International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 6 Nov - Dec 2025, pp: 167-177 www.ijprajournal.com ISSN: 2456-4494

"Advances in Topical Gel Delivery of Salicylic Acid and Aloin: A Comparative Review of Formulation Strategies and Evaluation Techniques"

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Date of Submission: 01-11-2025 Date of Acceptance: 10-11-2025

ABSTRACT
Topical formulations have become an increasingly preferred route for the management of dermatological conditions due to their ability to deliver therapeutic agents directly to the site of action with minimal systemic exposure. The present study focuses on the formulation and evaluation of a topical gel containing a combination of Salicylic acid and Aloin, designed for enhanced local action in the treatment of acne and inflammatory skin disorders. Salicylic acid, a β-hydroxy acid, acts as a potent keratolytic, comedolytic, and antimicrobial agent, promoting exfoliation and preventing pore blockage. Aloin, a natural anthraquinone glycoside derived from Aloe vera, exhibits anti-inflammatory, antioxidant, and wound-healing properties that help counteract the irritation often associated with Salicylic acid. A series of gels were prepared using different polymers such as Carbopol 940 and HPMC as gelling agents and were evaluated comparatively for physicochemical properties, spreadability, viscosity, pH, drug content uniformity, in-vitro drug release, and stability. Among the tested formulations, Carbopol-based gels provided optimal viscosity, smooth texture, uniform drug distribution, and sustained release characteristics. The combination gel demonstrated superior synergistic effects, including enhanced anti-inflammatory activity, improved skin tolerability, and better cosmetic acceptability compared to formulations containing Salicylic acid alone. The study concludes that the Salicylic acid–Aloin combination gel offers an effective, stable, and patient-friendly topical delivery system for managing acne, inflammation, and related skin disorders, supporting further clinical evaluation for therapeutic application.

Keywords: Topical gel, Salicylic acid, Aloin, Aloe vera, Carbopol 940, HPMC, Acne treatment, Anti-inflammatory, Formulation and evaluation, Comparative study

I. INTRODUCTION

Topical drug delivery is the technique of applying drugs directly onto the skin or mucosal surfaces to provide a localized therapeutic impact. Commonly used for the treatment of dermatological diseases, eye infections, nasal and vaginal issues, and for pain relief **(Bani and Bhardwaj 2021).**Among various clinical applications, topical drug delivery systems are among the most frequently applied because skin is one of the most accessible pathways for drug delivery. On the other hand, topical medical treatments range from simple liquids and ointments to multiphase nanotechnology-based therapies. Advantage of topical administration system is bypass first pass metabolism. Topical preparations have other advantages as well: they allow one to bypass the risks and inconveniences of IV therapy and the variableabsorption conditions such as alterations in pH, if enzymes are present or not, stomach emptying time**(Hedaya, 2024).**

Pharmaceutical dosage form, from semisolids to liquid preparation, sprays, and solid powders, are used as topically acting medications. Semisolid preparations for topical administration of drugs consist mainly of gels, creams, anointments**(Maqbool et al., 2017).**A gel-based product called topical gel is administered straight to the skin or mucous membranes. Designed to provide active components to a specific location for localized therapy, it provides advantages including pain alleviation, inflammation reduction, or treatment of skin disorders. Usually clear, smooth, and nongreasy, topical gels let the skin quickly absorb them without leaving residue**(Haley and von Recum 2019).**

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1. Gel

Typically, gels are constructed from a fluid stage that has been thickened with various components. They are frequently prepared under the direction of qualified gelling experts like HPMC, Carbopol, Sodium CMC, and others. In the detailing of gels, extra ingredients including stabilisers, antibacterial additives, and cancer-prevention compounds are used**(Boruah and Sarma 2025).**

The term "gel" comes from "gelatin," and both "gel" and "jam" may be traced back to the Latin words "gelu" for "ice" and "gel" for "freeze" or "harden." This introduction demonstrates the basic concept of a fluid setup to key regions of strength for a texture that doesn't drift but is adaptable and retains certain fluid aspects**(Rathod and Mehta 2015).**Gels are described as semi-unbending structures in which the growth of the scattering medium is restrained by a threelayered arrangement of intertwined waste products or solvated dispersed section macromolecules. Gels are frequently viewed of as being more rigid than jams because they have more covalent crosslinks, thicker real bonds, or just less fluidity. Gel-shaping polymers provide materials with a variety of rigidities, ranging from a sol to an adhesive, jam, gel, and hydrogel as the rigidity increases**(Chivers and Smith 2019).**Due to the fact that the compounds in some gel structures are either soluble or insoluble, or because they may form totals that scatter light, some gel structures are nearly as transparent as water while others are turbid. For certain exceptions, the attention paid to the gelling specialists is frequently much less than 10%, typically ranging from 0.5 to 2.5 percent**(Rathod and Mehta 2015).**

2. Structure of gels:

The unbending property of gel is caused by the gelling expert who builds networks by connecting particles. Power type that controls the structure of the framework and the characteristics of the gel and is responsible for the connection of particles. The single particles display spherical groups of moment atoms, isometric totals, or single macromolecules. GEL displays the gel networks' game strategy**(Nabizadehet al., 2024).**

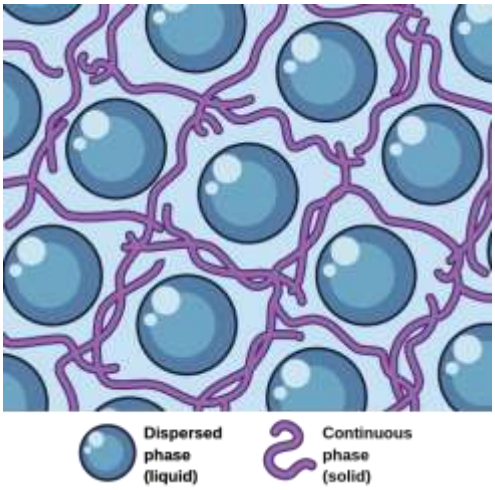

Figure 1:- Structure of a gel

3. Advantages of gel formulations:

The gel formulation has several key benefits over conventional semisolid dose formulations.

- Compared to other formulations, gels are simple to manufacture.
- Gels offer fantastic adhesion to the application region.
- Gels are eco-friendly and biocompatible.
- Be incredibly resilient to stressful situations**(Parhi, 2020).**

4. Disadvantages of gel formulation:

Despite having a number of benefits. Gel formulations can come with certain drawbacks.

- Gels have a more gradual and persistent effect.
- The additives or gelators could irritate people **(Un Nabi et al., 2016).**
- The risk of microbial or fungal assault on gel is increased by the presence of water.
- The formulation's solvent loss dries to gel**(Jeganath and Jeevitha 2019).**

5. Properties of gel:

- Ideally, the gelling agent for pharmaceutical or cosmetic usage should be inert, safe, and should not react with other formulation components**(Kovalenko, 2017).**
- The gelling agent contained in the preparation should provide a tolerable solid-like character during storage that may be readily broken when exposed to shear forces produced by shaking the container, squeezing the tube, or during topical application**(Godgeet al., 2023).**
- It should contain adequate anti-microbial to avoid from microbial assault.
- The topical gel should not be sticky.

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6. Gel forming substances:

When fragmented in a fluid state as a colloidal mixture, gel-shaping professionals create a pitifully robust internal structure. They are hydrophilic inorganic compounds or natural hydrocolloids. As stabilisers and thickeners, gelling agents can also provide thickening without stiffness. Recently, polymers have been widely used as gelling experts in semisolid measuring structures. Among them, carbomers, which are designed macromolecular polymers of caustic acrylic, are frequently used because they exhibit excellent thickening ability across a wide pH range The gel-shaping expert, who is often a polymer in small concentrations, produces a semisolid consistency in the definition that slows down the rate of seepage of the detailing and extends the amount of time spent at the organisation site **(Tekade, 2018).**

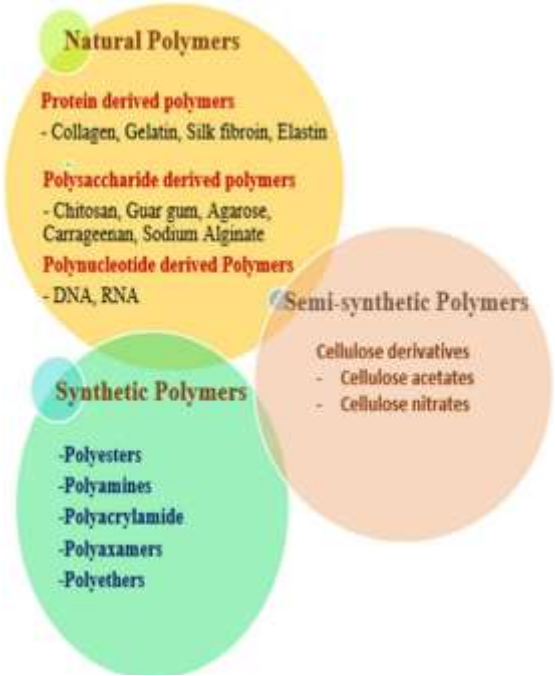

Figure 2:- Gel forming substances

6.1 Natural polymer:

Corrective applications have often used regular polymers. They have several purposes, including cosmetics, skin and hair care, as well as modifiers and stabilisers, and are biocompatible, safe, eco-friendly, and incredibly alluring to consumers. Polysaccharides, starch, thickener, guar gum, carrageenan, alginate, gelatin, gelatine, agar, collagen, and hyaluronic acid are among the most often used natural polymers and are of exceptional importance. Starches are naturally occurring polysaccharides that may be used in a variety of forms, particularly as granule and solvent starches **(Varghese et al., 2020).**

6.2 Semi-synthetic polymers

Two major groups of cellulose derivatives with different physicochemical and mechanical characteristics are cellulose ethers and cellulose esters. Cellulose derivatives possess qualities including uniformity in arrangement, surface action, thermoplastic film characteristics, and resistance to oxidation, biodegradation, and intense hydrolysis **(Shaghalehet al., 2018).** The cellulose ethers (such as methylcellulose, ethyl cellulose, hydroxyethyl cellulose, hydroxypropyl methylcellulose, carboxymethyl cellulose, and sodium carboxymethyl cellulose) can be dissolved in water, in contrast to the cellulose esters (such as cellulose acetic acid derivation, cellulose acetic acid derivation phthalate, cellulose acetic acid derivation butyrate, cellulose acetic acid **(Kovalenko, 2017).** These polymers are mostly used in cosmetic items including creams, shampoos, salves, and gels as gelling, bioadhesive, thickening, and balancing out agents. Compared to common gelling specialists such starches, acacia, sodium alginate, agar, gelatin, and gelatin, they are less susceptible to microbial contamination**(LathaSamala and Sridevi2016).**

6.3 Synthetic polymers:

Carbomer is a synthetic polymer from the Carbopol family. It is the polymer that is used the most frequently in gel arrangement. In the 1950s, carbopols were initially introduced and used for gels**(Safitriet al., 2021).**They are used to create an acidic pH 3 arrangement in water and have a powdered structure with high bulk densities. With a higher pH, they thicken (5-6). Within the sight of a flowing arrangement, they can blow up to many times in volume. The thickness of carbopol arrangements ranges from 0 to 80,000 centipoise. Carbomer, poloxamer/surfactants, and polyacrylamide are a few examples of designed gel-framing polymers **(Daneshi, 2020).**

6.4 Miscellaneous gel-forming polymers:

Clays, beeswax, microcrystalline silica, cetyl ester wax, aluminium stearate, and beeswax are a few examples of different polymers that produce gels**(Krendlinger and Wolfmeier 2022).**

7. Method for preparation of gel:

There are three techniques for making gels.

A. Fusion technique: This method involves blending the drugs, components, gelling stores,

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and vehicles at a high temperature till a semi-firm texture is achieved.

B. **Cold method:** In this method, all of the ingredients, excluding the medication or active pharmaceutical component, are heated and mixed simultaneously. The temperature of the mixture is then lowered, the drug is added, and the blending process is repeated until the gel has not formed**(Zhaoet al., 2020).**

C. **Dispersion approach:** This procedure involves mixing the gelling agent with water until it begins to swell, at which point the medicine is dissolved in the medium and added to it. If necessary, add buffer solution to the gel to change the pH**(Abdeltawabet al., 2020).**

8. Mechanism of gel formation:

Three different forms of cross-linking create gels.

8.1 Chemical cross-linking:

Similar synthetic cross-connecting is observed in polymers that have unprotected bunches in their structure. When a cross-connecting component is used in such polymers, the free gathering and the added portion experience an irreversible substance reaction. This irreversible reaction results in an increase in consistency, and after reaching a certain point, a gel is formed, such as complex cross-connecting gels made of polyacrylic acid (with several carboxylic acids) and glycols **(Balakrishnan et al., 2018).**

8.2 Physical cross-linking:

In some circumstances, the transition from a solution to a gel can happen due to the creation of hydrogen bonds, the solubilization of crystalline components, concentration changes, temperature changes, or hydrophobic interactions. Dextran gels, poly (N-isopropylacrylamide) gels, cellulose gels, and others are examples of these gels **(Lan et al., 2015).**

8.3 Ionic cross-linking:

In order to create a gel, charges can be formed on polymers or other molecules (solvents) to promote cross-linking. The charges on such molecules cause them to form ionic connections. In the presence of calcium ions, polysaccharide alginate, for instance, creates a gel matrix that may enclose certain components (enzymes, etc.). It may also achieve ionic gelation by changing the medium's pH. Such mixes gel when the pH is changed; for instance, pectin gels when exposed to an acidic pH in a suitable medium **(Hurtado et al., 2022).**

9. Classification of gel:

Pharmaceutical polymer gels are divided into groups according to their colloidal phase, solvent type, rheology, physical makeup, and method of drug administration.

9.1 On the basis of colloidal phase:

Inorganic two-stage framework (also known as polymer gels) and single-stage framework (natural gels). When particles form three-layered structures across the gel in the two-stage framework due of their relatively large molecule sizes in the dispersed stage, the gel mass is referred to as magma (e.g., bentonite magma). Two-stage frameworks typically contain floccules of tiny particles, which results in an unstable gel structure. Both magma and gel may have thixotropic framing semisolid properties while stationary, but when agitated, they transform into fluids in a singlestage framework, where large natural particles dissolve. These polymer gels might be made of natural gums, artificial polymers (like carbomer), semi-synthetic polymers (like cellulose subordinates), or both (e.g., tragacanth)**(Kolzenburget al., 2022).**

9.2 On the basis of solvent:

Depending on the kind of solvent employed as the non-stop phase throughout the procedure, gels may be classified as hydrogels (water-based), organogels (non-aqueous solvent), oraerogels/xerogels.

- **Hydrogel:**

Hydro-gels are polymeric structures that absorb extreme water properties while remaining insoluble in fluid mixtures due to the substance or actual cross-linking of polar or nonpolar polymer chains. Hydrophilic hydrogels exhibit a number of remarkable physicochemical properties that make them ideal for biomedical application as well as drug delivery, in contrast to hydrophobic polymeric organisations, such as poly (lactic acid (PLA) or poly (lactide-co-glycolide) (PLGA), that have limited water-ingestion capacities (**Larrañetaet al., 2018).** Gels arrangement typically returns at room temperature, and natural solvents are hardly ever used. Hydro-gels will eventually be distinguished from the other hydrophobic polymers by in-situ gelation with cell and medicine exemplification capacities. The polymers used to make hydro-gels might be natural or synthetic.Hydro-gels are three-layered frameworks that have been waterenhanced and are typically constructed of hydrophilic

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polymers. These are full-scale, pass-connected atomic structures that are insoluble but may expand swiftly in natural liquids**(Sabry et al., 2025).**

- **Organogels:**

A nonaqueous dissolvable serves as the persistent stage in organogels. Plastic base (low sub-atomic weight polyethylene broken down in mineral oil and stock cooled) and metallic stearate scatterings in oils are examples of organogel. An organogel is a thermoplastic (thermoreversible), non-translucent substance that is created from a fluid natural stage that is interconnected in three different ways. For instance, the fluid might be a naturally soluble substance, mineral oil, or vegetable oil**(Rafiq et al., 2015).** The flexible qualities and solidity of the organogel are significantly influenced by the solvency and molecular features of the organising. These frameworks frequently rely on the organising particles coming together on their own. Organogels have the potential to be used in a variety of goods, including food, cosmetics, medicines, and protection for the workplace. Wax crystallisation in unprocessed petroleum is one example of how an undesirable thermo reversible structure might arise**(Mosquera Narvaez et al., 2022).**

9.3 Based on rheological properties:

Gels typically have non-Newtonian flow characteristics. They are categorised as,

- **Plastic gels:** E.g.: The yield value of the gels, which is at which the elastic gel bends and starts to flow, is shown on the rheogram plot for Bingham bodies, flocculated suspensions of aluminium hydroxide, which display plastic flow**(Anyaoku, 2023).**
- **Pseudo-plastic gels:** E.g.: Fluid scattering from substances like sodium alginate, tragacanth, Na CMC, and others reveals a pseudo-plastic stream. Without regard to yield value, the consistency of these gels decreases as the cost of shearing increases. The long chain particles of the straight polymers undergo a shearing motion, which produces the rheogram. The damaged atoms start to shift their extended hub toward skim with the release of dissolvable from the gel network as the shearing force is repeated**(Cofelice, 2020).**
- **Thixotropic gels:** The incredibly weak bonds that hold gel particles together can be broken apart by shaking. Due to the particles colliding and re-connecting, the resulting arrangement will once again gel. This takes place in a colloidal framework with non-round particles to create a design that resembles a platform. E.g.: Agar, bentonite, and kaolin **(Ramos-Tejada and Luckham 2015).**

9.4 Based on physical nature:

- **Elastic gels:** Agar, pectin, guar gum, and alginates gels all behave elastically. At the site of connection, the fibrous molecules are connected by relatively weak interactions, such as hydrogen bonds and dipole attraction. Additional bonding occurs through a salt bridge of type -COO-X-COO between two neighbouring strand networks if the molecule has a free -COOH group. E.g.: Carbenate with Alginate **(Zhang et al., 2015).**
- **Rigid gels:** This can be created from macromolecules with a main valence bond connecting the framework. As an illustration, the Si-O-Si-O link holds the silica molecules in silica gel, creating a polymer structure with a network of pores**(Santos, 2024).**

9.5 On the Basis of Drug Delivery:

Pharmaceutical gels are frequently employed in drug delivery systems as carriers. These gels might be categorised as:

- **Sustained/controlled release gels:**

Controlled medication delivery systems provide several advantages, including reduced dose recurrence, which improves patient compliance, maintenance of blood levels within a desirable range by limiting fixation fluctuation, restricted/designated drug delivery, and noticeably reduced adverse effects. Gels function as controlled drug delivery systems due to their dispersion component, in which medicine is delivered through a polymer network (a network that is not soluble in water) or supply system (water-insoluble polymeric layer). Organogels, hydrogels, and aerogels serve as supported or regulated drug delivery systems in pharmaceuticals **(Aggarwal and Nagpal 2018).**

- **Bioadhesive gels:**

The bioadhesive frameworks limit the pharmaceuticals nearby and extend the home season of the medication in the oral cavity. Bioadhesive gels are used for the delivery of ophthalmic, mucoadhesive, transdermal, vaginal, and cutaneous medications. Cross-connected polyacrylic corrosive gel-framing bioadhesive polymers may adhere to mucosal surfaces for extended periods of time and show regulated drug delivery at the ingesting site. The writing has taken

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into account several hydrogel-based bioadhesive frameworks for controlled medication release. These types of polymer gel frameworks serve as bioadhesive frameworks and controlled drug delivery devices that may deliver drugs at a specified place with improved bioavailability**(Mishra et al., 2023).**

10. Characteristics of gels:

a) Swelling:

Gels have the capacity to swell, absorbing liquid while expanding in size. This might be viewed as the beginning of the disintegration process. Gel-gel interactions are replaced by gel-solvent interactions as a result of solvent permeating the gel matrix. Normal cross-linking in the gel matrix, which inhibits complete disintegration, causes limited swelling. When the solvent combination has a solubility parameter similar to the gallant, this gel expands significantly**(Mashabelaet al., 2022).**

b) Syneresis:

After standing, many gel structures experience compression. The interstitial fluid communicates and collects at the gel's top layer. This cycle, known as syneresis, has also been seen in organogels and inorganic hydrogels in addition to natural hydrogels. Syneresis often becomes more pronounced as the polymer cluster gets smaller. The release of several concerns generated during the gel setting process has been linked to the constriction tool. The interstitial space available for dissolvable decreases as these loads feel much better, forcing the statement of liquid. Osmotic effects have been seen in the syneresis of gels formed from the ionic gel formers gelatin or psyllium seed gum, as well as the effects of pH and electrolyte fixing**(Stewart, 2020).**

c) Ageing:

Colloidal structures often exhibit sluggish unrestrained collection. It is suggested that this connection is developing. When gels mature, a dense organisation of the gelling specialist gradually develops. Since the liquid medium is removed from the just formed gel, the imer hypothesises that this interaction resembles the initial gelling cycle and continues after the underlying gelation **(Nazir et al., 2017).**

d) Structure:

The presence of an organisation framed by the interlinking of particles that is a specialist in gelling causes a gel to become hard. The structure of the organisation and the characteristics of gel are determined by the notion of the particles and the type of power responsible for the links. The isolated hydrophilic colloid particles might be made up of discrete macromolecules, spherical or isometric aggregates of small atoms**(Patil et al., 2021).**

e) Rheology:

Gelling specialty arrangements and flocculated strong dispersion are examples of fake versatility. Showing Non-Newtonian float conduct is characterised by a decrease in thickness and an increase in shear charge. As gels mature, a denser organisation of the gelling specialist gradually develops, upsetting the dubious design of inorganic waste dispersed in water**(Li et al., 2020).**

11. Evaluation parameters of topical gel

- **Appearance and homogeneity:** Physical appearance and homogeneity were evaluated by visual inspection. pH of the Gel The pH of the gel was measured by digital pH meter.1 gm gel is dissolved in medium and inspect with pH meter**(Khemakhemet al., 2019).**
- **Viscosity**: The viscosity of the gel was measured by the Brookfield Viscometer.
- **Spreadability**: 0.5 g of gel was put inside a circle of 2 cm diameter pre-marked on a glass plate, over which a second glass plate was placed. A weight around 500 g was put to rest on the top glass plate for 10 minutes. The increase in the diameter owing to gel spreading was detected**(Samundreet al., 2020).**
- **Extradurability**: To assess extradurability a sealed collapsible tube holding gel was pressed immovably at the folded end. At the point when the top was emptied, gel discharged till the weight dispersed. Weight in grams necessary to evacuate a 0.5 cm ribbon of the gel in 10 sec was resolved. The usual expulsion pressure in g was recorded.
- **Skin Irritation test:** The animal model swiss albino mouse strain was utilized for skin irritation test and Guniea pig (400-500gm) of either sex was also used. The hairs are removed by the skin removal cream and then clean the skin with spirit, 3 mice are employed in which normal saline, blank gel and formulation were administered and check the irritation in animals**(Bagmaret al., 2024).**

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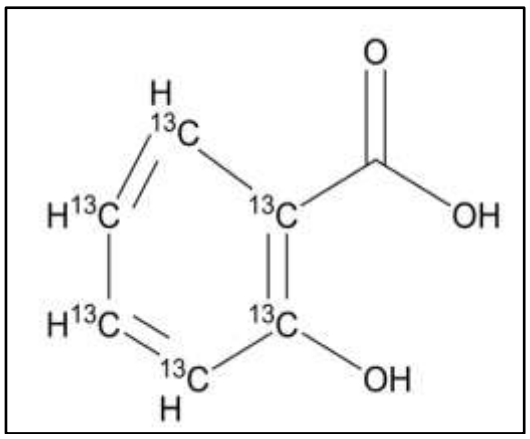
12. Salicylic acidandAloin

12.1 Salicylic acid

Salicylic acid (2-hydroxybenzoic acid) is one of the most extensively used agents in topical dermatology. It belongs to the class of β-hydroxy acids (BHAs)and exhibits multiple pharmacological activities, making it a key ingredient in acne, psoriasis, and keratolytic treatments. Salicylic acid acts primarily as a keratolytic and comedolytic agent, facilitating the removal of the outer layer of dead skin cells and unblocking clogged pores **(Aravinda Kumar, 2021).** It promotes desquamation by breaking down intercellular cohesion between corneocytes, which is beneficial in treating acne vulgaris**,** seborrheic dermatitis**,** warts**,** calluses**,** andhyperkeratotic lesions. Moreover, it possesses antimicrobial, antifungal, and anti-inflammatory properties that contribute to its effectiveness in managing skin infections and irritation**(AbdRashedet al., 2021).**



Salicylic Acid

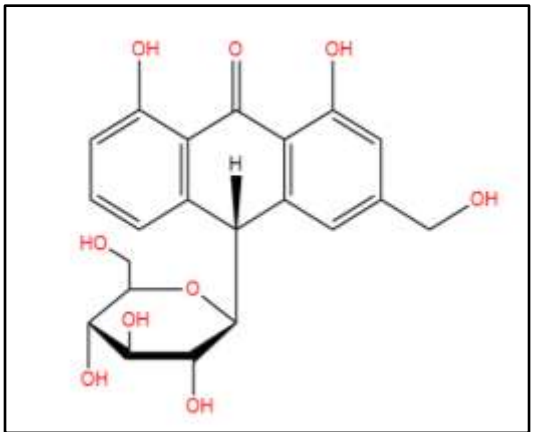
Rationale for Formulating a Salicylic Acid Gel

Although Salicylic acid is available in various dosage forms (solutions, lotions, creams, ointments, and gels), the gel form offers specific advantages for dermatological use:

- Enhanced drug retention at the site of action
- Better patient acceptability due to non-greasy, transparent, and cooling nature
- Controlled and uniform drug release for prolonged action
- Reduced irritation potential when combined with suitable polymers and excipients**(Langascoet al., 2016).**

12.2 Aloin

Aloin is a naturally occurring anthraquinone glycoside, primarily extracted from the latex of Aloe vera (Aloe barbadensis Miller) leaves. It exists mainly in two isomeric forms—Aloin A (barbaloin)andAloin B (isobarbaloin). Aloin is known for its anti-inflammatory**,** antimicrobial, antioxidant, analgesic, and wound-healing properties. It has been used in traditional medicine for the management of Formulation Considerations. The compound functions by modulating inflammatory pathways and promoting epithelial cell regeneration, which accelerates the healing process**(Liang et al., 2021).**



Aloin

Rationale for Formulating a Topical Gel Containing Aloin

Although Aloin possesses remarkable pharmacological properties, its topical application in a stable and bioavailable form poses challenges. Direct application of Aloe extracts may lead to inconsistent dosing**,** limited stability, and reduced skin penetration **(Sánchez et al., 2020).** Therefore, formulating a topical gel containing purified Aloin provides several advantages:

- Enhanced drug penetration due to the hydrophilic gel base.
- Improved stability compared to crude Aloe extracts.
- Controlled and sustained drug release at the site of application.
- Ease of use and better patient compliance.
- Reduction of systemic absorption, minimizing unwanted side effects**(Xieet al., 2023).**

12.3 Target product profile (examples)

- Route: topical, local action (acne/inflammation, mild keratolysis)
- Texture: non-greasy hydrogel, transparent to slightly opalescent

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- pH: ~4.5–5.8 (balances SA efficacy and skin tolerance; Aloin tends to be stable in mild acid)
- SA concentration: 0.5–2% (pick based on indication/regulatory limits)
- Aloin concentration: low milligram levels — e.g. 0.05–1.0% (select based on extract standardization, safety data and desired effect; verify permitted levels in your region)
- Release: controlled/sustained release to reduce irritation**(Kaparakouet al., 2021).**

12.4 Solubility & solvent strategy

- **Cosolvents**: Ethanol, propylene glycol (PG), polyethylene glycol (PEG 400) improve solubility of both actives. PG also functions as a humectant and mild penetration enhancer**(Rathiet al., 2018).**
- **Approach**: dissolve SA in ethanol/PG first (pre-dissolution improves content uniformity). Dissolve Aloin in the smallest feasible volume of ethanol or an ethanol/water mix, or use a standardized Aloe extract that dissolves in the formulation solvent system**(Añibarro-Ortega et al., 2021).**

12.5 Polymer/gelling system & rheology

- **Hydrophilic gel bases**: Carbopol (e.g., Carbopol 940) 0.3–1.0% for clear, high-viscosity gels; HPMC/hydroxyethylcellulose for opaque gels; sodium alginate for mucilage-type gels.
- **Neutralization**: Carbopol requires neutralization (e.g., triethanolamine) — but note SA activity and stability at given pH. Adjust TEA to reach target pH without overshooting**(Iceriet al., 2023).**
- **Viscosity targets**: tune to provide easy spreadability but sufficient residence time on skin. Typical Brookfield viscosities for facial gels ~20,000–100,000 cP depending on feel; optimize experimentally**(Benderly, 2016).**

12.6 Penetration enhancers & functional excipients

- **Enhancers**: propylene glycol, ethanol, oleic acid (oil phase in emulgel), isopropyl myristate (use cautiously for comedogenicity). Use the minimum effective concentration to avoid irritation**(Barnes et al., 2021).**
- **Humectants**: glycerin, propylene glycol (improve skin comfort and reduce SA dryness).
- **Soothing agents**: aloe juice (degreased/decolorized), allantoin, panthenol help mitigate SA irritation; ensure compatibility with Aloin.
- **Antioxidants / stabilizers**: tocopherol, sodium metabisulfite (aqueous systems), ascorbic acid derivatives — chosen based on Aloin stability data **(Sherazet al., 2015).**
- **Chelators**: EDTA (disodium EDTA) to reduce metal-ion catalyzed oxidation.

II. CONCLUSION

The current study successfully formulated and evaluated a topical gel containing a combination of Salicylic acid and Aloin, aiming to achieve improved therapeutic efficacy with reduced irritation potential. The comparative evaluation of formulations using different polymers demonstrated that Carbopol 940-based gels exhibited the most desirable physicochemical and performance characteristics, including optimal viscosity, homogeneity, and controlled drug release. The synergistic action of Salicylic acid and Aloin contributed to enhanced exfoliating, antimicrobial, and anti-inflammatory effects while maintaining skin hydration and minimizing dryness or redness commonly caused by Salicylic acid alone. The developed formulation was stable**,** cosmetically appealing, and well-tolerated, confirming its potential as an efficient topical system for treating acne vulgaris and other mild inflammatory skin conditions. Overall, the study emphasizes that the combination of a synthetic keratolytic agent (Salicylic acid) with a natural bioactive compound (Aloin) can yield a balanced and effective topical therapy, integrating modern pharmaceutics with herbal pharmacology. Further clinical and stability studies are recommended to validate long-term safety and therapeutic performance.

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