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Formulation And Evaluation Of Polyherbal Hair Gel

[1]Ayushi Patri, [2]Shalaka Mali, [3]Pallavi Singh, [4]Vishva Chauhan

[1]Student, [2]Student, [3]Student, [4]Assistant professor

[1]ROFEL SHRI G.M. BILAKHIA COLLEGE OF PHARMACY, Vapi, Gujarat, India.

Abstract: The study focuses on the formulation and evaluation of a polyherbal hair gel using hibiscus extract, aloe vera juice, bottle gourd juice, and hydroxypropyl methylcellulose (HPMC) as the base polymer. The primary aim is to create a semi synthetic hair care product that enhances promotes hair moisture and improves hair texture while minimizing side effects associated with synthetic products. The gel was prepared by incorporating the herbal extracts into an HPMC base with consistent stirring to achieve homogeneity. Evaluation parameters included pH balance, viscosity, spread ability, stability tests. The formulation demonstrated good stability, and effective conditioning benefits for the hair. This polyherbal gel offers a promising alternative for synthetic hair care solutions.

Keywords **– Aloe Vera, Bottle Gourd, Hibiscus, Polyherbal Hair Gel.**

I. INTRODUCTION

The formulation and evaluation of polyherbal hair (figure 1) gels represent a growing trend in cosmeceutical research, driven by consumer demand for natural, sustainable alternatives to synthetic hair care products. This formulation combines aloe vera (*Aloe barbadensis miller*), hibiscus (*Hibiscus rosa-sinensis*) and bottle gourd (*Lagenaria siceraria*)—three botanicals with complementary properties for hair health and hair vitality.

Aloe vera provides intense hydration via its water-rich gel matrix while balancing scalp pH. Hibiscus contributes amino acids, mucilage, and antioxidants that strengthen hair follicles, enhance growth, and combat dandruff through antimicrobial activity. Bottle gourd juice, rich in vitamins B and C, demonstrates anti-aging potential for hair by reducing oxidative stress.

Figure 1- Hair gel

II. MATERIALS AND METHODS

1. ALOE VERA

Aloe Barbadensis Miller, commonly known as Aloe Vera (figure 2), is a perennial succulent plant belonging to the Asphodelaceae (Liliaceae) family. It is a versatile natural ingredient with numerous benefits for hair care. It gently cleanses the scalp, removing excess sebum and product buildup, making it ideal for managing oily hair without stripping it of its natural moisture. It also promotes hair growth by removing dead skin cells from the scalp, which can block hair follicles, and by providing essential vitamins and minerals that nourish the hair strands.

Figure 2- Aloe vera

2. HIBISCUS

Hibiscus Rosa Sinensis, commonly known as the Chinese Rose (figure 3), is a tropical hibiscus species belonging to the family Malvaceae. Hibiscus in polyherbal hair gels provides several benefits due to its rich composition of vitamins, amino acids, and antioxidants. It can help promote hair growth, strengthen hair follicles, and prevent hair fall. Additionally, it acts as a natural conditioner, adding shine and smoothness to hair. Hibiscus also possesses antibacterial properties that can contribute to scalp health and potentially reduce dandruff.

Figure 3- Hibiscus

3. BOTTLE GOURD

Bottle gourd (*Lagenaria siceraria*), also known as lauki (figure 4), is a beneficial ingredient in polyherbal hair gels. It is known for its cooling and nourishing properties, which can help reduce hair fall, promote hair growth, and improve scalp health. The vitamins and minerals present in bottle gourd, especially Vitamin B, can help soothe the scalp, reduce frizz, and add shine.

Figure 4- Bottle gourd

4. GLYCERIN

Acts as a humectant, attracting and retaining moisture from the environment to the hair and scalp, which helps keep hair hydrated, soft, and manageable. Conditions and nourishes hair, reducing dryness and frizz, and enhancing softness and shine.

5. HPMC (Hydroxypropyl Methylcellulose)

Functions as a thickening agent, increasing the viscosity of the gel to provide the desired texture and stability. Improves the spreading ability of the product and gives a soft, smooth feel to the gel.

6. SODIUM BENZOATE

Serves as a preservative, extending the shelf life of the hair gel by preventing the growth of bacteria, fungi, and other microbes. Offers antimicrobial and antifungal properties to ensure product safety and stability.

7. TRIETHANOLAMINE

Adjusts and maintains the pH of the formulation, ensuring it is safe and comfortable for use on hair and scalp.

8. ROSE WATER

Provides moisturizing and hydrating benefits, helping to prevent dryness and making hair soft. Adds a pleasant fragrance and imparts shine to the hair, especially beneficial for curly hair to reduce frizz.

III. PROCEDURE

3.1. Preparation of aloe vera juice.

- Select mature, healthy aloe vera leaves free from damage or disease and wash them to remove dirt, dust and other impurities.
- Place the washed leaves upright in a container for 12 to 15 minutes to allow the yellow latex (aloin) to drain out naturally. Aloin is bitter and can be irritating, so this step is important to reduce its content.
- Cut off the thorny edges on both sides of the leaf and carefully separate the clear inner gel (fillet) from the green outer rind using a sharp knife or spoon, avoiding contamination with latex or rind.
- Rinse the extracted gel pieces in clean water multiple times to remove any residual latex or green rind.
- The clean gel is then grounded to obtain a uniform pulp or slurry.
- The juice is filtered using muslin cloth to remove fibrous material and suspended solids.

3.2. Preparation of hibiscus extract

- Select fresh and mature flowers free from damage and wash them thoroughly.
- Separate the petals of hibiscus from stalk.
- Boil the petals in distilled water for some time to extract everything from the petals.
- Keep that boiled petals in the flower for 24 hours in undisturbed condition.
- Separate the water from petals through muslin cloth.

- Then again filter it through muslin cloth to avoid any residues of hibiscus in the water.

3.3. Preparation of bottle gourd juice

- Fresh bottle gourd fruits are selected, washed thoroughly to remove dirt.
- The fruits are cut into small pieces. These pieces are blanched in hot water at about 80-85°C for 2-4 minutes. Blanching deactivates enzymes and prevents browning, thus preserving the juice quality.
- After blanching, the pieces are used to remove juice. These pieces are then blended in the mixer to obtain a slurry.
- The slurry is filtered through muslin cloth to obtain the juice. The juice is the double filtered to remove the coarse particles.
- The juice is immediately filled into airtight container.

IV. METHOD OF PREPARATION OF POLYHERBAL HAIR GEL

- Dissolve HPMC in the glycerine until no lumps are observed.
- Take the measured amount of distilled water and dissolve sodium benzoate in it.
- Then slowly add distilled water in the glycerine with stirring.
- Then keep this base undisturbed for 24 hours.
- Then next day mix the measured amount of hibiscus extract and bottle gourd juice and add to the base prepared with continuous stirring to avoid lumps.
- Then add the aloe vera juice and rose water into the mixture and keep it undisturbed for another 24 hours before transferring into the container.

V. MATERIALS USED FOR FORMULATION

Table 1: Materials used for formulation

Sr.no	Material	Category
1.	Aloe vera	Strengthening
2.	Hibiscus flowers	Nourishing
3.	Bottle gourd	Frizz reduction
4.	Glycerin	Emollient
5.	Hydroxypropyl methyl cellulose (HPMC)	Gelling agent
6.	Sodium benzoate	Preservative
7.	Triethanolamine	pH adjuster
8.	Distilled water	Vehicle
9.	Rose water	Aromatic agent

5.1. DIFFERENT BATCHES OF POLYHERBAL HAIR GEL

Table 2: Different batches of polyherbal hair gel

SR. NO.	INGREDIENTS	H1	H2	H3	H4
1.	Aloe vera juice	14ml	_	12ml	**8.3ml**
2.	Hibiscus extract	10ml	11ml	12ml	**15ml**
3.	Bottle gourd juice	10ml	11ml	10ml	**8.3ml**
4.	Flax seeds	_	12.3 ml	_	_
5.	Glycerin	_	_	_	**1ml**

6.	Hydroxypropyl methyl cellulose (HPMC)	1.1gm	1.3gm	1.5gm	**1.6gm**
7.	Sodium benzoate	_	0.5gm	0.5gm	**0.5gm**
8.	Triethanolamine	1ml	0.7ml	1ml	**2 – 3 drops**
9.	Distilled water	15ml	15ml	15ml	**16 ml**
10.	Rose water	4-5 drops	4-5 drops	4-5 drops	**4-5 drops**

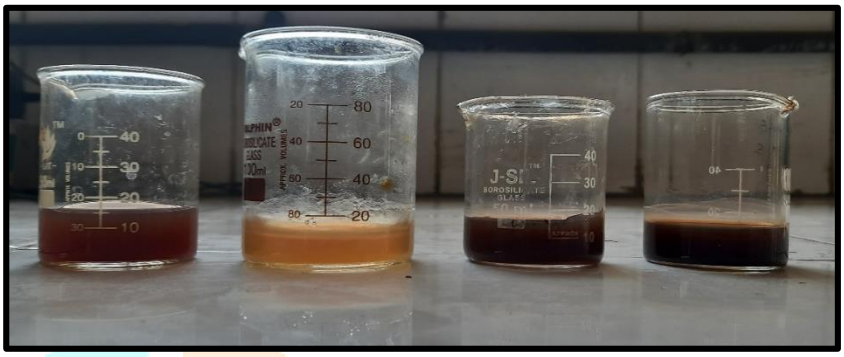


Figure 5: Different batches of polymerized hair gel

Problems faced in H1: The H1 batch got degrade within 2 hours as sodium benzoate (preservative) was not added.
Problems faced in H2: In H2 batch, instability issue was observed due to flax seed gel.
Problems faced in H3: In H3 batch, course particles of HPMC were observed.
H4 batch had all the desired properties that required to fulfil our criteria for hair gel and solved all the problems faced in the previous batches.

VI. AUTHENTICATION

- Plant authentication (figure 6) refers to the process of verifying the identity of medicinal plant species used in drug formulations to ensure they meet the standards specified in the Indian Pharmacopoeia (IP). This involves confirming botanical identity at the genus and species level, particularly crucial for raw drugs (powders, seeds, etc.) where morphological features may be compromised.
- The authentication of *ALOE BARBADENSIS MILLER, HIBISCUS ROSA SINENSIS* and *LAGNERIA SICRERIA* were done the BKM Science College, Valsad.

VII. TLC ANALYSIS

TLC is a separation method that is used for both qualitative and quantitative analysis of sample. It is based on principle of separation through adsorption. Separation is proportional to the relative empathy of compound towards mobile phase and stationary phase.

Step 1: Preparation of Plant Extract

- Drying and Powdering: Collect Hibiscus plant material, wash thoroughly, dry in shade, and grind to a fine powder.
- Extraction: Weigh about 5 g of powdered material and extract with methanol (20 mL) by maceration.

Step 2: Preparation of Standard Solution

- Quercetin Standard: Prepare a stock solution of quercetin by dissolving 25mg in 25ml of methanol.

Step 3: Preparation of TLC Plate

- Use pre-coated silica gel 60 F254 plates.
- Draw a faint pencil line about 1.5 cm from the bottom as the origin for sample application.

Step 4: Application of Samples

- Sample Application: Using a capillary tube, apply a small spot of the Hibiscus extract and the quercetin standard solution separately on the origin line, keeping enough distance between spots to avoid overlapping.
- Allow the spots to dry completely.

Step 5: Preparation of Mobile Phase

- Mobile Phase Example: water: butyl alcohol: acetic acid (5:4:1, v/v/v) is effective for flavonoid separation and quercetin detection.
- Pour the mobile phase into the TLC chamber and allow it to saturate for 15–30 minutes.

Step 6: Development of the TLC Plate

- Place the prepared TLC plate vertically in the chamber, ensuring the spots are above the solvent level.
- Allow the solvent to ascend until it is about 1–2 cm from the top edge of the plate.
- Remove the plate and immediately mark the solvent front with a pencil.

Step 7: Visualization and Detection

- Compare Spots: Note the color and Rf (retention factor) values of the spots from the Hibiscus extract and compare them with the quercetin standard.

Step 8: Calculation of Rf Value

- Rf=Distance travelled by solvent front Distance travelled by compound.
- Measure the distance from the origin to the center of each spot and to the solvent front.
- Calculate and compare the Rf values of the extract and standard. For quercetin, an Rf around 0.64–0.65 is typical in the above mobile phase.

Step 9: Interpretation

- A spot in the Hibiscus extract with the same Rf and color/fluorescence as the quercetin standard confirms the presence of quercetin or structurally related flavonoids.

VIII. FT-IR SPECTROSCOPY

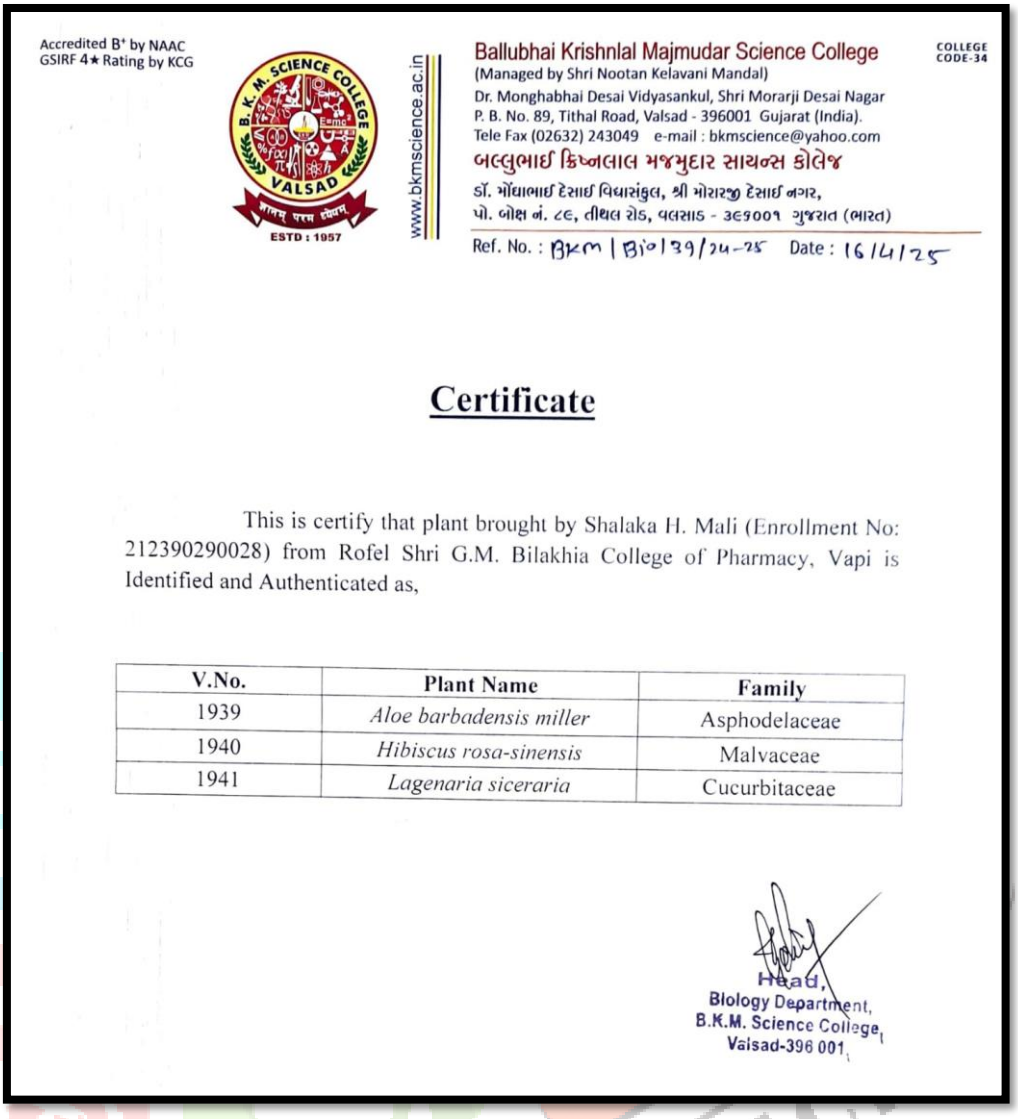
The FT-IR data is used to identify the functional group of the extract. The active components are separated based on its peak value. The FT-IR test of *ALOE BARBADENSIS MILLER* juice (figure 7), *HIBISCUS ROSA SINESIS* (figure 8) extract, *LAGNERIA SICRERIA* juice (figure 9) and the formulation (figure 10) were done in CENTRE OF EXCELLENCE, Vapi. The FT-IR spectra were observed in the range of 400-4000 cm^{-1}.

IX. PHYTOCHEMICAL SCREENING

The extract of *HIBISCUS ROSA SINESIS* and juice of *ALOE BARBADENSIS MILLER* and *LAGNERIA SICRERIA* is screened for various phytochemical test. Standard methods are used for phytochemical screening.

X. RESULTS AND DISCUSSION

10.1. AUTHENTICATION CERTIFICATE



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Ballubhai Krishnlal Majmudar Science College
(Managed by Shri Nootan Kelavani Mandal)
Dr. Monghabhai Desai Vidyasankul, Shri Morarji Desai Nagar
P. B. No. 89, Tithal Road, Valsad - 396001 Gujarat (India).
Tele Fax (02632) 243049 e-mail : bkmscience@yahoo.com
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ESTD : 1957

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Certificate

This is certify that plant brought by Shalaka H. Mali (Enrollment No: 212390290028) from Rofel Shri G.M. Bilakhia College of Pharmacy, Vapi is Identified and Authenticated as,

V.No.	Plant Name	Family
1939	*Aloe barbadensis miller*	Asphodelaceae
1940	*Hibiscus rosa-sinensis*	Malvaceae
1941	*Lagenaria siceraria*	Cucurbitaceae

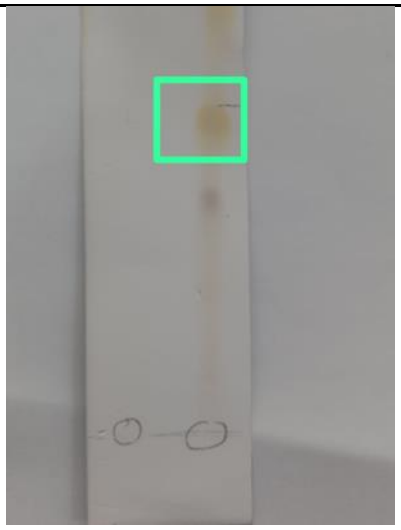
Head,
Biology Department,
B.K.M. Science College,
Valsad-396 001.

Figure 6 : Authentication certificate

This authentication certificate indicates the plants that we have chosen for the formulation is according to the taxonomical classification.

10.2. TLC ANALYSIS

Table 3: TLC analysis

Solvent system-water: butyl alcohol: acetic acid (5:4:1)	
Rf value (standard)	0.65
Rf value (sample)	0.64

The TLC data indicates the Rf value of sample of extract of *Hibiscus rosa-sinensis*. The closeness of the Rf value of standard (Quercetin) and sample suggests that the chromatographic separation achieved good reproducibility and accuracy. The value fall within a relatively close range which indicates presence of Flavonoids.

10.3. TEST OF SECONDARY METABOLITES BY PRELIMINARY PHYTOCHEMICAL SCREENING TEST

Secondary metabolites are the compounds that are not directly engaged in the normal growth and development but do have some ecological function within the body. It provides protection against pathogen.

Table 4: Phytochemical screening

Sr No	Name of Test	Inference		
1.	**Test for alkaloids:**	Aloe vera	Hibiscus	Bottle gourd
	1. Dragendroff's test	✓	✓	✓
	2. Wagner's test	✓	✓	✓
	3. Hager's test	✓	--	✓
	4. Tannic acid test	✓	✓	✓
2.	**Test for tannins:**			
	1. Ferric chloride test	✓	✓	✓
3.	**Test for flavonoids:**			
	1. Shinoda test	✓	✓	✓
	2. Alkali reagent test	✓	✓	✓
4.	**Test for steroids and phytosterols:**			
	1. Salkowski's test	✓	--	✓
	2. Liebermann Burchard test	--	--	✓

5.	**Test for volatile oils:** 1. Sudan test	--	✓	--
6.	**Test for Glycoside:** 1. Killer Killani test 2. Borntrager test 3. Bromine water test	✓ ✓ ✓	-- -- --	-- -- --

Phytochemical screening summaries that extract of *Aloe barbadensis miller, Hibiscus rosa-sinensis, Lagneria sicreria* contains Alkaloids, Tannins, Flavonoids, steroids, phytosterols and Glycosides.

10.4. FT-IR INTERPRETATION

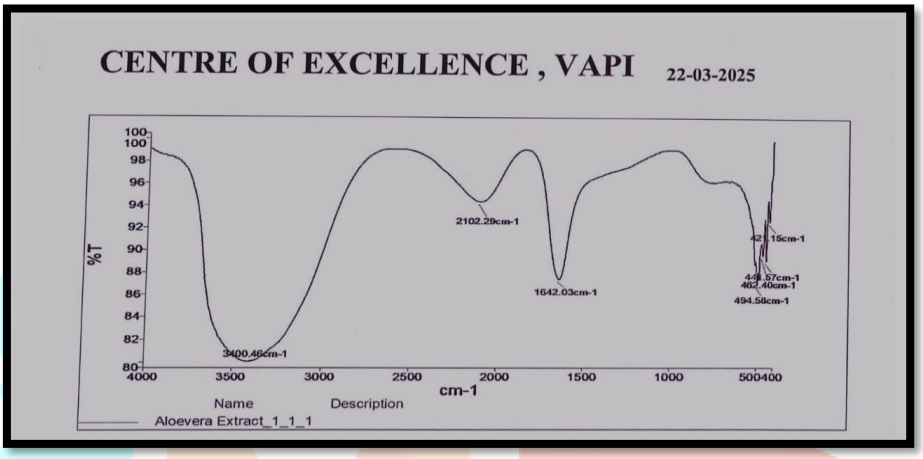


Figure 7 : FT-IR graph of aloe vera juice

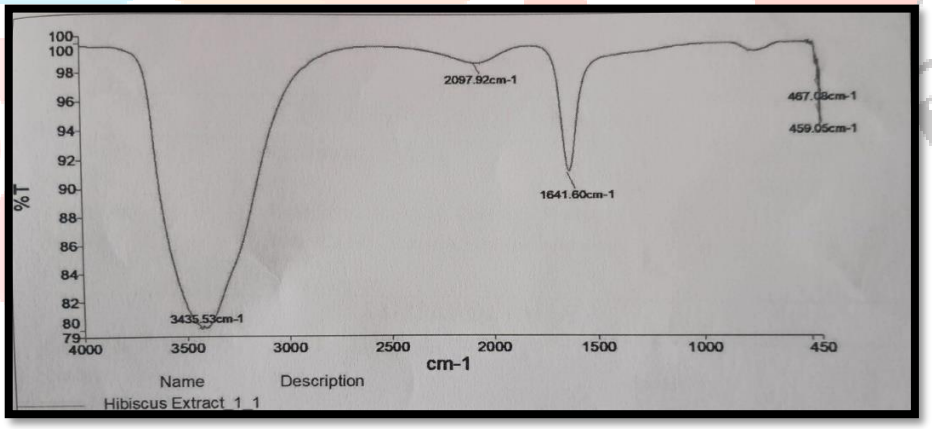


Figure 8 : FT-IR graph of hibiscus extract

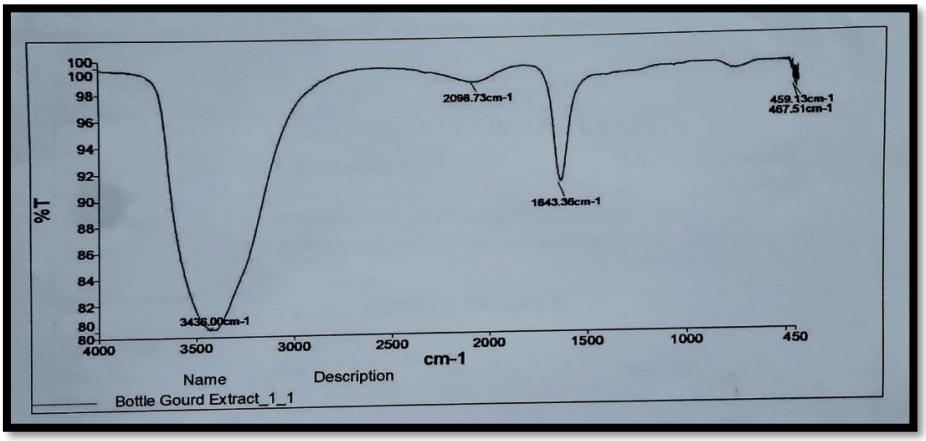


Figure 9 : FT-IR graph of bottle gourd juice

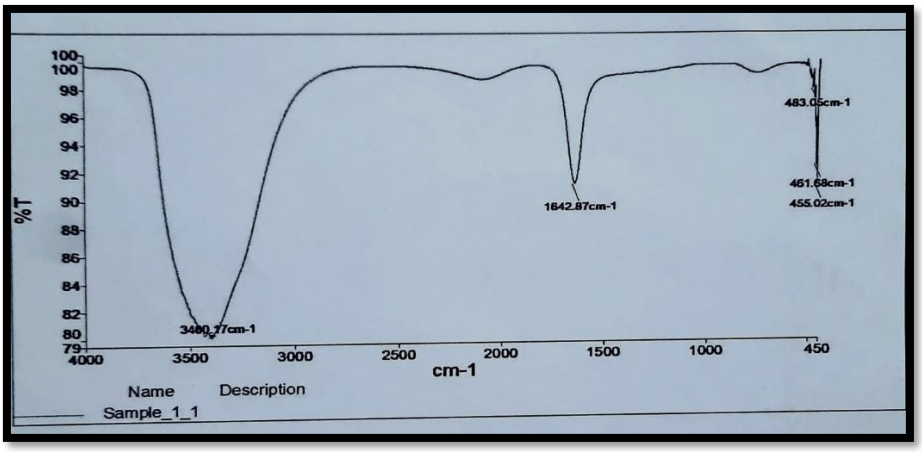


Figure 10 : FT-IR graph of formulation

Table 5: FT-IR interpretation of aloe vera juice

Sr.No.	Observed Frequency Range (cm^{-1})	Standard Frequency Range (cm^{-1})	Functional group
1	3400.46	3200-3650	O-H stretch (alcohols, phenols, carboxylic acids)
2	1642.03	1600-1800	C=O stretch (carbonyl) and C=C stretch (alkenes)
3	421.15 - 494.58	400-900	Fingerprint region (C-O, C-C stretch/bands)

Table 6: FT-IR interpretation of hibiscus extract

Sr.No.	Observed Frequency Range (cm^{-1})	Standard Frequency Range (cm^{-1})	Functional group
1	3453.53	3300-3500	O-H stretch (alcohols, phenols, carboxylic acids)
2	1641.60	1680-1760	C=O stretch (carbonyl) and C=C stretch (alkenes)
3	451.41- 467.08	400-900	Fingerprint region (C-O, C-C stretch/bands)

Table 7: FT-IR interpretation of bottle gourd juice

Sr.No.	Observed Frequency Range (cm^{-1})	Standard Frequency Range (cm^{-1})	Functional group
1	3436.00	3300-3500	O-H stretch (alcohols, phenols, carboxylic acids)
2	1643.36	1680-1760	C=O stretch (carbonyl) and C=C stretch (alkenes)
3	467.51	400-900	Fingerprint region (C-O, C-C stretch/bands)
4	459.13	400-900	Fingerprint region (C-O, C-C stretch/bands)

Table 8: FT-IR interpretation of formulation

Sr.No.	Observed Frequency Range (cm^{-1})	Standard Frequency Range (cm^{-1})	Functional group
1	3400.17	3300-3500	O-H stretch (alcohols, phenols, carboxylic acids), N-H stretch (amides, amines)
2	1642.87	1680-1760	C=O stretch (carbonyl) and C=C stretch (alkenes)
3	483.05	400-900	Fingerprint region (C-O, C-C stretch/bands)
4	461.68	400-900	Fingerprint region (C-O, C-C stretch/bands)

The FT-IR spectra show the signal at 3400.17 cm^{-1}, 1642.87 cm^{-1}, 483.05 cm^{-1}, 461.68 cm^{-1}, 455.02 cm^{-1} indicating the presence of alcohols, phenols, carboxylic acids, carbonyl group, amides, alkenes and amines in the hair gel sample.

10.5. EVALUTION PARAMETERS OF POLY HERBAL HAIR GEL

Table 9: Evaluation parameters

SR. NO.	PARAMETERS	RESULT
1.	Appearance	Dark brown
2.	pH	4.83
3.	Viscosity	5399 cp
4.	Spread ability	Easy to spread, smooth
5.	Texture	Non-greasy, soft
6.	Stability	No separation, stable
7.	Moisturizing effect	Leaves hair hydrated
8.	Skin irritation	No irritation

10.6. LABEL

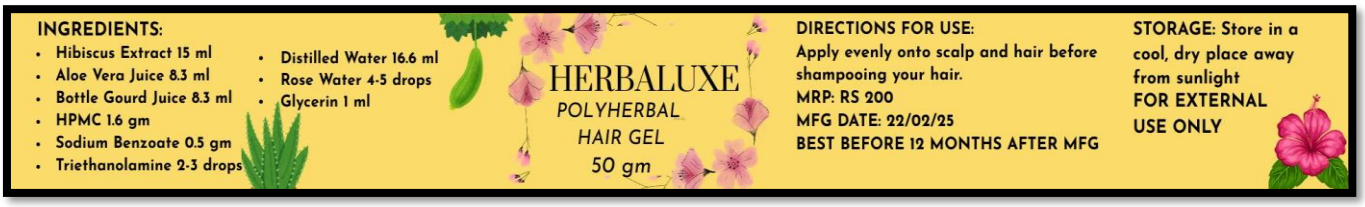


Figure 11 : Label

XI. CONCLUSION

The present study successfully formulated a polyherbal hair gel incorporating hibiscus extract, aloe vera juice, and bottle gourd juice, each known for their traditional and therapeutic benefits in hair care. The prepared gel exhibited desirable physicochemical properties, including suitable pH, good spread ability, homogeneity, and ease of application. Evaluation parameters confirmed that the formulation was stable, non-irritant, and possessed good aesthetic appeal. The herbal ingredients demonstrated synergistic effects, enhancing the gel's moisturizing, conditioning, and hair growth-promoting properties. Hibiscus contributed to improved scalp health and hair strength, aloe vera provided hydration and soothing effects, while bottle gourd added additional nourishment and cooling properties. Overall, the formulated polyherbal hair gel proved to be a promising natural alternative to synthetic hair care products, offering effectiveness along with minimal risk of side effects. Further in vivo studies and consumer acceptability tests can strengthen its potential for commercial application in the cosmetic and personal care industry.

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XII. REFERNCE

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