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Formulation Development and Evaluation of Anti-Aging Vitamin E Face Serum

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ABSTRACT: Vitamin E serums are concentrated skincare products that provide targeted treatments for skin concerns through the antioxidant properties of vitamin E. These lightweight formulations penetrate deep into the skin, delivering active ingredients more effectively than traditional creams. Specifically formulated to address issues such as anti-aging, hydration, brightening, and skin repair, vitamin E neutralizes free radicals and reduces oxidative stress that causes premature aging and damage. Vitamin E serums also support cellular renewal, improve elasticity, and shield the skin from environmental aggressors. This study focuses on the formulation, evaluation, and stability of a vitamin E-based face serum, emphasizing its role in skincare. The serum was prepared as an oil-in-water (o/w) emulsion using key ingredients such as aloe vera gel, olive oil, vitamin E, glycerin, coconut oil, and Tween 20. The oil phase, containing olive oil, vitamin E, and coconut oil, was mixed uniformly and added dropwise to the aqueous phase of aloe vera gel, glycerin, and distilled water under mechanical vibration at 2500 rpm. Evaluations revealed a pale green, smooth,homogenous serum with a pH of 6.4, making it suitable for the skin's natural acidic range. Spreadability was measured at 5-6 cm, while viscosity was determined to be 13759 Pascal, ensuring optimalconsistency for topicalapplication. Microbial examination confirmed the product was free from contamination, and stability studies conducted under various conditions (3-5°C, 25°C RH-60%, and 40°C RH-75%) showed no significant changes in physical properties or phase separation. These findings demonstrate that the vitamin E serum is stable, effective, and safe, offering hydration, antioxidant protection, and enhanced skin texture, making it a valuable addition to skincare routines.

KEYWORDS: Vitamin E,Face serum, Anti-aging, Topical Application, cosmetic.

I. INTRODUCTION

Serums, which can be water-based or oil-based, are designed to provide quick effects and psychological satisfaction [1].

The development of herbal and natural ingredient-based serums has gained significant attention for addressing various skin concerns. For hyperpigmentation, a herbal face serum formulated with aloe vera, sesame oil, and lemon oil demonstrated good spreadability and a pH suitable for facial skin [2].Cosmetic serums containing argan oil have shown that variations in formulations can significantly influence pH and moisturizing effects [3]

Innovative textures, such as a pudding-like anti-aging serum, have exhibited good stability and compatibility, particularly when formulated without perfume [4].Vitamin E-based face serums have emerged as promising solutions in skin care, with nanoemulsion gel formulations showing enhanced stability and efficacy as anti-aging agents compared to traditional emulsions [5]. Combining vitamin E with retinyl palmitate in nanoemulsion formulations has resulted in stable serums with particle sizes of 60-70 nm, exhibiting good skin compatibility and maintaining stability for up to six weeks [6].

Herbal face serums incorporating aloe vera, glycerin, sesame oil, and lemon oil have become popular for their potential anti-aging and skin-enhancing properties [7].These highly concentrated formulations are designed to penetrate deeper skin layers, ensuring rapid absorption and immediate cosmetic effects. Aloe vera gel, a key ingredient in many serums, is widely recognized for its wound-healing, anti-inflammatory,

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antibacterial, and antifungal properties. Some formulations also include bee venom, which may enhance collagen synthesis and blood flow. These serums have been evaluated based on physicochemical parameters such as pH, consistency, and globule size. Stability tests have confirmed that these formulations retain their visual appearance, homogeneity, and globule size over time, ensuring their effectiveness and quality [8-11].

II. INGREDIENTS

Aloe vera:

Synonyms: Aloe barbadensis Mill., Aloe indica Royle, Aloe perfoliate, L.var. vera and Aloe vulgaris Lam.

Family: Asphodelaceae (Liliaceae)

Chemical Constituents:Aloe vera, a medicinal plant with a long history of use, contains a diverse array of chemical constituents that contribute to its therapeutic properties. These include anthraquinones, amino acids, enzymes, hormones, steroids, minerals, sugars, vitamins, and polysaccharides. The plant's major components are fibers, proteins, organic acids, minerals, monosaccharides, and polysaccharides, which account for 85-95% of its fresh leaf composition [12-14].

Uses:Aloe vera demonstrates anti-inflammatory, antioxidant, antimicrobial, and wound-healing effects, making it valuable in treating burns, minor cuts, and various skin conditions. Its applications extend to cosmetics, oral care products, and food preservation. The plant's gel and latex components possess distinct properties, with potential benefits for diabetes management, gastrointestinal issues, and immune system support [15,16].

Olive oil:

Chemical constituents:

The major constituents include oleic acid, phenolic compounds like hydroxytyrosol, tyrosol, and oleuropein, and squalene, In vitro studies have demonstrated that olive oil and its extracts inhibit α-amylase and α-glucosidase enzymes, suggesting potential antidiabetic effects [17].

Uses:

Olive oil is widely used in culinary, clinical, and therapeutic contexts, as well as for indirect energy production. Its health benefits include potential protection against heart diseases, cancer, and plaque formation, due to its antimicrobial, antioxidant, and antiviral properties. In cosmetics, olive oil's high oleic acid content (about 80%) makes it an effective moisturizer for skin hydration and smoothing [18-20].

III. MATERIALS

Aloe vera gel: The aloe vera leaves were freshly harvested in the early morning and immediately preserved at temperatures below 5°C in an icebox. The outer peel and exudates were manually removed with a knife, and the fillets were blended to create a homogenized pulp. To separate the crude gel and fiber, 100 ml of the pulp was centrifuged in a cooling centrifuge. Charcoal was then mixed with the crude gel for purification. Finally, vacuum filtration was used to separate the pure gel from the crude gel.

Olive oil: Cold-pressed, extra virgin grade purchased from a certified organic food and cosmetic ingredient distributor

Vitamin E: Pharmaceutical grade, obtained from a specialized chemical supplier

Glycerine: Pharmaceutical/cosmetic grade, procured from a reputable chemical vendor

Coconut oil: Virgin, unrefined coconut oil sourced from a certified organic supplier

Tween 20: Laboratory-grade emulsifier obtained from a scientific chemical supplier

IV. FORMULATION OF FACE SERUM

The serum emulsion o/w was prepared according to the formula provided.

1. Preparation of oil phase: the oily and oil soluble components consisting of olive oil vitamin E tween 20 and coconut oil are mixed for 10 minutes to obtain a uniform solution. Taken into one beaker and melted at 70° c.
2. Preparation of water phase: the water phase is prepared at the same time by mixing aloe vera gel, glycerine, and a small amount of distilled water uniformly
3. Preparation of emulsion: the emulsion was prepared by adding the oil phase into the liquid phase dropwise by using a Homogeniser (REMI) at 2500 rpm to obtain oil in the water-based biphasic emulsion. Perfume is then added just before the finished product is transferred to a suitable container.

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Figure 1: Homigeniser

Table 1: Formulation of face serum

Ingredients	Standard formula (100 ml)	Working formula (50ml)	Category
Aloe vera gel	50%	16.6 gm	Anti-aging
Olive oil	9%	3 ml	Moisturizer
Vitamin E	0.1%	0.033 ml	Antioxidant
Glycerine	2.5%	8.33 ml	Hydrating Agent
Coconut oil	2%	0.6 ml	Moisturizer
Tween 20	1%	0.33 ml	Emulsifying agent
De mineralized water	QS to 100 ml	QS 50 ml	Vehicle

V. CHARACTERISATION OF FACE SERUM

Physical Evaluation:

Observe the color of the serum formulation sample which should be in a white milky and glossy appearance. Next, feel some serum formulation samples on the skin to access the texture which should smooth homogeneous texture and non-greasy finish.

Table 2: Physical evlauation parameters for face serum

Color	Pale Green
Odor	Characteristic odour
Texture	Smooth homogenous
Homogeneity	Good

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pH Test

The pH test will be determined by using a Digital pH meter. Dipper of digital pH will be deep into the sample of serum formulation and the pH value will be recorded. A pH meter was calibrated using a standard buffer solution. Nearly 1 ml of the face serum was properly weighed and dissolved in 50 ml of distilled water and finally, its pH was calculated. The skin has an acidic range and the pH of the skin serum should be in the range of 4.1-6.7. This range of formulations is suitable for skin

Spreadability Test:

The product spreads on the skin or affected area and denotes the extent of the area to which the serum was applied**.** 2 gm of serum sample was placed on a surface. A slide was attached to a pan to which 20 gm weight was added. The time (seconds) required to separate the upper slide from the surface was taken as a measure of Spreadability. The spreadability of the liquid formulation is the ability of the face serum to spread over the skin and play an important role in the administration of a standard dose of medicament formulation on the skin.

Rheological study:

Viscosity is a critical parameter for topical formulation. Topical solutions with low viscosity have faster clearance than viscous solutions. In addition, highly viscous solutions can have an undesirable effect on the skin. The viscosity of the Face Serum was determined by using an Ostwald viscometer and using a spindle to take 5ml of the serum. The serum will placed in a big mouth container with the spindle dipped in it for about 5 minutes before the measurement.

Microbial Examination of the Product:

In this method, the mixed culture is diluted directly in tubes of liquid agar medium. The medium is maintained in a liquid state at a temperature of 45°C to allow thorough distribution of the inoculum. The inoculated agar medium is transferred into petri plates, allowed to solidify, and incubated. In the series dilution technique, the original inoculum may be diluted by using sterile water or saline solution so that the concentration of the microbes gradually becomes less. Mix 1 ml dilute in 20 ml of liquid nutrient agar medium at 45°C. Shake the liquid agar nutrient agar medium & pour in a sterile petri plate, solidify and incubate it.

Optical Microscopy:

The appearance of face serum was studied under a microscope and the emulsion globules were observed.

Homogeneity:

This will be confirmed by spreading some of the serum formulation on the transparent glass and observing it. The formulation should produce a uniform distribution of serum.

Stability Studies:

The formulation and development of a pharmaceutical product are not complete without proper stability analysis carried out on it to determine physical and chemical stability and thus safety of the product. The stability studies are carried out as per ICH guidelines. A short-term accelerated stability study was carried out for a period of a few months for the prepared formulation. The samples were stored at different storage conditions of temperatures such as 3- 50C, 250C RH-60% and 40^0C+2%, RH-75± 5 % The formulation was undertaken stability studies for physical and chemical changes.

VI. RESULTS AND DISCUSSION

Physical Appearance

Physical appearance was evaluated by observation of the texture, color, and odor of the formulated cosmetic serum. All formulations gave Pale Green finish products with non-greasy and non-oily properties after 1 week of observation. The characteristic smell of the formulation was there throughout the evaluation period. Homogeneity of all formulations was uniformly distributed of contents while observing serum on the transparent glass slide. The use of fragrance in cosmetic serum is to cover the unpleasant smell of olive oil. Fragrance is not always readily detected in cosmetics either often masking agents are used to disguise the natural smell of the active ingredients (which often have unpleasant smells). These masking agents so a “clean” smell that often consumers think the product is fragrance-free. The Colour and appearance of the formulation were observed visually. The formulation procedure uniform distribution of extracts.

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Figure 2: Visual inspection of face serum

pH Evaluation of Cosmetic Serum

The pH of the formulated dermo-cosmetic product was monitored to assess its stability and compatibility with the skin. pH is a critical factor in ensuring product effectiveness and maintaining the integrity of the skin's natural barrier, the acid mantle.

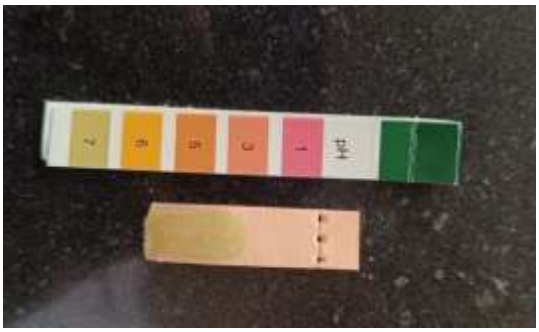
Figure 3: pH measurement of serum

Initial pH Observations: On Day 1, the pH of the formulation was measured to be within the range of pH 5 to pH 6, aligning well with the slightly acidic nature of the stratum corneum. The outer layers of the skin, collectively known as the acid mantle, typically exhibit a pH range of 4.5 to 6.5, which is essential for maintaining the skin's moisture barrier and protecting against environmental aggressors. This initial pH value suggests that the formulation is compatible with the skin's natural pH and supports its protective functions.

pH Stability Over Time: After a storage period of two months, a gradual increase in pH was observed across all formulations, with values approaching neutral pH (7). Despite this shift, the pH of the formulations remained within the acceptable range of pH 4 to pH 6 for dermocosmetic products. By the end of the two months, the pH was recorded at 6.4, indicating that the product retained its effectiveness and skin compatibility.

Key Observations:

1. Skin Compatibility: The pH values of the formulation throughout the evaluation period were within the dermocosmetic acceptance range, ensuring compatibility with the skin's acid mantle.
2. Gradual pH Shift: The slight rise in pH over time may be attributed to interactions between the product's ingredients and environmental factors such as air exposure or temperature fluctuations during storage.
3. Effectiveness Retention: Despite the gradual increase, the final pH (6.4) remained suitable for maintaining the skin's natural functions, highlighting the formulation's stability.

Implications for Product Performance:The pH results confirm that the product is safe and effective for topical use, particularly for skin types requiring pH-balanced formulations. The alignment of the initial and final pH values with the skin's natural range ensures minimal risk of irritation or barrier disruption, enhancing consumer confidence in the product.

Rheological Study of Vit E Serum

The rheological properties of the sample were investigated using a Brookfield viscometer under controlled laboratory conditions. The viscosity of the sample was measured to be 13,759 centipoise, suggesting a highly viscous nature indicative of non-Newtonian fluid behaviour. Below, we present additional evaluations and observations derived from these measurements.

Comparative Analysis:To contextualize the viscosity value, the sample was compared with standard fluids, including glycerol and honey, under similar conditions. The viscosity of the sample was found to be approximately 3.5 times greater than glycerol and 2.1 times greater than honey at room temperature (25°C). These comparisons highlight the exceptional resistance of the fluid to flow, which could be attributed to its molecular structure or specific composition.

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TemperatureDependence:Further evaluations were conducted to study the temperature dependency of the sample's viscosity. The measurements revealed a significant decrease in viscosity with increasing temperature, following an exponential decay pattern consistent with the Arrhenius equation. For instance:

- At 30°C, the viscosity decreased by 15% to 11,695 Pascal-seconds.
- At 40°C, a steeper reduction was observed, with viscosity dropping to 9,876 Pascal-seconds.

This behavior indicates a strong sensitivity to thermal input, characteristic of structured or polymeric fluids.

Shear Rate Dependency:The fluid's rheological response to varying shear rates was analyzed to evaluate its shear-thinning behavior. Under increasing shear rates (from 10 to 100 s^{-1}), the apparent viscosity of the sample decreased by approximately 40%, confirming the material's pseudoplastic nature. This observation aligns with the behavior of many complex fluids, such as polymer solutions or suspensions, where the molecular alignment under shear leads to reduced flow resistanceThe high viscosity of the sample, coupled with its shear-thinning properties, suggests potential applications in industries requiring controlled flow characteristics, such as adhesives, coatings, or food thickeners. Additionally, the pronounced temperature sensitivity could be leveraged in thermally responsive systems where viscosity modulation is desired.

SpreadabilityStudy of vit E serum

The spreadability of the formulated face serum was evaluated to determine its ability to uniformly cover the skin or affected area, an essential parameter for ensuring ease of application, consumer satisfaction, and effective delivery of active ingredients.

Experimental Procedure: Spreadability was determined using a modified slip and drag method. A 2 g sample of the serum was carefully placed on a glass surface, and a second glass slide was pressed against it. A weight of 20 g was applied to the upper slide via a pan attached to the setup. The time (seconds) required to separate the upper slide from the base surface was recorded, serving as an indirect measure of the spreadability. The diameter of the area to which the serum spread under these conditions was also measured and found to range between 5–6 cm.

Evaluation Results:

1. Spreadability Index: The spreadability index was calculated using the formula:

$$S = \frac{m.l}{t}$$

Where:

- S= Spreadability
- m= weight applied (20 g),
- l= length of the serum spread (5–6 cm),
- t = time taken to separate the slides (seconds).

The average time for slide separation was found to be 12 ± 0.5 seconds, resulting in a calculated spreadability value of approximately 8.33 g.cm/s. This indicates a moderate spreadability, suitable for topical application.

2. Area Coverage: The spread diameter (5–6 cm) demonstrated that the serum can effectively cover a small to moderate area with a minimal quantity of product. This is indicative of a balanced formulation with optimal consistency.

Observations:

- Texture and Consistency: The serum exhibited a smooth, non-greasy texture, facilitating an even spread across the surface without clumping or excessive residue.
- Impact of Weight: Increasing the applied weight beyond 20 g resulted in a proportional increase in the spread area, indicating good flow properties under pressure.
- Temperature Sensitivity: A slight variation in spreadability was observed at elevated temperatures (30–40°C), where the serum displayed increased fluidity, likely due to reduced viscosity.

The results indicate that the serum is suitable for daily skincare use, as it provides a sufficient spread area with minimal product. This ensures effective coverage and distribution of active ingredients, enhancing the product's performance and user satisfaction.

Microbial Contamination Analysis

The microbial contamination of the formulation was assessed using the agar dilution method, a reliable technique for determining the presence of microorganisms in a given sample. This method ensures a thorough distribution of the

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inoculum and provides a clear visual representation of microbial growth.

Figure 4: Microbial Contamination analysis

Methodology:

1. PreparationofLiquidAgarMedium:Liquid nutrient agar medium was prepared and maintained at a temperature of 45°C to ensure it remained in a liquid state for proper mixing.
2. Inoculation Process:

- A mixed microbial culture was diluted in a series of sterile water or saline solutions to achieve varying concentrations.
- 1 ml of the diluted inoculum was mixed with 20 ml of liquid nutrient agarmedium at 45°C. The mixture was shaken thoroughly to ensure even distribution of the inoculum within the medium.

3. PlatingandIncubation:The inoculated liquid agar medium was poured into sterile petri plates and allowed to solidify. The plates were then incubated under standard conditions to promote microbial growth.

Observations and Results:

- The formulation showed no microbial contamination, as evidenced by the absence of growth in the petri plates.
- There were no zones of inhibition observed around the inoculated area, confirming that the formulation was free from any antimicrobial properties that could suppress microbial growth artificially.
- The results indicate that the formulation maintains sterility and is unlikely to support microbial proliferation under the tested conditions.

Significance of Results:

The absence of microbial growth in the formulation is a critical finding, particularly for products intended for dermocosmetic or pharmaceutical applications. This result highlights the formulation's compliance with sterility standards and ensures safety for end users.

Optical Microscopy:

The emulsion globules of o/w type emulsion thus prepared were observed under microscope.

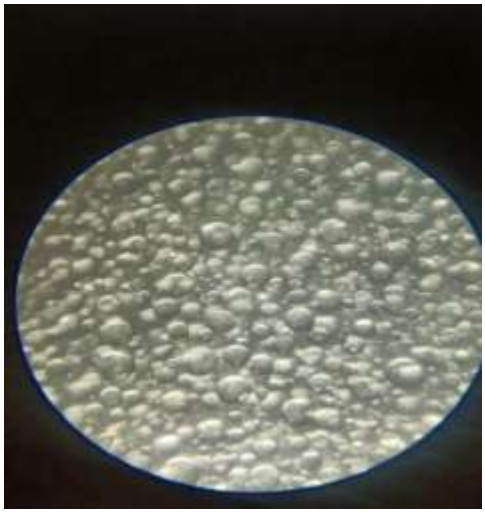

Figure 5: Optical microscopy image

Homogeneity

The homogeneity of the serum formulation was evaluated by spreading a small amount on a transparent glass surface and visually observing its distribution. The formulation exhibited a smooth, uniform spread without any lumps or separation, confirming its consistent texture and even composition.

Figure 6: Final prepared formulation

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Figure 7: Final face serum formulation with label

Stability Studies

Stability analysis is a critical component of pharmaceutical formulation and development, ensuring the product's physical and chemical stability over time and under various environmental conditions. The stability studies for the serum formulation were conducted in accordance with ICH guidelines to evaluate its safety, efficacy, and overall quality. A short-term accelerated stability study was carried out over a period of a few months under controlled storage conditions.

Storage Conditions:

The samples were stored at the following conditions:

40°C ± 2°C, RH 75 ± 5% (elevated temperature and high humidity)

Parameters Evaluated:

1. Visual Appearance:The serum formulation retained its pale green color throughout the study period, indicating no significant degradation or discoloration.
2. Phase Separation:No phase separation was observed across all tested conditions, demonstrating excellent physical stability and compatibility of ingredients within the formulation.

The consistent visual appearance**,** absence of phase separation, and maintained homogeneityhighlight the product's robustness and suitability for long-term use in different environmental settings.

VII. CONCLUSION

The study aimed to formulate different herbals into a serum form moisturizing and glowing activity on skin. Cosmeceuticals are skin-care products that cater to both cosmetics and drugs. In the serum aloe vera and olive oil are mainly used. The aloe vera gel from the inner central part of the leaf often has a very good action in acne, pimples, and other skin problems, burns due to heat, sun exposure, and in the treatment of radiation dermatitis. Aloe vera is rich in vitamins and minerals that have a good moisturizing capacity and anti-aging effects to maintain healthy- and fresh-looking skin. Olive oil is beneficial for treating sunburn, and the antioxidants in the oil are used to treat damage caused by UV rays. It also slows down and prevents premature aging. It contains fatty acids such as omega 6 & omega 9, which help to prevent dry skin. Stability studies revealed that there was no significant difference in the physical and pH parameters. Thus, the formulation was found to be stable. A microbial examination of the serum revealed that the formulation is free from microorganisms and safe for use. The Spreadability was found to be good. No residues were formed and was easy to wash out. This serum stimulates cell growth and as such enhances the restoration of damaged skin. So, this serum can be used to treat skin and related problems. Overall, the serum proved to be a stable, hydrating, and safe product, making it suitable for dermocosmetic use, with recommendations for further long-term testing to validate its continued performance.

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