# FORMULATION AND EVALUATION OF POLYHERBAL MUCOADHESIVE GEL FOR ORAL ULCER HEALING

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**ABSTRACT:**

Oral ulcers are common painful lesions of the oral mucosa that affect eating, speaking, and overall oral comfort. This study focuses on the development and evaluation of a polyherbal mucoadhesive gel containing Psidium guajava, Glycyrrhiza glabra, and Ocimum sanctum for effective oral ulcer healing. These herbal ingredients were selected for their anti-inflammatory, antimicrobial, antioxidant, wound-healing, and mucoprotective properties. The extracts were incorporated into a mucoadhesive gel base to prolong retention at the ulcer site, enhance contact time, and provide sustained release of active constituents on the oral mucosa. The formulation was evaluated for morphology, pH, viscosity, spreadability, drug content, and in-vitro drug release, showing its potential to reduce inflammation, control microbial growth, relieve pain, and accelerate tissue regeneration. The polyherbal mucoadhesive gel offers advantages such as improved bioavailability, reduced dosing frequency, better patient compliance, and minimal side effects, making it a promising and economical alternative to conventional oral ulcer treatments.

Keywords: Oral ulcer, polyherbal gel, mucoadhesive drug delivery, guava leaf, liquorice, tulasi, wound healing.

## 1.INTRODUCTION:

Oral ulcers (aphthous ulcers/canker sores) are common lesions of the oral mucosa characterized by painful round or oval sores with a white or yellow centre and a red border. They commonly occur on the cheeks, lips, tongue, gums, and palate, causing pain during eating, speaking, and oral hygiene. Their prevalence ranges from 5–25% worldwide.

Oral ulcers are classified into minor, major, and herpetiform types. Minor ulcers are small and heal within 10–15 days without scarring, while major ulcers are larger, deeper, and may scar. Herpetiform ulcers appear as multiple small lesions that may merge. Their causes are multifactorial, including nutritional deficiencies (vitamin B12, iron, folic acid), infections, trauma, stress, hormonal changes, poor oral hygiene, and systemic diseases. Conventional treatments

mainly provide symptomatic relief and often require repeated application due to rapid removal by saliva.

Mucoadhesive drug delivery systems offer an improved approach by adhering to oral mucosa, prolonging drug contact time, enhancing absorption, and enabling localized sustained release while bypassing first-pass metabolism. Among them, mucoadhesive gels are preferred because they are easy to apply, spread well, and form a protective barrier over ulcers. Herbal medicines are increasingly used because of their safety, biocompatibility, and minimal side effects. They contain bioactive compounds such as flavonoids, tannins, and phenolics with antimicrobial, anti-inflammatory, antioxidant, and wound-healing effects.

This study focuses on a polyherbal mucoadhesive gel containing Psidium guajava, Glycyrrhiza glabra, and Ocimum sanctum. Guava provides antimicrobial and wound-healing action, liquorice offers anti-inflammatory and soothing effects, and tulasi contributes antimicrobial, antioxidant, and immunomodulatory activity. Their combination produces a synergistic effect against inflammation, infection, oxidative stress, and tissue damage. Incorporation into Carbopol 934 improves retention and controlled release, making polyherbal mucoadhesive gel a promising alternative for effective oral ulcer management.

**2.PLANT PROFILE**

The present study utilizes a polyherbal combination of three medicinal plants, namely Guava (Psidium guajava), Liquorice (Glycyrrhiza glabra), and Tulasi (Ocimum sanctum), which are well known for their therapeutic potential in the treatment of oral ulcers. These plants are widely used in traditional systems of medicine due to their rich phytochemical composition and diverse pharmacological activities.

Psidium guajava (Guava) belongs to the family Myrtaceae and is widely distributed in tropical and subtropical regions. The leaves are rich in flavonoids, tannins, phenolic compounds, and saponins, which exhibit antimicrobial, antioxidant, anti-inflammatory, and wound-healing properties. Guava leaves help reduce microbial load, control inflammation, and promote tissue regeneration.

Glycyrrhiza glabra (Liquorice), a member of the Fabaceae family, contains glycyrrhizin,

flavonoids, and other phytoconstituents. It shows anti-inflammatory, antimicrobial, antioxidant, and anti-ulcer activities. Its demulcent and mucoprotective properties help form a soothing layer over ulcers, reducing pain and enhancing healing.

Ocimum sanctum (Tulasi), belonging to the family Lamiaceae, is rich in eugenol, flavonoids, and phenolic compounds. It exhibits antimicrobial, antioxidant, anti-inflammatory, and immunomodulatory effects. Tulasi helps prevent infections, reduce oxidative stress, and improve healing.

The combination of these plants provides a synergistic effect. Guava offers antimicrobial action, Liquorice provides soothing and anti-inflammatory effects, and Tulasi enhances immunity and antioxidant activity. This polyherbal combination is highly suitable for formulating a mucoadhesive gel for effective oral ulcer treatment.

**3.EXCIPIENT PROFILE:**

The formulation of the polyherbal mucoadhesive gel utilizes a specific selection of excipients to ensure effective drug delivery, stability, and patient comfort. Carbopol-934 serves as the primary gelling agent and mucoadhesive polymer; it is a high molecular weight polyacrylic acid that becomes adhesive upon hydration, thereby increasing the residence time of the herbal extracts on the oral mucosa. Because Carbopol is naturally acidic, Triethanolamine is added dropwise as a neutralizing agent to trigger gel formation and achieve a physiological pH suitable for the mouth. Glycerin is incorporated as a humectant and co-solvent to maintain the moisture content of the gel and prevent it from drying out during use. To ensure microbial stability and a long shelf life, Sodium Benzoate is included as a preservative. Additionally, Sucrose is added as a sweetening agent to mask any bitter herbal tastes and improve patient compliance, while Purified Water acts as the essential vehicle for hydrating the polymer and dissolving the active botanical constituents.

## 4.MATERIALS AND METHODS:

### 4.1. Chemicals and reagents:

Psidium guajava (Guava leaves powder) – purchased from local market, Glycyrrhiza glabra (Liquorice root powder) – purchased from local market, Ocimum sanctum (Tulsi leaves powder) – purchased from local market, Carbopol 934 – procured from Loba Chemie / Larkchem, Glycerin – procured from Central Drug House, Sodium benzoate – procured from Sisco Research Laboratories, Sucrose – procured from SRL / Larkchem, Triethanolamine – procured from Fine-Chem Limited.

### 4.2. Instruments and equipment:

The instruments used in the study included a digital balance manufactured by Wensar for accurate weighing of ingredients, a pH meter from Vision Lab Instruments for determination of formulation pH, and a magnetic stirrer supplied by Remi Equipment Limited for uniform mixing of the gel formulation. A UV spectrophotometer manufactured by Vibrionic Lab Instruments was used for absorbance analysis, while an FTIR spectrophotometer from Wensar was employed for compatibility studies and functional group identification.

### 4.3. Calibration curve:

10mg of "guava, Tulasi, Liquorice" was accurately weighed and transferred into 10 ml volumetric flask and dissolved in ethanol solution and get a concentration of 1000µg/ml from this ,1ml of solution was withdrawn and diluted to 10ml with ethanol solution to get a concentration of 100µg/ml, from this 0.2 ml,0.4 ml,0.6 ml,0.8 ml and 1 ml were withdrawn and volume was made up to 10 ml using ethanol to get a concentration of 2,4,6,8 and 10µg/ml. Absorbance of these solutions were measured against blank as ethanol solution at 276nm.

### 4.4. FTIR compatibility studies:

FTIR (Fourier-Transform Infrared Spectroscopy) compatibility studies assess chemical interactions between a drug and excipients by analysing shifts in characteristic absorption peaks in their IR spectra, indicating stable physical mixtures (compatible) or new peak formations/shifts (incompatible/reactive). The FTIR studies were conducted by potassium bromide disc pellet method. 10 mg of the samples and 400 mg of KBr were taken in a mortar and triturated. A small amount of the triturated sample was then taken into the pellet maker. It was then compressed at 10/kg/cm² using a hydraulic press. The pellet was taken on the sample holder. It was then scanned from 4000 $cm^{-1}$to 400$cm^{21}$in FTIR Spectrophotometer and

comparability characteristics were determined. Samples were prepared for drug and excipients also. The spectra obtained were compared and interrupted for functional group peaks. drug was dissolved in ethanol and scanned over a wavelength range of 276 nm using UV spectrophotometer and the wavelength maxima were determined.

**4.4. Preparation of polyherbal extract:**

Required quantities of powdered Psidium guajava, Glycyrrhiza glabra, and Ocimum sanctum were accurately weighed and extracted individually using an aqueous solvent by the Maceration method in a 1:10 drug-to-water ratio for 24–48 hours. The extracts were then filtered, concentrated using a water bath, and stored in airtight containers for further formulation studies.

**4.5. Qualitative phytochemical screening:**

Qualitative phytochemical screening was performed on the aqueous extracts of Psidium guajava, Glycyrrhiza glabra, and Ocimum sanctum to identify the major classes of secondary metabolites present. Standard chemical tests were carried out as follows:

**Flavonoids** were detected in Psidium guajava and Ocimum sanctum using the Shinoda test (pink/red coloration), alkaline reagent (sodium hydroxide) test (yellow coloration), and ferric chloride test (dark green coloration).

**Tannins** in Psidium guajava were identified using the ferric chloride test (greenish coloration) and lead acetate test (white precipitate formation).

**Glycosides (glycyrrhizin)** in Glycyrrhiza glabra were detected by the Liebermann–Burchard test, indicated by a color change from blue-green to red-orange.

Saponins in Glycyrrhiza glabra were confirmed by the foam test, which showed persistent foam formation upon shaking.

**4.6. Formulation of mucoadhesive gel:**

The mucoadhesive gel was prepared by first hydrating Carbopol 934 polymer in purified water. The required quantity of polymer was accurately weighed and sprinkled slowly into purified water with continuous stirring to avoid lump formation. The dispersion was then allowed to stand for several hours to ensure complete hydration and swelling of the polymer. Separately, the drug was dissolved in purified water and stirred until a clear and uniform solution was obtained. To this drug solution, Glycerin was added as a humectant, followed by Sodium benzoate, previously dissolved in a small quantity of warm water, as a preservative. The mixture was stirred thoroughly until a homogeneous solution was formed.

Measured quantities of Guava extract, Liquorice extract, and Tulsi extract were mixed together and added slowly to the hydrated polymer dispersion with gentle stirring to ensure uniform distribution throughout the formulation. Finally, the pH of the preparation was adjusted gradually by adding Triethanolamine dropwise under continuous stirring, which resulted in gel formation. The final pH of the gel was maintained between 6.0 and 7.0, making it suitable for application on the oral/buccal mucosa.

| S.NO | INGREDIENTS | F1 | F2 | F3 | F4 |
|---|---|---|---|---|---|
| 1. | Carbopol-934 | 0.4g | 0.2g | 0.4g | 0.2g |
| 2. | Glycerine | 0.5ml | 0.5ml | 0.5ml | 0.5ml |
| 3. | Sodium benzoate | 0.05gm | 0.05gm | 0.05gm | 0.05gm |
| 4. | Sucrose | 0.5g | 0.5g | 0.5g | 0.5g |
| 5. | Drug extract | | | | |
| 6. | Guava leaves extract | 1ml | 1ml | 1ml | 1ml |
| 7. | Liquorice extract | 1ml | 1ml | 1ml | 1ml |
| 8. | Tulsi leaves extract | 1ml | 1ml | 1ml | 1ml |
| 9. | Triethanolamine | 0.1ml | 0.1ml | 0.05ml | 0.05ml |
| 10. | Water | 6ml | 6ml | 6ml | 6ml |

**TABLE 1: FORMULATION TABLE**

**FIGURE :1 MUCOADHESIVE GEL**

**4.7. Evaluation of mucoadhesive gel:**

**4.7.1. Physical appearance:**

All gel formulations were visually inspected under good lighting conditions for colour, clarity, homogeneity, phase separation, and texture. The evaluation was performed immediately after preparation and after one week of storage at room temperature.

**4.7.2. $P^H$ determination:**

The pH of each gel formulation was determined using a calibrated digital pH meter (Wensar Equipments). For each measurement, 1 g of gel was accurately weighed, disperse in 10 mL of freshly prepared distilled water, and allowed to equilibrate for 5minute. All measurements were performed in triplicate and mean values were reported. Acceptable pH range is application: 6.2-7.2.

**4.7.3. Viscosity measurement:**

Viscosity (in cps) of the prepared gels was measured by a Brookfield DV-III viscometer at 100 rpm, using spindle number 7 at 25°C. Samples of the gels were to settle over 30 min at the room temperature, before the measurements were taken. The test was performed for three times on each formulation. Viscosity values of 10,000–30,000 cP indicate easily spreadable formulations, while values of 30,000–60,000 cP reflect a good balance of spreadability, adhesion, and patient-friendliness.

**4.7.4. Spreadability:**

The Spreadability of the formulation was measured by spreading 0.5 g of the gel on a circle of 2 cm diameter premarked on a glass plate and then a second glass plate was employed. Half a kilogram of weight was permitted to rest on the upper glass plate for 5 min. The diameter of the circle after spreading the gel was determined.

Spreadability is calculated using the formula $S = M \times L / T$.

where S = spreadability (g·cm/sec), M = weight applied

(g), L = length of glass slide (cm), and T = time taken for separation (seconds). Higher

spreadability values indicate better ease of application.

**4.7.5. Invitro drug release:**

A modified Franz dispersion cell was utilized to concentrate on the medication arrival of the bio-adhesive gel dissemination tubes with an inner width of 2cm and a cellophane film toward one side will be utilized. The cylinder was loaded up with two grams of gel. This collection was soaked in a measuring glass filled with 20 ml of Phosphate buffer solution (pH 6.8) and kept over a thermostatically controlled stirrer set to 37°C. The items in the receptacle were mixed at 300 rpm with a Teflon-covered dot. To keep up with the sink conditions, the examples (2ml) were removed at 0.30, 1, 2, 3, 4, 5, and 6 h and supplanted with phosphate buffer
(pH 6.8). The drug content of the sample was determined using spectrophotometry.

**FIGURE 2: INVITRO DRUG RELEASE SETUP**

## 5. RESULT AND DISCUSSION:

### 5.1. Compatibility curve:

The calibration curves of guava, liquorice, tulasi, and polyherbal extract were developed by UV spectrophotometric analysis at 276 nm over the concentration range of 2–10 µg/mL. All extracts showed a proportional increase in absorbance with increasing concentration, confirming good linearity of the analytical method. The regression equation obtained for the polyherbal extract was Y = 0.055X + 0.001 with a correlation coefficient ($R^2$ = 0.999), indicating excellent reproducibility and accuracy of the method for quantitative estimation.

| CONCENTRATION µg/ml | ABSORBANCE |
|---|---|
| 2 | 0.112 |
| 4 | 0.221 |
| 6 | 0.336 |
| 8 | 0.447 |
| 10 | 0.558 |

**TABLE 2: CALIBRATION GRAPH OF POLYHERBAL EXTRACT**

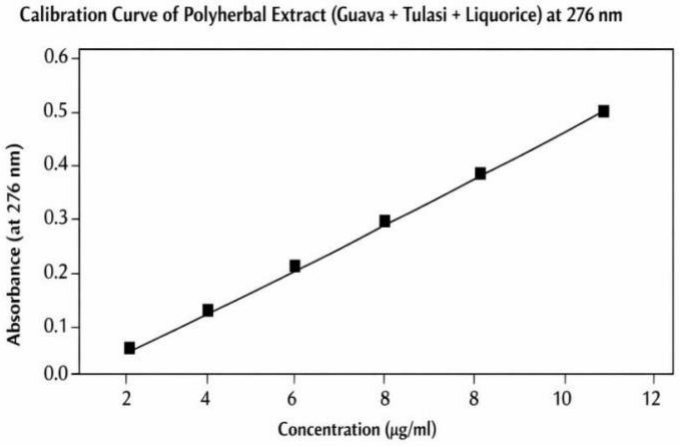


**FIGURE 3: CALIBRATION CURVE OF POLYHERBAL EXTRACT**

The UV absorbance of “guava, liquorice, tulasi” standard solution in the range of 2-10µg/ml of drug in Hydroalcoholic solution showed linearity at λmax 276nm.The

linearity was plotted for absorbance against concentration with $R^2$ value 0.999 and with the slope equation Y=0.055X+0.001

### 5.2. FTIR compability studies:

In the present study, physical mixture of "Ibuprofen "in solid form along with different polymers were prepared and analyzed by FTIR to find out the compatibility between the drug and polymers. The IR spectra of "polyherb" along with the physical mixture of "polyherb" with different polymers are shown from the graph, which showed that the drug and excipients are chemically compatible, as there were no abnormal peaks.

**INTERPRETATION OF GUAVA:**

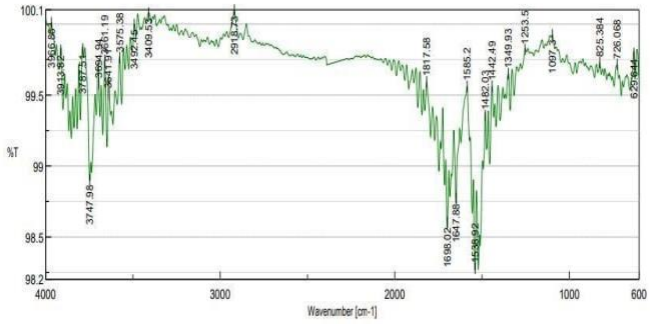


**FIGURE 4: FTIR IMAGE OF GUAVA**

| Functional Group | Type of Vibration | Characteristic Absorbance ($cm^{-1}$) | Test Absorption ($cm^{-1}$) |
|---|---|---|---|
| O–H | Stretching | 3700–3200 | ~3400 |
| C–H | Stretching | 3000–2850 | ~2920 |
| C=O | Stretching | 1750–1650 | 1698.02 |
| C=C | Stretching | 1680–1450 | 1647.88 |
| Aromatic C=C | Stretching | 1600–1500 | 1585.20 |

**TABLE 3: FTIR DATA FOR GUAVA**

**DISCUSSION:**

FT-IR studies revealed that there is no chemical interaction between drug and a polymer by ensuring that there are no any new peak appearance and the disappearance of already existing peak.

**INTERPRETATION OF LIQUORICE:**

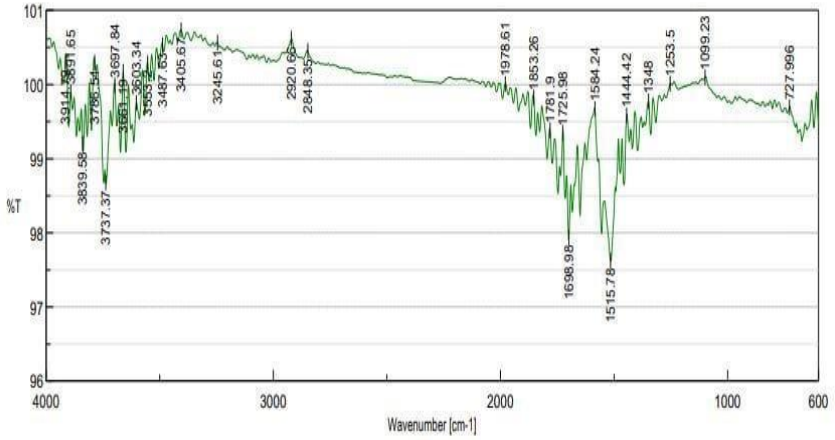


**FIGURE 5: FTIR IMAGE OF LIQUORICE**

| **Functional Group** | **Type of Vibration** | **Characteristic Absorbance ($cm^{-1}$)** | **Test Absorption ($cm^{-1}$)** |
|---|---|---|---|
| O–H | Stretching | 3700–3200 | 3839.58, 3737.37, 3697.84, 3487.65, 3405.6, 3245.61 |
| C–H | Stretching | 3000–2850 | 2920.68, 2848.35 |
| C=O | Stretching | 1750–1650 | 1725.98, 1698.98 |
| C=C | Stretching | 1680–1450 | 1584.24, 1515.76 |
| C–H | Bending | 1480–1400 | 1444.42 |

**TABLE 4: FTIR DATA FOR LIQUORICE**

**DISCUSSION:**

FT-IR studies revealed that there is no chemical interaction between drug and a polymer by ensuring that there is no any new peak appearance and the disappearance of already existing peak

**INTERPRETATION OF TULASI:**

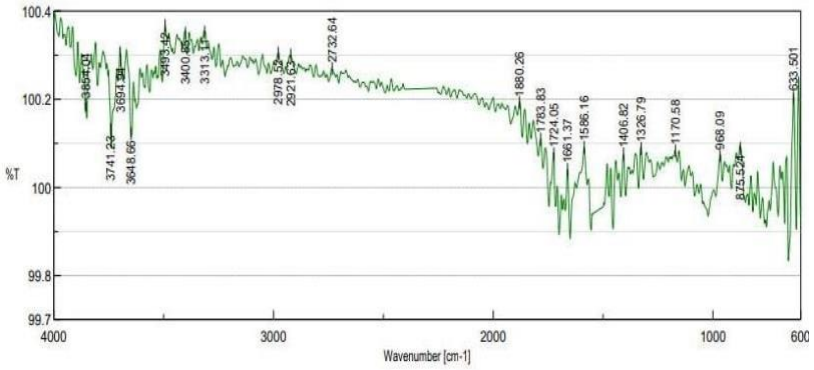


**FIGURE 6: FTIR IMAGE OF TULASI**

| **Functional Group** | **Type of Vibration** | **Characteristic Absorbance ($cm^{-1}$)** | **Test Absorption (cm-1)** |
|---|---|---|---|
| O-H | Stretching | 3700-3200 | 3741.22,3648.66 |
| C-H | Stretching | 3000-2850 | 2978.54,2921.64 |
| C-H(aldehyde) | Stretching | 2850-2700 | 2732.64 |
| C=O | Stretching | 1750-1650 | 1724.05,1680.26 |
| C=C | stretching | 1680-1450 | 1661.37,1585.16 |

**TABLE 5: FTIR DATA FOR TULASI**

**DISCUSSION**:

FT-IR studies revealed that there is no chemical interaction between drug and a polymer by ensuring that there is no any new peak appearance and the disappearance of already existing peak.

**INTERPRETATION OF POLYHERB + CARBOPOL:**

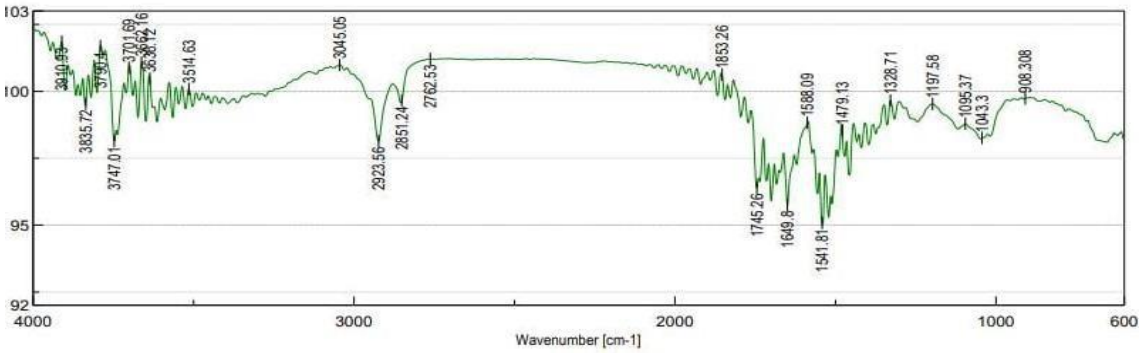


**FIGURE 7: FTIR IMAGE OF POLYHERB+CARBOPOL**

| Functional Group | Type of Vibration | Characteristic Absorbance ($cm^{-1}$) | Test Absorption ($cm^{-1}$) |
|---|---|---|---|
| O-H | stretching | 3600-3200 | 3400-3300 |
| N-H | Stretching | 3500-3300 | 3350 |
| C-H | Asymmetric stretching | 2950-2920 | 2920 |
| C-H | Symmetric stretching | 2870-2850 | 2850 |

**TABLE 6: FTIR DATA OF POLYHERBAL +CARBOPOL**

**DISCUSSION:**

FT-IR studies revealed that there is no chemical interaction between drug and a polymer by ensuring that there is no any new peak appearance and the disappearance of already existing peak.

**INTERPRETATION OF POLYHERB+ GLYCERINE:**

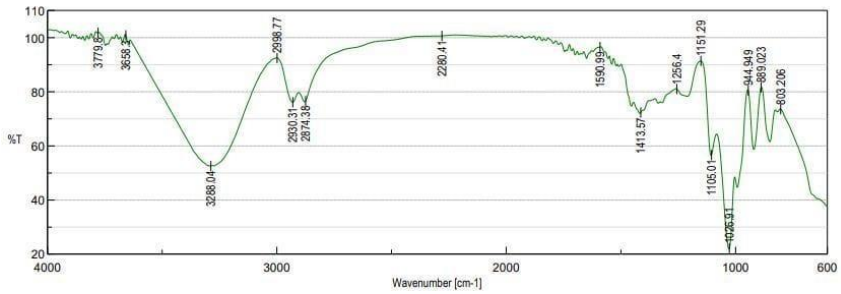

**FIGURE 8: FTIR IMAGE OF POLYHERB+GLYCERINE**

| Functional Group | Type of Vibration | Characteristic Absorbance ($cm^{-1}$) | Test Absorption ($cm^{-1}$) |
|---|---|---|---|
| O-H | Broad stretching | 3600-3200cm-1 | 3374cm-1 |
| N-H | stretching | 3500-3300cm-1 | 3340-3320cm-1 |
| C-H | Asymmetric stretching | 2950-2920cm-1 | 2922cm-1 |
| C-H | Symmetric stretching | 2870-2850cm-1 | 2852cm-1 |
| O-H | Very broad stretching | 3300-2500cm-1 | 3000-2500cm-1 |

**TABLE 7: FTIR DATA OF POLYHERB+GLYCERINE**

**DISCUSSION:**

FT-IR studies revealed that there is no chemical interaction between drug and a polymer by ensuring that there is no any new peak appearance and the disappearance of already existing peak.

**INTERPRETATION OF POLYHERB+ TRIETHANOLAMINE:**

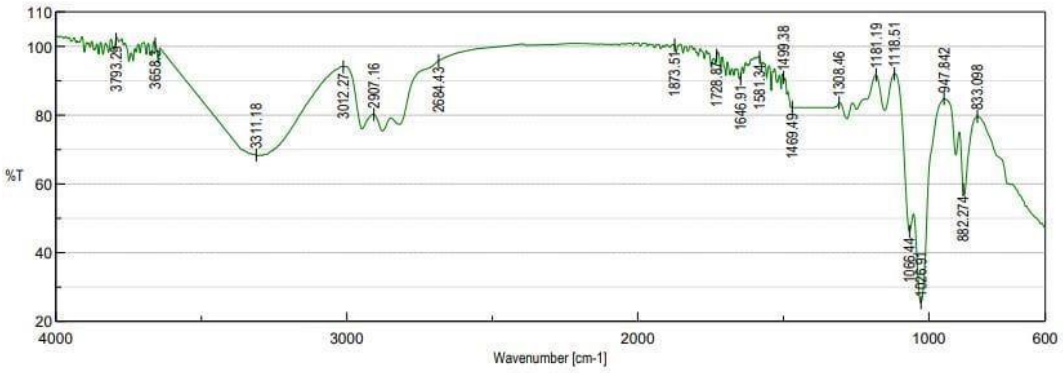


**FIGURE 9: FTIR IMAGE OF POLYHERB+ TRIETHANOLAMINE**

| Functional Group | Type of Vibration | Characteristic Absorbance ($cm^{-1}$) | Test Absorption ($cm^{-1}$) |
|---|---|---|---|
| O-H | Broad stretching | 3600-3200cm-1 | 3374cm-1 |
| N-H | stretching | 3500-3300cm-1 | 3320-3340cm-1 |
| C-H | Asymmetric stretching | 2950-2920cm-1 | 2922cm-1 |
| C-H | Symmetric stretching | 2870-2850cm-1 | 2852cm-1 |
| O-H | Very broad stretching | 3300-2500cm-1 | 3000-2500cm-1 |

**TABLE 8: FTIR DATA FOR POLYHERB+ TRIETHANOLAMINE**

**DISCUSSION**:

FT-IR studies revealed that there is no chemical interaction between drug and a polymer by ensuring that there is no any new peak appearance and the disappearance of already existing peak.

**Compatibility Conclusion:**

The FTIR spectrophotometric analysis of the mucoadhesive gel containing guava leaves extract, liquorice root extract, tulsi leaves extract, carbopol, glycerine, and triethanolamine indicates satisfactory compatibility among all components.

The FTIR spectra of the formulated gel showed the presence of characteristic functional group peaks corresponding to the individual constituents, such as:

O–H stretching (phenolic and alcoholic groups from herbal extracts and glycerine),

C=O stretching (carboxylic groups of carbopol),

C–N and N–H vibrations (from phytoconstituents and tri-ethanolamine),  C–H stretching (aliphatic groups).

No significant shifting, disappearance, or formation of new peaks was observed in the formulation spectrum compared to the spectra of the individual ingredients. This indicates the absence of chemical interaction or degradation between the herbal extracts and excipients.

**5.3. PREPARATION OF HERBAL EXTRACT:**

**FIGURE 10: HERBAL EXTRACT**

**5.4. Qualitative phytochemical screening:**

**IDENTIFICATION TEST:**

GUAVA LEAVES:

TEST FOR FLAVONOIDS:

| S.NO | NAME OF THE TEST | RESULT |
|---|---|---|
| 1. | Shinoda test | Pink colour(positive) |
| 2. | Sodium hydroxide test | Yellow colour (Positive) |

TABLE 9: RESULTS FOR FLAVONOIDS IDENTIFICATION TEST

**TEST FOR TANNINS:**

| S.NO | NAME OF THE TEST | RESULT |
|---|---|---|
| 1. | Ferric chloride test | Dark green colour (positive) |
| 2. | Lead acetate test | Curdy white precipitate(positive) |

TABLE10: RESULTS FOR TANNINS IDENTIFICATION TEST

**DISCUSSION:**

The result shows that the presence of flavonoids, & tannins in the given sample of guava leaves powder extract.

**LIQUORICE ROOT:**

**TEST FOR GLYCYRRHIZIN:**

| S.NO | NAME OF THE TEST | RESULT |
|---|---|---|
| 1. | Libermann- Burchard test | Red colour(positive) |
| 2. | Foam test | Presence of foam (positive) |

TABLE 11: RESULTS FOR GLYCYRRHIZIN IDENTIFICATION TEST

**DISCUSSION:**

The result shows that the presence of glycyrrhizin, in the given sample of liquorice root powder extract

**TULSI LEAVES:**

**TEST FOR FLAVONOIDS:**

| S.NO | NAME OF THE TEST | RESULT |
|---|---|---|
| 1. | Shinoda test | Pink colour(positive) |
| 2. | Alkaline reagent test | Yellow colour(positive) |
| 3. | Ferric chloride test | Dark green colour(positive) |

TABLE 12: RESULTS FOR FLAVONOIDS IDENTIFICATION TEST

**DISCUSSION:**

The result shows that the presence of flavonoids, in the given sample of tulsi leaves powder

**5.5. Evaluation of mucoadhesive gel:**

| Characteristics | Observation |
|---|---|
| Colour | Brownish amber |
| Texture | Appears smooth with a slightly whipped |
| Phase separation | Uniform dispersion |

**TABLE 13: MORPHOLOGY IDENTIFICATION RESULTS**

**5.5.1.PH TEST:**

The PH of polyherbal mucoadhesive gel was measured using a calibrated digital PH meter & was found to be

F1 =5.7

F2 =6.1

F3 =6.74

F4 =7.4


**FIGURE 12:PH METER**

**DISCUSSION:**

Formulation F3 showed a pH of 6.74, which is within the normal salivary range (6.0–7.0). This near-neutral pH indicates that the formulation is suitable for oral application and will not cause irritation to the ulcerated mucosa. Hence, F3 is considered safe, stable, and ideal for mouth ulcer treatment.

**5.5.2. VISCOSITY TEST:**

The viscosity of the polyherbal mucoadhesive gel was determined using a Brookfield viscometer (or suitable rotational viscometer) at room temperature (25± 1 c). The measured viscosity was found to be

- F1 = 61,500cps
- F2 =48,200cps
- F3 =52,600cps
- F4=44,900cps

**DISCUSSION:**

Viscosity is an important parameter for mucoadhesive oral gels as it affects spreadability, adhesion, and retention time. Formulation F3 showed an optimum viscosity of approximately 52,600 cps, indicating a balanced gel consistency that allows easy application while ensuring prolonged contact with the oral mucosa. This ideal viscosity is likely due to proper polymer concentration and gel network formation, which enhance mucoadhesion and stability. Therefore, F3 was considered the optimized formulation for effective oral ulcer treatment.

**5.5.3. SPREADABILITY TEST:**

The spreadability of the polyherbal mucoadhesive gel was evaluated using the drag method (slip & drag technique) with two glass slides & a fixed weight. The gel demonstrated a spreadability value of polyherbal mucoadhesive gels are

- F1 =426g.cm/sec

- F2 =492g.cm/sec
- F3 =630g.cm/sec
- F4 =537g.cm/sec

**FIGURE 13: SPREADABILITY DISCUSSION:**

Formulation F3 was selected as the optimized polyherbal mucoadhesive gel due to its superior performance and ideal spreadability of 630 g·cm/sec, ensuring easy application and uniform drug distribution. It exhibited an optimal balance between viscosity and mucoadhesion, allowing prolonged retention on the oral mucosa. The presence of guava, liquorice, and tulsi extracts provides anti-inflammatory, antimicrobial, and wound-healing benefits, supporting faster ulcer recovery. Additionally, its smooth and homogeneous texture indicates good stability and formulation compatibility, making F3 a promising and effective treatment for oral ulcers.

**5.5.4. IN VITRO DRUG RELEASE:**

| TIME (hrs) | F1(%) | F2(%) | F3(%) | F4(%) |
|---|---|---|---|---|
| 1 | 22 | 25 | 28 | 20 |
| 2 | 38 | 42 | 46 | 35 |
| 3 | 54 | 61 | 66 | 50 |
| 4 | 69 | 76 | 81 | 63 |
| 5 | 82 | 82 | 94 | 75 |

**TABLE 14: RESULTS OF INVITRO DRUG RELEASE**

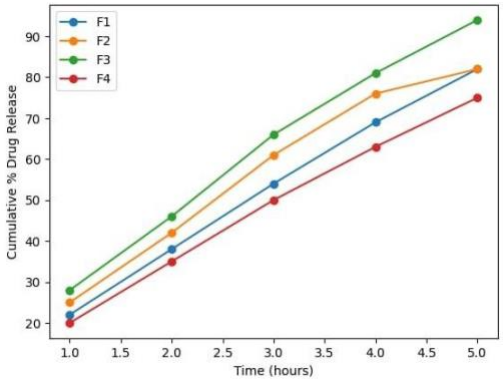


**FIGURE 14: INVITRO DRUG RELEASE GRAPH**

**DISCUSSION:**

The in-vitro drug release study showed that the polyherbal mucoadhesive gel released the drug gradually over 5 hours. An initial release was observed in the first hour, followed by sustained and controlled release. Nearly 90% drug release at 5 hours indicates the formulation is suitable for prolonged oral ulcer treatment.

**6. Summary & conclusion:**

The present study successfully developed a polyherbal mucoadhesive gel containing Guava, Tulasi, and Liquorice for oral ulcer management. The selected herbal extracts were incorporated based on their anti-inflammatory, antimicrobial, antioxidant, and wound-healing properties. All formulations showed acceptable physicochemical characteristics, including suitable Ph, viscosity, spreadability, homogeneity, and mucoadhesive properties. Among the formulations, F3 exhibited optimum pH (6.74), viscosity (52,600cps), spreadability (630 g·cm/sec), and maximum in vitro drug release (94% at 5 hours), indicating superior formulation performance. FTIR studies confirmed compatibility between herbal extracts and excipients, with no evidence of chemical interaction. The gel also showed good stability, uniform consistency, and sustained drug release, supporting prolonged local action in the oral cavity. Overall, the developed polyherbal mucoadhesive gel can be considered a promising, safe, and economical alternative for oral ulcer treatment. Further in vivo and clinical studies are recommended to establish therapeutic efficacy and commercial applicability.

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