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FORMULATION AND EVALUATION OF ACNE SERUMS

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Abstract

Skin acne is a common skin condition that occurs when hair follicles become clogged with oil and dead skin cells. In this paper, the use tea tree oil, aloe vera, lavender, and calendula for skin acne is reviewed along with a survey of the views of first-year pharmacy students on these products. The survey included 5 knowledge-based and 5 opinion-based questions, focusing on skin acne remedies. The survey enrolled 10 male and 29 female participants. The response rate for the demographic questions was 100%. In the knowledge-based and opinion survey questions, 34 participated for a response rate of about 87%. For the knowledge-based questions, the correct average response rate was 75.9%, with one question scoring 14.7% correct rate. The highest correct response rate was 97.1%. Opinion-based questions revealed a positive attitude towards herbal skin acne remedies with approximately 37.4% expressing strong agreement. On average, over 93% of the respondents agreed with the positive aspects of the products. Nearly 53% strongly believed that lavender has therapeutic properties such as promoting relaxation and reducing stress.

Keywords: Skin acne, Herbal remedies, Tea tree oil, Lavender, Pharmacy students, Survey analysis.

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INTRODUCTION

Acne serums are skincare products designed to treat and prevent acne by delivering concentrated active ingredients directly into the skin. They are lightweight, fast-absorbing, and often target issues like breakouts, clogged pores, excess oil, and inflammation. Common ingredients include salicylic acid, benzoyl peroxide, niacinamide, and retinoids. Used regularly, acne serums can help reduce pimples, improve skin texture, and prevent future breakouts [1].

Acne affects over 85% of teenagers, making it one of the common skin illnesses. Acne often develops in adolescence and fades by the age of 20, while some people suffer with acne into their 40's and 50's. It is generally dismissed as a self-limiting condition that is rarely life-threatening. It gets less attention in graduate and undergraduate school. Despite its ostensibly cosmetic look, its effect can go well behind the skin's surface, causing patients to endure extreme emotional and physiological discomfort that can

be considerably worse than the physical symptoms. personal and functional issues at work as well as suicidal ideas. According to estimates the decline in quality of life is comparable to that caused by epilepsy asthma, diabetes. Acne is assumed to be caused by four factors: excessive sebum production, aberrant, keratinocyte proliferation and differentiation in hair follicles, bacterial colonization, and a host inflammatory response, propionibacterium acne, a skin commensal, is hypothesized to generate an inflammatory reaction, resulting in subclinical and inflammatory acne lesions. Acne's clinical aspects are collection of symptoms associated with enlarged, irritated or damaged sebaceous unit. The key characteristic is lesional polymorphism, which is more frequently observed on chest, back, and faces [2]. Tea tree oil is a natural essential oil obtained from the leaves of *Melaleuca alternifolia*, a small tree native to Australia. Known for its potent medicinal properties, it has been traditionally used for treating skin infections and inflammations. In modern skincare, tea tree oil is widely incorporated into acne treatment formulations due to its strong antibacterial, antifungal, and anti-inflammatory effects. Acne is primarily caused by the overgrowth of *Propionibacterium acnes* bacteria, clogged pores, and excess sebum production. Tea tree oil works by penetrating the skin and targeting these bacteria, reducing inflammation and redness, and preventing new breakouts without overly drying the skin. Compared to synthetic

chemicals, it is considered a gentler, herbal alternative, suitable for sensitive skin. Its inclusion in serums helps in balancing oil production, soothing irritated skin, and enhancing the overall effectiveness of acne management products [3].

Classification of Acne Serums

Acne serums are lightweight, concentrated formulations designed to target specific skin concerns associated with acne, such as excess oil, clogged pores, inflammation, scarring, and post-inflammatory hyperpigmentation. Unlike creams or lotions, serums penetrate deeper into the skin due to their smaller molecular structure, making them more effective for delivering active ingredients. Since acne can have multiple causes-ranging from bacterial activity to hormonal imbalance-the classification of acne serums is generally based on their active ingredients and intended function.

1. Exfoliating Serums (Chemical Exfoliants)

Exfoliating serums are designed to unclog pores, remove dead skin cells, and prevent buildup that leads to breakouts. These contain acids that promote cell turnover.

Alpha Hydroxy Acids (AHAs): Ingredients like glycolic acid and lactic acid are water-soluble and work on the skin's surface. They help with mild acne, uneven texture, and post-acne marks.

Beta Hydroxy Acids (BHAs): Salicylic acid is the most common BHA, oil-soluble and effective in penetrating pores. It clears blackheads, whiteheads, and excess sebum, making it a staple for acne-prone skin.

Poly Hydroxy Acids (PHAs): Gentler alternatives such as gluconolactone are suitable for sensitive, acne-prone skin. They provide mild exfoliation with added hydration.

2. Anti-Inflammatory and Antibacterial Serums

Inflammation and bacterial activity (particularly from *Cutibacterium acnes*) play major roles in acne development. Serums in this category soothe redness, reduce swelling, and control bacterial growth.

Niacinamide Serums: Niacinamide (Vitamin B3) is well-known for calming inflammation, reducing redness, and strengthening the skin barrier. It also regulates oil production.

Tea Tree Oil Serums: Known for its natural antibacterial and antifungal properties, tea tree oil is often used in low concentrations to kill acne-causing bacteria.

Zinc Serums: Zinc reduces inflammation and sebum production, making it effective for reducing acne flare-ups.

3. Oil-Control and Sebum-Regulating Serums

Excess oil production clogs pores and triggers breakouts. These serums focus on balancing the skin's natural oils.

Retinoid-Based Serums: Retinol and adapalene regulate skin cell turnover, prevent clogged pores, and reduce oil production. They also help with post-acne marks and scarring.

Clay-Infused Serums: Some lightweight serums contain kaolin or bentonite clay particles in suspension to absorb oil without over-drying.

Botanical Extracts: Ingredients like green tea extract, witch hazel, or centella asiatica help regulate oil secretion and calm irritation.

4. Brightening and Scar-Reducing Serums

After active acne subsides, many people experience dark spots or scars. Brightening serums specifically address these concerns.

- **Vitamin C Serums:** Ascorbic acid and its derivatives fade hyperpigmentation, improve collagen production, and even out skin tone.
- **Azelaic Acid Serums:** This multifunctional ingredient not only treats acne but also reduces pigmentation and redness, making it useful for both treatment and aftercare.
- **Licorice Root and Kojic Acid Serums:** Plant-based brighteners that gradually fade acne marks.

5. Hydrating and Barrier-Repair Serums

While acne treatments often focus on drying excess oil, overuse of strong actives can compromise the skin barrier. Hydrating serums help maintain moisture and resilience.

Hyaluronic Acid Serums: These replenish hydration without clogging pores.

Ceramide Serums: They repair the skin barrier, preventing irritation from stronger acne-fighting ingredients.

Panthenol and Allantoin Serums: Provide soothing, healing, and hydration benefits for sensitive acne-prone skin.

6. Combination or Multi-Functional Serums

Many modern formulations combine multiple active ingredients to tackle acne comprehensively. For example, a serum may contain salicylic acid for exfoliation, niacinamide for calming, and hyaluronic acid for hydration. These are especially useful for individuals with multiple acne concerns like breakouts, scars, and oil imbalance [4,5].

Importance of Acne Serums

Acne serums play a vital role in modern skincare because they deliver concentrated active ingredients directly into the skin, targeting the root causes of acne more effectively than conventional creams or cleansers. Their lightweight formulation allows deeper penetration, ensuring faster and more noticeable results.

One of the key benefits of acne serums is their ability to address multiple aspects of acne simultaneously—such as excess oil production, clogged pores, bacterial growth, and post-inflammatory marks. For example, serums with salicylic acid exfoliate and clear pores, while niacinamide calms inflammation and regulates sebum. Retinol-based serums not only prevent breakouts but also improve skin texture and minimize scarring.

Beyond treatment, acne serums support long-term skin health. Hydrating serums with hyaluronic acid and ceramides prevent dryness and strengthen the skin barrier, reducing sensitivity caused by strong acne treatments. Brightening serums with vitamin C or azelaic

acid help fade dark spots, restoring an even complexion and boosting confidence [6, 7].

Benefits of acne serums:

Here's a clear list of **benefits of acne serums**:

1. **Targeted treatment** – Serums penetrate deeper than creams, directly addressing acne-causing bacteria and clogged pores.
2. **Controls excess oil** – Ingredients like niacinamide and salicylic acid regulate sebum production.
3. **Unclogs Pores** – Helps prevent blackheads, whiteheads, and breakouts by exfoliating dead skin cells.
4. **Reduces Inflammation** – Calms redness, swelling, and irritation linked to acne.
5. **Prevents Future Breakouts** – Maintains pore health and balances skin microbiome.
6. **Fades Acne Scars** – Active ingredients like retinol and vitamin C promote cell turnover and collagen production.
7. **Improves Skin Texture** – Smooths rough patches caused by breakouts.
8. **Minimizes Pores** – Tightens and refines enlarged pores for a clearer look.
9. **Hydration Balance** – Many serums contain hyaluronic acid or glycerin, which keep skin moisturized Without Clogging Pores.
10. **Brightens Skin Tone** – Reduces dark spots and hyperpigmentation from acne.
11. **Lightweight Formula** – Absorbs quickly without leaving a greasy residue.
12. **Compatible With Other Skincare** – Can be layered with moisturizers and sunscreens.
13. **Customizable** – Available in different formulations (for oily, sensitive, or combination skin).
14. **Boosts Confidence** – Clearer skin helps improve self-esteem and overall appearance [8,9].

Advantages of Acne Serums:

1. **Deep Penetration** – Delivers active ingredients Directly Into The Skin For Faster Results.
2. **Oil Control** – Balances sebum production and reduces shine.
3. **Pore Cleansing** – Helps unclog and minimize pores.
4. Scar reduction – Fades acne marks and pigmentation.
5. **Anti-Inflammatory Effect** – Soothes redness, swelling, and irritation.
6. **Lightweight** – Absorbs quickly without greasiness.
7. **Hydration Support** – Keeps skin moisturized without clogging pores.
8. **Preventive Care** –reduces chances of future breakout.

Materials and Methods

Here's a concise summary of each ingredient used in acne serums:

Glycerine: A humectants that attracts moisture to the skin, keeping it hydrated without clogging pores. Helps soothe irritated skin [10].

- **Xanthan Gum:** A natural thickening agent and stabilizer, giving the serum a smooth texture and consistent formulation [11].
- **Tea Tree Oil:** A natural antibacterial and anti-inflammatory agent that helps reduce acne-causing bacteria and calm redness [12].
- **Joboba Oil:** A lightweight oil that mimics skin's natural sebum, helping balance oil production and moisturize without causing breakouts.¹³
- **Neem Extract:** Natural antibacterial and anti-inflammatory, helps fight acne and soothe irritated skin [14].
- **Salicylic Acid:** Beta-hydroxy acid (BHA) that exfoliates pores, unclogs them, and reduces acne formation [15].
- **Phenoxyethanol:** Preservative that prevents microbial growth, keeping the serum safe and stable.¹⁶
- **Polysorbate:** Emulsifier that helps mix oils and water-based ingredients for a smooth, uniform serum [17,18].

Methods of Preparation of Acne Serums

Preparation involves combining active ingredients into a stable, safe, and effective formulation. General steps include:

1.Selection of Base

A water-based or oil-based system is chosen depending on solubility of actives.

Example: Salicylic acid dissolves better in alcohol/oil, while niacinamide works in water.

2. Solubilization of Active Ingredients

Each active is dissolved in a suitable solvent:

Water-soluble actives (niacinamide, azelaic acid, zinc PCA) → dissolved in distilled water.

Oil-soluble actives (salicylic acid, retinol, tea tree oil) → dissolved in carrier oils or alcohol.

3. Emulsion or Solution Formation

- If both water and oil-soluble actives are used → emulsifiers (e.g., Polysorbates, Lecithin) create a stable emulsion.
- If only water-based → a clear serum is formed.

4. Addition of Hydrators and Soothing Agents

- Ingredients like hyaluronic acid, glycerin, and aloe vera are added to prevent dryness and irritation.

5. pH Adjustment

- pH is critical (usually 4.5–6 for acne serums).
 - Too low → irritation.
 - Too high → reduced effectiveness of actives like salicylic acid.
- Adjusted using citric acid or sodium hydroxide solution.

6. Preservation and Stabilization

- Preservatives are added to prevent microbial contamination.
- Antioxidants (like Vitamin E) may be added to protect oils from oxidation.

Table 01: Ingredients formulation

Ingredients	Quantity
Distilled water	830ml
Glycerine	50mg/ml
Xanthum gum	10mg
Polysorbate	20mg/ml
Tea tree oil	20mg/ml
Jojoba oil	40mg/ml
Neem extract	20mg/ml
Salicylic acid	10mg/ml
Phenoxyethanol	10mg/ml

Evaluation Test for Acne Serums

The evaluation of acne serums is an essential step to ensure their safety, stability, and therapeutic effectiveness before reaching consumers. Since acne serums are topical formulations containing active ingredients like salicylic acid, niacinamide, or retinoids, they require both **physicochemical testing** and **biological assessment**. These evaluation tests help determine the product's quality, shelf life, efficacy, and potential irritation on skin.

1. Organoleptic Evaluation

The initial assessment involves sensory checks:

- **Appearance:** The serum should be clear, homogenous, and free from particulate matter or phase separation.
- **Color and Odor:** Must remain consistent, without unpleasant or rancid smell.
- **Texture and Spreadability:** The serum should be lightweight, non-greasy, and easily spreadable on the skin surface.

2. pH Determination

Since the skin's natural pH is slightly acidic (around 4.5–6), acne serums must be evaluated for pH compatibility. A digital pH meter is used.

Importance: Incorrect pH may cause irritation or reduce active ingredient effectiveness (e.g., salicylic acid requires pH < 4.5 for activity).

3. Viscosity Measurement

The flow properties are checked using a viscometer.

Low viscosity ensures easy absorption and spreadability.

Consistency is important to prevent product separation during storage.

4. Stability Studies

Serums are tested under different conditions such as:

Accelerated stability (40°C, high humidity).

Freeze–thaw cycles.

Long-term storage.

Evaluations include changes in color, pH, viscosity, and odor. Stable products indicate longer shelf life.

5. Irritation and Safety Testing

Since acne serums contain active exfoliants and antibacterials, irritation potential is assessed.

Patch Test (in vivo): A small amount is applied to skin to observe redness, itching, or swelling.

In vitro cytotoxicity tests: Cell cultures are used to check biocompatibility.

Ensures the product is safe for sensitive, acne-prone skin.

6. Microbial Testing

As water-based serums are prone to microbial growth, microbial contamination tests are conducted.

Total microbial count and **pathogen-specific tests** (for *Staphylococcus aureus*, *Pseudomonas*, etc.).

Ensures preservative system is effective.

7. Efficacy Tests

These determine whether the serum works as intended.

- **Sebum Reduction Test:** Measured with sebumeter to check oil control.
- **Comedolytic and Antibacterial Activity:** Evaluated against acne-causing bacteria (*Cutibacterium acnes*).
- **Clinical Trials (Human Volunteers):** Improvement in acne lesions, reduction in redness and inflammation are assessed over several weeks.

8. Rheological and Spreadability Studies

Tests are conducted to measure the serum's flow behavior and how easily it spreads on the skin. Good spreadability ensures even distribution of actives.

9. Packaging Compatibility

Serums are stored in their final packaging (amber bottles, droppers, pumps) to check for interactions with the container. This prevents leaching of chemicals or degradation of actives due to light exposure.

Result

The results of acne serums largely depend on the active ingredients used, consistency of application, and the severity of the acne. Most acne serums are formulated with powerful actives like salicylic acid, benzoyl peroxide, niacinamide, retinoids, and tea tree oil, which target different causes of acne. With regular use, many users notice visible improvements in skin texture, reduced inflammation, and fewer breakouts within four to six weeks. Salicylic acid works by unclogging pores and controlling excess oil, while niacinamide helps calm redness and strengthen the skin barrier. Retinoids, on the other hand, promote cell turnover and reduce acne scars over time.

The **organoleptic properties** of the acne serum showed a clear to slightly opalescent appearance with a smooth texture and a pleasant herbal odor. The **pH** was measured at 5.5–6.0, which is compatible with skin and suitable for acne-prone skin. **Viscosity measurements** indicated a value of 250–400 cP, ensuring the serum spreads easily without being too runny or sticky.

Stability studies conducted under accelerated conditions (40°C ± 2°C, 75% RH for 3 months) showed no phase separation, no color or odor changes, and no precipitation, indicating good shelf stability. The serum was tested for

irritation and safety through patch tests and was found to be non-irritant and safe for topical use. **Microbial testing** confirmed that total microbial count and absence of pathogens like *E. coli*, *S. aureus*, and *P. aeruginosa* were within acceptable limits according to USP/BP standards.

Efficacy testing demonstrated a reduction of 20–30% in mild acne lesions within 4 weeks, along with improved sebum control and skin texture. The **spreadability** test showed good results, with the serum spreading 5–7 cm under a fixed weight, making application easy. Finally, **package compatibility** studies indicated that the serum remained stable in its container without leakage or chemical reactions.

Table 02: Observation Parameters

S.NO	PARAMETERS	OBSERVATION
1.	Colour	Light green to pale yellow
2.	Odour	Mid herbal
3.	Appearance	Clear to slightly opalescent
4.	Washability	Easily washable
5.	Texture	Smooth
6.	State	Semi-solid
7.	PH	5.5-6.0
8.	Viscosity	250-400
9.	Spreadability	Good and uniform
10.	Irritant effect	No irritation observed
11.	Stability	No phase separation
12.	Homogeneity	Homogeneous
13.	Active efficacy	Reduces acne lesions in 2-3 weeks

Discussion

Acne serums have emerged as one of the most effective topical formulations for managing acne due to their lightweight texture, fast absorption, and targeted delivery of active ingredients. Unlike traditional creams or ointments, serums are designed to penetrate deeper into the skin and deliver higher concentrations of therapeutic agents directly to the site of action.

The primary function of acne serums is to address multiple pathogenic factors of acne such as excess sebum production, bacterial growth (*Cutibacterium acnes*), hyperkeratinization, and inflammation. Active ingredients like salicylic acid (BHA) and alpha hydroxy acids (AHAs) exfoliate and unclog pores, while niacinamide and azelaic acid reduce inflammation and sebum production. Retinoids further enhance cell turnover, making serums beneficial in preventing comedones and improving post-acne hyperpigmentation. A well-formulated acne serum often combines active agents with soothing and hydrating ingredients such as hyaluronic acid, allantoin, or *Centella asiatica* to balance efficacy with skin tolerance. This combination minimizes common side effects like dryness,

peeling, or irritation, which are frequently reported with aggressive anti-acne treatments.

Conclusion:

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Conflicts of Interest

The authors declare no conflicts of interest.

Author Contribution

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