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Comprehensive Review on Formulation and Evaluation of Herbal Anti-Inflammatory Emulgel Prepared from is Nyctanthes Arbor-Tristis Powdered-Based Leaves Extract

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Abstract: *Inflammation is a protective physiological response to tissue injury, infection, or other harmful stimuli. Although conventional anti-inflammatory drugs are effective, prolonged use may be associated with adverse effects, creating interest in herbal alternatives* ***[3,5].*** *Nyctanthes arbor-tristis Linn. (Nyctaginaceae), commonly known as Parijat or Harshingar, has been traditionally used in Ayurveda and has been investigated for various pharmacological activities, including anti-inflammatory effects* ***[1,3,4].*** *The leaves contain iridoid glucosides and other phytochemicals that may contribute to their biological activities* ***[2].*** *The present study aims to formulate and evaluate a topical herbal emulgel containing an extract prepared from powdered leaves of Nyctanthes arbor-tristis. The leaves will be collected, authenticated, dried, powdered, and extracted using a suitable extraction method. The obtained extract will be incorporated into an emulgel using an appropriate oil phase, aqueous phase, emulsifying agents, gelling agent, humectant, and preservatives* ***[5].*** *The prepared formulations will be evaluated for physical appearance, homogeneity, pH, spreadability, viscosity, extrudability, washability, extract content, and stability. The topical anti-inflammatory potential may be assessed using a suitable in-vitro method, such as inhibition of protein denaturation. The developed emulgel is expected to provide convenient topical application and sustained contact of the herbal extract with the skin. This study may provide a simple and economical approach for developing a plant-based topical formulation with potential anti-inflammatory activity.*

Keywords: *Inflammation*

I. INTRODUCTION

Inflammation is a natural protective response of the body to tissue injury, infection, or other harmful stimuli. It involves a complex series of cellular and biochemical processes and may produce symptoms such as pain, redness, swelling, and reduced function. Although conventional anti-inflammatory medicines are widely used, interest in plant-based preparations has increased because medicinal plants contain diverse bioactive constituents that may possess pharmacological activities. Therefore, the development of suitable topical herbal formulations is an important area of pharmaceutical research [6,8,13].

Earlier experimental research demonstrated anti-inflammatory activity in leaf extracts of Nyctanthes arbor-tristis, supporting the traditional use of the plant in inflammatory conditions. Further research investigated β-sitosterol isolated from N. arbor-tristis leaves and reported analgesic and anti-inflammatory activity, providing additional evidence of the plant's pharmacological potential [6,8]

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Fig:-1 ***Nyctanthes arbor-tristis leaves*** **Fig:-2** ***Nyctanthes arbor-tristis flowers***

Phytochemical investigations of N. arbor-tristis have reported biologically important constituents in its leaves. Research into the plant's phytochemicals and their possible interactions with inflammatory targets has also supported continued investigation of its potential anti-inflammatory properties. However, further experimental evaluation is necessary to establish the activity of a prepared topical formulation **[7,13].**

The emulgel system is useful for topical formulations because it combines the properties of an emulsion and a gel. It can accommodate ingredients with different solubility characteristics while providing a convenient, spreadable, and relatively non-greasy dosage form. Emulgels have been discussed as promising systems for topical delivery of anti-inflammatory and other therapeutically active substances **[9,10,11].**

Topical delivery allows a formulation to be applied directly to the intended skin area and may reduce systemic exposure compared with some orally administered medicines. Emulgels have been investigated for their potential to improve local drug delivery, maintain contact with the skin, and provide suitable release characteristics. Their physicochemical properties can be optimized by selecting appropriate gelling agents, emulsifiers, oil phases, and other excipients **[9,10,11].**

In the present study, powdered leaves of Nyctanthes arbor-tristis will be used as the starting material for preparing a leaf extract, which will subsequently be incorporated into an emulgel formulation. Previous research on topical formulations containing N. arbor-tristis leaf extract provides a basis for further formulation development. The prepared emulgel will be evaluated for appearance, homogeneity, pH, viscosity, spreadability, extrudability, washability, extract content, and stability. Its potential anti-inflammatory activity will be investigated using an appropriate in-vitro evaluation method **[6,12,13].**

II. REVIEW OF LITERATURE

1. Botanical Profile of *Nyctanthes arbor-tristis*

Nyctanthes arbor-tristis Linn. belongs to the family **Oleaceae** and is commonly known as **Parijat, Harshingar, or Night-flowering Jasmine**. It is a small tree or shrub widely distributed in India and other parts of South and Southeast Asia. The plant is recognized by its fragrant white flowers with orange-coloured centres that generally open during the night and fall by morning.

The plant has considerable importance in traditional systems of medicine, including Ayurveda. Different parts such as the **leaves, flowers, seeds, bark, and roots** have traditionally been used for conditions including fever, arthritis, sciatica, inflammation, and various other disorders. Contemporary reviews have compiled evidence for several pharmacological activities of the plant and have emphasized the need for further research into its active constituents, mechanisms, and safety. **[14,15]**

2. Phytochemical Constituents

Phytochemical investigations indicate that *N. arbor-tristis* contains several classes of biologically active compounds. Reported constituents include **flavonoids, tannins, alkaloids, sterols, terpenoids, saponins, glycosides, phenolic compounds, and iridoid glycosides**. Compounds such as arbortristosides and β-sitosterol have attracted particular scientific interest. **[14,15]**

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The phytochemical composition may vary depending on the plant part, geographical location, extraction solvent, and extraction procedure. Therefore, appropriate authentication and standardized processing of the leaves are important when developing a reproducible herbal formulation.

β-Sitosterol isolated from *N. arbor-tristis* leaves has demonstrated analgesic and anti-inflammatory activity in experimental models, suggesting that leaf phytoconstituents may contribute to the plant's pharmacological effects. **[16]**

3. Pharmacological Activities

Several pharmacological activities have been reported for extracts and isolated constituents of *N. arbor-tristis*. These include:

- Anti-inflammatory activity
- Analgesic activity
- Antioxidant activity
- Antimicrobial activity
- Antimalarial activity
- Antidiabetic activity
- Hepatoprotective activity
- Anticancer activity
- Wound-healing activity
- Immunomodulatory activity

A recent comprehensive review summarized evidence for anti-inflammatory, antioxidant, wound-healing, hepatoprotective, anticonvulsant, and other activities while also emphasizing the need for further toxicological and mechanistic studies. **[14,15,22]**

4. Anti-inflammatory Activity

The anti-inflammatory activity of *N. arbor-tristis* leaves has been investigated experimentally. Saxena et al. reported that a water-soluble fraction of an alcoholic leaf extract reduced inflammatory responses in several experimental models, including carrageenan-, formalin-, histamine-, and serotonin-induced inflammation. The preparation also reduced inflammation in experimental joint and arthritis models. **[17]**

Khatune et al. investigated different leaf extracts and subsequently isolated β-sitosterol from the active fraction. β-Sitosterol demonstrated dose-dependent analgesic and anti-inflammatory effects in experimental models, providing evidence that individual constituents of the leaves may contribute to the observed activity. **[16]**

More recent research investigated a bioactive extract of *N. arbor-tristis* using both cellular and animal models. The study reported reductions in inflammatory mediators and markers including nitric oxide, reactive oxygen species, COX-2, TNF-α, IL-6, and IL-1β, and suggested involvement of inflammatory signalling pathways. **[18]**





Fig:-3 ***Nyctanthes arbor-tristis Leaf***

Fig:-4 ***Nyctanthes arbor-tristis Powder***

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These findings provide a scientific rationale for further investigation of *N. arbor-tristis* leaf extract in a suitable topical dosage form

5. Extraction Methods

Extraction is an important step in herbal formulation because the extraction technique and solvent influence the quantity and type of phytoconstituents obtained. Before extraction, authenticated leaves are generally **cleaned, dried, powdered, and stored under appropriate conditions**.

Common extraction approaches include:

- Maceration
- Soxhlet extraction
- Infusion
- Decoction
- Percolation
- Ultrasonic-assisted extraction

The choice of solvent depends on the chemical characteristics of the constituents of interest. Polar solvents may favour extraction of phenolic compounds, flavonoids, glycosides, and tannins, whereas less-polar solvents can extract constituents such as sterols and certain terpenoids.

For the proposed study, powdered *N. arbor-tristis* leaves can therefore be subjected to a suitably selected extraction procedure, followed by filtration and concentration of the extract. The extraction method should be kept consistent between batches to improve reproducibility. **[14,15]**

6. Topical Drug Delivery

Topical drug delivery involves application of a pharmaceutical formulation directly to the skin or affected superficial tissue. It can be useful when localized treatment is desired and may provide drug or active-constituent exposure at the site of application.

However, the skin provides a significant barrier to penetration. Consequently, formulation characteristics such as the vehicle, viscosity, solubility of the active substance, particle characteristics, and interaction with the skin can influence topical delivery. **[19]**

Conventional topical preparations include creams, ointments, lotions, gels, and pastes. Each dosage form has advantages and limitations. For example, ointments may be greasy, whereas conventional gels may have limitations in incorporating some poorly water-soluble constituents. These considerations have encouraged the development of hybrid systems such as emulgels. **[19]**

7. Emulgel: Formulation and Advantages

An **emulgel** is a semisolid topical dosage form prepared by incorporating an emulsion into a gel base. It combines characteristics of both emulsions and gels. Depending on the formulation, either an oil-in-water or water-in-oil emulsion can be incorporated into a suitable gel network. **[20,21]**

The general components of an emulgel may include:

- Oil phase
- Aqueous phase
- Emulsifying agent
- Gelling agent
- Humectant
- Preservative
- Active ingredient or herbal extract

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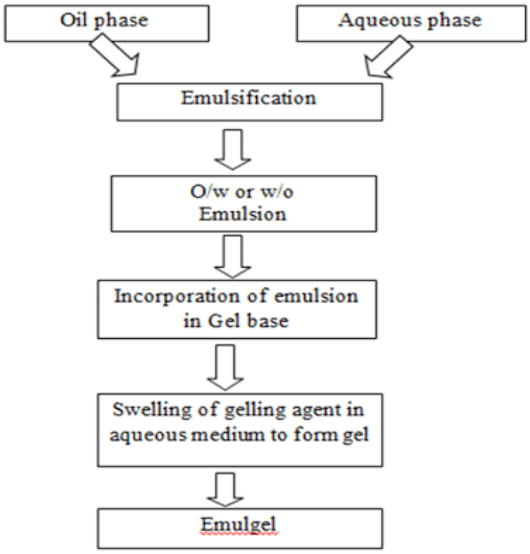
Emulgels have several potential advantages for topical delivery. They are generally **spreadable, non-greasy, easily removable, and convenient to apply**. They can also accommodate hydrophilic and lipophilic components and may provide controlled or prolonged release. **[20,21]**

Recent reviews have discussed the use of emulgels for anti-inflammatory and arthritis-related applications and have identified formulation variables such as the oil phase, emulsifier, and gelling agent as important factors affecting stability and performance. **[20,22]**



8. Previous *Nyctanthes arbor-tristis* Topical Formulations

Research on *N. arbor-tristis* has progressed from investigation of crude extracts and isolated constituents to development of topical delivery systems. The anti-inflammatory activity of the leaves was established experimentally in earlier pharmacological studies. **[17,20]**

More recent formulation research has investigated *N. arbor-tristis* leaf extract in advanced topical systems, demonstrating that the plant extract can be incorporated into a topical formulation and evaluated for physicochemical and delivery-related properties. Such studies provide a useful foundation for further formulation development. **[17,20]**

However, the existence of previous topical formulations means that the proposed project should **not claim that every topical formulation of *N. arbor-tristis* is novel**. Instead, the specific formulation design, extract preparation, excipient selection, optimization strategy, and anti-inflammatory evaluation should be clearly defined as the research focus. **[17,20]**

SIGNIFICANCE OF THE STUDY

The proposed formulation is significant because it combines the reported anti-inflammatory potential of *Nyctanthes arbor-tristis* leaves with a convenient topical drug-delivery system. Instead of using the plant material directly on the skin, the proposed study involves collection and authentication of the leaves, drying and powdering of the plant material, preparation of an extract, and incorporation of the extract into an emulgel. This approach allows the herbal material to be processed into a standardized pharmaceutical formulation that can be systematically evaluated. **[14,16,20]**

The use of powdered leaves as the starting material also provides a practical approach for a laboratory-scale herbal formulation. Proper authentication of the plant material is important because the identity and quality of medicinal plant

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material can influence the reproducibility of the formulation. Following extraction, preliminary phytochemical evaluation may be performed to identify major classes of constituents present in the extract. [**14,16,20]**

The developed emulgel can be evaluated using pharmaceutical parameters such as physical appearance, colour, odour, homogeneity, pH, viscosity, spreadability, extrudability, washability, extract content, and stability. An appropriate in-vitro anti-inflammatory method may also be used to obtain preliminary evidence of biological activity. Such evaluation can help establish a relationship between the herbal extract and the characteristics of the final topical dosage form. **[14,16,20]**

RESEARCH GAP

Although the anti-inflammatory activity of *N. arbor-tristis* leaves has been reported in experimental studies, there remains a need for further investigation of the plant in modern topical delivery systems. Earlier work established anti-inflammatory activity of leaf extracts, while other studies investigated isolated constituents such as β-sitosterol.

More recent formulation research demonstrates that *N. arbor-tristis* leaf extract can be incorporated into advanced topical systems. For example, a 2025 study developed an ethosomal gel containing *N. arbor-tristis* leaf extract and evaluated its physicochemical and drug-release characteristics. Other research has investigated *N. arbor-tristis* in gel, ointment, and combined-herbal topical formulations. **[17,22]**

Importantly, the available literature does not establish a well-defined and extensively studied formulation specifically focused on a **single-herb *Nyctanthes arbor-tristis* powdered-leaf-derived extract incorporated into a conventional herbal emulgel for anti-inflammatory evaluation**. A 2023 report described an emulgel containing *N. arbor-tristis* together with *Clitoria ternatea*, meaning it was a polyherbal rather than a single-herb formulation. Therefore, further systematic work on a single-herb *N. arbor-tristis* leaf-extract emulgel, including optimization of formulation variables and evaluation of its physicochemical properties and in-vitro anti-inflammatory potential, is justified.

The research gap therefore lies not in demonstrating that *N. arbor-tristis* has any anti-inflammatory potential at all—the activity has already been reported—but in developing and systematically evaluating a **simple, reproducible, economical, single-herbal emulgel formulation based on its powdered leaves/extract**. **[22]**

OBJECTIVES OF THE PRESENT STUDY

- To collect and authenticate the leaves of *Nyctanthes arbor-tristis* Linn.
- To prepare powdered leaf material under suitable conditions.
- To prepare an appropriate extract from the powdered leaves using a suitable extraction method.
- To perform preliminary phytochemical screening of the prepared leaf extract.
- To formulate a herbal emulgel containing *Nyctanthes arbor-tristis* leaf extract using suitable pharmaceutical excipients.
- To optimize the formulation by studying appropriate formulation variables and concentrations of excipients.
- To evaluate the prepared emulgel for physical appearance, homogeneity, pH, viscosity, spreadability, extrudability, washability, extract content, and other relevant physicochemical parameters.
- To investigate the in-vitro release characteristics of the herbal extract from the optimized formulation, where appropriate.
- To evaluate the preliminary anti-inflammatory activity of the optimized formulation using a suitable in-vitro method.
- To assess the stability of the optimized herbal emulgel under suitable storage conditions.
- To determine whether *Nyctanthes arbor-tristis* leaf extract can be successfully incorporated into an emulgel as a potential topical herbal anti-inflammatory formulation.

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III. METHODOLOGY

The methodology will consist of **collection and authentication of *Nyctanthes arbor-tristis* leaves, preparation of powdered leaf extract, preliminary phytochemical screening, formulation of the extract into an emulgel, and evaluation of the prepared formulation for physicochemical and in-vitro anti-inflammatory activity**. The overall procedure is based on established approaches reported for *N. arbor-tristis* leaves and topical emulgel formulations.**[23–27]**

1. Collection and Authentication of Plant Material

Fresh leaves of *Nyctanthes arbor-tristis* Linn. will be collected from a suitable location during the appropriate season. The plant material will be authenticated by a qualified botanist or an appropriate institutional herbarium. The authenticated specimen will be preserved as a voucher specimen for future reference **[23,24]**

2. Preparation of Leaf Powder

The collected leaves will be washed carefully with water to remove dust and foreign matter. The leaves will be shade-dried at room temperature until a constant weight is obtained. The dried leaves will be pulverized using a suitable grinder and passed through an appropriate sieve to obtain a uniform powder. The powdered material will be stored in an airtight container away from light and moisture **[23,24].**

3. Extraction of *Nyctanthes arbor-tristis* Leaves

A suitable quantity of powdered leaves will be extracted using an appropriate solvent, selected according to the phytochemical constituents and available laboratory facilities. The extraction may be performed by **maceration or Soxhlet extraction**. After extraction, the extract will be filtered and concentrated at a controlled temperature to obtain a semisolid or dried extract. The percentage yield of the extract will be calculated**[23,24].**

Previous experimental work has reported anti-inflammatory activity from *N. arbor-tristis* leaf extracts, providing a scientific basis for investigating the leaves as an anti-inflammatory herbal ingredient**[23,24].**

4. Preliminary Phytochemical Screening

The prepared leaf extract will be subjected to preliminary phytochemical screening to detect major classes of phytoconstituents such as:

Flavonoids
Phenolic compounds
Tannins
Alkaloids
Glycosides
Terpenoids
Steroids
Saponins

Appropriate standard qualitative chemical tests will be performed according to established pharmacognostic/phytochemical procedures **[23,24].**

5. Preparation of Emulgel

The herbal emulgel will be prepared by separately preparing the **oil phase, aqueous phase, emulsion, and gel base**.

Oil phase: The selected oil and oil-soluble emulsifying ingredients will be mixed and heated appropriately.

Aqueous phase: Purified water containing suitable water-soluble ingredients will be prepared separately.

Emulsion: The oil phase will be gradually incorporated into the aqueous phase with continuous stirring to form a uniform emulsion.

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Gel base: A suitable gelling agent, such as Carbopol, will be dispersed in purified water and allowed to hydrate. The pH will then be adjusted using a suitable neutralizing agent.

Emulgel formation: The prepared emulsion will be slowly incorporated into the hydrated gel base with continuous and uniform stirring. The required quantity of *N. arbor-tristis* leaf extract will then be incorporated carefully to obtain a homogeneous herbal emulgel **[25,26].**

Emulgels are hybrid topical systems combining an emulsion with a gel network and are widely investigated for topical delivery of pharmaceutical and herbal active ingredients **[25,26].**

6. Formulation Development

Different formulations, such as **F1, F2, F3, F4, and F5**, may be prepared by varying the concentration of the gelling agent, emulsifier, oil phase, or herbal extract. The formulations will be compared based on their physical characteristics and evaluation parameters, and the formulation showing suitable properties will be selected as the optimized formulation **[25–27].**

7. Evaluation of Herbal Emulgel

The prepared formulations will be evaluated for:

a. Physical appearance:

Colour, odour, texture, and general appearance will be observed.

b. Homogeneity:

The formulation will be examined for uniformity and absence of lumps or visible particles.

c. pH:

The pH will be measured using a calibrated digital pH meter. The formulation should have a suitable pH for topical application.

d. Viscosity:

Viscosity will be determined using a suitable viscometer under controlled conditions.

e. Spreadability:

Spreadability will be evaluated to determine the ease with which the formulation spreads over the skin surface.

f. Extrudability:

The ease with which the emulgel can be removed from its container or collapsible tube will be determined.

g. Washability:

The ease of removal of the formulation from the skin using water will be assessed.

h. Extract content:

The amount of herbal extract present in the formulation will be determined using an appropriate analytical method.

i. Stability study:

The optimized formulation will be subjected to suitable storage conditions and evaluated periodically for changes in appearance, pH, viscosity, homogeneity, and other relevant characteristics **[25–27].**

8. In-vitro Anti-inflammatory Activity

The anti-inflammatory potential of the prepared emulgel may be evaluated using an appropriate **in-vitro protein-denaturation inhibition assay**. The test formulation will be compared with a suitable standard anti-inflammatory drug and a control **[23,24].**

The percentage inhibition of protein denaturation will be calculated using:

$$\% \text{ inhibition} = \frac{A_t - A_c}{A_c} \times 100$$

Where,

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A_t: Absorbance of the Test/Treatment sample

A_C: Absorbance of the Control

A higher percentage inhibition indicates greater inhibition of protein denaturation under the experimental conditions. The method provides a **preliminary in-vitro indication** of anti-inflammatory potential and does not by itself establish clinical effectiveness.

9. Selection of Optimized Formulation

The formulation showing suitable characteristics with respect to **homogeneity, pH, viscosity, spreadability, extrudability, stability, and in-vitro anti-inflammatory activity** will be selected as the optimized formulation **[25–27].**

10. Statistical Analysis

The experimental results will preferably be expressed as **mean ± standard deviation (SD)**. Appropriate statistical analysis may be performed to determine significant differences between formulations and the standard preparation.

EXPECTED OUTCOMES

The proposed study, **"Formulation and Evaluation of Herbal Anti-inflammatory Emulgel Prepared from *Nyctanthes arbor-tristis* Powdered Leaf Extract,"** is expected to result in the successful development of a stable and pharmaceutically acceptable herbal emulgel containing *Nyctanthes arbor-tristis* leaf extract.

Successful preparation of leaf extract:

Authenticated *N. arbor-tristis* leaves are expected to yield a suitable extract after drying, powdering, and extraction using an appropriate solvent. The extract is expected to contain phytoconstituents such as flavonoids, phenolics, tannins, glycosides, terpenoids, and other biologically active compounds **[28,29].**

Confirmation of phytochemical constituents:

Preliminary phytochemical screening is expected to demonstrate the presence of one or more bioactive phytochemical groups. Previous investigations have identified biologically active constituents in *N. arbor-tristis* leaves, including β-sitosterol, which has demonstrated anti-inflammatory activity in experimental studies **[28,29].**

Successful development of herbal emulgel:

The leaf extract is expected to be successfully incorporated into an emulgel containing suitable emulsifying and gelling agents. The resulting formulation is expected to possess acceptable appearance, uniformity, consistency, and texture **[30,31].**

Acceptable physicochemical properties:

The optimized formulation is expected to demonstrate suitable **pH, viscosity, homogeneity, spreadability, extrudability, and washability**, making it appropriate for topical application. Emulgels are reported to provide useful characteristics for topical delivery because they combine properties of emulsions and gels **[30,31].**

Good spreadability and topical application:

The formulation is expected to spread uniformly over the application area without excessive greasiness and to remain in contact with the skin for an appropriate period **[30,31].**

Preliminary anti-inflammatory activity:

The prepared emulgel is expected to demonstrate measurable anti-inflammatory potential in a suitable **in-vitro assay**, such as inhibition of protein denaturation. This expectation is supported by earlier experimental evidence demonstrating anti-inflammatory activity of *N. arbor-tristis* leaf preparations **[28,29].**

Identification of an optimized formulation:

Among the different formulations prepared, one formulation is expected to show comparatively desirable physicochemical characteristics and anti-inflammatory activity and therefore may be selected as the optimized formulation **[30–32]**

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Improved pharmaceutical usability of the herbal extract:
Incorporating the plant extract into an emulgel is expected to provide a more convenient topical dosage form than applying the crude plant material directly. Previous research has also demonstrated the feasibility of incorporating *N. arbor-tristis* leaf extract into topical delivery systems **[30–32]**

Preliminary stability of the optimized formulation:
The optimized formulation is expected to retain its important physical characteristics during the selected stability-testing period, with no major changes in appearance, homogeneity, pH, or viscosity **[30,31].**

Basis for further research:
The findings are expected to provide preliminary formulation and biological-evaluation data that may support further investigation of *N. arbor-tristis* leaf extract as a potential herbal topical anti-inflammatory formulation. However, **in-vitro activity alone cannot establish clinical efficacy or safety in humans [28–31].**

IV. CONCLUSION

Nyctanthes arbor-tristis Linn. (Parijat/Harshingar) is a medicinal plant with a documented history of traditional use and experimentally investigated pharmacological properties. In particular, studies on its leaves have demonstrated **anti-inflammatory and analgesic potential**, supporting further investigation of the plant as a source of bioactive **constituents [33,34].**

The proposed study aims to utilize **powdered *N. arbor-tristis* leaves to prepare an extract and incorporate the extract into a topical emulgel**. Emulgel offers the combined advantages of an emulsion and gel and can provide a convenient, spreadable topical dosage form **[35,36].**

Systematic evaluation of the prepared formulation—including **appearance, homogeneity, pH, viscosity, spreadability, extrudability, washability, stability, and in-vitro anti-inflammatory activity**—will help determine its pharmaceutical suitability. Previous research has established anti-inflammatory activity of *N. arbor-tristis* leaf preparations, while recent work has explored the incorporation of its leaf extract into advanced topical systems **[33,34,37].**

Therefore, the proposed formulation may provide a **simple and economical herbal topical dosage form with potential anti-inflammatory activity**. However, successful in-vitro results would represent preliminary evidence and would require further safety, pharmacological, and clinical investigations before therapeutic use in humans can be established **[33–37].**

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