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Research Paper

Formulation and Therapeutic Assessment of Face Serums for Hyperpigmentation Disorders

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ABSTRACT

Hyperpigmentation is a common dermatological condition characterized by the darkening of certain areas of the skin due to increased melanin production or abnormal melanin distribution. It may result from sun exposure, acne, hormonal changes, inflammation, drug reactions, or aging. Face serums have emerged as a popular topical dosage form for hyperpigmentation because of their lightweight texture, high concentration of active ingredients, enhanced penetration, and cosmetic acceptability. This review discusses the causes, pathophysiology, classification, ideal properties, formulation aspects, active ingredients, mechanism of action, evaluation parameters, safety concerns, and future prospects of face serums used in hyperpigmentation management. The article also highlights novel ingredients and advanced delivery systems for improved efficacy and stability.[1]

INTRODUCTION

The skin is the largest organ of the human body and serves as the first line of defense against environmental, physical, chemical, and microbial insults. Beyond its protective role, the skin also has a major influence on physical appearance, self-image, social interaction, and psychological well-being. A healthy skin appearance is usually associated with smooth texture, adequate

hydration, elasticity, and an even skin tone. Among the many cosmetic and dermatological concerns affecting the skin, hyperpigmentation is one of the most common and widely reported problems across different age groups, genders, and skin types.[2] Hyperpigmentation is a condition in which certain areas of the skin become darker than the surrounding skin due to increased melanin synthesis, abnormal melanin distribution, or deposition of melanin in the epidermis and/or

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dermis. It commonly appears in the form of dark spots, acne marks, melasma, sun spots, post-inflammatory marks, and uneven skin tone. Although hyperpigmentation is generally not a life-threatening disorder, it is often considered cosmetically undesirable and may significantly affect an individual's confidence, quality of life, and emotional comfort, especially when it occurs on the face.[3]



Fig 1 – Face serum

The development of hyperpigmentation is a complex process involving multiple internal and external factors. Common causes include:

- Excessive sun exposure
- Hormonal fluctuations
- Acne and inflammation
- Skin injury
- Aging
- Drug-induced reactions
- Improper cosmetic practices

Among these, ultraviolet (UV) radiation is considered one of the most important triggers because it stimulates melanocytes to produce excess melanin as a protective response. Similarly, skin inflammation due to acne, eczema, burns, or irritation can lead to post-inflammatory hyperpigmentation (PIH), which is especially common in individuals with medium to darker skin tones. In women, hormonal influences may result in melasma, a chronic pigmentary condition that often affects the cheeks, forehead, nose, and upper lip.[4]

The biological basis of hyperpigmentation lies in the activity of melanocytes, which are specialized pigment-producing cells present in the basal layer of the epidermis. These cells synthesize melanin, the natural pigment responsible for the color of skin, hair, and eyes. Melanin production occurs through a biochemical process known as melanogenesis, in which the enzyme tyrosinase plays a key role. When melanogenesis becomes overactive or dysregulated, excess pigment accumulates in the skin, resulting in visible hyperpigmentation. [5]

2.Advantages of Face Serum for Hyperpigmentation:

- ❖ One of the biggest advantages of face serums is that they contain higher concentrations of active ingredients compared to many creams and lotions.
- ❖ Face serums usually have a lightweight and low-viscosity texture, which allows them to penetrate the skin more easily than heavier formulations.
- ❖ Face serums can be easily incorporated into a daily skincare regimen.
- ❖ Serums are generally preferred because they provide a pleasant cosmetic feel.[6]
- ❖ Serums are often formulated for specific skin concerns, making them more focused than general moisturizers.

3.Disadvantages of Face Serum for Hyperpigmentation

- ❖ One of the main disadvantages is that hyperpigmentation serums usually do not produce immediate results.
- ❖ Some serums can cause skin irritation, especially if they contain strong or multiple active ingredients.
- ❖ Certain active ingredients used in pigmentation serums are chemically unstable.

- ❖ A serum that works well for one person may not work well for another.
- ❖ Many users combine multiple skincare products without understanding ingredient compatibility.

4.Key Ingredients:

1. KOJIC ACID

Introduction

Kojic acid is a well-known skin brightening and depigmenting agent widely used in cosmetic and dermatological formulations for the treatment of hyperpigmentation, melasma, acne marks, sun spots, and uneven skin tone.[7]

It is a natural metabolic product produced by certain species of fungi during the fermentation process of some foods such as:

- Rice
- Soy sauce
- Sake

Because of its strong skin-lightening effect, kojic acid has become one of the most popular ingredients in face serums and brightening products.



Fig 2 kojic acid

2. ALOE VERA

Introduction

Aloe vera is one of the most widely used herbal skincare ingredients because of its soothing,

hydrating, healing, and anti-inflammatory properties. It is obtained from the leaves of the Aloe vera plant and is commonly used in topical cosmetic formulations.[8]

Although aloe vera is not as strong a depigmenting agent as kojic acid or alpha arbutin, it plays an important supportive role in hyperpigmentation treatment.



Fig 3 aloe vera

3. VITAMIN E

Introduction

Vitamin E is a well-known fat-soluble antioxidant used in both pharmaceutical and cosmetic formulations. It is highly valued in skincare because it helps protect the skin from oxidative damage, dryness, irritation, and environmental stress.[9]

In pigmentation serums, vitamin E is often used as a supportive antioxidant and skin-conditioning ingredient.



Fig 4 vitamin e

4. TURMERIC



Introduction

Turmeric is a traditional herbal ingredient widely used in Ayurveda, cosmetic care, and skin treatments. It is obtained from the rhizome of *Curcuma longa* and is known for its:[10]

- Anti-inflammatory properties
- Antioxidant activity
- Skin brightening effect
- Healing benefits [11]

Turmeric has long been used in face packs and skincare for improving complexion and reducing blemishes.



Fig 5 Turmeric

5. GREEN TEA

Introduction

Green tea is a popular botanical ingredient in skincare and cosmetic formulations due to its strong antioxidant, anti-inflammatory, soothing, and protective properties.[12] It is derived from the leaves of *Camellia sinensis* and is rich in biologically active compounds that support skin

health.



Fig 6 Green tea

5. EVALUATION

a) Physical Appearance:

The texture, color, and scent of the created cosmetic serum were assessed in order to gauge its physical appearance. [13]

b) PH:

A digital pH meter will be used to determine the pH test. A digital pH dipper will be inserted deeply into the serum

formulation sample, while the value of the pH will be recorded. Since the skin has an alkaline pH level of about 4-6, [14] the formulation's pH should be acidic as well.



Fig 7 PH test

C Viscosity:

Utilizing 4.5 ml of the colostrum and a spindle type model S6, the Brookfield viscometer is used to measure the formulation's viscosity at 100 rpm. Approximately five minutes before to the measurement, the spinning instrument [15] will be submerged in the serum in a large mouth container.

**Fig 8 viscosity test****d) Spread ability Test:**

A parallel plate method, commonly used to evaluate and quantify the spread ability of semisolid preparations, was utilized to determine spread ability[16]

**Fig 9 spread ability test****6. Market formulation :**

S.no	Marketed Product	Therapeutic Uses	Company Name
1	Vitamin c + E+ ferulic	Brightness and protects skin	Minimalist
2	Anti ageing vitamin c serum	Antioxidant	Aliver
3	Healthy Renew face serum	Improve skin texture	Cetaphil
4	Polypeptide serum	Smooths the appearance	Face facts
5	Hydrating hyaluronic acid serum	Replenishes hydration for instantly smoother	Cerave

7.Future Prospective:

The field of skincare and cosmetic dermatology is rapidly evolving due to advances in pharmaceutical science, biotechnology, nanotechnology, and dermatological research. Hyperpigmentation remains a common and challenging condition, and although current face serums provide beneficial results, there is significant scope for improvement in terms of efficacy, safety, stability, and personalization.[17] Future developments in face serums for hyperpigmentation are expected to focus on more scientifically advanced, targeted, and patient-specific approaches.

8.RESULT AND DISSCUSSION:-

Sr. No.	Parameter	Method	Observation/Requirement
1	Appearance	Visual inspection	Clear or slightly translucent, free from particles
2	Color	Visual observation	Light yellow/green (depending on ingredients)
3	Odor	Smelling	Pleasant and acceptable
4	Texture	Touch method	Smooth and non-greasy
5	Homogeneity	Visual inspection	Uniform, no lumps

CONCLUSION

Hyperpigmentation is a common dermatological and cosmetic concern characterized by the appearance of dark patches, uneven skin tone, and discoloration due to excess melanin production. Although it is not a harmful condition, it significantly affects an individual's appearance, confidence, and quality of life, especially when it occurs on visible areas such as the face. Therefore, effective and safe management of hyperpigmentation remains an important objective in both cosmetic science and dermatology.[18]

Face serums have emerged as one of the most preferred and effective topical formulations for the management of hyperpigmentation due to their lightweight texture, fast absorption, and high concentration of active ingredients. Unlike conventional creams, serums provide better penetration and targeted delivery of active compounds into the skin, which enhances their effectiveness in reducing pigmentation.[19]

In this study, various active ingredients such as kojic acid, aloe vera, vitamin E, turmeric, and green tea have been discussed in detail. Among these, kojic acid acts as a primary depigmenting agent by inhibiting melanin synthesis through the suppression of tyrosinase activity. On the other hand, aloe vera, vitamin E, turmeric, and green tea serve as supportive ingredients by providing anti-inflammatory, antioxidant, soothing, and skin-repairing effects, which are essential for improving overall skin health and preventing further pigmentation.[20]

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