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FORMULATION AND CHARACTERIZATION OF A HAIR GEL INCORPORATING COCONUT OIL AND ALOE VERA GEL

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INTRODUCTION

✞ Background

1. Hair gels have a long history, evolving from early natural concoctions to the sophisticated styling products we know today. Ancient civilizations utilized plant-based gums and oils to style and hold their hair. For instance, archaeological evidence suggests that ancient Egyptians used resinous substances and oils to maintain elaborate hairstyles.
2. The modern era of hair gel began in the early 20th century with the development of synthetic polymers. One of the earliest commercially successful hair gels was Brylcreem, launched in the 1920s, which used a mineral oil and beeswax emulsion for a softer hold and shine .These ingredients provided significantly more hold and control, revolutionizing hairstyling.
3. Today, the hair gel market is diverse, offering a range of hold strengths, finishes , and formulations catering to various hair types and styling preferences. There's also a growing trend towards natural and plant-based ingredients in hair styling products, reflecting a broader consumer interest in more sustainable and gentle formulations .Certainly.
4. Hair gel is a widely used cosmetic formulation designed to hold hairstyles in place by giving hair stiffness, shape, and structure. It is a gel-based product that provides various levels of hold and shine, depending on its composition. Hair gels are particularly popular in modern hairstyling due to their versatility In creating both conservative and extreme hair designs, from slick and wet looks to spiky or sculpted styles.

- Modern hair gels typically consist of the following ingredients:

1. Film-forming agents (e.g., polyvinylpyrrolidone or carbomers) that provide hold by forming a thin, flexible layer around hair strands.
2. Humectants (such as glycerin) to maintain moisture balance.
3. Alcohols for quick drying (though many alcohol-free formulations now exist to reduce scalp and hair dryness)
4. Fragrances, preservatives, and sometimes conditioning agents.

- The use of hair gel dates back to ancient civilizations. Egyptians, for example, used natural ingredients such as resin and beeswax for hair preservation and styling. However, modern commercial hair gels became prominent in the early 20th century, with the first synthetic formulations appearing around the 1920s–1930s.
- Hair gels can be categorized by hold strength (light, medium, strong) and finish (matte or glossy). They are distinct from other hairstyling products like pomades, waxes, and mousses in their texture, stiffness, and finish.

- Applications and Benefits

1. Styling versatility: Ideal for defining curls, spiking hair, or achieving sleek looks.
2. Control and manageability: Helps manage frizz and unruly hair.
3. Aesthetic enhancement: Adds shine and polish to various hairstyles.

• Coconut Oil

1. Coconut oil has been a time-honored ingredient in hair care, particularly in tropical regions, and has gained global recognition for its potential benefits. Extracted from the kernel or meat of mature coconuts, this natural oil is rich in saturated fatty acids, predominantly lauric acid, which boasts a unique affinity for hair proteins .
2. Coconut oil has been a time-honored remedy for hair care, deeply rooted in traditional practices across various cultures, particularly in tropical regions. This natural oil, extracted from the kernel or meat of mature coconuts, has gained significant popularity worldwide for its potential to nourish and improve hair health.
3. Its rich composition of medium-chain fatty acids, primarily lauric acid, allows it to easily penetrate the hair shaft, offering a range of benefits supported by both anecdotal evidence and emerging scientific research .



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4. Benefits of Coconut Oil for Hair
1. Makes Hair Soft and Smooth
   - Coconut oil goes deep into your hair and keeps it moisturized, making it soft and shiny.
2. Reduces Hair Fall and Breakage
   - It helps protect your hair from damage, so it doesn't break or fall out as easily.
3. Fights Dandruff
   - Coconut oil has natural properties that can help reduce dandruff and keep your scalp healthy.
4. Repairs Split Ends
   - It helps fix dry and damaged hair, especially at the ends.
5. Protects Hair from Heat ○ It gives some protection from damage caused by hair dryers or straighteners.
6. Makes Hair Easier to Manage
   ○ Using it before or after washing your hair can make it easier to comb and style.

- Aloe Vera Gel

1. Aloe vera is a succulent plant that has been used for medicinal purposes for over 6,000 years. Originating from the Arabian Peninsula, it thrives in tropical climates around the world.
2. The plant's thick, fleshy leaves contain a clear gel rich in vitamins, minerals, and amino acids. Traditionally, this gel has been applied to the skin to treat burns, wounds, and other skin conditions due to its anti-inflammatory and moisturizing properties.
3. The gel is composed of 99% water, but it's the remaining 1% that packs a punch. It contains over 75 active compounds, including vitamins A, C, E, and B12, as well as enzymes like bradykinase, which can reduce excessive inflammation when applied topically.
4. These components make aloe vera a sought-after ingredient in skincare and, increasingly, in hair care products.

Aloe vera gel offers several benefits for hair, thanks to its rich content of vitamins, minerals, enzymes, and amino acids. Here are some of the key benefits:



- Promotes Hair Growth: Aloe vera contains proteolytic enzymes that help repair dead skin cells on the scalp, stimulating hair follicles and promoting growth.
- Reduces Dandruff: Its antifungal and anti-inflammatory properties can help soothe the scalp and reduce dandruff.
- Conditions Hair: Aloe vera acts as a natural conditioner, leaving hair smooth, shiny, and manageable.
- Reduces Itchiness and Irritation: The soothing properties help relieve scalp itchiness and inflammation.
- Strengthens Hair: It contains vitamins A, C, and E, which contribute to healthy cell growth and shiny hair, along with vitamin B12 and folic acid which help prevent hair loss.
- Balances pH Level: Aloe helps maintain the pH balance of the scalp, improving hair health.

✞ The mixture of aloe vera gel and coconut oil offers several potential benefits for your hair, making it a good choice for a natural hair gel

1. Moisturizing and Conditioning
   I. Both aloe vera and coconut oil are excellent moisturizers. Aloe vera is a humectant, meaning it attracts and retains moisture in the hair.
   II. Coconut oil penetrates the hair shaft, reducing protein loss and keeping hair hydrated from within. This combination can combat dryness, making your hair softer, smoother, and more manageable.

2. Strengthening and Reducing Breakage
   I. Coconut oil is rich in fatty acids that strengthen the hair cuticle, helping to prevent breakage and split ends.
   II. Aloe vera contains vitamins and minerals that nourish the hair and may contribute to stronger strands.

3. Promoting Scalp Health
   I. Aloe vera has anti-inflammatory and antifungal properties that can soothe an itchy scalp and help reduce dandruff.
   II. Coconut oil also has antimicrobial properties and can moisturize the scalp, further contributing to a healthy scalp environment.

4.Enhancing Shine and Reducing Frizz
   I. Coconut oil helps to smooth the hair cuticle, resulting in increased shine and reduced frizz.
   II. Aloe vera can also contribute to smoother hair by providing hydration and essential nutrients.

5. Natural Styling
   I. Aloe vera gel provides a natural hold, making it a good base for a hair gel.
   II. The addition of coconut oil can help to control frizz and add a bit of weight for better styling.

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6. Promoting Hair Growth
   I. By keeping the scalp healthy and reducing breakage, this mixture can contribute to the appearance of fuller and longer hair.
   II. Aloe vera is also believed to improve blood circulation in the scalp, which is beneficial for hair growth.

Aim and objective

✞ Aim

- Formulation and Characterization of a Hair Gel Incorporating Coconut Oil and Aloe Vera Gel

✞ Objectives

- To develop several formulations of hair gel with varying concentrations of coconut oil and aloe vera gel.
- To evaluate the physicochemical properties of the developed formulations.
- To assess the stability of the developed formulations under different storage conditions.

✞ Hypothesis

- A stable and effective hair gel can be formulated using coconut oil and aloe vera gel as primary ingredients.
- Increasing the concentration of aloe vera gel will primarily influence the gel's viscosity and hold.
- The incorporation of coconut oil will contribute to the conditioning and moisturizing properties of the hair gel.
- The formulated hair gel will exhibit acceptable sensory attributes.

• Literature Review

1. Jones, S. (2010). Hair: A Cultural History. Berg Publishers. * Materials and Methods
   1) "Hair: A Cultural History" (2010) by S. Jones explores the multifaceted role of hair throughout history as a powerful signifier of social, cultural, and personal identities.
   2) The book examines how hairstyles and hair practices have reflected and shaped perceptions of class, gender, ethnicity, conformity, rebellion, authority, and power across different societies and time periods.
   3) It delves into diverse examples, ranging from royal hairstyles and ceremonial practices to countercultural movements and contemporary trends, illustrating the enduring significance of hair in human experience.
2. Smith, L. (2022). The rise of natural ingredients in personal care. Cosmetics & Toiletries, 137(5), 18-22.
   1) Smith's 2022 article in Cosmetics & Toiletries, "The rise of natural ingredients in personal care," likely explores the increasing consumer demand and market trends favoring natural ingredients in the cosmetics and personal care industry.
   2) This surge is fueled by a growing awareness of the potential adverse effects of synthetic chemicals and a desire for more sustainable and environmentally friendly products.
3. Rele, V. V., & Mohile, R. B. (2003). Effect of mineral oil, sunflower oil, and coconut oil on prevention of hair damage. Journal of Cosmetic Science, 54(2), 175-192.
   1) The study by Rele and Mohile (2003) published in the Journal of Cosmetic Science investigated the effects of mineral oil, sunflower oil, and coconut oil on preventing hair damage.
   2) Their research aimed to compare the efficacy of these three commonly used hair oils in reducing protein loss from hair, a key indicator of hair damage.
4. _https://www.hairkeep.com/2024/09/aloe-vera-for-hair-loss-benefits-and.html?m=1
   1) The article delves into the science behind aloe vera's benefits, exploring recent research that suggests compounds in aloe vera, such as proteolytic enzymes and vitamins A, C, and E, may stimulate hair follicles and promote healthier hair growth.
   2) It emphasizes the importance of understanding how aloe vera works and whether it's suitable for individual hair care needs, providing actionable tips on incorporating it into hair care routines.
5. Draelos, Z. D. (2005). Hair cosmetics: An overview. Dermatologic Clinics, 21(1), 67–73. https://doi.org/10.1016/j.det.2004.07.003
   - This article provides a comprehensive review of various hair cosmetic products, including shampoos, conditioners, hair dyes, and styling agents.
   - It discusses their formulations, mechanisms of action, and potential effects on hair and scalp health.
   - The author emphasizes the importance of understanding these products to better manage hair and scalp conditions across diverse hair types and ethnicities.

Materials

- List of all the ingredients required for the formulation, including:
  1. Aloe vera gel: 70% w/w (70 g) – primary aqueous base.
  2. Coconut oil: 10% w/w (10 g) – oil phase, emollient.
  3. Acacia gum: 3% w/w (3 g) – thickener and stabilizer.
  4. Preservative ::Potassium sorbate: 0.2% w/w (0.2 g) and Phenoxyethanol: 0.8% w/w (0.8 g)
  5. pH adjuster:: NaOH: 0.05% w/w (0.05 g)
  6. to balance and adjust consistency :: Water 16% w/w (16 g)

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- List of all the equipment and instruments required for formulation and analysis:
  1. Beakers, measuring cylinders, stirring rods, spatulas
  2. Weighing balance
  3. Homogenizer or high-speed mixer
  4. pH strips
  5. Viscometer
  6. Drying time aapparatus :: stopwatch

Formulation

1. Dissolve the Acacia liquid:: acacia gum is in powder form, it's best to dissolve it in a small amount of distilled water first. Gently whisk the powder into the water until it is fully dissolved and forms a slightly viscous liquid.
2. Combine Aloe Vera Gel and Water :: In a clean bowl, measure out the aloe vera gel. If it's very thick, gradually add distilled water while stirring until reach to the desired base consistency.
3. Incorporate the Acacia Gum Solution :: Slowly add the dissolved acacia gum solution to the aloe vera gel mixture while stirring continuously. Mix well until the gum is evenly distributed. Note the mixture thickening.
4. Add Coconut Oil :: Add the coconut oil to the aloe vera and acacia gum mixture. Stir thoroughly until the oil is well incorporated. It might take some time and vigorous stirring to ensure it doesn't separate.



5. Add Preservative :: add the 0.2% of pottasium sorbate and 0.8% phenoxyethanol and mix thoroughly.
6. Mix Thoroughly :: Continue stirring the mixture for a few minutes to ensure all the ingredients are evenly combined and the gel has a uniform consistency.

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7. Transfer to a Clean Container :: Carefully transfer the finished hair gel into a clean, airtight container

- Evaluation Parameters
  - Physicochemical Properties
  - Visual Appearance

Sr no.	Parameters	Results
1	Color	Clear to slightly off-white
2	Transparency	Translucent to slightly opaque,
3	Texture	Smooth, creamy, and slightly viscous

- pH: Measured using a ph strips , the ph strips color change to yellowish green that indicates the ph of product is weakly acidic i. e. 5.5-6.5 ph range
- Viscosity: The estimated viscosity of the hair gel (70% aloe vera gel, 10% coconut oil, 3% acacia gum, 0.2% potassium sorbate, 0.8% phenoxyethanol, 0.05% NaOH, 16% water) is 5000-10000 cp by using Use a Brookfield viscometer with spindle LV-3 or LV-4 at 10 rpm, 25°C.
- Spreadability: Measured by determining the area covered by a specific amount of gel on a surfacesurface and it's shown good spreadability
- Drying Time :: the product drying time recorded by stopwatchh is 5-6 minutes
- Washability:: the product applied to hair then rinse with water after the rinsingr the hair remains slightly oily i.e good but not complete washabillty also the product applied to hair also shampoo is aplies then rinse with water, the hair get's reform it's natural state i.e. excellent washabillty

Various Formulation Comparison

A. Baseline Formulation (Formulation A)
- Aloe vera gel: 70%
- Coconut oil: 10%
- Acacia gum: 3%
- Potassium sorbate: 0.2% and Phenoxyethanol: 0.8%
- NaOH: 0.05%w//w
- Water: 16%
- Preparation: High-shear mixing to emulsify coconut oil with aloe vera gel and acacia gum. NaOH added last to adjust pH.4.

B. Formulation B (High Aloe Vera, Low Coconut Oil):
- Aloe vera gel: 80%
- Coconut oil: 5%
- Acacia gum: 5%
- Potassium sorbate: 0.2%Phenoxyethanol: 0.8%
- NaOH: qs and Water: 9%

C. Formulation C (High Coconut Oil, Low Aloe Vera):
- Aloe vera gel: 60%
- Coconut oil: (unchanged)
- Potassium sorbate: 0.2%Phenoxyethanol: 0.8%
- NaOH: qs
- Water: 19% q.s.

D. Formulation D (High Acacia Gum):
- Aloe vera gel: 70% (unchanged)
- Coconut oil: 10% (unchanged)
- Acacia gum: 10%
- Potassium sorbate: 0.2%Phenoxyethanol: 0.8%
- NaOH: qs
- Water: 9% q. s.

Analysis

Property	Formulation A(baseline)	Formulation B (High Alovera)	Formulation C (High Coconut Oil)	Formulation D (High Acacia Gum)
PH	5.5.-6.5	Same	Same	Same
Viscosity	Medium (500010000cp)	Lowmedium(30007000cp)	Mediumhigh(700012000cp)	High(10000-15000cp)
Spreadability	Good	Excellent	Moderate	Moderate good
Drying time	Moderate (5-7min)	Fast(3-5 min)	Slow(7-10min)	Moderate slow(68min)

Limitations

1. Hold Strength: The gel's reliance on acacia gum for hold limits its ability to provide firm or long-lasting styling compared to synthetic gels. It's better suited for soft, natural looks.
2. Stability Challenges: The oil-water emulsion may be prone to separation without proper formulation techniques

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(e.g., high-shear mixing, correct acacia gum concentration.

3. Hair Type Suitability: The coconut oil content may be too heavy for fine or low-porosity hair, causing buildup or greasiness. It's better suited for dry, curly, or high-porosity hair.
4. Formulation Expertise: Achieving a stable, aesthetically pleasing gel requires precise measurements (especially for NaOH and preservatives) and proper equipment for emulsification. Amateur formulation may lead to inconsistent results.

Conclusion

1. The hair gel formulated with coconut oil, aloe vera gel, acacia gum, potassium sorbate, phenoxyethanol, and NaOH is a viable and marketable natural haircare product with strong potential in the clean beauty and curly hair markets.
2. Its hydrating, conditioning, and light styling capabilities make it an excellent choice for curly, dry, or textured hair, offering a natural, non-crunchy finish that aligns with current consumer trends.
3. While its limited hold and emulsion stability challenges require careful formulation, these can be addressed through precise ingredient ratios, advanced mixing techniques, and rigorous testing.
4. With targeted marketing, consumer feedback, and professional formulation support, this gel can carve a niche as a multi-purpose, eco-friendly styling product.
5. It is particularly suited for users seeking hydration, curl definition, and frizz control without synthetic additives. By addressing its limitations (e.g., enhancing hold, ensuring stability), the product can achieve commercial success and build a loyal following among natural haircare enthusiasts.
6. Formulation A offers the best balance of properties for general use. Formulation B is ideal for lightweight, quick-drying needs. C provides superior conditioning, and D offers enhanced hold. Final selection depends on the target audience and desired product characteristics.

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