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"FORMULATION AND EVALUATION OF NANOGEL FOR ANTIBACTERIAL AND ANTIINFLAMMATORY PROPERTIES OF PERGULARIA DAEMIA"

Ms. Tahura J. Shaikh[1], Mr. Vishal S. Madankar*[2], Mr. Anil B. Panchal[3]

[1]Research Scholar, Department of Pharmaceutics, Delight College of Pharmacy, Koregaon Bhima, Pune, Maharashtra, India-412216.

[2]Assistant Professor, Department of Quality Assurance, Delight College of Pharmacy, Koregaon Bhima, Pune, Maharashtra, India-412216.

[2]Assistant Professor, Department of Pharmaceutics, Delight College of Pharmacy, Koregaon Bhima, Pune, Maharashtra, India-412216.

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***Corresponding Author**

Mr. Vishal S. Madankar

Assistant Professor, Department of Quality Assurance, Delight College of Pharmacy, Koregaon Bhima, Pune, Maharashtra, India-412216.

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ABSTRACT

Nanogels have emerged as promising drug delivery systems due to their high biocompatibility, controlled drug release, and enhanced therapeutic efficacy. Pergularia daemia, a medicinal plant widely used in traditional medicine, is known for its significant antibacterial and anti-inflammatory properties attributed to its rich phytochemical composition. The present study focuses on the formulation and evaluation of an herbal nanogel incorporating Pergularia daemia extract to enhance its therapeutic potential. The nanogel was prepared using suitable polymers and cross-linking agents, followed by characterization for physicochemical properties such as particle size, pH, viscosity, spreadability, and stability. The antibacterial activity of the formulated nanogel was evaluated against selected pathogenic microorganisms using standard microbiological methods, while anti-inflammatory activity was assessed through in vitro and/or in vivo models. Results demonstrated that the Pergularia daemia-loaded nanogel exhibited satisfactory physicochemical characteristics, improved stability, and sustained release behaviour. The

nanogel showed significant antibacterial activity and notable anti-inflammatory effects compared to the crude extract, indicating enhanced bioavailability and efficacy. Overall, the study suggests that Pergularia daemia-based nanogel formulations hold potential as an effective topical therapeutic system for managing bacterial infections and inflammatory conditions.

KEYWORDS: Nanogel**,** Pergularia daemia, Antibacterial activity, Anti-inflammatory activity, Phytochemical extract, Topical formulation, Medicinal plant, Controlled drug release.

INTRODUCTION

Nanogels are nanosized, cross-linked polymeric networks capable of holding large amounts of water and bioactive compounds, making them excellent carriers for topical drug delivery. Due to their small particle size, high surface area, biocompatibility, and controlled drug release properties, nanogels have gained significant attention in the treatment of infectious and inflammatory disorders. They enhance drug penetration through the skin and improve the stability and bioavailability of both synthetic and herbal active ingredients.

Pergularia daemia (Family: Asclepiadaceae) is a medicinal plant traditionally used for the treatment of inflammation, wounds, fever, and microbial infections. Phytochemical studies have revealed the presence of flavonoids, alkaloids, glycosides, and phenolic compounds responsible for its antibacterial and anti-inflammatory activities. However, the therapeutic application of plant extracts is often limited by poor solubility, instability, and low skin penetration. Incorporation of Pergularia daemia extract into a nanogel system may overcome these limitations and enhance its pharmacological efficacy. Therefore, formulation and evaluation of a Pergularia daemia-based nanogel present a promising approach for effective antibacterial and anti-inflammatory therapy.[1,38,39]

PERGULARIA DAEMIA

- **Family:** Asclepiadaceae
- **Family (as per The Plant List):** Apocynaceae
- **Species:** Pergularia daemia
- **Species Name:** (as per The Plant List) Pergularia daemia (Forssk) Chiov.
- **Common name:** Trellis Vine

- **Conversational name:** Utarani, Utranajutuka, Sagovani, Gutuk (Hin); Kurudigina balli, Halukoratiga (Kan); Veliparuthi, Uthamani, Belapatri, Vaelipparuthi, Seendal kodi (Tam); Guruli, Dushtupatige, Gittupaku, Gurti chettu (Tel); Hunturi, Utrali, Uturudi, Itnadi, Iturhi (Ori.); Yugaphala (San).

Pergularia is a periodic herbaceous factory in the family Asclepiadaceae native to India and srilanka. A slender, hispid, fusty- smelling imperishable rambler. Leaves opposite, membranous, 3-9 cm long and about as wide, astronomically ovate, orbicular or deeply cordate, acute or short acuminate at apex, pubescent beneath, petioles 2- 9 cm long. Flowers greenish- unheroic or dull white pigmented with grandiloquent, borne in axillary, long-peduncled, drooping clusters. Fruits (follicles) lanceolate, long- refocused, about 5 cm long, covered with soft backbones and seeds are pubescent, astronomically ovate.

Pergularia daemia is said to have further magical operation as it retains different mending eventuality for wide range of illness. The roots of this factory have been used to treat inflammation and pain.[2]

Pergularia daemia is a medicinal factory with a wide range of traditional uses. It has colourful parcels similar as,

- Anti-seditious
- Anti – Bacterial
- Antioxidant
- Anti-diabetic
- Analgesic
- Anticancer
- Antimicrobial
- Antipyretic
- Hepatoprotective
- Antifungal
- Central nervous system depressant

Pergularia daemia excerpt, contains several phytochemical ingredients, they're grouped as alkaloids, glycosides, steroids, coumarins and especially rich in flavonoids.

PHYTOCHEMICAL ANALYSIS

The tests were done to find the presence of the active chemical ingredients similar as alkaloids, glycosides, terpenoids, steroids, flavonoids, tannins by the following Procedures.[3]

Alkaloids: Alkaloids are introductory nitrogenous composites with definite physiological and pharmacological exertion. Alkaloid result produces white unheroic precipitate when many drops of Mayer's reagents are added. utmost alkaloids are rained from neutral or slightly acidic result by Mayer's reagent. The alcoholic excerpt was faded to blankness and the residue was hotted on a scorching water bath with 2 hydrochloric acids. After cooling, the admixture was filtered and treated with many drops of Mayer's reagents. The sample were also observed for the presence of turbidity or unheroic rush.[4]

Steroids: 1 ml of the factory excerpt was dissolved in 10 ml of chloroform and equal volume of concentrated sulphuric acid was added by sides of the test tube. The upper subcaste turns red and sulphuric acid subcaste showed unheroic with green luminescence. This indicated the presence of steroids.[5]

Terpenoids: To 2 ml of the factory excerpt was added to 2 ml of acetic anhydride and concentrated H2SO4. The conformation of blue green ring indicates the presence of terpenoids.[6]

Tannins: 2 ml of excerpt was added to many drops of 1 lead acetate, and the unheroic precipitate indicated the presence of tannins.[7]

Saponins: 5 ml of Extract was mixed with 20 ml of distilled water and also agitated in a graduated cylinder for 15 twinkles. conformation of froth indicates the presence of Saponin.[8]

Flavonoids: 1 gm of the powdered sample was boiled with 10 ml of distilled water for 5 twinkles and filtered while hot and many drops of 20 sodium hydroxide result was added to 1 ml of the cooled filtrate. A change to unheroic colour which on addition of acid changed to colourless result depicted the presence of flavonoids.[9]

Glycosides: Glycosides are composites which upon hydrolysis give rise to one or further sugars (aglycones) and an emulsion which isn't a sugar (aglycone or genine). To 1 ml of the excerpt in glacial acetic acid, many drops of ferric chloride and concentrated sulphuric acid

was added and observed for a sanguine- brown colour at the junction of 2 layers and the bluish green colour in the upper subcaste.

Phenols & amp; Tannins: Crude excerpt was mixed with 2 ml of 2 $Fecl_3$ result. A blue green or black colour indicated the presence of phenols & amp; tannins.

Coumarins: 3 ml of 10 NaOH was added to 2 ml of excerpt and the conformation of unheroic colour indicates the presence of coumarins.[10]

These secondary metabolites synthesized from therefore factory have been reported for the treatment of colourful habitual complaint. Pergularia daemia phytoconstituents set as a crucial part in natural medicine development as it harbours numerous In vitro and In vivo pharmacological conditioning.

Pergularia daemia col has shown Anti-bacterial property which makes it an essential condiment in the treatment of colourful infections.

Fig. 1: Leaves of Pergularia Daemia.

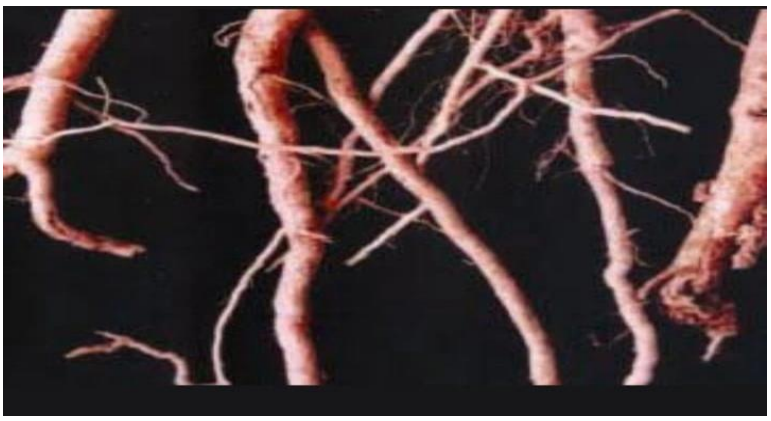


Fig. 2: Roots of Pergularia Daemia.

PHARMACOLOGICAL PROFILE

As a Phytomedicine: The factory Pergularia daemia has been traditionally used as anthelmintic, laxative, antipyretic expectorant and also used to treat immature diarrhoea and malarial intermittent complications. It's extensively distributed in the tropical and sub-tropical regions of the world. colourful phytochemical including terpenoid, flavonoids, sterols and cardenolids have been insulated and linked from the colourful corridor of the factory (leaves, stems, shoots, roots, seeds and fruits). P. daemia extensively used by colourful ethnical communities in Western Ghats of India for the treatment of variety of affections, while generally the roots of the factory have been used to treat liver complaint and hostility. The present review composition aims towards medicinal parcels, chemical ingredients and other important aspects of P. daemia.[11]

Anti-inflammatory, Analgesic and Antipyretic: exertion Crude ethanol excerpt of Pergularia daemia leaves was consecutively fractionated with petroleum ether, solvent ether, ethyl acetate, butanol and butanone. The ethanolic excerpt and colourful fragments were delved for anti-inflammatory exertion in rats at a cure of 100 mg kg- 1 via intraperitonially. Ethanol excerpt and its butanol bit displayed significant anti-inflammatory exertion when compared with separate controls and were similar with that of standard medicine aspirin. Another study was also demonstrated on the anti-inflammatory exertion of Pergularia daemia by using colourful solvent excerpts. In the result they set up that alcohol excerpt of P. daemia showed significant reduction in lump of paw at a cure of 300 mg kg- 1 b.wt. which was original to diclofenac sodium as a standard in a cure of 15 mg kg- 1 b.wt. The anti-inflammatory exertion of Pergularia daemia excerpt could be attributed due to the presence of steroids. Analgesic effect of waterless and ethanol excerpt of Pergularia daemia was demonstrated in the experimental models using Eddy's hot plate and Heat conduction system using thermal stimulants. Both excerpts showed the analgesic exertion when compared with control and analysed statistically by Tukey Kramer Multiple Comparison Test. Antipyretic exertion was also reported from the upstanding corridor of Pergularia daemia excerpt.[12]

Antibacterial: exertion the promising antibacterial exertion was observed in ethyl acetate and ethanol excerpts of Pergularia daemia which showed significant antibacterial against S. aureus, P. aeruginosa, A. hydrophila, E. coli and S. typhi. also, have reported that the ethanol excerpt of P. daemia displayed antibacterial exertion. In addition, recent report also showed the antibacterial exertion of Pergularia daemia splint excerpt was tested by using colourful

detergents similar as hexane, chloroform and ethyl acetate against B. subtilis, S. aureus, E. coli and P. vulgaris.[13]

Central nervous system: depressant exertion the roots of P. daemia were estimated for central nervous system depressant exertion. This study was delved on Swiss albino mice using chlorpromazine and pentobarbitone sodium convinced sleeping time. Alcohol and waterless root excerpt of P. daemia showed significant central nervous system depressant exertion and was compared with that of control and medicine treated groups. Their results concluded that both alcohol and waterless excerpt showed central nervous system depressant exertion and this exertion is substantially due to the presence of glycosides present in P. daemia roots.[14]

Hepatoprotective: exertion Pergularia daemia is traditionally used as a folk drug for treating hostility. A primary disquisition on the upstanding corridor of Pergularia daemia showed significant hepatoprotective exertion at a fixed cure position of 200 mg kg- 1 likewise, extended their study to identify the active composites of P. daemia which are responsible for hepatoprotection. They delved on both waterless and ethanolic excerpt which showed the presence of triterpenoids and flavonoids in ethanolic excerpt. Their result suggests that presence of flavonoids in Daemia could be responsible for hepatoprotection. In addition, an in vitro evaluation hepatoprotective exertion of Pergularia daemia was also delved. ethanolic excerpt. The result of this study also justify that flavonoids are responsible for hepatoprotective exertion. therefore, it's apparent from these studies that flavonoids like quercetin, kaempferol and isorhamnetin glycosides could be liable for colourful liver diseases.[15]

Antioxidant: exertion- In vitro webbing of antioxidant exertion on P. daemia root excerpt. In their primary phytochemical test, both waterless and ethanolic excerpt indicated the presence of alkaloid, glycoside, steroid, flavonoid, saponin, terpenoid, tannin and phenolic emulsion. The result attained from their study shows that P. daemia displayed antioxidant exertion which may be attributed to the presence of polyphenolic and other phytochemical ingredients. This may be used in precluding oxidant stress related regressed conditions.[16]

Anticancer: exertion- Anticancer exertion of Pergularia daemia was screened against sixty mortal cancer cell lines and was organized into sub panels representing leukaemia, carcinoma and cancer of the lung, colon, order, ovary and central nervous system. In their result, it was

set up that α- amyrin displayed anticancer exertion in low energy. Triterpenoids play a vital part as anticancer agents and structural revision of this class of composites can affect in the establishment of an innovative medicine for the treatment of cancer.[17]

MATERIAL AND METHOD

The Pergularia daemia leaves was exposed for two days of sun drying before spending 72 hours at 50 °C in a charger teetotaller. The mechanical grinding of the dried B. Pergularia daemia handed the powdered material demanded for the birth process.

Hot birth- 30 g dried pulverized sample were taken in three Soxhlet outfit containing 200 ml of detergent. The birth was carried out in a Soxhlet outfit for 12 hr with different detergents like methanol at 60 0C.

Green synthesis of silver nanoparticles

The trial was done using results of AgNO3 with attention of 0.2 mM, 1 mM, and 2 mm the results were stirred at a temperature of 60 ^{0} C for duration of 5 twinkles using a hot plate. latterly, a volume of 5 ml of Pergularia daemia admixture was incrementally introduced into the admixture. also, same admixture was placed on a glamorous stirrer for durations of 5, 13, and 20 twinkles, with a rotational speed of 500 revolutions per nanosecond (rpm). The BOAgNPs that were prepared were attained through filtration using a clean muslin cloth. latterly, the filtrate passed a secondary filtration process using Whatman sludge paper and was later held at a temperature of 4 degrees Celsius in medication for the creation of nanoparticles. The evidence of the conflation of AgNO3 has been vindicated through the observed revision in colour, transitioning from a bright orange tinge to a dark orange shade.[18,19]

METHODS FOR PREPARATION OF NANOGEL

1) Emulsion Solvent Diffusion Method

The waterless result of medicine is solubilized in an organic subcaste. Polymer and gelatinizing agent are dissolved in water to form the medicine phase, which is added drop wise to the waterless phase has been homogenized for 30 twinkles at 6000 rpm. When a conflation is homogenized into a nanodroplet by a homogenizer, an oil painting water conflation is created.[20] To produce nanogel, triethanolamine is added to the oil painting in water conflation and continuously stirred for an hour at 8000 reels per nanosecond.[21]

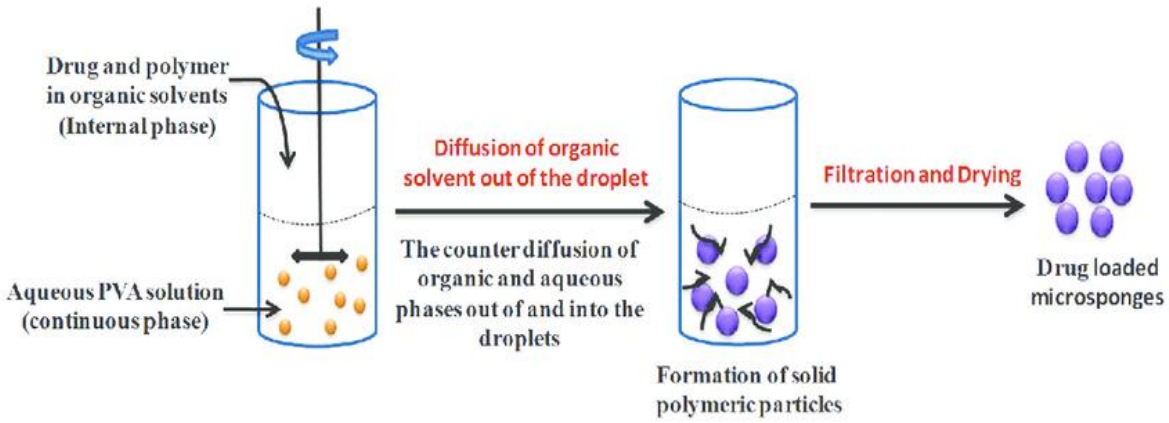
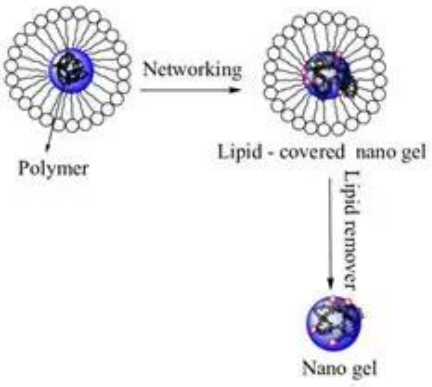


Fig. 3: Emulsion Solvent Diffusion Method.

2) Nano Precipitated Method

When the organic phase contained both drug and polymer replied with the surfactant waterless subcaste, the polymer rained out. After the junking of the redundant detergent, polymeric nanoparticles are left out,[22] gelatinizing agent and necessary quantities of nanoparticle dissipation are added after the patches have been bedewed. The pH is stabilized y using triethanolamine.[23]



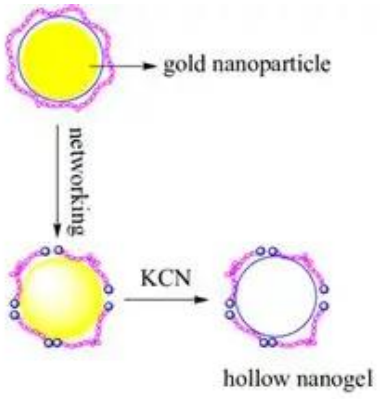


Fig. 4: Nanogel. **Fig. 5: Hollow Nanogel.**

3) Evaporation of the Solvent Method

During two hours of treatment, the medicine- polymer admixture is fitted into the designated area of the waterless phase. This process is accompanied by nonstop shifting at 1000 rpm, eased by a glamorous stirrer.[24] The nano sponges attained as a consequence are farther subordinated to filtration, followed by a drying process in a hot air roaster maintained at a temperature of 40 °C for 24 hours.[25] Eventually, the dried nano sponges are precisely transferred into vials for storehouse. To achieve a homogeneous dissipation, it's

recommended to immerse the polymer in water for 2 hours before the inauguration of gel conformation.[26,27] latterly, the polymer should be subordinated to agitation at a rotational speed of 6000 rpm. The pH is modified with the use of a pH- conforming agent. latterly, the waterless dissipation is combined with the optimized nano sponge suspense and saturation enhancers.[28,29]

4) Rear Micellar Method

A polymer, drug, and surfactant are dissolved in an organic detergent. After adding the cross-linking agent, it must incorporate over an extended period of time during the night.[30] After the nanoparticles have been purified, the solvents faded, creating a withered bulk.[31] It was created by dissolving the gelatinizing element in water. When nanoparticles and a waterless phase containing a gelatinizing agent are combined, nanogel is formed. The operation of a negativing substance modifies the pH.[32]

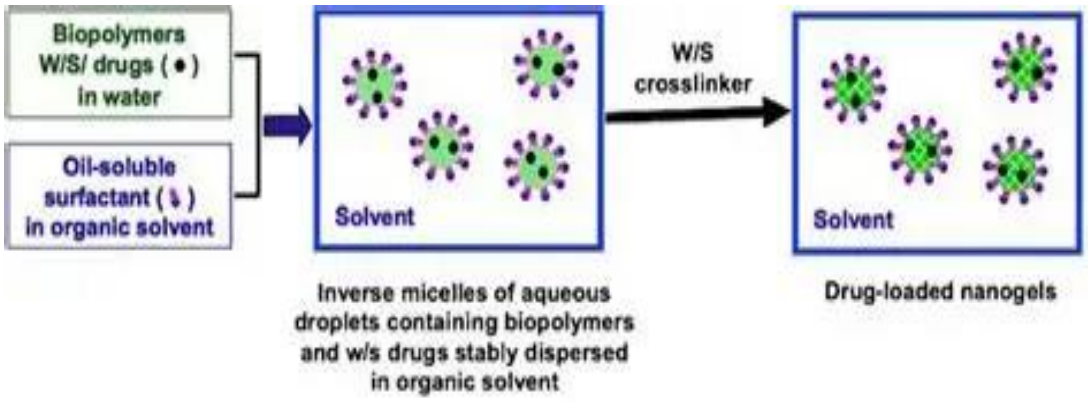


Fig. 6: Micellar Method.

5) Modified prolixity Emulsification system

A polymer containing the detergent is mixed with the drug in a precisely calculated rate. The organic phase is created when the medicine- polymer admixture is continuously agitated in the waterless phase at a rotating speed of 5000 to 10,000 rpm.[33] A hypefitted with a needle is used to add the organic phase at a rate of 0.5 mL per nanosecond to the waterless stabilizer result. After being agitated for six twinkles at a rotational speed ranging from (10000 – 25000) rpm, the suspense is coming subordinated to sonication for five to ten twinkles.[34,35]

EVALUATION TEST OF NANOGEL

Physical Evaluation

Physical parameters similar as colour, thickness, appearance, marshland capability and odour can be assessed.

PH

pH of 1 waterless result of the expression was measured by using a calibrated digital pH cadence at constant temperature.[36] The pH of the nanogel expression was determined by employing a pH cadence. In order to carry out this determination, a mass of 1 gram of nanogel was measured and latterly dispersed in 10 millilitres of distilled water. The sample was allowed to incubate for a duration of 4-5 twinkles in order to gain the precise pH dimension. The data collection process involved carrying three separate readings.

Spreadability

Spreadability denotes the extent of area to which the gel readily spread on operation to skin or the affected part. The bioavailability effectiveness of a gel expression also depends on its spreading value. The spreadability is expressed in terms of time in seconds taken by two slides slip off from the gel, placed in between the slides, under certain cargo. lower the time taken for separation of two slides, better the spreadability. Two sets of glass slides of standard confines were taken. The herbal gel expression was placed over one of the slides. The other slide was placed on the top of the gel, similar that the gel was squeezed between the two slides in an area enthralled by a distance of 6 cm along the slide. A 30gm weight was tied to the upper slide precisely. The time taken for the upper slide to travel the distance of 6 cm and separated down from the lower slide under the influence of the weight was noted. The trial was repeated three times both formulated gels and retailed gel.[36]

The computation of spreadability was determined by the application of a certain formula. S = M. L/ T,

Where, S = Spreadability,
L = Length of glass slide,
M = weight tied to advanced slide, T = Time taken to separate the slides.

Density

Density of gels was determined using Brookfield viscometer. Gels were tested for their rheological characteristics at 250C using Brookfield viscometer. The dimension was made over the whole range of speed settings from10rpm to 100rpm with 30 seconds between 2 consecutive pets and also in a descending order.

Content Uniformity

About 1 gm of gel was directly counted and transferred to 100 ml volumetric beaker to which about 70 ml of methanol was added. After mixing, the volume was made up to 100 ml with methanol. The content was filtered using sludge paper. A volume of 1 ml was pipette out from the filtrate and suitably adulterated with methanol. also, the excerpt was estimated Spectro photo metrically by using Shimadzu UV spectrophotometer- 1700 at separate λ maximum.[37]

Extrudability

The fusions were put into flexible aluminium tubes. The tubes were compressed in order to banish a gel strip measuring 0.5 cm within a 10-alternate timeframe, and the extrudability of the phrasings was latterly assessed.

The ruse effectiveness of the nanogel was assessed by quantifying the quantum of medicine present in the nanogel expression (in milligrams) and comparing it to the original quantum of medicine introduced (in milligrams) to the waterless phase.

Stability studies

The optimized expression passed stability testing for a duration of 45 days, following the guidelines set by the International Council for Harmonisation (ICH). The testing was conducted at a controlled temperature of 40º ± 2ºC and a relative moisture (RH) of 75. The optimized expression was estimated for variations in medicine content and in-vitro prolixity characteristics using the preliminarily described methodology.

CONCLUSION

Pergularia daemia has colourful phytochemicals similar as flavonoids, alkaloids, terpenoids, tannin and steroids. The factory also exhibits several pharmacological parcels similar as antiinflammation, analgesic, antipyretic, antioxidant, anticancer, antidiabetic, hepatoprotective, antibacterial, antifungal and central nervous system depressant exertion.

Nanogels, being a flexible and protean medicine carrier, have multitudinous operations in the pharmaceutical sphere. Nanogels showed pledge as a new type of bio-responsive delivery system due to their profitable parcels. In the case of cancer, skin ails, diabetes, etc., nanogel may transfigure the natural product into the most effective drug. The transdermal delivery of Medicinals using these cross-linked nanogels has great eventuality, as it has been shown to increase patient compliance while causing smaller adverse goods. Nanogels have an advanced penetration capability and lesser bioavailability of the drug. It can be concluded that nanogels are promising lozenge form in targeted medicine delivery that grease efficacity but minimizes toxin or damage to conterminous organs.

It's believed that detailed information presented in this review would help the experimenters to get apprehensive of this factory.

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