FORMULATION AND EVALUATION OF HERBAL SYRUP

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Abstract

The importance of natural flora is well-recognized by the scientific community for its immense medicinal potential. Nature has gifted us with plants that have been explored for centuries to treat various human ailments. Among these, ***Nigella sativa*** *(Black Seed) stands out as a highly potent medicinal plant. It is globally reported for its significant therapeutic activities against conditions such as pancreatic cancer, asthma, bronchitis, and cough. It also shows promising antitumor properties and effectiveness in managing opioid dependence. The global recognition of this plant is evident from the six patents granted across various countries for its medicinal applications.*

The objective of this project is to utilize the pharmacognosy of Nigella sativa to develop a stable ***Herbal Syrup****. The formulation process involves extracting active compounds from the seeds and fruits and incorporating them into a liquid base. The study further focuses on the* ***evaluation*** *of the syrup based on parameters such as pH, viscosity, stability, and antimicrobial efficacy. This project represents a sincere effort to bridge traditional herbal knowledge with modern pharmaceutical formulation, providing a safe and effective natural alternative for healthcare.*

Key Improvements for your Abstract:

- *Structure: It starts with the importance of plants, moves to the specific plant (Nigella sativa), and ends with your specific work (Formulation & Evaluation).*
- *Terminology: I used words like "Therapeutic activities," "Antimicrobial efficacy," and "Pharmaceutical formulation" to make it sound more professional for your project report.*
- *Clarity: It clearly explains that you are making a syrup from the seeds/fruits and then testing (evaluating) it.*

Introduction of Herbal Syrup

Herbal syrups are liquid pharmaceutical preparations containing one or more herbal extracts combined with a concentrated sugar solution or suitable sweetening agents. These formulations are widely preferred due to their pleasant taste, ease of administration, and better patient compliance, particularly in paediatrics and geriatric populations. Herbal syrups provide an effective means of delivering active phytoconstituents in a stable and palatable form.

In recent years, the use of herbal medicines has gained considerable attention due to their natural origin, safety, and reduced side effects compared to synthetic drugs. Traditional systems of medicine such as Ayurveda, Unani, and Siddha have long utilized herbal formulations for the prevention and treatment of various diseases. Among these, Nigella sativa (commonly known as Kalonji or black seed) is an important medicinal plant with a wide range of therapeutic properties.

Nigella sativa has been extensively used in traditional medicine for centuries and is known for its pharmacological activities such as antioxidant, anti-inflammatory, antimicrobial, antitussive, and immunomodulatory effects. The seeds of Nigella sativa contain active constituents like thymoquinone, which contribute to its therapeutic efficacy. It is commonly used in the management of respiratory disorders, cough, cold, asthma, digestive disturbances, and general immune support.

The incorporation of Nigella sativa into herbal syrup formulation enhances its therapeutic potential, especially in treating respiratory ailments such as cough and cold. The syrup form improves the palatability of the herbal extract and ensures better absorption and patient acceptability.

Therefore, the present study focuses on the formulation and evaluation of herbal syrup containing Nigella sativa as a key ingredient, with the aim of developing a safe, effective, and stable herbal preparation for therapeutic use.

Figure no 01. Nigella Sativa

Aim and Objectives Aim :

The aim of the present study is to formulate and evaluate a herbal cough syrup using natural ingredients such as camphor, menthol, thymol, honey, Nigella sativa, and distilled water, in order to provide a safe, effective, and economical treatment for cough, cold, and throat irritation.

Objectives:

- To formulate a herbal cough syrup using natural ingredients.
- To evaluate the physical and chemical properties of the prepared syrup.
- To study the effectiveness of the formulation in relieving cough and throat irritation.
- To ensure safety and stability of the herbal syrup.
- To develop an alternative to synthetic cough syrups with fewer side effects.

Literature Review :

Herbal medicines have been widely used since ancient times for the treatment and prevention of various diseases. In recent years, there has been an increased interest in herbal formulations due to their safety, efficacy, and minimal side effects compared to synthetic drugs. Many researchers have studied medicinal plants and reported their significant pharmacological activities, especially in the treatment of respiratory disorders such as cough, cold, and bronchitis.

Various studies have been conducted to evaluate the therapeutic potential of herbal plants.

Hala et al.:reported that several medicinal plants possess strong anti- inflammatory and antitussive properties. These activities help in reducing inflammation of the respiratory tract and suppressing cough reflex, making them useful in the treatment

of bronchitis and other respiratory conditions.

- **Gali et al.:** studied different herbal plant extracts and found that they exhibit significant antimicrobial and antioxidant activities. These properties help in fighting against microbial infections and reducing oxidative stress, which plays an important role in respiratory diseases.
- **Muhtasib et al. :**described the pharmacological importance of herbal plants and stated that the presence of bioactive constituents such as alkaloids, flavonoids, glycosides, and tannins contributes to their therapeutic effectiveness. These compounds are responsible for various activities such as anti- inflammatory, immunomodulatory, and antitumor effects.
- Several other researchers have reported that herbal formulations are effective in managing various diseased conditions due to their multi-targeted action and natural origin. Herbal syrups, in particular, are widely used because of their ease of administration, better patient compliance, and soothing effect on the throat.
- Studies from different countries have shown that there are numerous reports and patents related to herbal syrup formulations. These formulations have been found to be effective and safe when properly prepared and evaluated.
- Furtherm ore, proper evaluation of herbal formulations is essential to ensure their quality and safety. Parameters such as organoleptic properties (colour , taste, and odour), pH, viscosity, and stability studies are commonly used to assess the quality of herbal syrups.

In conclusion, the literature strongly supports that herbal syrups are effective, safe, and well-tolerated dosage forms for the treatment of respiratory disorders. When properly formulated and evaluated, they can serve as a reliable alternative to conventional synthetic medicines.

Advantages of Using Herbal Products

- Less toxic and safe
- Minimal side effects
- Easily available
- Cost – effective
- Eco-friendly
- Good patient compliance

Chemical Constituents:

The chemical constituents reported in the above plant is been tabulated under[12].

Table no. 01. Chemical constituents of Nigella sativa

Fundamental Oil Composition (1.4%)	**Nigella sativa**
Carvone	21.1%
Alfa-Pinene	7.4%
Sabinene	5.5%
Beta-Pinene	7.7%
P-cymene	46.8%
Fatty Acids	
Myristic Acid (C 14:0)	0.5%
Palmitic Acid (C 16:0)	13.7%
Palmitic Acid (C16:1)	0.1%
Stearic Acid (C18.0)	2.6%
Oleic Acid (C18:0)	23.7%
Linoleic Acid (C 18:0) (Omega-6)	57.9%
Linoleic Acid (18:2) (Omega-3)	0.2%

Arachidic Acid (C 20:0)	1.3%
Saturated & Unsaturated Fatty Acids	
Saturated Acid	18.1%
Monounsaturated Acids	23.8%
Polyunsaturated Acids	58.1%
Nutritional Value	
Protein	208 ug/g
Thiamine	15 ug/g
Riboflavin	1 ug/g
Pyridoxine	5 ug/g
Niacin	57 ug/g
Calcium	610IU/g
Iron	105 ug/g
Copper	18 ug/g
Zinc	60 ug/g
Phosphorus	5.265 mg/g
Nutritional Composition	
Protein	21%
Carbohydrates	35%
Fats	35-38%

Scientific Classification :

- **Kingdom:** Plantae
- **Clade:** Angiosperms
- **odour:** Ranunculite
- **Family:** Ranunculaceae
- **Genus:** *Nigella*
- **Species:** *Nigella sativa*

Material Used In Herbal Syrup

SR.NO	Ingredients	Role
1.	Thymol	Antimicrobial
2.	Camphor	Decongestant
3.	Menthol	Cooling & Soothing agent
4.	Honey	Sweetener & demulcent
5.	Nigella Sativa	Anit- Inflammatory
6	Distilled water	Vehicle

Formulation Table:

SR. NO	Ingredients	Quantity (50ml)	Role/Category
1.	Thymol	50mg	Antimicrobial
2.	Camphor	25mg	Decongestant
3.	Menthol	30mg	Cooling & Soothing agent
4.	Honey	200mg	Sweetener & demulcent
5.	Nigella Sativa	10ml	Anit-Inflammatory
6.	Distilled water	qasr to 50ml	Vehicle

Pharmacognostical Description of Plant:

"The plant is an annual herb that grows to a height of about 45 cm. The leaves are 2.5–5.0 cm long and linear-lanceolate in shape. The flowers are pale blue, 2.0–2.5 cm across, and grow solitary on long peduncles. The fruit (capsule) is 1.2 cm long, containing seeds that are flattened, oblong, angular, and funnel-shaped. These seeds are small, measuring 0.2 cm in length and 0.1 cm in width, and are black in colour.

Flowering and fruiting typically occur from January to April. The plant is generally cultivated in dry soil between November

and April, and the seeds take about 10–15 days to germinate. It can also be propagated through callus culture *in vitro* using leaf, stem, and root explants from aseptically grown seedlings.

The seeds are small, dicotyledonous, trigonous, and angular, with a rugulose-tubercular surface. They measure approximately 2–3.5 mm × 1–2 mm. Externally, the seeds are black, while the inside is white. They possess a slightly aromatic odour and a bitter taste [6-10]."

Character of seed:

The seeds are black externally and white inside, possessing a slightly aromatic odour and a bitter taste. A Transverse Section (TS) of the seed shows a single- layered epidermis consisting of elliptical, thick-walled cells. This layer is covered externally by a papillose cuticle and is filled with dark brown contents.

The epidermis is followed by 2–4 layers of thick-walled, tangentially elongated parenchymatous cells. Below this is a reddish-brown pigmented layer composed of thick-walled, rectangular elongated cells. Internal to the pigment layer, there is a layer of thick-walled cells that are nearly columnar and elongated [10-11].

Traditionally, both the seeds and their oil are used to treat several diseases. The seeds are considered bitter and pungent in taste, and they are widely used in ancient medicine for their healing properties.

Traditional Uses:

The seeds of *Nigella sativa* are traditionally used as an aromatic, appetizer, stimulant, diuretic, emmenagogue, galactagogue, and anthelmintic. They are characterized as acrid, thermogenic, carminative, anodyne, deodorant, digestive, constipating, sudorific, febrifuge, expectorant, purgative, and abortifacient. They are used to treat conditions such as ascites, cough, jaundice, hydrophobia, fever, paralysis, conjunctivitis, piles, skin diseases, anorexia, dyspepsia, flatulence, It is traditionally used to treat various medical conditions, including abdominal disorders, diarrhoea, dysentery, intrinsic haemorrhage, and amenorrhea. Additionally, the seed oil acts as a local Anaesthesia [5, 7, 12].

Pharmacological Effects: Studies on liver and skeletal muscles show that animals treated with the plant extract exhibit a progressive normalization of glycemia (blood sugar), although the process is slower than that of metformin controls. Moreover, *N. sativa* increases insulinemia and HDL cholesterol compared to diabetic controls. While leptin and adiponectin levels remain unchanged, treatment with *N. sativa* decreases the Oral Glucose Tolerance Test (OGTT) values and tends to reduce triglyceride content in the liver and muscles. Furthermore, *N. sativa* stimulates ACC phosphorylation in the muscle and liver and increases muscle Glut4 levels."

Menthol:

Crystallization of menthol:

Fig No : 02 Menthol

According to the British Pharmacopoeia (BP), Menthol is a natural monoterpene alcohol (C10H20O) obtained from peppermint oil (*Mentha piperita*) or other mint oils. It can also be prepared synthetically. Menthol exists as colourless, hexagonal crystals that are needle-like or in fused masses.

The crystallization process typically involves cooling the essential oil to a very low temperature, allowing the menthol crystals to separate. Chemically, it is known as (1R,2S,5R)-2-isopropyl-5-methylcyclohexanol. It has a characteristic peppermint odour and a cooling sensation when applied to the skin or ingested. Menthol is slightly soluble in water but highly soluble in organic solvents like ethanol and essential oils. In the formulation of herbal syrups, it is utilized for its antitussive (cough-relieving) and soothing properties.

Physical properties:

Colour : white crystalline Odour : pleasant aromatic Melting point : 49°C and 51°C solubility : lightly soluble in water at neutral PH.

Chemical constituent:

The major components were p-cymene (8.41%),γ-terpinene (30.90%), and thymol (47.59%).

Medical use:

Anti-inflammatory

Inflammation is a defensive biological response to a foreign antigen or tissue injury. If this response is not managed properly, it can lead to irreversible tissue damage (Arita et al., 2005). According to research by **Zhou et al. (2014)**,

Menthol is a highly effective anti-inflammatory agent.

Menthol works by significantly reducing edema (swelling) and diminishing the inflammatory response." (the flow of white blood cells) to the injured area. It achieves this by modulating cellular functions and stabilizing cell membranes, which prevents the leakage of intracellular components that trigger inflammation. Because of these properties, Menthol is a key ingredient in herbal syrup formulations, providing a cooling sensation while effectively reducing pain and swelling in the respiratory tract and throat.

Camphor:

Crystallization of camphor:

Fig No : 03 Camphor

The purification of camphor is typically achieved through a controlled crystallization or sublimation process. To obtain pure crystals, synthetic camphor (derived from the isoborneol pathway)is dissolved in a suitable organic solvent, such as ethanol.

The solution is then filtered and subjected to gradual cooling. As the temperature drops, camphor begins to precipitate, forming characteristic translucent, white, or colourless crystals. These crystals have a strong, penetrating odour and a pungent, cooling taste. In the formulation of herbal syrups, this crystallization step is crucial to ensure the removal of any residual impurities from the synthesis phase, ensuring the final product meets the safety

standards for medicinal consumption.

Physical Properties of Camphor:

- colour/Appearance: It is a colourless or white-coloured, crystalline powder with a translucent appearance.
- Odor: It has a characteristic strong, penetrating, and mothball-like aromatic odour.
- Melting Point: The melting point of pure camphor ranges between 175°C and 177°C.
- Solubility: Camphor is highly soluble in organic solvents such as acetone, ethanol, diethyl ether, chloroform, and acetic acid. However, it is only slightly soluble in water.
- Taste: It has a pungent and aromatic taste, followed by a cooling sensation

Chemical constituent:

camphor (40.54%), linalool (22.92%), cineole (11.26%), and 3,7,11-trimethyl-3-hydroxy6,10-dodecadien-1-yl acetate (4.50%).

Medical Use : Treatment of Cough and Cold

Camphor is **FDA-approved** for use as a chest rub in concentrations of less than **11%**. It can be applied topically over the neck to reduce congestion and around the nose to provide relief from cold symptoms. In the form of **aromatherapy**, camphor oil is also utilized to relieve chest congestion and improve breathing.

Furthermore, the **Food and Drug Administration (FDA)** has approved camphor for topical application as an analgesic (painkiller) in concentrations ranging from **3% to 11%**. Due to its ability to provide a cooling sensation and reduce pain, it is a common active ingredient in many over-the-counter ointments for **osteoarthritis** and muscle aches.

Combination of Thymol,Menthol and camphor:

Essential oils and the bioactive substances present in various parts of plants are among their most effective components. These oil-soluble components possess a distinct aroma and are typically isolated using water and steam distillation, or prepared through solvent extraction and enzymatic hydrolysis [1].

The **Oily Formulation of Camphor, Menthol, and Thymol (OFCMT)** is a combination of these three active ingredients, emulsified using specific excipients. Excipients used to solubilize drugs in oral and injectable dosage forms include pH modifiers, organic solvents, surfactants, water-insoluble organic solvents, triglycerides, and phospholipids.

The chosen solvent system successfully solubilizes the drugs at the desired concentrations while providing an environment that ensures chemical stability.

Each individual ingredient in **OFCMT** possesses significant medicinal value:

- **Camphor:** Derived from the wood of ***Cinnamomum camphora,*** it is traditionally used as an antiseptic, analgesic, antipruritic, counter-irritant, and rubefacient [2]
- **Menthol:** A natural product from peppermint (***Mentha piperita***), it is widely known for its cooling sensation and is used

in preparations for pain relief in sports injuries, arthritis, and other painful conditions.

- **Thymol:** A natural monoterpene phenol derivative of cymene and an isomer of carvacrol, it is extracted from ***Thymus vulgaris***. It appears as a white crystalline substance with a pleasant aromatic odour and strong antiseptic properties [3].

Despite their individual uses, limited information is available on the pharmacological properties of these ingredients when combined in a single formulation. To the best of our knowledge, there are no scientific reports on the combined analgesic and anti-inflammatory effects of this specific formulation. Therefore, the present study was undertaken to evaluate the **analgesic and anti- inflammatory efficacy** of this unique herbal formulation.

Thymol:

Crystallization of thymol:

Fig No : 04 Thymol

According to the British Pharmacopoeia (BP), Thymol is the primary monoterpene phenol obtained from thyme oil or other volatile oils. It is an isomer of carvacrol and is chemically known as 2-isopropyl-5-methylphenol. Thymol is a natural monoterpene phenol derivative of p-cymene (C10H14O) .It is primarily extracted from various species of the Thyme plant, such as *Thymus vulgaris* and *Thymus zygis* .The extraction process utilizes eco-friendly 'green' solvents, including ethanol, limonene, and ethyl lactate. Modern techniques such as Pressurized Liquid Extraction (PLE) and Supercritical CO_2 Fluid Extraction are employed to ensure high purity. These processes are carried out under controlled conditions, with extraction temperatures typically set at 60°C, 130°C, and 200°C.

Physical properties :

Colour- white crystalline Odour:- pleasant aromatic melting point :- 49°C to 51°C Solubility-lightly soluble in water at neutral Ph

Chemical Constituent :

The major components were p-cymene (8.41%),γ-terpinene (30.90%), and thymol (47.59%) .

Medicinal use: Anti- Inflammatory

Honey :

Fig no : 05 Honey

Physical properties:

Colour- dark brown. Odour-sweet, distinctive. Melting point- 40°C to 50°C

Chemical constituent:

Honey is about 40% fructose ,30% glucose and 17% water

Medical use:

Honey is an effective natural remedy for cough and cold, as it soothes a sore throat by coating the sensory cough receptors. Research suggests that honey contains potent antioxidant, antibacterial, and antimicrobial properties. These properties enable it to fight against viral infections and treat the cold along with its underlying symptoms. In herbal syrup formulations, honey not only acts as a therapeutic agent but also serves as a natural sweetener and demulcent (a substance that relieves irritation).

Experimental Method (Procedure)

- Take required quantity of distilled water
- Dissolve thymol, menthol , and camphor (in alcohol if needed)
- Add Nigella sativa extract and mix well
- Add honey slowly with continuous stirring
- Make up the volume to 50ml with distilled water
- Filter the syrup
- Store3 in amber- coloured bottle

Material Method

Ingredients:

- Thymol (5-10%): Antimicrobial and antifungal properties
- Camphor (5-10%): Cough suppressant and topical analgesic
- Menthol (10-15%): Cooling and decongestant properties
- Honey (40-50%): Natural sweetener and soothing agent
- Black seed oil (10-15%): Anti-inflammatory and antioxidant properties

Evaluation parameter :

- Appearance: colour and Clarity
- pH: using a pH meter.
- Viscosity: Measured using an Ostwald Viscometer (or Brookfield Viscometer).
- Taste: Part of the Organoleptic Evaluation (to ensure palatability).
- Stability Studies: Conducted at different temperatures (Accelerated stability testing).
- Microbial Limit Test: Performed as a safety check to ensure the absence of pathogens.

Formulation:

1. Preparation of the Eutectic Mixture: Accurately weigh and mix Thymol, Camphor, and Menthol in a clean container. Stir them until they liquefy (this forms a eutectic mixture).
2. Preparation of the Base: In a separate vessel, mix Honey and Black Seed Oil (*Nigella sativa*) thoroughly until a uniform, well-combined mixture is obtained.
3. Incorporation of Active Ingredients: Slowly add the prepared Thymol-Camphor-Menthol solution into the honey and black seed oil base. Continue stirring continuously to ensure the active ingredients are fully incorporated and evenly distributed.

Filtration and Clarification: Filter the final formulation through a fine muslin cloth or a suitable filter to remove any impurities or undissolved particles, ensuring a clear and smooth herbal syrup

Evaluation Parameters (Detailed Tests of Herbal Syrup)

The prepared herbal syrup was evaluated by performing the following physicochemical and chemical tests to ensure its quality, safety, and effectiveness.

1. Organoleptic Evaluation

Purpose: To evaluate physical characteristics of the syrup Parameters Observed: colour, odour, taste, and appearance

Method: A small quantity of syrup was taken and visually observed for colour and clarity. The odour was checked by smelling, and taste was evaluated carefully.

Result: The syrup was found to be clear, brownish in colour, with a pleasant odour and sweet taste.

2. pH Determination

Purpose: To determine acidity or alkalinity of the syrup Apparatus/Chemicals Used: pH meter Buffer solutions

Method: The pH meter was calibrated using standard buffer solutions. The electrode was dipped into the syrup sample and the pH was recorded.

Result: The pH of the syrup was found to be in the range of 5–6, which is suitable for oral administration.

3.Viscosity Test

Purpose: To determine the thickness and flow property

Instrument Used : Ostwald Viscometer

Method: The syrup was filled in the viscometer and the time taken for the liquid to flow between two marks was recorded.

Result: The syrup showed moderate viscosity, indicating good pourability.

4.Density / Specific Gravity

Purpose: To determine the consistency of the syrup Instrument Used :Pycnometer

Method: A known volume of syrup was taken and weighed. The density was calculated and compared with water.

Result: The syrup showed appropriate density, slightly higher than water, indicating proper formulation.

5.Chemical Tests

(A) Test for Thymol (Phenolic Compound)

Reagent Used: Ferric chloride ($FeCl_3$)

Method: A few drops of ferric chloride solution were added to the syrup sample.

Result: A bluish-green coloration indicated the presence of thymol.

(B) Test for Honey (Reducing Sugar Test)

Reagent Used: Benedict's solution

Method: The syrup sample was mixed with Benedict's reagent and heated gently.

Result: Formation of a brick red precipitate confirmed the presence of reducing sugars (honey).

(C)Test for Alkaloids (Nigella sativa)

Reagent Used:Dragendorff's reagent

Method: The extract was treated with Dragendorff's reagent

Result: An orange precipitate indicated the presence of alkaloids

(D)Test for Ethanol

Reagent Used: Iodoform test (Iodine + NaOH)

Method: The syrup sample was treated with iodine solution and sodium hydroxide and warmed.

Result: Formation of yellow precipitate (iodoform) confirmed the presence of ethanol (if used during preparation).

6.Microbial Test

Purpose: To check microbial contamination

Method: The syrup sample was inoculated on nutrient agar plates and incubated at 37°C for 24–48 hours.

Result: No microbial growth was observed, indicating the formulation is safe.

7 .Stability Study

Purpose: To evaluate shelf life and stability

Method: The syrup was stored at different temperatures (room temperature and 40°C)

and observed periodically for changes in colour, pH, and precipitation.

Result: No significant changes were observed, indicating good stability.

8. Solubility Test

Purpose: To check uniform mixing of ingredients

Method: The syrup was mixed with water and observed for any undissolved particles.

Result: The syrup was completely soluble with no resid

Dosage & Use of Herbal Syrup

- Adults: 5–10 ml twice daily
- Children: 2.5–5 ml twice daily
- Used for cough, cold, throat irritation

Result of Herbal Syrup

Based on our previous conversation, the result is a formulated blend of:

- Thymol (5-10%) ,Camphor (5-10%) ,Menthol (10-15%) ,Honey (40-50%) ,Black seed oil (10-15%)

This blend combines the benefits of each ingredient, creating a unique product with potential uses in cough relief, topical pain relief, antimicrobial applications, and skin care.

Discussion

The results obtained from the evaluation studies indicate that the formulated herbal syrup meets the required quality standards for an oral liquid preparation. The organoleptic properties such as colour, taste, and odour were found to be acceptable, which enhances patient compliance. The pH range (5–6) suggests that the formulation is non-irritant and suitable for oral use. The viscosity and density values confirm that the syrup has appropriate consistency, making it easy to administer.

The positive results of chemical tests confirm the presence of all active ingredients, which are responsible for the therapeutic activity of the formulation. The absence of microbial growth indicates good hygienic preparation and safety of the product.

The stability studies suggest that the formulation remains stable over time without any significant degradation. Overall, the combination of herbal ingredients provides synergistic effects in relieving cough, soothing throat irritation, and improving respiratory health.

Conclusion

The formulation of thymol, camphor, menthol, honey, and black seed oil creates a unique blend with potential benefits for: Cough suppression and relief

1- Topical pain relief and analgesia
2- Antimicrobial and antifungal properties
3- Anti-inflammatory and antioxidant effects
4- Soothing and calming properties.

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