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# Research Article on Formulation and Evaluation of Herbal Face Serum

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**Abstract:** *Hyperpigmentation is a skin condition caused by excess melanin production, leading to dark patches on the skin. Common causes include sun exposure, hormonal changes, inflammation, and aging1. Conventional treatments may be effective but can cause side effects and are often expensive. Therefore, natural alternatives are gaining attention in dermatology. Ferula asafoetida (asafoetida) is a traditional medicinal plant known for its antioxidant, anti-inflammatory, and antimicrobial properties. These properties may help reduce hyperpigmentation by inhibiting melanin production and protecting the skin from oxidative stress. This study evaluates the potential of asafoetida as a natural remedy for hyperpigmentation, including its effectiveness, safety, and use in topical formulations. The research suggests that asafoetida could be a promising and cost-effective herbal treatment, although further clinical studies are needed to confirm its safety and efficacy.*

**Keywords:** Melanin, Melanogenesis, Tyrosinase inhibition, Antioxidant activity, Herbal medicine Skin pigmentation, Anti-inflammatory activity, Dermatology.

## I. INTRODUCTION

Skin hyperpigmentation is a common skin condition in which certain areas of the skin become darker than the surrounding skin due to excessive production of melanin. Melanin is the natural pigment responsible for skin, hair, and eye colour and is produced by melanocytes through a process called melanogenesis[1]. When melanin accumulates excessively in the skin cells, the condition is known as melanosis.

Hyperpigmentation can be classified based on the depth of melanin deposition. In epidermal melanosis, melanin levels increase in the epidermis while the number of melanocytes remains normal. In dermal melanosis, melanin is deposited deeper in the dermis between collagen fibers, making treatment more difficult. Melanocytes produce two main types of melanin: eumelanin, which is brown to black in colour, and pheomelanin, which is yellow to reddish.

Several factors can cause hyperpigmentation, including prolonged sun exposure, hormonal imbalance, inflammation, acne, aging, pregnancy, and certain medications. Ultraviolet (UV) radiation is one of the major causes because it stimulates melanocytes to produce more melanin. Common forms of hyperpigmentation include melasma, freckles, age spots, and post-inflammatory hyperpigmentation.


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**1.1 Fig. Hyperpigmentation**

**1.1 The main types of Hyperpigmentation :**

1. Melasma
2. Post inflammatory hyper pigmentation
3. Age Spot or Liver Spot
4. Periorbital Hyperpigmentation

**1. Melasma :** Melasma is an acquired skin condition that causes irregular brown patches, mainly on sun-exposed areas of the face. It is linked to genetic factors, UV exposure, and hormonal changes[1.] Sunlight can increase melanin production by activating mast cells, which release histamine and stimulate pigment-forming cells.

**2. Post inflammatory Hyperpigmentation:**

Post-inflammatory hyperpigmentation (PIH) is a skin condition where dark patches appear after inflammation or injury to the skin[2.] It can occur due to acne, eczema, fungal infections, psoriasis, drug reactions, or cosmetic procedures.

**3. Age Spot:**

Age spots are signs of skin aging that usually appear on sun-exposed areas like the face and hands. Their brown color is mainly caused by the build up of lipofuscin, a pigment formed from oxidized fats.

**4. Periorbital hyperpigmentation:**

Periorbital hyperpigmentation is the darkening of the skin around the eyes, commonly called dark circles. It can occur due to genetics, sun exposure, aging, or lifestyle factors and may appear brown, blue in color.[2]

**1.2 Causes of hyperpigmentation:-**

These may be exogenous and endogenous factors. These factors are divided by different criteria as follow

**A. Nutritional factor:**

1. Kwashiorkor
2. Vitamin B12 Deficiency
3. Folic Acid Deficiency

**B. Hormonal factor:**

1. Melasma is common in pregnancy
2. Hormonal contraceptive use

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**C. Endocrinologic factor:**

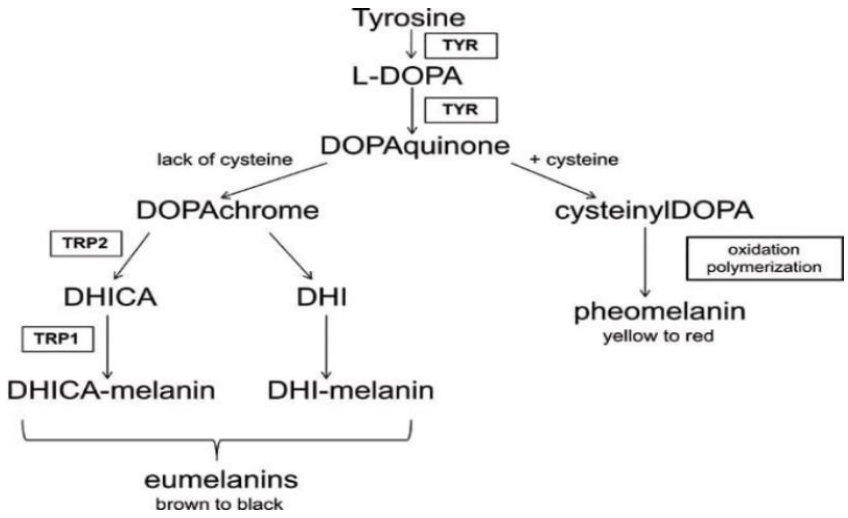
1. Addison's disease
2. Cushing's syndrome
3. Diabetes

**D. Excess Sun Exposure:**

Ultraviolet (UV) radiation leads to the generation of reactive oxygen species (ROS) within skin cells[4]. These ROS act as signaling molecules that activate intracellular pathways, particularly the mitogen-activated protein kinase (MAPK) pathway. In human keratinocytes, exposure to UV-B radiation enhances the activity

**E.Melanin:-**

Tyrosinase is the key enzyme involved in melanin synthesis, and its overactivity can lead to hyperpigmentation. The process begins with the amino acid tyrosine, which is converted by tyrosinase into L-3,4-dihydroxyphenylalanine (L-DOPA)[3]. This intermediate is then oxidized to form dopaquinone. Through a series of subsequent oxidation reactions and free radical.




**1.2 Fig. Melanin Cycle**

**1.3 Treatment for Hyperpigmentation:-**

**1. Topical therapies :**

Topical therapies (creams, gels, serums and lotions applied to the skin) are the most common treatment option for hyperpigmentation. Topical therapies includes,

**A. Retinoids:** Retinoids, which are derived from vitamin A, are known to enhance skin texture and help reduce melanin production.

**B. Azelaic acid:** Beneficial for post-inflammatory hyperpigmentation (PIH) and melasma.

**2. Tyrosinase inhibitory effect:**

Tyrosinase is a copper-containing, glycosylated enzyme found specifically in melanocytes, where it plays a central role in melanin production[5]. It catalyzes the conversion of L-tyrosine into L-DOPA, which is then further oxidized to form dopaquinone and subsequently dopachrome.

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**3. Antioxidants:**

Reactive oxygen species (ROS) are counteracted by antioxidants, which protect cells and tissues from oxidative stress–induced damage. The skin's antioxidant defense system consists of both enzymatic components (such as superoxide dismutase and catalase) and non-enzymatic compounds. Non-enzymatic antioxidants include molecules like lipoic acid, resveratrol, vitamin C, and vitamin E[6].

**4. Home Remedies:**

**A. Potato Juice:** Potato juice can be prepared by grating a potato and extracting its liquid, which is then applied to areas of hyperpigmentation[7]. The natural enzymes present in potatoes may help reduce the appearance of dark spots and support skin brightening[8].

**B. Banana and Papaya Pulp:** Crush the pulp of these fruits and gently apply it to the facial skin. This may help enhance skin radiance and contribute to a more uniform complexion[9].

**C. Aloe Vera Gel:** Combine aloe vera gel with honey and apply the mixture to areas of hyperpigmentation[10].

**1.4 Drug: ( *Ferula asafoetida* )**

The plant selected for this study is *Ferula asafoetida* Linn. Asafoetida is an oleo-gum resin obtained from the roots of *Ferula asafoetida*. This plant is known to possess more than twenty-five pharmacological and therapeutic properties. It is commonly referred to as both the "Food of the Gods" and "Devil's dung."

**Extract of Ferula asafetida as a skin hyperpigmentation treating agent :** The extract of *Ferula asafoetida* is obtained from its powdered form using a hydroalcoholic extraction method. It is rich in phenolic compounds, particularly ferulic acid, along with other antioxidants.

**Pharmacological importance of Ferula asafoetida plant:**

The extract of asafoetida has been reported to show notable antifungal, anti-inflammatory, and antioxidant activities. In addition, resin extracts have demonstrated strong anticholesterolemic and anticancer properties[11]. Aqueous extracts of the gum resin are also associated with antihypertensive and anticancer effects, while dried gum resin extracts exhibit antibacterial activity.

**1.5 Dosage Form:**

**Types of Face Serum:**

Skin care has become increasingly important among both men and women due to growing awareness of maintaining healthy and attractive Skin[12]. proper skin care routine helps improve the appearance, structure, and overall function of the skin. Common skin care products include moisturizers, sunscreens, toners, masks, eye creams, and facial serums. Among these, facial serums have gained great popularity because of their lightweight texture, rapid absorption, and quick visible results[13]. Serums contain concentrated active ingredients that penetrate deeply into the skin and effectively target concerns such as pigmentation, dryness, wrinkles, and dullness. In recent years, pharmaceutical-based cosmetic serums have emerged as advanced, non-invasive skin care formulations that combine cosmetic and pharmaceutical benefits for improved skin health.

1. **Oil-Based Serum** – Made with fast-absorbing oils that moisturize and nourish the skin. Best for dry skin.
2. **Gel-Based Serum** – Lightweight and water-based, gives a cooling and tightening effect. Suitable for oily skin.
3. **Water-Based Serum** – Contains hydrophilic active ingredients and absorbs quickly without leaving oiliness[14].
4. **Emulsion Serum** – Contains both oil and water phases, providing hydration and effective delivery of active ingredients into the skin.

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**Advantages of face serums:**

1. Serums are lightweight, fluid formulations that are rapidly absorbed by the skin.
2. They allow active ingredients to penetrate more effectively compared to heavier creams and gels.
3. Their small molecular structure enhances absorption, enabling concentrated actives to deliver better results.
4. In emulsion systems, the oil phase can function as a carrier that improves transport of active compounds across biological membranes and supports better absorption.
5. Serums contain high levels of active compounds that specifically target concerns such as pigmentation, fine lines, dullness, and acne.

## II. OBJECTIVES:

Formulation and Evaluation of Topical Delivery System containing Ferula Asafoetida extract for the treatment of Face Hyperpigmentation. This was achieved by,

1. To characterize Ferula asafoetida in order to confirm its identity, purity, quality, and safety for topical application.
2. To evaluate the selected formulation excipients for their identity, quality, and compatibility with the plant extract.
3. To develop both medicated and non-medicated face serum formulations using different types and concentrations of additives.
4. To assess the prepared formulations for their physicochemical properties such as pH, viscosity, and homogeneity.
5. To evaluate the functional performance of the serum, including spreadability and absorption characteristics.
6. To conduct stability studies to identify the most stable and optimized formulation.

## III. PLAN OF WORK

**Selection of Research Topic**

⇩

**Literature Survey**

⇩

**Selection of Herbal Ingredients and Excipients**

⇩

**Procurement of Raw Material**

⇩

**Compatibility of Ingredients**

⇩

**Formulation of Hyperpigmentation Face Serum**

⇩

**Evaluation of Face Serum**

⇩

**Report Writing / Thesis Typing**


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## IV. DRUG PROFILE:

**Profile of drug: Ferula asafoetida**
**Official status: Ayurvedic Pharmacopoeia**
**Vernacular names of ferula asafoetida in India:**

| Sr.No. | Language | Folk names |
|---|---|---|
| 1. | Arabic | Tyib |
| 2. | Marathi | Hing |
| 3. | Gujarat | Hing |
| 4. | Kashmiri | Yang-sap |
| 5. | Malayalam | Kayam |
| 6. | Tamil | Perungaayam |
| 7. | Oriya | Hengu |
| 8. | Sanskrit | Badika |
| 9. | Telugu | Inguva |
| 10. | Turkish | Seytan, tersi, Seytan boku |

**Table no. 1: Vernacular names F. asafoetida:**

**Synonyms:** Hing, Hingu, Devil's dung.
**Common Names:** Hing, Asafoetida in English.
**Biological source of drug**: Hingu consist of ole-resin obtained from rhizomes and root of Ferula Asafoetida Linn[15].
**Family:** Umbelliferae

**4.1 Fig.- Plant of Ferula asafoetida**

**Taxonomic classification F. asafoetida:**

| Taxonomical rank | Taxon |
|---|---|
| Kingdom | plantae |
| Division | Magnoliophyta |
| Class | Magnoliopsida |
| Family | Umbelliferae |
| Genus | Ferula |
| Species | Asafoetida |
| Common Name | Hing, Hingu |

**Table no. 2: Taxonomical classification F. asafoetida:**

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**Phytochemical constituent of Ferula asafoetida:**

Ferula asafoetida contains several chemical components, including carbohydrates (~68%), moisture (~16%), proteins (~4%), lipids (~1%), minerals (~7%), and fiber (~4%). Its main active constituents are resin (40–64%), gum (~25%), and essential oil (10–17%)[16.]

**Reported Therapeutic and Pharmacological Properties of F. asafoetida:**

1. Antibacterial
2. Antioxidant
3. Anti-carcinogenic
4. Anti-pigmentation
5. Anticholesterolemic
6. Antifungal

## V. SELECTION OF INGREDIENTS:

- **List of materials used for face serum formulation:**[22]

| Sr. No | Name of Ingredients | Quantity of Ingredients | Role in experiment |
|---|---|---|---|
| 1. | Ferula asafoetida powder | 30 mg | Active ingredient |
| 2. | Aloe Vera gel | 5 ml | Hydrating agent, moisturizing agent |
| 3. | HPMC K100 | 250 mg | Gelling agent, viscosity builder |
| 4. | Almond oil | 4 ml | Oil phase, rich in vitamin E |
| 5. | Tween 80 | 1.5 ml | Surfactant and emulsifier |
| 6. | Triethanolamine (TEA) | 0.1 ml | Alkalizing agent, emulsifying agent |
| 7. | Sodium benzoate | 0.5 mg | Preservative |
| 8. | Glycerine | 3 ml | Humectant |
| 9 | . Rosewater | 3 ml | Flavouring agent |
| 10. | Vitamin E | 1 Cap. | Antioxidant |
| 11. | Distilled water | Quantity to make 30 ml | Vehicle |

**Table No. 3: List of materials used for face serum formulation:**


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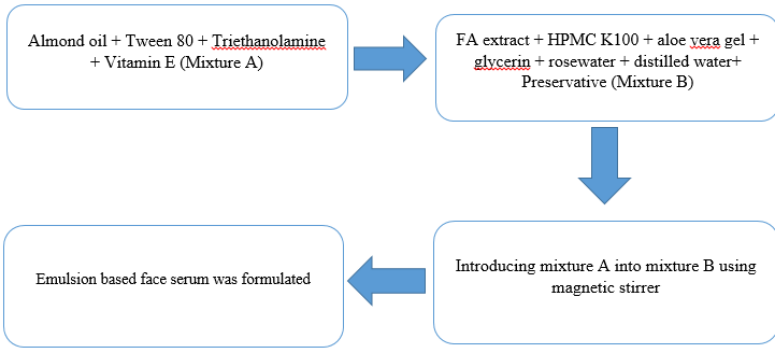
## VI. METHOD OF PREPARATION:




## VII. EVALUATION PARAMETERS :

1. Physical characterization
2. Texture
3. Presence of foreign particle
4. pH
5. Viscocity
6. Microscopic detection of globule formation
7. Phase separation study
8. Skin irritation test
9. Stability study
10. Drug Content

**1. Physical Characterization :**
Physical evaluation of the face serum was carried out by observing its colour, clarity, odour, and stability (absence or presence of phase separation) through visual inspection[23].

**2. Texture:**
The texture of the face serum was evaluated based on its visual appearance and feel upon application.

**3. Presence of Foreign particle:**
Evaluation was carried out by observing the appearance, assessing the texture by touch, and inspecting the sample with a magnifying lens.

**4. pH:**
The pH of the face serum was measured using a digital pH meter. Prior to analysis, the instrument was calibrated with standard buffer solutions of pH 7 and pH 4[24]. Approximately 10 mL of the serum was transferred into a clean beaker, and the electrode was immersed in the sample.

**5. Viscosity:**
The viscosity of the prepared face serum was determined using a Ostwald viscometer. Measurements were carried out between 1.5 to 2.5 cP .The Serum Flow time is 150 sec.

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**6. Microscopic detection of globule formation:**
A small quantity of the face serum was placed on a clean glass slide, and a coverslip was gently positioned over it to form a thin, uniform layer. The prepared slide was then examined under a microscope at different magnifications (10×, 45×, and 100×) using the respective objective lenses.

**7. Phase separation study :**
The formulations were kept undisturbed for 24 hours and observed at 8-hour intervals (8, 16, and 24 hours) to detect any occurrence of phase separation[25].

**8. Skin Irritation Test :**
The skin irritation test was performed to evaluate the safety and compatibility of the formulated face serum for topical application. A small quantity of the serum was applied to a selected area of skin. The volunteers did not report any discomfort, and no visible skin reactions were observed during the study. The pH of the formulation was also within the acceptable range for facial skin.

**9. Stability study:**
A stability study was carried out to evaluate the physical and chemical stability, as well as the overall safety of the formulation. The samples were stored under different conditions, including 4 ± 2°C with 60% relative humidity and 30°C with 75% relative humidity, for a period of 45 days. At 15-day intervals, the samples were analyzed to assess stability and to detect any changes in their characteristics.

**10. Drug Content:** The Asafoetida is anaylazed in UV Spectrophotometry.The sample solution must be clear and properly filtered. The Ferulic Acid has Absorption maximum around 320 – 325 nm. The Absorbance must be around 0.2- 0.8. is usually recorded in the range of 200 – 400 nm by using distilled water as a blank solution[26].

## VIII. RESULTS AND DISCUSSIONS:

**1. Physical characterization:**
All face serum formulations containing FA extract were observed to be whitish in colour, turbid in appearance, odourless, and homogeneous. The whitish colour was attributed to the presence of HPMC K100, while the turbidity was due to the emulsion-based nature of the formulation.

**2. Texture :**
All face serum formulations containing FA extract exhibited a smooth and uniform texture.

**3. Presence of foreign particle:**
All formulations of the FA extract-based face serum were free from foreign particles, as verified by both visual observation and touch[27].

**4. pH:**
The pH of all face serum formulation of FA extract was found between the range of 5.5 to 6.5 which was considered as acceptable and between ideal range as normal skin pH ranges from pH 5.5 to 7 . The variation in pH among all formulation was almost negligible.

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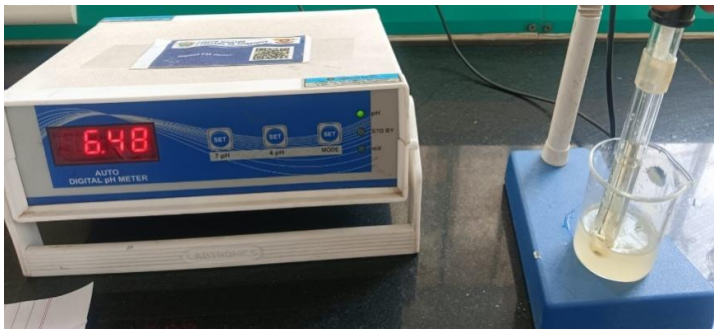


**10.1 Fig.- $P^H$ Meter**

| Sr.no. | Formulation code | $p^H$ |
|---|---|---|
| 1. | F1 | 6.10± 0.07 |
| 2. | F2 | 6.24± 0.24 |
| 3. | F3 | 6.48± 0.36 |

**Table No.4 : $P^H$ Reading**

**5. Viscosity :** The viscosity of the face serum formulations depended on the amount of HPMC K100 used. An increase in HPMC K100 concentration resulted in higher viscosity, whereas a lower concentration led to reduced viscosity. Additionally, all formulations exhibited shear-thinning characteristics, where the viscosity decreased as the applied shear rate increased[28].

| Sr. No. | Formulation Code | Flow Time(Sec) | Calculated Viscocity (cP) |
|---|---|---|---|
| 1. | F1 | 152 | 1.52 |
| 2. | F2 | 198 | 1.98 |
| 3. | F3 | 223 | 2.23 |

**Table No.5 : Viscometer Reading**

**6. Microscopic detection of globule formation:**

Microscopic evaluation of all face serum formulations confirmed the successful formation of oil-in-water (O/W) emulsion systems through the presence of oil globules[29]. Some formulations showed smaller and uniformly distributed globules due to higher emulsifier concentration and lower viscosity, while others exhibited larger globules because of lower emulsifier content and higher viscosity. Smaller globule size improves drug entrapment efficiency and bioavailability. Therefore, the formulations with smaller and uniform globules were considered most suitable for further characterization[30].

**10.2 Fig.- Globule Formation under Microscope**

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**7. Phase separation:**

The phase separation study showed that formulations were more stable than mainly due to their higher viscosity. Among these three formulations exhibited the highest drug diffusion[31.] Microscopic analysis also revealed that had a greater number of well-formed globules with smaller globule size, as discussed earlier. Since smaller globules contribute to better drug entrapment and improved bioavailability.

| Sr no. | Formulation Code | Phase Seperation | | |
|---|---|---|---|---|
| | | 8 Hrs | 16 Hrs | 24Hrs |
| 1. | F1 | No | Yes | Yes |
| 2. | F2 | No | No | Yes |
| 3. | F3 | No | No | No |

**Table No.6 : Phase Seperation Reading**

**8. Skin Irritation Test:**

The serum was applied to a small area of skin and observed for signs of redness, itching, burning, swelling, or any allergic reaction over a specific period [32.]The pH of the serum was also found to be suitable for skin application These findings indicate that the face serum is gentle. The absence of adverse reactions suggests that the formulation has good skin compatibility and can be considered safe for cosmetic application[33.]

**9. Stability study:**

The face serum formulation did not indicate gross change in appearance, viscosity, pH, and drug release. Short-term stability study of prepared face serum formulation was carried out by storing in collapsible tube at temperature 4±2°C and 30±2°C for a period of 45 days. At intervals of one week the face serum was visually examined for any physical changes[34.]

| Sr. No. | Parameters | Initials | 15 days | 30 Days | 45 Days |
|---|---|---|---|---|---|
| **4±2°C 60%RH** | | | | | |
| **Formulation Batch** | | **F3** | **F3** | **F3** | **F3** |
| 1. | Colour | White | White | White | White |
| 2. | Viscocity | 1.57± 0.02 | 1.67± 0.02 | 1.78± 0.02 | 1.89± 0.02 |
| 3. | $p^H$ | 5.80± 0.01 | 6.09± 0.11 | 6.34±0.12 | 6.24± 0.01 |
| 4. | Phase Seperation | No | No | No | No |

**Table No.7 : Stability Test Reading**

**10. Drug Content :**

The water extract prepared from asafoetida was subjected to UV spectrophotometric analysis after filtration to obtain a clear solution. The spectrum exhibited a noticeable absorption peak near 320–325 nm, which suggests the presence of ferulic acid and other phenolic constituents[35.]

**Procedure:**

1. Take 1 mL of Asafoetida Extract and dilute with 9 mL distilled water.
2. Switch on the UV-Visible spectrophotometer and allow it to warm up.
3. Fill the quartz cuvette with distilled water and set it as blank.
4. Replace the blank with the diluted sample.
5. Scan the sample in the wavelength range of 200-400 nm.
6. The absorbance values and Record determine the max.

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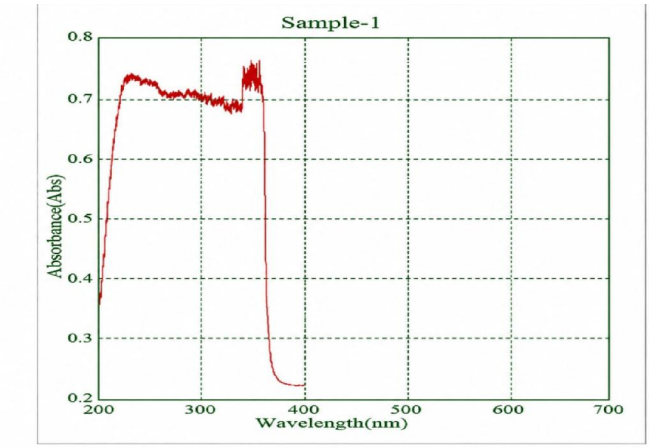


**10.3 Fig.- UV Spectrum**

| Wavelength(nm) | Absorbance |
|---|---|
| 319 | 0.70 |

**10.4 Fig.- Herbal Face Serum**

## IX. CONCLUSION:

The Ferula asafoetida extract and all other excipients used in the preparation of the face serum successfully met the required standards for identity, purity, and overall quality. Proper evaluation of the raw materials confirmed that they were suitable for cosmetic formulation and safe for topical application. During the compatibility study, no visible signs of physical or chemical interaction were observed between the Ferula asafoetida extract and the other formulation additives, indicating that the active ingredient was stable and compatible with the selected excipients. This compatibility is important for maintaining the effectiveness and safety of the final product. skin hyperpigmentation is a common dermatological condition characterized by excessive melanin deposition in the skin, leading to darkened

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patches or uneven skin tone. Factors such as ultraviolet radiation, hormonal imbalance, inflammation, aging, and certain medications contribute to its development, while appropriate skin care and targeted formulations like facial serums may help in its management.The formulated face serum containing Ferula asafoetida extract exhibited desirable physicochemical properties such as good consistency, appropriate viscosity, smooth texture, and a skin-friendly pH that makes it suitable for regular facial application. The serum also showed satisfactory spreadability and mechanical stability, which are essential for easy application and user acceptance. Additionally, the selected optimized formulations remained stable throughout the 30-day stability study without any significant changes in colour, odour, appearance, or texture. This stability indicates that the formulation can maintain its quality and effectiveness over time, making it a promising and reliable product for topical cosmetic use.

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