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Formulation And Evaluation Of Herbal Foot Cream

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Abstract: The aim of this research was to formulate and evaluate a herbal foot cream utilizing the synergistic properties of *Aloe barbadensis*, *Azadirachta indica* and *Moringa oleifera* along with the moisturizing benefits of Almond and Coconut oils. These herbal ingredients are traditionally known for their antimicrobial, anti-inflammatory, and skin-healing properties, suggesting their potential in addressing common foot problems such as dryness, cracking, and minor infections. The cream was formulated using a stable emulsion base, incorporating the selected herbal extracts at predetermined concentrations and the emollient oils. The formulated cream underwent a series of evaluation tests, including physical appearance, pH, viscosity, spreadability, skin irritation studies, and in vitro antimicrobial activity against common foot pathogens.

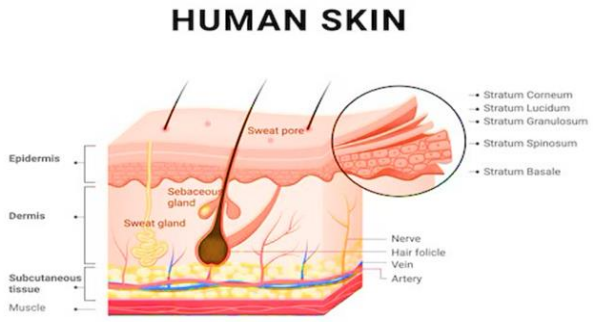
keywords **– Aloe vera, Cracking, Herbal foot cream, Moringa, Neem.**

I. INTRODUCTION

The traditional systems of medicine evolved over centuries had responsible for safeguarding of the world until the allopathic system of medicine. As the latter system used knowledge of modern biology and chemistry, for both discovery and treatment, it found fast acceptability among the users and now it occupies predominant space in the area of healthcare. Inspite of this, the contribution of the traditional preparations is increasing because of the general impression that these products are safe; while the single-molecule based modern drugs used in the allopathic system can have severe adverse effects. World health organization (WHO) has been promoting traditional medicine as a source of less expensive, comprehensive medical care, especially in developing countries, 8% of the world's population relies on medicinal plants for their primary health care.[1]

1.1.INTRODUCTION TO SKIN

Skin is the largest organ in our body and helps serve as a protective barrier against environmental factors. The skin contains three main layers (epidermis, dermis, hypodermis)(fig.1) to prevent skin cancer, acne, wrinkles, and rashes. The skin of the feet is classified as thick skin and contains five distinct layers stratum



Basale, stratum spinosum, stratum granulosum, stratum lucidum and stratum corneum but the skin of the feet becomes dry and feels uncomfortable and painful as there is no oil gland present.[2], [3]

1.2. INTRODUCTION TO FOOT CRACKS

Cracked heels, also known as heel fissures,(fig.2) occur when the skin on the heels becomes dry, thick and cracks, often due to lack of moisture or increased pressure.[4] Cracked heels are a common foot problem where the skin on the heel's splits or cracks, forming fissures. The primary cause is dry, thickened skin, often due to a lack of moisture, but other factors can contribute. Initially, you might notice dry, thickened skin (calluses) around the heel, which then develops into cracks or fissures. Cracked heels can range from a minor nuisance to a painful condition, especially if the cracks are deep or infected. Deep cracks can lead to pain, bleeding, and potentially infection.[5]

Xerosis - Xerosis cutis is the medical term for abnormally dry skin. A less severe form of xerosis is xeroderma or normal dry skin. While xerosis is often a temporary condition that leaves the skin looking scaly, it can also cause discomfort, itchiness, and inflammation. If left untreated, this condition can cause breaks or cracks in the skin and lead to bacterial infection.[5]

Figure 1- Structure of skin

Reasons for cracking: - lack of moisture is the primary cause of cracked heels, as the limited sweat glands in foot skin lead to roughness and chapping. Other contributing factors include the loss of elasticity in ageing skin, which makes it more susceptible to cracking and prolonged standing that puts excessive pressure on the heels. Certain medical conditions such as psoriasis, eczema, thyroid issues, diabetes and athlete's foot can also contribute to heel fissures. Nutritional deficiencies, specifically in zinc, vitamins and minerals can negatively impact heel health. Obesity, by increasing strain on the heel's fat pad can cause it to spread and crack if the skin lacks sufficient flexibility. Additionally, wearing exposing footwear like open-back shoes or sandals can lead to the heel fat spreading, elevating the risk of cracks and inadequate foot hygiene is another contributing factor.[6]

Figure 2- Foot cracks

1.3. TOPICAL DRUG DELIVERY SYSTEM

A topical delivery system is the material that brings a medicine into contact with and through the skin. The skin barrier presents a hurdle for topical medication administration. Topical delivery encompasses two categories of products: External topicals are smeared or sprayed into cutaneous tissues to cover the afflicted area. Internal topicals are applied to the mucous membrane, vagina, or anorectal tissues for local activity. Topical treatments typically provide localized effects by penetrating the skin's underlying layers.[4]

1.4. HERBAL FOOT CREAM

Herbal foot creams are a specialised category of skincare products designed to address common foot related issues such as dryness, cracked heels and fungal infections. The skin on the feet is naturally dry due to the absence of oil glands, making it prone to damage and requiring specialised care. These creams are formulated using natural ingredients, offering a safer and eco-friendly alternative to synthetic products. The use of herbal ingredients in foot cream is rooted in traditional medicine, where plants like aloe vera, neem and moringa have been utilised for their therapeutic properties.

1.5. INTRODUCTION TO ALOE BARBADENSIS[7], [8], [9]

Aloe vera,(Fig.3) also known as the "lily of the desert", is a succulent plant widely recognized for its medicinal properties. Its use dates back centuries in various cultures, including traditional Indian medicine. The gel obtained from its leaves is particularly valued for its soothing, moisturizing and healing properties.

Biological source: - Aloe is the dried juice collected by incision from the bases of the leaves of Aloe barbadensis miller (also known as aloe vera), a plant belonging to the Asphodelaceae (Liliaceae) family.

Chemical constituents: - Aloe vera contains Aloesin, Aloin (anthraquinone glycoside), Aleoresin A, Aleoresin E, Isoaleoresin D, Salicylic acid, Lupeol, phenols, sulphur and cinnamomic acid.

Uses: - It has anti-inflammatory, anti-microbial and wound healing properties. Hydrates, moisturizes and heals crack. Repairs and relieves dry skin disorders such as rough and cracked heels.

Figure 3 – Aloe barbadensis

1.6. INTRODUCTION TO AZADIRACHTA INDICA[9], [10]

Azadirachta indica(Fig.4), commonly known as neem, margosa, nimtree or Indian lilac, is a fast growing, evergreen tree in the mahogany family (meliaceae). Nim is a noun derived from Sanskrit nimba. It is one of the two species in genus azadirachta. Its fruits and seeds are the source of neem oil. Neem tree is known for their medicinal properties, use in traditional medicine and as a natural pesticide.

Biological source: - Neem consist of dried leaves of azadirachta indica a. juss. and other parts of neem tree including flowers, fruits, seeds, roots, bark and belonging to the family meliaceae. Nimbidine and Nimbinene show antifungal and antibacterial activity.

Chemical constituents: - Leaves contains Limonoids (nimbin, nimbolinin, nimbidine), Triterpenoid (Azadirichtin), sodium nimbinate, ascorbic acid, sitosterol, polyphenollics, flavonoids, alkaloids, glycosides and tannins.

Uses: - Neem is found to be very useful plant it shows Antibacterial, Antifungal, Anti-inflammatory and Antiviral activity.

Figure 4 – Azadirachta indica

1.7. INTRODUCTION TO MORINGA OLEIFERA[11], [12], [13]

Moringa oleifera(Fig.5), often referred to as the “miracle tree” or “tree of life”, is a fast growing, drought resistant tree belonging to the family moringacae. It is also called as drumstick tree, horseradish tree and sahajan.

Biological source: - Moringa consist of dried leaves of moringa oleifera lam. and also, fruits (pods), flowers, roots, seeds and bark of the plant belonging to the family moringaceae.

Chemical constituents: - The leaves contain niazirin, niazirinin- a nitrile glycoside, Flavonoids like quercetin and rutin, benzyl isothiocyanate, benzyl glucosinolate, alkaloids, tannins, sterols, magnesium, iron, calcium, potassium, etc. Tannins in aq. Ext. show a potent antibacterial effect.

Uses: -It is known to show Antioxidant, Antimicrobial, Anti-inflammatory, Wound healing, Antiseptic activities.

Figure 5 – Moringa oleifera

These ingredients not only enhance the efficacy of the cream but also align with the growing consumer preference for natural and sustainable skincare solutions. Herbal foot creams are formulated to provide intense hydration, repair damaged skin and restore the skin's natural barrier. They often include emollients and natural herbal extracts to ensure long-lasting benefits. These products are gaining popularity due to their ability to address foot care needs without the side effects associated with chemical-based creams.

II. OBJECTIVES

To develop, formulate and evaluate herbal foot cream containing *aloe barbadensis, azadirachta indica* and *moringa oleifera* extract, assessing their physicochemical properties, spreadability, Ph, safety, efficacy and pharmacological effects for potential use as a natural remedy for foot discomfort and related condition.

III. MATERIALS AND METHODS

The foot crack cream must be formulated using a carefully selected set of ingredients and standardized technique for optimal healing, hydration and protection. The materials employed in this study consist of crucial active elements such as moisturizers, soothing agents, nourishers and emulsifiers which works together to treat crack heels. The methodology consists of a step-by-step formulation procedure to produce a stable and effective product. Furthermore, numerous evaluation procedures are used to assess the final formulation's quality and efficacy, including pH measurement, viscosity testing, spreadability analysis and skin compatibility study.

3.1. MATERIALS

The herbal foot crack cream was formulated using a combination of natural ingredients known for their skin-healing, moisturizing, and antimicrobial properties. Each component was carefully selected for its traditional use and scientific support in dermatological applications.

- **Aloe vera gel (aloe barbadensis): -** Extracted from fresh leaves, Aloe vera is widely known for its anti-inflammatory, antibacterial, antifungal, and wound-healing properties. It acts as a natural moisturizer and promotes regeneration of skin tissues.
- **Neem (azadirachta indica): -** Extracted from fresh and dried neem leaves. Neem is found to be very useful plant it shows Antibacterial, Antifungal, Anti-inflammatory and Antiviral activity.
- **Moringa (moringa oleifera): -** Extracted from fresh and dried moringa leaves. It is known to show Antioxidant, Antimicrobial, Anti-inflammatory, Wound healing, Antiseptic activities.
- **White bees wax: -** It acts as a natural thickener and skin protectant. It also provides a semi-solid base and enhances the stability of the formulation.
- **Almond oil: -** Almond oil is a nutrient-rich, plant-based oil derived from the seeds (or nuts) of the almond tree (Prunus dulcis). It is widely used in skincare due to its light texture, rich emollient properties, and high vitamin content. Almond oil is especially valued for its ability to soften, hydrate, and soothe the skin.
- **Coconut oil: -** Coconut oil is a versatile, plant-based oil extracted from the Extracted from the dried endosperm of Cocos nucifera. Rich in medium-chain fatty acids, it deeply nourishes dry skin and forms a protective barrier that prevents moisture loss.
- **Liquid paraffin: -** Paraffin also known as paraffinum liquidum, paraffin oil, liquid paraffin oil or Russian mineral oil, is a very highly refined mineral oil used in cosmetics. It soothes dry skin or act as a soothing agent.
- **Borax: -** Used as a mild antiseptic and emulsifier, borax helps in blending the water and oil phases of the cream and contributes to the cream's texture.
- **Vitamin E: -** Vitamin E (tocopherol) is used as antioxidant. It prevents oxidation of the formulation.
- **Rose oil: -** Rose oil is used as perfume in the formulation.

3.2. METHODOLOGY

3.2.1. EXTRACTION OF ALOE BARBADENSIS[14]

Aloe vera gel was directly obtained by aloe vera plant, here is the method for extraction of aloe vera.

a) **Harvesting and preparation: -** Harvest aloe vera leaves. Wash the leaves and remove the tips and butts of the leaves.

b) **Filleting: -** Remove the green rind and exudates (the outer layer of the leaf). This process was results in the gel fillet.

c) **Gel filtration: -** Scrape out the mucilage with a blunt-edged knife and stir vigorously in a blender to make it uniform.

d) **Purification: -** Filter the crude gel. If using the blender method, strain the solution through muslin cloth and filter.

e) **Stabilization: -** Add preservatives like sodium benzoate, potassium sorbate, citric acid, and/or Vitamin E. Store the gel at 4°C in an airtight bottle. Refrigerate prepared aloe vera gel in an airtight container for up to 1 week, or up to 2 months with added vitamin C or E.

3.2.2. EXTRACTION OF AZADIRACHTA INDICA[15]

The **MACERATION** procedure is used for extraction of Azadirachta indica.

a) Preparation: - Fresh and dried neem leaves was collected, washed and dried. They are then ground into a fine powder.

b) Maceration: - The 10 gm of neem powder is mixed with the 100 ml of distilled water. Keep it for 48 hours and stir it periodically.

c) Filtration: - The macerated mixture is filtered through a fine mesh cloth or filter paper to separate the solid residue from the liquid extract (filtrate). Then transfer the filtrate in an air tight container and stored in a refrigerator.

3.2.3. EXTRACTION OF MORINGA OLEIFERA[12], [16], [17]

The **DECOCTION** procedure is used for the extraction of moringa oleifera.

a) Preparation: - Fresh and dried moringa leaves was collected, washed and dried. Then crush the moringa leaves into a fine powder.

b) Decoction: - Then 10 gm of moringa powder is added in 100 ml of boiling (distilled) water (1:10 ratio). Allow the mixture to simmer for 30 minutes, while stirring occasionally.

c) Filtration: - Once cooled, filter the extract using a sterile filter paper to remove solid residue from the liquid extract. Then transfer the filtrate in an air tight container and stored in a refrigerator.

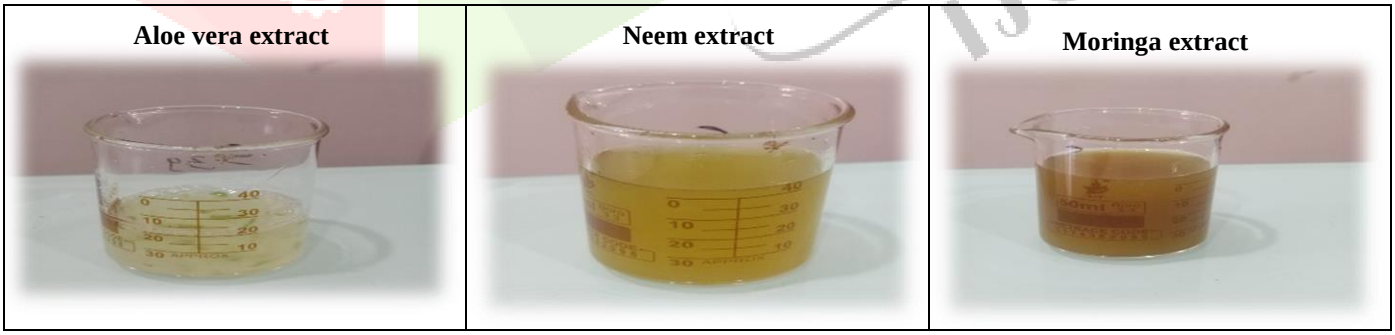


Figure 6 – Extracts of aloe vera, neem and moringa

3.2.4. PHYTOCHEMICAL ANALYSIS[18]

The prepared extracts of aloe vera, neem and moringa was phytochemically investigated for constituents like alkaloids, glycosides, tannins, flavonoids, saponins, triterpenoids/steroids and volatile oils. The presence of these phytoconstituents was characterised by various phytochemical tests.

3.2.5. METHOD OF PREPARATION OF FOOT CREAM[19]

1. Weigh the required quantity of white beeswax, liquid paraffin, almond oil and coconut oil and melt in china dish, by heating on a water bath up to 70°C.
2. In a glass beaker, dissolve borax in aloe vera, neem and moringa extracts and heat up 70°C.
3. When both oily and aqueous phases reaches the same temperature (70°C), gradually add aqueous phase to the melted oil phase by drop by drop with constant stirring.

4. Stir continuously until it becomes cool. When the temperature lowers to 40-45°C, incorporate rose oil and vitamin E and mix uniformly until a homogenous semisolid mass is obtained.

❖ **Dispensing: -** Weigh the prescribed quantity of cream on a butter paper and transfer to a container or metallic/plastic collapsible tube, close it thoroughly and label.

Table 1 – Formulation of herbal foot cream

SR.NO	INGREDIENTS	F1 (20 gm)	F2 (20 gm)	F3 (20 gm)	F4 (20 gm)
1	White bees wax (gm)	2.62	3.25	3.86	**4.4**
2	Liquid paraffin (ml)	6.44	7.07	7.69	**8.22**
3	Coconut oil (ml)	1.52	2.15	2.77	**3.3**
4	Almond oil (ml)	1.42	2.05	2.67	**3.2**
5	Borax (gm)	0.4	0.4	0.4	**0.4**
6	Aloe extract (ml)	3	3	3	**3.5**
7	Neem extract (ml)	1	1	1	**0.5**
8	Moringa extract	1	1	1	**0.5**
9	Distilled water (ml)	6.6	4	1.8	**--**
10	Methyl paraben (gm)	0.05	0.05	0.05	**0.05**
11	Vitamin E	q.s.	q.s.	q.s.	**q.s.**
12	Rose oil	q.s.	q.s.	q.s.	**q.s.**

(In the formulation F1, F2 and F3 the cream is prepared but it shows the **phase separation** (separation of oil and water phases). In the formulation F4 the cream is prepared and not shows phase separation so the formulation **F4** is considered as final batch formulation)

Figure 7 – Prepared herbal foot cream (F4)

IV. EVALUATION OF FOOT CREAM

4.1. PHYSICAL EVALUATION [20]

The following physical characteristics are used to evaluate the herbal cream formulations.

- **Color: -** The cream's color is identified through visual inspection.
- **Odor: -** The cream's odor is mostly distinctive.
- **Consistency: -** A manual rubbing of the cream on the hand is used to assess the formulation. The consistency of the cream is smooth. No oily residue must be left on the skin's surface after the use of the cream.
- **State: -** The cream's condition is visually inspected. The cream must be in a semisolid form.

4.2. pH TESTING[20], [21]

The pH paper is can be used to measure the pH of the produced herbal cream. The pH meter was calibrated using standard buffer solution. About 0.5g of cream was weighed and dissolved in 50 ml of water and its pH as measured. (Fig.8)

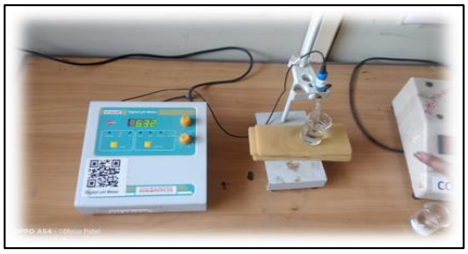


Figure 8 – pH testing

4.3. IRRITATION TEST[20]

On the left dorsal surface, mark an area of one square centimeter. Cover the designated area with cream, and record the time. For up to 24 hours, irritability, erythema, and edema must be monitored and reported at regular intervals.

4.4. HOMOGENEITY[20]

The homogeneity of the formulation can be evaluated by touch and appearance.

4.5. SPREADABILITY[20]

A sufficient amount of cream is divided between two glass slides, and the slides are subjected to a 5-minute weight application of 100 grams. The spreadability of the two slides are measured by monitoring the movement of the upper glass slide over the lower slide, or the amount of time needed to separate them. (Fig.9)

The formula for it is **S= m x l/t.**

Where, m = weight on the upper slide.

l = length travelled on the glass slide.

t = amount of time spent.

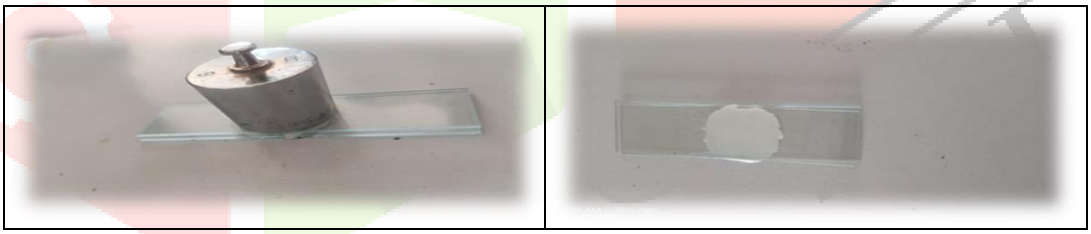


Figure 9 – Spreadability testing

4.6. DYE TEST[20]

The cream is combined with Sudan red dye. Under a microscope, observe a small amount of cream that has been placed on a slide and protected with a cover slip. It is an o/w type if the dispersed globule appears reddish while the ground appears colourless; w/o type cream exhibit the opposite characteristic. (Fig.10)

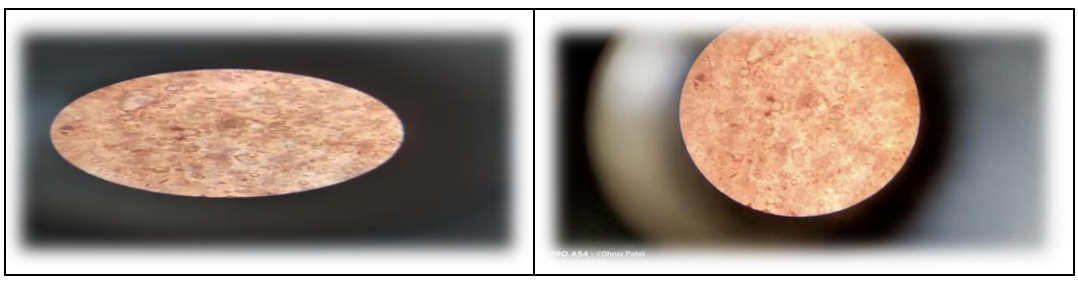


Figure 10 – Dye test

4.7. VISCOSITY[20]

Viscosity of the prepared cream was measured by the Brookfield Viscometer (Fig.11). By using spindle no. 94 (S-94) and a Brookfield viscometer set to 100 rpm, one can measure the viscosity of herbal cream formulations. The viscosity of the prepared cream (F4) was found to be 1498 cp (centipoise).

Figure 11 – Viscosity testing by Brookfield Viscometer

4.8. ACID VALUE[20]

After precisely weighing and dissolving 10 grams of the material in 50 milliliters of an equal volume mixture of alcohol and solvent ether, the flask is to be connected to a reflux condenser and heated gradually until the sample is completely dissolved. 1 ml of phenolphthalein should be then added, and the mixture is titrated with 0.1N NaOH until a faint pink colour appeared after 30 seconds of shaking.

Acid value = n x 5.61/w

n = the amount of ml of NaOH required.

w = the weight of substance.

4.9. SAPONIFICATION VALUE[20]

After adding approximately 2 grams of the material to 25 milliliters of 0.5 N alcoholic KOH and refluxing it for 30 minutes, 1 millilitre of phenolphthalein should be added and titrated right away with 0.5 N HCL.

Saponification value = (b-a) x 28.05/w

a =The volume in ml of titrant.

b = The volume in ml of titrate.

w = The weight of substance in gm.

4.10. THIN LAYER CHROMATOGRAPHY[22], [23], [24], [25], [26]

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 compounds towards mobile phase and stationary phase.

Methodology: - Apply 5 µl of test solution on the pre-coated TLC plate of uniform thickness. Developed the plate in the solvent system.

4.11. FT-IR SPECTROSCOPY[22], [27], [28], [29], [30]

The FT-IR data is used to identify the functional group of the extract. The active components are separated based on its peak value in the region of IR radiation. The FT-IR test of aloe barbadensis, azadirachta indica and moringa oleifera extracts were done in CENTRE OF EXCELLENCE, Vapi. The FT-IR spectra was observed in the range of 400-4000 cm^{-1}.

4.12. ANTI-MICROBIAL TESTING[31]

The antibacterial screening of Herbal preparation was done by cup-plate method. The cream was tested against bacteria namely S. aureus. A loopful of the pure bacterial culture was suspended in nutrient broth and incubated for 24 hours. Nutrient agar media was sterilized and poured into petri plates. After solidification, 0.1ml of the inoculum was spread over the agar evenly using a rod. 6 mm diameter cavity was prepared by

crok borer and extracts and formulated foot cream is placed in the cavity. The inoculated plates are incubated for 24 hours. Later, the zone of inhibition around the disc was observed.

4.13. STABILITY TESTING[32]

Cream batch F4 placed at room temperature for 60 days and observed. The result of F4 cream was stable for 60 days. Also no microbial growth/contamination. There is no changes in F4 cream stability under room temperature.

V. RESULT AND DISCUSSION

5.1. ASSESSMENT OF PHYTOCHEMICAL TESTING

Table 2 – Summary of phytochemical testing

Sr No.	Chemical test	Aloe vera extract	Moringa extract	Neem extract
	Alkaloids			
1	Dragendroff's test	+	+	+
2	Mayer's test	+	+	+
3	Hager's test	+	+	+
4	Wagner's test	+	+	+
	Glycosides			
1	Borntrager's test	+	-	-
2	Killer killani test	+	+	+
3	Baljet test	+	+	-
	Saponins			
1	Foam test	+	-	-
	Flavonoids			
1	Lead acetate test	-	+	+
2	NaOH addition test	-	+	+
	Terpenoids/Steroids			
1	Salkowski test	+	+	+
	Tannins			
1	$FeCl_3$ test	-	+	+
2	Lead acetate test	+	+	+
	Volatile oils			
1	Sudan red dye test	-	+	+

The conducted tests reveal the presence of a variety of organic compounds such as alkaloids, glycosides, flavonoids, terpenoids, tannins and volatile oils in the extracts. (Where, + = Positive, - = Negative)

5.2. ASSESMENT OF EVALUATION PARAMETERS

Table 3 – Result of evaluation parameters

Sr. No.	Evaluation parameters	Result (F4)
1	Physical parameters	
	Color Odour Consistency State	**Creamy white** **Rose like** **Smooth** **Semisolid**
2	pH	**6.32 (4.5 – 7)**
3	Irritation	**No irritation**
4	Homogeneity	**Homogenous**
5	Spreadability	**Good**

6	Viscosity	**1498 cp**
7	Washability	**Washable**
8	Dye test	**W/O type**
9	Acid value	**4.48 (<5)**
10	Saponification value	**84.15**

Considering the evaluated parameters F4 batch is the favourable choice because the F1, F2 & F3 batches showing the phase separation after preparation. The F4 batch has good consistency, state, pH range similar to skin, good spreadability, washability, viscosity and also acid value below 5. So, F4 batch exhibits the optimal quality attributes.

5.3. ASSESMENT OF TLC ANALYSIS

Table 4 – Result of TLC analysis

	Neem	Moringa
For neem: - Solvent system (mobile phase) : - Chloroform : Acetone : Formic acid (25:15:5:5) Spot observed in iodine chamber. For moringa: - Solvent system (mobile phase) : - Chloroform : methanol : water (65:30:5) Spot observed in iodine chamber.		
Rf value (standard)	**0.55**	**0.32**
Rf value (sample)	**0.58**, 0.25	**0.30**

The TLC data indicates the Rf value of aqueous samples of extract of azadirachta indica and moringa oleifera. The closeness of the Rf value of standard and sample suggests that the chromatographic separation achieved good reproducibility and accuracy. Both values fall within a relatively close range.

5.4. FT-IR INTERPRETATION

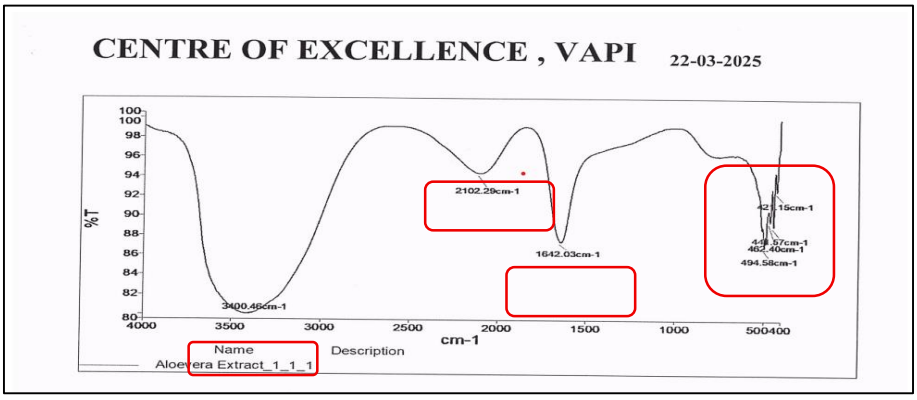


Figure 12 - FT-IR graph of aloe vera

Table 5 – Interaction studies through FT-IR spectroscopy (fig.12)

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), N-H stretch (amides, amines)
2	2102.29	2100-2250	Alkynes (C≡C)
3	1642.03	1600-1800	C=O stretch (Carbonyl) and C=C stretch (alkenes)
4	421.15 - 494.58	400-900	Fingerprint region (C-O, C-C stretch/bands)

The FT-IR spectra shows the signal at 3400.46 cm^{-1}, 2102.29 cm^{-1}, 1642.03 cm^{-1}, 421.15-494.58 cm^{-1} indicating the presence of alcohols, phenols, carboxylic acids, amides, amines, alkylenes, alkenes and alkanes groups in aqueous extract of aloe barbadensis.

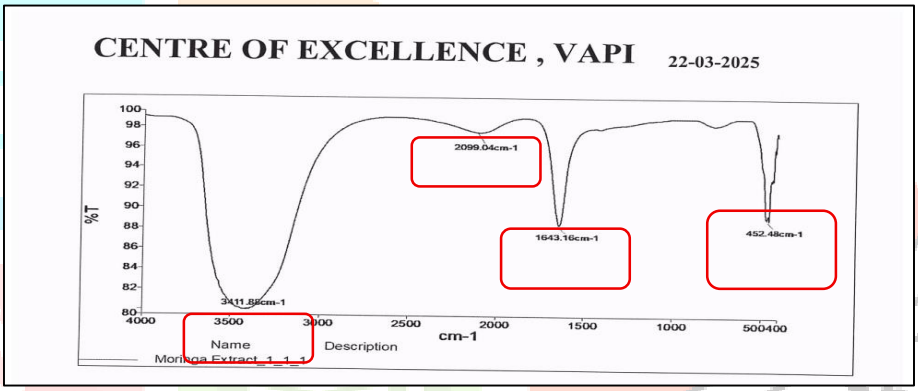


Figure 13 - FT-IR graph of moringa

Table 6 – Interaction studies through FT-IR spectroscopy (fig.13)

Sr. No.	Observed frequency range (cm^{-1})	Standard frequency range (cm^{-1})	Functional Group
1	3411.88	3200-3650	O-H stretch (alcohols, phenols, carboxylic acids), N-H stretch (amides, amines)
2	2099.04	2100-2250	Alkynes (C≡C)
3	1643.16	1600-1800	C=O stretch (Carbonyl) and C=C stretch (alkenes)
4	452.48	400-900	Fingerprint region (C-O, C-C stretch/bands)

The FT-IR spectra shows the signal at 3411.88 cm^{-1}, 2099.04 cm^{-1}, 1643.16 cm^{-1}, 452.48 cm^{-1} indicating the presence of alcohols, phenols, carboxylic acids, amines, amides, alkylenes, alkenes and alkanes groups in aqueous extract of moringa oleifera.

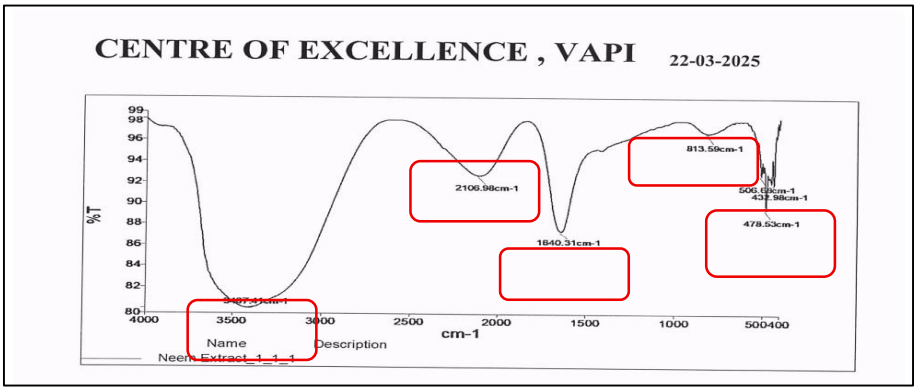


Figure 14 - FT-IR graph of neem

Table 7 – Interaction studies through FT-IR spectroscopy (fig.14)

Sr. No.	Observed frequency range (cm^{-1})	Standard frequency range (cm^{-1})	Functional Group
1	3407.41	3200-3650	O-H stretch (alcohols, phenols, carboxylic acids), N-H stretch (amides, amines)
2	2106.98	2100-2250	Alkynes (C≡C)
3	1640.31	1600-1800	C=O stretch (Carbonyl) and C=C stretch (alkenes)
4	432.98 – 813.59	400-900	Fingerprint region (C-O, C-C stretch/bands)

The FT-IR spectra shows the signal at 3407.41 cm^{-1}, 2106.98 cm^{-1}, 1640.31 cm^{-1}, 432.98-813.59 cm^{-1} indicating the presence of alcohols, phenols, carboxylic acids, amines, amides, alkylenes, alkenes and alkanes groups in aqueous extract of Azadirachta indica.

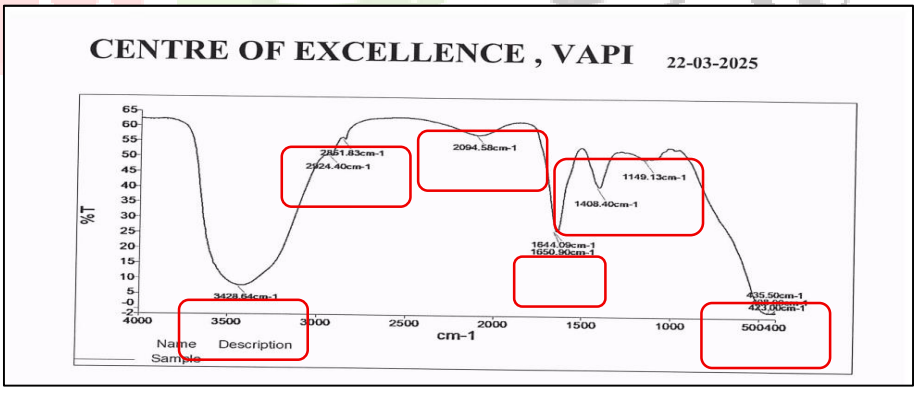


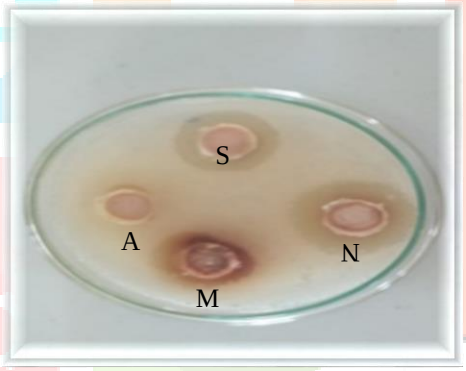
Figure 15 - FT-IR graph of sample

Table 8 – Interaction studies through FT-IR spectroscopy (fig.15)

Sr No.	Observed frequency range (cm^{-1})	Standard frequency range (cm^{-1})	Functional Group
1	3428.64	3200-3650	O-H stretch (alcohols, phenols, carboxylic acids), N-H stretch (amides, amines)
2	2094.58	2100-2250	Alkynes (C≡C)
3	1650.90, 1644.09	1600-1800	C=O stretch (Carbonyl) and C=C stretch (alkenes)
4	2850-2960	2850-3000	C-H stretch (alkanes)
5	1375-1475	1375-1465	C-H bend (alkanes)
6	408.00-1149.13	400-900	Fingerprint region (C-O, C-C stretch/bands)

The FT-IR spectra shows the signal at 3428.64 cm^{-1}, 2094.58 cm^{-1}, 1650.90-1644.09 cm^{-1}, 2850-2960 cm^{-1}, 1375-1475 cm^{-1}, 408.00-1149.13 cm^{-1} indicating the presence of alcohols, phenols, carboxylic acids, amines, amides, alkylenes, alkenes and alkanes groups in sample.

5.5. ASSESMENT OF ANTI-MICROBIAL TESTING



Where,
A - Aloe vera extract.
M - Moringa extract.
N - Neem extract.
S - Sample(F4).

Figure 16 – Observation of anti-microbial testing (F4) against S.aureus

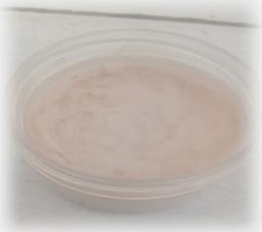
Table 9 – Assessment of anti-microbial testing (Fig.16)

Concentration (mg/ml)	**For S.aureus**			
	A	N	M	C
	Zone of inhibition			
50 mg/ml	7 mm	15 mm	10 mm	12 mm

The result of anti-microbial testing shows that the extracts of neem and moringa and sample (F4) was showing inhibition against S.aureus and the formulation was found to be effective against S.aureus. (Figure 16)

5.6. ASSESMENT OF STABILITY TESTING

Table 10 – Assessment of stability study of formulation (F4)

STABILITY STUDY	ON THE DAY OF PREPARATION	AFTER 1 MONTH OF PREPARATION	AFTER 2 MONTH OF PREPARATION
Appearance			
Colour	No change	No change	No change
Odour	No bad odour	No bad odour	No bad odour
pH	6.32	6.26	6.24
Irritancy	Non-irritant	Non-irritant	Non irritant
Phase separation	No phase separation	No phase separation	No phase separation

The result of the stability study shows that there is no change in prepared formulation's colour, odour, irritation and pH at room temperature for 2 month and also no phase separation is observed during this period. So, the formulation was found to be physically stable within two month.

VI. LABELLING OF HERBAL FOOT CREAM

Figure 17 – Label of the herbal foot cream

VI. CONCLUSION

The successful formulation and evaluation of the herbal foot cream incorporating Aloe vera, Neem, and Moringa extracts, along with Almond and Coconut oils, demonstrates the potential of these natural ingredients in providing effective foot care. The formulated cream exhibited acceptable physical properties, including appearance, pH, and viscosity, indicating good stability revealed the cream to be safe for topical application. Furthermore, the inclusion of Aloe vera contributed significant moisturizing properties, helping to alleviate dryness and cracking. Neem extract demonstrated promising in vitro antimicrobial activity, suggesting its potential in preventing and treating common foot infections. Moringa extract, known for its skin-healing and anti-inflammatory properties, likely contributed to the overall therapeutic effect of the cream. The Almond and Coconut oils further enhanced the moisturizing and emollient properties, leaving the skin feeling soft and supple. In conclusion, the herbal foot cream formulated in this study presents a natural and potentially effective alternative for foot care, addressing issues like dryness, minor infections, and promoting overall foot health.

VII. ABBREVIATIONS

F1, F2, F3, F4 = Formulation of different batches of foot cream
FT-IR = Fourier Transform Infrared Spectroscopy
O/W = Oil in water
pH = Hydrogen ion Concentration
q.s. = Quantity Sufficient

TLC = Thin layer Chromatography
W/O = Water in oil

CONTENT	TITLE OF FIGURES AND TABLES
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Figure 2	Foot cracks
Figure 3	Aloe barbadensis
Figure 4	Azadirachta indica
Figure 5	Moringa oleifera
Figure 6	Extracts of aloe vera, neem and moringa
Figure 7	Prepared herbal foot cream (F4)
Figure 8	pH testing
Figure 9	Spreadability testing
Figure 10	Dye test
Figure 11	Viscosity testing by Brookfield Viscometer
Figure 12	FT-IR graph of aloe vera
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Table 9	Assessment of anti-microbial testing (Fig.16)
Table 10	Assessment of stability study of formulation (F4)

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