Formualtion and Evaluation of Polyherbal Anti-Acne Serum Containing Tridax Procumbens and Ocimum Tenuiflorum Leaves

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***Abstract*—Acne vulgaris is a frequently occurring inflammatory skin disorder that mainly affects adolescents and young adults. The condition develops due to excessive sebum production, blockage of hair follicles, bacterial growth, and inflammatory reactions within the skin. Although conventional anti-acne medications are widely available, prolonged use may produce adverse effects such as dryness, irritation, peeling, and microbial resistance. Therefore, herbal formulations are gaining importance as safer alternatives for topical acne treatment.**

The present study focused on the formulation and evaluation of a polyherbal anti-acne serum containing extracts of Ocimum tenuiflorum and Tridax procumbens. These medicinal plants possess antimicrobial, antioxidant, anti-inflammatory, and wound-healing properties beneficial for acne management. The serum was prepared using Aloe vera gel, glycerin, vitamin E, Tween 20, rose water, and distilled water as formulation components.

The developed formulations were evaluated for appearance, homogeneity, pH, viscosity, spreadability, irritancy, and stability. The serum showed satisfactory physicochemical properties, suitable skin compatibility, and good spreadability without producing irritation.

The study suggests that the formulated polyherbal serum may serve as a safe and effective topical preparation for acne-prone skin and could be considered a promising herbal alternative to synthetic anti-acne products.

***Index Terms*—Acne vulgaris, Herbal serum, Ocimum tenuiflorum, Tridax procumbens, Polyherbal formulation.**

I. INTRODUCTION

The skin is the largest and one of the most functionally active organs of the human body, serving as a protective barrier between the internal physiological environment and external surroundings. It performs several essential functions including thermoregulation, sensory perception, immune defense, prevention of transepidermal water loss, and protection against microbial invasion, ultraviolet radiation, and environmental

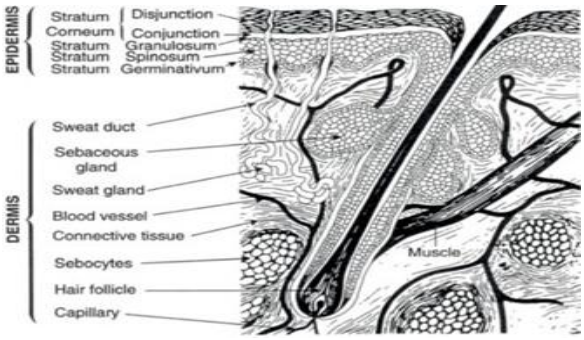

Figure No. 1 Diagram of normal human skin

pollutants. Because of continuous exposure to physical, chemical, and biological stressors, the skin is highly susceptible to a variety of dermatological disorders. Among these conditions, acne vulgaris is recognized as one of the most prevalent chronic inflammatory diseases affecting individuals globally.

Acne vulgaris is a multifactorial disorder involving the pilosebaceous unit and commonly occurs during adolescence due to hormonal changes associated with puberty. However, the prevalence of adult acne has also increased considerably in recent years. Clinically, the condition is characterized by the presence of comedones, papules, pustules, nodules, and cystic lesions, primarily distributed over the face, neck, chest, shoulders, and upper back where sebaceous glands are abundant. The pathogenesis of acne is complex and involves several interrelated mechanisms including excessive sebum production, abnormal follicular keratinization, colonization of follicles by Cutibacterium acnes, and inflammatory responses

mediated by cytokines and oxidative stress. Additional contributing factors such as hormonal imbalance, dietary habits, stress, cosmetic products, genetic predisposition, and environmental pollution may further aggravate acne severity.

Although acne vulgaris is not generally considered a life-threatening disease, its psychological and social impact can be substantial. Persistent acne lesions and post-acne scarring may lead to reduced self-confidence, emotional stress, anxiety, depression, and impaired quality of life. Consequently, effective and safe acne management remains an important area of interest in dermatological and pharmaceutical research.

Conventional anti-acne therapies include topical and systemic agents such as retinoids, benzoyl peroxide, antibiotics, salicylic acid, azelaic acid, and hormonal treatments. These medications are widely used to reduce microbial growth, inflammation, and sebum production. However, prolonged or excessive use of synthetic drugs is often associated with undesirable adverse effects including erythema, skin irritation, dryness, peeling, photosensitivity, allergic reactions, and development of antibiotic-resistant microbial strains. In addition, some synthetic formulations may produce poor patient compliance due to discomfort during long-term application. These limitations have encouraged researchers to explore safer and naturally derived alternatives with improved therapeutic efficacy and tolerability.

In recent years, herbal cosmeceuticals have attracted significant attention because of their natural origin, lower incidence of side effects, and multifunctional pharmacological activities. Medicinal plants contain numerous bioactive phytoconstituents such as flavonoids, alkaloids, tannins, glycosides, phenolic compounds, saponins, and terpenoids that exhibit antimicrobial, antioxidant, anti-inflammatory, wound-healing, and skin-protective properties. Herbal formulations are increasingly preferred in skincare applications because they are generally considered safer, biodegradable, biocompatible, and suitable for long-term use.

Polyherbal formulations have emerged as an important approach in herbal therapeutics because the combination of different medicinal plants may produce synergistic pharmacological effects. Such formulations can simultaneously target multiple pathways involved in acne pathogenesis including bacterial proliferation, inflammation, oxidative stress, and tissue damage. The use of polyherbal combinations may therefore enhance therapeutic effectiveness while minimizing adverse reactions commonly associated with synthetic agents.

Ocimum tenuiflorum .

II. MATERIALS AND METHODS

A. Materials

1) Ocimum Tenuiflorum

- Synonyms: Holy Basil, Tulsi, Sacred Basil, Ocimum sanctum Linn.
- Biological Source: Ocimum tenuiflorum consists of the dried leaves and aerial parts of the plant Ocimum tenuiflorum Linn
- Family: Lamiaceae

Chemical Constituents: Eugenol, Ursolic acid, Rosmarinic acid, Linalool, Carvacrol, Flavonoids, Tannins, Saponins, Phenolic compounds, Essential oils

Uses of Ocimum Tenuiflorum

- Used in the treatment of acne and skin infections
- Possesses antibacterial and antifungal properties
- Reduces inflammation and redness of the skin
- Acts as an antioxidant and protects skin cells from oxidative stress
- Promotes wound healing and tissue repair
- Used in herbal cosmetic and dermatological preparations

Benefits of Ocimum Tenuiflorum for skin

- Assists in controlling acne-causing bacteria on the skin.
- Helps soothe inflamed and irritated skin conditions.
- Protects skin cells from environmental oxidative stress.
- Supports faster healing of damaged skin tissues.
- Aids in reducing excessive oil accumulation on the skin surface.
- Helps maintain clean and refreshed skin by removing impurities.
- Provides protection against certain microbial skin infections.

Fig No.2 Diagram of Ocimum tenuiflorum leave

2) Rose Water

- Synonyms: Gulab Jal, Rose Hydrosol, Rose Distillate,
- Biological Source: Rose water is obtained by the distillation of fresh petals of Rosa damascena or other species of Rosa.
- Family: Rosaceae

Chemical Constituents: Citronellol, Geraniol, Nerol, Phenyl ethyl alcohol, Flavonoids, Tannins, Essential oils

Uses of Rose Water

- Used as a natural skin toner in cosmetic formulations.
- Commonly incorporated in face serums, creams, and gels.
- Helps provide freshness and fragrance to skincare products.
- Used in formulations intended for sensitive and acne-prone skin.
- Acts as a mild soothing agent in topical preparations.
- Helps improve the cosmetic acceptability of herbal formulations.

Benefits of Rose Water for Skin

- Helps soothe and refresh the skin naturally.
- Assists in maintaining proper skin hydration.
- Helps reduce mild skin irritation and redness.
- Supports removal of excess oil and impurities from the skin.
- Contributes to softer and smoother skin texture.
- Provides a cooling and calming effect on the skin surface.
- Helps improve overall skin freshness and appearance.

3) Tridax Procumbens

- Synonyms: Coat Buttons, Tridax Daisy, Mexican Daisy.
- Biological Source: Tridax procumbens consists of the whole plant or aerial parts of Tridax procumbens Linn.
- Family: Asteraceae

Chemical Constituents: Flavonoids, Alkaloids, Tannins, Saponins, Carotenoids, Terpenoids, Phenolic compounds, Essential oils

Uses of Tridax Procumbens

- Used in herbal formulations for wound healing.
- Commonly utilized in traditional skin care preparations.
- Used for treatment of minor skin infections and inflammation.
- Incorporated into herbal creams, gels, and serums.
- Used in topical preparations for acne-prone skin.
- Helps support tissue repair and skin regeneration.

Benefits of Tridax Procumbens for Skin

- Helps reduce acne-causing microbial growth on the skin.
- Assists in soothing inflamed and irritated skin conditions.
- Supports faster healing of damaged skin tissues.
- Helps protect skin cells from oxidative stress and damage.
- Contributes to healthier and smoother skin appearance.
- Assists in reducing redness and skin discomfort.
- Helps maintain skin cleanliness by controlling impurities.
- Supports regeneration of affected skin areas.
- Provides mild antimicrobial protection for the skin.
- Widely used in herbal and cosmetic skincare formulations.

Fig No.3 Diagram of Tridax procumbens leaves

B. Methods

- Collection and Preparation of Plant Material

1. Fresh leaves of Ocimum tenuiflorum and Tridax procumbens were collected from the local area.
2. The collected plant materials were carefully inspected to remove damaged or infected leaves.
3. The leaves were washed thoroughly with distilled water to remove dust, dirt, and other impurities.
4. The cleaned leaves were shade dried at room temperature for several days until complete drying was achieved.
5. The dried leaves were then powdered using a mechanical grinder.
6. The powdered plant material was passed through a suitable sieve to obtain uniform particle size.
7. The powdered samples were stored in airtight containers for further experimental work

Fig No.4 #60 No sieve powder of drug

- Extraction of Herbal Extracts by Decoction Method

The extraction of phytoconstituents from Ocimum tenuiflorum and Tridax procumbens leaves was carried out using the decoction method. This method was selected for effective extraction of water-soluble bioactive constituents required for formulation of the polyherbal anti-acne serum.

Step 1: Preparation of Decoction

About 10 g of powdered Ocimum tenuiflorum leaves and 10 g of powdered Tridax procumbens leaves were transferred separately into clean beakers containing 100 mL of distilled water.

Step 2: Heating Process

The mixtures were heated gently and boiled for approximately 30–45 minutes until the volume was reduced to about half of the original quantity. Continuous stirring was carried out during heating to ensure proper extraction of phytoconstituents.

Step 3: Cooling and Filtration

After boiling, the extracts were allowed to cool at room temperature. The mixtures were filtered first through muslin cloth and then through Whatman No. 1 filter paper to obtain clear aqueous extracts.

Step 4: Storage of Extracts

The prepared extracts were collected in amber-colored glass bottles and stored under refrigerated conditions at 4°C until further use in the formulation of the polyherbal anti-acne serum.

The decoction method provided effective extraction of water-soluble active constituents possessing antimicrobial, antioxidant, and anti-inflammatory activities beneficial for acne management.

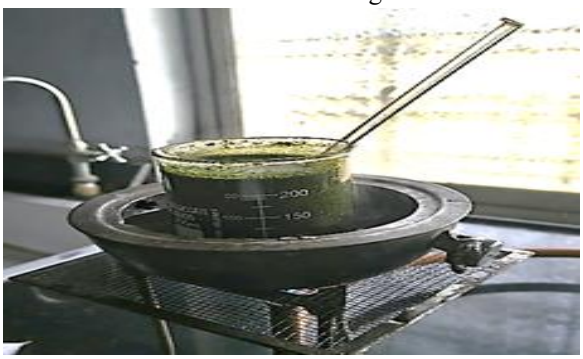

Fig No.5 deccoction

- Preparation of Anti-Acne Serum

1. Required quantities of herbal extracts of Ocimum tenuiflorum and Tridax procumbens were accurately weighed.
2. Aloe vera gel was taken in a clean beaker and used as a base for serum preparation.
3. Glycerin was added to the base as a humectant to provide moisturizing effect.

4. Vitamin E was incorporated as an antioxidant to protect the formulation from oxidation.
5. Tween 20 was added as a surfactant to improve the uniform mixing of ingredients.
6. Rose water and distilled water were added as the vehicle for the formulation.
7. The herbal extracts were slowly incorporated into the mixture with continuous stirring to obtain a uniform solution.
8. Citric acid was added to adjust the pH of the formulation.
9. The mixture was stirred continuously until a homogeneous serum was obtained.
10. The prepared formulations were labeled as F1, F2, F3, and F4 and stored in suitable containers.

Fig No. 6 Prepration of formulation

- Formulation

Table No. 10 formulation

Ingredient	F1 (20 ml)	F2 (20 ml)	F3 (20 ml)	F4 (20 ml)
Ocimum Tenuiflorum extract	2.0 ml	2.5 ml	3.0 ml	3.5 ml
Tridax Procumbens extract	2.0 ml	2.5 ml	3.0 ml	3.5 ml
Aloe vera gel	3.0 ml	4.0 ml	5.0 ml	6.0 ml
Glycerin	1.0 ml	1.5 ml	2.0 ml	2.5 ml
Vitamin E	0.5 ml	0.5 ml	0.5 ml	0.5 ml
Tween 20	0.5 ml	0.5 ml	0.5 ml	0.5 ml
Rose water	q.S.to 20 ml	q.s. to 20 ml	q.s. to 20 ml	q.s. to 20 ml
Citric acid (1%)	q.s.	q.s.	q.s.	q.s.

- Drug–Excipient Compatibility Study

1. Drug–excipient compatibility study was carried out to determine possible interactions between herbal extracts and excipients.
2. Fourier Transform Infrared Spectroscopy (FTIR) was used for this analysis.
3. Samples of herbal extract and formulation were prepared for FTIR analysis.
4. The samples were scanned over a wavelength range of 4000–400 cm^{-1}.
5. The obtained spectra were analyzed for characteristic peaks of functional groups.
6. The spectra of the extract and formulation were compared to detect any possible interaction.

- Evaluation of Herbal Anti-Acne Serum

The prepared herbal anti-acne serum formulations were evaluated for various physicochemical parameters to determine their quality, stability, and suitability for topical application. The evaluation tests included organoleptic properties, pH determination, viscosity measurement, irritancy test, and spreadability study.

1.Organoleptic Properties

The prepared serum formulations were evaluated for organoleptic characteristics such as color, odor, appearance, and texture. A small quantity of the formulation was taken on a clean glass slide and visually observed under normal light conditions. The color of the formulation was recorded and the odor was evaluated by smelling the formulation. The appearance and texture were also examined to ensure that the serum was smooth and uniform without any phase separation. Organoleptic evaluation helps in determining the aesthetic acceptability of the formulation for topical use.

2. Determination of pH

The pH of the prepared serum formulations was determined using a digital pH meter. Before measurement, the pH meter was calibrated using standard buffer solutions. A small quantity of serum sample was taken in a clean beaker and the electrode of the pH meter was immersed into the formulation. The pH value displayed on the instrument was recorded. Maintaining an appropriate pH is important because formulations with unsuitable pH may cause skin irritation or discomfort during application.

3. Viscosity Measurement

The viscosity of the prepared serum formulations was determined using a Brookfield viscometer. A suitable quantity of serum was taken in the sample container of the viscometer. The appropriate spindle was selected and immersed in the formulation. The instrument was operated at a constant speed and the viscosity reading was recorded. The viscosity of the formulation was expressed in centipoise (cP). Viscosity plays an important role in determining the consistency and flow behavior of the serum.

4. Irritancy Test

The irritancy test was carried out to evaluate the safety of the serum formulation for topical application. A small quantity of the serum was applied on a selected area of the skin. The applied area was observed for any signs of redness, itching, irritation, or inflammation for a certain period of time. If no irritation or redness was observed, the formulation was considered safe and suitable for topical application.

5. Spreadability Test

Spreadability of the serum formulation was determined to evaluate the ease with which the formulation spreads on the skin surface. A small amount of serum was placed between two clean glass slides. A certain weight was placed on the upper slide to allow the formulation to spread uniformly. The diameter of spreading was measured after a specific period of time. Good spreadability indicates that the formulation can be easily applied and uniformly distributed on the skin.

III. RESULT

1. Organoleptic properties:

Table No 2: Organoleptic Properties of Serum Formulations (F1–F4)

Sr. No.	Parameter	F1	F2	F3	F4
1	Formulation	Light green yellowish	Light green yellowish	Green yellowish	Light green yellowish
2	Colour	Herbal	Herbal	Herbal	Characteristic herbal
3	Odour	Slightly turbid	Semi-clear	Clear	Clear and smooth
4	Appearance	Smooth	Smooth	Smooth	Non-greasy
5	Texture	Low viscosity	Moderate viscosity	Moderate viscosity	Slightly viscous
6	Consistency	Slightly non-uniform	Uniform	Uniform	Highly uniform
7	Homogeneity	Light green	Light green	Green	Light green

The organoleptic properties of the prepared herbal anti-acne serum formulations (F1–F4) were evaluated visually for colour, odour, appearance, texture, consistency, and homogeneity. All formulations showed a greenish colour and characteristic herbal odour due to the presence of herbal extracts of Ocimum tenuiflorum and Tridax procumbens. Formulation F1 appeared slightly turbid and showed lower viscosity, while F2 and F3 showed improved clarity and uniformity. Among all formulations, F4 showed clear appearance, smooth texture, and good homogeneity with slightly viscous consistency, making it suitable for topical application. Therefore, F4 was selected as the optimized formulation for further evaluation studies.

2. pH Determination

Table No3: pH of Serum Formulations

Formulation	pH Value
F1	6.2
F2	6.5
F3	6.8
F4	7.1

The pH of the prepared herbal anti-acne serum formulations was determined using a digital pH meter. The pH of all formulations was found to be within the acceptable range for topical skin preparations (pH 5.5–7.5). Among all formulations, F4 showed a pH of 7.1,

which is suitable for skin application and minimizes the risk of irritation. Therefore, F4 was considered appropriate for topical use. 9.5. pH:

3. Viscosity:

Table No.15: Viscosity of Serum Formulations

Formulation	Viscosity (cP)
F1	820
F2	950
F3	1080
F4	1250

The viscosity of the prepared serum formulations was measured using a Brookfield viscometer. The viscosity increased gradually from F1 to F4 due to variation in the concentration of formulation components. F4 showed optimum viscosity (1250 cP), which is suitable for serum formulation as it allows easy application and proper retention on the skin surface.

4. Spreadability:

Table No.16: Spreadability of Serum Formulations

Formulation	Spreadability (g·cm/sec)
F1	5.8
F2	6.4
F3	7.1
F4	7.8

Spreadability of the serum formulations was determined to evaluate ease of application on the skin. Higher spreadability indicates better topical application. Among the formulations, F4 showed the highest spreadability (7.8 g·cm/sec), indicating that the serum spreads easily on the skin surface without excessive friction.

5. Skin Irritation Test:

Table No.17: Irritation Test of Serum Formulations

Formulation	Observation	Result
F1	No redness	Non-irritant
F2	No redness	Non-irritant
F3	No redness	Non-irritant
F4	No redness or swelling	Non-irritant

The skin irritation test was performed by applying a small quantity of the formulation on the skin surface and observing for any signs of redness, itching, or swelling. All formulations showed no visible irritation, indicating that the serum is safe for topical application. The optimized formulation F4 showed no redness, itching, or swelling, confirming its safety and compatibility with skin.

- FTIR of optimized batch (f4) FTIR Analysis of Final Formulation (F4 Batch Serum)

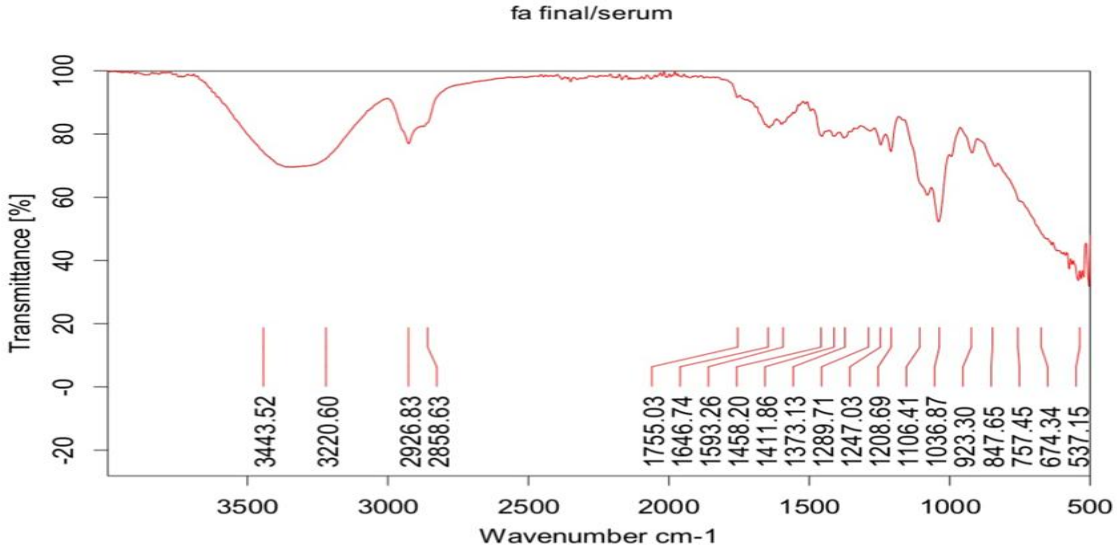

Figure No.11: FTIR spectrum of final formulation (F4 batch) of anti-acne herbal serum containing Ocimum tenuiflorum and Tridax procumbens

(Table No.12): FTIR Peak Interpretation of Final F4 Serum

Sr. No	Wavenumber (cm^{-1})	Functional Group	Interpretation
1	3443.52	O–H stretching	Alcohols/Phenolic compounds
2	3220.60	O–H stretching	Hydrogen bonded alcohols
3	2926.83	C–H stretching	Alkanes
4	2858.63	C–H stretching	Alkanes
5	1755.03	C=O stretching	Esters/Carbonyl compounds
6	1649.74	C=C stretching	Alkenes
7	1605.63	N–H bending	Amines
8	1458.20	C–H bending	Aromatic compounds
9	1411.86	O–H bending	Phenolic Compound
10	1373.13	C-H bending	Alkanes
11	1289.70	C–O stretching	Alcohol / Ester
12	1247.03	C–O stretching	Ether
13	1208.69	C–O stretching	Alcohol
14	1106.41	C–O stretching	Carbohydrates
15	1036.87	C–O stretching	Ether
16	923.30	C–H bending	Aromatic ring
17	847.65	C–H bending	Aromatic compounds
18	757.45	C–H bending	Aromatic compounds
19	674.34	C–Cl stretching	Halogen compound
20	537.15	C–Br stretching	Halogen compound

Interpretation

The FTIR spectrum of the final formulation (F4 batch) of the herbal anti-acne serum showed several characteristic absorption peaks corresponding to different functional groups present in the formulation. A broad peak observed at 3443.52 cm^{-1} corresponds to O–H stretching vibrations, indicating the presence of alcohols and phenolic compounds. Peaks at 2926.83 cm^{-1} and 2858.63 cm^{-1} correspond to C–H stretching vibrations of alkanes. The absorption peak at 1755.03 cm^{-1} indicates C=O stretching, suggesting the presence of carbonyl compounds such as esters or ketones. The peak observed at 1649.74 cm^{-1} corresponds to C=C stretching, indicating aromatic compounds and alkenes. Peaks in the region 1289–1036 cm^{-1} correspond to C–O stretching vibrations, suggesting alcohols, ethers, and carbohydrate groups. These results confirm the presence of bioactive phytoconstituents from Ocimum tenuiflorum and Tridax procumbens in the final formulation, indicating compatibility between the plant extracts and excipients in the serum formulation.

IV. CONCLUSION

The present study successfully developed and evaluated a polyherbal anti-acne serum containing extracts of Ocimum tenuiflorum and Tridax procumbens. The prepared formulations showed satisfactory physicochemical properties such as appropriate pH, good spreadability, acceptable viscosity, and absence of skin irritation, indicating their suitability for topical application. FTIR analysis confirmed the compatibility of the herbal extracts with the formulation ingredients without significant interaction. Among all formulations, the F4 batch demonstrated better stability and overall performance. The presence of bioactive phytoconstituents with antimicrobial, anti-inflammatory, and antioxidant properties may contribute to the anti-acne potential of the formulation. Thus, the developed polyherbal serum can be considered a promising natural alternative for the management of acne with improved safety and skin compatibility.

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