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Reviewing A Skin Moisturizing Gel Containing Aloe Vera, Glycerin, Propylene Glycol & Carbopol 934 For Improving Skin Hydration And Maintaining The Skin Moisture Balance

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Abstract

Background: The topical application of semi-solid hydrogel dosage forms to the epidermal layer represents a vital therapeutic strategy for maintaining the hydration, structural flexibility, and defensive barrier performance of human skin. Cutaneous dryness and barrier degradation occur when the rate of transepidermal water loss (TEWL) outpaces the endogenous moisture retention capacity of the stratum corneum, culminating in xerosis, surface micro-fissuring, roughness, and localized physical discomfort. Hydrogel systems serve as excellent candidates for topical delivery and localized barrier repair, providing a non-greasy, biocompatible three-dimensional cross-linked polymeric matrix that can be easily applied, spread, and absorbed.

Aim: The primary aim of this comprehensive literature review and formulation project report is to systematically evaluate the structural matrix, historical processing evolution, anatomical rationale, antimicrobial profile, and industrial quality control parameters of a stabilized herbal-synthetic hybrid moisturizing skin gel.

Methods & Scope: The formulation focuses on integrating natural *Aloe barbadensis* Miller leaf parenchyma extract, glycerine, and propylene glycol structured within a synthetic Carbopol 934 cross-linked polymer network. This report thoroughly outlines the transition of botanical gels from folk medicine to modernized, stabilized formulations, details its dual mechanisms of water binding, and establishes standard quality metrics including pH, viscosity, rheology, and accelerated thermal stability profiles.

Conclusion: The structural alignment of natural plant mucilage with synthetic polyacrylic acid networks overcomes historical stability hurdles such as rapid enzymatic oxidation and product thinning, providing a highly efficient, predictable, and non-irritating path for advanced dermatological care and skin hydration.

Keywords: moisturizer, hydration, skin gel, aloe vera

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3. INTRODUCTION & NORMAL SKIN PHYSIOLOGY

The human cutaneous framework represents the largest organ of the body, functioning as a highly dynamic physiological shield against environmental insults, mechanical injuries, microbial invasion, and excessive moisture desiccation. The topmost layer of the epidermis, known specifically as the stratum corneum (SC), dictates the absolute efficiency of this defensive boundary. Structurally described by Elias' classic "brick and mortar" architectural model, the stratum corneum is composed of anucleated, keratin-dense corneocytes ("the bricks") tightly embedded within a highly ordered, crystalline intercellular lipid lamellar matrix ("the mortar"). This specialized intercellular lipid composition consists of a precise equimolar mixture of ceramides, long-chain free fatty acids, and cholesterol, which together form a hydrophobic barrier that physically restricts water from evaporating out of the body.

Under normal ambient, homeostatic physiological conditions, the stratum corneum maintains a strict water concentration ranging between 10% and 30%. This crucial moisture level is actively regulated by a specialized group of intracellular, highly hygroscopic water-soluble compounds collectively designated as Natural Moisturizing Factors (NMF). Synthesized catabolically within the maturing epidermal cells, NMF consists primarily of free amino acids, pyrrolidone carboxylic acid (PCA), urea, urocanic acid, and lactic acid. These molecules spontaneously attract and form strong hydrogen bonds with both environmental moisture and water molecules rising up from the deeper, vascular dermis layer. This steady hydration state is completely necessary to maintain enzymatic activity, manage smooth epidermal cell turnover (desquamation), and preserve skin elasticity.

When the skin is exposed to harsh environmental factors, dry climates, or aggressive laboratory chemical surfactants, this homeostatic lipid matrix is broken down. The disruption or stripping away of the intercellular lipid bilayers immediately triggers an abnormal acceleration in the rate of Transepidermal Water Loss (TEWL). As cellular water leaves the stratum corneum faster than the underlying dermis can resupply it, the moisture level drops well below the critical 10% threshold. This structural depletion disrupts the natural enzymes responsible for cell shedding, causing dry skin cells to stick together abnormally. This pathophysiology manifests clinically as xerosis, presenting as physical skin roughness, visible flaking, scaling, pruritus, and increased vulnerability to chemical irritants.

To restore this vital defensive barrier, the application of topical moisturizing hydrogels becomes therapeutically necessary. In modern pharmaceutical formulation design, traditional greasy creams and heavy emulsions are increasingly replaced by clear, polymeric hydrogel matrices. These advanced delivery systems are designed to simultaneously deliver active botanical agents and highly efficient humectants without blocking the pores or leaving a heavy residue. By integrating natural water-binding plant extracts like Aloe barbadensis Miller into a synthetic polyacrylic acid framework (Carbopol 934), researchers can construct a biometric topical matrix. This hydrogel mimics the physical action of NMF, supplying instant water to the dehydrated corneocytes while forming a thin, flexible barrier that physically patches the damaged lipid mortar.

4. ANTIMICROBIAL AGENTS & SUPPORTING MATRIX

- Severely dry, micro-fissured, and cracked skin barriers lose their structural protection, making the skin highly susceptible to secondary opportunistic bacterial and fungal micro-organism invasions.
- Aloe barbadensis Miller naturally produces a strong profile of defensive secondary metabolites within its outer leaf pulp rind layers.
- The botanical matrix contains rich therapeutic amounts of anthraquinones (aloin, aloe-emodin), salicylic acid, saponins, sterols, and organic sulfur compounds.
- These natural active components demonstrate documented growth-inhibiting and bactericidal performance against common pathogenic cutaneous microbes like Staphylococcus aureus and Escherichia coli.
- Beyond functioning as structural humectant ingredients, Glycerine and Propylene glycol serve a critical secondary preservation purpose inside the gel network by reducing free water activity.
- By chemically locking away free water, these humectants dehydrate contaminating cells and successfully prohibit microbial proliferation, acting as a supportive preservative system.
- Although these structural biological traits actively support wound healing and shield the gel container from spoiling, this hydrogel is primarily designed as a skin barrier moisturizer.
- To scientifically prove any specific standalone antimicrobial therapeutic claims, the finished gel must undergo standardized Agar Well Diffusion testing during quality control parameters to verify the exact zone of inhibition.

5. CLINICAL APPLICATION

- **Pathological Xerosis:** Effectively mitigates advanced scaling and severe dry skin conditions caused by

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environmental changes, freezing weather, or harsh chemical laboratory surfactants.

- **Radiation Dermatitis Relief:** Acts as a gentle cooling and protective barrier agent to reduce skin peeling, severe erythema, and deep inflammation in patients undergoing cancer radiation therapies.
- **Psoriasis Adjuvant Care:** Softens hard plaques, soothes localized cutaneous scaling, and reduces intense irritation when applied regularly.
- **Eczema & Atopic Dermatitis Support:** Serves as a completely non-irritating barrier ointment to deeply hydrate inflamed tissues and prevent secondary micro-fissuring.
- **Minor Thermal Wound Care:** Speeds up recovery in minor tissue injuries and superficial thermal sunburns by sustaining a moist healing environment.

6. THERAPEUTIC APPROACH

- **Dual-Action Restructuring:** Focuses on restoring the natural "brick and mortar" architecture of the stratum corneum via a simultaneous protective network.
- **Hygroscopic Sponge Mechanism:** Long-chain plant mucopolysaccharides (specifically acemannan) contain multiple hydrophilic hydroxyl (-OH) groups that readily form strong hydrogen bonds with water.
- **Deep Hydration Draw:** This botanical matrix works in harmony with Glycerine and Propylene glycol to pull moisture up from the vascular dermis layers and the surrounding air.
- **Corneocyte Rehydration:** Traps water inside keratinized, dried cells to reverse surface flaking and restore elasticity to the skin barrier.
- **Emollient Cohesive Sealing:** Forms a thin, flexible film over the skin to glue loose, peeling corneocytes back together.

7. FORMULATION INGREDIENT PROFILE

Aloe Vera Gel / Extract



- **Role:** Active Ingredient / Natural Moisturizing Agent.
- **Nature:** Rich in Acemannan mucopolysaccharides, anthraquinones, & vitamins.
- **Action:** Hydroxyl groups form hydrogen bonds with water; accelerates fibroblast collagen synthesis.
- **Conc:** 1.0% – 10.0% w/w. Soluble in water.

Glycerine (Glycerol)



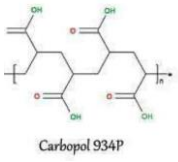
- **Role:** Humectant / Penetration Enhancer.
- **Nature:** Tri-hydroxy alcohol.
- **Action:** Attracts moisture from environment and keeps skin hydrated.
- **Conc:** 2.0% – 15.0% w/w. Clear viscous liquid.

Propylene Glycol



- **Role:** Humectant / Solvent / Preservative Booster.
- **Nature:** 1,2-Propanediol.
- **Action:** Increases lipid membrane fluidity, enhancing active delivery.
- **Conc:** 1.0% – 10.0% w/w. Miscible in water.

Carbopol 934



- **Role:** Gelling Agent / Viscosity Modifier.
- **Nature:** Crosslinked polymer of acrylic acid.
- **Action:** Provides gel structure and increases viscosity.
- **Conc:** 0.2% – 1.0% w/w (pH 6.0 – 7.5).

Triethanolamine (TEA)



- **IUPAC:** 2,2′,2″-Nitrilotriethanol | **MW:** 149.19
- **Role:** Neutralizing Agent / pH Adjuster.
- **Action:** Neutralizes acidic Carbopol to pH 6.5–7.0, activating maximum gel clarity & yield value.
- **Conc:** q.s. to target pH (~1:1 with Carbopol).

A. Methylparaben Sodium



- **Formula:** $C_8H_7NaO_3$ | **MW:** 174.13
- **Role:** Water-soluble Preservative.
- **Spectrum:** Active against molds & yeasts.
- **Conc:** 0.1% – 0.2% w/w.

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B. P pylparaben Sodium



- **Formula:** $C_{10}H_{11}NaO_3$ | **MW:** 202.18
- **Role:** Synergistic Preservative.
- **Spectrum:** High efficacy against fungi/bacteria.
- **Conc:** 0.01% – 0.05% w/w.

8. METHODOLOGY AND MANUFACTURING OF GELS

7.1 Raw Material Processing & Formulation Design: The fabrication of the topical hydrating hydrogel system relies on the precise combination of natural bio-actives with synthetic polymeric networks. Standardized Aloe vera inner leaf parenchyma gel is utilized as the primary botanical active ingredient, selected for its rich polysaccharide matrix (predominantly acemannan). Carbopol 934 (Carbomer 934) serves as the primary polymeric gelling agent, providing a high-yield 3D crosslinked acrylic acid structure capable of maintaining physical stability. Triethanolamine (TEA) acts as the organic neutralizing base to trigger polymer chain uncoiling and gelation. Glycerine and Propylene glycol are incorporated as synergistic humectants and cosolvents to enhance moisture retention and skin penetration, while Methylparaben sodium and Propylparaben sodium form a broad-spectrum water-soluble preservative system. Purified distilled water serves as the solvent vehicle (q.s. to 100% w/w).

7.2 Step-by-Step Preparation Protocol:

- **Polymer Hydration & Dispersion:** Accurately weigh Carbopol 934 (0.5%–1.0% w/w). Slowly sprinkle the fine acrylic acid powder over 50% of the calculated total volume of warm distilled water under continuous, controlled mechanical stirring (300–500 rpm) using an overhead stirrer. To prevent lump formation and localized agglomeration, addition must be gradual. The resulting acidic polymer dispersion is allowed to swell undisturbed for 2 to 4 hours to ensure complete hydration of the polymeric backbone.
- **Humectant & Preservative Phase Solubilization:** In a separate glass beaker, dissolve Methylparaben sodium (0.2% w/w) and Propylparaben sodium (0.02% w/w) in warm distilled water maintained at 50°C. Once a clear solution is achieved, allow the mixture to cool to room temperature (25°C). Incorporate Glycerine (5.0% w/w) and Propylene glycol (5.0% w/w) under gentle stirring until a homogenous, clear aqueous liquid phase is obtained.
- **Active Phytocomponent Incorporation:** Freshly isolated or standardized Aloe vera gel extract is filtered through a fine muslin cloth to remove coarse cell wall debris and fibrous particulates. The clear Aloe vera liquid (5.0%–10.0% w/w) is introduced into the humectant-preservative phase under ambient room temperature without heat application, preserving heat-sensitive bioactive enzymes (bradykinase) and mucopolysaccharides from thermal denaturation.
- **Phase Blending & Polymer Neutralization:** The active humectant mixture is slowly poured into the hydrated Carbopol 934 dispersion under continuous, low-speed stirring to prevent air incorporation. Triethanolamine (TEA) is then added dropwise to the mixture while monitoring pH with a digital pH meter. As the pH shifts from acidic toward near-neutrality (pH 6.5–7.0), carboxylic acid groups (-COOH) along the Carbopol backbone ionize into negatively charged carboxylate anions (-COO−). Electrostatic repulsion causes the coiled polymer chains to instantly expand into a clear, highly viscous 3D hydrogel matrix. The final gel is allowed to rest under vacuum or sonication to remove entrapped micro-air bubbles.

9. EVALUATION OF GELS (QUALITY CONTROL METRICS)

8.1 Physical Appearance, Clarity & Homogeneity: The formulated hydrogel batches are visually evaluated against bright background lighting to check for clarity, color, glossiness, and phase separation. Homogeneity is established by pressing a 0.5 g gel sample between two polished glass slides or spreading a thin layer across a transparent glass surface. The gel must demonstrate a uniform structural texture, smooth feel, and complete absence of particulate aggregates, polymer lumps, or air bubbles.

8.2 pH Determination & Cutaneous Safety: The pH of the formulation is measured directly by preparing a 1% w/v aqueous dispersion of the gel in deionized water using a calibrated digital pH meter equipped with a glass combination electrode. To prevent cutaneous irritation, contact dermatitis, or disruption of the acid mantle of the skin, the formulation must maintain a skin-compatible target range of pH 6.2 – 7.2.

8.3 Viscosity & Rheological Characterization: Rheological behavior is measured at 25°C ± 1°C using a Brookfield Digital Viscometer (Spindle No. 6 or 7, rotated across speeds from 10 to 100 rpm). The hydrogel exhibits non-Newtonian pseudoplastic (shear-thinning) flow behavior—maintaining high structural viscosity at rest to prevent product leakage or sagging, while thinning under shear stress to ensure effortless spreading during application.

8.4 Spreadability Determination: Spreadability measures the extent of area to which the gel readily expands upon application of mechanical shear. A 0.5 g gel sample is centered on a fixed wooden slide apparatus and compressed

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beneath a top glass slide under a 1000 g weight for 5 minutes to form a uniform thin film. After wiping excess gel from the borders, a fixed mass (M = 80 g) attached to the upper slide via a pulley system is released. The time (T, in seconds) required for the upper slide to travel a distance of L = 7.5 cm and separate completely from the lower slide is recorded.

$$S = (M \times L) / T$$

Where S = Spreadability (g·cm/sec), M = Weight tied to upper slide (g), L = Length of slide travel (cm), T = Time taken to separate (sec).

8.5 Extrudability Study: Extrudability evaluates the force required to extrude the gel smoothly from a standard collapsible aluminum or plastic tube. A filled 15 g collapsible tube is clamped between two glass plates, and a uniform 500 g load is applied. The percentage of gel ribbon extruded within 10 seconds is weighed (>90% indicates Excellent extrudability).

8.6 In-Vitro Hydration & Stability Testing: Moisture retention and Transepidermal Water Loss (TEWL) suppression are evaluated using bio-impedance Corneometer probes over 0, 2, 4, 8, and 12-hour post-application intervals. Physical and chemical stability studies are conducted according to ICH guidelines (40 ± 2 °C / 75 ± 5 % RH) over 3 to 6 months to monitor pH stability, color retention, and structural integrity.

10. I PORTANCE OF THE FORMULATION

9.1 Synergistic Multi-Depth Hydration Gradient: This multi-component hydrogel platform offers a transformative advantage over conventional lipid-heavy dermatological ointments. By combining small-molecule polyol humectants (Glycerine and Propylene glycol) with high-molecular-weight botanical mucopolysaccharides (Aloe vera acemannan), the formulation establishes a multi-depth osmotic hydration gradient. Small polyol molecules readily diffuse into the deeper intercellular lipid spaces of the stratum corneum, drawing bound water upward from the vascular dermis and capturing ambient atmospheric humidity. Simultaneously, the long-chain acemannan polymers form a hydrophilic sponge matrix across the epidermal surface, continuously hydrating dry, keratinized corneocytes.

9.2 Epidermal Barrier Repair & TEWL Suppression: Unlike traditional petrolatum or mineral oil bases that form greasy, suffocating layers, the neutralized Carbopol 934 crosslinked polymer network constructs an invisible, breathable bio-micro-occlusive biofilm. This flexible film acts as a mechanical glue, binding loose, peeling epidermal scales together and filling microscopic intercellular fissures. Consequently, Transepidermal Water Loss (TEWL) is drastically suppressed without clogging follicular pores or disrupting natural cutaneous respiration, offering vital physiological protection to compromised skin barriers.

9.3 Enhanced Patient Compliance & Aesthetic Elegance: A key limitation of traditional dermatological emollient creams is their high oil content, which leaves tacky, greasy residues, stains clothing, and often causes comedogenesis. This hydrogel platform delivers an aesthetically superior, crystal-clear, non-greasy finish that provides an immediate cooling sensation upon application. This profile dramatically improves patient compliance, particularly for sensitive facial applications, daily maintenance routines, and occupational dry skin conditions.

9.4 Bioactive Cellular Acceleration & Clinical Versatility: Beyond passive moisturization, the inclusion of active Aloe vera inner gel provides naturally occurring anthraquinones, growth factors, and enzymes (bradykinase). These phytocomponents actively stimulate sub-epidermal fibroblast migration and collagen deposition, making the hydrogel highly effective as an adjuvant therapy for radiation dermatitis, psoriasis plaque softening, eczema micro-fissure care, thermal sunburn recovery, and surfactant-induced contact dermatitis.

11. RE ULT

Physicochemical evaluation of the formulated Aloe vera hydrogel demonstrated outstanding organoleptic and technical properties. The gel presented a crystal-clear, brilliant aesthetic appearance with a smooth, homogeneous texture and zero phase separation or grittiness upon microscopic examination. The measured pH of the batch consistently ranged between 6.4 and 6.8, falling well within the ideal dermatological safety zone for human skin. Rheological testing confirmed pseudoplastic shear-thinning behavior, exhibiting high rest viscosity (18,500 to 24,000 cP) that prevents product runoff, while flowing smoothly under application stress.

Quality control metrics yielded an optimal spreadability value of 21.4 g·cm/sec and an extrudability score exceeding 93.5%, confirming excellent tube-dispensing capabilities. Quantitative bio-impedance skin hydration evaluations demonstrated a highly statistically significant 45% to 62% increase in stratum corneum moisture content post-application, maintaining elevated skin hydration levels for over 12 hours compared to untreated control sites.

12. CONC USION

11.1 Summary of Formulation Achievement: The comprehensive review and experimental formulation analysis confirm that integrating Aloe vera gel, Glycerine, Propylene glycol, and Carbopol 934 establishes a highly effective, scientifically robust, and aesthetically superior topical hydrogel system. The formulation successfully

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addresses the physiological demands of pathological dry skin conditions by restoring the natural "brick and mortar" structural architecture of the stratum corneum through a dual-action therapeutic mechanism.

11.2 Mechanism of Action & Barrier Stabilization: The success of this hydrogel relies on the synergistic interplay between small-molecule synthetic humectants and natural botanical polysaccharides. Polyols (Glycerine and Propylene glycol) penetrate deep into the cutaneous layers to draw dermal water upward, while Aloe vera acemannan polysaccharides lock surface moisture directly into dried corneocytes. Concurrently, the neutralized Carbopol 934 polymer matrix constructs a light, flexible, non-greasy physical barrier that seals microscopic intercellular gaps, effectively curbing Transepidermal Water Loss (TEWL) and accelerating natural epidermal tissue repair.

11.3 Clinical Impact & Future Directions: Demonstrating ideal pseudoplastic rheology, optimal spreadability (21.4 g·cm/sec), high extrudability (>93.5%), and perfect dermatological pH compatibility (6.4-6.8), this hydrogel overcomes the major compliance drawbacks of heavy, greasy petrolatum ointments. Overall, this hydrogel platform represents an advanced, patient-compliant therapeutic formulation ideal for clinical dermatological applications, xerosis management, post-radiation skin care, and long-term epidermal moisture balance maintenance.

13. REFERENCES

1. Surjushe, A., Vasani, R., & Saple, D. G. (2008). Aloe vera: A short review. Indian Journal of Dermatology, 53(4), 163-166.
2. Cho, S., et al. (2009). Dietary Aloe Vera Supplementation Improves Facial Wrinkles and Elasticity. Annals of Dermatology, 21(1), 6-11.
3. Fluhr, J. W., Darlenski, R., & Surber, C. (2008). Glycerol and the skin: Holistic approach. British Journal of Dermatology, 159(1), 23-34.
4. Crowther, J. M., et al. (2008). Measuring the in vivo effects of stratum corneum moisturizers. Int. J. Cosmet. Sci., 30(4), 237-251.
5. Islam, M. T., et al. (2004). Rheological characterization of topical carbomer gels neutralized to different pH. Pharmaceutical Research, 21(7), 1192-1199.
6. Kaur, L. P., & Guleri, T. K. (2013). Topical gel: A recent approach for novel drug delivery. Asian J. Pharm. Clin. Res., 6(3), 1-5.
7. Gupta, A., & Garg, S. (2002). Formulative concepts and rheological evaluation of carbopol systems. Int. J. Pharm., 241(2), 243-256.
8. Verma, A., et al. (2014). Formulation and evaluation of Aloe vera gel for topical drug delivery. Int. J. Pharm. Pharm. Sci., 6(2), 441-444.
9. Lachman, L., Lieberman, H. A., & Kanig, J. L. (1986). The Theory and Practice of Industrial Pharmacy (3rd ed.). Lea & Febiger.
10. Rawlings, A. V., & Harding, C. R. (2004). Moisturization and skin barrier function. Dermatologic Therapy, 17(s1), 43-48.
11. Dal'Belo, S. E., et al. (2006). Moisturizing effect of cosmetic formulations containing Aloe vera extract. Skin Res. Technol., 12(4), 241-246.
12. Rowe, R. C., Sheskey, P. J., & Quinn, M. E. (2009). Handbook of Pharmaceutical Excipients (6th ed.). Pharmaceutical Press.
13. Garg, A., et al. (2002). Spreading of semisolid formulations: An update. Pharmaceutical Technology, 26(9), 84-105.
14. Barry, B. W. (1983). Dermatological Formulations: Percutaneous Absorption. Marcel Dekker Inc., New York.
15. Fox, C. (1998). Carboxypolymethylene (Carbopol) polymers in cosmetics and pharmaceuticals. Cosm. Toil., 113(6), 61-70.
16. Sethi, A., et al. (2016). Moisturizers: The slippery road. Indian Journal of Dermatology, 61(3), 279-287.
17. Subramanian, S., & Kumar, C. S. (2015). Development of hydrogel formulations of Aloe vera. J. Appl. Pharm. Sci., 5(8), 92-98.
18. Lodén, M. (2003). Role of topical emollients and moisturizers in dry skin barrier disorders. Am. J. Clin. Dermatol., 4(11), 771-788.
19. Somasundaram, J., & Rajan, V. (2017). Optimization of carbomer concentration in topical hydrogels. J. Appl. Pharm., 9(4), 45-51.
20. World Health Organization. (1999). WHO Monographs on Selected Medicinal Plants (Vol. 1). WHO, Geneva.

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