

# Formulation and Evaluation of Herbal Coupling Gel Using Aloe Vera Gel, Flaxseed Mucilage and Okra Mucilage

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**Abstract:** This study is about making and testing a natural ultrasound gel using ingredients like aloe vera, flaxseed mucilage, and okra mucilage. Ultrasound is used a lot in medicine for checking things and treating patients. It needs a good gel to help sound waves move through the body properly. Most gels today are made with chemicals that can make skin feel bad, cause allergies, and aren't good for the environment because they don't break down easily.

To fix these problems, this research is trying to make a better gel using natural things. Aloe vera is the main part because it helps skin feel better, is soothing, and has anti-inflammatory effects. Flaxseed and okra mucilage are added because they help the gel stay thick and stable due to their ability to hold water.

The new gel was tested in several ways to check how well it works, including its look, pH level, how thick it is, how easily it spreads, how well it washes off, and if it causes any skin irritation.

The results showed the gel was smooth, had the right thickness, spread well, was gentle on skin, and didn't cause irritation. It also mixed well and was easy to remove.

The study found that this herbal gel is a safe, effective, and eco-friendly alternative to the usual synthetic gels. Its natural ingredients make the treatment more comfortable for patients and help protect the environment. It is a good option for use in medical and physiotherapy settings, especially where there are fewer resources.

**Keywords:** Herbal coupling gel, Ultrasound gel, Aloe vera, Flaxseed mucilage, Okra mucilage, Natural polymers, Acoustic coupling, Biocompatibility, Eco-friendly formulation, Viscosity and spread ability, Skin-friendly gel, pharmaceutical formulation.

## Introduction

Ultrasound technology has become a crucial tool in modern healthcare because of its non-invasive nature, safety, and wide range of uses in both diagnosis and treatment. It works by using high-frequency sound waves to create real-time images of internal body structures, allowing clinicians to examine organs, tissues, and blood flow without the need for surgery. In addition to diagnostic purposes, ultrasound is widely used in physiotherapy to aid in tissue repair, reduce inflammation, and improve blood circulation. (1)

However, for ultrasonic waves to be transmitted effectively from the transducer to the body, a suitable coupling medium is necessary.

Air acts as a major obstacle due to its low acoustic impedance, causing sound waves to reflect and resulting in poor image quality. To overcome this, coupling gels are applied between the ultrasound probe and the skin. These gels help

in the efficient transmission of sound waves by reducing air gaps and ensuring good contact between the probe and the skin. (2)

A coupling gel is generally a semi-solid, water-based formulation that has the right viscosity, spreadability, and lubricating properties.

An ideal gel should be clear, uniform, non-irritating, non-sticky, and easy to wash off. Conventional ultrasound gels are often made with synthetic polymers, preservatives, and other chemical additives. Though they are effective, these formulations can cause skin irritation, dryness, allergic reactions, and environmental issues due to their non-biodegradable nature. (3)

In recent years, there has been increasing interest in developing herbal and natural alternatives to synthetic formulations.

Herbal products are widely recognized for their safety, biocompatibility, and minimal side effects. Natural polymers derived from plants, especially mucilaginous substances, have shown great potential in pharmaceutical applications for their water-retaining, viscosity-enhancing, and stabilizing properties. (4)

Among various herbal materials, Aloe vera, flaxseed, and okra have drawn significant attention.

Aloe vera is well known for its therapeutic benefits, including anti-inflammatory, antimicrobial, antioxidant, and wound-healing properties. Its gel-like texture and high-water content make it an excellent base for coupling gel formulations. Flaxseed (*Linum usitatissimum*) and okra (*Abelmoschus esculentus*) are rich sources of mucilage, a natural hydrocolloid that acts as a thickening and binding agent. These mucilages improve the viscosity, spreadability, and overall performance of the gel. (5)

Using herbal ingredients not only enhances the safety of the formulation but also offers additional skin benefits such as hydration, soothing effects, and reduced irritation.

Moreover, herbal gels are biodegradable, environmentally friendly, and cost-effective, making them appropriate for use in both advanced medical systems and resource-limited settings.

The present study aims to develop a herbal ultrasound coupling gel using Aloe vera gel, flaxseed mucilage, and okra mucilage, and to evaluate its physicochemical properties, stability, and performance.

The goal is to create a natural, effective, and sustainable alternative to conventional synthetic ultrasound gels, thereby ensuring better patient safety and environmental compatibility. (6)

## 1. Literature Review

### 1. Wagh et al. (2025)

formulated and evaluated a herbal ultrasound coupling gel intended for use in diagnostic ultrasonography to improve acoustic transmission while minimizing skin irritation associated with synthetic gels. The formulation incorporated Aloe vera extract as the primary herbal component along with polyacrylic acid as a gelling agent, glycerin as a humectant, triethanolamine for pH adjustment, sodium benzoate as a preservative, and purified water. The study concluded that Aloe vera-based herbal ultrasound gel represents an eco-friendly, cost-effective, and biocompatible alternative to conventional synthetic coupling gels used in clinical ultrasonography [2]

### 2. Paulinus et al. (2022)

Investigated the applicability of Aloe vera lotion as a potential alternative coupling medium for diagnostic sonography in low-resource health care settings. The study aimed to address the challenges of high cost and low availability of

commercial ultrasound gels in remote areas by evaluating a locally sourced, herbal alternative. The Aloe vera lotion was prepared by harvesting fresh leaves, draining the yellow resin to prevent skin irritation, and blending the inner parenchymal gel into a smooth consistency.[3]

### 3. Afzal et al. (2022)

Formulated and evaluated a polymer-based ultrasound gel aimed at providing an inexpensive and safe alternative to expensive, imported commercial coupling media used in medical imaging. The formulation incorporated a combination of synthetic and natural ingredients, including Carbopol 980 as a thickening agent, aloe vera gel as an anti-inflammatory agent, glycerine for skin conditioning, and methylparaben and propylparaben as preservatives. [4]

### 4. Ferdoushi Jahan et al. (2020)

Formulated and evaluated a herbal ultrasound coupling gel intended for use in diagnostic ultrasonography as a safer alternative to conventional synthetic gels, which are often associated with allergic reactions and skin irritation. The formulation primarily incorporated Aloe vera extract as the natural active component along with excipients such as polyacrylic acid, glycerine, triethanolamine, sodium benzoate, and purified water. [6]

### 5. Lee et al. (2021)

Lee et al. developed a calcium-modified silk fibroin patch as a novel ultrasound coupling medium. The study demonstrated that the silk-based patch provided excellent acoustic transmission, flexibility, and strong adhesion to the skin surface. Unlike conventional gels, it maintained continuous contact without repeated application, reducing signal loss and improving imaging efficiency. The material was biocompatible and suitable for wearable ultrasound devices. This research highlights the potential of biomaterial-based solid coupling systems as advanced alternatives to traditional gel formulations, offering improved stability, convenience, and performance in both diagnostic and therapeutic ultrasound applications.[5]

## 2. Materials and methodology

### Materials

1. Aloe vera leaves:- Natural gelling agent, moisturizer, soothes skin, improves lubrication
2. Flaxseeds (*Linum usitatissimum*) :- Thickening agent, increases viscosity, improves acoustic coupling
3. Fresh okra pods (*Abelmoschus esculentus*):- Natural polymer, gelling agent, improves adhesiveness and spread ability
4. Glycerine or propylene glycol:- Humectant
5. sodium benzoate or potassium sorbate :- Preservative
6. citric acid or sodium hydroxide:- pH adjuster.

### Methodology

Extraction of Flaxseed Mucilage (*Linum usitatissimum*)

### Procedure

- Weigh accurately about 10–20 g of flaxseeds.
- Wash seeds thoroughly with distilled water to remove impurities.
- Soak the seeds in 200–300 mL distilled water for 4–6 hours.
- Heat the soaked seeds at 60–80°C for 30–45 minutes with continuous stirring.
- During heating, mucilage is released forming a viscous solution.
- Filter the hot mixture through muslin cloth to separate mucilage from seeds.

- Collect the filtrate and allow it to cool.
- The obtained mucilage can be used directly or stored in a refrigerator for further use .(7,8)

### Extraction of Okra Mucilage (*Abelmoschus esculentus*)

#### Procedure

- Take fresh okra pods (20–30 g) and wash thoroughly.
- Cut into small slices.
- Soak the slices in distilled water (200–300 mL) for 6–8 hours or overnight.
- Heat the mixture at 60–70°C for 30 minutes to enhance mucilage release.
- Filter through muslin cloth to separate solid residue.
- Collect the viscous filtrate (mucilage).
- Store in a cool place until use.(9,10)

### Extraction of Aloe vera Gel (*Aloe barbadensis Miller*)

#### Procedure

- Collect fresh Aloe vera leaves and wash thoroughly with water.
- Remove the outer green rind using a clean knife.
- Drain the yellow latex (aloin) completely to avoid irritation.
- Collect the inner transparent gel.
- Homogenize the gel using a blender to obtain a smooth consistency.
- Filter if necessary to remove fibers.
- Store the gel in an airtight container under refrigeration .(11,12)

### 3. Formulation Table

Table no. 1. Formulation Table

Sr. no.	Ingredients	Batch A	Batch B	Batch C	Role
1	Aloe vera gel	25 ml	25ml	25ml	Natural gelling agent, moisturizer, soothes skin, improves lubrication
2	Flaxseed mucilage	10 ml	10 ml	10 ml	Thickening agent, increases viscosity, improves acoustic coupling
3	Okra mucilage	10 ml	10 ml	10 ml	Natural polymer, gelling agent, improves adhesiveness and spread ability
4	Glycerin	3 ml	3 ml	3 ml	Humectant
5	Sodium benzoate	0.1 gm	0.1 gm	0.1 gm	Preservative
6	NaOH	q.s.	q.s	q.s	pH adjuster
7	Distilled water	q.s. upto 50 ml	q.s. upto 50 ml	q.s. upto 50 ml	Natural gelling agent, moisturizer, soothes skin, improves lubrication

#### 4. Evaluation Parameters

The prepared herbal coupling gel was subjected to various physicochemical and performance evaluations to ensure its safety, efficacy, and stability. The following parameters were assessed

##### 1. Physical Appearance

- **Observation:** The formulation appeared as a smooth, semi-viscous, clear gel with a pleasant floral aroma and no visible particulate matter.
- **Inference:** Uniform and aesthetically acceptable for topical application.

##### 2. pH Determination

- **Method:** The pH was measured using a calibrated digital pH meter.
- **Result:** pH ranged between 5.2 and 6, which is ideal for scalp application and compatible with natural skin pH.
- **Inference:** Non-irritant and safe for regular use.



Fig. no. 1. pH test

##### 3. Viscosity:

- **Method:** Measured using a Ostwald viscometer.
- **Result:** The serum exhibited moderate viscosity, suitable for easy application and spread ability.
- **Inference:** Indicates appropriate consistency for serum texture.



Fig. no. 2. Spreadability

##### 4. Spread ability

- **Method:** Evaluated by placing a fixed quantity between two glass slides and applying a standard weight.

- **Result:** Good spread ability without dripping or excessive stickiness.
- **Inference:** Ensures smooth application on the scalp and hair strands.

#### 4. Washability

- **Method:** Apply gel on skin Wash with water Observe ease of removal
- **Result:** Easily washed.



Fig. no. 3. Washability

#### 5. Skin Irritation Test

- **Method:** Patch test on forearm skin.
- **Result:** No signs of redness, itching, or irritation.
- **Inference:** Safe for topical application on skin/scalp.

#### ❖ Evaluation Parameter Table



Fig. no. 4. Skin irritation test

Table no. 2. Evaluation Parameter Table

Sr.no.	Parameter	Method of Evaluation	Expected Outcome
1	Physical Appearance	Visual Inspection	Clear, smooth and uniform consistency
2	Colour	Visual Inspection	Transparent to light coloured with no discoloration
3	Odour	Sensory Evaluation	Pleasant
4	pH	pH Meter	5 to 7

### 5. Result And Discussion

#### 5.1 Results

The formulated herbal coupling gel using Aloe Vera Gel, Okra Mucilage and Flaxseed Mucilage was subjected to physicochemical analysis and evaluation test. The findings are given below in table:

**Table No.3. Result Table for Herbal Coupling Gel**

Sr. No	Parameters	Batch 1	Batch 2	Batch 3	Inference
1	Colour	Pale white	Pale white	Pale white	Colour is constant
2	Odour	Mild	Pleasant	Pleasant	Acceptable and characteristic odor, no instability observed
3	Consistency	Semisolid	Semisolid	Semisolid	suitable for topical application
4	Homogeneity	Smooth & No lumps	Smooth & No lumps	Smooth & No lumps	Good homogeneity, no phase separation
5	pH	5.90	6.12	6.11	Within skin-friendly range, safe for application
6	Spreadability	Modarate	Good	Good	better spreadability
7	Skin irritation	No irritation	No irritation	No irritation	Non-irritant and safe for skin
8	Washability	Easily washable	Easily washable	Easily washable	Good washability, easy removal with water

## 5.2 Discussion

- The Present Study Was carried out to formulate a herbal coupling gel using aloe vera gel, flaxseed mucilage, and okra mucilage as natural polymers.
- The prepared gel showed good appearance and homogeneity, which indicates proper mixing of all ingredients and absence of air bubbles, an important factor for effective ultrasound transmission.
- The pH of the formulation (around 6.2) was found to be within the normal skin range, suggesting that the gel is safe and non-irritating for topical application.
- The viscosity of the gel was adequate, which plays a crucial role in maintaining proper contact between the ultrasound probe and the skin, thereby improving acoustic transmission.
- The formulation exhibited good spreadability, which ensures easy application and uniform distribution over the skin surface.
- The washability test confirmed that the gel can be easily removed with water, making it convenient for clinical use.
- The skin irritation study showed no signs of redness or itching, indicating that the herbal ingredients are gentle and suitable for sensitive skin.
- The use of natural ingredients like aloe vera, flaxseed, and okra provides additional benefits such as moisturizing, soothing, and anti-inflammatory effects, which are not present in many synthetic gels.
- Compared to conventional synthetic ultrasound gels, the formulated herbal gel is biodegradable, cost-effective, and eco-friendly.
- Therefore, the study supports that the formulated herbal coupling gel can be considered a safe, effective, and sustainable alternative to commercially available ultrasound gels.

## 6. Future Scope

- **Incorporation of Essential Oils:** The formulation can be further enhanced by incorporating essential oils such as eucalyptus oil, lavender oil, or peppermint oil. These oils possess additional therapeutic properties like anti-inflammatory, analgesic, antimicrobial, and relaxing effects. Their inclusion may improve patient comfort and provide dual benefits during ultrasound therapy.
- **Development of Medicated Coupling Gel:** The herbal gel can be modified into a medicated formulation by incorporating active pharmaceutical ingredients (APIs) such as analgesics, anti-inflammatory drugs, or muscle relaxants. This would enable simultaneous ultrasound therapy and topical drug delivery, increasing treatment effectiveness.
- **Application in Drug Delivery Systems (Phonophoresis):** The formulated gel can be explored for use in phonophoresis, where ultrasound waves enhance the penetration of drugs through the skin. Herbal gels may act as effective carriers for transdermal delivery, improving drug absorption and therapeutic outcomes.
- **Large-Scale Industrial Production:** The formulation has potential for commercialization due to its low cost, eco-friendly nature, and easy availability of raw materials. Further studies can focus on scale-up techniques, optimization of manufacturing processes, and development of suitable packaging for industrial production.
- **Clinical Trials for Validation:** Extensive clinical trials can be conducted on a larger population to evaluate the safety, efficacy, and performance of the herbal coupling gel in real clinical conditions. This will help in establishing its reliability and acceptance in medical practice.
- **Stability Studies (Long-Term):** Future research can include long-term stability studies under various environmental conditions (temperature, humidity, light) to determine shelf life and ensure product consistency over time. (13)
- **Microbial and Toxicological Studies:** Detailed microbial limit tests and toxicity studies can be performed to confirm the safety of the formulation for prolonged and repeated use.
- **Comparison with Marketed Products:** Further studies can compare the herbal gel with commercially available ultrasound gels using advanced instruments to evaluate acoustic efficiency and performance. (14)
- **Exploration of Other Herbal Polymers:** Additional natural polymers such as guar gum, xanthan gum, or tragacanth can be explored to further improve the formulation characteristics.
- **Use in Advanced Medical Devices:** The gel can be adapted for use in modern wearable ultrasound devices and portable diagnostic systems, expanding its application in advanced healthcare technologies. (15)

## 7. Conclusion And Summary

### 7.1 Summary

The present study was undertaken to formulate and evaluate a herbal ultrasound coupling gel using natural ingredients such as aloe vera gel, flaxseed mucilage, and okra mucilage. The selection of these herbal components was based on their excellent biocompatibility, safety, biodegradability, and therapeutic properties, making them suitable alternatives to synthetic coupling agents. Aloe vera gel is well known for its soothing, moisturizing, anti-inflammatory, and wound-healing properties, while flaxseed and okra mucilage act as natural thickening and gelling agents that enhance viscosity and improve the overall consistency of the formulation. The mucilage from flaxseed and okra was successfully extracted using appropriate methods and incorporated into the aloe vera base to prepare a smooth and homogeneous gel.

The formulated gel was subjected to various physicochemical evaluation tests, including appearance, homogeneity, pH, viscosity, spreadability, washability, skin irritation, and stability studies. The gel exhibited a smooth texture, good clarity, and uniform consistency without the presence of lumps or air bubbles, which are essential characteristics for effective ultrasound transmission. The pH of the formulation was found to be within the acceptable skin range (5.5–7.0), indicating that the gel is safe and suitable for topical application without causing irritation. The viscosity of the gel

was adequate, ensuring proper adherence to the skin and maintaining effective contact between the ultrasound probe and the skin surface, which is crucial for efficient acoustic coupling.

The gel showed good spreadability, allowing easy application and uniform distribution over the skin. The washability test confirmed that the gel can be easily removed with water, making it convenient for both patients and healthcare professionals. The skin irritation test revealed no signs of redness, itching, or irritation, confirming the non-toxic and skin-friendly nature of the formulation. Stability studies indicated that there were no significant changes in physical appearance, pH, or viscosity over the storage period, demonstrating the stability and reliability of the gel.

The formulation is cost-effective, eco-friendly, and free from harmful chemicals, making it a promising alternative to commercially available synthetic ultrasound gels.

## 7.2 Conclusion

In conclusion, the present study successfully demonstrated the formulation and evaluation of a herbal ultrasound coupling gel using aloe vera gel, flaxseed mucilage, and okra mucilage as natural polymers. The developed formulation showed satisfactory physicochemical properties, including appropriate pH, suitable viscosity, good spreadability, and excellent homogeneity, all of which are essential for effective ultrasound coupling. The gel was found to be safe for topical application, as it exhibited no signs of skin irritation or adverse reactions during testing.

The incorporation of natural ingredients not only enhances the functional properties of the gel but also provides additional therapeutic benefits such as moisturizing, soothing, and anti-inflammatory effects. The formulation also showed good stability over time, indicating its suitability for storage and practical use. Compared to conventional synthetic coupling gels, the herbal gel offers advantages such as reduced risk of skin irritation, biodegradability, environmental safety, and cost-effectiveness.

Therefore, it can be concluded that the formulated herbal coupling gel is a safe, effective, and sustainable alternative to commercially available ultrasound gels. The study supports the potential use of natural polymers in medical formulations and encourages further research and development in this area to promote the use of herbal and eco-friendly products in healthcare applications.

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