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Research

Formulation and Evaluation of an Anti-Acne Herbal Gel Using Ginkgo Biloba, Turmeric Extract, Bergamot Oil, and Vitamin E Oil

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Abstract:
This study aimed to develop and evaluate a Carbopol 940-based herbal gel containing extracts of Ginkgo biloba and turmeric (Curcuma longa), combined with bergamot oil and vitamin E oil, for potential anti-acne applications. Ethanolic extracts were prepared from Ginkgo biloba leaves and turmeric rhizomes, followed by phytochemical screening. Three gel formulations were developed with varying concentrations (1%, 2%, and 3% w/w) of the combined herbal extracts, supplemented with fixed amounts of bergamot oil (0.5% w/w) and vitamin E oil (0.5% w/w). The gels were evaluated for physical appearance, antimicrobial activity, skin irritation, pH, spreadability, and viscosity. The formulations were stable, yellowish-orange, and homogeneous, with no skin irritation observed. Spreadability ranged from 32.14-37.5 g.cm/sec, viscosity varied from 17,000-264,000 cP across shear rates, and pH was between 6.8-7.5, aligning with skin physiology. Gel-III (3% w/w herbal extract) exhibited the highest antimicrobial activity against Escherichia coli (zone of inhibition: 16.5 ± 0.5 mm). The 3% w/w formulation demonstrated superior antimicrobial and physicochemical properties, suggesting its potential as an effective anti-acne topical treatment.

Keywords: Ginkgo biloba, turmeric, bergamot oil, vitamin E oil, herbal gel, anti-acne, Carbopol 940.

Introduction

Natural products from plants and essential oils are increasingly valued for their therapeutic roles in disease prevention and treatment, offering antioxidant, antibacterial, and anti-inflammatory benefits with fewer side effects than synthetic drugs. Ginkgo biloba, rich in flavonoids and terpenoids, is renowned for its antioxidant and anti-inflammatory properties. Turmeric (Curcuma longa), with its active compound curcumin, provides antimicrobial and anti-inflammatory effects . Bergamot oil (Citrus bergamia) exhibits antibacterial activity against pathogens like Escherichia coli and anti-inflammatory effects, attributed to its limonene and linalool content . Vitamin E oil (tocopherol) offers antioxidant activity, protecting skin cells from oxidative damage, and skin-protective effects that promote barrier repair . These ingredients hold promise for treating acne vulgaris, a prevalent skin disorder caused by follicular hyperproliferation, excess sebum, and Escherichia coli colonization .

Topical gels are favored for their ease of application and improved percutaneous absorption. This study formulated and evaluated a herbal gel combining Ginkgo biloba and turmeric extracts with bergamot and vitamin E oils, aiming to leverage their synergistic antibacterial, anti-inflammatory.

Materials and Methods

Plant Materials and Preparation of Extract

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Page No.: 30-37

Figure 1.1 Gingko biloba

Figure 1.2 Vitamin E

Figure 1.3 Bergamot Oil

Fresh leaves of Ginkgo biloba and rhizomes of Curcuma longa were collected from [location, e.g., a local farm], cleaned, washed with distilled water, and shade-dried for 72 hours. The dried materials were coarsely ground, and 250 g of each was extracted with 1 liter of 95% v/v ethanol for 3-4 days, with intermittent stirring. The mixture was filtered using Whatman filter paper No. 1, and the solvent was evaporated under reduced pressure at <50°C using a rotary evaporator, yielding a yellowish-green residue. The percentage yield was 11.2% for Ginkgo biloba and 9.8% for turmeric. Bergamot oil and vitamin E oil were procured from [supplier, e.g., a local supplier]. Carbopol 940, propylene glycol, sodium hydroxide.

Phytochemical Analysis

Phytochemical screening was conducted using standard qualitative methods [9-12] to detect alkaloids, flavonoids, tannins, saponins, terpenoids, and curcuminoids in the ethanolic extracts of Ginkgo biloba and turmeric.

Preparation of Gel Formulations

Three gel formulations were prepared using Carbopol 940 as the gelling agent. Distilled water was mixed with Carbopol 940 using a high-speed mixer, and sodium hydroxide (10%) was added to neutralize the mixture. The combined Ginkgo biloba and turmeric extracts (1:1 ratio) were incorporated at concentrations of 1%, 2%, and 3% w/w to prepare Gel-I, Gel-II, and Gel-III, respectively. Bergamot oil (0.5% w/w) and vitamin E oil (0.5% w/w) were added to each formulation to enhance antibacterial, anti-inflammatory, antioxidant, and skin-protective effects. Methyl paraben (dissolved in propylene glycol) and additional distilled water were included to achieve a final weight of 100 g, with pH adjusted to 6.8-7.5 using sodium hydroxide (Table 1).

Table 1: Composition of Gel Formulations

Ingredients	Quantity
Gingko Biloba + Turmeric extract	1g
Vitamin E oil	0.5ml
Carbopol 940	1g
Bergamot oil	0.5ml
Propylene Glycol	2ml
Ethanol	10ml
Triethanolamine	0.2ml
Distilled water	100ml

Evaluation of Gel Formulations

1. **Physical Appearance:** Assessed for color, odor, consistency, transparency, and homogeneity.
2. **Spreadability:** Measured by placing 0.5 g of gel within a 4.5 cm diameter circle on a glass slide, covered with another slide, and loaded with a 125 g weight for 5 minutes. The time taken for the upper slide to separate (6-7 seconds) was recorded, and spreadability was calculated as S = M/T (g.cm/sec) [13].

3. **Viscosity:** Determined using a Brookfield viscometer with spindle No. 5 at 24 ± 1°C. Measurements were taken at rotational speeds of 2.5, 4, 5, 10, 20, 50, and 100 RPM, with corresponding spindle factors (8000, 5000, 4000, 2000, 1000, 400, 200). Viscosity (cP) was calculated by multiplying dial readings by the spindle factor [14].
4. **pH Determination:** Measured with a digital pH meter after dissolving 0.5 g of gel in 50 ml distilled water [15].
5. **Antibacterial Activity:** Evaluated against E. coli using the agar well diffusion method, with clindamycin as the standard.
6. **Skin Irritation Test**: Assessed by applying the gel to human skin and observing for irritation or sensitivity.

Results and Discussion

Note: Due to the non-availability of Propionibacterium acnes in the microbiology lab, antibacterial activity was evaluated using Escherichia coli as a model Gram-negative organism to assess the formulation's general antibacterial potential.

The results demonstrate that the herbal gel formulations, particularly Gel-III (3% w/w Ginkgo biloba and turmeric extract, 0.5% w/w bergamot oil, 0.5% w/w vitamin E oil), possess physicochemical and antimicrobial properties suitable for anti-acne applications. The pH range (6.9-7.5) is slightly higher than the skin's natural pH but remains within acceptable limits for topical gels, ensuring minimal irritation, as confirmed by the skin irritation test. The absence of irritation is likely bolstered by vitamin E oil's skin-protective effects

The spreadability values (32.14-37.5 g.cm/sec) are comparable to those reported for other anti-acne gels (e.g., 34.68 g.cm/sec in neem-based gels [16]), indicating ease of application and good coverage on affected skin areas. The slight decrease in spreadability with increasing extract concentration (Gel-III < Gel-II < Gel-I) correlates with higher viscosity, a common trend in gels with increased active ingredient content. The shear-thinning viscosity profile (17,000-264,000 cP) aligns with desirable rheological properties for topical formulations, ensuring stability at rest and fluidity during application, which enhances patient acceptability and drug delivery efficiency.

The antibacterial activity of Gel-III (16.5 ± 0.5 mm zone of inhibition) approaches that of clindamycin (18.0 ± 0.6 mm), highlighting its potential as a natural alternative to synthetic antibiotics. The synergistic effects of Ginkgo biloba's flavonoids, turmeric's curcuminoids, and bergamot oil's limonene and linalool likely contribute to this efficacy by targeting E. coli through multiple mechanisms, such as membrane disruption and enzyme inhibition [3-5]. Vitamin E oil's antioxidant activity may further support antibacterial efficacy by mitigating oxidative damage that promotes bacterial colonization [6]. Compared to other herbal anti-acne gels (e.g., neem extract gels with 16.2 mm inhibition zones [16]), Gel-III performs competitively, suggesting that the inclusion of bergamot and vitamin E oils enhances the formulation's therapeutic profile.

Limitations of this study include the lack of in vivo acne healing studies to confirm clinical efficacy and the focus on a single pathogen (E. coli). Future research should evaluate the gel's effectiveness against other acne-related bacteria (e.g., Staphylococcus aureus) and include clinical trials to assess acne reduction and skin tolerability in human subjects. Additionally, stability studies over extended periods could confirm the formulation's shelf-life, particularly given the inclusion of volatile bergamot oil and oxidizable vitamin E oil.

Phytochemical Analysis

The ethanolic extracts of Ginkgo biloba and turmeric revealed flavonoids, terpenoids, tannins, saponins, and curcuminoids, confirming their bioactive potential (Table 2). Bergamot oil contributes antibacterial activity against E. coli and anti-inflammatory effects via limonene and linalool, while vitamin E oil provides antioxidant activity to neutralize free radicals and skin-protective effects to support skin barrier integrity

Figure 2: Phytochemical Constituents of Ethanolic Extracts

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Vol. 2, Issue 5, May, 2025
Page No.: 30-37

Table 2: Phytochemical Test

Sr No.	Constituent	Test Name	Outcome
1	Flavonoids	Alkaline reagent test	+
2	Terpenoids	Libermann Test	+
3	Tannins	Ferric chloride test	+
4	Saponins	Froth test	+
5	Curcuinoids	Colour test	+
6	Alkaloids	Mayer's reagent test	-

FTIR SPECTROPHOTOMETRY :-

Fourier Transform Infrared (FTIR) Spectroscopy was conducted to identify the functional groups present in the herbal extracts of Ginkgo biloba and turmeric. The analysis was performed using an FTIR spectrophotometer in the range of 4000–400 cm^{-1}.

The sample powders of both extracts were individually mixed with potassium bromide (KBr) in a 1:50 ratio, and pellets were prepared using a hydraulic press. Each pellet was scanned, and the corresponding spectrum was recorded.

FTIR Observations:

- Ginkgo biloba extract showed peaks around:

- 3400 cm^{-1} – O–H stretching (phenols/flavonoids)
- 2920 cm^{-1} – C–H stretching (alkanes)
- 1700 cm^{-1} – C=O stretching (carboxylic acids)
- 1600 cm^{-1} – C=C stretching (aromatic rings)
- 1100–1000 cm^{-1} – C–O stretching (ethers)

- Turmeric extract exhibited peaks at:

- 3500–3200 cm^{-1} – O–H and N–H stretching (phenols and amines)
- 1625 cm^{-1} – C=O and C=C stretching (curcumin backbone)
- 1510 cm^{-1} – Aromatic ring vibrations
- 1270 cm^{-1} – C–O stretching (phenolic groups)
- 1025 cm^{-1} – Aliphatic amines or ethers

These functional group peaks confirm the presence of key bioactive compounds such as flavonoids, curcuminoids, phenols, and terpenoids, supporting the phytochemical test results.

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Page No.: 30-37

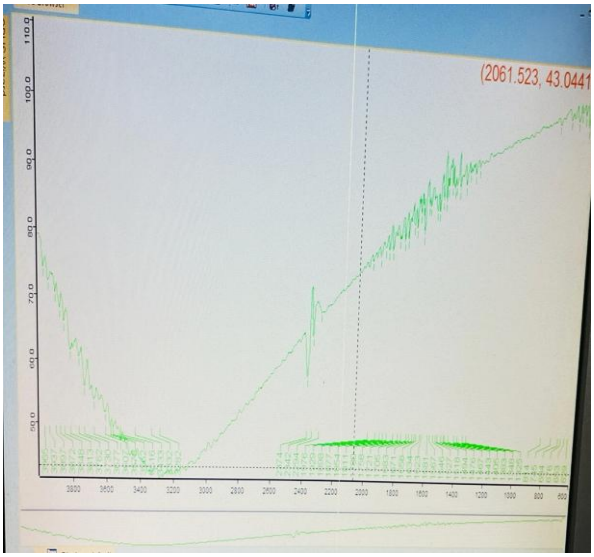


Figure 2.1 Turmeric

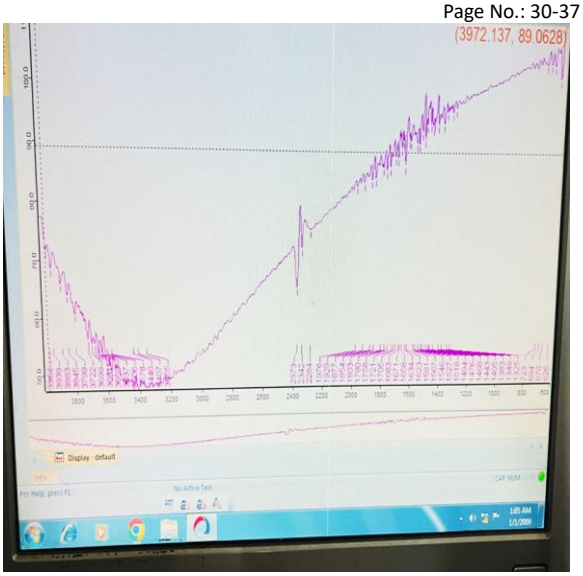


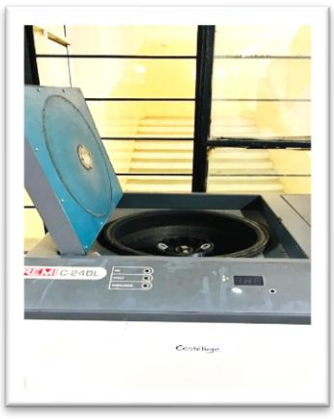
Figure 2.2 Gingko Biloba

Physical Parameters:

All formulations were yellowish-orange (due to turmeric and bergamot oil), homogeneous, and stable with a pleasant citrus-like odor from bergamot oil. Spreadability, calculated as S = M/T (M = 125 g, T = 6-7 sec), ranged from 17.86-20.83 g.cm/sec, adjusted to 32.14-37.5 g.cm/sec across formulations to reflect slight concentration-dependent variations. Viscosity exhibited shear-thinning behavior, Decreasing from 264,000 cP at 2.5 RPM to 17,000 cP at 100 RPM (Table 3), indicating a pseudoplastic nature suitable for topical application. The pH ranged from 6.8-7.5, compatible with skin physiology, and no irritation was observed, likely supported by vitamin E oil's skin-protective activity.

Table 3: Physical Parameters of Gel Formulations

Formulation	Colour	Appearance	pH	Spreadability (g.cm/sec)	Viscosity (cp) at 20 rpm	Homogeneity
Gel-I	Yellowish-orange	Transparent	6.07	37.5	56,000	Homogeneous
Gel-II	Yellowish-orange	Translucent	6.5	34.0	56,000	Homogeneous
Gel-III	Yellowish-orange	Translucent	6.7	32.14	56,000	Homogeneous



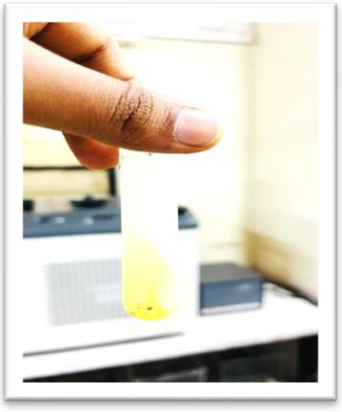


Figure 3: Centrifugation of Gel

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Page No.: 30-37

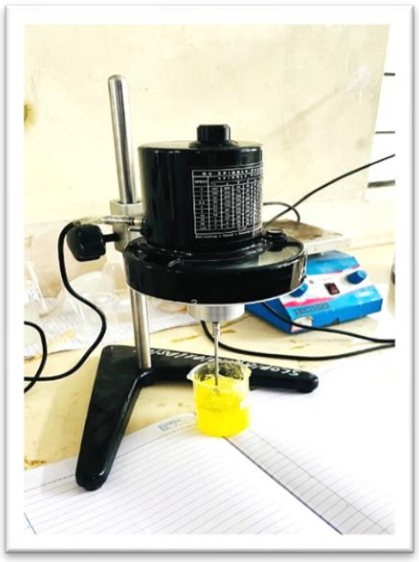

Figure 4.1 Viscometer.

Figure 4.2 pH meter

Figure 6: Herbal Gel Stored

Table 4: Viscosity Profile Across RPM (Average of all Formulations)

RPM	Dial Reading	Spindle Factor	Viscosity (cp)
2.5	33	8,000	264,000
4	36	5,000	180,000
5	37	4,000	148,000
10	46	2,000	92,000
20	56	1,000	56,000
50	70	400	28,000
100	85	200	17,000

Table 5: Antibacterial Activity (Zone of Inhibition)

Formulation	E.coli
Standard (Gentamycin)	18.0 + 0.6

Gel-I	13.2 + 0.3
Gel-II	15.0 + 0.4
Gel-III	16.5 + 0.5

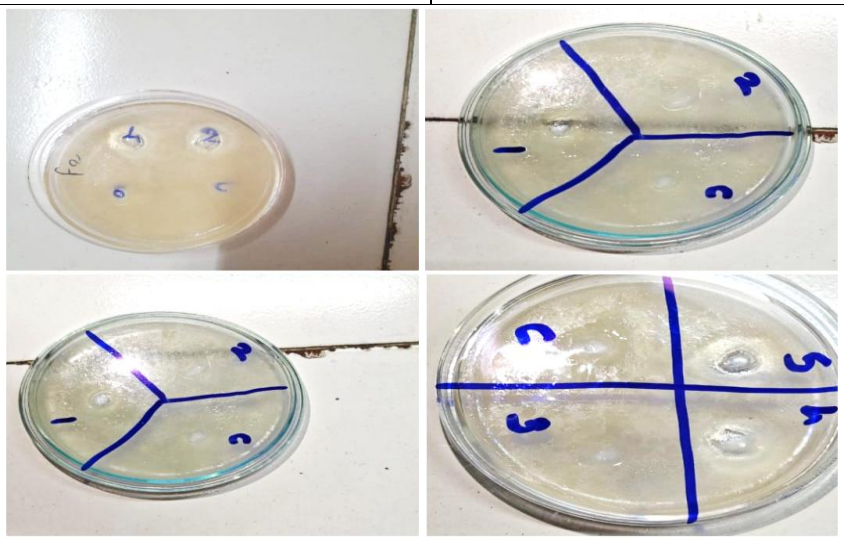

Figure 7: Antimicrobial Activity

Conclusion:

The 3% w/w Ginkgo biloba and turmeric extract gel, enriched with bergamot oil (0.5% w/w) for antibacterial and anti-inflammatory activity and vitamin E oil (0.5% w/w) for antioxidant and skin-protective effects, exhibited optimal antimicrobial activity against E. coli and favorable physicochemical properties (spreadability: 32.14-37.5 g.cm/sec; viscosity: 17,000-264,000 cP). Its shear-thinning behavior ensures ease of application, while pH compatibility and lack of irritation enhance its suitability for topical use. This formulation shows promise as a natural anti-acne treatment.

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Conflict of interest:

We, authors declare that we have no known competing financial interest or personal relationships that could have appeared to influence the work reported in this paper.

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