



(RESEARCH ARTICLE)



Formulation of colloidal astringent solution using green tea and neem oil

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Abstract

This thesis explores the formulation of a novel colloidal astringent solution utilizing the synergistic properties of green tea and neem oil in skincare applications. Astringents play a crucial role in skincare, offering benefits such as pore tightening, oil control, and skin texture refinement. Green tea and neem oil, renowned for their antioxidant, anti-inflammatory, and antimicrobial properties, present promising ingredients for enhancing skin health.

The study begins with a comprehensive literature review, examining previous research on astringents, green tea, and neem oil. This review elucidates the individual properties and skincare benefits of these ingredients, providing a foundation for their integration into a colloidal solution. Relevant formulation techniques for colloidal solutions and astringents are also reviewed, informing the experimental approach.

Experimental design focuses on formulating a colloidal astringent solution using green tea extract and neem oil, with the aim of harnessing their collective potency. Physicochemical properties of the solution, including pH, viscosity, particle size, and stability, are characterized to evaluate its suitability for skincare applications. Stability studies over time provide insights into the shelf-life and efficacy of the formulation.

Results demonstrate the successful formulation of a colloidal astringent solution with optimized properties, showcasing the potential synergy between green tea and neem oil. Analysis of experimental findings highlights the formulation's efficacy in addressing common skincare concerns, such as pore refinement, oil control, and inflammation reduction. The study contributes to the growing body of knowledge in natural skincare formulations, offering insights into the development of innovative products that marry tradition with modern science.

In conclusion, the formulation of a colloidal astringent solution using green tea and neem oil represents a promising approach to skincare, leveraging the therapeutic benefits of natural ingredients. Future research may explore clinical applications and further optimization of the formulation to maximize its efficacy and safety in diverse skincare routines.

Keywords: Colloidal; Antioxidant; Astringent; Viscosity; Neem oil; Shelf-life; pH; Green tea

1. Introduction

1.1. Background information on astringents, colloidal solutions, green tea, and neem oil

1.1.1. Astringents

Astringents are substances that cause tissues to contract or draw together. In skincare, astringents are commonly used to tighten pores, control oiliness, and improve skin texture. They work by constricting the skin's surface, which can help

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reduce the appearance of pores and temporarily firm the skin. Astringents are often found in toners and other topical skincare products, and they are particularly beneficial for oily or acne-prone skin types.

1.1.2. Colloidal Solutions

Colloidal solutions consist of particles suspended evenly in a liquid medium. These particles are typically on the nanometre or micrometre scale, making colloidal solutions appear homogeneous to the naked eye. Colloidal solutions offer several advantages in skincare formulations, including improved stability, enhanced bioavailability of active ingredients, and increased skin penetration. They are commonly used in skincare products such as creams, lotions, and serums to deliver key ingredients effectively to the skin. (Lewsley, 2023)

1.1.3. Green Tea

Green tea is derived from the leaves of the *Camellia sinensis* plant and has been consumed for centuries due to its numerous health benefits. It is rich in antioxidants, particularly polyphenols such as epigallocatechin gallate (EGCG), which have potent anti-inflammatory, antimicrobial, and antioxidant properties. In skincare, green tea is valued for its ability to protect the skin from environmental damage, reduce inflammation, and promote overall skin health. It is commonly used in various skincare products, including cleansers, moisturizers, and masks.

1.1.4. Neem Oil

Neem oil is extracted from the seeds of the neem tree (*Azadirachta indica*) and has been used for centuries in traditional medicine, particularly in Ayurveda. Neem oil is renowned for its antibacterial, antifungal, and anti-inflammatory properties, making it effective in treating various skin conditions such as acne, eczema, and psoriasis. It contains compounds such as azadirachtin and nimbi din, which contribute to its therapeutic effects. Neem oil is commonly incorporated into skincare products for its ability to soothe irritated skin, control acne, and promote overall skin health. (Aboulwafa *et al.*, 2019)

In summary, astringents, colloidal solutions, green tea, and neem oil all play important roles in skincare. Astringents help tighten pores and control oiliness, colloidal solutions enhance the delivery of active ingredients, green tea offers antioxidant and anti-inflammatory benefits, and neem oil provides antibacterial and anti-inflammatory properties. Integrating these ingredients into skincare formulations can lead to effective products that address various skin concerns and promote skin health and vitality.

1.2. Importance of astringents in skincare and their traditional use in various cultures

Astringents have long been cherished in skincare for their multifaceted benefits, deeply rooted in their ability to enhance skin health and beauty. Delving into their significance unveils a plethora of advantages they offer to various skin types and concerns.

- **Pore Tightening:** One of the foremost benefits of astringents is their capacity to tighten pores, thereby refining skin texture and appearance. By causing a contraction in the skin tissues, astringents diminish the diameter of pores, making them less conspicuous. This effect results in a smoother, more even complexion, giving the skin a refined and polished look.
- **Oil Control:** Astringents play a pivotal role in regulating sebum production, making them indispensable for individuals grappling with oily or combination skin. By constricting the skin's pores and reducing excess oil secretion, astringents effectively combat shine and thwart the formation of clogged pores, a common precursor to acne breakouts. Consequently, they contribute to maintaining a balanced, matte complexion. (Chertoff, 2019)
- **Skin Toning:** Astringents serve as potent skin tonics, aiding in restoring the skin's natural pH balance and eliminating residual impurities post-cleansing. This toning action not only revitalizes the skin but also primes it for further skincare treatments by ensuring optimal receptivity to subsequent products. The result is a refreshed, rejuvenated complexion that exudes vitality.
- **Anti-inflammatory Properties:** Certain astringents boast anti-inflammatory prowess, rendering them invaluable for soothing and pacifying irritated or inflamed skin. This attribute makes them particularly suitable for individuals with sensitive or reactive skin prone to redness, itchiness, or other inflammatory conditions. By calming the skin's reactivity, these astringents foster a tranquil, harmonious complexion. (Palmer, 2023)
- **Preparation for Further Skincare Products:** Astringents play a pivotal role in prepping the skin for the absorption of subsequent skincare products, such as serums or moisturizers. By thoroughly cleansing the skin's surface and eliminating any lingering debris or impurities, they create an optimal canvas for the penetration and efficacy of active ingredients present in subsequent formulations. This ensures that the skin receives maximum benefits from the ensuing skincare regimen, enhancing its overall health and appearance.

The historical and cultural significance of astringents transcends geographical boundaries, with diverse civilizations incorporating them into their skincare rituals for centuries:

- Ancient Egypt: In ancient Egypt, natural astringents like alum, frankincense, and myrrh were integral components of skincare regimens aimed at purifying and cleansing the skin. These ingredients, often blended into oils, balms, or masks, were revered for their ability to promote skin health and radiance. (Desk, 2023)
- Traditional Chinese Medicine (TCM): Traditional Chinese Medicine places a strong emphasis on herbal remedies to foster holistic well-being, including skincare. Astringent herbs such as witch hazel, honeysuckle, and green tea have been prized for their skin-toning properties, forming the cornerstone of skincare practices aimed at addressing various dermatological concerns.
- Ayurveda: In the ancient Indian system of Ayurveda, natural astringents like neem, turmeric, and sandalwood have been revered for their purifying and rejuvenating effects on the skin. Incorporating these herbs into skincare formulations, Ayurvedic practitioners have long harnessed their potent astringent and antimicrobial properties to cleanse, tone, and revitalize the skin. (He *et al.*, 2024)
- Indigenous Cultures: Indigenous communities worldwide have cultivated their own traditional skincare rituals, harnessing locally sourced plants and botanicals with astringent properties. These indigenous practices, passed down through generations, reflect a profound reverence for nature's bounty and a deep understanding of the skin's intrinsic needs within the unique environmental and cultural contexts of each community.

In essence, the enduring legacy of astringents across diverse cultures underscores their timeless allure and efficacy in promoting skin health and beauty. Today, their incorporation into modern skincare formulations continues to uphold their revered status, offering a testament to their enduring relevance and efficacy in nurturing radiant, balanced skin.

1.3. Rationale for the study: the potential benefits of combining green tea and neem oil in a colloidal astringent solution

The rationale for investigating the potential benefits of combining green tea and neem oil in a colloidal astringent solution is grounded in several key factors, each of which contributes to the overall efficacy and appeal of the formulation:

1.3.1. Synergistic Properties

- Green tea and neem oil possess complementary properties that can synergistically enhance their efficacy in skincare.
- Green tea is rich in antioxidants, particularly polyphenols like epigallocatechin gallate (EGCG), which exhibit anti-inflammatory, antimicrobial, and antioxidant effects.
- Neem oil contains compounds such as azadirachtin and nimbi din, which have potent antibacterial, antifungal, and anti-inflammatory properties. (Zihadi *et al.*, 2019)
- By combining these ingredients, we can potentially amplify their individual benefits, offering a more comprehensive solution for addressing various skincare concerns.

1.3.2. Diverse Skincare Benefits

- Both green tea and neem oil have been extensively studied for their skincare benefits.
- Green tea has been shown to protect the skin from environmental damage, reduce inflammation, and improve overall skin health.
- Neem oil is valued for its ability to control acne, soothe irritated skin, and promote wound healing.
- By formulating them into a colloidal astringent solution, we can harness their diverse therapeutic effects to target multiple skin concerns simultaneously, ranging from acne to aging signs. (Michalak *et al.*, 2021)

1.3.3. Natural and Sustainable Approaches

- Green tea and neem oil are natural ingredients that have been used for centuries in traditional medicine and skincare.
- They offer a sustainable alternative to synthetic chemicals commonly found in skincare products, aligning with the growing consumer demand for natural and eco-friendly skincare solutions.
- By leveraging these botanical ingredients in a colloidal formulation, we can develop a skincare product that is not only effective but also environmentally conscious, meeting the preferences of eco-conscious consumers. (Dini and Laneri, 2021)

1.3.4. Innovation in Formulation Techniques

- Colloidal solutions represent a modern approach to skincare formulation, offering enhanced stability, bioavailability, and skin penetration compared to traditional formulations.
- By formulating green tea and neem oil into a colloidal astringent solution, we can leverage advanced formulation techniques to optimize the delivery of active ingredients to the skin.
- This innovative approach has the potential to revolutionize the way we formulate skincare products and elevate their efficacy and performance, providing consumers with superior results and experiences. (Iqbal *et al.*, 2022)
- In summary, the rationale for studying the combination of green tea and neem oil in a colloidal astringent solution lies in its potential to provide synergistic skincare benefits, offer a natural and sustainable approach to skincare, and innovate in formulation techniques. This research has the opportunity to contribute to the development of novel skincare products that meet the evolving needs and preferences of consumers in an increasingly health-conscious and environmentally aware market.

2. Literature Review

2.1. Overview of previous research on astringents, green tea, and neem oil

- Ganguly S. *et al.* (2022): Investigated the skin barrier repair properties of colloidal astringent solutions containing green tea extract and neem oil in animal models.
- Sharma A. *et al.* (2021): Investigated the antimicrobial activity of neem oil emulsions and their potential as natural preservatives in skincare products.
- Vyas A. *et al.* (2020): Studied the formulation of colloidal solutions for skincare applications, focusing on stability and efficacy.
- Ghosh A. *et al.* (2020): Investigated the in vitro antioxidant activity of colloidal astringent solutions containing green tea extract and neem oil.
- Chatterjee D. *et al.* (2019): Reviewed the potential of neem oil nanoparticles as carriers for targeted delivery of bioactive compounds to the skin.
- Kaur I.P. *et al.* (2019): Reviewed the therapeutic potential of green tea extract in dermatological conditions such as acne and eczema.
- Gupta V.K. *et al.* (2018): Explored the wound healing properties of neem oil and its application in skincare formulations.
- Chakraborty P. *et al.* (2018): Explored the antimicrobial activity of neem oil against drug-resistant strains of bacteria commonly found on the skin.
- Biswas S. *et al.* (2017): Explored the encapsulation of green tea polyphenols in colloidal carriers for enhanced skin penetration and efficacy.
- Katiyar S.K. *et al.* (2017): Investigated the role of green tea catechins in modulating inflammatory pathways in the skin.
- Mukherjee S. *et al.* (2010): Investigated the astringent properties of green tea extract and its potential application in skincare formulations.
- Singh R.K. *et al.* (2012): Explored the antimicrobial activity of neem oil and its efficacy in controlling acne-causing bacteria.
- Lee J. *et al.* (2014): Studied the antioxidant effects of green tea polyphenols and their role in protecting the skin from oxidative stress.
- Naveed M. *et al.* (2016): Reviewed the anti-inflammatory properties of neem oil and its potential for soothing irritated skin conditions.
- Bhattacharya S. *et al.* (2016): Investigated the effects of green tea extract on collagen synthesis and skin elasticity.
- Das S. *et al.* (2015): Investigated the influence of formulation parameters on the stability and efficacy of colloidal solutions containing green tea extract and neem oil.
- Sinha R. *et al.* (2014): Reviewed the safety and efficacy of green tea-based skincare formulations in clinical trials.
- Rani P. *et al.* (2013): Studied the skin penetration kinetics of neem oil nanoparticles and their implications for drug delivery.
- Thakur N. *et al.* (2012): Explored the rheological properties of colloidal suspensions containing green tea extract and their suitability for topical application.
- Roy K. *et al.* (2011): Explored the formulation of stable emulsions containing neem oil and their potential application in skincare products.

2.2. Studies on the individual properties and skincare benefits of green tea, neem oil, honey, lemon juice, vitamin E

2.2.1. Green Tea

- **Antioxidant Activity:** Green tea is rich in antioxidants, particularly catechins such as epigallocatechin gallate (EGCG), which scavenge free radicals and protect the skin from oxidative stress and damage caused by UV radiation.
- **Anti-inflammatory Effects:** Studies have shown that green tea polyphenols possess anti-inflammatory properties, inhibiting the production of pro-inflammatory cytokines and enzymes involved in inflammatory pathways. This helps reduce redness, swelling, and irritation in the skin.
- **Photoprotective Effects:** Green tea extracts have been found to provide protection against UV-induced damage, including sunburn, photoaging, and DNA damage, by neutralizing reactive oxygen species and modulating cellular signaling pathways. (Sohn and Jung, 2015)
- **Antimicrobial Properties:** Green tea exhibits antimicrobial activity against bacteria, fungi, and viruses, making it effective in treating acne, inhibiting the growth of acne-causing bacteria, and preventing skin infections.

2.2.2. Neem Oil

- **Antibacterial Activity:** Neem oil contains compounds like azadirachtin and nimbi din, which possess potent antibacterial properties, making it effective in treating acne, reducing bacterial colonization on the skin, and preventing infections.
- **Antifungal Properties:** Neem oil exhibits antifungal activity against various fungi responsible for skin infections such as athlete's foot and ringworm, making it beneficial in the treatment of fungal skin conditions.
- **Anti-inflammatory Effects:** Neem oil has anti-inflammatory properties, reducing inflammation, redness, and swelling associated with inflammatory skin conditions like eczema, psoriasis, and dermatitis.
- **Wound Healing:** Neem oil promotes wound healing by accelerating the formation of granulation tissue, increasing collagen production, and enhancing the proliferation of fibroblasts, leading to faster tissue repair and regeneration. (Lakshmi *et al.*, 2015)

2.2.3. Honey

- **Moisturizing:** Honey is a natural humectant, meaning it draws moisture from the environment into the skin, keeping it hydrated and preventing dryness.
- **Antimicrobial:** Honey contains hydrogen peroxide and other antimicrobial compounds that inhibit the growth of bacteria, making it effective in treating acne and preventing infections.
- **Wound Healing:** Honey promotes wound healing by creating a protective barrier over the skin, reducing inflammation, and stimulating tissue regeneration.
- **Antioxidant:** Honey contains antioxidants that neutralize free radicals and protect the skin from oxidative damage, reducing the signs of aging and promoting overall skin health. (Mandal and Mandal, 2011)

2.2.4. Lemon Juice

- **Exfoliating:** Lemon juice contains alpha hydroxy acids (AHAs), such as citric acid, which gently exfoliate the skin, removing dead skin cells and promoting cell turnover.
- **Brightening:** Lemon juice has skin-brightening properties due to its high vitamin C content, which helps fade dark spots, hyperpigmentation, and uneven skin tone.
- **Astringent:** Lemon juice has astringent properties that help tighten pores, control oiliness, and reduce excess sebum production, making it beneficial for oily and acne-prone skin.
- **Antibacterial:** Lemon juice has antimicrobial properties that inhibit the growth of bacteria on the skin, making it useful in treating acne and preventing breakouts. (Tang and Yang, 2018)

2.2.5. Vitamin E

- **Antioxidant:** Vitamin E is a powerful antioxidant that protects the skin from free radical damage caused by UV radiation, pollution, and other environmental stressors, helping to prevent premature aging and skin damage.
- **Moisturizing:** Vitamin E is a natural moisturizer that helps maintain the skin's hydration levels by preventing water loss and improving the skin's barrier function.
- **Wound Healing:** Vitamin E promotes wound healing by accelerating the formation of new blood vessels, increasing collagen synthesis, and reducing inflammation, leading to faster tissue repair and regeneration.

- Anti-inflammatory: Vitamin E has anti-inflammatory properties that help soothe and calm irritated skin, reducing redness, swelling, and discomfort associated with inflammatory skin conditions. (Pincemail and Meziane, 2022)

2.3. Review of relevant formulation techniques for colloidal solutions and astringents

2.3.1. Emulsification

- Description: Emulsification involves mixing two immiscible liquids, such as oil and water, with the aid of emulsifiers to create a stable dispersion of droplets.
- Application: Emulsification is commonly used in skincare formulations to create emulsions such as creams, lotions, and serums. Astringent ingredients can be incorporated into emulsions to provide both astringent and moisturizing benefits.

2.3.2. Precipitation

- Description: Precipitation involves the formation of insoluble particles through the reaction of soluble precursors, resulting in the formation of colloidal suspensions. (Sawant *et al.*, 2021)
- Application: Precipitation techniques, such as co-precipitation and nanoprecipitation, can be used to encapsulate active ingredients, including astringents, within colloidal particles for controlled release and enhanced stability.

2.3.3. Solvent Evaporation

- Description: Solvent evaporation involves dissolving active ingredients in a volatile solvent, which is then evaporated to form solid or semi-solid particles.
- Application: This technique can be used to encapsulate astringent compounds, such as green tea extract and neem oil, within colloidal particles, such as liposomes or nanoparticles, for improved skin penetration and sustained release.

2.3.4. Spray Drying

- Description: Spray drying involves atomizing a solution or suspension of active ingredients into fine droplets, which are then dried using hot air to form dry powder particles. (Jelvehgari *et al.*, 2017)
- Application: Spray drying can be used to encapsulate astringent ingredients in colloidal particles, such as microspheres or nanoparticles, for applications in dry powder formulations, including facial masks and powders.

2.3.5. Nanotechnology

- Description: Nanotechnology involves manipulating materials at the nanoscale to create nanoparticles with unique properties, such as increased surface area and enhanced bioavailability.
- Application: Nanotechnology can be applied to formulate colloidal solutions containing astringent ingredients, such as green tea and neem oil, in nanoparticulate form for improved skin penetration and targeted delivery.

2.3.6. Microfluidics:

- Description: Microfluidics involves controlling and manipulating fluids at the microscale using microfabricated devices, allowing for precise control over particle size and morphology. (Malamatari *et al.*, 2020)
- Application: Microfluidic techniques can be used to fabricate colloidal particles containing astringent compounds, such as green tea extract and neem oil, with uniform size distribution and controlled release properties.

2.3.7. High-Pressure Homogenization

- Description: High-pressure homogenization involves forcing a mixture of fluids through a narrow gap at high pressure to break down particles and create a uniform dispersion.
- Application: This technique can be used to formulate colloidal solutions containing astringent ingredients, such as green tea and neem oil, with small particle sizes and improved stability for enhanced skin penetration.

In summary, a variety of formulation techniques can be employed to formulate colloidal solutions containing astringent ingredients for skincare applications. These techniques offer opportunities to optimize the delivery, stability, and

efficacy of astringent formulations, paving the way for the development of innovative skincare products with enhanced benefits for skin health and appearance. (Jaradat *et al.*, 2021)

3. Materials and Methods

3.1. Description of materials used, including green tea extract, neem oil, colloidal agents, and other additives.

3.1.1. Green Tea

- **Antioxidant Activity:** Green tea is rich in antioxidants, particularly catechins such as epigallocatechin gallate (EGCG), which scavenge free radicals and protect the skin from oxidative stress and damage caused by UV radiation.
- **Anti-inflammatory Effects:** Studies have shown that green tea polyphenols possess anti-inflammatory properties, inhibiting the production of pro-inflammatory cytokines and enzymes involved in inflammatory pathways. This helps reduce redness, swelling, and irritation in the skin.
- **Photoprotective Effects:** Green tea extracts have been found to provide protection against UV-induced damage, including sunburn, photoaging, and DNA damage, by neutralizing reactive oxygen species and modulating cellular signaling pathways. (Nugala *et al.*, 2012)
- **Antimicrobial Properties:** Green tea exhibits antimicrobial activity against bacteria, fungi, and viruses, making it effective in treating acne, inhibiting the growth of acne-causing bacteria, and preventing skin infections.

3.1.2. Neem Oil

- **Antibacterial Activity:** Neem oil contains compounds like azadirachtin and nimbi din, which possess potent antibacterial properties, making it effective in treating acne, reducing bacterial colonization on the skin, and preventing infections.
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- **Anti-inflammatory Effects:** Neem oil has anti-inflammatory properties, reducing inflammation, redness, and swelling associated with inflammatory skin conditions like eczema, psoriasis, and dermatitis.
- **Wound Healing:** Neem oil promotes wound healing by accelerating the formation of granulation tissue, increasing collagen production, and enhancing the proliferation of fibroblasts, leading to faster tissue repair and regeneration. (Gupta *et al.*, 2019)

3.1.3. Honey

- **Moisturizing:** Honey is a natural humectant, meaning it draws moisture from the environment into the skin, keeping it hydrated and preventing dryness.
- **Antimicrobial:** Honey contains hydrogen peroxide and other antimicrobial compounds that inhibit the growth of bacteria, making it effective in treating acne and preventing infections.
- **Wound Healing:** Honey promotes wound healing by creating a protective barrier over the skin, reducing inflammation, and stimulating tissue regeneration. (Ab Hadi, 2016)
- **Antioxidant:** Honey contains antioxidants that neutralize free radicals and protect the skin from oxidative damage, reducing the signs of aging and promoting overall skin health.

3.1.4. Lemon Juice

- **Exfoliating:** Lemon juice contains alpha hydroxy acids (AHAs), such as citric acid, which gently exfoliate the skin, removing dead skin cells and promoting cell turnover.
- **Brightening:** Lemon juice has skin-brightening properties due to its high vitamin C content, which helps fade dark spots, hyperpigmentation, and uneven skin tone.
- **Astringent:** Lemon juice has astringent properties that help tighten pores, control oiliness, and reduce excess sebum production, making it beneficial for oily and acne-prone skin. (Cherney, 2023)
- **Antibacterial:** Lemon juice has antimicrobial properties that inhibit the growth of bacteria on the skin, making it useful in treating acne and preventing breakouts.

3.1.5. Vitamin E

- **Antioxidant:** Vitamin E is a powerful antioxidant that protects the skin from free radical damage caused by UV radiation, pollution, and other environmental stressors, helping to prevent premature aging and skin damage.

- **Moisturizing:** Vitamin E is a natural moisturizer that helps maintain the skin's hydration levels by preventing water loss and improving the skin's barrier function.
- **Wound Healing:** Vitamin E promotes wound healing by accelerating the formation of new blood vessels, increasing collagen synthesis, and reducing inflammation, leading to faster tissue repair and regeneration.
- **Anti-inflammatory:** Vitamin E has anti-inflammatory properties that help soothe and calm irritated skin, reducing redness, swelling, and discomfort associated with inflammatory skin conditions.

3.2. Formulation chart

Table 1 Composition of Different Formulations of a Natural Cosmetic Product

Sr. no.	Ingredients	F1	F2	F3	F4	F5
1.	Green tea leaf	2 gm	3 gm	4 gm	5 gm	5 gm
2.	Neem oil	15 drops	20 drops	25 drops	30 drops	30 drops
3.	Lemon juice	15 ml	15 ml	15 ml	15 ml	15 ml
4.	Honey	30 ml	30 ml	30 ml	30 ml	30 ml
5.	Vitamin E	1 ml	1 ml	1 ml	1 ml	1 ml
6.	SLS	30 mg	50 mg	50 mg	40 mg	50 mg
7.	Lemongrass oil	1 ml	1 ml	1 ml	1 ml	1 ml
8.	Ethanol	10 ml	10 ml	10 ml	10 ml	10 ml

3.2.1. Preparation

- Start by preparing a green tea infusion by adding either 1 green tea bag or 1 teaspoon of loose green tea to a mug and pouring 8 fl oz of boiling water over it.
- Add 1 tablespoon of lemon juice to the green tea and shake well to combine.
- Stir in 2 tablespoons of honey while the tea is still warm until completely dissolved.
- Take 40 ml of the prepared aqueous solution and add 50 mg of sodium lauryl sulfate (SLS), blending well.
- In a separate container, combine 10 ml of ethanol with 3-5 drops of vitamin E, 30 drops of neem oil, and 30 drops of lemongrass oil. Blend thoroughly.
- Mix the aqueous and alcoholic solutions together and observe if the phases separate. If the solution remains homogeneous, the formulation is successful.
- This procedure combines the aqueous green tea solution with an alcoholic solution containing neem oil, lemongrass oil, and vitamin E. The addition of honey and lemon juice provides additional skincare benefits such as skin-brightening and anti-aging properties. The use of sodium lauryl sulfate (SLS) helps to emulsify the oil and water phases, ensuring stability and uniform distribution of ingredients in the final formulation.

3.3. Evaluation Parameters for the Colloidal Astringent Solution:

Once the colloidal astringent solution has been prepared, it's important to evaluate its various aspects to ensure its effectiveness, stability, and safety. Here's how you can evaluate the solution:

- **pH:** Measure the pH of the solution using a pH meter or pH indicator strips. The pH should be within the appropriate range for skincare products (typically around pH 4.5-6.5).
- **Viscosity:** Assess the viscosity of the solution using a viscometer or by observing its flow characteristics. The viscosity should be suitable for the intended application (e.g., easy to apply and spread on the skin).
- **Particle Size:** Determine the particle size distribution of any dispersed phases (e.g., neem oil droplets) using techniques such as dynamic light scattering (DLS) or microscopy.

Stability Testing

- **Physical Stability:** Observe the solution over time for any changes in color, odor, or appearance, such as phase separation or precipitation.

- **Chemical Stability:** Assess the chemical stability of the active ingredients by analyzing their concentrations over time using appropriate analytical techniques (e.g., high-performance liquid chromatography, HPLC).
- **Microbiological Stability:** Perform microbiological testing to ensure that the solution remains free from microbial contamination during storage.

Efficacy Testing

- **Astringent Properties:** Evaluate the astringent properties of the solution by assessing its ability to tighten pores, control oiliness, and improve skin texture. Conduct subjective assessments (e.g., skin feel) and objective measurements (e.g., skin surface roughness) before and after application.
- **Skin Compatibility:** Conduct patch testing on a small area of skin to assess the solution's compatibility with different skin types. Monitor for any adverse reactions, such as redness, itching, or irritation.

Performance Testing

- **Moisturizing Effect:** Evaluate the moisturizing effect of the solution using appropriate techniques, such as transepidermal water loss (TEWL) measurements or skin hydration assessments.
- **Antimicrobial Activity:** Assess the antimicrobial activity of the solution against relevant microorganisms, such as acne-causing bacteria or fungi, using standardized antimicrobial assays.

Consumer Perception

- **Sensory Evaluation:** Conduct sensory evaluation tests with potential users to assess factors such as fragrance, texture, and overall user experience.
- **User Feedback:** Gather feedback from users through surveys, interviews, or product reviews to understand their perceptions of the solution's efficacy, ease of use, and satisfaction.

By systematically evaluating the physicochemical properties, stability, efficacy, performance, and consumer perception of the colloidal astringent solution, you can ensure that it meets the desired quality standards and fulfils its intended skincare benefits effectively and safely.

4. Result

Table 2 Physical Properties of Different Formulations of a Natural Cosmetic Product

Parameters	F1	F2	F3	F4	F5
Colour	Pale in colour	Pale in colour	Pale in colour	Pale in colour	Pale in colour
Odor	Light smell of lemongrass	Stronger than F1	Stronger than F2	Lighter than F3	Strong smell of lemongrass
Appearance	Colloidal solution	Colloidal solution	Colloidal solution	Colloidal solution	Colloidal solution
foam	Foam is not formed heavy	Foam is not formed heavy	Heavy foam formed	Heavy foam formed	Heavy foam formed

5. Discussion

5.1. Interpretation of the results in the context of existing literature and theoretical frameworks

Interpreting the results of the evaluation in the context of existing literature and theoretical frameworks is crucial for understanding the efficacy, mechanisms of action, and potential applications of the colloidal astringent solution. Here's how you can interpret the results:

5.2. Physicochemical Properties

- **Comparison with Literature:** Compare the measured pH, viscosity, and particle size of the colloidal solution with values reported in existing literature for similar formulations. Assess whether the properties align with established standards for skincare products.
- **Theoretical Framework:** Consider theoretical frameworks related to colloidal science and skincare formulation to interpret the observed physicochemical properties. For example, understanding the principles of emulsion stability and particle size distribution can help explain the behavior of the solution.

5.3. Stability Testing

- **Literature Review:** Refer to existing studies on stability testing of colloidal formulations and skincare products to contextualize the observed changes in color, odor, or appearance over time. Assess whether the stability profile of the solution aligns with expectations based on similar formulations.
- **Theoretical Framework:** Apply theoretical models of chemical and physical stability, such as Ostwald ripening or coalescence, to interpret the observed changes in stability parameters. Consider factors such as emulsifier concentration, pH, and temperature that may influence stability.

5.4. Efficacy Testing

- **Literature Comparison:** Compare the observed astringent properties and skin compatibility of the colloidal solution with findings from existing literature on astringents, green tea, neem oil, and other relevant ingredients. Assess whether the observed effects align with reported benefits and mechanisms of action.
- **Theoretical Framework:** Apply theoretical models of astringency, such as protein precipitation or pore tightening, to interpret the observed efficacy of the solution. Consider how the active ingredients interact with skin proteins and lipids to produce the observed effects.

5.5. Performance Testing

- **Literature Review:** Review existing literature on moisturizing effects, antimicrobial activity, and other performance parameters of skincare products to contextualize the observed results. Assess whether the solution demonstrates performance characteristics consistent with its intended benefits.
- **Theoretical Framework:** Consider theoretical frameworks related to skin physiology, such as the skin barrier function and microbial ecology, to interpret the observed performance of the solution. Evaluate how the formulation components interact with the skin and microorganisms to produce the observed effects.

5.6. Consumer Perception

- **Comparative Analysis:** Compare user feedback and sensory evaluation results with existing consumer studies on similar skincare products. Assess whether the solution meets consumer expectations and preferences based on established benchmarks.
- **Theoretical Framework:** Apply theoretical models of consumer behavior and sensory perception to interpret the observed consumer feedback. Consider factors such as fragrance preference, texture preference, and perceived efficacy in shaping consumer perception of the solution.

By integrating the results of the evaluation with existing literature and theoretical frameworks, you can gain deeper insights into the efficacy, mechanisms of action, and potential applications of the colloidal astringent solution in skincare. This holistic approach enables a comprehensive understanding of the solution's performance and informs further research, development, and optimization efforts.

5.7. Analysis of the potential synergistic effects of combining green tea and neem oil in the colloidal astringent solution

The potential synergistic effects of combining green tea and neem oil in a colloidal astringent solution can be analyzed based on their individual properties and mechanisms of action:

5.7.1. Antioxidant Activity

- **Green Tea:** Green tea is rich in polyphenolic antioxidants, particularly epigallocatechin gallate (EGCG), which scavenges free radicals and protects the skin from oxidative damage.
- **Neem Oil:** Neem oil contains antioxidants such as vitamin E and carotenoids, which also contribute to its free radical-scavenging activity.

- Synergistic Effect: Combining green tea and neem oil may result in enhanced antioxidant activity due to the complementary nature of their antioxidant compounds. This synergistic effect can provide superior protection against oxidative stress and prevent premature aging of the skin.

5.7.2. Anti-inflammatory Effects

- Green Tea: Green tea polyphenols possess anti-inflammatory properties, inhibiting the production of pro-inflammatory cytokines and enzymes.
- Neem Oil: Neem oil exhibits anti-inflammatory effects, reducing inflammation and redness associated with skin conditions such as acne and eczema.
- Synergistic Effect: The combination of green tea and neem oil may exert synergistic anti-inflammatory effects, targeting multiple pathways involved in inflammation. This can lead to greater reduction in skin inflammation and improved management of inflammatory skin conditions.

5.7.3. Antimicrobial Activity

- Green Tea: Green tea has antimicrobial properties, inhibiting the growth of bacteria and fungi on the skin.
- Neem Oil: Neem oil exhibits broad-spectrum antimicrobial activity against bacteria, fungi, and viruses.
- Synergistic Effect: By combining green tea and neem oil, the colloidal astringent solution can benefit from the complementary antimicrobial properties of both ingredients. This synergistic effect may enhance the solution's ability to combat acne-causing bacteria, fungi responsible for skin infections, and other microbial pathogens.

5.7.4. Sebum Regulation

- Green Tea: Green tea helps regulate sebum production and reduces excess oiliness on the skin.
- Neem Oil: Neem oil has a balancing effect on sebum production, making it beneficial for oily and acne-prone skin.
- Synergistic Effect: The combination of green tea and neem oil in the colloidal astringent solution may synergistically regulate sebum production, leading to a balanced and less oily complexion. This can help prevent clogged pores, reduce acne breakouts, and improve overall skin texture.

5.7.5. Skin Healing and Regeneration

- Green Tea: Green tea promotes skin healing and regeneration through its antioxidant and anti-inflammatory properties.
- Neem Oil: Neem oil accelerates wound healing, stimulates collagen production, and enhances tissue regeneration.
- Synergistic Effect: By combining green tea and neem oil, the colloidal astringent solution may facilitate faster and more effective skin healing and regeneration. This synergistic effect can be particularly beneficial for addressing skin damage, scars, and other imperfections.

In summary, the combination of green tea and neem oil in a colloidal astringent solution offers the potential for synergistic effects across multiple skincare parameters, including antioxidant activity, anti-inflammatory effects, antimicrobial activity, sebum regulation, and skin healing. This synergistic interaction enhances the overall efficacy of the solution and provides comprehensive skincare benefits for various skin types and conditions.

5.8. Consideration of practical applications and implications for skincare product development

The analysis of the potential synergistic effects of combining green tea and neem oil in a colloidal astringent solution has several practical applications and implications for skincare product development:

5.8.1. Formulation Optimization

Skincare product developers can leverage the synergistic effects of green tea and neem oil by optimizing the formulation of colloidal astringent solutions. This may involve fine-tuning the concentrations of green tea extract and neem oil, selecting appropriate emulsifiers or surfactants to enhance stability, and optimizing the pH and viscosity of the solution for optimal skin compatibility and performance.

5.8.2. Targeted Skincare Solutions

The synergistic effects of green tea and neem oil make colloidal astringent solutions suitable for addressing a wide range of skincare concerns, including acne, inflammation, oxidative stress, and excess oiliness. Skincare product developers

can formulate targeted solutions tailored to specific skin types and conditions, such as acne-prone, sensitive, or aging skin.

5.8.3. Natural and Sustainable Formulations

Green tea and neem oil are natural ingredients with proven skincare benefits and eco-friendly profiles. By incorporating these botanical ingredients into colloidal astringent solutions, skincare product developers can meet the growing consumer demand for natural and sustainable skincare products. This aligns with the trend towards clean beauty and environmentally conscious consumer choices.

5.8.4. Market Positioning and Branding

Skincare brands can differentiate themselves in the market by highlighting the synergistic effects of green tea and neem oil in their colloidal astringent solutions. Emphasizing the natural, science-backed benefits of these ingredients can resonate with consumers seeking effective, yet gentle skincare solutions. This can enhance brand credibility and appeal to health-conscious and environmentally aware consumers.

5.8.5. Clinical Validation and Consumer Trials

Conducting clinical studies and consumer trials to validate the efficacy and safety of colloidal astringent solutions containing green tea and neem oil is essential for product development. These studies can provide scientific evidence supporting the claims of the product, validate its performance in real-world settings, and gather valuable feedback from consumers for further optimization.

5.8.6. Integration with Skincare Regimens

Colloidal astringent solutions can be integrated into daily skincare regimens as toners, cleansers, or spot treatments to complement existing skincare products. By incorporating synergistic ingredients like green tea and neem oil, these solutions can enhance the overall effectiveness of skincare routines, providing comprehensive care for the skin and addressing multiple concerns simultaneously.

In conclusion, the consideration of practical applications and implications for skincare product development based on the synergistic effects of combining green tea and neem oil in colloidal astringent solutions offers opportunities for formulating effective, natural, and sustainable skincare products tailored to consumer preferences and market trends. By leveraging the synergistic benefits of these botanical ingredients, skincare brands can innovate and create impactful solutions that promote healthy, radiant skin.

5.9. Consideration of practical applications and implications for skincare product development

The analysis of the potential synergistic effects of combining green tea and neem oil in a colloidal astringent solution has several practical applications and implications for skincare product development:

5.9.1. Formulation Optimization

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In conclusion, the consideration of practical applications and implications for skincare product development based on the synergistic effects of combining green tea and neem oil in colloidal astringent solutions offers opportunities for formulating effective, natural, and sustainable skincare products tailored to consumer preferences and market trends. By leveraging the synergistic benefits of these botanical ingredients, skincare brands can innovate and create impactful solutions that promote healthy, radiant skin.

6. Conclusion

In conclusion, the formulation of colloidal astringent solutions using green tea and neem oil offers significant potential for skincare product development. Through an analysis of their individual properties and the potential synergistic effects, it becomes evident that these ingredients complement each other well, providing a holistic approach to skincare.

Green tea brings antioxidant, anti-inflammatory, and sebum-regulating properties to the formulation, while neem oil contributes antimicrobial, anti-inflammatory, and wound-healing benefits. When combined, these ingredients create a powerful synergy that can address various skincare concerns such as acne, inflammation, oxidative stress, and excess oiliness. Practical applications and implications for skincare product development include formulation optimization, targeted skincare solutions, natural and sustainable formulations, market positioning, clinical validation, consumer trials, and integration with skincare regimens. By leveraging the synergistic effects of green tea and neem oil, skincare brands can develop effective, science-backed products that resonate with health-conscious consumers seeking natural, yet potent solutions for their skincare needs.

In summary, the formulation of colloidal astringent solutions using green tea and neem oil represents a promising avenue for innovation in the skincare industry. With careful formulation, validation, and consumer feedback, these products have the potential to revolutionize skincare routines and promote healthier, more radiant skin for users around the world.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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