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Deepa
School of Pharmacy and Research,
Dev Bhoomi Uttarakhand
University, Naugaon, Dehradun,
Uttarakhand, India

Nagendra Bisht
School of Pharmacy and Research,
Dev Bhoomi Uttarakhand
University, Naugaon, Dehradun,
Uttarakhand, India

Amar Kumar
School of Pharmacy and Research,
Dev Bhoomi Uttarakhand
University, Naugaon, Dehradun,
Uttarakhand, India

Riya Jaisawal
School of Pharmacy and Research,
Dev Bhoomi Uttarakhand
University, Naugaon, Dehradun,
Uttarakhand, India

Chavi Mittal
School of Pharmacy and Research,
Dev Bhoomi Uttarakhand
University, Naugaon, Dehradun,
Uttarakhand, India

Corresponding Author:
Chavi Mittal
School of Pharmacy and Research,
Dev Bhoomi Uttarakhand
University, Naugaon, Dehradun,
Uttarakhand, India

Formulation and evaluation of herbal gargle containing *Zanthoxylum armatum*

Deepa, Nagendra Bisht, Amar Kumar, Riya Jaisawal and Chavi Mittal

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Abstract

Zanthoxylum armatum widely used in traditional medicine, exhibits potent antimicrobial, anti-inflammatory, analgesic, and antioxidant properties attributed to its rich phytoconstituents like alkaloids and flavonoids. Traditionally utilized for toothache and throat infections, it provides a promising alternative to synthetic oral care products, which frequently cause adverse effects such as mucosal irritation, altered taste, and disruption of normal oral flora. Given the dynamic and infection-prone nature of the oral cavity, this study aimed to formulate and evaluate a herbal gargle containing the stem bark extract of *Zanthoxylum armatum* for localized drug delivery. The hydroalcoholic extract, obtained through maceration, was incorporated into a gargle base utilizing excipients like glycerin, sorbitol, sodium benzoate, and flavoring agents. The prepared formulation was systematically evaluated for organoleptic characteristics, pH, chemical testing, and stability under various storage conditions. Results indicated that the gargle possessed highly acceptable sensory properties, an oral-friendly pH, and excellent physicochemical stability throughout the study period. In conclusion, *Zanthoxylum armatum* the herbal gargle presents a safe, stable, and effective biocompatible alternative for maintaining oral hygiene and managing minor oral and pharyngeal infections, validating the potential of herbal formulations in oral care.

Keywords: *Zanthoxylum armatum* herbal gargle, oral hygiene, antimicrobial, anti-inflammatory, stem bark extract

1. Introduction

Gargles are aqueous liquid dosage forms intended for the treatment of infections of the oral cavity and throat. They are designed to be brought into contact with the mucous membranes of the mouth and pharynx for a sufficient duration to exert local therapeutic effects (Allen, 2013; Aulton & Taylor, 2018) ^[5, 6]. Gargles are commonly used in the management of conditions such as pharyngitis, tonsillitis, gingivitis, and stomatitis, where reduction of microbial load and inflammation is essential for recovery (Chopra & Roberts, 2019) ^[7].

These formulations typically contain antiseptic, antimicrobial, and anti-inflammatory agents that act locally without significant systemic absorption. Due to their direct contact with affected tissues, gargles provide rapid relief from symptoms such as pain, irritation, and microbial infection (Aulton & Taylor, 2018) ^[6]. In recent years, there has been a paradigm shift towards the use of herbal formulations in oral healthcare, primarily due to concerns regarding the adverse effects associated with synthetic agents. Herbal gargles are prepared using plant-derived ingredients that possess therapeutic properties such as antimicrobial, anti-inflammatory, analgesic, and antioxidant activities (Ekor, 2014; Cowan, 1999) ^[10, 8].

Medicinal plants have been extensively used in traditional systems of medicine such as Ayurveda for the prevention and treatment of oral diseases. These plants contain bioactive phytoconstituents including alkaloids, flavonoids, tannins, saponins, and essential oils, which are known to inhibit the growth of pathogenic microorganisms and reduce inflammation (Pandey & Tripathi, 2014; Cowan, 1999) ^[15, 8].

The increasing incidence of oral diseases such as dental caries, periodontal diseases, and throat infections has necessitated the development of safer and more effective therapeutic alternatives. Synthetic oral care products available in the market, such as chlorhexidine-based mouthwashes, although effective, are associated with several side effects including tooth staining, mucosal

irritation, altered taste sensation, and dryness of mouth on prolonged use (James *et al.*, 2017; Van Strydonck *et al.*, 2012) [11, 27].

Moreover, long-term use of synthetic antimicrobial agents may contribute to the development of microbial resistance, further emphasizing the need for alternative therapies (Ekor, 2014) [10]. In contrast, herbal formulations are generally considered safer, biodegradable, and more compatible with the human body, making them suitable for long-term use with minimal adverse effects (Cowan, 1999) [8]. Herbal gargles, therefore, represent a promising approach in oral healthcare by combining traditional knowledge with modern pharmaceutical formulation techniques. They not only help in maintaining oral hygiene but also provide therapeutic benefits in managing infections and inflammation (Pandey & Tripathi, 2014) [15].

Among the various medicinal plants used in oral care, *Zanthoxylum armatum* DC. has gained considerable attention due to its wide range of pharmacological activities. It belongs to the family Rutaceae and is commonly known as Timur, Toothache tree, or Indian prickly ash. The plant is widely distributed in the Himalayan regions of India, Nepal, and other parts of Asia (Singh & Singh, 2021; Sati & Joshi, 2022) [22, 19].

Traditionally, *Zanthoxylum armatum* has been used for the treatment of toothache, gum disorders, bad breath, and throat infections. The bark, fruits, and seeds of the plant are commonly used in indigenous medicine due to their analgesic and antimicrobial properties (Verma & Sharma, 2021) [28].

Phytochemical investigations have revealed that *Zanthoxylum armatum* contains a variety of bioactive compounds such as alkaloids, flavonoids, tannins, lignans, coumarins, and essential oils. These constituents are responsible for its diverse pharmacological activities including antimicrobial, anti-inflammatory, antioxidant, and analgesic effects (Sati & Joshi, 2022; Singh & Singh, 2021) [19, 22]. Several studies have demonstrated that extracts of *Zanthoxylum armatum* exhibit significant antimicrobial activity against a wide range of microorganisms, including oral pathogens such as *Streptococcus mutans* and *Staphylococcus aureus*, which are commonly associated with dental and throat infections (Phuyal *et al.*, 2020; Cowan, 1999) [16, 8].

In addition to its antimicrobial activity, the plant also exhibits anti-inflammatory and analgesic properties, which are beneficial in reducing pain and inflammation associated with oral conditions (Verma & Sharma, 2021) [28]. These properties make *Zanthoxylum armatum* an ideal candidate for incorporation into herbal oral care formulations. Recent research has also explored the use of *Zanthoxylum armatum* in various pharmaceutical preparations such as herbal toothpastes, mouthwashes, and powders, demonstrating its effectiveness and safety in oral care applications (Sati & Joshi, 2022) [19].

Therefore, the formulation of herbal gargle containing *Zanthoxylum armatum* can provide a natural, safe, and effective alternative to conventional synthetic oral care products. Such a formulation is expected to offer antimicrobial protection, reduce inflammation, and improve overall oral hygiene with minimal side effects. Hence, the present study is aimed at the formulation and evaluation of an herbal gargle containing *Zanthoxylum armatum*, with the objective of assessing its physicochemical properties and therapeutic potential in oral healthcare.

2. *Zanthoxylum armatum*

In Indian medical literature, *Zanthoxylum armatum* is one of the most significant medicinal herbs. Ten or so species are cultivated in India. The Indian traditional system uses nearly

every part of this plant to treat a variety of illnesses due to its important medicinal qualities.

It was further documented by means of scientific research. Medicinal plants are those that have active components that are used to treat illness or ease pain. (Okigbo RN, 2008) [14].

Plants are regarded as having a major part in the healthcare system since they have a therapeutic and pharmacological purpose in shielding people from the impacts of diseases and other difficulties (Akhtar N, 2009) [4]. This is the primary cause of the widespread use of herbal remedies in poorer nations. Medicinal plants are managed systematically and used in the future [2]. Both traditional users and the pharmaceutical sector have consistently reported a progressive growth in the use of therapeutic plants. (Srivastava J, 2006) [20].

Medicinal plants offer opportunities for biological screening, industry-relevant techniques, and developments in pharmacological studies of natural products. The most readily available and natural source of biological principles with therapeutic potential is plants. Consequently, there is a pressing need to screen plants in order to create new medications. Nevertheless, comprehensive details about this species are unavailable. The botany, phytochemistry, pharmacology, and ethnomedical applications of *Zanthoxylum armatum* were the primary topics of this review. (Kumar A, 1996) [12].



Fig 1: Morphological parts of *Zanthoxylum armatum*

2.1 Nomenclature of *Zanthoxylum armatum*

Kingdom: Plantae

Order: Sapindales

Family: Rutaceae

Genus: *Zanthoxylum*

Species: *Zanthoxylum armatum*

Binomial Name: *Zanthoxylum armatum* DC.

2.2 Botanical Description of *Zanthoxylum armatum*

Zanthoxylum armatum DC. is a deciduous, aromatic, and spiny shrub or small tree belonging to the family Rutaceae, commonly found in the Himalayan regions of India, Nepal, and other parts of Asia (Singh & Singh, 2021) [22]. The plant typically grows up to 3–6 meters in height and is characterized by the presence of sharp prickles on its branches and stems, which serve as a protective adaptation. The plant is well adapted to subtropical and temperate climates and is commonly found at altitudes ranging from 1000 to 2500 meters in the Himalayan region. Khare CP, 2007) [13]. The plant bears small, greenish-yellow or pale-yellow flowers that are arranged in terminal or axillary panicles. The flowers are unisexual and the plant is generally dioecious in nature (Sati & Joshi, 2022) [19]. The leaves are alternate, imparipinnate, and composed of 5–11 leaflets. The leaflets are lanceolate to ovate in shape, with serrated margins and a characteristic aromatic odour due to the presence of essential oils (Verma & Sharma, 2021) [28]. The fruits are small, globose capsules that turn red or reddish-brown upon maturation. Each fruit contains a single black, shiny seed. The

fruits are highly aromatic and are commonly used in traditional medicine and as a spice. Due to the presence of various bioactive compounds such as alkaloids, flavonoids, tannins, and essential oils, *Zanthoxylum armatum* exhibits significant pharmacological activities, particularly in oral and dental care (Singh & Singh, 2021) ^[22].

2.3. Pharmacological Activities of *Zanthoxylum armatum*

Zanthoxylum armatum is a well-known medicinal plant that exhibits a wide range of pharmacological activities due to the presence of bioactive phytoconstituents such as alkaloids, flavonoids, lignans, and essential oils (Shah *et al.*, 2025) ^[17].

2.3.1. Antimicrobial Activity

Zanthoxylum armatum shows significant antimicrobial activity against various pathogenic microorganisms, including bacteria and fungi. It has been reported to be effective against oral pathogens such as *Streptococcus mutans* and *Staphylococcus aureus*, making it useful in oral healthcare formulations. Essential oils present in the plant have been reported to increase membrane permeability in microorganisms, leading to leakage of intracellular contents and eventual cell death (Singh *et al.*, 2021) ^[21].

2.3.2. Anti-Inflammatory Activity

Zanthoxylum armatum possesses significant anti-inflammatory activity, which is beneficial in the treatment of inflammatory conditions of the oral cavity and throat. Experimental studies have shown that plant extracts inhibit the production of inflammatory mediators such as prostaglandins, histamine, and cytokines. *In vivo* studies have demonstrated that administration of *Zanthoxylum armatum* extract significantly reduces edema and inflammation in animal models, supporting its traditional use in inflammatory disorders. (Alam *et al.*, 2020) ^[1]. The anti-inflammatory effect is primarily due to the presence of flavonoids and other phenolic compounds that inhibit cyclooxygenase (COX) and lipoxygenase (LOX) pathways, thereby reducing the synthesis of pro-inflammatory mediators. This activity is particularly important in herbal gargles, as it helps in reducing swelling, redness, and irritation of the throat mucosa (Singh *et al.*, 2021) ^[21].

2.3.3. Analgesic (Antinociceptive) Activity

Zanthoxylum armatum is well known for its analgesic or pain-relieving properties, which justify its traditional use in the treatment of toothache and other painful conditions. (Ahmad N, 1980) ^[2] Studies have shown that the plant extract exhibits significant antinociceptive activity in various experimental models (Alam *et al.*, 2020) ^[1]. The analgesic effect is believed to be mediated through both central and peripheral mechanisms, involving inhibition of pain mediators such as prostaglandins and modulation of pain receptors. Additionally, the presence of essential oils contributes to a mild local anesthetic effect, which helps in relieving pain in oral and dental conditions (Singh *et al.*, 2021) ^[21].

2.4. Medicinal Uses

2.4.1. Treatment of Toothache and Oral Disorders

Zanthoxylum armatum is traditionally used for the management of toothache, gum diseases, and bad breath. The analgesic and antimicrobial properties of the plant help in reducing pain and controlling oral infections (Verma & Sharma, 2021) ^[28].

2.4.2. Treatment of Throat Infections

The plant is commonly used in the treatment of sore throat, pharyngitis, and tonsillitis. Gargling with preparations containing *Zanthoxylum armatum* helps reduce inflammation and microbial load in the throat (Singh *et al.*, 2021) ^[21].

2.4.3. Digestive Disorders

Zanthoxylum armatum is used as a stomachic and carminative agent. It helps in improving digestion, relieving abdominal pain, and treating conditions such as indigestion and flatulence (Shah *et al.*, 2025) ^[17].

2.4.4. Skin Diseases and Wound Healing

The plant is used for the treatment of skin infections, wounds, and ulcers due to its antimicrobial and healing properties. It promotes faster healing and prevents infection (Verma & Sharma, 2021) ^[28].

2.4.5. Respiratory Disorders

Zanthoxylum armatum is used in traditional medicine for the treatment of respiratory conditions such as cough, asthma, and bronchitis. It helps in clearing mucus and improving respiratory function (Shah *et al.*, 2025) ^[17].

3. Gargle

Gargles are concentrated clear fluids applied to the back of the mouth to stop throat infections. Gargling helps lower the amount of bacteria and viruses in the throat and provides immediate relief from throat pain and discomfort by slowing the progression of illness.

(Suzuki T, 2012) ^[23]. Gargling helps with everything from small illnesses like the common cold to serious respiratory infections like influenza. The most common conditions for which gargling is used include sore throats, allergies, sinus infections, viral respiratory infections including colds, and other minor ailments (Sakai M, 2008) ^[24]. Both acute and chronic upper respiratory tract infections can be effectively treated and recovered from by gargling. Herbal gargling products have been shown to be effective and cost-effective in lowering respiratory infections caused by bacteria, viruses, or both.

One of the main causes of death worldwide is respiratory infections. Acute Severe Respiratory Syndrome Globally, coronavirus-2 (SARS-CoV-2) has killed millions of people and infected millions more. The virus enters the body through the nasal cavity, nasopharynx, oropharynx, and begins to multiply in the throat and nose. (Wölfel R, 2020) ^[29]. A common medical condition that causes sore throats is upper respiratory tract infections (URTIs), which are caused by bacteria or viruses directly invading the airways (Umeda, M, 2021; Satomura, K, 2005) ^[26, 18]. Sore throats and other respiratory diseases primarily brought on by bacteria or viruses can be effectively treated by gargling.

3.1. Uses of Gargle

3.1.1. Sorethroat

Gargling is a commonly recommended remedy for sore throat as it helps in reducing irritation and inflammation of the pharyngeal mucosa (Shah, NC, 1991) ^[25]. Warm saline gargles are especially effective in conditions like common cold and mild throat infections by reducing edema and loosening mucus (Eccles, 2005) ^[9]. They may also be used along with over-the-counter medications such as analgesics to enhance symptomatic relief (Eccles, 2005) ^[9].

3.1.2. Sinus and Respiratory Infections

Gargles may help in reducing the severity of upper respiratory tract infections by decreasing microbial load in the throat. They are useful in conditions such as colds, influenza, streptococcal throat infections, and other respiratory tract infections. Gargling may also provide relief in throat irritation caused by allergies such as pollen and dust (Satomura *et al.*, 2005) ^[18].

3.1.3. Dental Health

Gargles play an important role in maintaining oral hygiene by reducing bacterial accumulation in the oral cavity. They help in preventing gum-related diseases such as gingivitis and periodontitis, and also reduce the risk of dental caries by controlling plaque formation (Marsh, 2003).

3.1.4. Antimicrobial Action

Medicated gargles containing antiseptic or herbal agents help in eliminating pathogenic microorganisms including bacteria and fungi present in the oral cavity. This contributes to prevention and management of oral infections (Cowan, 1999) ^[8].

3.1.5. Relief From Pain and Inflammation

Gargles provide a soothing effect on the mucous membranes of the throat, thereby reducing pain, irritation, and inflammation associated with infections and other conditions (Eccles, 2005) ^[9].

3.1.6. Management of Halitosis (Bad Breath)

Gargles help in reducing bad breath by eliminating odor-causing bacteria present in the oral cavity and maintaining overall oral hygiene.

4. Methodology

The herbal gargle was formulated using extract of *Zanthoxylum armatum* along with suitable excipients to obtain a stable and effective oral formulation. The prepared gargle was evaluated for its physicochemical properties such as pH, viscosity, appearance, and stability. Further, its antimicrobial efficacy and overall acceptability were assessed to determine its potential as a herbal oral care product.

4.1. Materials and Methods

1. *Zanthoxylum armatum* (bark)
2. Glycerin (humectant)
3. Sorbitol (sweetening agent)
4. Sodium benzoate (preservative)
5. Peppermint oil (flavoring agent)
6. Tween 80 (solubilizing agent)
7. Purified water (vehicle)

Table 1: Ingredients and its role in formulation of gargle

S. No.	Ingredients	Role
1.	<i>Zanthoxylum armatum</i>	Antibacterial, analgesic and anti-inflammatory
2.	Glycerin	Humectant
3.	Sorbitol	Sweetner
4.	Sodium Benzoate	Preservative
5.	Peppermint oil	Flavour
6.	Purified Water	Vehicle

4.2. Extraction of Plant Extracts

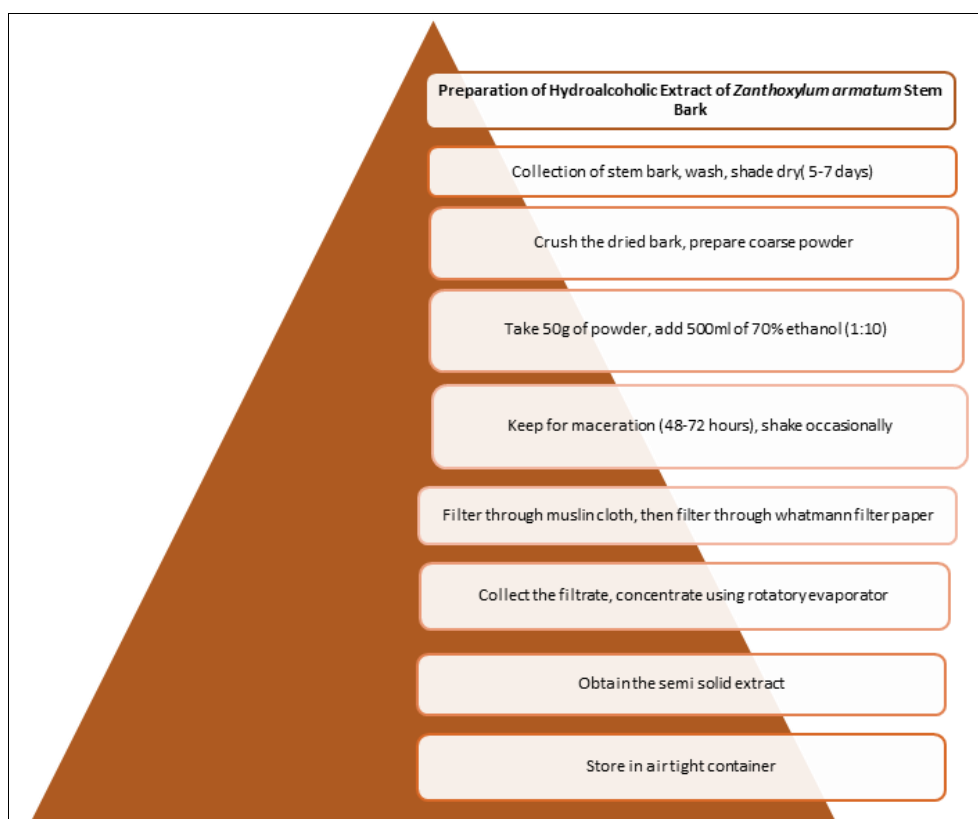


Fig 2: The of Hydroalcoholic Extract of *Zanthoxylum armatum* Stem Bark

4.3. Formulation Method

The herbal gargle was prepared by dissolving the required ingredients in purified water under continuous stirring to obtain a uniform solution. The *Zanthoxylum armatum* extract was then

incorporated, followed by adjustment of pH and final volume to produce a stable and effective gargle formulation. The formulation method is illustrated in the figure 3.

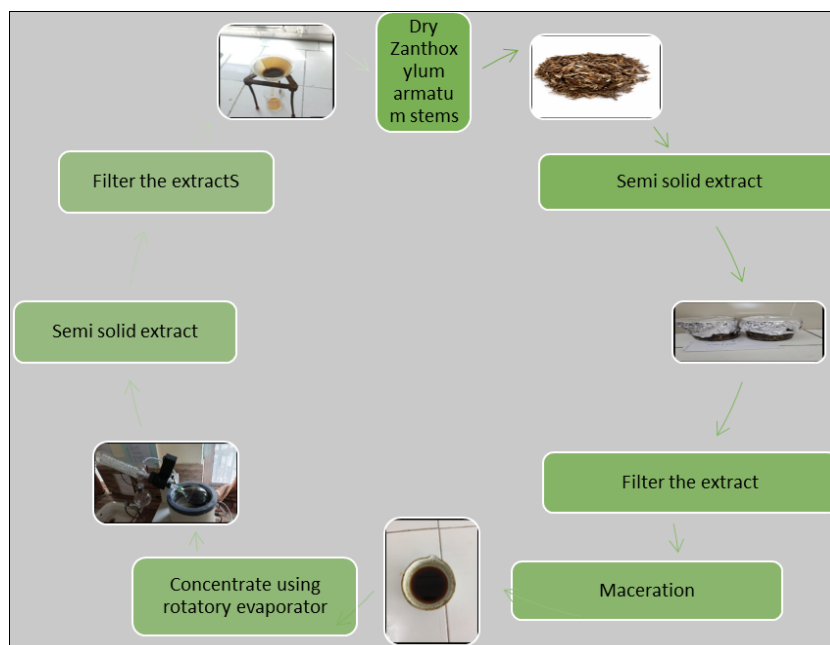


Fig 3: Formulation of *Zanthoxylum armatum* extract

4.3.1. Formulation of Herbal Gargle with *Zanthoxylum armatum* Extract

The herbal gargle was formulated using extract of *Zanthoxylum armatum* extract with suitable excipients such as sweetening, flavoring, and preservative agents to obtain a stable oral rinse. The ingredients were mixed in appropriate proportions to prepare a homogeneous, effective, and patient-friendly herbal gargle. The further steps are shown in figure 4.

- **Odour:** Characteristic
- **Taste:** Pungent
- **Smoothness:** Smooth

4.4. Evaluation Test

4.4.1. Physical Stability

This test included recording the visual appearance, physical separation and homogeneity of the formulated mouthwash. The different mouthwashes then kept in different temperature; 12°C and 25°C and the appearance is then checked in different temperature and the sample is found to be stable.

4.4.2. Clarity Test

The sample is taken in a beaker and then it is checked against white and black backgrounds. During the test on traces of any particles are observed in the sample. Hence, the gargle is found to be clear.

4.4.3. Viscosity Test

The viscosity of prepared herbal gargle is found to be 3.1 which indicates that the preparation has low viscosity and it is easily flowable.

4.4.4. PH Stability Analysis

pH paper is used for measuring pH value. In 5ml of gargle a pH paper dipped into it. It showed a colour which detected the pH range between 6-7 by comparing it with standard pH colour range. Thus, pH value found is between 6-7.

4.4.5. Phytochemical Screening

Preliminary phytochemical analysis of the *Zanthoxylum armatum* extract was carried out using standard qualitative chemical tests to identify the presence of important secondary metabolites. The extract was tested for alkaloids, flavonoids, and saponins, and the observed positive results confirmed the presence of these bioactive constituents responsible for its therapeutic potential.

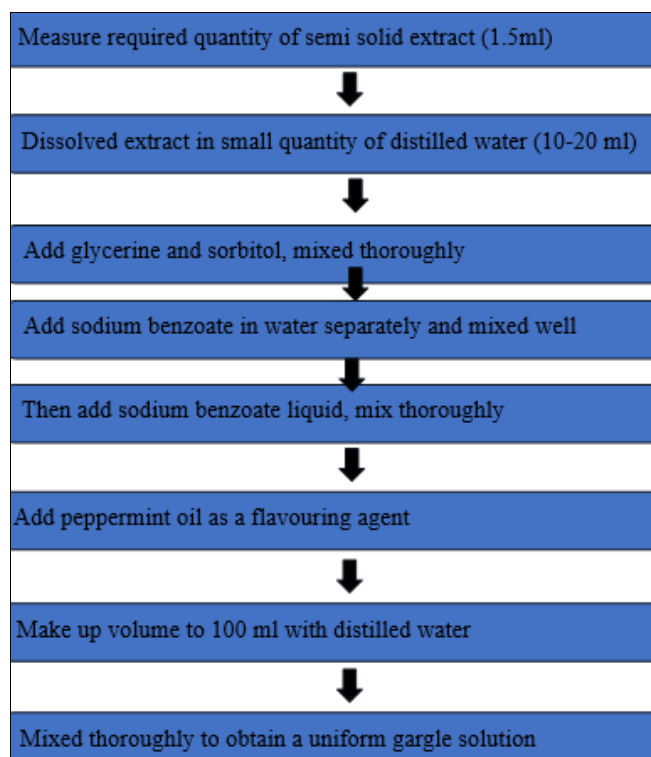


Fig 4: Formulation methods of Herbal Gargle

4.3.2. Organoleptic Character

- **Colour:** Yellow

Table 2: Chemical tests of the herbal Gargle.

Test	Procedure	Observation	Result
Test for alkaloids	Wager's test: 2ml filtrate was taken in test tube and add few drops of Wager's reagent.	Formation of Reddish-brown precipitate indicates presence of alkaloids.	
Test for flavonoids	Lead acetate test: 2ml of extract was taken and add few drops of lead acetate solution.	Formation of yellow precipitate and that indicates presence of flavonoids.	
Test for saponin	15ml of extract is dissolved with distilled water and shake for minutes.	Formation of layer of foams that indicates presence of saponins	

5. Results

The look of gargle retained its colour and homogeneity after a one-month examination. This mouth-gargle entirely prepared from plants parts and safe for health.

Formulation of herbal gargle was prepared successfully.

Evaluation test of herbal gargle was performed successfully.

6. Conclusion

The developed liquid herbal gargle has strong potential for long-term use in managing various throat disorders. The herbal formulation is suitable and acceptable for extended use. In addition, the prepared gargle was standardized through several physicochemical evaluations such as appearance, consistency, and phase separation, and all test results were found within acceptable limits. Therefore, the formulated herbal gargle is considered effective, safe, and suitable for people of all age groups.

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