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Research Article

Formulation And Evaluation of Nanogel by Using Pergularia daemia for Anti-Inflammatory Property

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Abstract

Pergularia daemia is a medicinal plant that has long been used in traditional medicine to manage inflammation and related conditions. In this study, extracts of the plant were prepared and incorporated into a nanogel formulation using appropriate polymers to enhance its therapeutic efficacy. Commonly known as the "kiosk vine," it is a perennial, hairy climber belonging to the family Asclepiadaceae. The plant is valued for its antibacterial and anti-inflammatory properties, which are attributed to the presence of various phytochemicals such as flavonoids, alkaloids, terpenoids, tannins, and steroids.

The research focuses on extracting bioactive compounds using suitable solvents. These compounds are then incorporated into nanogels formed by chemically or physically crosslinked polymers. Such nanogels are three-dimensional hydrogel networks with nanoscale dimensions. They offer several advantages over conventional drug delivery systems, including tunable size, ease of preparation, swelling capacity, biocompatibility, hydrophilicity, and responsiveness to external stimuli such as temperature, pH, light, and biological signals.

Keywords: Pergularia daemia, Nanogel, Anti-inflammatory, Alkaloids, Terpenoids

INTRODUCTION:

Herbal remedies have been practiced for generations and remain a valuable source of medicinal compounds. Pergularia daemia (family: Apocynaceae), commonly called Veliparuthi, is one such plant widely found in tropical and subtropical parts of India. In traditional systems like Ayurveda and folk medicine, it has been used to manage various conditions including inflammation, ulcers, wound healing, diarrhoea, asthma, fever, and skin disorders [1].

Phytochemical investigations have shown that *Pergularia daemia* contains several biologically active constituents such as flavonoids, alkaloids, saponins, and terpenoids. These compounds contribute to its anti-inflammatory and antioxidant properties. Experimental research further indicates that the plant extract can suppress key inflammatory mediators, including prostaglandins and cytokines, highlighting its therapeutic potential [2].

Nanogels are especially useful for topical and transdermal delivery of anti-inflammatory agents because they can effectively penetrate the skin barrier and provide sustained drug release. Their small particle size (generally 20–200 nm) enhances interaction with biological membranes, resulting in improved therapeutic outcomes. In addition, nanogels are typically biocompatible, non-toxic, and can be engineered to respond to environmental triggers such as pH and temperature.

Nanotechnology represents a significant advancement in drug delivery systems, offering clear advantages over conventional dosage forms. Nano-based formulations have been shown to improve the bioavailability of both synthetic and plant-derived compounds. Compared to other nanocarriers, nanogels provide benefits such as biodegradability, efficient transport characteristics, and enhanced permeation, making them highly suitable for delivering bioactive molecules.

This strategy combines traditional herbal knowledge with modern nanotechnology to develop safer and more effective treatments for inflammatory disorders.

Drug Profile:

Botanical name: Pergularia daemia (Forsk.) Chiov.

Family: Asclepiadaceae / Apocynaceae-related classification in older literature.

Common/traditional names: Veliparuthi, Uthamani, Uttara Varuni, Utranajutuka.

Parts used: Mostly leaves and roots; whole plant is also used in experimental studies.

Traditional uses: Anthelmintic, laxative, antipyretic, expectorant, treatment for diarrhoea, malarial intermittent fever, cough, sore eyes, asthma, uterine/menstrual disorders, and rheumatic swellings.

Pharmacological actions reported: Anti-inflammatory, analgesic, antipyretic, hepatoprotective, antioxidant, antibacterial, antifungal, antidiabetic, wound healing, antifertility, and diuretic [3].

Figure 1: [Pergularia Daemia leaves]

Medicinal Uses:

Anthelmintic and laxative effects: Traditionally employed to eliminate intestinal parasites and ease bowel movements in cases of constipation.

Antipyretic activity: Commonly used to lower fever, including recurrent and malarial fevers [4].

Respiratory support: Utilized for managing cough, asthma, bronchitis, and other catarrhal conditions by aiding mucus clearance.

Anti-inflammatory and pain-relieving properties: Applied in conditions such as arthritis, rheumatism, swelling, and general body pain.

Digestive benefits: Used in the treatment of infantile diarrhoea, gastric ulcers, and other gastrointestinal disorders.

Gynaecological applications: Traditionally administered for menstrual irregularities, including amenorrhea and dysmenorrhea, and to assist during childbirth.

Skin and wound healing: Preparations from latex or leaves are applied to treat boils, wounds, cuts, and various skin conditions [5].

Metabolic and hepatic support: Reported in traditional and experimental studies to be beneficial in managing liver disorders and diabetes.

Pre-Formulation Studies:

a) Plant collection and Cleaning: Fresh Pergularia daemia leaves are collected and washed to remove dust, dried in the shade for 1-4 weeks, and ground into a fine powder.

b) Extraction Method: Maceration or boiling is used. A common method involves dispersing 5 g of powdered leaves in 100 ml of distilled water, followed by boiling at 60–80°C for 25 minutes, then filtering to remove insoluble residue.

Results: The aqueous extract is light green, and the methanolic extract shows higher solubility for phytochemicals.

c) Preliminary Phytochemical Screening: Preformulation studies often identify the active secondary metabolites present in the leaves.

Results: Pergularia daemia extract contains flavonoids, alkaloids, tannins, terpenoids, steroids, saponins, and reducing sugars.

Significance: These compounds, particularly flavonoids and polyphenols, are responsible for reducing metal ions.

d) Solubility and pH-related observations: To guide nanogel formulation and topical suitability [6]. The extract has good solubility and PH was found to be suitable for applying on skin.

e) Gelling agent selection: Carbopol and HPMC are selected because of their ability to form stable, transparent and compatibility with natural extract.

f) Compatibility Studies: This study confirms no chemical interaction between pergularia daemia and the gelling agents.

MATERIAL AND METHODS:

Table 1: INGREDIENTS

S. N.	INGREDIENTS	ROLE
1.	Pergularia daemia leaves	Active herbal ingredient
2.	Carbopol	Gelling agent
3.	Propylene glycol	Humectant
4.	Ethyl cellulose	Polymer Material
5.	Sodium benzoate	Preservative
6.	Glycerine	Humectant, Skin Condition
7.	Triethanolamine	pH Adjustment
8.	Water	Vehicle

Methodology:

Table 2: Formulation Table:

Trial 1:

SR. NO.	INGREDIENTS	QUANTITY
1.	Leaf Extract Solution	8ml
2.	HPMC	1.0gm
3.	Propylene glycol	10ml
4.	Glycerine	2ml
5.	Sodium benzoate	3ml
6.	Ethyl cellulose	10ml
7.	Triethanolamine	7
8.	Water	100ml

METHOD OF PREPARATION:

Emulsion Solvent Diffusion Method:

1] Preparation of Pergularia Daemia Leaves Extract:

i. Fresh, healthy leaves are collected and thoroughly washed with water to remove any adhering dirt or impurities.

ii. The clean leaves are then shade dried at room temperature until completely free from moisture. Once dried, the leaves are ground into coarse powder [7].

iii. The powdered material is subjected to extraction using a suitable solvent. In the maceration method, the powder is soaked in methanol for 24 hours to several days with intermittent shaking, then the solution is heated on water bath.

iv. The obtained extract is filtered using filter paper.

v. Finally, the concentrated extract is transferred to a clean, airtight container and stored at low temperature until the further use [8].

2] Preparation of Base:

i.Take purified water and keep it at room temperature.

ii.Add HPMC powder into the water with constant stirring to prevent clumping.

iii.Continue stirring until the polymer disperse evenly, then allow it to hydrate for several hours or overnight so the gel becomes clear and viscous.

iv.Adjust the volume with water.

3] Preparation of Nanogel:

i.Prepare the leaf extract.

ii.Then dissolve the leaf extract into organic phase (propylene glycol(10ml)).

iii.Add HPMC solution into it [9].

iv.Then add glycerine (2ml) while continuous stirring and add ethyl cellulose(10ml).

v.Prepare aqueous phase separately with purified water.

vi.Then add organic phase into aqueous under highspeed homogenizer to form an emulsion.

vii.Removal of partial solvent by solvent diffusion to reduce droplet size and formation of nanosized dispersion.

viii.Addition of neutralizer (Triethanolamine) to adjust pH and Sodium benzoate (Preservative(10ml)) to the formulation [10].

Observation:

First trial was failed due HPMC that shows less gelling property as compared to Carbopol.

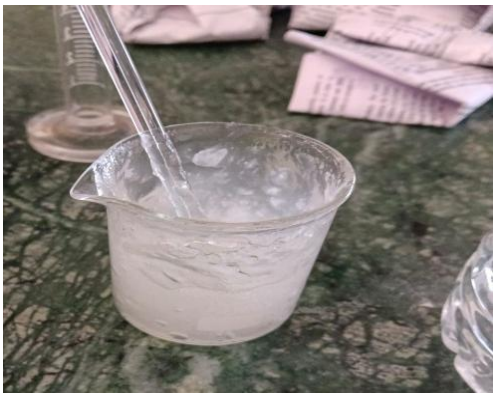

Figure 2: HPMC Solution

Table 3:

Trail 2:

SR.NO.	INGREDIENTS	QUANTITY
1.	Leaf Extract Solution	8ml
2.	Carbopol	1.0gm
3.	Propylene glycol	10ml
4.	Glycerine	2ml
5.	Sodium benzoate	1ml
6.	Ethyl Cellulose	10ml
7.	Triethanolamine	7
8.	Water	100ml

1] Preparation of Pergularia Daemia Leaves Extract:

i. Fresh, healthy leaves are collected and thoroughly washed with water to remove any adhering dirt or impurities.

ii. The clean leaves are then shade dried at room temperature until completely free from moisture. Once dried, the leaves are ground into coarse powder.

iii. The powdered material is subjected to extraction using a suitable solvent. In the maceration method, the powder is soaked in methanol for 24 hours to several days with intermittent shaking, then the solution is heated on water bath.

iv. The obtained extract is filtered using filter paper.

v. Finally, the concentrated extract is transferred to a clean, airtight container and stored at low temperature until the further use.

2] Preparation of Base:

i. Take purified water and keep it at room temperature.

ii. Add Carbopol powder into the water with constant stirring to prevent clumping.

iii. Continue stirring until the polymer disperse evenly, then allow it to hydrate for several hours or overnight so the gel becomes clear and viscous.

iv. Adjust the volume with water.

3] Preparation of Nanogel:

i. Prepare the leaf extract.

ii. Then dissolve the leaf extract into organic phase (propylene glycol(10ml)).

iii. Add Carbopol solution into it.

iv. Then add glycerine (2ml) while continuous stirring and add ethyl cellulose(10ml).

v. Prepare aqueous phase separately with purified water.

vi. Then add organic phase into aqueous under highspeed homogenizer to form an emulsion.

vii. Removal of partial solvent by solvent diffusion to reduce droplet size and formation of nanosized dispersion.

viii. Addition of neutralizer (Triethanolamine) to adjust pH and Sodium benzoate (Preservative(10ml)) to the formulation.

Observation:

Second trial was failed due to adding less amount of sodium benzoate (Preservative).

Table 4:

Trail 3:

SR.NO.	INGREDIENTS	QUANTITY
1.	Leaf Extract Solution	8ml
2.	Carbopol	1.0gm
3.	Propylene glycol	10ml
4.	Glycerine	2ml
5.	Sodium benzoate	3ml
6.	Ethyl cellulose	10ml
7.	Triethanolamine	7
8.	Water	100ml

1] Preparation of Pergularia Daemia Leaves Extract:

i. Fresh, healthy leaves are collected and thoroughly washed with water to remove any adhering dirt or impurities.

ii. The clean leaves are then shade dried at room temperature until completely free from moisture. Once dried, the leaves are ground into coarse powder.

iii. The powdered material is subjected to extraction using a suitable solvent. In the maceration method, the powder is soaked in methanol for 24 hours to several days with intermittent shaking, then the solution is heated on water bath. Collect healthy leaves and wash them well with water to remove dirt.

iv. The obtained extract is filtered using filter paper.

v. Finally, the concentrated extract is transferred to a clean, airtight container and stored at low temperature until the further use.

2] Preparation of Base:

i. Take purified water and keep it at room temperature.

ii. Add Carbopol powder(1.0gm) into the water with constant stirring to prevent clumping.

iii. Continue stirring until the polymer disperse evenly, then allow it to hydrate for several hours or overnight so the gel becomes clear and viscous.

iv. Adjust the volume with water.

3] Preparation of Nanogel:

i. Prepare the leaf extract.

ii. Then dissolve the leaf extract into organic phase (propylene glycol(10ml)).

iii. Add Carbopol solution into it.

iv. Then add glycerine (2ml) while continuous stirring and add ethyl cellulose(10ml).

v. Prepare aqueous phase separately with purified water.

vi. Then add organic phase into aqueous under highspeed homogenizer to form an emulsion.

vii. Removal of partial solvent by solvent diffusion to reduce droplet size and formation of nanosized dispersion.

viii. Addition of neutralizer (Triethanolamine) to adjust pH and Sodium benzoate (Preservative(10ml)) to the formulation.

Observation:

Due to better result of this trial, we decided to finalize this formulation for preparation of nanogel.

Figure 3: Extraction of pergularia daemia

Figure 4: Extracted solution

Figure 5: Carbopol Solution

Figure 6: Nanogel

Evaluation Parameter:

1) Organoleptic Properties:

Organoleptic properties was determined by the texture, colour, odour.

2) PH test: The PH of Nanogel was found by the PH meter

3) Spreadability test: Spreadability was determined by spreading the nanogel on glass slide.

4) Skin Irritation test: This was determined by applying nanogel on skin.

5) Viscosity test: Viscosity was determined by using viscometer.

6) Phytochemical Analysis:

1)Test for Alkaloids:

a) Mayor's Test:

- Add 2-3 ml drops of Mayers reagent to the sample.
- Shake it for sometimes.

Observation:

A formation of yellow colour precipitate indicates the presence of alkaloids.

b) Dragendroff's Test:

- Add 2-3 ml drops of dragendroff's reagent.
- Shake it for sometimes.

Observation:

A formation of red colour precipitate indicates the presence of alkaloids.

2) Test for Flavonoids:

- Add 2-3 ml of lead acetate solution into sample.
- Shake it for some time.

Observation:

A formation of yellow colour precipitate indicates the presence of flavonoids.

3) Test for Amino acids:

a) Ninhydrin Test:

- Add 2-3 ml of ninhydrin solution to sample.
- Heat the solution on water bath for 5 minutes.

Observation:

A formation of purple colour precipitate indicates the presence of amino acids.

4) Test for Tannins:

a) Ferric Chloride Test ($Fecl_3$):

- Add 2-3 ml of ferric chloride solution to sample.
- Shake it for some time.

Observation:

A formation of dark blue colour indicates the presence of tannins.

5) Test for Carbohydrate:

a) Molisch's test:

- Add 2-3 ml of Molisch's reagent to sample.
- Then add concentrated sulphuric acid (SO_4) to the above sample.

Observation:

A formation of violet ring at the interface indicates presence of Carbohydrates.

RESULT AND DISCUSSION:

The nanogel formulated using Pergularia daemia extract was successfully prepared by the selected method (Emulsion solvent diffusion). shows good physicochemical stability, smooth texture, suitable pH, and excellent spreadability for topical application. The formulation exhibited nanosized particles with uniform distribution and high entrapment efficiency, indicating effective incorporation of bioactive phytoconstituents such as flavonoids and phenolic compounds

The hydroalcoholic extract of Pergularia daemia leaves showed the presence of several bioactive phytoconstituents including flavonoids, alkaloids, tannins, amino acids and carbohydrates. These secondary metabolites are widely associated with anti-inflammatory and antioxidant activities. The total phenolic content and flavonoid content were found to be significantly high, suggesting that the extract possesses strong free radical scavenging potential that may contribute to inflammation suppression.

Trial 1:

First trial was failed due HPMC that shows less gelling property as compared to Carbopol.

Trial 2:

Second trial was failed due to adding less amount of sodium benzoate (Preservative).

Trial 3:

Due to better result of this trial, we decided to finalize this formulation for preparation of nanogel.

1) Organoleptic Properties:

Parameters	Observation
Colour	Light green
Texture	Smooth
Odour	Odourless

2) PH test: The PH of Nanogel was found to be 5.5.

3) Spreadability test: Nanogel was easily Spreadable on skin**.**

4) Skin Irritation test: Nanogel does not produce any irritation to skin.

5) Viscosity test: Nanogel has good viscosity.

6) Phytochemical Analysis:

1)Test for Alkaloids:

a) Mayor's Test:

Observation:

A formation of yellow colour precipitate indicates the presence of alkaloids.

Inference: Passed

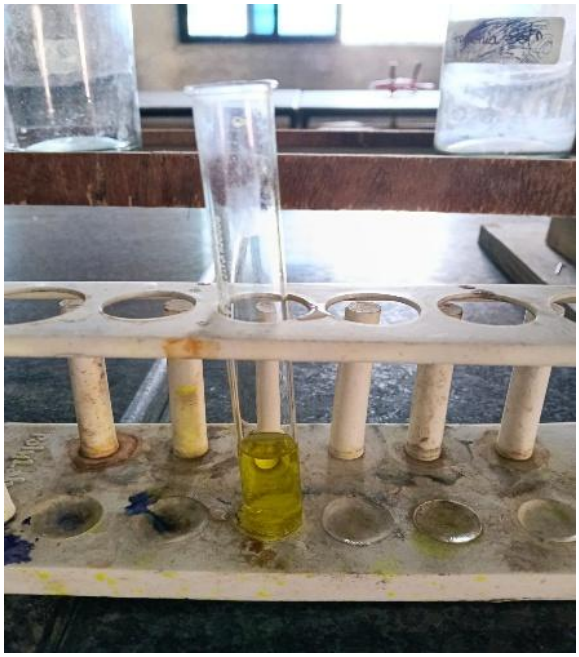

Figure 7: Mayor's test

b) Dragendroff's Test:

Observation:

A formation of red colour precipitate indicates the presence of alkaloids.

Inference: Passed

Figure 8: Dragendroff's test

2) Test for Flavonoids:

Observation:

A formation of yellow colour precipitate indicates the presence of flavonoids.

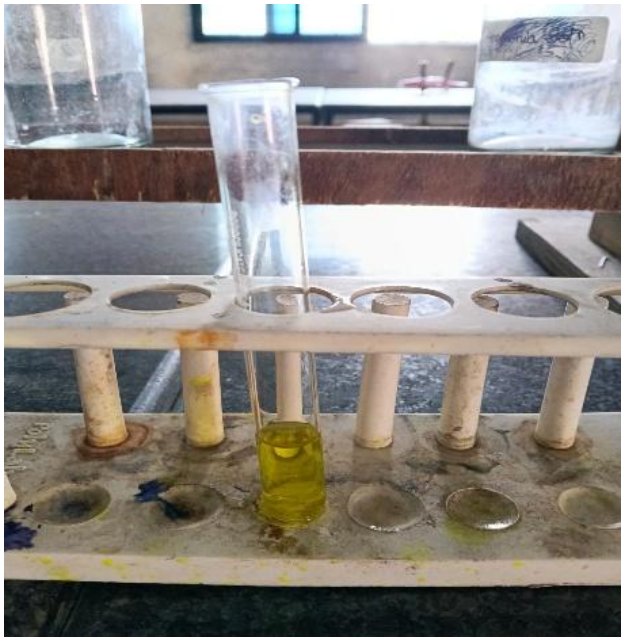

Figure 9: Flavonoids test

3) Test for Amino acids:

a) Ninhydrin Test:

Observation:

A formation of purple colour precipitate indicates the presence of amino acids.

Inference: Passed

Figure 10: Ninhydrin test

4) Test for Tannins:

a) Ferric Chloride Test ($Fecl_3$):

Observation:

A formation of dark blue colour indicates the presence of tannins.

Inference: Passed

Figure 11: Ferric chloride test

5) Test for Carbohydrate:

a) Molisch's test:

Observation:

A formation of violet ring at the interface indicates presence of Carbohydrates.

Inference: Passed

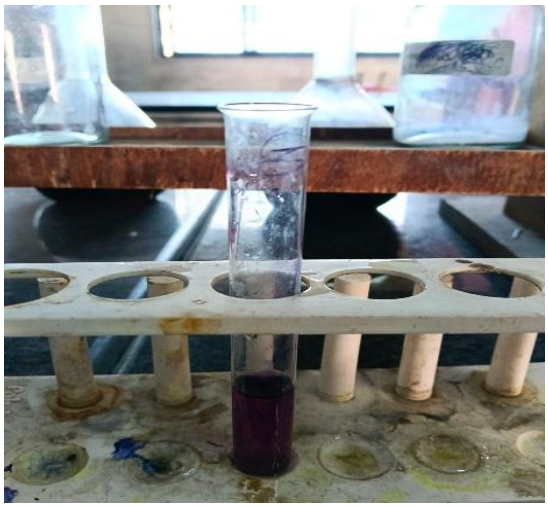

Figure 12: Molisch's test

CONCLUSION:

The present study successfully demonstrated the formulation and evaluation of a nanogel incorporating Pergularia daemia leaf extract for its anti-inflammatory potential. The nanogel system was effectively developed using suitable polymers and exhibited desirable physicochemical characteristics, including appropriate pH, viscosity, spreadability, and stability, making it suitable for topical application. Phytochemical constituents present in Pergularia daemia, such as flavonoids, alkaloids, and phenolic compounds, contributed significantly to the observed anti-inflammatory activity. The nanogel formulation enhanced the bioavailability and controlled release of the active constituents. The nanogel containing Pergularia daemia leaf extract represents a promising, safe, and effective herbal-based delivery system for the management of inflammatory conditions.

Future Scope:

1. Advanced Phytochemical-Based Nanocarriers:

- *Pergularia daemia* contains alkaloids, flavonoids, terpenoids, and steroids with reported anti-inflammatory, antimicrobial, analgesic, and anticancer activities.

  Future research can focus on encapsulating specific bioactive fractions within nanogels to enhance stability, solubility, and therapeutic efficiency.

2. Targeted Drug Delivery Systems:

- Nanogels can be engineered for site-specific drug delivery (skin, wound, cancer cells, inflamed tissues). Using *P. daemia* extract may lead to:
- Improved penetration through biological barriers
- Reduced systemic toxicity
- Controlled and sustained release

3. Wound Healing and Antimicrobial Applications:

- Smart nanogels for managing chronic wounds
- Hydrogel–nanogel composites for burn treatment
- Antimicrobial dressings incorporating *P. daemia* nanogels

4. Anti-cancer Nanogel Systems:

- Research can explore:
- Loading *P. daemia* phytochemicals into stimuli-responsive nanogels
- Combining nanogels with chemotherapy agents for synergistic effects
- In-vitro and in-vivo cancer model validation

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