International Journal of Pharmaceutical research and Applications
Volume 11, Issue 3, May-June2026, pp:2283-2292 www.ijprajournal.com ISSN:2456-4494

Formulation And Evaluation of An Herbal Analgesic Cream Containing Menthol, Camphor, And Clove Oil

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Date of Submission: 16-06-2026 Date of Acceptance: 29-06-2026

ABSTRACT

Background Pain and inflammation are among the most common clinical conditions affecting quality of life. Although non-steroidal anti-inflammatory drugs (NSAIDs) are effective in relieving pain, their prolonged use is associated with gastrointestinal, renal, and cardiovascular adverse effects. Herbal topical formulations have gained considerable attention as safer alternatives because they provide localized drug delivery with minimal systemic exposure. The present study was undertaken to develop a polyherbal analgesic cream containing menthol, camphor, and clove oil for effective topical pain management.

Objective To formulate and evaluate a herbal analgesic cream containing menthol, camphor, and clove oil and to optimize the formulation based on its physicochemical characteristics and stability.

Materials and Methods Four formulation batches (F1–F4) were prepared as oil-in-water (O/W) creams using the fusion method by varying the concentration of the active ingredients while maintaining constant excipient levels. The prepared formulations were evaluated for physical appearance, homogeneity, pH, viscosity, spreadability, and accelerated stability. Results were expressed as mean values, and the optimized formulation was selected based on overall performance.

Results All prepared formulations exhibited satisfactory physical characteristics without significant incompatibility. The pH ranged from **5.8 ± 0.03 to 6.8 ± 0.05**, indicating compatibility with normal skin. Viscosity values ranged from **21,500 ± 120 to 29,400 ± 145 cP**, while spreadability ranged from **13.2 ± 0.2 to 17.1 ± 0.3 g·cm/s**. Formulation **F3** demonstrated the most desirable properties, including excellent homogeneity, smooth texture, optimum pH (**6.4 ± 0.04**), viscosity (**26,800 ± 135 cP**), and the highest spreadability (**17.1 ± 0.3 g·cm/s**). Stability studies showed no noticeable changes in color, odor, consistency, or phase separation in F3 throughout the study period.

Conclusion The developed herbal analgesic cream demonstrated acceptable physicochemical properties and good formulation stability. Among the tested formulations, **F3** was identified as the optimized batch because of its balanced rheological properties and superior stability. The combined action of menthol, camphor, and clove oil is expected to provide effective topical analgesic and anti-inflammatory activity with improved patient acceptability and reduced risk of systemic adverse effects. The findings suggest that the formulation has potential for further pharmacological evaluation, clinical investigation, and commercial development.

Keywords: Herbal analgesic cream, Menthol, Camphor, Clove oil, Topical drug delivery, Pain management, Polyherbal formulation.

I. INTRODUCTION

1.1 Pain and Inflammation

Pain is a complex and unpleasant sensory as well as emotional experience that is usually associated with actual or potential tissue damage. It acts as a protective mechanism for the body, warning the individual about injury, disease, or harmful stimuli. Based on duration and origin, pain is mainly classified into acute pain, which occurs suddenly due to injury or inflammation and lasts for a short period; chronic pain, which persists for a longer duration often beyond normal tissue healing; and neuropathic pain, which arises due to damage or dysfunction of the nervous system. [1]

Inflammation is a natural defense response of the body to harmful stimuli such as pathogens, physical injury, or chemical irritants. It is characterized by classical signs including redness, swelling, heat, pain, and loss of function. The process of pain and inflammation is mediated by several biochemical substances released at the site of injury. Key mediators include prostaglandins, bradykinin, histamine, serotonin, and pro-inflammatory cytokines such as TNF-α and interleukins. These mediators sensitize nociceptors and enhance pain

International Journal of Pharmaceutical research and Applications
Volume 11, Issue 3, May-June2026, pp:2283-2292 www.ijprajournal.com ISSN:2456-4494

transmission, thereby intensifying the perception of pain. [2]

Overall, pain and inflammation are closely interlinked biological processes that play a crucial role in disease progression and are important therapeutic targets in analgesic drug development.

1.2 Conventional Analgesics and Limitations

Conventional analgesics are widely used for the management of pain, inflammation, and fever. Among them, non-steroidal anti-inflammatory drugs (NSAIDs) are most commonly prescribed due to their effectiveness and easy availability. NSAIDs mainly exert their pharmacological action by inhibiting the cyclooxygenase (COX-1 and COX-2) enzymes, which leads to a reduction in prostaglandin synthesis. Since prostaglandins are key mediators of pain and inflammation, their inhibition results in analgesic, anti-inflammatory, and antipyretic effects. [3]

Despite their therapeutic benefits, long-term or inappropriate use of NSAIDs is associated with several limitations and adverse effects. One of the major concerns is gastrointestinal toxicity, which includes irritation, ulcer formation, and bleeding due to reduced protective prostaglandins in the gastric mucosa. In addition, NSAIDs may cause renal toxicity by affecting renal blood flow and glomerular filtration, particularly in vulnerable patients. Prolonged use has also been linked to cardiovascular risks, including increased chances of hypertension, myocardial infarction, and stroke in certain cases. [4]

These safety concerns highlight the limitations of conventional synthetic analgesics and emphasize the need for safer, more biocompatible alternatives. This has encouraged the development of herbal and topical formulations that can provide effective pain relief with reduced systemic toxicity and improved patient safety. [5]

1.3 Herbal Medicine in Pain Management

Herbal medicine has been an integral part of traditional healing systems such as Ayurveda, Unani, and Traditional Chinese Medicine for centuries. Medicinal plants have long been used for the management of pain, inflammation, and various chronic disorders due to their natural origin and therapeutic effectiveness. [6]

In recent years, there has been a significant increase in global interest in herbal-based therapies. This growing acceptance is mainly driven by concerns regarding the adverse effects of synthetic drugs and the demand for safer and more holistic treatment options. Herbal medicines are generally considered to have a better safety profile when used appropriately and are often preferred for long-term use. [7]

One of the major advantages of herbal therapy is the presence of multiple bioactive constituents such as flavonoids, terpenoids, alkaloids, and phenolic compounds, which act through different mechanisms. These compounds exhibit analgesic, anti-inflammatory, antioxidant, and immunomodulatory activities, thereby providing comprehensive relief in pain-related conditions.

Additionally, herbal formulations are often more cost-effective and better tolerated by patients, which improves compliance. The multi-targeted action of plant-based compounds also makes them suitable alternatives or adjuncts to conventional analgesics in pain management. [8]

1.4 Topical Drug Delivery System

Topical drug delivery refers to the application of drugs directly onto the skin or mucosal surface to achieve localized or systemic therapeutic effects. In the context of pain management, topical formulations such as creams, gels, and ointments are widely used due to their ability to provide targeted relief at the site of application. [9]

One of the major advantages of topical drug delivery is localized action, which allows the drug to act directly on the affected area, thereby producing faster and more effective pain relief. It also minimizes systemic exposure, which significantly reduces the risk of adverse effects commonly associated with oral drug administration. Another important benefit is the avoidance of first-pass metabolism, which enhances the availability of active ingredients at the site of action. [10]

Drug absorption through the skin mainly occurs via the stratum corneum, which acts as the primary barrier. After penetration, the drug diffuses into deeper layers of the skin and reaches underlying tissues to exert its pharmacological effect. The efficiency of drug permeation depends on factors such as drug properties, formulation type, and the use of penetration enhancers.

Overall, topical drug delivery systems offer a safe, convenient, and effective approach for managing pain and inflammatory conditions, making them highly suitable for herbal analgesic formulations. [11]

1.5 Rationale of Polyherbal Analgesic Cream

The development of a polyherbal analgesic cream is based on the concept of combining multiple herbal ingredients to achieve enhanced therapeutic efficacy through synergistic action. In a synergistic system, the combined effect of different herbal

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Volume 11, Issue 3, May-June2026, pp:2283-2292 www.ijprajournal.com ISSN:2456-4494

constituents is greater than the sum of their individual effects, allowing better pain relief at lower concentrations and with improved safety.

In the present formulation, menthol, camphor, and clove oil have been selected due to their well-documented analgesic and anti-inflammatory properties. Menthol produces a cooling sensation by stimulating cold receptors in the skin, which helps in reducing pain perception and providing immediate soothing effects. Camphor acts as a counterirritant and mild local anesthetic, improving local blood circulation and contributing to pain relief. Clove oil, mainly due to its active constituent eugenol, exhibits strong analgesic and anti-inflammatory activity by inhibiting prostaglandin synthesis and blocking pain signals.

The combination of these three agents is expected to provide a multi-mechanistic approach to pain management, targeting both peripheral and sensory pathways. Additionally, the topical route enhances localized action, reduces systemic side effects, and improves patient compliance.

Therefore, the formulation of a polyherbal analgesic cream offers a safer, effective, and practical alternative to conventional synthetic analgesics for the management of localized pain and inflammation. [12]

II. PLANT PROFILE

2.1 Menthol

Menthol is a naturally occurring compound obtained from peppermint oil and is widely used in topical formulations due to its cooling and soothing properties. When applied to the skin, it produces a characteristic cooling sensation that helps in relieving pain and discomfort. [11]

Pharmacologically, menthol acts by stimulating cold-sensitive receptors in the skin, particularly TRPM8 channels, which create a cooling effect and reduce the perception of pain. [12] It also exhibits mild anti-inflammatory activity and acts as a counter-irritant, diverting attention from deeper pain. Due to these properties, menthol is commonly used in analgesic creams, gels, and balms for the management of muscle pain, joint pain, and minor injuries. [13]

Figure no. 1: Menthol

2.2 Camphor [14]

Camphor is a terpenoid compound traditionally obtained from the wood of *Cinnamomum camphora*. It is widely used in topical medicinal preparations because of its analgesic and anti-inflammatory properties.

Camphor acts mainly as a counter-irritant by stimulating sensory nerve endings, which helps in reducing pain perception. It produces a warming or cooling sensation depending on its concentration. Additionally, camphor improves local blood circulation, which may contribute to faster relief from pain and inflammation. However, it should be used within safe limits, as higher concentrations may cause skin irritation or toxicity.

Figure no. 2: Camphor

2.3 Clove Oil

Clove oil is extracted from the dried flower buds of *Syzygium aromaticum* and is well known for its strong analgesic and antiseptic properties. [15] The major active constituent of clove oil is eugenol, which is responsible for most of its pharmacological effects. [16]

Eugenol exhibits significant analgesic activity by inhibiting the synthesis of prostaglandins and acting as a local anesthetic. [17] It also possesses anti-inflammatory, antioxidant, and antimicrobial properties. Due to these effects, clove oil is widely used in dental preparations and topical formulations for the relief of muscular and joint pain. [18]

Figure no. 3: Clove Oil

3. Mechanism of Analgesic Action

The analgesic effect of a polyherbal cream containing menthol, camphor, and clove oil is

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achieved through multiple complementary mechanisms. [19]

Menthol works by activating TRPM8 receptors, producing a cooling sensation that reduces pain perception. Camphor acts as a counter-irritant, stimulating nerve endings and creating a mild warming or cooling effect, which helps to distract from deeper pain signals. It may also improve local blood circulation. [20]

Clove oil, through its active constituent eugenol, inhibits the cyclooxygenase (COX) pathway, thereby reducing the production of prostaglandins, which are key mediators of pain and inflammation. It also provides a local anesthetic effect by numbing the affected area. [21]

Together, these ingredients produce a synergistic effect by acting through different pathways, including sensory modulation, counter-irritation, and inhibition of inflammatory mediators. This multi-mechanistic approach enhances the overall analgesic efficacy while minimizing dependence on synthetic drugs. [22]

Table 2.1: Mechanism of Action of Active Ingredients

Ingredient	Mechanism	Pharmacological Effect
Menthol	TRPM8 receptor activation	Cooling, analgesic
Camphor	Counter-irritant action	Pain relief, improved circulation
Clove Oil (Eugenol)	COX inhibition	Analgesic, anti-inflammatory

III. MATERIALS AND METHODS

This section outlines the materials used, instruments employed, formulation strategy, and the method followed for the preparation of the herbal analgesic cream containing menthol, camphor, and clove oil.

3.1 Materials

The developed formulation utilized selected herbal active ingredients along with standard pharmaceutical excipients. The primary herbal components included menthol, camphor, and clove oil, which are well recognized for their analgesic, anti-inflammatory, and counterirritant properties.

Along with these actives, various excipients were used to prepare a stable and effective cream base. These included emulsifying agents, emollients, humectants, preservatives, and solvents such as stearic acid, cetyl alcohol, glycerin, propylene glycol, triethanolamine, and purified water. All ingredients used in the study were of analytical or pharmaceutical grade to ensure quality and reproducibility.

3.2 Instruments

A range of laboratory instruments and equipment were employed for formulation development and evaluation studies. A digital pH meter was used for determining pH, while a Brookfield viscometer was used to measure viscosity and flow behavior of the formulations.

In addition, an electronic balance was used for precise weighing of ingredients, a magnetic stirrer facilitated uniform mixing during formulation, and standard laboratory glassware was used for preparation, handling, and evaluation of the cream samples.

3.3 Formulation Design

The herbal analgesic cream was formulated as an oil-in-water (O/W) emulsion using suitable excipients and active herbal ingredients. Different ingredients were selected to achieve optimum consistency, spreadability, stability, and therapeutic effectiveness. Menthol, camphor, and clove oil were incorporated as active analgesic agents. Stearic acid and cetyl alcohol were used to prepare a stable cream base. Glycerin and propylene glycol improved moisture retention and skin penetration, while triethanolamine helped in emulsification and pH adjustment.

The formulation was prepared by the fusion method in which the oil phase and aqueous phase were heated separately and mixed with continuous stirring to obtain a homogeneous cream.

Table 3.1: Formula Composition of Herbal Analgesic Cream

Sr. No.	Ingredients	Category	Quantity (% w/w)
1	Menthol	Analgesic, Cooling Agent	5%
2	Camphor	Counterirritant	3%
3	Clove Oil	Analgesic Agent	2%
4	Stearic Acid	Emulsifying Agent	10%
5	Cetyl Alcohol	Stabilizer, Emollient	4%

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Sr. No.	Ingredients	Category	Quantity (% w/w)
6	Glycerin	Humectant	5%
7	Propylene Glycol	Penetration Enhancer	5%
8	Triethanolamine	pH Adjuster	2%
9	Purified Water	Vehicle	q.s. to 100%

3.4 Method of Preparation

The herbal analgesic cream was prepared by using the fusion method. The oil-soluble ingredients such as stearic acid and cetyl alcohol were weighed accurately and melted together at a temperature of approximately 70–75°C.

In another beaker, the aqueous phase containing purified water, glycerin, and triethanolamine was heated to the same temperature. The aqueous phase was then added slowly to the oil phase with continuous stirring to form a stable emulsion.

After complete emulsification, the formulation was allowed to cool gradually with continuous stirring. Menthol, camphor, and clove oil were incorporated at a lower temperature to prevent loss of volatile constituents. The prepared cream was mixed thoroughly until a smooth and homogeneous formulation was obtained. Finally, the cream was transferred into suitable airtight containers for further evaluation studies.

IV. FORMULATION AND EVALUATION

4.1 Formulation of Herbal Analgesic Cream

The herbal analgesic cream containing menthol, camphor, and clove oil was prepared as an oil-in-water (O/W) emulsion using the fusion method. The formulation was designed to achieve effective topical analgesic action along with good stability, spreadability, and patient acceptability.

The oil phase, consisting of stearic acid and cetyl alcohol, was melted by heating at 70–75°C. In parallel, the aqueous phase containing purified water, glycerin, propylene glycol, and triethanolamine was heated to the same temperature. The aqueous phase was then slowly added to the oil phase with continuous stirring to form a uniform emulsion.

After emulsification, the mixture was allowed to cool with continuous stirring. Menthol, camphor, and clove oil were added at a lower temperature to prevent loss of volatile components. The final formulation obtained was smooth, homogeneous, and free from phase separation.

4.2 Formulation of Different Batches

Different batches (F1–F4) of the herbal analgesic cream were prepared by varying the concentration of active ingredients (menthol, camphor, and clove oil), while keeping the excipients constant. This was done to optimize the formulation and identify the most effective and stable composition.

All batches were prepared using the same fusion method under identical conditions. The gradual increase in active ingredient concentration was intended to evaluate its effect on physical properties such as texture, odor, viscosity, spreadability, and stability, as well as on overall performance.

The prepared formulations were then subjected to various evaluation tests including physical appearance, pH, viscosity, spreadability, and stability studies to select the optimized batch suitable for topical analgesic application.

Table 4.1: Composition of Different Batches of Herbal Analgesic Cream

Ingredients	F1 (% w/w)	F2 (% w/w)	F3 (% w/w)	F4 (% w/w)
Menthol	2%	3%	4%	5%
Camphor	1%	2%	3%	4%
Clove Oil	0.5%	1%	1.5%	2%
Stearic Acid	10%	10%	10%	10%
Cetyl Alcohol	4%	4%	4%	4%
Glycerin	5%	5%	5%	5%
Propylene Glycol	5%	5%	5%	5%
Triethanolamine	2%	2%	2%	2%

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Ingredients	F1 (% w/w)	F2 (% w/w)	F3 (% w/w)	F4 (% w/w)
Purified Water	q.s. to 100	q.s. to 100	q.s. to 100	q.s. to 100

4.4 Method of Preparation of Different Batches

The herbal analgesic cream was prepared using the fusion method, which is widely used for the formulation of topical creams due to its ability to produce stable and homogeneous emulsions.

Initially, the oil phase was prepared by melting accurately weighed quantities of stearic acid and cetyl alcohol at 70–75°C with continuous stirring until a uniform mixture was obtained. Stearic acid acted as an emulsifier and thickening agent, while cetyl alcohol contributed to smooth texture and emollient properties.

In a separate container, the aqueous phase was prepared by dissolving purified water, glycerin, propylene glycol, and triethanolamine and heating them to the same temperature range. Glycerin acted as a humectant, propylene glycol enhanced skin penetration, and triethanolamine helped in pH adjustment and emulsion stability.

The aqueous phase was then slowly added to the oil phase with continuous stirring to form a stable oil-in-water emulsion. The mixture was allowed to cool gradually while stirring to obtain a smooth consistency.

Menthol, camphor, and clove oil were incorporated after partial cooling to avoid loss of volatile components, followed by thorough mixing to ensure uniform distribution. The final formulations were packed in airtight containers and stored for evaluation.

4.5 Purpose of Preparing Different Batches

Multiple batches were prepared to optimize the formulation and identify the most suitable composition of the herbal analgesic cream with maximum effectiveness and stability.

The main objectives included determining the optimal concentration of active ingredients for effective analgesic action, evaluating the effect of varying concentrations on physical properties such as texture, appearance, and odor, and comparing viscosity, spreadability, and homogeneity among batches.

Additionally, the study aimed to assess the impact of formulation variation on stability, phase separation, and skin compatibility. The optimized batch was selected based on overall evaluation parameters such as stability, consistency, pH, spreadability, and patient acceptability for further studies.

4.6 Physical Evaluation

The physical properties of all prepared formulation batches (F1–F4) were assessed through visual and sensory examination. Each batch was evaluated for its appearance, color, odor, texture, and overall homogeneity to ensure suitability for topical application. All formulations showed generally acceptable characteristics with smooth consistency and no visible lumps or gritty particles.

Among the batches, F1, F2, and F3 exhibited smooth and uniform appearance with good homogeneity. Batch F4, however, appeared slightly thicker and comparatively more greasy in texture, which may be attributed to the higher concentration of active ingredients. In terms of odor, F1 showed a mild minty smell, while F2 and F3 had a more pleasant aromatic fragrance. F4 exhibited a relatively stronger odor due to the higher level of volatile components.

Overall, F3 demonstrated the best balance of smooth texture, uniformity, and pleasant odor, making it more suitable for topical application compared to the other batches.

4.6.1 Determination of pH

The pH of all formulations was determined using a calibrated digital pH meter after dispersing a small quantity of cream in distilled water. All batches showed pH values within the acceptable skin-compatible range of 5.5 to 7.0.

F1 and F2 exhibited slightly acidic pH values, while F3 and F4 were closer to neutral. This range indicates that all formulations are unlikely to cause skin irritation and are suitable for dermatological application. Among them, F3 showed an optimal pH that closely matches normal skin physiology, supporting better skin compatibility.

4.6.2 Viscosity Study

The viscosity of the prepared formulations was evaluated using a Brookfield viscometer to understand their flow behavior and consistency. A gradual increase in viscosity was observed from F1 to F4, which was mainly due to the increasing concentration of active ingredients and excipients.

F1 showed lower viscosity, indicating a comparatively thinner consistency, while F4 showed the highest viscosity, making it thicker and slightly difficult to spread. F3 demonstrated an optimum balance between consistency and ease of application, which is desirable for a topical analgesic cream.

4.6.3 Spreadability Study

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Spreadability of all batches was assessed using the glass slide method to determine the ease with which the cream can be applied over the skin surface. The ability of a formulation to spread uniformly is an important factor for patient acceptability and therapeutic efficiency.
F1 and F2 showed moderate spreadability, whereas F3 demonstrated the highest spreadability, indicating smooth and uniform application with minimal effort. F4, despite its higher viscosity, showed reduced spreadability, which may limit ease of application. Overall, F3 was found to provide the most favorable spreading characteristics.

4.6.4 Stability Studies

The stability of all formulations was evaluated under accelerated conditions to assess their physical integrity over time. The formulations were observed for changes in color, odor, consistency, and phase separation.
Most batches remained stable during the study period, with no significant changes observed in F1, F2, and F3. However, F4 showed slight changes in color and odor along with minor phase separation, indicating reduced stability due to higher volatile oil content. Among all, F3 remained completely stable under tested conditions, confirming its robustness and suitability for long-term storage.

4.6.5 Optimized Batch Selection

Based on the comprehensive evaluation of all physical, chemical, rheological, and stability parameters, formulation batch F3 was identified as the optimized formulation.
F3 demonstrated superior characteristics, including smooth and uniform texture, pleasant aroma, optimal pH compatible with skin, balanced viscosity, excellent spreadability, and high physical stability without phase separation. These properties collectively make F3 the most suitable candidate for a topical herbal analgesic cream, ensuring both therapeutic effectiveness and patient acceptability.

V. RESULTS AND DISCUSSION

5.1 Physical Evaluation Results

The prepared herbal analgesic cream formulations were evaluated for physical characteristics such as appearance, color, odor, texture, homogeneity, and phase separation. All batches showed acceptable physical properties with smooth consistency and characteristic aromatic odor due to the presence of menthol, camphor, and clove oil.
Batch F1 and F2 exhibited smooth texture and good homogeneity, whereas batch F3 showed excellent consistency with better spreadability and elegant appearance. Batch F4 appeared comparatively thicker and slightly greasy because of the higher concentration of active ingredients. No significant phase separation was observed in batches F1, F2, and F3 during the study period.
The physical evaluation indicated that the prepared formulations were aesthetically acceptable and suitable for topical application.

Table 5.1: Physical Evaluation Results of Different Batches

Parameters	F1	F2	F3	F4
Appearance	Smooth	Smooth	Smooth	Slightly thick
Color	White	Off-white	Creamish white	Creamish white
Odor	Mild minty	Pleasant aromatic	Pleasant aromatic	Strong aromatic
Homogeneity	Good	Good	Excellent	Good
Texture	Soft	Smooth	Smooth	Slightly greasy
Phase Separation	Absent	Absent	Absent	Slightly observed

Discussion

The results demonstrated that increasing the concentration of active ingredients slightly affected the texture and consistency of the cream. Batch F3 showed optimum physical properties with smooth texture, good homogeneity, and pleasant odor, indicating better formulation compatibility. Higher concentrations in batch F4 may have contributed to increased greasiness and slight instability.

5.2 pH and Homogeneity Results

The pH of topical formulations is an important parameter because formulations with unsuitable pH may cause skin irritation. The pH values of all prepared batches were found within the acceptable skin-compatible range of 5.5–7.0.

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Homogeneity studies revealed that all formulations were uniformly mixed and free from lumps or coarse particles. Among all batches, F3 exhibited the best homogeneity and smooth consistency.

Table 5.2: pH and Homogeneity Results

Formulation Batch	pH	Homogeneity
F1	5.8	Good
F2	6.1	Good
F3	6.4	Excellent
F4	6.8	Good

Discussion

The pH values confirmed that all formulations were suitable for topical application without causing skin irritation. The slight increase in pH from F1 to F4 was mainly due to increased concentration of active ingredients and formulation components. Batch F3 showed optimum pH and excellent homogeneity, making it more acceptable for skin application.

5.3 Viscosity and Spreadability Results

Viscosity and spreadability are important rheological parameters that influence the application and patient acceptability of topical formulations. Viscosity determines the consistency and retention of the cream on the skin surface, whereas spreadability reflects ease of application.

The viscosity of all batches increased gradually with increase in concentration of active ingredients. Batch F3 showed optimum viscosity and excellent spreadability compared to other formulations.

Table 5.3: Viscosity and Spreadability Results

Formulation Batch	Viscosity (cP)	Spreadability (g·cm/sec)
F1	21,500	13.2
F2	24,300	15.4
F3	26,800	17.1
F4	29,400	14.0

Discussion

The results indicated that viscosity increased with increase in active ingredient concentration. Although F4 exhibited maximum viscosity, its spreadability was comparatively lower due to thicker consistency. Batch F3 showed balanced rheological properties with optimum viscosity and maximum spreadability, indicating ease of application and better patient compliance.

5.4 Stability Study Results

Stability studies were carried out under accelerated storage conditions to evaluate the physical stability of the prepared formulations. Parameters such as appearance, color, odor, consistency, and phase separation were observed periodically during storage. Batches F1, F2, and F3 remained stable throughout the study period without significant changes in physical properties. Batch F4 showed slight changes in odor and consistency because of higher concentration of volatile oils.

Table 5.4: Stability Study Results

Parameters	F1	F2	F3	F4
Color Change	No	No	No	Slight
Odor Change	No	No	No	Slight
Phase Separation	Absent	Absent	Absent	Slight
Consistency	Stable	Stable	Stable	Slightly unstable
Overall Stability	Good	Good	Excellent	Moderate

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Volume 11, Issue 3, May-June2026, pp:2283-2292 www.ijprajournal.com ISSN:2456-4494

Discussion

The stability study demonstrated that the prepared herbal analgesic creams possessed satisfactory physical stability. Batch F3 exhibited excellent stability without any phase separation or significant changes in odor and appearance. The slight instability observed in F4 could be attributed to the higher concentration of volatile constituents such as menthol and camphor.

Based on overall evaluation and stability results, batch F3 was considered the optimized formulation due to its desirable physicochemical properties, stability, and patient acceptability.

VI. CONCLUSION AND FUTURE SCOPE

6.1 Conclusion

The present study successfully developed and evaluated a herbal analgesic cream containing menthol, camphor, and clove oil for effective topical pain management. The selected herbal ingredients are well known for their analgesic, anti-inflammatory, cooling, and soothing properties, making them suitable for topical formulation.

Different formulation batches were prepared and assessed for key physicochemical and rheological parameters including appearance, pH, homogeneity, viscosity, spreadability, and stability. All formulations showed acceptable characteristics for topical use, while formulation F3 demonstrated the best overall performance with optimum pH, good spreadability, ideal viscosity, excellent homogeneity, and superior stability without phase separation.

The therapeutic effect of the formulation can be attributed to the synergistic action of its components. Menthol provides a cooling and analgesic effect, camphor acts as a counterirritant and enhances local circulation, and clove oil (eugenol) contributes significant analgesic and anti-inflammatory activity. Together, they enhance overall pain-relieving efficacy.

In conclusion, the developed herbal analgesic cream represents a safe, effective, and patient-friendly alternative to conventional topical analgesics, with reduced risk of systemic side effects.

6.2 Future Scope

The present work provides a strong basis for further research and development in herbal topical formulations.

Future studies may focus on the development of nano-based herbal creams or nanoemulsions to improve drug penetration, stability, and controlled release properties. Clinical evaluation is essential to confirm safety and efficacy in human subjects and to establish long-term therapeutic benefits.

The formulation also holds strong potential for commercial development, as demand for natural and herbal products continues to grow globally. Further research may explore the inclusion of additional medicinal plant extracts to enhance analgesic activity.

Extended stability studies under various environmental conditions can be conducted to determine shelf life, while detailed pharmacological and toxicological studies can help in understanding the exact mechanism of action and safety profile of the formulation.

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