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Emerging Formulations and Clinical Applications of Topical Salicylic Acid In Acne Management

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A commonly utilized beta-hydroxy acid, salicylic acid is essential in dermatology, especially for treating acne. Its medicinal and pharmacological characteristics, methods of action, and efficacy in controlling certain skin disorders are investigated in this article. Salicylic acid is quite powerful against inflammatory and non-inflammatory acne as it acts as a keratolytic and comedolytic agent, stimulates exfoliation, and lowers sebum production, as a result, clearing blocked pores. Its anti-inflammatory and antibacterial properties are also investigated in this article, thereby stressing its capacity to control Cutibacterium acnes spread and lower inflammation. Along with its ideal concentrations and treatment times, salicylic acid's practical uses—including its inclusion into cleansers, peels, and gels—are examined. The outcome underlines the therapeutic relevance of salicylic acid as a safe, efficient, flexible topical therapy providing significant advantages with minimum adverse effects for different skin types.

Keywords: Acne; Anti-inflammatory; Exfoliation; Salicylic acid; Skincare.

Topically applied salicylic acid (SA) has been used for more than two millennia to treat different skin conditions. Early in the 19th century, Buchner, Brugnatelle, and Fontana separated salicin—a natural source of salicylic acid—from willow bark and discovered it in other plants like meadowsweet (Spirea spp.), which Leroux subsequently improved. German physician Paul Gerson Unna confirmed his claim for characterizing SA's features and uses when he found in the 1860s SA's capacity to soften and exfoliate the stratum corneum. As a comedolytic agent, SA is extensively utilized in acne treatments also improving the penetration of other topical drugs .[1]

Commonly included in over-the-counter cleansers, salicylic acid is appropriate as first treatment for moderate acne or as part of more general regimens because of its anti-inflammatory and modest comedolytic properties. Treatments for human diseases have long come from plants; one of the first medicinal molecules taken from them came from the bark of willow trees (Salix). Later on, salicin was found to have both an aromatic and a sugar component, spirsaure, therefore known as salicylic acid for its connection with Salix and Spirea.[2]

First synthesized manufactured in 1852, its chemical composition was 2-hydroxybenzoic acid. Natural salicin was utilized as an analgesic

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and antipyretic in the 19th century; although its use sometimes produced gastrointestinal trouble, this restriction leaded to manufacture a less irritating acetyl-SA derivative, eventually used as a medicine. Bayer registered acetylsalicylic acid as Aspirin in 1899, therefore signifying early expansion in the pharmaceutical business. Naturally occurring from the bark of white willow, birch leaves, and certain savoy tree species, SA is an organic substance utilized in chemical industry and medicine.[3]

SA derivatives are found mostly in medicine applications for treating rheumatic and cardiovascular problems. Among the most often used drugs generated from SA is acetylsalicylic acid, the active component of aspirin. In dermatology, SA also refers to skin disorders and lesions. In cosmetic surgery, chemical peels use SA's keratolytic and antibacterial qualities as well as exfoliating action. SA is a preservative as well as an active component in cosmetic products.[4]

Chemical — Physical Properties of Salicylic Acid

Classed as a beta-hydroxy acid (BHA), salicylic acid (C† H† O*f*) is a white crystalline chemical molecule with lipophilic monohydroxybenzoic character. Found in plants naturally, it possesses fungicidal, bacteriostatic, and keratolytic action. Often used in anti-acne treatments, it is a phytohormone in plants that promotes pathogen defense, stress resistance, and growth. Its structure allows reactions as both an acid and an alcohol by including a hydroxyl (-OH) and carboxyl (-COOH) group.[1, 5]

From wintergreen oil, salicylic acid is industrially synthesised via the Kolbe-Schmitt process or green chemistry. Well-known for its intramolecular hydrogen bonding, its safety and potency make it a WHO Essential Medicine. Salicylates, its salts and esters, also find use in many other fields.[6]

Therapeutic Aspects of Salicylic Acid

Salicylates have always drawn a lot of interest. Up until acetylsalicylic acid, a new medicine based on a salicylic acid derivative, was created in 1897, they were the topic of extensive research. Mostly used as an analgesic, antipyretic, antithrombotic (including antiplatelet), and anti-inflammatory drug, aspirin is also Salicylic acid is most often utilized in medicine to treat skin disorders and lesions needing enough exfoliation and dead epidermal cell elimination.[7] Psoriasis is a common example whereby scales are removed by salicylic acid treatments. Apart from treating calluses, corns, knuckle nodules, and warts, keratolytic medicines including salicylic acid are also utilized in the topical treatment of seborrhoecolic dermatitis and dandruff. Apart from these features, salicylic acid performs other purposes. Its effect can include anesthetic, anti-inflammatory, photoprotective, antiseptic, antifungal, and antibacterial ones.[8]

Cosmetic effects

A lipophilic molecule, salicylic acid breaks down intercellular cement and ionic connections in corneocytes, therefore acting superficially from the stratum corneum to the stratum spinosum. It also penetrates the epidermis and dissolves fat. Found in OTC products at 0.5–2%, it lowers sebum, and encourages exfoliation, therefore supporting collagen formation and skin regeneration.[9]

These effects address photodamage, freckles, and lentigines; they also increase hydration, lessen wrinkles, scars, and hyperpigmentation. It improves the absorption of several other active skincare products as well.[10]

Overview of Acne

Commonly affecting teenagers and occasionally adults, acne vulgaris is a chronic inflammatory disease of the pilosebaceous units. Its development consists of elevated sebum production, follicular hyperkeratinization, Cutibacterium acnes proliferation, and an inflammatory immunological response producing both non-inflammatory (comedones) and inflammatory lesions (papules, pustules, and nodules).[11]

The primary line of therapy for mild to severe acne is topical one. Because of its keratolytic and comedolytic actions, salicylic acid is a main agent. It exfoliates the skin, unclogs pores, and lowers irritation; its lipophilic character helps it to efficiently reach regions rich in sebum. This makes it very helpful for avoiding new lesions as well as for treating already existing ones.[12]

Systemic therapy include antibiotics or isotretinoin may be required for moderate to severe instances; hormonal medications work well for women with hormonally driven acne.

Incorporating both physical therapy and mental well-being assistance, acne care should also address its psychological impact.[13]

Pathophysiology of Acne

Mostly affecting regions with sebaceous (oil) glands, which are attached to hair follicles containing fine hairs, acne is an inflammatory skin condition. Under healthy skin, sebaceous glands create sebum that leaves via pores—openings in the hair follicles—onto the surface of the skin. Usually rising to the skin's surface when old cells are removed, keratinocytes are a kind of skin cell found lining the follicle. In acne, hair, sebum, and keratinocytes bind together within the pore to stop keratinocyte normal shedding and trap sebum inside.[14, 18]

Normally living on the skin, this buildup lets bacteria such Cutibacterium acnes multiply inside the blocked follicles, causing inflammation marked by swelling, redness, heat, and discomfort. Ruptures in the follicular wall cause germs, skin cells, and sebum to leak into the surrounding skin and create lesions, or pimples.[15]

Mechanism of Action of Salicylic acid in Acne Treatment

Dermatology makes extensive use of topical salicylic acid because of its several ways of action in treating acne. Its therapeutic effectiveness results from its capacity to target several pathogenic elements causing acne and reach thoroughly into the lipid layers of the skin (16). The system of action consists in:

1. Keratolytic Action: Salicylic acid disturbs the intercellular cement, mostly made of desmosomes, therefore encouraging the desquamation of keratinocytes in the stratum corneum. This action helps dead skin cells to exfoliate, therefore unclogging pores and stopping the development of new comedones.

2. Comedolytic Effect: Salicylic acid efficiently removes current comedones—both blackheads and whiteheads—by increasing epidermal turnover, therefore preventing the growth of new ones. Its lipophilic character enables it to enter sebaceous glands, therefore focusing on particularly acne-prone regions.

3. Anti-Inflammatory Properties: By blocking cyclooxygenase (COX) enzymes and hence lowering the synthesis of pro-inflammatory prostaglandins, salicylic acid alters inflammatory pathways. This system helps with redness, swelling, and irritation usually linked with inflammatory acne.

4. Antimicrobial Activity: Salicylic acid has bacteriostatic action, especially against *Cutibacterium acnes (previously Propionibacterium acnes)*, a bacterium linked to acne etiology. Reducing bacterial count lowers the inflammation and infection risk.

5. Sebum Regulation: Salicylic acid helps break down and lower sebum collection in the pores, therefore avoiding pore blockage. This control of sebum output helps much more to lower the severity of acne.

6. Exfoliation and Skin Renewal: Salicylic acid encourages skin regeneration by means of its exfoliative properties, therefore enhancing skin texture and lowering post-inflammatory hyperpigmentation related with acne lesions.

Contraindications to Exfoliation with Salicylic Acid

Salicylic acid exfoliation should be used carefully or may not be appropriate for those with several diseases or lifestyle choices including:

- Among skin disorders, rosacea and atopic dermatitis.
- Reduced or atrophy of sebaceous glands.
- Unusual sunlight exposure.
- Recent skin treatments perhaps incompatible with a chemical peel.
- Some seasons, especially spring and summer, are more likely to cause sunburn or hyperpigmentation from greater acid concentrations utilized.[17]

Topical Applications of Salicylic Acid

Available in several forms and doses catered to certain therapies, salicylic acid is a flexible topical medication used to treat a range of skin disorders[18]. The main uses of it are summed here:

Cleansers and Wipes: Applied to cure acne, these products exfoliate skin and assist to clean pores, but they may dry up skin therefore careful use is advised.

Gels and Liquids: Great for lower concentration acne treatments and wart removal. Because of their potency, high-concentration wart treatments are not appropriate for other skin disorders.

Moisturizers and Lotions: Use salicylic acid as an exfoliation; usually paired with moisturizing components to avoid skin dryness.

Face Peels: Applied for thorough exfoliation to treat disorders like sun damage, melasma, and acne, they are best done under expert direction for safety.

These several uses show the potency of salicylic acid in certain skin disorders; particular usage rely on the treatment requirements and product composition.[19, 27]

Benefits of Salicylic Acid

Because salicylic acid lowers sebum generation and encourages surface exfoliation of the skin, it is a good topical therapy for mild to severe acne. Targeting acne lesions directly, available in over-the-counter (OTC) medicines in concentrations ranging from 0.5% to 2%, it speeds healing with least scarring. Salicylic acid also lowers tyrosinase activity, therefore controlling melanin generation and aiding in the reduction of post-acne hyperpigmentation (9, 20). For people with darker skin tones especially, this is very helpful as it reduces the likelihood of producing post-inflammatory hyperpigmentation unlike some other acne treatments. Studies confirm the use of salicylic acid both as a stand-alone agent in chemical peels and in conjunction with other treatments, including oral isotretinoin, can considerably enhance skin look by properly reducing post-acne pigment.[21]

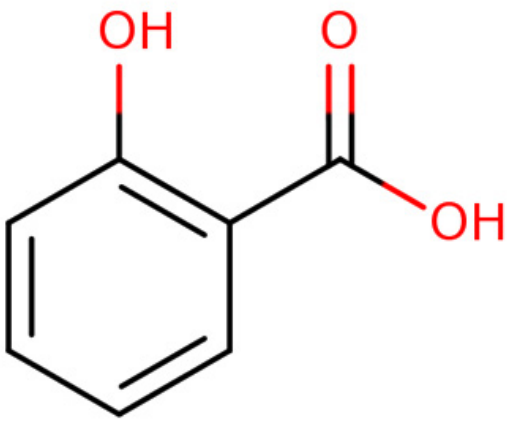

Fig. 1. Salicylic acid structure

Recommended Concentrations and Treatment Durations of SA

Designed to guide efficient therapeutic methods, the following table offers a succinct summary of the ideal concentrations, forms, and durations for salicylic acid administration in acne therapy.[22]

Side Effects of Salicylic Acid

Although salicylic acid applied topically in doses up to 2% is usually well-tolerated, it can occasionally produce minor adverse effects. Usually they consist of moderate stinging, dryness, minor burning, irritation, skin redness, and peeling. Common and typically minor, these responses are expected as part of the effect of the therapy to encourage exfoliation and cell turnover. [17, 23]

Additionally are transient symptoms including flushing or a feeling of warmth. Although these side effects are usually controllable and

Table 1. Chemical - Physical Properties of SA

Property	Value
Appearance	Colorless, odorless, needle-shaped crystals
Taste	Acrid
Boiling Point	211°C
Melting Point	315°C
Solubility in Water	1.8 g/L at 25°C
Solubility in Organic Solvents	Soluble in carbon tetrachloride, benzene, propanol, ethanol, and acetone
Density	1.44 at 20°C
Vapor Pressure	8.2×10u mmHg at 25°C
Sensitivity to Sunlight	Photochemical degradation emitting irritating fumes and acrid-smelling smoke
Heat of Combustion	3.026 MJ/mole at 25°C
pH (Saturated Solution)	2.4
pKa (Dissociation Constant)	2.97

Table 2. Con. & Duration of SA

Indication	Concentration	Dosage Form	Route of Administration	Duration of Treatment
Acne	5% 2% 2 - 3% 20 - 30%	Cream Gel Lotion Peel	Topical	6 days - 12 weeks 8 weeks 12 weeks 8 - 20 weeks

anticipated to go away on their own in a few days, they show the acid's action on the skin in killing dead cells and cleaning pores.[24]

More severe side effects occasionally can arise. Though rare at low dosages, users may have more noticeable redness, peeling, or pain. Users should closely follow application instructions and restrict usage if significant dryness or irritation arises to help to prevent aggravation of these symptoms. [25, 27]

Minimizing hazards depends on following correct instructions. For over-the-counter salicylic acid preparations, this usually involves using the product no more than twice daily and making sure the skin is not unduly exposed to other irritants or treatments that can raise sensitivity. Correct usage maximizes benefits and lowers the possibility of negative effects. [26]

CONCLUSION

This article emphasizes the important part salicylic acid plays in treating acne and in more general dermatological uses. Its great efficiency and safety profile are attributed in part to its many mechanisms: keratolytic action, anti-inflammatory capabilities, and antibacterial activity. The adaptability of salicylic acid is shown by its application in many forms, therefore addressing different therapy requirements. Previous studies emphasize how effective it is at lowering acne lesions, lessening post-inflammatory hyperpigmentation, and smoothing out skin. Although commonly tolerated, minimizing negative effects depends on following advised doses and uses recommendations. In the end, salicylic acid is still the pillar of dermatological treatment as it provides a good way to control acne and presents a future direction for therapeutic developments.

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The sole author was responsible for the conceptualization, methodology, data collection, analysis, writing, and final approval of the manuscript

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