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TOPICAL HERBAL GEL OF *SYZYGIUM SAMARANGENSE* FRUIT EXTRACT: FORMULATION, EVALUATION, AND ANTI-ACNE ACTIVITY

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ABSTRACT

Background: Acne vulgaris is a common inflammatory disorder of the pilosebaceous unit associated with follicular hyperkeratinization, excessive sebum production, microbial colonization and inflammation. Increasing interest in herbal topical preparations has encouraged the investigation of plant-derived bioactive constituents as potential alternatives for acne management. *Syzygium samarangense* is a medicinally relevant plant belonging to the family Myrtaceae and contains various phytoconstituents with reported biological activities. **Objective:** The present study was aimed at formulating and evaluating an herbal anti-acne gel containing ethanolic fruit extract of *Syzygium samarangense*. **Methods:** The shade-dried fruit powder was extracted with ethanol by the maceration method. The obtained extract was subjected to preliminary phytochemical screening. Three topical gel formulations, F1, F2 and F3, containing 10%, 15% and 20% w/w fruit extract, respectively, were prepared using Carbopol 940 as the gelling agent. The formulations were evaluated for physical appearance, homogeneity, grittiness, odour, spreadability, pH and washability. Antibacterial activity was evaluated by the agar well diffusion method against *Staphylococcus aureus* and

Escherichia coli, using amoxicillin as the positive control. **Results:** From 200 g of dried fruit powder, 50 g of semisolid ethanolic extract was obtained, corresponding to an extraction yield of 25% w/w. Phytochemical screening indicated the presence of phenols, flavonoids, terpenoids, tannins and glycosides, whereas alkaloids were not detected. All three formulations exhibited smooth appearance, good homogeneity, absence of grittiness and easy washability. The spreadability values of F1, F2 and F3 were 25.0, 25.0 and 21.4 g·cm/s, respectively. The pH values were 6.2, 6.2 and 6.5 for F1, F2 and F3, respectively. No antibacterial activity was observed against *E. coli*. Against *S. aureus*, F1, F2 and F3 produced inhibition zones of 5, 11 and 12 mm, respectively, whereas amoxicillin produced a 26 mm inhibition zone. **Conclusion**: The findings indicate that *S. samarangense* fruit extract can be incorporated into a Carbopol 940-based topical gel with acceptable physicochemical properties. Among the formulations, F3 containing 20% extract demonstrated the highest antibacterial activity against *S. aureus*. Further studies are required to establish the antimicrobial efficacy, stability and clinical applicability of the formulation.

KEYWORDS: *Syzygium samarangense*, herbal gel, anti-acne, Carbopol 940, phytochemical screening, antibacterial activity, *Staphylococcus aureus*.

INTRODUCTION

Definition

Acne vulgaris is one of the most common chronic inflammatory disorders of the pilosebaceous unit and predominantly affects the face, chest, and back. It is characterized by the formation of comedones, papules, pustules, nodules, and, in severe cases, scarring. The pathogenesis of acne is multifactorial and involves follicular hyperkeratinisation, increased sebum production, microbial colonization, and inflammation. Hormonal changes, particularly increased androgen activity, stimulate sebaceous gland secretion and contribute to follicular obstruction and the development of acne lesions. The condition is highly prevalent among adolescents and young adults and may have significant psychological and social consequences.

Microbial colonization is an important factor in the progression of inflammatory acne. *Cutibacterium acnes* (formerly *Propionibacterium acnes*) is closely associated with acne pathogenesis and contributes to inflammation through the production of microbial enzymes and inflammatory mediators. The accumulation of sebum and keratinous material within the pilosebaceous follicle provides a favourable environment for microbial proliferation and

inflammatory responses. Therefore, therapeutic approaches possessing antimicrobial and anti-inflammatory properties may be beneficial in the management of acne.

Anti-acne Agents

Conventional acne therapy includes topical retinoids, benzoyl peroxide, antibiotics, and other keratolytic or antimicrobial agents. Although these treatments are clinically effective, prolonged use may produce undesirable effects such as dryness, irritation, erythema, and other local reactions. The increasing concern regarding antimicrobial resistance associated with prolonged antibiotic use has encouraged research into alternative and complementary approaches for acne management. Consequently, herbal products have attracted considerable interest because plant-derived phytoconstituents may exhibit antimicrobial, antioxidant, anti-inflammatory, and other beneficial biological activities.

Herbal cosmetics incorporate plant-derived materials or their preparations into cosmetic formulations and have gained increasing attention for skin-care application. Various medicinal plants, including aloe vera, neem, turmeric, tea tree, and clove, have been investigated for their potential anti-acne, antimicrobial, antioxidant, and anti-inflammatory properties. In addition to the biological activity of plant extracts, the choice of an appropriate topical dosage form is important for achieving acceptable application and retention on the skin.

Gels

Gels are semisolid preparations in which a gelling agent forms a three-dimensional network within a suitable liquid medium. Topical gels are widely investigated because they are generally non-greasy, easily spreadable, washable, and convenient for application to the skin. The incorporation of herbal extracts into gel systems may provide a suitable vehicle for topical delivery while maintaining acceptable physicochemical characteristics. Previous studies have reported the formulation and evaluation of herbal or polyherbal anti-acne gels, demonstrating the potential of herbal ingredients in topical acne preparations.

Plant profile

Fig. 1: Water apple.

Syzygium samarangense (Blume) Merr. & L.M. Perry, commonly known as wax apple or water apple, belongs to the family Myrtaceae. The plant is traditionally utilized for various purposes, and its different parts contain biologically active phytoconstituents. Phenolic compounds, flavonoids, tannins, and other secondary metabolites present in plant materials are associated with biological activities such as antioxidant and antimicrobial effects. However, comparatively limited attention has been directed toward the development of a topical anti-acne gel containing *S. samarangense* fruit extract.

Therefore, the present study was undertaken to formulate and evaluate an herbal anti-acne gel containing ethanolic fruit extract of *Syzygium samarangense*. The developed formulations were evaluated for their physicochemical properties and antimicrobial activity to determine their potential as a topical herbal formulation for acne management.

MATERIALS AND METHODS

2.1 Collection and Authentication of Plant Material

Fresh fruits of *Syzygium samarangense* were collected from the local market in Vellore District, Tamil Nadu, India. The plant material was authenticated by Dr. J. Suresh Kumar, M.Sc., M.Phil., Ph.D., PGDCA., M.A., Department of Botany, Government Arts College, Tiruvannamalai, Tamil Nadu, on 11 June 2026. An authentication certificate was obtained and retained as a record for the study.

2.2 Preparation of Ethanolic Fruit Extract

The collected fruits were thoroughly washed with distilled water to remove adhering contaminants and were cut into small pieces. The material was shade-dried for approximately two weeks and subsequently coarsely powdered using a mechanical blender. About 200 g of the dried fruit powder was subjected to extraction by maceration using ethanol as the solvent for approximately one week with occasional shaking. After extraction, the mixture was

filtered through muslin cloth and the filtrate was concentrated at 40–50°C using a hot plate to obtain a semisolid extract. The obtained extract was stored in a tightly closed container at 4°C until further use.

The percentage extraction yield was calculated using the following equation.

Percentage yield (% w/w) = (Weight of extract / Weight of dried powder) × 100

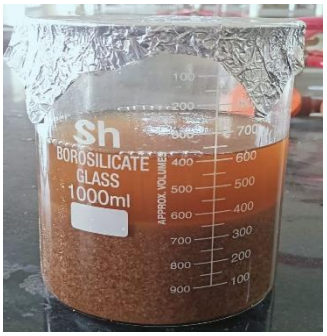

Fig. 2: Extract.

2.3 Preliminary Phytochemical Screening

The ethanolic fruit extract of *S. samarangense* was subjected to preliminary phytochemical screening using standard qualitative chemical tests for phenols, flavonoids, terpenoids, alkaloids, tannins and glycosides. The presence or absence of individual phytoconstituents was determined based on characteristic colour changes or precipitate formation following the respective tests.

2.4 Formulation of Anti-Acne Gel

This should be one of the most important sections.

Table 2: Composition of *S. samarangense* fruit extract gel formulations.

Ingredients	F1 (10%)	F2 (15%)	F3 (20%)	Purpose
***S. samarangense* fruit extract**	5 g	7.5 g	10 g	Active ingredient
Carbopol 940	1 g	1.25 g	1.5 g	Gelling agent
Propylene glycol	5 g	5 g	5 g	Solvent/vehicle
Methyl paraben	0.1 g	0.1 g	0.1 g	Preservative
Propyl paraben	0.01 g	0.01 g	0.01 g	Preservative
Glycerin	2.5 g	2.5 g	2.5 g	Humectant
Triethanolamine	q.s.	q.s.	q.s.	Neutralizing/pH-adjusting agent
Distilled water	q.s. to 50 g	q.s. to 50 g	q.s. to 50 g	Vehicle

2.5 Preparation of *S. samarangense* Fruit Extract Gel

Carbopol 940 was accurately weighed according to the formulation and gradually dispersed in approximately 20–25 mL of distilled water with continuous stirring to avoid lump formation. The dispersion was allowed to hydrate for 30–45 min.

In a separate vessel, methyl paraben and propyl paraben were dissolved in propylene glycol with gentle warming at approximately 40–50°C. Glycerine was subsequently incorporated into the preservative solution.

The required quantity of semisolid *S. samarangense* fruit extract was triturated with a small portion of the propylene glycol-glycerine-preservative mixture to obtain a uniform dispersion. The extract dispersion was gradually incorporated into the hydrated Carbopol 940 dispersion with continuous stirring until a homogeneous mixture was obtained.

Triethanolamine was then added gradually with gentle stirring until gel formation occurred and the desired pH was achieved. The formulation was finally adjusted to 50 g with distilled water and mixed carefully to minimize air entrapment. The prepared gels were allowed to stand for approximately 24 h at room temperature and subsequently transferred into tightly closed containers until further evaluation.

2.6 Evaluation of Gel Formulations

2.6.1 Physical Evaluation

The prepared formulations were visually examined for colour, odour, homogeneity and grittiness. Homogeneity was assessed by visual inspection for the presence of lumps, aggregates or phase separation. Grittiness was evaluated by observing the texture of the formulation during application.

2.6.2 Spreadability

Spreadability was determined using two standard glass slides. A specified quantity of gel was placed between the slides and the excess formulation was removed. A weight of 20 g was attached to the upper slide, and the time required for the slide to move through a predetermined distance of 7.5 cm was recorded. The experiment was performed in triplicate. Spreadability was calculated using.

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

where **S** is spreadability (g·cm/s), **M** is the weight attached to the slide (g), **L** is the distance travelled by the slide (cm), and **T** is the time required for movement (s).

2.6.3 Determination of pH

The pH of each formulation was determined using a calibrated digital pH meter. Approximately 1 g of gel was dispersed in 100 mL of distilled water and allowed to equilibrate for 2 h before measurement. The pH of each formulation was recorded.

2.6.4 Viscosity

The viscosity of the prepared herbal gel was measured using a rotational viscometer (LABMAN LMDV-60) at25±2℃ using spindle no 4 (SP4) at a spindle speed of 1.5 rpm.

2.6.5 Washability

Washability was evaluated by applying a small quantity of each gel formulation onto the skin and subsequently washing the applied area with water. The ease with which the formulation was removed was visually assessed and recorded.

2.7 Antibacterial Activity

The antibacterial activity of the prepared gel formulations was evaluated by the agar well diffusion method against *Staphylococcus aureus* and *Escherichia coli*. The bacterial strains were obtained from BN Micro Lab, Tiruvannamalai, Tamil Nadu. Mueller–Hinton agar was used as the culture medium.

The prepared gel formulations were diluted before testing. Approximately 100 mg of each formulation was dispersed in 0.9 mL of sterile distilled water to obtain a final volume of 1 mL and mixed thoroughly to obtain a uniform dispersion. Based on the extract content, the resulting concentrations corresponded to 10 mg/mL for F1, 15 mg/mL for F2 and 20 mg/mL for F3.

A standardized bacterial inoculum was used to inoculate Mueller–Hinton agar plates. Wells of approximately 10 mm diameter were aseptically prepared in the agar. About 100 µL of each gel preparation was introduced into the respective wells. Amoxicillin (1 mg/mL) was used as the positive control, while the plain gel base was used as the negative control. The plates were incubated at 37°C for the specified incubation period, after which the diameter of the inhibition zones was measured in millimetres.

The experiment was performed under the same conditions for all formulations, and the inhibition-zone diameters were recorded and compared with the controls.

3. RESULTS

3.1 Extraction Yield

Maceration of 200 g of shade-dried *S. samarangense* fruit powder with ethanol yielded 50 g of semisolid extract. The percentage yield was calculated as.

Percentage yield = (Weight of extract / Weight of dried powder) × 100

= (50 / 200) × 100

= **25% w/w**

Thus, the extraction process produced a 25% w/w semisolid ethanolic extract.

Fig. 3: Semisolid yield.

3.2 Phytochemical Screening

Table 1: Preliminary phytochemical screening of *S. samarangense* fruit extract.

Phytoconstituent	Test	Observation	Inference
Phenols	Ferric chloride	Bluish-green to dark-green colour	+
Phenols	Lead acetate	White precipitate	+
Flavonoids	Ferric chloride	Bluish-green colour	+
Flavonoids	Lead acetate	Yellow precipitate	+
Flavonoids	Alkaline reagent	Intense yellow colour, disappeared with dilute HCl	+
Terpenoids	Salkowski	Reddish-brown ring	+
Terpenoids	Liebermann–Burchard	Greenish/bluish-green colour	+
Alkaloids	Mayer's	No cream precipitate	–
Alkaloids	Dragendroff’s	No orange-red precipitate	–
Alkaloids	Wagner's	No reddish-brown precipitate	–
Alkaloids	Hager's	No yellow precipitate	–
Tannins	Ferric chloride	Greenish-blue colour	+
Tannins	Lead acetate	Yellow precipitate	+
Tannins	Gelatin	White precipitate	+
Glycosides	Keller–Killiani	Brown ring with bluish-green upper layer	+

+ = present; − = absent

Fig.4. Phenol

Fig.5. Flavonoids

Fig.6. Terpenoids

Fig.7. Alkaloids

Fig.8. Tannins.

Fig.9. Glycosides.

Preliminary phytochemical screening of the ethanolic fruit extract revealed the presence of phenols, flavonoids, terpenoids, tannins and glycosides. Alkaloids were not detected by the qualitative tests employed. The findings indicate the presence of several classes of secondary metabolites that may contribute to the biological properties of the extract.

3.3 Physical Characteristics

Table 4: Physical evaluation of gel formulations.

Parameter	F1	F2	F3
Colour	Brown	Light brown	Dark brown
Odour	Fruity	Fruity	Strong fruity
Homogeneity	Homogeneous	Homogeneous	Homogeneous
Grittiness	Absent	Absent	Absent
Washability	Easy	Easy	Easy

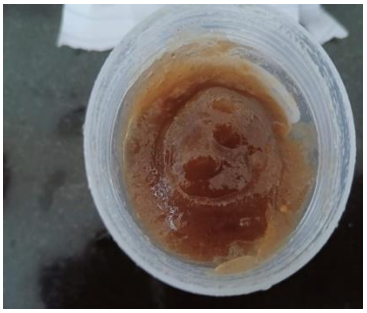

Fig.10(F1)

Fig.11(F2)

Fig.12(F3)

All three formulations exhibited a smooth and homogeneous appearance without visible lumps or phase separation. F1 showed a brown colour, F2 showed a light-brown colour, and

F3 showed a dark-brown colour. The progressive variation in colour may be associated with the increasing concentration of fruit extract. Grittiness was absent in all formulations, indicating a smooth texture. The formulations exhibited a characteristic fruity odour, with F3 showing a comparatively stronger odour. All formulations were easily washable with water.

3.4 Spreadability

Table 5: Spreadability of gel formulations.

Formulation	Spreadability (g·cm/s)
F1	25.0
F2	25.0
F3	21.4

F1 and F2 showed a spreadability of 25.0 g·cm/s, whereas F3 showed a comparatively lower value of 21.4 g·cm/s. The lower spreadability of F3 may be associated with its higher extract and Carbopol 940 content, which may contribute to increased resistance to spreading. Nevertheless, all formulations demonstrated acceptable ease of application under the experimental conditions.

3.5 pH

Table 6: pH of gel formulations.

Formulation	pH
F1	6.2
F2	6.2
F3	6.5

The pH values of F1, F2 and F3 were 6.2, 6.2 and 6.5, respectively. The formulations showed pH values suitable for topical application and were within the predetermined formulation range. The similar pH values observed for F1 and F2 indicate consistent neutralization of the Carbopol-based gel system, while F3 showed a slightly higher pH.

3.6 Viscosity

Formulation	Temperature	Speed	Viscosity
F1	24.4°C	1.5 rpm	140,307
F2	23.3°C	1.5 rpm	227,260
F3	24.8°C	1.5 rpm	152,648

3.7 Antibacterial Activity

Table 7: Antibacterial activity of *S. samarangense* gel formulations.

Sample	Concentration	*E. coli*	*S. aureus*
F1	10 mg/mL	0 mm	5 mm
F2	15 mg/mL	0 mm	11 mm
F3	20 mg/mL	0 mm	12 mm
Amoxicillin	1 mg/mL	28 mm	26 mm
Plain gel base	—	0 mm	0 mm

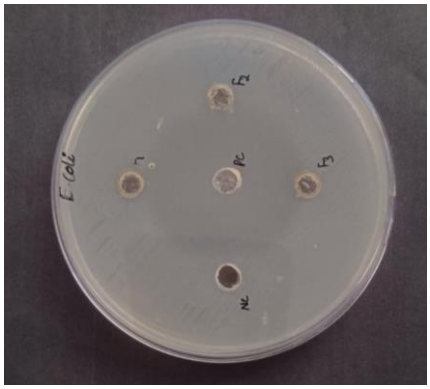

Fig.13. *E. coli* Inhibition.

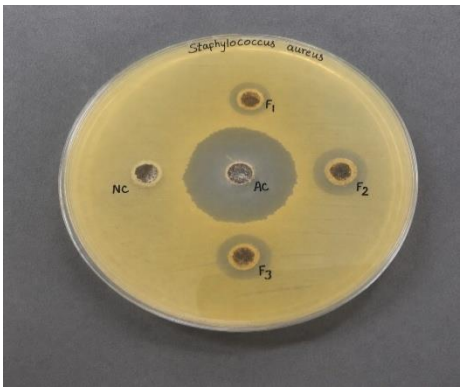

Fig.14. *S. aureus* Inhibition.

The antibacterial activity of the formulations was evaluated against *S. aureus* and *E. coli*. No inhibition zone was observed for F1, F2 or F3 against *E. coli*. In contrast, all three formulations produced measurable inhibition zones against *S. aureus*, measuring 5, 11 and 12 mm for F1, F2 and F3, respectively. The inhibition zone increased with increasing extract concentration, with F3 showing the highest inhibition zone of 12 mm. The positive control, amoxicillin, produced inhibition zones of 28 and 26 mm against *E. coli* and *S. aureus*, respectively, whereas the plain gel base showed no inhibition. These findings indicate that the antibacterial activity of the developed formulations was more pronounced against the Gram-positive organism tested.

DISCUSSION

The ethanolic maceration of *S. samarangense* fruit powder produced a 25% w/w semisolid extract yield. The extraction yield may be influenced by the solvent used, duration of extraction, particle size, moisture content and concentration procedure. Ethanol is widely employed for the extraction of a broad range of polar and moderately polar phytoconstituents from plant materials.

Preliminary phytochemical screening demonstrated the presence of phenols, flavonoids, terpenoids, tannins and glycosides, whereas alkaloids were not detected. The presence of

these secondary metabolites is of interest because phenolic compounds and flavonoids are commonly associated with antioxidant activity, while tannins and other polyphenolic constituents may contribute to antimicrobial and anti-inflammatory effects. However, qualitative phytochemical screening alone cannot establish the concentration or individual contribution of these constituents to the observed biological activity.

The prepared formulations showed satisfactory physical characteristics. The absence of visible lumps, aggregates and phase separation indicated adequate incorporation of the extract into the Carbopol 940 gel system. The progressive change in colour from F1 to F3 may be attributed to the increasing concentration of the fruit extract. The absence of grittiness in all formulations suggests that the semisolid extract was uniformly incorporated into the gel base. The spreadability values were 25.0, 25.0 and 21.4 g·cm/s for F1, F2 and F3, respectively. The lower spreadability observed for F3 may be related to its higher Carbopol 940 concentration and increased solid content, which can increase the resistance of the formulation to flow. Nevertheless, all formulations could be readily applied to the skin under the test conditions.

The pH values of the formulations ranged from 6.2 to 6.5. The relatively similar pH values indicate that the formulations were appropriately neutralized with triethanolamine. Maintenance of a suitable pH is important for the acceptability of topical preparations and minimizing the possibility of irritation.

The antibacterial evaluation demonstrated a concentration-dependent increase in inhibition against *S. aureus*. F1, F2 and F3 produced inhibition zones of 5, 11 and 12 mm, respectively, whereas the plain gel base showed no inhibition. The increasing activity with increasing extract concentration suggests that constituents present in the fruit extract may contribute to the observed antibacterial effect. However, the activity was substantially lower than that of amoxicillin, which produced a 26-mm inhibition zone against *S. aureus*. No inhibition was observed against *E. coli* for any of the formulations. The difference in response between the two organisms may be related to differences in their cell-envelope structures and susceptibility to plant-derived constituents.

The absence of inhibition against *E. coli* and the comparatively lower activity against *S. aureus* indicate that the antibacterial potential of the formulation is organism-dependent and should not be generalized as broad-spectrum antibacterial activity. Furthermore, agar well diffusion results can be influenced by factors such as extract concentration, diffusion

characteristics, gel viscosity, molecular size of active constituents, inoculum density and agar composition. Therefore, additional studies involving standardized antimicrobial assays, determination of minimum inhibitory concentration and minimum bactericidal concentration, and characterization of the active constituents would be useful to further establish the antimicrobial potential of *S. samarangense* fruit extract.

Overall, F3 exhibited the highest antibacterial activity among the three formulations while maintaining acceptable physicochemical characteristics. However, the present findings support the potential of the formulation as an area for further investigation rather than establishing clinical anti-acne efficacy.

5. CONCLUSION

The present study successfully developed three topical gel formulations containing 10%, 15% and 20% ethanolic fruit extract of *Syzygium samarangense* using Carbopol 940 as the gelling agent. The ethanolic extraction produced a 25% w/w semisolid extract, and preliminary phytochemical screening revealed the presence of phenols, flavonoids, terpenoids, tannins and glycosides.

All formulations exhibited satisfactory physical characteristics, including good homogeneity, absence of grittiness, acceptable pH, good spreadability and easy washability. In the antibacterial study, the formulations showed no inhibition against *Escherichia coli*, whereas concentration-dependent inhibition was observed against *Staphylococcus aureus*. F3 containing 20% extract showed the highest inhibition zone against *S. aureus*.

The findings suggest that *S. samarangense* fruit extract can be incorporated into a topical gel with acceptable physicochemical characteristics and shows preliminary antibacterial potential against *S. aureus*. However, further investigations involving phytochemical characterization, standardized antimicrobial assays, stability studies, skin-safety assessment and appropriate in vivo or clinical studies are required before establishing its efficacy as an anti-acne formulation.

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