Revitalizing the hair ends: Formulation and evaluation of the elderflower (*Sambucus nigra*) hair mask for enhanced hair health

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ABSTRACT

Background: Elderflower (Sambucus nigra) is esteemed for its historical use in traditional medicine and culinary applications, attributed to its rich content of bioactive compounds, including flavonoids, phenolic compounds, and essential oils. Recognizing its potential benefits for skin and hair health, elderflower has found its place in the cosmetic industry. This study ventured into developing and evaluating the elderflower hair mask, an innovative product tailored to nourish and rejuvenate hair ends. Materials and Methods: The formulation of the elderflower hair mask incorporates a blend of lemon and cedar hydrosols, BTMS (behentrimonium methosulfate, cetearyl alcohol), broccoli oil, elderflower powder, grapefruit essential oil, and laurel essential oil. The research encompasses the detailed preparation process and emphasizes the significance of equipment cleansing and disinfection protocols. A notable aspect is the use of freshly milled elderflower powder, ensuring the preservation of its potency. Comprehensive traceability worksheets are employed to meticulously record ingredients, batch numbers, and due dates, thereby ensuring product quality and traceability. The pH of the elderflower hair mask is at 6, harmonizing with the natural pH of healthy hair, thus facilitating effective conditioning without disrupting the structural integrity of the hair. Results: This study illuminated the distinctive attributes of each ingredient within the formulation. Lemon hydrosol contributes cleansing and clarifying properties, while cedar hydrosol offers soothing effects. BTMS demonstrates its prowess in hair conditioning, while broccoli oil aids in moisture retention. Grapefruit essential oil contributes an invigorating aroma, and laurel essential oil is recognized for its potential to promote hair strength and scalp health. Discussion: The elderflower hair mask embodies a holistic approach to hair care by carefully selecting and formulating these ingredients. The pH alignment with the hair's natural pH underscores its effectiveness in conditioning. This innovative product has the potential to revitalize and nourish hair ends, offering a fusion of traditional wisdom and modern cosmetic science. Further research may delve into the mask's specific benefits, supporting its role in enhancing hair health and overall well-being.

Key words: Elderflower, Cosmetics, Natural ingredients, Hair mask

INTRODUCTION

Elderflower (*Sambucus nigra*) has a longstanding tradition of use in traditional medicine and culinary practices, attributed to its bioactive constituents such as flavonoids, phenolic compounds, and essential oils [1,2]. Beyond its historical uses, elderflower has gained attention in the cosmetic industry due to its potential benefits for skin health and beauty [3,4]. The

diverse phytochemical profile of elderflower suggests its capacity to offer antioxidant, anti-inflammatory, and moisturizing effects [5]. As consumer preference shifts toward natural and sustainable cosmetic ingredients, exploring elderflower's cosmetic potential becomes increasingly relevant [6,7]. Elderflower also have excellent antigenotoxic properties (repairing damage to genetic material) that has been linked to anti-aging properties [6,8–11]. Overall, the cosmetic properties of

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Submission: 02.09.2023; Acceptance: 30.10.2023 DOI: 10.7241/ourd.20241.2 the elderflower make it a valuable natural ingredient for use in skincare and haircare products [12].

Elderflower's excellence as a hair product ingredient is attributed to its rich content of bioactive compounds, notably flavonoids, antioxidants, and essential oils. Flavonoids, such as quercetin and rutin, contribute to elderflower's anti-inflammatory and soothing properties [13], effectively addressing scalp irritations and itchiness. Moreover, the high concentration of antioxidants present in elderflower combats oxidative stress, protecting hair from environmental damage and promoting overall hair health [14]. These compounds collectively contribute to elderflower's nourishing, hydrating, and fortifying effects on hair strands, resulting in a hair product ingredient that revitalizes, strengthens, and promotes a healthier and more vibrant hair appearance.

This study aimed to develop and evaluate the effectiveness of the elderflower hair mask, a specially formulated product designed to nourish and revitalize hair ends. The study aimed to provide a comprehensive understanding of the hair mask's application process, the selection of key ingredients, and their individual and combined contributions to enhancing hair health. Through a detailed exploration of each ingredient's properties, the study sought to showcase the mask's benefits in promoting softer, smoother, and more revitalized hair ends. Ultimately, the study aimed to offer a holistic approach to hair care by offering users an effective and enjoyable solution for addressing common hair end concerns and elevating their overall hair care routine.

MATERIALS AND METHODS

Ingredients

Lemon hydrosol (INCI: Citrus limonum (lemon) hydrosol water; CAS: 8020-19-7), Cedar hydrosol (INCI: Cedrus atlantica bark water; CAS: 92201-55-3), BTMS (INCI: Behentrimonium Methosulfate (and) Cetearyl Alcohol; CAS: 81646-13-1/241148-11-0) and Laurel essential oil (INCI: Laurus nobilis leaf oil; CAS: 8007-48-5/84603-73-6) were purchased at Aromazone (Paris, France).

Broccoli oil (INCI: Brassica oleracea italica seed oil; CAS: 223749-36-8), and Grapefruit essential oil (INCI: Citrus paradisi seed oil; CAS: 90045-43-5) were purchased at Plena Natura (Amadora, Portugal).

Elderflower Harvest and Preparation

In May 2023, elderflowers were harvested from Vila Real, Portugal (41°17'51.6"N 7°44'15.3"W) and airdried for three weeks at room temperature (20–25°C) in a dark and dry place to prevent direct sunlight exposure. The desiccated elderflowers were meticulously preserved within an airtight glass receptacle pending subsequent analysis [11].

Elderflower Powder

It is imperative to acknowledge that the storage of materials in a powdered state might exert a detrimental influence on their longevity. This is attributable to escalated fragility, which yields a larger surface area, engendering heightened susceptibility to oxidation and the dissipation of volatile entities. This phenomenon is particularly pronounced in botanical specimens encompassing essential oils, tannins, and bitter constituents [5]. Consequently, to avert such potential deterioration, elderflowers were methodically milled into powder form using a coffee mill immediately before each experimental undertaking (Fig. 1).

The versatility of elderflower extends to its preparation for cosmetic formulations, offering the flexibility to customize its texture according to specific product requirements. Elderflowers may be meticulously powdered into various particle sizes, allowing for tailored formulations across a spectrum of cosmetic applications. Depending on the intended cosmetic product, the elderflower may be ground into finer or coarser powders, each possessing distinct properties that contribute to the final product's desired texture, appearance, and functionality. This adaptability



Figure 1: Elderflower powder.

underscores the remarkable potential of elderflower as an ingredient, enabling cosmetic formulators to harness its benefits in diverse formulations, from finely textured lotions to coarser exfoliating scrubs, thus enriching the creative possibilities within the realm of natural cosmetics.

Equipment Cleaning and Disinfection

Equipment cleansing and disinfection are indispensable practices within the realm of product manufacturing and process control. Thorough and systematic cleaning and disinfection of equipment ensure the removal of contaminants, residues, and microbial populations that could compromise product quality and safety. By meticulously following established protocols, equipment is effectively sanitized, mitigating the risk of cross-contamination and microbial growth. The cleansing phase involves the removal of physical debris and substances, while disinfection eradicates potentially harmful microorganisms. These procedures uphold stringent hygiene standards and contribute to equipment longevity and optimal performance. A well-executed regimen of equipment cleansing and disinfection safeguards the integrity of products, enhances process reliability, and aligns with regulatory requirements, fostering a controlled and safe manufacturing environment.

Home-Made Cosmetics Cleaning and Disinfection Protocol

Maintaining proper cleanliness and hygiene while creating home-made cosmetics is essential to ensure the safety and quality of the products. Follow this cleaning and disinfection protocol to mitigate contamination risks and produce safe cosmetics:

- 1. Preparation:
 - Before beginning, all the necessary equipment, ingredients, and packaging materials should be gathered.
 - Before handling any ingredients or equipment, hands should be washed thoroughly with soap and water.
- 2. Work Surface:
 - The work should begin with a clean and sanitized work surface. The area should be wiped down with a household disinfectant, water mixture, and food-safe sanitizer.
 - Disposable or freshly cleaned cloths or paper towels for wiping surfaces should be used.

- 3. Equipment Cleaning:
 - Before using any equipment, washing them with warm water and soap to remove dirt and residue is necessary.
 - The equipment should be rinsed thoroughly to remove soap and then air-dried or pat-dried with clean paper towels.
- 4. Equipment Disinfection:
 - A sanitizing solution for non-porous equipment (stainless steel, glass) should be used. Equipment surfaces should be wiped down with this solution and air-dried. The equipment should be rinsed thoroughly with water after disinfection.
 - For porous equipment (wooden utensils), separate, dedicated cosmetic-making equipment should be used to avoid contamination.
- 5. Ingredient Handling:
 - Clean and sanitized measuring tools and containers for ingredients should always be used.
 - Ingredients should be avoided touching directly with the hands; using clean utensils or disposable gloves is necessary.
- 6. Packaging:
 - The packaging containers that will be used for the cosmetics should be clean and disinfected.
 - Finished products should be stored in a cool, dry place away from direct sunlight to prevent spoilage.
- 7. Hygiene:
 - Wearing a clean apron or clothing designated for cosmetic-making to prevent cross-contamination is fundamental.
 - Cosmetics should not be made if the formulator is sick or has open wounds to prevent contamination.
- 8. Cleaning After Use:
 - Once one has finished making the cosmetics, the work area and equipment should immediately be cleaned.
 - Utensils and equipment should be washed with warm water and soap and disinfected as outlined earlier.
 - The work surface should be cleaned with a household disinfectant or a mixture of water and food-safe sanitizer.

Following these cleaning and disinfection steps ensures that the home-made cosmetics are produced in a safe and hygienic environment, minimizing the risk of contamination and ensuring the quality of the products. The protocol should be reviewed and updated to align with best practices and relevant guidelines.

Records

A traceability worksheet was created for each preparation (Table 1). This fundamental record-keeping tool captures crucial data to ensure accountability and transparency within the product lifecycle. It succinctly documents essential information, including the International Nomenclature of Cosmetic Ingredients (INCI) name, batch number, quantity utilized, and the due date of each ingredient. This concise yet vital record not only facilitates efficient tracking of ingredient usage yet also aids in quality control, regulatory compliance, and swift response to any potential concerns. By systematically logging these key details, the traceability worksheet empowers businesses to swiftly assess ingredient usage, verify product integrity, and guarantee timely adherence to due dates. In its simplicity, this worksheet reinforces the foundation of a reliable and well-managed supply chain, safeguarding the quality and safety of products while maintaining an organized and efficient production process [15].

Elderflower Hair Mask

The exact formulation is described in Table 2. The determination of specific ingredient percentages in the formulation was guided by a comprehensive approach that balanced scientific knowledge, empirical experimentation, and formulation expertise. Each ingredient's functional role, inherent properties, and potential benefits were meticulously considered during the formulation design. Before formulating the elderflower hair mask, an extensive review of existing literature, research studies, and established formulations involving similar ingredients was conducted. This served as a foundation to establish initial concentration ranges. Empirical testing played a pivotal role, involving the creation of various small-scale batches with incremental adjustments to ingredient concentrations. Rigorous sensory evaluations accompanied these iterations to assess texture, scent, and application ease.

Furthermore, efficacy testing was conducted to gauge the impact of ingredient variations on desired hair health outcomes, including softness, shine, and manageability. Compatibility and stability tests were also performed to ensure that the ingredients interacted harmoniously and maintained the desired properties over time. The formulation underwent multiple refinements, informed by both empirical data and formulation expertise, to achieve a harmonious balance of ingredients that deliver optimal hair care benefits and align with safety, stability, and sensory expectations. These systematic approaches culminated in establishing the specific percentages for each ingredient, offering a scientifically grounded and effective formulation for the elderflower hair mask.

The preparation of these cosmetic ingredients was as follows:

- 1. The process was initiated by sterilizing all equipment, containers, and utensils to ensure a clean and hygienic environment for formulation.
- 2. Separate containers were prepared for each phase (Stainless steel bowls, Aromazone), with the ingredients accurately weighed using a digital scale (Plena Natura, 200 g/0.01 g).
- 3. In a heat-resistant container, the ingredients of Phase A (Cedar and Lemon Hydrosols) were combined (Fig. 2a).
- 4. In a heat-resistant container, the ingredients of Phase B (BTMS and Broccoli Oil) were combined (Fig. 2b).
- 5. The Phase B mixture was heated to 75°C using a double boiler until the BTMS had melted completely. The mixture was stirred well to ensure uniform blending of the ingredients (Electric Mini Mixer, GranVelada).
- 6. Phase B (melted BTMS and Broccoli Oil) was mixed thoroughly with Phase A (hydrosol blend) for 3 minutes.
- 7. The mixture was allowed to cool down to a suitable temperature (around 40–45°C) (Fig. 2c).
- 8. Phase C (enriching botanicals and fragrance) ingredients were added one by one to the mixture

Table 1: Traceability worksheet.

Date: 22/05/2023		Final quantity: 100 g		
Ingredient	INCI Name	Quantity (g)	Batch No.	Due Date
Lemon hydrosol	Citrus limonum (lemon) hydrosol water	32	21HY0185/2	10/2023
Cedar hydrosol	Cedrus atlantica bark water	46.6	21HY0095/5	01/2024
BTMS	Behentrimonium Methosulfate (and) Cetearyl Alcohol	8	22EMU0002/	07/2024
Broccoli oil	Brassica oleracea italica seed oil	10.4	0011780R	06/2023
Elderflower powder	N/A	2	N/A	N/A
Grapefruit essential oil	Citrus paradisi seed oil	0.5	008731	10/2023
Laurel essential oil	Laurus nobilis leaf oil	0.5	21HE0075/5	09/2024

and stirred for 2 minutes to ensure even distribution (Fig. 2d).

- 9. Stirring was continued periodically as the mixture cooled to prevent any separation or settling of the ingredients (Fig. 2e).
- 10. Once the mixture had cooled significantly (around 30°C), it was carefully poured into a sterilized amber jar.
- 11. The jar was sealed, and the hair mist was stored in a cool, dark place to preserve its quality.

Labeling

Home-made cosmetic labelling is integral to creating and sharing personal care products. Accurate and

Table 2: Elderflower hair mask formulation.

Phase	Ingredient	%
A	Lemon hydrosol	32
A	Cedar hydrosol	46.6
В	BTMS	10
В	Broccoli oil	4.4
С	Elderflower powder	6
С	Grapefruit essential oil	0.5
С	Laurel essential oil	0.5

thoughtful labelling remains crucial while not bound by the same regulatory standards as commercial products. A home-made cosmetic label should include essential details such as the product name, list of ingredients, and clear usage instructions. Transparency is paramount, indicating any allergens or potential sensitizers to ensure consumer safety. Additionally, including the creation date or batch number offers a sense of traceability. While the design may reflect the creator's personal style, ensuring legibility and clarity is vital. Though home-made cosmetics lack regulatory mandates, a well-crafted label demonstrates a commitment to responsibility and respect for those who use the products.

RESULTS

The pH of the elderflower hair mask was determined using pH stripes and was in the range of 6. The pH level of cosmetic formulations is a critical parameter that profoundly influences their compatibility with the skin and hair. In the context of hair care products, maintaining an optimal pH range is imperative to



Figure 2: Steps of the preparation: a) Phase A mixture; b) Phase B mixture; c) mixture of Phase A into Phase B; d) addition of Phase C ingredients; e) final result.

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ensure the health and integrity of the hair strands and the scalp. With a pH level of 6, the elderberry hair mask falls within the slightly acidic to neutral range, closely mirroring the natural pH of healthy Hair. This pH level is strategically chosen to provide effective conditioning and revitalization without causing disruption to the hair's cuticle structure or disturbing the scalp's equilibrium.

The texture assessment revealed that the mask had a creamy and smooth consistency that was easy to apply evenly onto the hair ends. The mask had a non-greasy and lightweight feel and did not leave any residue on their hair. Aroma evaluation highlighted the mask's aromatic appeal and the invigorating and citrusy scent derived from the grapefruit essential oil. After using the mask, the hair ends felt noticeably softer and smoother after a single application.

To assess the stability of the elderflower hair mask over time, a comprehensive study was conducted to monitor potential changes in texture and scent commonly associated with natural formulations. The hair mask was stored under controlled conditions, including varying temperature and humidity levels, to simulate real-world storage conditions. Texture evaluations were conducted periodically, with results consistently demonstrating that the hair mask maintained its creamy consistency and smooth texture throughout the entire study duration. No significant alterations in texture, such as phase separation or thickening, were observed. Additionally, sensory assessments of the aroma revealed that the characteristic citrusy and invigorating scent derived from grapefruit essential oil remained stable and appealing throughout the storage period. These findings collectively attest to the robust stability of the elderflower hair mask, dispelling concerns regarding potential changes in texture or scent commonly associated with natural formulations. The careful selection of ingredients and formulation techniques, in conjunction with appropriate preservation strategies, contributes to the long-term stability and quality of the hair mask, reinforcing its potential as a reliable and effective natural hair care product.

DISCUSSION

The hair care routine may be elevated with the rejuvenating properties of the elderflower hair mask, specially formulated to nourish and revitalize the hair ends. These steps should be followed for optimal application:

- Preparation: After shampooing and conditioning the hair, the hair should be gently dry pat with a towel, leaving the ends slightly damp.
- Application: The container of the elderflower hair mask should be open, and a small amount of the creamy mask should be taken and rubbed between the palms to distribute it evenly.
- Focus on Ends: The mask should be primarily applied to the ends of the hair, where it tends to be most fragile and prone to dryness. The mask should be worked into the ends using the fingers, gently massaging it to ensure thorough coverage.
- Treatment Time: The hair mask must penetrate and nourish the hair ends for 5–10 minutes. For a more profound treatment, we advise wrapping the hair ends with a warm, damp towel to enhance the mask's absorption.
- Rinse: After the treatment period, the hair should be rinsed thoroughly with lukewarm water to remove the mask. The hair ends will feel noticeably softer and smoother, even during rinsing.
- Frequency: For optimal results, the hair mask should be incorporated into the beauty routine once a week or as needed, focusing on providing the hair ends with the nourishment they deserve.

Lemon hydrosol is an excellent choice for this formulation due to its array of beneficial properties that contribute to hair care. Lemon hydrosol is known for its refreshing and cleansing properties. It may help remove excess oil, dirt, and impurities from the hair, leaving it feeling revitalized and clean. It has a natural astringent effect that may help balance oil production on the scalp and clarify the hair strands. This may be especially beneficial for those with oily or greasy hair. It also contains natural compounds that may promote a healthy scalp environment. It may assist in maintaining a balanced pH and reducing the likelihood of issues such as dandruff or scalp irritation. It may impart a natural shine to the hair, enhancing its overall appearance and luster. The invigorating citrus aroma of lemon hydrosol adds a sensory element to the hair care experience, providing a refreshing and uplifting feeling. Lemon hydrosol contains antioxidants that help protect the hair from environmental stressors and oxidative damage, promoting healthier-looking hair. It is generally considered gentle and suitable for various hair types, making it a versatile choice for your formulation. In this formulation, the lemon hydrosol's

cleansing, clarifying, and refreshing properties may complement other ingredients, creating a well-rounded hair mask that aims to revitalize and nourish the hair ends.

Cedar hydrosol is a well-suited ingredient for this hair mask formulation due to its unique properties that may contribute to hair health and overall cosmetic benefits. Cedar hydrosol possesses natural soothing properties, which may help alleviate scalp irritations, redness, and itchiness. This makes it beneficial for individuals with sensitive or irritated scalps. The antiinflammatory compounds present in cedar hydrosol may assist in reducing inflammation on the scalp, potentially relieving discomfort and promoting a healthier scalp environment. It has a balancing effect on sebum production, making it suitable for both oily and dry scalps. It may help regulate oiliness and promote a harmonious scalp balance. Cedar hydrosol is believed to have properties that may strengthen hair follicles and promote healthy hair growth. This may contribute to overall hair vitality and resilience. The woody and earthy aroma of cedar hydrosol provides a grounding and aromatherapeutic aspect to your hair mask, creating a sensory experience during use. With its inherent antimicrobial properties, Cedar hydrosol may contribute to the natural preservation of your hair mask, helping maintain its freshness over time. Cedar hydrosol imparts gentle hydration to the hair strands, helping to maintain moisture balance and prevent dryness, particularly in the hair ends. Cedar hydrosol complements the other ingredients in this hair mask formulation, especially when paired with lemon hydrosol. Together, they provide a harmonious blend of properties that cleanse, clarify, soothe, and nourish the hair ends.

BTMS is a commonly chosen ingredient for hair care formulations, including hair masks, due to its excellent conditioning and emulsifying properties. BTMS is renowned for its exceptional conditioning capabilities. It helps detangle the hair, improve manageability, and impart a soft, silky texture to the hair strands. This is particularly beneficial for dry or damaged hair ends. It acts as an emulsifying agent that assists in blending water-based and oil-based ingredients together, creating a stable and well-mixed formulation. This ensures that the hair mask maintains a consistent texture and appearance. BTMS carries a positive charge, which enables it to bond with negatively charged hair fibers. This positive interaction helps improve the hair's overall smoothness, reduces static, and enhances shine. Unlike other conditioning agents, BTMS is known for its easy rinsing, leaving minimal residue while providing practical conditioning benefits. BTMS is considered mild and gentle on the hair and scalp, making it suitable for various hair types, including sensitive scalps. It is compatible with numerous ingredients, making it versatile for formulating multiple hair care products. BTMS imparts conditioning without a heavy or greasy feeling, making it suitable for leave-in or rinse-off applications like a hair mask. In the context of this formulation, BTMS contributes to the mask's overall texture, conditioning, and emulsification, ensuring that the enriching botanicals are evenly distributed and easily applied to the hair ends.

Broccoli oil, derived from broccoli seeds, is a thoughtful and beneficial choice for this hair mask formulation due to its unique composition and potential hairenhancing properties. Broccoli oil is rich in essential fatty acids, vitamins (such as vitamin C and vitamin K), and antioxidants, which may contribute to nourishing and revitalizing hair strands. It is a lightweight oil that provides moisture to the hair without weighing it down, making it an ideal choice for hair mask formulations that aim to nourish hair ends without causing greasiness. The natural sheen-enhancing properties of broccoli oil may add a healthy and radiant appearance to the hair strands, helping to combat dullness and promote vitality. Broccoli oil's vitamin-rich profile may help support overall hair health, potentially contributing to hair strength and resilience. The antioxidants in broccoli oil may offer some level of protection against environmental stressors, including heat damage from styling tools. Broccoli oil's moisturizing properties may help improve hair texture, making it smoother and more manageable. Broccoli oil is known for absorbing quickly into the hair, providing moisture and nutrients without leaving a heavy or greasy residue. In this hair mask formulation, broccoli oil adds an enriching element that promotes hydration, shine, and overall hair well-being. Its lightweight nature and nutrient content make it a versatile choice, especially for targeting hair ends and preventing dryness.

Grapefruit essential oil is a beneficial choice for this hair mask formulation due to its array of properties that may enhance the product's overall effectiveness and sensory experience. When used in hair care products, grapefruit essential oil has a naturally uplifting and invigorating aroma that provides a refreshing and energizing sensation. It helps awaken the senses and promote a positive mood. It is known for its cleansing properties, which may assist in removing excess oil, dirt, and product buildup from the hair and scalp. This makes it suitable for individuals with oily or congested scalps. It also contains antioxidants that help protect the hair from oxidative stress caused by environmental factors. This contributes to maintaining healthier-looking hair. The antiseptic properties of grapefruit essential oil can help maintain a clean and healthy scalp, potentially reducing the risk of microbial imbalances and scalp issues. Some compounds found in grapefruit essential oil are believed to support blood circulation to the scalp, which may, in turn, support healthy hair growth and follicle health. The invigorating and citrusy scent of grapefruit essential oil creates a spalike experience during hair mask application, promoting relaxation and well-being. Grapefruit essential oil has natural antimicrobial properties that contribute to the preservation of your hair mask formulation, helping to extend its shelf life. In this formulation, grapefruit essential oil enhances the hair mask's overall sensory experience while contributing to its cleansing, revitalizing, and antioxidant properties.

Laurel essential oil, also known as bay laurel essential oil, is a valuable addition to this hair mask formulation due to its unique properties that contribute to hair health and overall sensory experience. Laurel essential oil has a stimulating aroma that invigorates the senses and provide a refreshing experience during hair mask application. It is believed to have natural antiseptic and antimicrobial properties, which help maintain a clean and healthy scalp by addressing potential microbial imbalances. The unique blend of compounds in laurel essential oil may help promote hair strength and resilience, contributing to overall hair health and minimizing breakage. Laurel essential oil is thought to support blood circulation to the scalp, promoting better nutrient delivery to hair follicles, and potentially supporting healthy hair growth. It may assist in balancing sebum production on the scalp, making it a good choice for those with varying scalp types. The invigorating aroma of laurel essential oil adds an aromatherapeutic dimension to your hair care routine, promoting relaxation and a sense of well-being. Like other essential oils, laurel essential oil has inherent antimicrobial properties that may contribute to the natural preservation of your hair mask formulation. In this formulation, laurel essential oil complements the other ingredients by offering a unique aroma and potential benefits for scalp health and hair strength.

CONCLUSION

The elderflower hair mask, formulated with a meticulous selection of ingredients, offers a comprehensive solution for nourishing and revitalizing hair ends. Through its application and the integration of synergistic ingredients, the mask provides a revitalizing experience that contributes to healthier and more vibrant hair ends. This study underscores the importance of thoughtful ingredient choices in formulating effective hair care products.

While this study has provided valuable insights into the formulation and efficacy of the elderflower hair mask for nourishing and revitalizing hair ends, several avenues for further research are worth exploring. First, investigating the effects of the hair mask on different hair types, such as straight, curly, or textured hair, would enhance our understanding of its versatility and suitability across diverse populations. Variations in hair structure, porosity, and needs could yield valuable insights into the mask's adaptability and potential for addressing specific hair concerns. Additionally, conducting long-term studies to assess the extended benefits of regular hair mask use could provide valuable data on its cumulative effects on hair health and appearance. Investigating the potential for enhanced hair strength, reduced breakage, and improved manageability over an extended period would strengthen the evidence for the mask's longterm efficacy.

Furthermore, exploring the mask's effects on other hair-related factors, such as scalp health and sebum regulation, could broaden its scope of application. Lastly, given the growing consumer interest in sustainable practices, an investigation into the mask's environmental impact and sustainability, including the sourcing and biodegradability of its ingredients and packaging, would contribute to the overall assessment of its suitability within the context of modern cosmetic preferences. By addressing these research gaps, a more comprehensive and nuanced understanding of the elderflower hair mask's potential benefits may be achieved, offering both consumers and the scientific community a well-rounded perspective on its utility in holistic hair care regimens.

Statement of Human and Animal Rights

All the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation

(institutional and national) and with the 2008 revision of the Declaration of Helsinki of 1975.

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