RESEARCH ARTICLE

Pharmacognostic, Pharmacological, and Formulation Perspectives of *Curcuma aromatica*

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ABSTRACT
Curcuma aromatica Salisb (*C. aromatica*) goes by several names: "Savanaharidra" in Ayurveda, "wild turmeric" in English, "Yu Jin" in Chinese, and "jangli haldi" in Hindi. It has several traditional uses in South-east Asian medicine, including coloring and flavoring foods and drinks. The purpose of this research is threefold: first, to understand the pharmacognostic features of *C. aromatica* rhizome through techniques like phytochemical screening and powder microscopy; second, to investigate the pharmacological activities of the hydroalcoholic extract of *C. aromatica* through studies of its antimicrobial effects *in vitro*; and third, to develop topical gel formulation containing *C. aromatica* and explore the antimicrobial activity of the products along with short-term accelerated stability study of the optimized formulation. The research shed light on the salient characteristics of *C. aromatica*, including its physicochemical and pharmacognostic properties. Several phytochemicals were identified via preliminary analysis. The presence of pharmacological activities, such as antibacterial and antifungal properties, was also uncovered in the investigation.
Keywords: *Curcuma aromatica*, Pharmacognostic, Pharmacological, Formulation, Physicochemical, Histological
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INTRODUCTION

Curcuma aromatica Salisb (C. aromatica) is known by various names across different cultures: "Savanaharidra" in Ayurveda, "wild turmeric" in English, "jangli haldi" in Hindi, and "Yu Jin" in Chinese.[1] Traditionally, it has been widely used in Southeast Asian medicine for purposes such as coloring and flavoring food and beverages. Its potent antibacterial properties have established it as a key remedy for numerous microbial infections since ancient times. The rhizomes of *C. aromatica* have been employed in traditional healing practices to relieve pain, slow the aging process, treat liver disorders, and prevent blood stagnation. When taken orally, these rhizomes serve as a carminative and tonic, while topical applications address various skin conditions.[2] In northeastern Indian villages, a paste made from aqueous extracts of *C. aromatica* rhizomes and leaves is commonly used to treat digestive issues like dyspepsia, rheumatism, wounds, diarrhea, and to protect against helminth infections. Additionally, the rhizome and roots of *C. aromatica* are popular ingredients in Thai spa therapies and skincare formulations.[3]

Research into the historical medicinal uses of *C. aromatica* rhizome extract is ongoing in the present scientific community with the hope of advancing modern medicine. Among these uses are those for wound healing, allergies, acne, obesity, antiangiogenic, antioxidant, antimicrobial, anti-inflammatory, antidiabetic, anticancer, antitussive, and antiallergic.[4] Evidence suggests that the rhizome of *C. aromatica* contains a wealth of compounds of medicinal value, including alkaloids, curcuminoids, flavonoids, terpenoids, and tannins.[5] Isolating and characterising the plant's major bioactive components with important medicinal qualities might lead to pharmaceutical applications, considering the plant's enormous therapeutic potential.

The purpose of this research is threefold: first, to understand the pharmacognostic features of *C. aromatica* rhizome through techniques like phytochemical screening and powder microscopy; second, to investigate the pharmacological activities of the hydroalcoholic extract of *C. aromatica* through studies of its antimicrobial effects *in vitro*; and third, to develop topical gel formulation containing *C. aromatica* and explore the antimicrobial activity of the products along with short-term accelerated stability study.

MATERIALS AND METHODS

Instrumentation

The research employed a computer-linked double-beam UV-Visible Spectrophotometer (Shimadzu®). Measurements were taken using quartz cuvettes with uniform 10 mm path lengths. All sample weighings were

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performed with a electronic balance (Shimadzu®). Sonication was carried out through digital sonicator (USA). Data capture was facilitated through Scope Image 9.0 software, while microscopic observations were conducted using a CosLab® HL-24(B) trinocular microscope.

Chemicals

A local vendor in Bilaspur procured all the chemicals, consumables, and reagents for the assessment from Sigma-Aldrich (India) and HiMedia (Germany). The experiment used double distilled water equipment from Borosil® in India.

Collection of Plant Material

In medicinal garden of J. K. College of Pharmacy in the Gatora neighbourhood of Bilaspur city, Chhattisgarh state, India, the rhizomes of the *Curcuma aromatica* tree were plucked. A botanist from Guru Ghasidas University in Bilaspur, Chhattisgarh certified the plant.

Preparation of Extract

We took the rhizomes from the tree, let them dry in the shade for a while, and then ground them up to the right consistency. A total of 100 g of dried powder was subjected to hot Soxhlet extraction using a solvent mixture composed of equal parts distilled water and 90% ethanol (50 mL each). The extraction process was carried out at 55–65°C for 32 cycles to ensure thorough extraction. A rotating vacuum evaporator was used to extract the solvent while maintaining controlled temperature and lowered pressure. The results showed a hydroalcoholic thorn extract yield of 11.8% w/w for *C. aromatica.*[6]

Pharmacognostic Evaluations

We looked at the organoleptic, physicochemical, histological, and phytochemical properties of C. aromatica rhizome powder. Considerable attention was paid to the organoleptic aspects, including form, size, texture, colour, and fracture. Following the procedures outlined in the Indian Pharmacopoeia (2020), the physiochemical parameters were studied. Since too much water in plant materials encourages bacterial development, mould presence, and degradation via hydrolytic activity, the LOD determination is very important. Chalk powder, earthy silica minerals, lime, and other earthy stuff may be identified by looking at the total ash value. If you're looking for earthy materials with a high concentration of calcium oxalate crystals in their cells, you can utilise acid insoluble ash; if you're looking for water-exhausted materials, you may use water-soluble ash. When the drug's extractive values are soluble in alcohol, it indicates that there are adulterants, production errors, or low quality ingredients. Histological examination of the transverse section was carried out using a trinocular microscope set at 30x magnification for accurate anatomical identification. Sulfuric acid and phloroglucinol were used to stain the portion. We used a trinocular microscope with a 10x magnification to conduct powder microscopy after suitably staining the sample. Features that were crucial were identified and appropriately written down.[7]

Phytochemical Evaluation

Phytochemicals were all identified by phytochemical screening of the extract, using the specified standard test protocols.[8]

Table 1: Formulation Chart

INGREDIENTS	F1	F2	F3	F4
Aqueous *C. aromatica* extract (g)	1	-	-	-
Methanol *C. aromatica* extract (g)	-	1	-	-
Ethyl acetate *C. aromatica* extract (g)	-	-	1	-
Petroleum ether *C. aromatica* extract (g)	-	-	-	1
Carbapol 940 (g)	1	1	1	1
Triethanolamine (mL)	0.4	0.4	0.4	0.4
Ethanol (mL)	24.5	24.5	24.5	24.5
DMSO (mL)	2	2	2	2
Distilled Water (mL)	74.1	74.1	74.1	74.1

Table 2: Physicochemical evaluations

Parameters	Description
% compressibility index	47.23
Acid insoluble ash (% w/w)	2.55
Alcohol soluble extractive value	8.02
Bulk density (g/cm^3)	0.336
Color	Yellow-brown
Loss on drying (105°C) (%)	0.31
Shape	Irregular
Size	22 – 26 mm
Tapped density (g/cm^3)	0.294
Texture	Rough
Total ash content (% w/w)	14.49
Water soluble ash (% w/w)	7.11

***In Vitro* Antimicrobial Activity**

Researchers tested extract's antimicrobial properties in vitro against a number of harmful bacterial species [*E. coli*, *K. pneumoniae*, and *B. subtilis*], and. Extract was also tested for its antifungal efficacy *in vitro* against *Aspergillus niger* and *Candida albicans*, two types of fungus strains. Several compounds were compared to two reference drugs, ciprofloxacin (anti-bacterial) and fluconazole (anti-fungal).[9]

Antibacterial Activity

The disc diffusion technique on Mueller Hinton Agar was used to evaluate the extract's antimicrobial properties in vitro. In the beginning the varieties of bacteria were cultivated in a broth with nutrients and then incubated at 37°C for 24 hours. After that, hygiene procedures were used to evenly distribute locally generated cultures onto Mueller Hinton Agar plates. The substance that was mixed with dimethyl sulfoxide (DMSO) was coated into the outermost layers of the infected plates using sterility Whatman No. 1 filter paper discs (6 mm in diameter). The antibacterial efficacy of the above discs was assessed by measuring the width of the boundaries of inhibition in millimeters following a 24-hour incubation period at 37°C. The chosen medication was ciprofloxacin, while the negative counterpart was a disc treated with DMSO.[10]

Antifungal Activity

Following typical experimental circumstances, the extract's antifungal potential was assessed in vitro on Potato Dextrose Agar employing the surface diffusion technique. Sterile Whatman No. 1 filter paper sheets (6 mm in

Table 3: Phytochemical analysis

Group	Test	Examination	Results
Alkaloid	Hager's test	Yellow precipitate	Alkaloid present
Flavonoid	Shinoda's test	Pinkish-red color	Flavonoid present
Tannin	Gelatin test	Green color appeared	Tannin present
Glycoside	Borntrager's test	No Faint pink color observed	Anthraquinone glycoside absent
Glycoside	Legal's test	No red color observed	Cardiac glycoside absent
Saponin	Froth formation test	Froth formation	Saponin present
Carbohydrate	Fehling's test	No Red precipitate	Carbohydrate absent
Phenol	$FeCl_3$ test	Bluish-black color observed	Phenol present
Protein	Xanthoprotic test	No yellow color observed	Protein absent
Sterol	Libermann-Burchard's test	Brown-ring formation	Sterol present
Diterpene	Copper acetate test	Eemerald green color observed	Diterpene present
Triterpene	Salkowski's test	Yellow color observed	Triterpene present

Table 4: Antimicrobial activity of *C. aromatica* extract

	E. coli	*B. subtilis*	*K. pneumonia*	*C. albicans*	*A. niger*
Curcuma aromatica	21.9 ± 1.31*** (50)	19.3 ± 1.33*** (12.5)	22.4 ± 1.37*** (25)	25.4 ± 0.88 (12.5)	19.6 ± 1.47*** (12.5)
Ciprofloxacin[#]	29.6 ± 0.57*** (6.25)	26.6 ± 1.15*** (6.25)	27.3 ± 0.57*** (6.25)	-	-
Fluconazole[$]	-	-	-	32.3 ± 1.15*** (6.25)	31.6 ± 0.66*** (6.25)

diameter) saturated with certain amounts of the extractive (100 µg/mL) and fluconazole (50 µg/mL) had been meticulously deposited upon the exterior of agar sheets following their had been infected containing an established solution of the test fungal strains. The inoculation plates were kept warm for 72 hours at 28 ± 2°C to assess the antifungal effectiveness. The control for negativity was a disk that was flooded with dimethyl sulfoxide.[11]

MIC Determination

The agar streak dilution technique was used to find the extract's MIC. The resulting substance was first made into an initial preparation in dimethyl sulfoxide at a concentration of 100 µg/mL. This solution's estimated quantities were added to uncontaminated, melted Mueller Hinton Agar that was kept between 40 and 50°C. A sturdy coating of about 3–4 mm thick was created by pouring the liquid onto sterile Petri dishes. The specimen of the extract-containing cemented agar was subsequent streaked with a microbiological solution that had been modified to 10^5 CFU/mL. For twenty-four hours, the previously created plates underwent incubation at 37±1°C.[12]

Formulation Development

The gel formulation consisted of *C. aromatica* extract, carbopol 940, triethanolamine, ethanol, and distilled water. Initially, the *C. aromatica* extract was blended with distilled water and ethanol. Separately, carbopol 940 was pre-hydrated using a solution of ethanol and distilled water. This hydrated carbopol mixture was then gradually added to the *C. aromatica* extract solution with continuous stirring to ensure uniform blending. As the gel began to form, dimethyl sulfoxide (DMSO) was incorporated as a permeation enhancer. The formulation was then allowed to stand undisturbed to complete the gelling process (Table 1).[13]

Evaluation Parameters[14]

Extrudability

To test the formulation's extrudability, 100 g of gels were initially placed into collapsible aluminium tubes with caps and sealed accordingly. The tubes, each holding a unique recipe, were securely clamped between two slides. After a duration of 10 minutes, a 500 g weight was placed on the slides, and the cap was subsequently opened to allow extrusion. The length of the gel ribbon extruded was then measured to assess the formulation's extrudability.

pH

A digital pH metre that had been calibrated was used to measure the dermal gel's pH. A glass electrode was immersed in a mixture prepared by dissolving 1 gram of the formulation in 25 mL of distilled water, and the reading was recorded once it stabilized. Each formulation underwent pH assessment in triplicate, and the average of the three measurements was documented as the final value.

Physical Appearance

The developed polyherbal gel was examined visually for its transparency, colour, and overall look. By feeling the mixture between the fingers and looking for lumps, roughness, homogeneity, and smoothness, we were able to measure the gel's smoothness.

Skin Irritation Test

A semi-occlusive bandage was used to cover the normally hairless skin for one hour after applying 0.5 g of the prepared gel over a 6 cm^2 region. Following the application period, the bandage was carefully taken off, and any remaining gel was completely removed from the skin. The treated area was then visually inspected for any signs of irritation, such as redness, rashes, or related dermatological reactions. This observation was carried out over a period of seven days. Grades were used to express the outcomes.

Spreadability

The spreadability of the polyherbal dermal gel was assessed based on the slip and drag principle. In this method, 2 grams of the gel formulation were evenly placed on a glass slide, which was then covered with another similar slide equipped

Table 5: Gel formulation description

Characteristics	F1	F2	F3	F4
Extrudability	+++	++	+++	+++
pH	6.3	6.6	6.1	6.5
Skin Irritancy	No irritation	No irritation	No irritation	No irritation
Spreadability (g.cm/sec)	13.76	17.81	15.66	16.37
Swelling index (%)	112	113	109	115
Viscosity (cps)	55000	49500	52300	51900
Washability	Best	Medium	Lowest	Medium

with a hook. To ensure uniform distribution and eliminate any air bubbles, a weighted object was placed on the slides, allowing the gel to form a consistent layer. Excess gel was carefully removed from the edges. Subsequently, the upper slide was subjected to a pulling force of 50 grams to evaluate the spreadability of the formulation. The formula was used to calculate the time it took for the top slide to travel a distance of 6 cm:

$S = M \times L / T$

Swelling Index

Quickly after preparation, 5 mL of emulsion was added to plastic pots to assess the creaming index. After 4 hours, the amount of the cream that had developed was measured in order to estimate the creaming %. By dissolving 2 grammes of the dermal polyherbal gel in 10 millilitres of distilled water, the swelling index of the finished product was ascertained. After one hour, the formula that had inflated was transferred from the beaker to a petridish. After reweighing the contents, we were able to determine the swelling index through:

$Si = Wt - Wo / Wo$

Viscosity

Using spindle number 6 at 25±1°C and 10 rpm, the Digital Brookfield Viscometer was used to determine the formulation's viscosity. Before taking the measurements, the gel was allowed to settle for at least 30 minutes in a wide-mouthed container that was filled to the brim with enough to submerge the spindle.

Washability

After applying the gel to the skin, we personally observed its impact and evaluated how easy it was to wash off with distilled water to determine the formulations' washability.

Accelerated Stability Studies

For 90 days, the optimised formulation was tested under controlled conditions of 40°C±2°C of temperature and 75%±5% of relative humidity. A PVC container was used to store the gel formulation that had been made, and it was covered with black foil. The crucial parameters that were previously discussed were reevaluated.

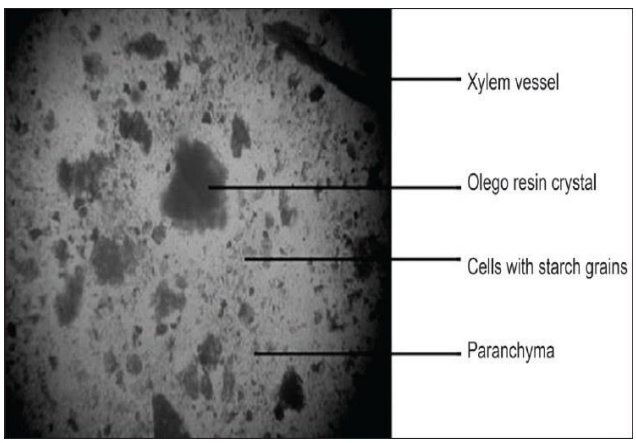

Figure 1: Powder Microscopy of *Curcuma aromatica*

Statistical Analysis

We performed all of our experiments three times. The resultant results were presented as the average plus or minus SD. Minitab® v.17 was used for statistical computations. When comparing the control and experimental groups for pharmacological activity, Student t-test was employed.

RESULTS

Physicochemical Evaluations

The rhizomes exhibited a coarse surface texture, a conical shape, and coloration varying from light ash to greyish-brown. Their size ranged between 18 and 26 mm. Physicochemical analysis indicated low moisture content, suggesting a reduced risk of spoilage, discoloration, or fungal contamination—issues commonly associated with high water levels. The moisture loss, assessed as loss on drying, was found to be 0.43%, aligning with pharmacopoeial standards. The total ash content measured 15.13% w/w, acid-insoluble ash was 1.98% w/w, and water-soluble ash stood at 6.56% w/w, confirming that the levels of inorganic impurities remained within acceptable limits. The powder demonstrated a high compressibility index of 42.85%, indicating poor flow properties. Furthermore, the material possessed a fine capillary network with extensive inter- and intra-particle voids. The alcohol-soluble extractive value was recorded at 9.82%, with corresponding bulk and tapped densities of 0.156 g/cm³ and 0.273 g/cm³, respectively, as detailed in Table 2.

Phytochemical Analysis

Carbohydrates, tannins, flavonoids, alkaloids, sterols, phenol, diterpenes, triterpenes, and glycosides were identified by phytochemical screening of the extract (Table 3).

Pharmacognostic Study

The transverse section of the rhizome revealed distinct anatomical structures, including the cork cambium, cortex, starch granules, stone cells, and parenchymatous tissues. The cork layer consisted of suberin-rich, brick-shaped or polygonal cells. Most of the phloem tissue was composed of parenchymatous cells. Notably, the rhizome featured well-defined polygonal stone cells—sclerenchymatous in nature—adapted to enhance structural support. Rigid, thick-walled cells that seemed either isodiametric or polyhedral and were discovered to be highly lignified made up the cortex. The high tannin concentration in thorn gives it a brownish-reddish brown color. There were starch granules

Table 6: Evaluation of the antimicrobial properties of the herbal extracts, gel-based formulations, reference antibiotic, and commercially available herbal product

Components	*E. coli*	*B. subtilis*
C. aromatica aqueous extract	13.6 ± 1.17*** (12.5)	11.7 ± 1.99*** (12.5)
C. aromatica ethyl acetate extract	14.2 ± 1.91*** (12.5)	15.8 ± 1.81*** (12.5)
C. aromatica methanol extract	16.9 ± 1.43*** (12.5)	13.5 ± 1.63*** (12.5)
C. aromatica petroleum ether extract	19.3 ± 1.33*** (12.5)	17.6 ± 1.47*** (12.5)
Clindamycin [#]	29.9 ± 1.57 (6.25)	28.1 ± 1.15 (6.25)
F1	22.4 ± 1.37*** (25)	20.2 ± 1.47*** (25)
F2	24.1 ± 1.72*** (25)	23.6 ± 1.69*** (25)
F3	20.7 ± 1.44*** (25)	21.9 ± 1.31*** (25)
F4	23.9 ± 1.73*** (25)	22.3 ± 1.52*** (25)
Marketed herbal formulation	24.8 ± 0.96 (12.5)	25.4 ± 0.88 (12.5)

of different sizes found. It was common to see thick-walled parenchymatous cells in the xylem part of the cross-section. Powder microscopy revealed several noteworthy features. There were heterogeneous rays that were either uni- or multi-seriate (1–11 seriate), and they were made up of procumbent cells and sheath cells. Innumerable small starch granules of varying sizes and fibres that did not separate were discovered. In the parenchyma strands, the fibers were either diffused into aggregates or organised in narrow bands. Fibres were organized alternately with considerable axial parenchyma, much of which was apotracheal, although it was obscure to the naked eye. It is common to see cells arranged in a single row that are upright (Figure 1).

Biological Activities

Antimicrobial Activity of Extract

Curcuma aromatica exhibited moderate antimicrobial activity against a range of microbial strains, including *Escherichia coli*, *Bacillus subtilis*, *Klebsiella pneumoniae*, *Candida albicans*, and *Aspergillus niger*. Among the tested organisms, the highest antibacterial effect was observed against *B. subtilis*, with a zone of inhibition (ZOI) measuring 16.6 mm and a minimum inhibitory concentration (MIC) of 12.5 µg/mL. However, these results were inferior to the standard antibiotic ciprofloxacin, which demonstrated a larger ZOI of 26.6 mm at a lower MIC of 6.25 µg/mL, as shown in Table 4. The extract showed weak antibacterial activity against *K. pneumoniae*, evidenced by a ZOI of 11.3 mm at a concentration of 50 µg/mL. Moderate efficacy was noted against *E. coli*, with a ZOI of 13.6 mm and an MIC of 12.5 µg/mL. In antifungal testing, the extract significantly inhibited the growth of *C. albicans* and *A. niger*. For *C. albicans*, a ZOI of 18.3 mm was recorded at an MIC of 25 µg/mL, while *A. niger* showed slightly better susceptibility, with a ZOI of 17.3 mm at an MIC of 12.5 µg/mL (Table 4). Although these antifungal effects were weaker than those of fluconazole, which produced a ZOI of 31.6 mm, the extract demonstrated comparatively greater potency against *A. niger* than *C. albicans*.

Characterization of Herbal Gel Formulation

Extrudability

An impressive extrudability spanning from ++ to +++ was shown by the prepared herbal gels. Extrudability, which allows for simple extrusion from the collapsible tube, falls in tandem with formulation viscosity.

pH

Herbal gel formulations (F1–F4) have pH values between 6.1 and 6.6, which is quite near to the skin's natural pH range (Table 4).

Physical Appearance

The colour, look, and transparency of the gel compositions were assessed visually. No matter the recipe, they were all oily, semi-solid, off-white to coloured, and partially see-through. The homogeneity, smoothness, clumpiness, and greasiness of the ointment formulations were determined by rubbing it between the fingers. The developed herbal gel formulations (F1-F4), although somewhat greasy, did not contain any particles, clumps, or aggregations.

Skin Irritancy

Following a week of using herbal gel formulations (F1-F4), there were no noticeable rashes, swelling, redness, or inflammation detected in the skin irritation test.

Spreadability

The spreadability of the ointment formulation was found to be rather limited, ranging from 13.76 to 17.81 g.cm/sec, for the herbal gel formulations (F1–F4). An analysis of the relationship between the two variables showed that the spreadability decreases dramatically when the formulation viscosity increases.

Swelling Index

A swelling index ranging from 106% to 115% was noted. Because the gel formulation is matrix-based, the swelling index indicated that the therapeutic material may be released in a controlled manner.

Viscosity

An important component that affects the spreadability, extrudability, and pourability of pharmaceuticals is their viscosity. Formulations F1–F4 of herbal gels have viscosities between 49,500 and 55,000 cps. Research on rheology has shown that formulation viscosity drops as torque rises because shear stress grows so dramatically.

Washability Test

All the herbal gel ointment formulations that were produced have an excellent washability feature. In terms of washability, formulation F1 was superior than formulation F3, which had the worst results.

Accelerated Stability Testing

After 90 days of storage under accelerated conditions ($40 \pm 2°C$ and $75 \pm 5\%$ relative humidity), the optimized formulation (F2) maintained stability in key parameters, including pH, viscosity, spreadability, swelling index, extrudability, and overall physical characteristics. While

minor variations were observed—specifically, a pH shift of 0.3 units, a viscosity change of 1000 cps, and a spreadability difference of 1.14 g·cm/sec—these changes were not considered significant. Additionally, no noticeable alterations were detected in the formulation's transparency, texture, or visual appearance (Table 5). The formulation was stable during the three months, and it will likely stay that way for much longer in tropical and subtropical climates.

Antimicrobial Study of Formulations

The antibacterial evaluation results for the herbal extracts, gel formulations, reference drug, and a commercially available herbal product are summarized in Table 6. The aqueous extract of *Curcuma aromatica* demonstrated minimal antibacterial effects. In comparison, the methanolic and ethyl acetate extracts of *C. aromatica* exhibited moderate inhibitory activity, as reflected by their average minimum inhibitory concentration (MIC) values against *Escherichia coli* and *Bacillus subtilis*. Among all extracts tested, the petroleum ether extract showed the most significant antibacterial potential, though it remained less effective than the standard antibiotic, Clindamycin. The gel formulations (F1–F4) produced similar trends to the corresponding extracts but displayed comparatively lower antibacterial efficacy than the marketed herbal preparation.

DISCUSSION

Cork cells, periderm, phelloderm, medullary rays, phloem fibres, and sclerides have been identified in pharmacognostic investigations conducted on transverse sections of rhizomes in earlier publications. Key microscopic features observed in this study include parenchymatous cells with thick walls in both the phloem and xylem regions, characterized by a substantial tannin presence. The cortex displayed densely lignified, isodiametric cells with robust walls. Additionally, sclerenchymatous stone cells and polygonal cork cells embedded within a suberin-rich layer were noted. Various starch grains, predominantly round and of differing sizes, along with several other distinctive structural elements, were also identified. Similarly, parenchymatous cells containing tannin and starch have been identified in powder microscopy reports. Powder microscopy revealed axial parenchyma and sheath cells, heterogeneous rays of procumbent cells with one or more seriation, a single row of upright cells, and fibres that were alternately arranged with the parenchyma strands, some of which were narrowly banded and others not.

While testing *C. aromatica* against several microbes, this research found that it exhibited a wide range of anti-microbial activity. Thorn extract exhibited intermediate zones of inhibition (ZOIs) against *E. coli* and *K. pneumoniae*, but the greatest ZOIs against *B. subtilis*, according to the assessment. At 50 µg/mL and 100 µg/mL, the anti-bacterial activity with moderate ZOIs was seen to be stronger than that against fungi *C. albicans* and *A. niger*. The extract did not show strong anti-microbial action when compared to standard medication samples, and none of the ZOIs were determined to be acceptable. The extract, on the other hand, demonstrated effective action against *B. subtilis*. The studied thorn extract was likewise ineffective against the drug-resistant *E. coli*. Comparatively, gram-negative facultative anaerobics such as *K. pneumonia* and *E. coli* were more effectively inhibited in their growth compared to gram-positive mesophiles such *B. subtitlis*. One possible explanation for the decreased action might be the fact that some antimicrobial phytochemicals are unable to reach the cytoplasm of bacteria because of their structural makeup, which forms a solid barrier. The entry of components is limited in gram-negative bacteria by means of an outer layer that is thicker (8-10 nm) and an inner layer that is uniformly 2-3 nm broad and made up of peptidoglycan. Some believe the extract's abundance of antimicrobial components—including flavonoids, alkaloids, steroidal components, saponins, and terpenoids—plays a significant part in its ability to fight off bacteria and fungi.

CONCLUSION

The research shed light on the salient characteristics of *C. aromatica*, including its physicochemical and pharmacognostic properties. Preliminary analysis revealed the existence of several phytochemicals. The presence of pharmacological activities, such as antibacterial and antifungal properties, was also uncovered in the investigation.

CONFLICT OF INTEREST

There are no disclosed conflicts of interest..

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