



A REVIEW ON ASSESSMENT OF CARBOPOL EFFECT ON TOPICAL GEL

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ABSTRACT

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.

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.

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

Effect of Carbopol on Herbal Gel Properties

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 ($-\text{COO}^-$).
- 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:

$$\text{Carbopol (acidic form)} + \text{Base} \rightarrow \text{Neutralized Carbopol (gel network)}$$

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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.

EFFECT OF NEEM IN A TOPICAL HERBAL GEL WITH CARBOPOL

Neem (*Azadirachta indica*) is widely used in topical herbal gels due to its antimicrobial, anti-inflammatory, antioxidant, and wound-healing properties. When formulated with Carbopol, neem extract forms a stable, effective, and bioadhesive topical gel that enhances its therapeutic benefits.

1. Role of Neem in Topical Gels

Neem extract contains bioactive compounds such as:
 Azadirachtin → Antimicrobial, antifungal
 Nimbin & Nimbidin → Anti-inflammatory, wound healing
 Quercetin & Polyphenols → Antioxidant, skin-protective
 Fatty acids & Vitamin E → Moisturizing, soothing

Therapeutic Uses in Herbal Gels

Acne Treatment – Kills acne-causing bacteria (*Propionibacterium acnes*)
 Wound Healing – Reduces inflammation and promotes skin regeneration
 Fungal Infections – Effective against ringworm, athlete's foot, candidiasis
 Eczema & Psoriasis – Soothes itching, redness, and scaling

2. Why Use Carbopol in Neem Gel?

Carbopol (Carbomer) is a synthetic polymer used as a gelling agent, viscosity enhancer, and controlled-release modifier. It improves stability, texture, and drug penetration in topical gels.

Advantages of Carbopol in Neem Gel

Enhanced Viscosity & Spreadability → Forms a smooth, uniform gel
 Improved Bioadhesion → Prolonged retention on skin for better absorption
 Sustained Release of Neem Actives → Prevents rapid degradation of azadirachtin & flavonoids
 Better Skin Penetration → Helps neem extract reach deeper skin layers
 pH Stability (5.5–6.5) → Maintains neem bioactivity

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)

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

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

MATERIAL AND METHOD CONSIDERATION**Neem gel formulation with carbopol****Ingredients (Per 100g of Gel)**

Ingredient	Quantity	Purpose
Neem Extract (Hydroalcoholic)	5-10%	Antimicrobial, anti-inflammatory
Carbopol 940	0.5-1%	Gelling agent
Triethanolamine (TEA)	0.5%	Neutralizer (pH adjustment)
Glycerin	2-5%	Humectant, moisturizer
Propylene Glycol	3%	Enhances neem penetration
Methylparaben	0.1%	Preservative
Purified Water	q.s. to 100g	Gel base

Preparation Method

1 Carbopol Dispersion → Disperse Carbopol 940 in purified water, stir for uniform hydration.

2 pH Adjustment → Add Triethanolamine (TEA) to adjust pH to 5.5-6.5, allowing full gel formation.

3 Neem Extract Addition → Mix neem extract with glycerin & propylene glycol, then incorporate into the gel.

4 Final Mixing → Homogenize the formulation, add preservatives, and store in a clean container.

5. Effectiveness of Neem-Carbopol Gel

Comparison: Neem Gel with & without Carbopol

Parameter	Neem Gel (With Carbopol)	Neem Gel (Without Carbopol)
Viscosity	High, stable	Lower, less stable
Spreadability	Smooth, even application	Can be uneven
Retention on Skin	High bioadhesion, prolonged effect	Rapid evaporation
Drug Release	Controlled, sustained release	Faster release, potential degradation
Absorption	Better skin penetration	Lower absorption
Microbial Stability	More stable	Less stable

Neem gel with Carbopol is more effective, stable, and bioavailable compared to traditional neem formulations.

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 constituents 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 deleterious 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.
- BawankarRaksha et 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 Ghrith 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 Dehury 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 Robledo et 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 Dharajiya et al(2017) The present study was conducted to assess the antimicrobial potential and phytochemical analysis of Aloe vera (Aloe barbadensis Miller) 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.

CONCLUSION

- 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.

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