REVIEW ON FABRICATION & ASSESSMENT OF HERBAL ALOE VERA MULTIPURPOSE GEL

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ABSTRACT

Aloe Vera gel is widely used for its versatile benefits in various industries, including skincare, pharmaceuticals, food, and cosmetics. The multipurpose nature of Aloe Vera gel makes it essential for multiple applications. These review study covers Compatibility of Aloe Vera with Other Ingredients for Topical Gel, pH Consideration, solubility, stability, formulation consideration, release kinetic, effect of carbopol polymer & comparision. Several literature were reviewed and collected recommendation for formulation & evaluation of topical herbal gel. Review Study suggested the cold extraction process for Aloe Vera, Tulsi & Neem. The use of herbal topical gels has gained popularity due to their therapeutic benefits, ease of application, and minimal systemic side effects. Among various gelling agents, Carbopol is widely used in pharmaceutical formulations to enhance viscosity, spreadability, and drug release. This review explores the role of Carbopol in the formulation of herbal topical gels, its impact on gel properties, and its effectiveness in drug delivery.

KEYWORDS : Polymer, Carbopol, Compatibility, Alevera, Multipurpose gel, Extraction

INTRODUCTION

Herbal topical gels are semisolid preparations containing herbal extracts or active phytochemicals intended for local or transdermal delivery. The selection of an appropriate gelling agent plays a crucial role in determining the stability, consistency, and therapeutic efficacy of the formulation. Carbopol, a synthetic high-molecular-weight polymer, is commonly used due to its excellent gel-forming ability, bioadhesion, and controlled drug release properties.

Role of neem, tulsi, and aloe vera in a topical herbal gel:

A topical herbal gel containing Neem (Azadirachta indica), Tulsi (Ocimum sanctum), and Aloe Vera (Aloe barbadensis miller) offers multiple skin benefits due to their antibacterial, antifungal, anti-inflammatory, and moisturizing properties. This combination is widely used in skincare, wound healing, acne treatment, and soothing irritated skin.

1. **Role of Aloe Vera in the Herbal Gel**

Scientific Name: *Aloe barbadensis miller*

Functions:

Skin Hydration & Moisturization – Acts as a natural humectant, keeping the skin hydrated.
Wound Healing & Skin Repair – Stimulates collagen synthesis, promoting faster healing of cuts and burns.
Anti-Inflammatory – Soothes irritation, redness, and rashes.
Cooling & Soothing Effect – Ideal for sunburn, insect bites, and minor skin injuries.
Enhances Absorption – Acts as a carrier for active herbal ingredients, improving penetration.

2. **Role of Neem in the Herbal Gel**
Scientific Name: *Azadirachta indica*
Functions:
Antibacterial & Antifungal – Kills acne-causing bacteria (*Propionibacterium acnes*) and prevents skin infections.
Anti-Inflammatory – Reduces swelling, redness, and irritation.
Controls Excess Oil & Acne – Regulates sebum production, making it ideal for oily skin.
Detoxifies Skin – Removes toxins and impurities from pores, reducing breakouts.
Wound Healing – Helps in treating minor wounds, rashes, and insect bites due to its antiseptic properties.

3**. Role of Tulsi in the Herbal Gel**
Scientific Name: *Ocimum sanctum*
Functions:
Antioxidant Protection – Neutralizes free radicals, preventing premature aging.
Antimicrobial & Antiviral – Fights bacteria and viruses that cause skin infections.
Reduces Acne & Blemishes – Soothes acne-prone skin, lightens scars and pigmentation.
Soothing & Cooling – Calms irritation, itchiness, and redness.
Improves Skin Tone & Glow – Enhances skin brightness and evens out complexion.

4. **Benefits of Aloe Vera + Neem + Tulsi in a Herbal Gel**
Ideal for Acne-Prone & Oily Skin – Controls oil, fights bacteria, and soothes breakouts.
Natural Skin Cleanser & Detoxifier – Removes dirt, impurities, and toxins.
Anti-Inflammatory & Healing – Reduces redness, irritation, and promotes wound healing.
Hydrating & Nourishing – Prevents dryness while healing damaged skin.
100% Herbal & Chemical-Free – Safe for all skin types, including sensitive skin.

Aloe Vera, Neem, and Tulsi work synergistically **in a** topical herbal gel **to provide a** powerful, natural skincare solution**. The combination is** perfect for acne treatment, hydration, soothing irritation, and overall skin health
Benefits of Aloe Vera + Neem + Tulsi Gel:
Acne Treatment: Controls excess oil, kills bacteria, and soothes inflammation.
Antifungal & Antimicrobial: Helps in skin infections and minor wounds.
Anti-Inflammatory: Reduces redness, irritation, and swelling.
Skin Hydration & Healing: Aloe Vera provides deep hydration and promotes skin regeneration

COMPATIBILITY STUDY

Compatibility of Aloe Vera with Other Ingredients for Topical Gel:
Aloe Vera gel is widely used in skincare and pharmaceutical formulations due to its hydrating, soothing, and healing properties. However, when formulating a topical gel, it is crucial to consider the compatibility of Aloe Vera with other ingredients to ensure stability, efficacy, and safety.

- **Compatible Ingredients with Aloe Vera for Topical Gel**

A. Hydrating & Moisturizing Agents

Ingredient	Compatibility	Purpose
Glycerin	Highly Compatible	Retains moisture, enhances skin hydration

Ingredient	Compatibility	Purpose
Hyaluronic Acid	Compatible	Deep hydration, plumps skin
Propylene Glycol	Compatible	Humectant, enhances ingredient penetration
Sodium PCA	Compatible	Improves moisture retention

B. Soothing & Anti-Inflammatory Agents

Ingredient	Compatibility	Purpose
Allantoin	Compatible	Soothes irritation, promotes healing
Panthenol (Pro-Vitamin B5)	Compatible	Hydrating, anti-inflammatory
Chamomile Extract	Compatible	Calming, reduces redness
Calendula Extract	Compatible	Heals wounds, soothes skin

C. Active Ingredients (For Skin Treatment)

Ingredient	Compatibility	Purpose
Niacinamide (Vitamin B3)	Compatible	Brightening, anti-acne
Salicylic Acid	Compatible in low concentration	Exfoliation, anti-acne
Tea Tree Oil	Compatible in small amounts	Antibacterial, anti-acne
Turmeric Extract (Curcumin)	Compatible	Antioxidant, anti-inflammatory

D. Preservatives (To Prevent Microbial Growth)

Ingredient	Compatibility	Purpose
Phenoxyethanol	Compatible	Broad-spectrum antimicrobial
Potassium Sorbate	Compatible	Natural preservative
Sodium Benzoate	Compatible	Antimicrobial
Parabens (Methylparaben, Propylparaben)	Use with caution	Some skin sensitivity concerns

E. Thickeners & Gelling Agents

Ingredient	Compatibility	Purpose
Carbomer	Compatible	Provides gel consistency
Xanthan Gum	Compatible	Natural thickener, stabilizes gel
Hydroxyethylcellulose (HEC)	Compatible	Improves gel texture
Guar Gum	Compatible	Natural thickener, enhances viscosity

F. Oils & Emollients

Ingredient	Compatibility	Purpose
Jojoba Oil	Compatible	Non-comedogenic moisturizer

Ingredient	Compatibility	Purpose
Coconut Oil	Can be occlusive	Deep moisturizer but may clog pores
Argan Oil	Compatible	Antioxidant-rich, hydrates skin
Vitamin E (Tocopherol)	Compatible	Antioxidant, protects skin

2. **Incompatible or Less Compatible Ingredients**

Ingredient	Issue	Alternative
High Concentration of Alcohols (Ethanol, Isopropanol)	Can dry out Aloe Vera gel, reduce effectiveness	Use mild preservatives instead
Strong Acids (e.g., High % of AHAs, BHAs, Retinoic Acid)	May degrade Aloe Vera components	Use in mild concentrations
Benzoyl Peroxide	May oxidize Aloe Vera, reducing potency	Use separate formulations
Essential Oils in High Concentration	May cause irritation, destabilize the gel	Use in low concentration (<1%)
Mineral Oil & Petrolatum	Can form a barrier, reducing Aloe Vera penetration	Use lightweight oils instead

Aloe Vera gel is **highly compatible** with many hydrating agents, botanical extracts, and mild active ingredients. However, **strong acids, oxidizers, and high concentrations of alcohols** should be avoided to prevent degradation or reduced efficacy.

- **Compatibility of Aloe Vera with Neem & Tulsi in Topical Gel Formulation:**

Aloe Vera, Neem (Azadirachta indica), and Tulsi (Ocimum sanctum) are widely used in skincare and medicinal formulations due to their antibacterial, anti-inflammatory, and healing properties. When combining these ingredients in a topical gel, their compatibility must be assessed based on pH stability, solubility, and interactions.

1. **Compatibility Overview**

Ingredient	Compatibility with Aloe Vera	Function in Topical Gel
Neem Extract (Azadirachta indica)	Highly Compatible	Antibacterial, anti-inflammatory, anti-acne
Tulsi Extract (Ocimum sanctum)	Highly Compatible	Antioxidant, antifungal, skin healing

Aloe Vera acts as a soothing base while Neem and Tulsi provide antimicrobial and antioxidant benefits, making them an excellent combination for acne treatment, wound healing, and skin detoxification.

pH CONSIDERATION FOR TOPICAL GEL

Aloe Vera Gel: pH 4.5 - 5.5
Neem Extract: pH 5.5 - 7
Tulsi Extract: pH 5 - 6.5

Optimal pH for Formulation: 5 - 6 (Stable for all three ingredients)
Maintaining a pH of 5-6 ensures that all active compounds remain stable without degradation.
pH Consideration for Aloe Vera Gel Formulations
Aloe Vera gel typically has a pH of 4.5 - 5.5. Ensure the formulation maintains a pH range between 4.5 - 6 for stability. Highly acidic (pH < 4) or alkaline (pH > 7) environments may degrade Aloe Vera's bioactive compounds.

SOLUBILITY & STABILITY CONSIDERATIONS

Neem & Tulsi extracts (aqueous or ethanol-based) are soluble in Aloe Vera gel and can be easily blended without phase separation. Neem oil can be used but should be emulsified properly with surfactants or gelling agents (e.g., Polysorbate 20 or Xanthan Gum) to prevent separation. High ethanol extracts (>10%) may destabilize Aloe Vera gel and should be used cautiously.

SELECTION OF EXTRACTION PROCESS

Maximizes Active Compound Yield – Extracts bioactive components like alkaloids, flavonoids, tannins, and saponins, ensuring a **potent formulation**.
Enhances Bioavailability – Converts plant material into **concentrated, absorbable forms** for better penetration into the skin.
Improves Stability & Shelf Life – Proper extraction removes **impurities** that can cause degradation, enhancing the **stability** of the final product.
Removes Unwanted Components – Eliminates **toxins, fibers, or insoluble materials**, ensuring **safety & purity**.
Optimizes Formulation Consistency – Standardizes active ingredient concentration, ensuring **batch-to-batch uniformity** in herbal gels, creams, or serums.

2. Common Extraction Methods & Their Importance

Extraction Method	Importance & Benefits	Best for (Herbs)
Maceration (Cold Extraction)	Gentle method, retains heat-sensitive compounds	**Aloe Vera, Tulsi**
Soxhlet Extraction (Hot Solvent Extraction)	High efficiency, extracts fat-soluble & heat-stable compounds	**Neem (leaves/seeds)**
Ultrasound-Assisted Extraction (UAE)	Fast, enhances active compound release	**Tulsi, Neem, Aloe Vera**
Supercritical Fluid Extraction (CO_2 Extraction)	High purity, solvent-free, retains essential oils	**Neem, Tulsi (essential oils)**
Hydrodistillation (Steam Distillation)	Best for extracting essential oils	**Tulsi oil, Neem oil**
Microwave-Assisted Extraction (MAE)	Reduces extraction time, eco-friendly	**Flavonoid-rich herbs**

How the Extraction Process Affects a Topical Herbal Gel (Neem, Tulsi, Aloe Vera):

Aloe Vera Extraction: Fresh aloe gel is extracted through cold pressing to preserve polysaccharides & enzymes that promote healing and hydration.

Neem Extraction: Ethanol or hydroalcoholic extraction helps concentrate limonoids & nimbin, which have antibacterial properties effective in acne treatment.

Tulsi Extraction: Steam distillation or solvent extraction ensures maximum eugenol & flavonoid content, boosting antioxidant & anti-inflammatory benefits.

The **right extraction process** is **critical** for ensuring the effectiveness of herbal formulations. Using improper methods may result in **loss of active compounds, reduced potency, and instability**. Proper extraction leads to **high-quality, standardized herbal products** that deliver **maximum therapeutic benefits**.

SUGGESTED FORMULATION RATIOS FOR A TOPICAL GEL

Ingredient	Suggested Percentage (%)
Aloe Vera Gel	60-80%
Neem Extract	2-5%
Tulsi Extract	2-5%
Gelling Agent (Carbomer/Xanthan Gum)	0.5-1.5%
Natural Preservative (Phenoxyethanol/Potassium Sorbate)	0.5-1%
Essential Oils (Tea Tree/Lavender - optional)	0.5-1%
Distilled Water	Balance

EFFECT OF CARBOPOL ON HERBAL GEL PROPERTIES

Carbopol as a Gelling Agent. Carbopol (Carbomer) is a polyacrylic acid derivative that swells in aqueous solutions, leading to the formation of a clear, viscous gel. It offers:

Improved viscosity and consistency

Enhanced bioadhesion, allowing better retention on the skin

Controlled drug release, preventing rapid degradation of herbal actives

pH-dependent swelling, affecting stability and absorption

1. **Viscosity and Rheology**: Carbopol concentration significantly influences the gel's viscosity. Studies suggest that 0.5% to 2% w/w Carbopol provides optimal viscosity for topical application. Higher concentrations may lead to increased stiffness, reducing spreadability.
2. **Spreadability and Application Ease:** An ideal topical gel should be easy to spread without excessive tackiness. Carbopol-modified gels demonstrate shear-thinning behavior, making them easy to apply but ensuring strong adhesion post-application.
3. **Drug Release and Permeation**; Carbopol enhances controlled drug release, preventing rapid evaporation or degradation of herbal actives.Studies show improved penetration of herbal extracts such as Aloe vera, Curcumin, and Neem when formulated with Carbopol.
4. **pH Stability and Compatibility**:Carbopol-based gels require pH adjustment (5-7) to maintain stability. Herbal actives with acidic or alkaline nature may require buffering agents to prevent degradation.

Comparative studies on herbal topical gels:
Carbopol vs. Natural Polymers (Guar Gum, Xanthan Gum, HPMC)
Carbopol provides superior clarity, viscosity control, and drug retention, making it preferable for cosmetic and medicinal topical gel.

Parameter	Carbopol	Natural Polymers
Clarity	Transparent	Opaque
Viscosity Control	Excellent	Moderate
Bioadhesion	High	Medium
Drug Release	Sustained	Faster
pH Sensitivity	High	Low

MECHANISM OF ACTION OF CARBOPOL IN TOPICAL GELS
Carbopol (Carbomer) is a high-molecular-weight polyacrylic acid polymer that functions as a gelling agent, viscosity enhancer, and controlled drug release modifier in pharmaceutical and cosmetic formulations. Its mechanism of action can be understood through the following key processes:

1. **Swelling & Gel Formation:** When dispersed in water or an aqueous medium, Carbopol particles absorb water and swell due to electrostatic repulsion between negatively charged carboxyl groups ($-COO^-$).
Upon neutralization (using alkali like NaOH or TEA), Carbopol undergoes complete hydration, forming a three-dimensional gel network that provides high viscosity and gel-like consistency.
Key Reaction:
Carbopol (acidic form) + Base → Neutralized Carbopol (gel network)\text{Carbopol (acidic form) + Base → Neutralized Carbopol (gel network)}Carbopol (acidic form) + Base → Neutralized Carbopol (gel network)

2. **Rheology Modification & Thickening**: Carbopol molecules act as rheology modifiers, increasing viscosity even at low concentrations (0.5-2%).
It exhibits shear-thinning behavior, meaning the gel becomes less viscous when applied (ease of spreading) but regains viscosity after application (ensures retention on skin/mucosa).
Effect on Herbal Gels: Enhances stability of phytochemicals (e.g., flavonoids, alkaloids).
Provides smooth texture and spreadability.

3. **Bioadhesion & Skin Retention**: The mucoadhesive property of Carbopol allows prolonged contact time with the skin, enhancing drug absorption. Forms a hydrated polymer matrix, preventing rapid evaporation of herbal actives and promoting sustained drug release. Example: Neem Gel: Carbopol retains active compounds (azadirachtin, flavonoids) on the skin, improving antimicrobial effects.

4. **Controlled Drug Release & Penetration:** The cross-linked polymer network traps herbal extracts and controls their release over time. Hydrophilic nature enhances penetration of water-soluble herbal actives through the skin.

pH-dependent swelling behavior modulates the drug diffusion rate. Example: Curcumin (Turmeric) Gel: Carbopol prolongs curcumin release, increasing anti-inflammatory effects.

5. **Stability & Compatibility**: Carbopol stabilizes emulsions, suspensions, and herbal extracts by preventing phase separation. Compatible with alcohol, glycols, essential oils, and plant extracts, making it suitable for herbal gels, creams, and lotions.

LITERATURE REVIEW

- (Kim et al., 2003).Polymers were included in the designed topical formulations in order to provide a prompt release of drug and to achieve as well as to maintain the drug concentration within the therapeutically effective range. As the concentration of the polymer was fixed as 1.5% in all the gel formulations no variation in viscosity was observed. Further the value between 0.384 and 0.391 poise was reported to be an ideal viscosity value for topical gel formulation developed using carbopol polymers
- (Nappinai, Pakalapati, Arimilli, 2006) A closed collapsible tube containing about 20 g of gel was pressed firmly at the crimped end and a clamp was applied to prevent any roll back. The cap was removed and the gel was extruded. The amount of the extruded gel was collected and weighed. The percentage of the extruded gel was calculated.
- (Queiroz et al., 2009).pH measurement of the gel was carried out using a digital pH meter by dipping the glass electrode completely into the gel system to cover the electrode. The measurement was carried out in triplicate and the average of the three readings was recorded
- (Nayak et al., 2005).Viscosity of gel was determined using Brookfield viscometer (S-62, model LVDV-E) at 25 °C with a spindle speed of the viscometer rotated at 12 rpm
- (Jain et al., 2007).Two sets of glass slides of standard dimensions were taken. The herbal gel formulation was placed over one of the slides. The other slide was placed on the top of the gel, such that the gel was sandwiched between the two slides in an area occupied by a distance of 7.5 cm along the slides. Hundred g weight of gel was placed on the upper slides so that the gel was between the two slides was pressed uniformly to form a thin layer. The weight was removed and the excess of gel adhering to the slides was scrapped off. The two slides in position were fixed to a stand without slightest disturbance and in such a way that only upper slides to slip off freely by the force of weight tied on it. A 20 g weight was tied to the upper slide carefully. The time taken for the upper slide to travel the distance of 7.5 cm and separated away from the lower slide under the influence of the weight was noted. The experiment was repeated for three times and the mean time was taken for calculation.
- (Martin, 1994) To find out the release pattern of active constituent from herbal gel, data obtained were fitted to different mathematical models
- (Blonco-Flonte et al., 1996), Among the two polymers used, carbopol 934 was reported to have more gelling property than carbopol 940 which is in correlation with our study. Carbopol 934 polymer proved to be a promising carrier for controlled release of active phyto constiuents in the gel formulation.
- (Walker, Smith, 1996) Dimethylsulfoxide and propylene glycol are reported to be the two best permeation enhancers (Panigrahi et al., 2006). Since DMSO reported to causes skin erosion we have used propylene glycol as permeation enhancer in the preparation of the gel formulation

- Subbiah Rajasekaran,et al(2005) In the present study, an attempt has been made to evaluate the presence of antioxidant property in the alcoholic extract of Aloe vera leaf gel. Oral administration of Aloe vera gel extract at a concentration of 300 mg/kg to diabetic rats significantly decreased the levels of blood glucose, glycosylated hemoglobin and increased hemoglobin. The increased levels of lipid peroxidation and hydroperoxides in tissues of diabetic rats were reverted back to near normal levels after the treatment with gel extract.
- Akira Yagi et al (2009)Aloe vera L. high molecular weight fractions (AHM) containing less than 10 ppm of barbaloin and polysaccharide(MW: 1000 kDa) with glycoprotein, verectin(MW:29 kDa), were prepared by patented hyper-dry system in combination of freeze–dry technique with microwave and far infrared radiation. AHM produced significant decrease in blood glucose level sustained for 6 weeks of the start of the study. Significant decrease in triglycerides was only observed 4 weeks after treatment and continued thereafter. No deterious effects on kidney and liver
- O'Brien, et al (2011)Aloe ferox leaf gel differs substantially from that of Aloe vera but almost no commercially relevant data is available this species. Leaf dimensions, gel yields and gel compositions were studied, based on samples from several natural populations. Glucose is the only free sugar in aloe gel.
- Priyanka Sharma et al(2013) .Aloe vera is a perennial, drought resisting succulent herb that belongs to the Asphodelaceae family. It is called the healing plant or the silent healer because of its wound and burn healing properties. Aloe vera has been known and used for centuries for its health beauty, medicinal and skin care attributes and is used in a variety of commercial products.
- BawankarRakshaet al(2014)The practice of using Aloe vera extract as a herbal medicine basically depend on folklore and by experiences of people over a long period of time. Extensive research, especially in the area of basic biochemical characterization and elucidation of bioactivities has been conducted in a systematic manner. This has resulted in the characterization of many biochemical compounds from Aloe vera, predominantly using the techniques of spectroscopy and chromatography
- Amit Pandey et al .(2016)Aloe vera belongs to the family Xanthorrhoeaceae (APG III System) commonly known as Ghrit Kumari, is the oldest medicinal plant ever known and the most applied medicinal plant worldwide. Aloe Vera is used for vigor, wellness and medicinal purposes since rigvedic times. Health benefits of aloe vera include its application in wound healing, treating burns, minimizing frost bite damage,
- Suhasini Dehury1 et al (2017) The present study was undertaken to evaluate the protective effect of aqueous leaf extract of Aloe vera (ALEAV) in animal model (wistar albino rats) through macroscopic and histopathological study of the colon after inducing ulcerative colitis by usage of acetic acid. 30 healthy albino rats of either sex 150-200g body wt. and 2-4 months age groups were divided into five groups (six in each). Group 1 was normal control group receiving vehicle 1ml of normal saline transrectally (negative control). Group 2 was ulcerative colitis control which was treated with normal saline
- Jacobo Robledoet al (2017) Aloe vera (Aloe barbadensis) is an important plant to cosmetics, pharmaceuticals, and food industry worldwide. In Colombia its cultivation has grown even when technical crop management is unknown. This study evaluated the growth of three aloe basal shoots weights ranges in two companion planting systems and monoculture (control). A completely randomized split plot design was

used growth and CBCP associated with HW are a promising alternative to aloe cultivation

- Darshan Dharajiyaet al(2017)The present study was conducted to assess the antimicrobial potential and phytochemical analysis of Aloe vera (Aloe barbadensisMiller) leaves extracts. The extracts were prepared by the sequential cold maceration method by using hexane, ethyl acetate, methanol and distilled water as a solvent. Antimicrobial activity of four extracts was performed by agar well diffusion method against different bacteria and fungi. Determination of Minimum Inhibitory Concentration (MIC) of different extracts
- Valerie A. Ferro, et al (2018)Aloe barbadensis Miller (or Aloe vera) has widespread use in health products, and despite numerous reports on the whole plant, little work has been performed on the inner gel, which has been used extensively in these products. This report describes the in vitro susceptibilities of two bacteria to this component. Global antibiotic resistance by bacteria is becoming an increasing public health concern, and the race to discover new antibacterial agents is on . One approach involves the search for new therapeutic agents with novel modes of action from natural resources.
- Chandrasekar R et al (2018) Aloe a miracle plant obtained from many species namely aloe vera, aloe barbadensis, aloe perryi, aloe ferox and various other species. Aloe vera the Indian species cultivated in India and other species are cultivated in Africa. Aloe is a cactuslike plant that grows in hot, dry climates. Aloe plant can withstand drought conditions and can grow without rainfall. Aloe produces two substances, gel and latex. Aloe gel is a clear, jelly-like substance found in the inner part of the aloe plant leaf.

EVALUATION & RECOMMENDATIONS FOR A TOPICAL HERBAL GEL

To ensure the quality, safety, stability, and effectiveness of a topical herbal gel (Neem, Tulsi, and Aloe Vera-based), it must undergo several evaluation tests. Below are the key evaluation parameters along with recommendations for formulation improvement.

1. **Physical & Organoleptic Evaluation**

Appearance & Color – Should be uniform and visually appealing.
Odor & Fragrance – Herbal or neutral, without unpleasant odors.
Texture & Consistency – Should be smooth, non-greasy, and easy to spread.
Spreadability – Should spread easily without excessive rubbing.
Recommendations:
Use natural stabilizers (Xanthan Gum, Carbomer) to maintain gel consistency.
Add natural essential oils (Tea Tree, Lavender) to enhance fragrance and antimicrobial benefits.

2. pH Measurement

Ideal pH: 5.0 – 6.5 (Similar to skin pH, ensuring non-irritation).
Method: Use a pH meter or pH paper to check the gel's pH.
Recommendations:
Adjust pH using citric acid (to lower) or sodium hydroxide (to increase) if out of range.
Maintain pH stability to prevent degradation of active ingredients.

3. Viscosity & Rheological Properties
Purpose: Ensures proper consistency & spreadability.
Method: Use a Brookfield viscometer to check the viscosity.
Recommendations:
Use Xanthan Gum (0.5-1%) or Hydroxyethylcellulose (HEC) (1-2%) for smooth gel texture. Avoid excess thickeners that may cause stickiness.

4. Microbial & Preservative Efficacy Test
Purpose: To check microbial contamination and preservative effectiveness.
Tests to Perform:
Total Plate Count (TPC) – Measures bacterial contamination.
Yeast & Mold Count – Ensures no fungal growth.
Pathogen Testing (E. coli, Staphylococcus aureus, Pseudomonas aeruginosa) – Ensures absence of harmful bacteria.
Recommendations:
Use natural preservatives like Phenoxyethanol (1%) or Potassium Sorbate (0.5%) to prevent microbial growth. Store at a cool temperature and in air-tight packaging to avoid contamination.

5. **Stability Testing**
Purpose: To check gel stability under different environmental conditions.
Tests to Perform:
Accelerated Stability Test (AST) – Store samples at 40°C / 75% RH for 3 months to check color, odor, pH, and consistency changes.
Freeze-Thaw Stability Test – Store at -5°C and 45°C alternately for 5 cycles to check phase separation.
Recommendations:
Use Carbomer (0.5-1%) to improve stability.
Use air-tight, UV-protected packaging to prevent oxidation of active ingredients.

6. **Skin Irritation & Patch Test**
Purpose: To ensure the gel is safe for all skin types.
Method: Apply gel on a small patch of skin (inner arm) and observe for 24 hours for irritation, redness, or allergic reaction.
Recommendations:
Ensure no parabens, synthetic fragrances, or harsh chemicals are included. Use aloe vera as a soothing base to reduce irritation risks.

7. Efficacy Testing (In-Vitro & In-Vivo Studies)
Purpose: To check the actual effectiveness of the gel.
Tests to Perform:
Anti-Bacterial Test – Check the gel's effect on acne-causing bacteria (P. acnes).
Moisturization Test – Measure skin hydration levels before & after application.
Wound Healing Test – Observe skin repair improvements over 7-14 days.
Recommendations:
Include Neem (2-5%) & Tulsi (2-5%) extracts in an optimized concentration for best

antibacterial effects.
Use Aloe Vera (60-80%) as a hydrating and healing agent.

8. **Packaging & Labeling Evaluation**
Purpose: Ensures proper storage, shelf life, and consumer appeal.
Recommendations:
se air-tight, opaque, or amber-colored containers to protect active ingredients.
Label should mention:
Key herbal ingredients & benefits
Usage instructions & storage conditions
Allergen warning (if applicable)
Batch number & expiry date

Final Recommendations for an Ideal Topical Herbal Gel
Maintain pH (5.0-6.5) to suit skin health.
Use a combination of Aloe Vera, Neem, and Tulsi extracts in safe concentrations (2-5%).
Ensure microbial stability by using mild natural preservatives.
Perform stability testing to prevent phase separation and degradation.
Choose the right packaging to preserve the herbal properties.

CONCLUSION

Multipurpose Aloe Vera gel is a highly beneficial and versatile product. Its ability to be used in various industries makes it a valuable ingredient in modern applications, promoting health, beauty, and wellness. Aloe Vera gel is **highly compatible** with many hydrating agents, botanical extracts, and mild active ingredients. However, **strong acids, oxidizers, and high concentrations of alcohols** should be avoided to prevent degradation or reduced efficacy. Aloe Vera, Neem, and Tulsi are highly compatible in a topical gel formulation when pH and solubility are properly maintained. The combination is ideal for acne-prone, oily, and irritated skin while ensuring hydration and protection. Carbopol plays a vital role in enhancing the stability, viscosity, and drug release profile of herbal topical gels. Its ability to modify rheological properties and improve skin retention makes it a preferred polymer in modern herbal gel formulations. Further research on Carbopol-herb interactions will help optimize its efficacy in herbal drug delivery. Carbopol enhances viscosity, bioadhesion, drug stability, and controlled release in herbal topical gels, making it a preferred polymer for cosmeceuticals and pharmaceutical formulations. Neem gel with Carbopol is more effective, stable, and bioavailable compared to traditional neem formulations. cold extraction process for Aloe Vera, Tulsi & Neem**.The combination is** perfect for acne treatment, hydration, soothing irritation, and overall skin health**.**

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