World Journal of Pharmaceutical Science and Research

www.wjpsronline.com

Research Article

ISSN: 2583-6579
SJIF Impact Factor: 6.916
Year - 2026
Volume: 5; Issue: 4
Page: 323-336

DEVELOPMENT AND EVALUATION OF A DUAL-ACTION HERBAL HAIR REMOVER GEL USING *CYPERUS ROTUNDUS* AND *CASSIA AURICULATA* EXTRACTS

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Article Received: 9 February 2026 | | ***Article Revised: 1 March 2026*** | | ***Article Accepted: 22 March 2026***

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How to cite this Article: Raslamol K., Sujith Sebastian, Veena K. R., Riswana M., Sanha E. V., Shahla Sherin S., Shamna K., Shanil T., Sreelakshmi D. R., Anaswara Vinu (2026) DEVELOPMENT AND EVALUATION OF A DUAL-ACTION HERBAL HAIR REMOVER GEL USING *CYPERUS ROTUNDUS* AND *CASSIA AURICULATA* EXTRACTS. World Journal of Pharmaceutical Science and Research, 5(4), 323-336.

ABSTRACT

Herbal cosmetics are increasingly preferred due to their safety, efficacy, and reduced side effects compared with synthetic formulations. The present study aimed to develop and evaluate a dual-action herbal hair remover gel using extracts of *Cyperus rotundus* rhizome and *Cassia auriculata* leaves. Volatile oil from *Cyperus rotundus* rhizomes was obtained by hydrodistillation, while *Cassia auriculata* leaves were extracted using Soxhlet extraction with methanol. The gel was formulated using Carbopol 940 as a gelling agent along with propylene glycol, polysorbate 80, triethanolamine, formic acid, and citric acid.Phytochemical screening of the extracts revealed the presence of alkaloids, flavonoids, tannins, saponins, glycosides, phenols, proteins, and carbohydrates. Six formulations (HR1–HR6) were prepared and evaluated for physicochemical parameters such as appearance, pH, homogeneity, transparency, and viscosity. The formulations showed satisfactory characteristics with pH ranging from 5.1–5.7, indicating suitability for topical application. Fourier Transform Infrared (FTIR) spectroscopy was performed to identify functional groups and assess compatibility between plant extracts and excipients. The FTIR spectrum showed characteristic peaks corresponding to hydroxyl, aromatic, and ether functional groups, confirming the presence of phytoconstituents without significant interaction within the formulation. Antimicrobial activity of the optimized formulation was evaluated using the agar well diffusion method against *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Candida albicans*. The formulation exhibited moderate antimicrobial activity with measurable zones of inhibition. The developed herbal hair remover gel demonstrated suitable physicochemical properties, antimicrobial potential, and formulation stability, suggesting its potential as a safe and effective alternative to conventional chemical depilatory products.

KEYWORDS: Herbal hair remover gel; *Cyperus rotundus*; *Cassia auriculata*; Antimicrobial activity; Fourier Transform Infrared Spectroscopy; Phytochemical screening.

INTRODUCTION

Hair removal is an important aspect of personal grooming and cosmetic care practiced across many cultures worldwide. The presence of unwanted hair on different parts of the body may cause aesthetic concerns and psychological discomfort, leading individuals to seek effective hair removal methods. Conventional depilatory methods include shaving, waxing, chemical depilatory creams, laser treatment, and electrolysis. Although these techniques are widely used, many synthetic depilatory products contain harsh chemicals such as calcium thioglycolate and potassium hydroxide that may cause skin irritation, allergic reactions, unpleasant odor, and long-term skin damage. Therefore, there is increasing interest in developing safer and more natural alternatives using plant-based ingredients.

In recent years, herbal cosmetics have gained considerable popularity due to their natural origin, safety, biocompatibility, and minimal side effects compared with synthetic products. Herbal formulations are often rich in biologically active phytochemicals such as flavonoids, alkaloids, tannins, phenols, saponins, and terpenoids that possess beneficial pharmacological activities including antimicrobial, antioxidant, anti-inflammatory, and skin-protective properties. These natural compounds not only enhance the therapeutic effectiveness of cosmetic formulations but also contribute to improved skin health and protection against microbial infections.

Among various medicinal plants, *Cyperus rotundus* (family: Cyperaceae), commonly known as nutgrass or Nagarmotha, has been widely used in traditional medicine systems such as Ayurveda, Unani, and traditional Chinese medicine. The plant is known to contain several bioactive compounds including essential oils, sesquiterpenes, flavonoids, and phenolic constituents that exhibit antimicrobial, antioxidant, anti-inflammatory, and hair growth inhibitory properties. Studies have reported that the essential oil obtained from *Cyperus rotundus* rhizomes can significantly reduce hair growth by inhibiting hair follicle activity, making it a promising natural agent for hair removal formulations.

Another important medicinal plant used in the present study is *Cassia auriculata* (family: Fabaceae), commonly known as *Tanner's cassia* or Avaram. This plant is widely distributed in tropical regions and has been traditionally used for treating skin disorders, diabetes, inflammation, and microbial infections. The leaves and flowers of *Cassia auriculata* contain various phytochemical constituents such as flavonoids, tannins, glycosides, and phenolic compounds that possess antioxidant and antimicrobial activities. These bioactive compounds can contribute to maintaining skin health and preventing microbial contamination in topical formulations.

The combination of *Cyperus rotundus* and *Cassia auriculata* in a topical gel formulation offers a dual advantage. While *Cyperus rotundus* may contribute to hair growth inhibition and depilatory activity, *Cassia auriculata* may provide additional antimicrobial and skin-protective effects. Incorporating these plant extracts into a gel base enhances ease of application, improved skin absorption, and better stability of active constituents. Gel formulations are widely preferred for topical delivery due to their non-greasy nature, smooth texture, and ability to spread easily on the skin.

To ensure the safety and effectiveness of herbal formulations, it is essential to evaluate their physicochemical properties and biological activities. Fourier Transform Infrared (FTIR) spectroscopy is commonly used to identify functional groups present in plant extracts and to determine compatibility between active ingredients and formulation excipients. In addition, antimicrobial studies are performed to assess the ability of the formulation to inhibit the growth of pathogenic microorganisms commonly associated with skin infections.

Therefore, the present study was undertaken to develop and evaluate a herbal hair remover gel containing extracts of *Cyperus rotundus* rhizome and *Cassia auriculata* leaves. The formulated gel was subjected to phytochemical screening, physicochemical evaluation, FTIR analysis, and antimicrobial studies to determine its potential as a safe and effective alternative to conventional chemical depilatory products.

MATERIALS AND METHODS

Materials

The plant materials used in this study were rhizomes of *Cyperus rotundus* and leaves of *Cassia auriculata*. All chemicals and excipients used for the formulation were of analytical grade. Carbopol 934 was used as a gelling agent, while propylene glycol acted as a humectant and solvent. Polysorbate 80 was used as an emulsifying agent, and triethanolamine was used as a neutralizing agent to adjust the pH and facilitate gel formation. Formic acid and citric acid were incorporated to enhance the depilatory activity of the formulation. Ethanol was used as a solvent during extraction, and rose oil was added to improve fragrance and acceptability of the final product.

Collection and Authentication of Plant Materials

The rhizomes of *Cyperus rotundus* and leaves of *Cassia auriculata* were collected from a local herbal garden and surrounding areas. The collected plant materials were thoroughly washed with distilled water to remove dust and impurities. The samples were shade-dried at room temperature for several days and then pulverized into coarse powder using a mechanical grinder. The powdered materials were stored in airtight containers until further use.

Preparation of Plant Extracts

Extraction of *Cyperus rotundus*

The rhizomes of *Cyperus rotundus* were subjected to hydrodistillation using a Clevenger-type apparatus to obtain volatile oil. The powdered rhizomes were placed in a distillation flask containing distilled water and heated for several hours. The volatile oil obtained during the process was collected and stored in a sealed container at low temperature for further formulation studies.

Figure No. 1: Extraction of *Cyperus rotundus*.

Extraction of *Cassia auriculata*

The dried powdered leaves of *Cassia auriculata* were extracted using the Soxhlet extraction method. Approximately 50 g of powdered plant material was placed in a Soxhlet extractor and extracted using methanol as the solvent for several cycles until complete extraction occurred. The extract was concentrated using a rotary evaporator and stored in a desiccator for further analysis.

Figure No. 2: Extraction of *Cassia auriculata*.

Phytochemical Screening

Preliminary phytochemical screening of both plant extracts was carried out to identify the presence of important bioactive constituents such as alkaloids, flavonoids, tannins, saponins, glycosides, phenols, proteins, and carbohydrates. Standard qualitative tests were performed for each class of phytochemicals.

Formulation of Herbal Hair Remover Gel

The herbal hair remover gel was prepared using the polymer dispersion method. Carbopol 934 was dispersed in distilled water and allowed to swell completely to form a uniform gel base. Propylene glycol and polysorbate 80 were added to the mixture with continuous stirring to ensure uniform distribution.

Table No. 1: Formulation of gel.

SL NO	INGREDIENTS	HR1	HR2	HR3	HR4	HR5	HR6
1.	*Cyperus rotundus* rhizome oil(ml)	0.5	0.6	0.7	0.8	0.9	1.0
2.	*Cassia auriculata* extracts(g)	0.5	0.5	0.5	0.5	0.5	0.5
3.	Carbopol 940(g)	0.3	0.3	0.3	0.3	0.3	0.3
4.	Propylene glycol(ml)	1.0	1.0	1.0	1.0	1.0	1.0
5.	Polysorbate 80(ml)	0.2	0.2	0.2	0.2	0.2	0.2
6.	Formic acid (ml)	0.1	0.1	0.1	0.1	0.1	0.1
7.	Rose oil(ml)	0.1	0.1	0.1	0.1	0.1	0.1
8.	Triethanolamine(ml)	0.5	0.5	0.5	0.5	0.5	0.5
9.	Citric acid (ml)	0.02	0.02	0.02	0.02	0.02	0.02
10.	Ethanol(ml)	1.0	1.0	1.0	1.0	1.0	1.0
11.	Water(ml)	q.s	q.s	q.s	q.s	q.s	q.s

The plant extracts obtained from *Cyperus rotundus* and *Cassia auriculata* were incorporated into the gel base. Formic acid and citric acid were then added carefully to provide depilatory action. Triethanolamine was added dropwise to neutralize the carbopol and adjust the pH, resulting in gel formation. Rose oil was finally added to impart fragrance and improve the cosmetic acceptability of the formulation.Six different formulations (HR1–HR6) were prepared by varying the concentration of the active ingredients and excipients.

Figure No. 3.

Figure No. 4.

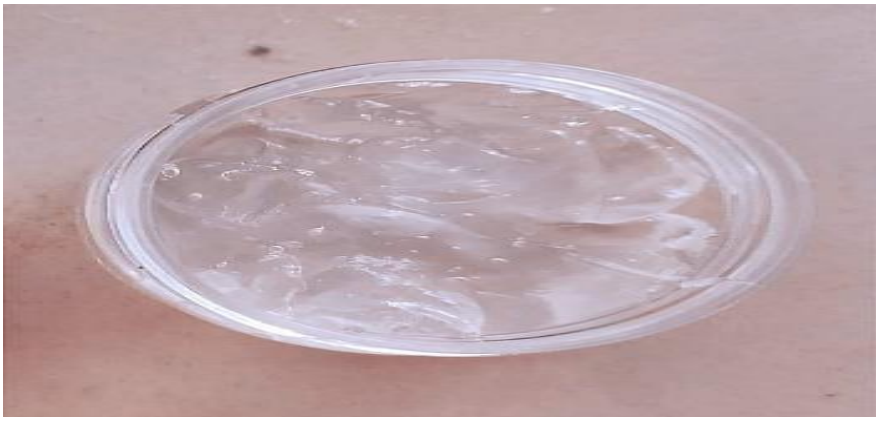


Figure No. 5.

Evaluation of Herbal Gel

Physical Appearance

The prepared gel formulations were visually examined for color, odor, homogeneity, and texture.

pH Determination

The pH of each formulation was determined using a calibrated digital pH meter. A small amount of gel was dispersed in distilled water, and the pH was measured at room temperature.

Homogeneity

Homogeneity was evaluated by visual inspection after the gel was set in the container. The formulations were observed for uniformity and absence of lumps.

Viscosity

The viscosity of the gel formulations was determined using a Brookfield viscometer at room temperature. Appropriate spindle and rotational speed were selected for measurement.

Transparency

Transparency of the gel formulations was examined visually against a black and white background.

Fourier Transform Infrared (FTIR) Analysis

Fourier Transform Infrared spectroscopy was performed to identify the functional groups present in the formulation and to evaluate compatibility between plant extracts and excipients. The FTIR spectrum was recorded in the range of 4000–600 cm^{-1} using an FTIR spectrophotometer. The characteristic peaks observed in the spectrum were analyzed to determine the presence of functional groups corresponding to various phytochemical constituents.

Antimicrobial Study

The antimicrobial activity of the formulated gel was evaluated using the agar well diffusion method. Nutrient agar plates were prepared and inoculated with microbial cultures including *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Candida albicans*. Wells were made in the agar plates, and the gel formulation was introduced into the wells.

The plates were incubated at 37°C for 24 hours. After incubation, the zones of inhibition around the wells were measured in millimeters to determine the antimicrobial activity of the formulation.

RESULTS AND DISCUSSION

Phytochemical Screening

Preliminary phytochemical analysis of the extracts obtained from *Cyperus rotundus* rhizomes and *Cassia auriculata* leaves was carried out to identify the presence of bioactive constituents responsible for the therapeutic activity of the formulation.

The screening revealed the presence of several important phytochemicals including alkaloids, flavonoids, tannins, saponins, glycosides, phenols, proteins, and carbohydrates. These compounds are known for their antimicrobial, antioxidant, and anti-inflammatory activities, which contribute to the effectiveness of herbal cosmetic formulations.

Table 2: Phytochemical Screening of Plant Extracts.

Phytochemical	***Cyperus rotundus***	***Cassia auriculata***
Alkaloids	Present	Present
Flavonoids	Present	Present

Tannins	Present	Present
Saponins	Present	Present
Glycosides	Present	Present
Phenols	Present	Present
Proteins	Present	Present
Carbohydrates	Present	Present

The presence of these phytochemicals confirms that both plant extracts possess biologically active compounds that can enhance the cosmetic and antimicrobial properties of the developed formulation.

Evaluation of Herbal Hair Remover Gel

Six formulations of herbal hair remover gel (HR1–HR6) were prepared and evaluated for physicochemical parameters including appearance, pH, homogeneity, transparency, and viscosity.

Table 3: Evaluation Parameters of Gel Formulations.

1. Physical appearance

SL NO	PARAMETERS	HR1	HR2	HR3	HR4	HR5	HR6
1	Color	Dark yellow	Dark brown	Reddish brown	Brown	Brown	Brown
2	Odour	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant
3	Smoothness	Not smooth	Smooth	Slightly smooth	Slightly smooth	Smooth	Very smooth

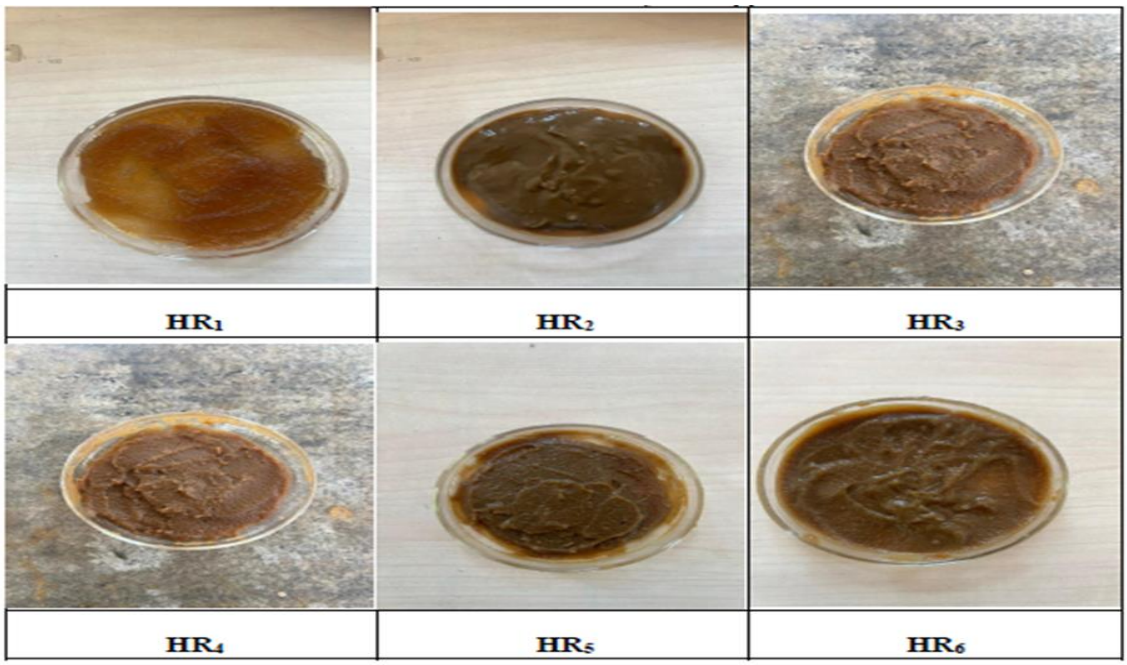


Figure No. 6: Hair removal gels.

2. Measurement of pH

SL NO	GEL	pH
1	HR1	5.1
2	HR2	5.4
3	HR3	5.7
4	HR4	5.6
5	HR5	5.4
6	HR6	5.3

3. Homogeneity

SL NO	GEL	RESULTS
1	HR1	Very poor
2	HR2	Average
3	HR3	Good
4	HR4	Poor
5	HR5	Good
6	HR6	Excellent

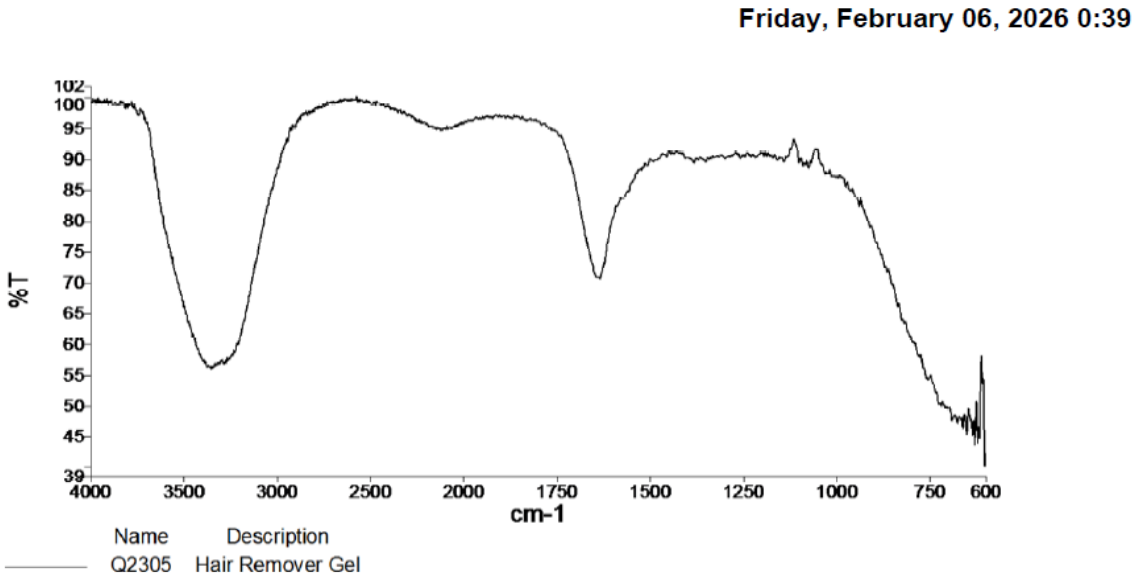
4. Viscosity determination

SL NO	GEL	VISCOSITY (cps)
1	HR1	2468
2	HR2	2499
3	HR3	3221
4	HR4	3419
5	HR5	3726
6	HR6	4132

The prepared formulations showed acceptable physicochemical characteristics. The pH of all formulations ranged from 5.1–5.7, which falls within the normal skin pH range, indicating suitability for topical application without causing irritation. All formulations exhibited good homogeneity without the presence of lumps or phase separation. The viscosity of the gel was found to be appropriate for topical application, ensuring easy spreadability and adherence to the skin surface.

FTIR Analysis

Fourier Transform Infrared (FTIR) spectroscopy was performed to identify functional groups present in the formulation and to evaluate compatibility between plant extracts and formulation excipients.



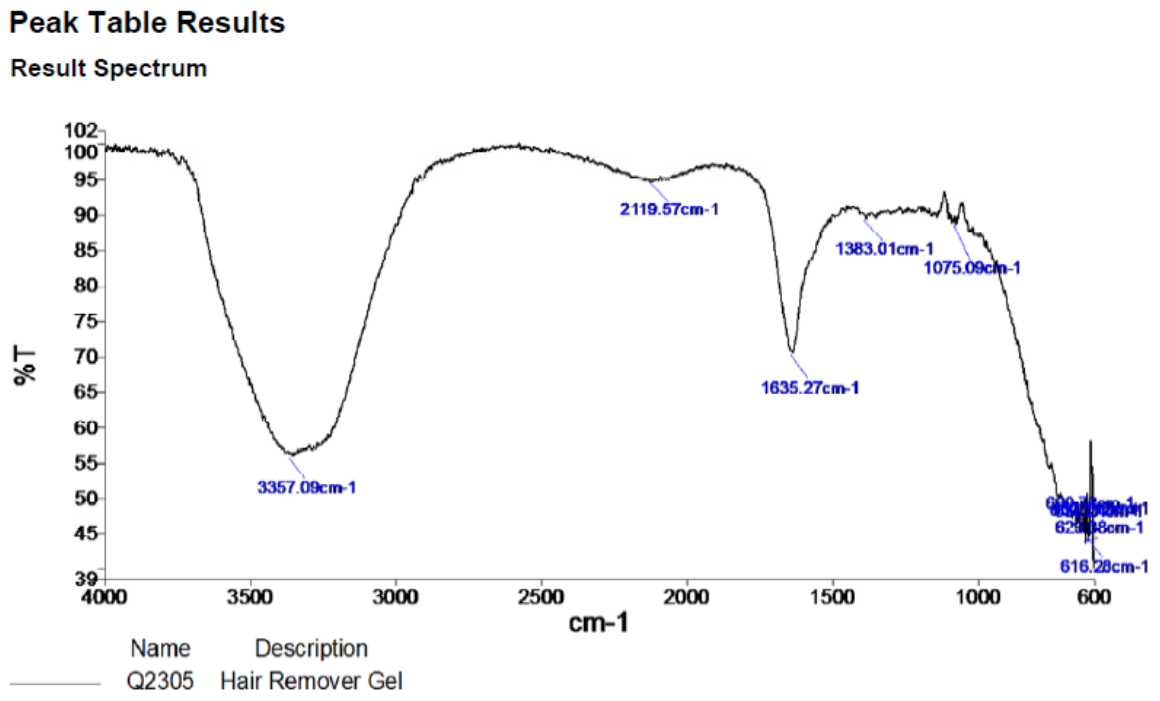


Table 4: FTIR Peak Interpretation.

Wavenumber (cm^{-1})	Functional Group	Assignment
3357	O–H stretching	Alcohols / Phenols
2119	C≡C stretching	Alkynes
1635	C=C stretching	Aromatic compounds
1383	C–H bending	Alkanes
1075	C–O stretching	Alcohols / Ethers
660–601	C–Cl stretching	Halogen derivatives

Discussion of FTIR Results

The FTIR spectrum of the formulated herbal gel exhibited several characteristic peaks indicating the presence of important functional groups.

The broad absorption peak observed at 3357 cm^{-1} corresponds to O–H stretching vibrations, indicating the presence of hydroxyl groups commonly found in phenolic compounds and flavonoids present in plant extracts. These compounds contribute to antioxidant and antimicrobial activities. The peak at 1635 cm^{-1} corresponds to C=C stretching vibrations associated with aromatic rings present in flavonoids and phenolic compounds. These phytoconstituents play an important role in biological activities such as antimicrobial and anti-inflammatory effects.

The absorption band at 1075 cm^{-1} corresponds to C–O stretching vibrations, which are characteristic of alcohol and ether functional groups found in glycosides and other phytochemicals. Importantly, no significant peak shifts or disappearance of characteristic peaks were observed in the FTIR spectrum, indicating that there was no chemical interaction between plant extracts and formulation excipients. This confirms the compatibility and stability of the developed gel formulation.

Antimicrobial Activity

The antimicrobial activity of the formulated gel was evaluated using the agar well diffusion method against common pathogenic microorganisms including *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Candida albicans*.

Table 4: Antimicrobial Activity of Herbal Gel.

Microorganism	Zone of Inhibition (mm)	Activity
Staphylococcus aureus	14	Moderate
Escherichia coli	12	Moderate
Pseudomonas aeruginosa	10	Mild
Candida albicans	13	Moderate

The formulation exhibited moderate antimicrobial activity against both Gram-positive and Gram-negative bacteria as well as fungal strains. The antimicrobial effect can be attributed to the presence of phytochemicals such as flavonoids, tannins, and phenolic compounds present in the plant extracts.

These compounds are known to disrupt microbial cell membranes, inhibit enzyme activity, and interfere with microbial metabolism, leading to inhibition of microbial growth.

DISCUSSION

The results obtained from phytochemical screening, physicochemical evaluation, FTIR analysis, and antimicrobial studies indicate that the developed herbal hair remover gel possesses promising characteristics for cosmetic application. The combination of *Cyperus rotundus* and *Cassia auriculata* extracts provides both depilatory and antimicrobial benefits. The gel formulation exhibited suitable pH, good stability, and desirable rheological properties.

Furthermore, the antimicrobial activity of the formulation may help protect the skin from microbial contamination during and after hair removal, making it a multifunctional herbal cosmetic product.

CONCLUSION

The present investigation was carried out to formulate and evaluate a herbal hair remover gel using plant extracts obtained from *Cyperus rotundus* rhizomes and *Cassia auriculata* leaves. The objective of the study was to develop a natural and effective depilatory formulation that could serve as a safer alternative to conventional chemical hair removal products, which often cause skin irritation, allergic reactions, and unpleasant side effects.

The plant materials were carefully collected, dried, and processed to obtain the required extracts. The volatile oil from *Cyperus rotundus* rhizomes was extracted using hydrodistillation, while the leaves of *Cassia auriculata* were subjected to Soxhlet extraction using methanol as a solvent. These extraction techniques enabled the isolation of bioactive compounds responsible for the pharmacological and cosmetic properties of the plants.

Preliminary phytochemical screening of both plant extracts confirmed the presence of several important bioactive constituents such as alkaloids, flavonoids, tannins, saponins, glycosides, phenols, proteins, and carbohydrates. These phytoconstituents are widely reported to possess antimicrobial, antioxidant, anti-inflammatory, and skin-protective properties. Their presence in the extracts supports the potential of the selected plants for use in herbal cosmetic formulations.

Six different gel formulations (HR1–HR6) were successfully prepared using Carbopol 934 as the primary gelling agent along with other excipients such as propylene glycol, polysorbate 80, triethanolamine, formic acid, and citric acid. The prepared gels were evaluated for several physicochemical parameters including appearance, homogeneity, pH, transparency, and viscosity. The formulations exhibited uniform consistency, good homogeneity, and acceptable texture without any phase separation or lump formation. The pH values of the formulations ranged from 5.1 to 5.7, which falls within the normal physiological pH range of the skin, indicating that the gel is safe for topical application and unlikely to cause irritation.

The viscosity of the prepared gels was found to be suitable for easy application and spreadability on the skin surface. Proper viscosity is an important factor for topical formulations because it ensures uniform distribution of the active ingredients and enhances the retention time of the formulation on the skin.

Further characterization of the formulation was carried out using Fourier Transform Infrared Spectroscopy (FTIR) to identify functional groups and determine compatibility between the plant extracts and formulation excipients. The FTIR spectra revealed characteristic peaks corresponding to hydroxyl, aromatic, and ether functional groups, which are typically associated with phenols, flavonoids, and other phytochemicals present in the plant extracts. Importantly, no significant shifts or disappearance of characteristic peaks were observed, indicating that there were no chemical interactions between the plant extracts and the excipients used in the formulation. This confirms the stability and compatibility of the developed herbal gel.

The antimicrobial activity of the herbal gel formulation was evaluated using the agar well diffusion method against common pathogenic microorganisms including *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Candida albicans*. The results demonstrated moderate antimicrobial activity against these microorganisms, as indicated by the zones of inhibition observed around the wells containing the formulation. The antimicrobial activity may be attributed to the presence of phytochemicals such as flavonoids, tannins, and phenolic compounds, which are known to inhibit microbial growth by disrupting microbial cell membranes and interfering with metabolic processes.

The combination of *Cyperus rotundus* and *Cassia auriculata* extracts in a gel formulation offers several advantages. While *Cyperus rotundus* is known for its potential hair growth inhibitory properties, *Cassia auriculata* contributes antimicrobial and skin-protective effects. This dual-action property makes the formulation beneficial not only for hair removal but also for maintaining skin hygiene and preventing microbial infections that may occur during hair removal procedures.

Overall, the results obtained from phytochemical screening, physicochemical evaluation, FTIR analysis, and antimicrobial studies indicate that the developed herbal hair remover gel possesses promising characteristics as a cosmetic formulation. The formulation demonstrated acceptable stability, suitable physicochemical properties, and significant biological activity.

In conclusion, the developed herbal gel formulation has the potential to serve as a safe, effective, and natural alternative to synthetic depilatory products currently available in the market. However, further studies such as clinical evaluation, dermatological safety assessment, and long-term stability studies are recommended to confirm its efficacy and safety for large-scale commercial application.

Future Scope

Although the present study successfully developed and evaluated a herbal hair remover gel using extracts of *Cyperus rotundus* and *Cassia auriculata*, further research is required to expand the potential applications and improve the overall effectiveness of the formulation.

One important area for future research is clinical evaluation and dermatological testing. While the present study evaluated physicochemical parameters and antimicrobial activity, clinical trials on human volunteers are necessary to confirm the safety, skin compatibility, and hair removal efficiency of the formulation under real usage conditions. Such studies would help establish the product as a reliable herbal alternative to synthetic depilatory products.

Another important aspect is long-term stability studies. Stability testing under different environmental conditions such as temperature, humidity, and light exposure can help determine the shelf life and storage requirements of the herbal gel formulation. Stability studies also help in identifying possible degradation of active phytochemicals over time.

Future studies may also focus on optimization of the formulation by modifying the concentration of plant extracts and excipients to enhance depilatory activity, spreadability, and cosmetic acceptability. The use of advanced formulation techniques such as nanoemulsion-based gels or herbal nanocarrier systems may further improve the penetration of active compounds into hair follicles.

Further phytochemical characterization and identification of individual bioactive compounds responsible for hair growth inhibition may provide deeper insight into the mechanism of action of the formulation. Advanced analytical techniques such as Fourier Transform Infrared Spectroscopy, chromatography, and spectroscopic methods can be used to study these active components in detail.

In addition, expanded antimicrobial and antifungal studies against a wider range of skin pathogens may provide further evidence of the protective benefits of the formulation. This could help position the product not only as a depilatory agent but also as a multifunctional herbal cosmetic with antimicrobial properties.

Finally, future research may explore large-scale production and commercialization of the formulation. Standardization of extraction procedures, quality control of raw materials, and compliance with cosmetic regulatory guidelines will be essential for industrial development and market acceptance of the herbal hair remover gel.

Overall, continued research and development can help improve the formulation and support its potential as a safe, effective, and commercially viable herbal cosmetic product.

Limitations of the Study

Although the present study successfully developed and evaluated a herbal hair remover gel containing extracts of *Cyperus rotundus* and *Cassia auriculata*, certain limitations were encountered during the course of the research that may influence the interpretation and applicability of the results.

One of the major limitations of the study is the absence of clinical evaluation on human volunteers. The formulation was evaluated only through physicochemical tests and in vitro antimicrobial studies. Although these results indicate the

potential effectiveness and safety of the formulation, clinical trials are necessary to confirm its actual depilatory efficacy, skin compatibility, and possible allergic reactions when applied to human skin.

Another limitation is the limited scope of antimicrobial testing. The antimicrobial activity of the formulation was tested against a few common microorganisms such as *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Candida albicans*. However, testing against a broader range of pathogenic microorganisms could provide a more comprehensive understanding of the antimicrobial potential of the formulation.

The study also did not include long-term stability testing under different environmental conditions such as temperature, humidity, and light exposure. Stability studies are essential to determine the shelf life, storage conditions, and long-term safety of herbal cosmetic formulations.

Another limitation involves the lack of advanced phytochemical characterization and quantification of active compounds. Although preliminary phytochemical screening confirmed the presence of several bioactive constituents, detailed analysis using advanced techniques such as chromatography and spectroscopic methods could provide better identification and quantification of the active components responsible for hair growth inhibition.

Additionally, the mechanism of hair removal or hair growth inhibition was not investigated in detail. Further studies focusing on the biological mechanism of action of the active constituents from *Cyperus rotundus* and *Cassia auriculata* could provide deeper insight into their depilatory properties.

Finally, the formulation was developed and evaluated on a laboratory scale, and large-scale production feasibility and industrial processing aspects were not studied. For commercial development, additional research related to formulation standardization, quality control, and regulatory compliance would be necessary.

Despite these limitations, the study provides valuable preliminary data supporting the potential of the developed herbal gel formulation as a natural alternative to synthetic depilatory products. Addressing these limitations in future studies would further strengthen the scientific validity and commercial applicability of the formulation.

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