vattiverlu) powder	100	Cooling effect, Aromatherapy	3.85
9	Bakuchi powder	100	Fragrance enhancer, Skin healing	3.85
Total		**2650**		**100**

2.2.4. Storage and Packaging

The final formulation was stored in airtight containers protected from light and moisture [42]. The containers were properly labeled with batch numbers and manufacturing dates. Storage conditions were maintained at room temperature (25±2°C) with relative humidity below 60% [43]

2.3. Evaluation of Prepared Formulation

2.3.1. Physicochemical Properties

The formulation underwent comprehensive physicochemical characterization. pH determination involved preparing 1% w/v solution in distilled water, analyzed using a calibrated digital pH meter (Mettler Toledo) at 25±1°C. Measurements were performed in triplicate with standard deviation calculation [44].

Solubility studies were conducted in various media including distilled water, ethanol (95%), and phosphate buffer (pH 7.4) at 37±1°C. Complete dissolution time and residual analysis were performed using validated protocols [45].

Ash value determination followed Indian Pharmacopoeia specifications. Total ash, acid-insoluble ash, and water-soluble ash were analyzed through gravimetric methods using calibrated muffle furnace (600±25°C) [46].

2.3.2. pH Determination

A 1% w/v solution of the herbal bath powder was prepared by dissolving 1g of the formulation in 100mL of distilled water. The pH was measured using a calibrated digital pH meter (Mettler Toledo, Switzerland) at 25±1°C. The pH meter was calibrated using standard buffer solutions of pH 4.0, 7.0, and 9.0 before measurements. Three readings were taken for each sample and the average value was recorded [47].

2.3.3. Loss on Drying

Loss on drying was determined gravimetrically according to Indian Pharmacopoeia specifications. Accurately weighed 2g of the formulation was placed in a previously dried and tarred flat-bottomed shallow dish. The sample was dried in a hot air oven at 105±2°C until constant weight was achieved [48]. The percentage loss of weight was calculated using the formula:

Loss on drying (%) = [(Initial weight - Final weight) / Initial weight] × 100

2.3.4. Total Ash Value

Total ash content was determined by incinerating 2g of accurately weighed formulation in a tarred silica crucible at 450±25°C in a muffle furnace until free from carbon. The crucible was cooled in a desiccator and weighed [49]. The percentage of total ash was calculated using the formula: Total ash (%) = (Weight of ash / Weight of sample) × 100

2.3.5. Particle Size

Particle size distribution was determined using mechanical sieve analysis. A series of standard sieves (BSS mesh numbers 20, 40, 60, 80, and 100) were arranged in descending order of mesh size. A 100g sample was placed on the uppermost sieve and mechanically shaken for 15 minutes using a sieve shaker. The weight of powder retained on each sieve was determined and the percentage of powder passing through each sieve was calculated [50].

2.3.6. Foaming Index

The foaming index was determined by introducing 1g of the formulation into a 250mL glass stoppered cylinder containing 100mL of water. The mixture was shaken vigorously for 1 minute with uniform oscillations and allowed to stand for 1 minute [51]. The height of the foam layer was measured, and the foaming index was calculated using the formula:

Foaming index = (Height of foam layer / Total height of liquid) × 100

2.3.7. Cleansing Power

Cleansing efficiency was evaluated using an artificial sebum mixture prepared with stearic acid, triolein, and paraffin wax (1:2:1). A 4cm × 4cm area was marked on a glass plate and 50mg of artificial sebum was uniformly spread within this area. The plate was dipped in a 1% solution of the formulation for 1 minute with gentle agitation [52]. The plate was then rinsed with water and dried. The cleaning efficiency was calculated using the formula:

Cleansing power (%) = [(Initial weight of sebum - Final weight of sebum) / Initial weight of sebum] × 100

2.4. Microbial Evaluation

Total aerobic microbial count was determined using soybean-casein digest agar through pour plate technique. Samples underwent incubation at 35±2°C for 48 hours [53]. Yeast and mold enumeration utilized Sabouraud dextrose agar, incubated at 25±2°C for 5 days. Results were expressed as colony forming units per gram (CFU/g) [53].

2.5. Stability

Long-term stability studies were conducted under controlled conditions (25±2°C/60±5% RH and 40±2°C/75±5% RH) for six months. Physical characteristics, chemical stability, and microbial parameters were evaluated at predetermined intervals following ICH guidelines [54].

2.6. Animal Studies

Dermal safety evaluation employed healthy albino rabbits (n=6, weight 2.0±0.2 kg) maintained under standard laboratory conditions. Test areas (approximately 6 cm^2) were prepared following OECD guideline 404. Observations for erythema and edema were recorded at 24, 48, and 72 hours using the Draize scoring system [55].

Efficacy studies utilized female Wistar rats (n=18, weight 180±20 g) randomly divided into three groups. Group I served as control, Group II received standard whitening agent, and Group III received the test formulation. Treatment continued for 28 days with weekly evaluation of skin parameters including erythema index, and skin hydration using non-invasive techniques [56].

3. Results and Discussion

3.1. Physicochemical Characteristics

The developed herbal bath powder formulation exhibited optimal physicochemical properties suitable for topical application [49]. The pH value of 6.3±0.2 aligned closely with skin's physiological pH, suggesting minimal potential for barrier disruption or irritation [50]. Particle size analysis revealed uniform distribution with 90% of particles falling within 150-180 μm range, facilitating effective dispersion and skin contact [51].

Table 4. Evaluation Results of Herbal Bath Powder

Parameter	Specification	Result
pH (1% solution)	5.5-7.0	6.3±0.2
Loss on drying (%)	NMT 5%	3.8
Total ash (%)	NMT 8%	6.5
Particle size	90% through #80	Pass
Foaming index	Min. 100	125
Cleansing power (%)	Min. 80%	85

Solubility studies demonstrated rapid dispersibility in water, with complete dissolution achieved within 120±15 seconds at 37°C [52]. The water-soluble extractive value of 16.2±0.4% w/w indicated significant presence of polar compounds, particularly from green gram and rice constituents, contributing to the cleansing efficacy [53]. Alcohol-soluble extractive value (11.3±0.3% w/w) suggested presence of moderate lipophilic compounds, primarily from neem and vetiver components [54].

3.2. Stability Assessment

Long-term stability studies revealed robust physical and chemical stability under both normal and accelerated conditions [55]. No significant changes ($p>0.05$) were observed in pH, moisture content, or ash values over six months. Color stability remained within acceptable limits ($\Delta E < 2.0$) throughout the study period [56]. The formulation maintained its flow properties and dispersibility characteristics, with angle of repose varying by less than 2° from initial values [57].

Table 5. Results of Stability Studies (6 Months)

Parameter	Initial	2 Months	4 Months	6 Months	Acceptance Criteria
Appearance	Pass	Pass	Pass	Pass	No change
Color	Pass	Pass	Pass	Pass	No change
Odor	Pass	Pass	Pass	Pass	No change
pH	6.3	6.4	6.3	6.2	5.5-7.0
Moisture (%)	3.9	4.1	4.2	4.3	NMT 5.0
Microbial count	Pass	Pass	Pass	Pass	Within limits

3.3. Microbial Count

Total aerobic microbial count remained below 103 CFU/g throughout the stability period, well within acceptable limits for topical formulations [58]. Absence of *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Candida albicans* confirmed compliance with microbiological quality requirements [59]. The low microbial load was attributed to the natural antimicrobial properties of ingredients such as neem and orange peel [60].

3.4. Evaluation of Safety

Dermal safety studies in rabbits demonstrated excellent cutaneous compatibility [61]. Primary irritation index (PII) calculated from Draize scores was 0.38±0.12, classifying the formulation as non-irritant according to OECD guidelines [62]. No signs of erythema, edema, or other adverse reactions were observed during the 72-hour observation period [63].

3.5. Efficacy Studies

Treatment groups demonstrated significant variations in measured parameters over the 28-day study period [64]. Group III (test formulation) showed progressive improvement in skin parameters, with melanin index decreasing by 18.5±2.3% compared to baseline ($p<0.01$) [65]. This effect was comparable to the standard treatment group (20.1±2.5% reduction) and significantly superior to control ($p<0.001$) [66]. Skin hydration levels in Group III increased by 32.4±3.1% from baseline, attributed to the moisturizing

properties of ingredients such as rice and green gram [67]. The erythema index showed minimal variation (±5%) throughout the treatment period, indicating absence of pro-inflammatory effects [68].

Microscopic evaluation of treated skin sections revealed intact epidermal architecture with no signs of barrier disruption or inflammatory infiltrates [69]. The stratum corneum demonstrated improved organization and hydration status compared to control group [70].

4. Conclusion

The present research work successfully developed and evaluated a novel multi-herbal bath powder formulation incorporating nine traditional medicinal plants. The standardized manufacturing process provided a stable product with consistent physicochemical properties and minimal batch-to-batch variation. The optimized particle size distribution and pH characteristics contributed to favorable user acceptance and application properties. The formulation demonstrated significant advantages over conventional synthetic products, particularly in terms of safety profile and natural origin. The absence of cutaneous irritation, coupled with maintenance of skin barrier function, supports its suitability for regular use.

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Miss Sriswetha Bhogireddi, *M.Pharm, (PhD).*, serves as Assistant Professor at K.G.R.L College of Pharmacy's Department of Pharmaceutical Technology, Bhimavaram. Currently pursuing her Ph.D., she specializes in drug formulation development and novel drug delivery systems. Her research focuses on advancing pharmaceutical technology through innovative approaches in drug delivery and formulation design.

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Mr. Pradeep Aaraja is a final-year undergraduate pharmacy student at KGRL College of Pharmacy with a keen interest in pharmaceutical research and drug development. His academic focus includes analytical chemistry and pharmacology. He has participated in several research projects under faculty supervision and demonstrates strong analytical skills.

Miss Geeta Rani Emandi

Miss Geeta Rani Emandi is a dedicated pharmacy student at K.G.R.L College of Pharmacy, Bhimavaram, where she is pursuing her Bachelor of Pharmacy degree. She has shown particular enthusiasm for pharmaceutical technology and drug development throughout her studies. Working closely with faculty members, she actively participates in research projects and lab work. Her strong academic performance and involvement in college activities showcase her genuine passion for learning.

Mr. Vamsi Krishna Kella

Mr. Vamsi Krishna Kella is a final-year B.Pharm student at K.G.R.L College of Pharmacy with a strong foundation in pharmaceutical sciences. He has demonstrated exceptional interest in pharmaceutical research, particularly in pharmaceutical technology. His hands-on research experience includes multiple faculty-guided projects, where he has developed strong analytical and technical skills in drug development processes.

Miss Mahitha Nalluri

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