

Formulation and Evaluation of Herbal Oil

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Abstract- — Inflammation is a natural protective response of the body against harmful stimuli such as infection, injury, toxins, and tissue damage. Although it plays an important role in healing and defense mechanisms, prolonged or chronic inflammation may lead to severe tissue damage and various disease conditions. Conventional anti-inflammatory drugs such as NSAIDs and corticosteroids are widely used for the management of inflammation; however, their long-term use is associated with several adverse effects including gastric irritation, renal toxicity, and cardiovascular complications. Due to these limitations, there is an increasing demand for safe, effective, and natural alternatives in the form of herbal formulations. The present study focuses on the formulation and evaluation of a herbal anti-inflammatory oil using *Annona reticulata* leaves extract along with turmeric, ginger, sesame oil, eucalyptus oil, mentha piperita oil, and vitamin E. *Annona reticulata* is rich in bioactive phytoconstituents such as flavonoids, alkaloids, tannins, and phenolic compounds which contribute to its anti-inflammatory and antioxidant activities. Turmeric provides curcumin, while ginger contains gingerols and shogaols, both of which are known for their strong anti-inflammatory properties. The essential oils included in the formulation enhance skin penetration, provide soothing effects, and improve overall therapeutic action. The formulated herbal oil was evaluated for various physicochemical parameters such as appearance, odor, pH, viscosity, spreadability, homogeneity, skin irritation, and stability. The results indicated that the formulation was stable, safe for topical application, and showed satisfactory characteristics. The synergistic effect of all herbal ingredients may contribute to effective reduction of inflammation with minimal side effects. Hence, the developed herbal oil formulation can be considered a promising, safe, and economical alternative for the management of inflammatory conditions. {1}

Keywords— *Annona reticulata*, herbal oil, turmeric, ginger, sesame oil, antiinflammatory, physicochemical evaluation, phytochemical screening..

I. INTRODUCTION

Inflammation is a complex biological response of the body against harmful stimuli such as infections, tissue injury, toxins, allergens, and various environmental factors. It is a natural defense mechanism that helps the body eliminate harmful agents, remove damaged tissues, and initiate the healing process. The inflammatory response is an essential component of innate immunity and plays a crucial role in maintaining tissue homeostasis. Although inflammation is beneficial in protecting the body, uncontrolled or prolonged inflammation can contribute to the development of several chronic diseases and tissue damage.

The process of inflammation involves the activation of immune cells, release of inflammatory mediators, increased blood flow, and migration of leukocytes to the affected site. These responses help in isolating and destroying harmful stimuli while promoting tissue repair. However, excessive production of inflammatory mediators may result in persistent inflammation and pathological conditions.

Inflammation is generally characterized by five cardinal signs:

- Redness (Rubor)
- Heat (Calor)
- Swelling (Tumor)
- Pain (Dolor)
- Loss of Function (Functio Laesa)

These signs occur due to vascular and cellular changes taking place at the site of injury or infection.

Types of Inflammation

Acute Inflammation

Acute inflammation is a rapid and short-duration response that occurs immediately after tissue injury or infection. It usually lasts from a few hours to a few days and is characterized by increased blood flow, fluid accumulation, and migration of neutrophils to the affected area.

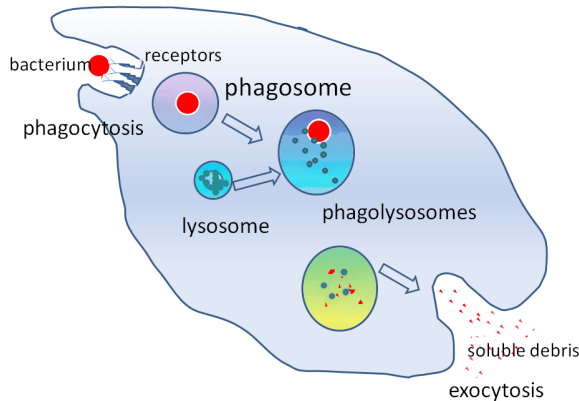


Fig. Acute Inflammation

Common causes of acute inflammation include:

- Bacterial and viral infections
- Physical injury
- Chemical exposure
- Burns and trauma
- Allergic reactions

The primary objective of acute inflammation is to eliminate the harmful stimulus and initiate tissue repair.

Chronic Inflammation

Chronic inflammation is a prolonged inflammatory response that may persist for weeks, months, or even years. It develops when the acute inflammatory response fails to eliminate the causative agent or when continuous exposure to irritants occurs.

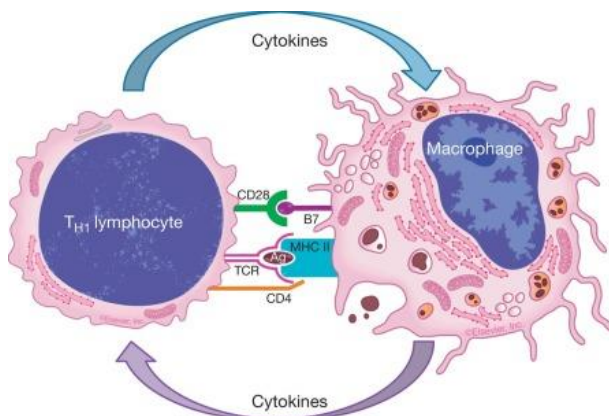


Fig. Chronic Inflammation

Chronic inflammation is associated with several disorders such as:

- Diabetes mellitus

- Cardiovascular diseases
- Cancer
- Autoimmune disorders
- Neurodegenerative diseases

Unlike acute inflammation, chronic inflammation is characterized by infiltration of macrophages, lymphocytes, and plasma cells leading to progressive tissue destruction and fibrosis.

Mechanism of Inflammation

The inflammatory process involves a series of coordinated biological events.

Step 1: Recognition of Injury

When tissue damage occurs, immune cells recognize harmful stimuli through specialized receptors. These receptors detect pathogens, damaged cells, or foreign substances.

Step 2: Release of Inflammatory Mediators

Activated immune cells release various inflammatory mediators such as:

- Histamine
- Prostaglandins
- Leukotrienes
- Cytokines
- Nitric oxide

These mediators initiate vascular and cellular changes at the site of injury.

Step 3: Vasodilation

Blood vessels dilate, resulting in increased blood flow to the affected area. This causes redness and warmth.

Step 4: Increased Vascular Permeability

Capillaries become more permeable, allowing plasma proteins and immune cells to migrate into tissues. This leads to swelling.

Step 5: Leukocyte Migration

White blood cells migrate toward the site of injury through chemotaxis and eliminate pathogens and damaged cells.

Step 6: Resolution and Repair

After removal of harmful stimuli, tissue repair mechanisms become activated, restoring normal structure and function.

Inflammatory Mediators

Inflammatory mediators are chemical substances responsible for regulating inflammatory responses.

Histamine

Histamine is released from mast cells and causes vasodilation and increased vascular permeability.

Prostaglandins

Prostaglandins are synthesized from arachidonic acid and contribute to pain, fever, and inflammation.

Cytokines

Cytokines such as TNF- α , IL-1, and IL-6 play important roles in immune regulation and inflammatory responses.

Nitric Oxide

Nitric oxide contributes to vasodilation and immune defense mechanisms.

Leukotrienes

Leukotrienes promote leukocyte recruitment and enhance inflammatory reactions.

Causes of Inflammation

Several factors can trigger inflammation including:

- Microbial infections
- Physical injury
- Chemical irritants
- Autoimmune reactions
- Allergic responses
- Environmental pollutants
- Oxidative stress
- Metabolic disorders

Persistent exposure to these factors may result in chronic inflammatory conditions.

Role of Oxidative Stress in Inflammation

Oxidative stress occurs when the production of reactive oxygen species exceeds the body's antioxidant defense mechanisms. Excessive oxidative stress can damage cellular components including proteins, lipids, and DNA.

Reactive oxygen species stimulate inflammatory pathways and enhance the production of pro-inflammatory cytokines. Therefore, antioxidants play a significant role in reducing inflammation and protecting tissues from damage.

Limitations of Conventional Anti-Inflammatory Therapy

Various synthetic drugs are available for the treatment of inflammation.

Non-Steroidal Anti-Inflammatory Drugs (NSAIDs)

NSAIDs inhibit cyclooxygenase enzymes and reduce prostaglandin synthesis. Long-term use may cause:

- Gastric ulceration
- Gastrointestinal bleeding
- Kidney damage
- Cardiovascular complications

Corticosteroids

Corticosteroids effectively suppress inflammation but prolonged use may lead to:

- Osteoporosis
- Hypertension
- Diabetes
- Immunosuppression

These limitations have increased interest in herbal alternatives.

Herbal Medicines in Inflammation Management

Medicinal plants have been used for centuries in traditional healthcare systems. Herbal medicines contain various bioactive constituents including alkaloids, flavonoids, tannins, terpenoids, and phenolic compounds that exhibit anti-inflammatory properties.

Advantages of herbal medicines include:

- Better safety profile
- Lower toxicity
- Cost effectiveness
- Easy availability
- Multiple therapeutic actions

Herbal preparations are increasingly being explored as alternatives for managing inflammatory disorders.

***Annona reticulata* as an Anti-Inflammatory Herb**

Annona reticulata belongs to the family Annonaceae and is commonly known as Ramphal or Custard Apple. Different parts of the plant have been traditionally used for treating various ailments.

The leaves contain bioactive compounds such as:

- Alkaloids
- Flavonoids
- Tannins
- Phenolic compounds
- Terpenoids

These constituents possess antioxidant and anti-inflammatory activities which help reduce inflammatory responses and tissue damage.

II. MATERIAL & METHOD

1. Material

Annona reticulata leaves extract :

Kingdom: Plantae

Order: Magnoliids

Family: *Annonaceae*

Genus: *Annona*

Species: *Annona reticulata*



Fig. *Annona reticulata*

Synonyms: *Annona excelsa* Kunt, *Annona laevis* Kunth, *Annona longifolia* Moc, *Annona longifolia* Sesse, *Annona riparia* kunth.

Chemical constituents: Dopamine, Salsolinol, Coclaurine,

3. Ginger powder :

Kingdom: Plantae

Order: Zingiberales

Family: *Zingiberaceae*

Genus: *Zingiber*

Species: *Zingiber officinale*



Fig . Ginger

Chemical constituents: Zingiberene, β -bisabolene, α -farnesene, Camphene, Cineole, Gingerols, Shogaols, Zingerone

4. Sesame oil :

Kingdom: Plantae

Order: Lamiales

Family: *Pedaliaceae*

Genus: *Sesamum*

Species: *Sesamum indicum*



Fig. Sesame oil

Chemical constituents: Oleic acid, Linoleic acid, Palmitic acid, Stearic acid, Sesamin, Sesamol, Sesamol

5. Eucalyptus oil :

Kingdom: Plantae

Order: Myrtales

Family: *Myrtaceae*

Genus: *Eucalyptus*

Species: *Eucalyptus globulus*

Chemical constituents: 1,8 - Cineole, α -pinene, β -pinene, Limonene, p-cymene



Fig Eucalyptus oil

6. Mentha piperita oil :

Kingdom: Plantae

Order: Lamiales

Family: *Lamiaceae*

Genus: *Mentha*

Species: *Mentha piperita*

Chemical constituents: Menthol (30 - 50 %), Menthone (15 - 30 %), Menthyl acetate, Menthofuran, Limonene, α -pinene, β -pinene



Fig. Mentha piperita oil

7. Vitamin E oil :

Vitamin E oil is a fat-soluble antioxidant oil derived from vitamin E compound (tocopherols & tocotrienols). Used in cosmetics, pharmaceuticals, and skincare.

Chemical Constituents : Contains tocopherols ($\alpha, \beta, \gamma, \delta$) and tocotrienols. Most active form: α -tocopherol. Lipophilic (fat-soluble) \rightarrow easily penetrates skin.

Sources: Vegetable oils (sunflower, wheat germ oil) Nuts & seeds (almonds, sunflower seeds) Green leafy vegetables.



Method

Sr. No.	Ingredients	Quantity(100ml)	Roles
1.	<i>Annona reticulata</i> leaves extract	3 g	Anti-arthritic Anti-inflammatory
2.	Sesame oil	90 ml	Base oil, Improves penetration

3.	Turmeric powder	1.5 g	Anti-inflammatory
4.	Ginger powder	2.5 g	Anti-inflammatory
5.	Eucalyptus oil	1 ml	Improves circulation
6.	<i>Mentha piperita</i> oil	1 ml	Cooling agent
7.	Vitamin E oil	0.5 ml	Antioxidant, preservative
8.	Remaining sesame oil	Q.S.	Vehicle

Collection of Material

Annona reticulata plant leaves collected from local area of Bhor. The collected leaves were washed and then shade dried. The dried leaves were powdered using mechanical grinder and stored in airtight container. The plant was identified by the Kisan Veer Mahavidyalaya Wai with Identification No. H-T-01.



Turmeric and ginger powder were procured from the local market, while sesame oil, eucalyptus oil, mentha piperita oil and vitamin E oil were obtained from college laboratory



Preparation of plant extract

About 50 g of the powdered shade-dried leaves of *Annona reticulata* leaves were extracted with 200 mL of 95% ethanol (drug-to-solvent ratio 1:4) using a Soxhlet apparatus for 72 hours at 40–50 °C.

Method of preparation of oil Preparation of Kalka (Herbal Paste)

Materials

- Ginger powder – 2.5 g
- Turmeric powder – 1.5 g
- *Annona reticulata* leaves extract – 3 g

Procedure

Take ginger powder and turmeric powder in a clean mortar. Add *Annona reticulata* leaves extract to the powders. Add small quantity of distilled water (10–15 ml). Triturate the mixture for 10–15 minutes until a smooth thick paste is obtained. This paste is called Kalka.

Preparation of Sneha (Medicated Oil)



Step 1: Oil Base

Take 90 ml sesame oil in a clean beaker.

Step 2: Addition of Kalka

Add the prepared Kalka to the sesame oil. Mix properly.

Step 3: Addition of Liquid

Add 100 ml distilled water to the mixture. Stir thoroughly.

Step 4: Heating (Sneha Paka)

Heat the mixture on a hot plate. Maintain temperature around 40–50°C. Continue heating for 30 minutes with continuous stirring.

Step 5: Completion

The process is complete when: Water completely evaporates
 Frothing stops Clear oil layer forms



Step 6: Filtration:

Filter the hot oil using whatman filter paper.

Step 7: Final Additives Cool the oil to about 40°C.

Add: Eucalyptus oil – 1 ml
 Peppermint oil – 1 ml
 Vitamin E – 0.5 ml

Step 8: Final Volume

Add sesame oil q.s. to make 100 ml.

Step 9: Storage

Store the oil in a clean glass beaker wrapped with aluminium foil.

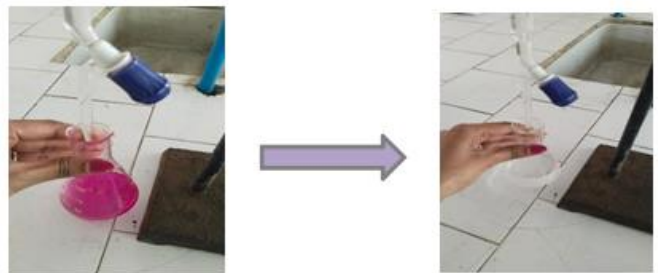
The herbal oil was successfully prepared using a standard and optimized procedure, ensuring proper extraction and uniform mixing of all ingredients. The process was carried out under controlled conditions to maintain the stability and effectiveness of the active constituents. The final formulation obtained was clear, homogeneous, and free from any impurities, indicating that the oil was well prepared and suitable for further evaluation and use.



Method for Physicochemical Evaluation of oil Saponification Value

Weigh about 1.8 g of oil into a conical flask. Add 25 ml of alcoholic KOH solution (0.5 N). Heat the flask gently on a water bath for 30–45 minutes with occasional shaking. After heating, allow it to cool. Add 2–3 drops of phenolphthalein indicator. Titrate the excess KOH with 0.5 N HCl until the pink color disappears. Also run a blank test without oil using same procedure.

Endpoint: Disappearance of pink color to colorless solution.



$$\text{Saponification Value} = \frac{(B - S) \times N \times 56.1}{W}$$

Where,

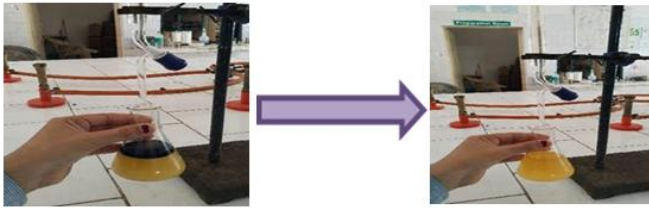
- B = Volume of HCl used for blank (ml)=14 ml
- S = Volume of HCl used for sample (ml)=2 ml
- N = Normality of HCl=0.5
- W = Weight of oil sample (g)=1.8 g
- 56.1= Molecular weight of KOH
- Saponification value of oil is 187 mg KOH/g

Iodine value

Weigh about 0.9 g of oil in a flask. Add 10–15 ml chloroform to dissolve it. Then add 25 ml Wijs solution (iodine monochloride solution). Keep the flask in dark place for 30 minutes (very important). After reaction, add 10 ml of potassium iodide (10%) and shake well. Add 50 ml distilled water. Titrate with 0.1 N sodium thiosulfate until solution becomes pale yellow. Add 2–3 drops starch indicator. Continue titration until blue color disappears.

Also perform a blank test.

Endpoint: Disappearance of blue starch–iodine color.



Iodine value:
$$\frac{(B - S) \times N \times 12.69}{W}$$

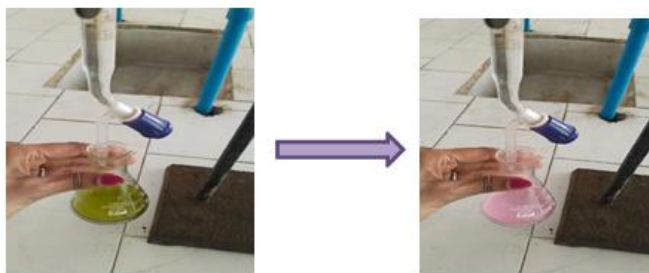
Where,

- B = Volume of Na₂S₂O₃ used for blank (ml)=22 ml
- S = Volume of Na₂S₂O₃ used for sample (ml)=14 ml
- N = Normality of sodium thiosulfate=0.1
- W = Weight of oil sample (g)=0.9 g
- 12.69 = Constant derived from iodine equivalent
- Iodine value of oil is 11.28 g I₂ / g

Acid value

Weigh accurately about 1.8 g of oil in a clean conical flask. Add 25 ml of neutral alcohol (ethanol or ethanol-ether mixture) and shake well to dissolve the oil. Add 2-3 drops of phenolphthalein indicator. Titrate this mixture with 0.1 N KOH solution with constant shaking until a light pink color appears and remains for 30 seconds. This is the endpoint.

Endpoint: Appearance of faint permanent pink color.



Acid value :
$$\frac{V \times N \times 56.1}{W}$$

Where,

- V = Volume of KOH used in titration (ml)=0.2 ml
- N = Normality of KOH=0.1
- W = Weight of oil sample (g)=1.8 g

- 56.1 = Molecular weight of KOH
- Acid value of oil is 0.62 mg KOH / g

pH

A small amount of the oil sample is taken and mixed with distilled water to form a slight emulsion. A clean glass rod is dipped into the mixture and a drop is placed on universal pH paper. The color change on the pH paper is observed and immediately compared with the standard pH color chart provided.



Yellow color observed.

So, pH is 5-6 which is weakly acidic.

Density

A clean and dry empty container is weighed and its weight is noted as W₂. Then a known volume of oil (V, in mL) is measured using a measuring cylinder and transferred into the same container. The container with oil is weighed again and recorded as W₁.

Density is calculated using the formula:

Density = (W₁ - W₂) / V = 42.17 - 32.25 / 10

Density of oil is 0.9 g/ml

Sr. No.	Test	Result	Inference
1	pH	5-6	Suitable for skin
2	Density	0.9 g/ml	Good flow property
3	Acid Value	0.62 mg KOH/g	Low free fatty acid content
4	Saponification Value	187 mg KOH/g	Presence of fatty acids
5	Iodine Value	11.28 g I ₂ /g	Indicates unsaturation
6	Solubility	Insoluble in water	Oil nature confirmed

III. SKIN INFLAMATION TEST

The skin inflammation test was carried out to evaluate the safety and compatibility of the prepared herbal oil on the skin after topical application. The test helps in determining whether the formulation produces any inflammatory response or adverse skin reaction when applied externally.

For the test, a small quantity of the formulated herbal oil was applied gently on a clean and marked area of the skin. The selected area was kept uncovered throughout the study period to allow proper observation of any visible skin reactions. After application, the site was carefully monitored at regular intervals for a duration of 2 hours. During the observation period, different parameters associated with skin inflammation were examined, including redness, swelling, itching, irritation, rashes, burning sensation, or any discomfort at the application site.

The applied area remained normal throughout the observation period. No signs of erythema, edema, itching, burning sensation, irritation, or allergic reaction were observed after application of the herbal oil. The skin showed good tolerance towards the formulation without producing any inflammatory response.

The absence of visible skin reactions indicates that the prepared herbal oil possesses good skin compatibility and can be safely used for topical application. The results suggest that the formulation is non-irritant, non-inflammatory, and suitable for external therapeutic use in arthritis-related conditions.

Procedure of Skin Inflammation Test

- A clean area of skin was selected and marked properly.
- A small quantity of the prepared herbal oil was taken.
- The oil was applied gently on the marked skin area.
- The applied area was kept uncovered throughout the test period.
- The site was observed continuously for 2 hours at regular intervals.
- The skin was checked for signs of inflammation such as:
 - Redness
 - Swelling
 - Itching
 - Burning sensation
 - Irritation
 - Rashes

After completion of the observation period, the skin condition was examined and observations were recorded.

No redness, swelling, itching, burning sensation, or irritation was observed, indicating that the formulation was safe for topical application.

Sr. No.	Parameter	Observation
1	Redness	Absent
2	Itching	Absent
3	Swelling	Absent
4	Irritation	No irritation observed

Phytochemical Evaluation Test

Sr. No.	Test	Observation	Inference
1	Dragendorff's Test	Orange precipitate	Alkaloids present
2	Alkaline Reagent Test	Yellow color	Flavonoids present
3	Lead Acetate Test	Yellow precipitate	Flavonoids present
4	Salkowski Test	Reddish brown color	Steroids present
5	Keller-Killiani Test	Brown ring formation	Glycosides present
6	Ferric Chloride Test	Dark green color	Tannins present

Solubility Test Table

Solvent	Observation
Water	Insoluble
Ethanol	Slightly Soluble
Methanol	Slightly Soluble
Hexane	Freely Soluble

IV. RESULT & DISCUSSION

The formulated herbal oil exhibited desirable physicochemical characteristics, indicating its suitability for topical application. The preparation showed uniform consistency, color and odor were acceptable and consistent with the natural constituents present in the formulation.

Evaluation of herbal oil

Sr. No.	Parameter	Observation
1.	Color	Dark Green
2.	Odor	Characteristic
3.	Physical state	Liquid with greasy in nature
4.	Solubility	1. Water- Insoluble 2. Ethanol- Slightly soluble 3. Methanol- Slightly soluble 4. Hexane- Freely soluble
5.	Clarity	Clear, no turbidity

Organoleptic Evaluation



Fig. Herbal Oil



Fig. Solubility Of Oil

Herbal oil cannot be directly used for phytochemical screening due to its non-polar nature, which interferes with the chemical reactions involved in qualitative tests. Therefore, it is necessary to first extract the active phytoconstituents from the oil using suitable polar solvents such as ethanol. This process helps to separate the bioactive compounds from the oil base into a testable form. The obtained extract is then subjected to various phytochemical tests to identify the presence of different chemical constituents.

Physicochemical Evaluation

Sr. No.	Parameter	Observation
1.	Saponification value	187 mg KOH/g
2.	Iodine value	11.28 g I ₂ /g
3.	Acid value	0.62 mg KOH / g
4.	pH	5-6 Weakly acidic
5.	Density	0.9 g/ml
6.	Skin irritation test	No irritation Safe for topical use

Phytochemical	Test	Procedure	Observation	Inference
Alkaloid	Dragendroff's test	2 ml of solution + few drops of dragendroff's reagent	Orange precipitate observed	Alkaloids Present (+)
Flavonoids	Alkaline reagent test	2 ml of solution + Add few drops of 10 % NaOH + Add acid	Yellow color- Disappears with addition of acid	Flavonoids Present (+)
Flavonoids	Lead acetate test	2 ml of solution + add lead acetate solution	Yellow precipitate	Flavonoids Present (+)
Steroids	Salkowski test	1 ml of solution + add chloroform + Conc. H ₂ SO ₄	Reddish- brown ring	Steroids Present (+)
Glycosides	Keller-killiani test	2 ml of solution + add glacial acetic acid + FeCl ₃ + add conc.H ₂ SO ₄	Brown ring at interface	Glycosides Present (+)
Tannins	Test for tannins	2 ml of solution + few drops of FeCl ₃	Black color observed	Tannins Present (+)

Based on the organoleptic, physicochemical, and phytochemical evaluations performed, it can be concluded that the formulated herbal oil exhibits good quality and acceptable characteristics suitable for further study. The organoleptic properties such as color, odor, and consistency indicate that the formulation is stable and possesses desirable sensory attributes. Physical evaluation parameters including density, pH, solubility, acid value, iodine value, and saponification value fall within acceptable ranges, suggesting proper formulation and stability of the oil. Phytochemical screening further confirms the presence of biologically active constituents in the extract, which may contribute to its therapeutic potential.

Evaluation Results of Anti-Arthritic Herbal Oil

Sr. No.	Evaluation Test	Result Obtained	Interpretation
1	Color	Dark Green	Acceptable appearance
2	Odor	Characteristic	Presence of herbal constituents
3	Physical State	Liquid	Suitable for topical application
4	Clarity	Clear	No impurities present

Sr. No.	Evaluation Test	Result Obtained	Interpretation
5	Consistency	Smooth and Homogeneous	Stable formulation
6	pH	5–6	Skin compatible
7	Density	0.9 g/ml	Good spreading property
8	Acid Value	0.62 mg KOH/g	Low rancidity and good stability
9	Saponification Value	187 mg KOH/g	Presence of fatty acids
10	Iodine Value	11.28 g I ₂ /g	Indicates unsaturated compounds
11	Solubility	Insoluble in water; soluble in hexane	Confirms oily nature
12	Phytochemical Tests	Positive for alkaloids, flavonoids, steroids, glycosides, tannins	Presence of active phytoconstituents
13	Skin Irritation Test	No redness or itching	Safe for topical use

V. CONCLUSION

The present study was successfully carried out to formulate and evaluate a herbal anti-inflammatory oil containing *Annona reticulata* leaves extract along with turmeric, ginger, sesame oil, eucalyptus oil, mentha piperita oil, and vitamin E. The formulation was developed with the objective of providing a safe, effective, and natural alternative for the management of inflammation. The selected herbal ingredients possess significant anti-inflammatory, antioxidant, analgesic, and soothing properties which may act synergistically to reduce

inflammatory responses and provide relief from pain and swelling.

The prepared herbal oil was evaluated for various physicochemical parameters such as color, odor, pH, viscosity, spreadability, homogeneity, skin irritation, and stability. The evaluation results indicated that the formulation possessed satisfactory characteristics, good stability, and was suitable for topical application without causing skin irritation. The presence of phytoconstituents such as flavonoids, alkaloids, tannins, phenolic compounds, curcumin, and gingerols may contribute to the therapeutic effectiveness of the formulation.

From the overall study, it can be concluded that the formulated herbal oil has promising anti-inflammatory potential and may be considered as a safer and economical alternative to conventional synthetic anti-inflammatory preparations. The herbal formulation may help in minimizing the adverse effects associated with long-term use of synthetic drugs while providing effective management of inflammation.

Summary

Inflammation is a protective biological response of the body against harmful stimuli such as infection, injury, toxins, and tissue damage. It plays an important role in defense and healing mechanisms; however, prolonged or uncontrolled inflammation may lead to chronic disorders and tissue destruction. The inflammatory process is mainly mediated by chemical substances such as prostaglandins, cytokines, histamine, and leukotrienes which produce redness, swelling, pain, and heat at the affected area. Conventional anti-inflammatory drugs including NSAIDs and corticosteroids are commonly used for the treatment of inflammation, but their long-term use is associated with several adverse effects such as gastric ulceration, renal toxicity, and cardiovascular complications. Hence, there is a growing interest in the development of herbal formulations as safer alternatives for the management of inflammation.

Medicinal plants have been used since ancient times in traditional systems of medicine due to their therapeutic efficacy and minimal side effects. In the present study, a herbal oil formulation was prepared using *Annona reticulata* leaves extract along with turmeric, ginger, sesame oil, eucalyptus oil, mentha piperita oil, and vitamin E. *Annona reticulata* contains various phytoconstituents such as flavonoids, alkaloids, tannins, and phenolic compounds which possess significant anti-inflammatory and antioxidant activities. Turmeric contains curcumin which inhibits inflammatory mediators, while ginger contains gingerols and shogaols that help reduce inflammation and pain. Sesame oil acts as a carrier and enhances skin

penetration, whereas eucalyptus and mentha oils provide soothing and cooling effects. Vitamin E acts as an antioxidant and improves the stability of the formulation.

The formulated herbal oil was evaluated for various physicochemical parameters including color, odor, pH, viscosity, spreadability, homogeneity, skin irritation, and stability. The formulation showed satisfactory characteristics and was found to be stable and suitable for topical application. The synergistic action of herbal ingredients may help in reducing inflammation effectively while minimizing the side effects commonly associated with synthetic drugs. Therefore, the developed herbal oil formulation may serve as a safe, effective, economical, and natural alternative for the management of inflammation and related conditions.

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