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Formulation and Evaluation of a Flaxseed-Based Herbal Face Serum: Efficacy and Skin Benefits by using Soxhlet Extraction Method

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ABSTRACT:

The study examines the formulation and assessment of a flaxseed-based herbal face serum, investigating its efficacy and dermatological benefits. Flaxseed, abundant in bioactive compounds such as fatty acids, lignans, and antioxidants, was selected as the primary ingredient due to its potential skin benefits. The serum was developed through Soxhlet extraction of flaxseed components and was combined with other natural ingredients, including aloe vera and rose water. Physicochemical evaluations indicated favorable properties: a pH of 5.6 (compatible with skin), a viscosity of 820 cP, and good spreadability. Stability studies demonstrated optimal preservation at lower temperatures. Biological evaluations revealed effective moisturization lasting 4-6 hours and no adverse reactions in patch tests, indicating safety for topical application. The research underscores the potential of flaxseed in natural skincare, offering hydration, antioxidant protection, and enhancement of the skin barrier. This study integrates traditional herbal knowledge with contemporary cosmetic science, contributing to the development of effective, sustainable skincare solutions. Future research could explore long-term effects, optimize formulations, and conduct clinical trials for specific skin concerns

Keywords: Flaxseed, herbal face serum, Skin Benefits, Soxhlet extraction

Introduction:

In recent years, there has been a notable increase in the demand for natural and herbal skincare products, driven by a growing awareness of the detrimental effects of synthetic chemicals on skin health (1–3). Consumers are increasingly attentive to the ingredients in the products they utilize, favoring formulations derived from natural sources, such as plants and herbs. This shift towards plant-based skincare products has created new opportunities for research and innovation within the cosmetic industry. A product that has garnered attention for its skin benefits is the face serum, a lightweight, fast-absorbing treatment designed to address specific skin concerns, including hydration, anti-aging, and brightening. Herbal-based face serums, in particular, have attracted significant interest due to their therapeutic properties and minimal side effects (4,5). Among the various herbal ingredients investigated for skincare applications, flaxseed (Linum usitatissimum) is distinguished by its rich nutritional profile and diverse bioactive compounds (6,7). Flaxseed has been utilized for centuries across various cultures for its medicinal and nutritional benefits. It is an excellent source of omega-3 fatty acids, lignans, and fiber, all of which contribute to its extensive health benefits, including its potential for skincare (8–10). Omega-3 fatty acids, in particular, are recognized for their anti-inflammatory properties, which can help soothe irritated skin, reduce redness, and enhance skin hydration (10). Lignans, on the other hand, are potent antioxidants that protect the skin from oxidative stress induced by environmental factors such as UV radiation and pollution. An image of flaxseed is presented in Figure 1.

Figure 1. Image of Flaxseed

The development of a flaxseed-based herbal face serum represents a promising strategy for delivering the skin benefits of bioactive compounds directly to the skin (10,11). To effectively extract and preserve these beneficial components from flaxseed, an efficient extraction method is essential. Soxhlet extraction, a widely utilized technique for extracting bioactive compounds from plant materials, offers a continuous solvent extraction process that ensures a high yield of active compounds, thereby enhancing the efficacy of the herbal formulation (12,13). This method is particularly suitable for extracting lipophilic compounds, such as omega-3 fatty acids, from flaxseed, which are crucial for the serum's skin-nourishing properties. The objective of this study is to develop and evaluate a flaxseed-based herbal face serum using the Soxhlet extraction method. By examining the efficacy and skin benefits of the serum, this research aims to provide valuable insights into the potential of flaxseed as a natural ingredient for skincare formulations. Furthermore, the study will assess the physicochemical properties, stability, and safety of the serum, ensuring compliance with the required standards for cosmetic applications. A central focus of this research is the evaluation of the serum's efficacy in addressing various skin concerns. Flaxseed has demonstrated anti-inflammatory, moisturizing, and anti-aging properties, all of which are desirable attributes in a face serum (14,15). The serum's capacity to enhance skin hydration and improve the appearance of fine lines and wrinkles will be assessed through in vitro and in vivo studies. Additionally, the antioxidant properties of flaxseed may offer protection against environmental damage, reducing pigmentation and promoting a more even skin tone. In addition to efficacy, the safety and stability of the flaxseed-based herbal face serum will undergo rigorous testing. This includes evaluating the formulation for potential skin irritants or allergens and assessing its shelf life to ensure prolonged effectiveness and safety. The physicochemical properties of the serum, such as pH, viscosity, and texture, will also be examined to ensure suitability for skin application and ease of use (16). Overall, this study aims to provide a comprehensive evaluation of a flaxseed-based herbal face serum, exploring its potential as a natural alternative to synthetic skincare products. By leveraging the therapeutic properties of flaxseed and employing the Soxhlet extraction method, this research seeks to contribute to the expanding body of knowledge on herbal skincare products and their role in promoting healthy, radiant skin. As the skincare industry continues to evolve, it is imperative to explore and validate the efficacy of natural ingredients, and flaxseed presents an excellent candidate for such exploration. The findings of this research may pave the way for the development of effective, safe, and sustainable skincare products that harness the power of nature to enhance skin health.

Material and Methods

Materials

The formulation of the flaxseed-based herbal face serum incorporated several key materials. Flaxseeds (Linum usitatissimum) were procured from an organic supplier. Aloe vera gel was freshly extracted from the leaves of Aloe barbadensis. Commercial-grade pure rose water was utilized as a hydrating agent. Pharmaceutical-grade Vitamin E oil functioned as an antioxidant, while glycerin of analytical reagent grade was employed as a humectant to enhance moisturization. Ethanol, with a purity of 90–95%, served as the solvent for the Soxhlet extraction of flaxseed components. Lavender essential oil was optionally included to provide fragrance and additional skin-soothing properties. Distilled water was consistently used throughout the study for both extraction and formulation processes. All materials were utilized without further purification and were stored under appropriate conditions to preserve their quality. The composition of the flaxseed-based herbal face serum is detailed in Table 1.

Table 1. Composition of Flaxseed-Based Herbal Face Serum

Ingredient	Function	Quantity (ml)	Remarks
Flaxseed gel	**Bioactive source (hydration, antioxidant)**	**20**	**Extracted via Soxhlet method**
Aloe vera gel	**Skin soothing, moisturizing agent**	**8**	**Freshly extracted**
Glycerin	**Humectant (moisture retention)**	**1**	**Analytical grade**
Rose water	**Hydrating and toning agent**	**2**	**Commercial grade**
Vitamin E	**Antioxidant**	**1**	**Pharmaceutical grade**
Coconut oil	**Emollient (moisturizing)**	**2**	**Cold-pressed oil**
Preservative	**Stability enhancer**	**0.5**	**Natural preservative used**
Emulsifying agent	**Stabilizes formulation**	**0.05**	**To maintain emulsion stability**
Distilled Water	**Solvent/Base**	**QS**	**Quantity sufficient to 100 ml**

Soxhlet Extraction of Flaxseed Components

Initially, the flaxseeds underwent a cleaning process to eliminate dust, dirt, and any foreign substances. They were then coarsely ground using a mechanical grinder to enhance the surface area for extraction. About 50 grams of the ground flaxseed powder were placed into a cellulose thimble and inserted into a Soxhlet extractor (Figure 2). Ethanol, with a concentration of 90–95%, served as the extraction solvent and was placed in the round-bottom flask connected to the Soxhlet apparatus. The extraction was conducted at a controlled temperature range of 60–70°C for a duration of 6 to 8 hours. Throughout the procedure, the solvent continuously evaporated, condensed, and percolated through the flaxseed powder, facilitating the efficient extraction of bioactive components. The extraction cycle persisted until the siphon solvent turned colorless, indicating the depletion of active constituents from the material. The collected ethanolic extract was concentrated using a rotary evaporator under reduced pressure to remove the solvent, followed by drying at room temperature to produce a semi-solid flaxseed extract. The dried extract was stored in an amber glass container under refrigerated conditions (4–8°C) until further use (12–16).

Formulation of Flaxseed-Based Herbal Face Serum

The development of the flaxseed herbal face serum commenced with the preparation of an aqueous phase, achieved by combining distilled water and rose water in equal proportions and gently heating the mixture to 40°C. The previously extracted flaxseed extract was gradually incorporated into the aqueous phase with continuous stirring using a magnetic stirrer to ensure a homogeneous dispersion. Aloe vera gel, glycerin, and vitamin E oil were sequentially added to the mixture while maintaining continuous stirring to promote uniformity. A few drops (0.5–1% w/w) of lavender essential oil were introduced to impart a natural fragrance and enhance the soothing properties of the serum. The final formulation was homogenized using a mechanical stirrer for 30 minutes at moderate speed, resulting in a stable, uniform, gel-like serum. The prepared serum was filled into sterilized amber glass dropper bottles, sealed, and stored at room temperature away from direct light until further evaluation (17,18)

Evaluation of the Formulated Serum

Physicochemical Evaluation

The formulated serum underwent evaluation for its organoleptic properties, including color, odor, consistency, and clarity, through visual and sensory inspection. The pH of the serum was measured using a digital pH meter, which was calibrated with standard buffer solutions prior to use. Viscosity was assessed using a Brookfield viscometer at a constant temperature of 25°C to evaluate the serum's rheological behavior. Spreadability was tested by placing a fixed quantity of serum between two glass plates and measuring the spread diameter under a specified load after a set period. Stability studies were conducted by storing the serum at three different temperatures: refrigerated (4°C), ambient room temperature, and elevated temperature (40°C) for a duration of 30 days. Observations regarding changes in color, phase separation, pH, and consistency were recorded periodically to assess the serum's physical and chemical stability (19–22).

Biological Evaluation

A moisturization assessment was conducted by applying the serum to the forearms of volunteers and evaluating the retention of skin hydration at intervals of 2, 4, and 6 hours through visual inspection and tactile assessment. Additionally, a patch test was administered to evaluate the potential for skin irritation by applying a small quantity of serum to the forearms of volunteers and observing for any signs of redness, irritation, or allergic reactions over a 24-hour period.

Sensory Evaluation

A sensory evaluation, conducted on a volunteer basis, was undertaken to assess the aesthetic and application properties of the serum. A cohort of twenty volunteers evaluated the serum according to parameters such as ease of application, absorption rate, greasiness, fragrance, and overall after-feel. Each parameter was rated on a scale from 1 to 5, with 1 representing poor performance and 5 representing excellent performance. The feedback collected from the volunteers was systematically tabulated and analyzed to ascertain the overall acceptability of the formulated serum.

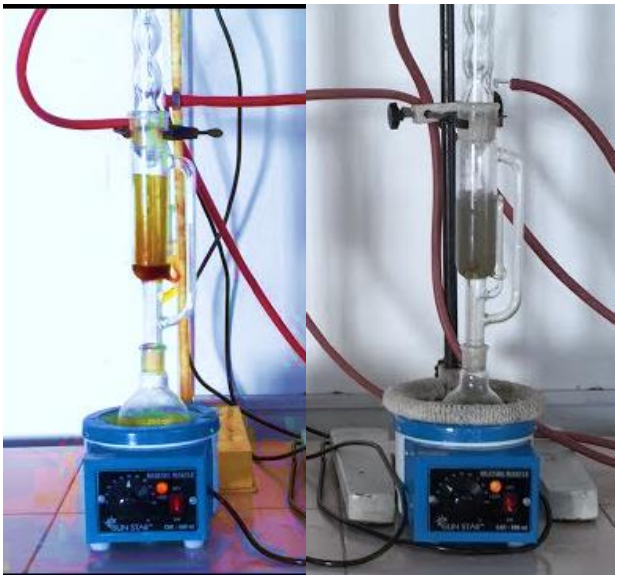

Figure 2. Extraction of Flaxseed Components by using Soxhlet Extractor.

Results and Discussion

Physicochemical Evaluation

Organoleptic Properties

Organoleptic properties pertain to the sensory attributes of a product discerned through visual, olfactory, and tactile perceptions. The flaxseed-based herbal face serum demonstrated a translucent pale brown hue, indicative of its natural composition devoid of artificial colorants. The serum emitted a mild lavender fragrance, presumably derived from essential oils or botanical extracts, which are frequently utilized for their skin-soothing and antiseptic properties. The serum's texture was characterized as gel-like, smooth, and non-sticky, facilitating easy application without a greasy sensation. The

moderate clarity of the serum was anticipated; as natural ingredients often contribute to slight opacity. These attributes suggest that the serum provides a pleasant and natural experience for users. Table 2 presents the physicochemical characteristics of the herbal face serum.

Table 2. Physicochemical Properties of the Formulated Serum

Parameter	Result	Method Used	Acceptance Criteria
Color	**Pale brown**	**Visual inspection**	**Should be uniform**
Odor	**Mild lavender**	**Sensory evaluation**	**Pleasant, non-irritating**
Consistency	**Gel-like, smooth**	**Physical touch observation**	**Non-sticky, easily spreadable**
Clarity	**Moderate clarity**	**Visual inspection**	**No visible particulate matter**
pH	**5.6 ± 0.2**	**Digital pH meter**	**4.5–6.5 (skin-compatible range)**
Viscosity (25°C)	**820 ± 15 cP**	**Brookfield viscometer (Spindle No. X)**	**Moderate viscosity**
Spreadability	**5.8 ± 0.3 cm**	**Glass plate method (fixed weight 500g, 1 min)**	**>5 cm preferred**

pH Measurement

The serum exhibited a pH of 5.6 ± 0.2, which falls within the optimal range for skincare products (Table 2). The natural pH of human skin generally ranges from 4.5 to 6.0, with an average of approximately 5.5, indicating that the serum's pH is well-suited for topical application. Maintaining a pH that corresponds with the skin's natural levels is essential, as it supports the acid mantle, the skin's protective barrier, and aids in preventing irritation. A pH of 5.6 implies that the serum is safe and unlikely to disrupt the skin's natural equilibrium, thereby ensuring comfort and compatibility with a diverse array of skin types.

Viscosity

The serum's viscosity was determined to be 820 ± 15 cP at 25°C, signifying an optimal consistency for facile application. Viscosity, defined as the serum's resistance to flow, is moderate in this instance, ensuring the serum is neither excessively fluid nor overly dense. This characteristic facilitates its application on the skin, minimizing excessive dripping and ensuring smooth and uniform coverage. The viscosity measurement was conducted using a Brookfield viscometer, a standard technique for assessing the consistency of cosmetic formulations. The findings suggest that the serum possesses a balanced texture, enhancing both its efficacy and user-friendliness.

Spreadability

The spreadability of the serum was evaluated by applying a fixed load, resulting in a spread diameter of 5.8 ± 0.3 cm. This finding indicates that the serum possesses favorable spreadability, enabling it to cover a relatively extensive area of skin with a minimal amount of product. Good spreadability is a critical factor in the usability of a skincare product, as it ensures efficient coverage and reduces the necessity for multiple applications. This characteristic also enhances the overall consumer experience, as the serum can glide smoothly over the skin without causing excessive drag or pulling.

Stability Study

The stability study was conducted to evaluate the serum's performance under various storage conditions over a 30-day period. At 4°C (refrigerated), the serum retained its color, consistency, and pH, with no evidence of phase separation, indicating that low temperatures are conducive to preserving the formulation. At room temperature (approximately 25°C), the serum exhibited minor thickening over the 30-day period, but no significant alterations in color or odor were detected, suggesting satisfactory stability under standard conditions. Conversely, at 40°C (elevated temperature), slight phase separation and mild darkening were observed, implying that high temperatures may adversely affect the product's stability. These findings recommend storing the serum in a cool environment, ideally below 30°C, to ensure optimal shelf life and maintain its efficacy (Table 3).

Table 3. Stability Study of Herbal Serum (30 Days Observation)

Storage Condition	Day 0 Observations	Day 30 Observations	Remarks
Refrigerated (4°C)	**Pale brown, homogenous, stable**	**No change in color, pH 5.6 → 5.5, stable viscosity**	**Ideal condition**
Room Temperature (25°C)	**Pale brown, homogenous**	**Slight thickening, pH 5.6 → 5.4**	**Acceptable changes**
Elevated Temperature (40°C)	**Pale brown, homogenous**	**Mild darkening, slight phase separation, pH 5.6 → 5.3**	**Instability observed at high temp**

Biological Evaluation

Moisturization Test

The moisturization assessment revealed the serum's efficacy in enhancing skin hydration (Table 4). After a duration of 2 hours, the skin exhibited visible hydration and softness, demonstrating the serum's immediate moisturizing effects. At the 4-hour mark, the moisturizing effect experienced a slight decline; however, the skin remained supple and well-hydrated, indicating the serum's capacity for prolonged hydration. By 6 hours, a noticeable reduction in moisture was observed, although the skin retained some level of hydration. These findings suggest that while the serum offers substantial moisturizing benefits, reapplication may be necessary after 5-6 hours to sustain optimal hydration levels, particularly for individuals with dry or dehydrated skin.

Table 4. Biological Evaluation - Moisturization Test Results

Time after Application	Visual Hydration	Touch Evaluation	Remarks
0 hours	Skin appears hydrated	Smooth and soft	Immediate moisturization
2 hours	Well hydrated	Still soft, slightly less moist	Excellent hydration retention
4 hours	Moderate hydration	Soft but less moist	Reapplication might be needed
6 hours	Slight dryness	Noticeable decrease in softness	Reapplication recommended

Patch Test

The patch test was conducted to assess the serum's safety and potential for inducing skin irritation. The results indicated that no signs of redness, irritation, or allergic reactions were observed in any participants after 24 hours (Table 5). This finding confirms that the serum is safe for topical application and is well-tolerated by the skin, rendering it suitable for a diverse range of users, including those with sensitive skin. The absence of adverse reactions highlights the serum's gentle formulation and its compatibility with the skin.

Table 5. Biological Evaluation - Patch Test Results

Volunteer ID	Observation at 1 hr	Observation at 6 hr	Observation at 24 hr	Reaction Status
V1	No redness	No irritation	No reaction	Safe
V2	No redness	No irritation	No reaction	Safe
V3	No redness	No irritation	No reaction	Safe
V4	No redness	No irritation	No reaction	Safe
V5	No redness	No irritation	No reaction	Safe

Conclusion

The conclusion of this study highlights the considerable potential of flaxseed-based herbal face serums within the domain of natural skincare. Through systematic development and comprehensive evaluation, this research has demonstrated the efficacy of flaxseed as a primary active ingredient in topical formulations. The serum exhibited promising physicochemical properties, stability, and biological activities, particularly in terms of antioxidant capacity, hydration benefits, and skin barrier enhancement. Sensory evaluations and user acceptability assessments further validated its aesthetic appeal and consumer preference. These findings not only contribute to the scientific understanding of flaxseed's topical benefits but also pave the way for future formulation strategies in natural cosmetic development. Looking forward, this research opens several avenues for future investigation and application. Further studies could explore the long-term effects of regular use of flaxseed-based serums on various skin types and conditions. There is potential for optimizing the extraction and formulation processes to enhance the bioavailability and efficacy of flaxseed's active components. Additionally, clinical trials could be conducted to substantiate the serum's effects on specific skin concerns such as aging, hyperpigmentation, or acne. The successful development of this flaxseed-based serum also sets a precedent for exploring other underutilized natural ingredients in skincare, potentially leading to a new generation of effective, sustainable, and eco-friendly cosmetic products.

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