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# "DEVELOPMENT OF HERBAL SKIN PROTECTIVE GEL CONTAINING ASIAN PIGEONWINGS FLOWER EXTRACT

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## ABSTRACT

The present research aims to formulate and evaluate a herbal antioxidant gel containing extract of Butterfly Pea, also known as Asian Pigeonwings. The flowers of this plant are rich in natural bioactive constituents such as anthocyanins, flavonoids, tannins, and phenolic compounds, which exhibit significant antioxidant activity. The extract was prepared and incorporated into a suitable gel base to develop a topical herbal formulation with enhanced stability and skin compatibility. The formulated gel was evaluated for various physicochemical parameters including color, appearance, homogeneity, pH, viscosity, spreadability, washability, and stability. Antioxidant activity of the formulation was also assessed using suitable in-vitro methods. The prepared gel showed satisfactory physical characteristics, good consistency, and appreciable antioxidant potential. The antioxidant properties of the formulation may help in reducing oxidative stress, protecting skin cells from free radical damage, and improving overall skin health. This study highlights the potential use of natural herbal ingredients in cosmetic and pharmaceutical preparations. The developed antioxidant gel can serve as a safe, economical, and effective alternative to synthetic antioxidant products and may have future applications in skincare and dermatological formulations

**KEYWORDS**: Butterfly pea flower, Antioxidant Activity, Skin Care, Herbal Drug, Natural Gel Formulation.

## INTRODUCTION

The use of herbal medicines and plant-based cosmetic formulations has increased rapidly due to the growing awareness regarding the harmful effects associated with synthetic chemicals. Herbal products are considered safer, biocompatible, cost-effective, and environmentally friendly. Among various herbal preparations, antioxidant formulations are widely used because antioxidants play an important role in protecting the body and skin from oxidative stress caused by free radicals.[1] Free radicals are unstable molecules generated during normal metabolic processes and environmental exposure such as pollution, ultraviolet radiation, and chemicals. Excessive production of free radicals can damage proteins, lipids, and DNA, leading to premature aging, inflammation, skin disorders, and other chronic diseases.[2] Therefore, antioxidant-rich herbal formulations have become an important area of research in pharmaceutical and cosmetic sciences.

Butterfly Pea, commonly known as Asian Pigeonwings or Butterfly Pea, is a perennial medicinal herb belonging to the Fabaceae family. The plant is widely distributed in tropical and subtropical regions and has been traditionally used in Ayurvedic and traditional medicine systems for various therapeutic purposes.[3] The flowers of Clitoria ternatea are especially valued because they contain significant amounts of anthocyanins, flavonoids, phenolic compounds, alkaloids, tannins, and glycosides, which are responsible for its potent antioxidant activity.[4] Anthocyanins present in the flowers provide a characteristic blue color and are known for their ability to neutralize free radicals and prevent oxidative damage.[5]

**Fig. Aisan Pigeonwing Flower.**

Several studies have reported that Clitoria ternatea possesses multiple pharmacological activities such as antioxidant, antimicrobial, anti-inflammatory, anti-diabetic, anti-cancer,

wound healing, and neuroprotective effects.[6] Due to these beneficial properties, the plant has gained considerable importance in the development of herbal pharmaceutical and cosmetic products. The antioxidant potential of Asian Pigeonwings makes it a promising natural ingredient for topical formulations intended to protect and nourish the skin.

Topical gel formulations are widely preferred in dermatological and cosmetic applications because they are non-greasy, transparent, easily spreadable, and provide better patient compliance compared to creams and ointments.[7] Gels can deliver active constituents effectively to the skin and provide a cooling and soothing effect after application. Herbal gels prepared using plant extracts have shown enhanced therapeutic effectiveness due to better penetration and prolonged contact with the skin surface.[8] Moreover, gels are easy to wash, aesthetically acceptable, and suitable for both medicinal and cosmetic use.

Incorporation of antioxidant-rich plant extracts into gel formulations can help reduce oxidative stress on the skin, prevent premature aging, improve skin hydration, and protect against environmental damage. Herbal antioxidant gels are also considered safer alternatives to synthetic antioxidant preparations, which may sometimes produce irritation or allergic reactions.[9] The use of natural antioxidants in skincare products has therefore become increasingly popular in recent years.

The present study is focused on the formulation and evaluation of an antioxidant herbal gel containing Asian Pigeonwings flower extract. The extract was incorporated into a suitable gel base using appropriate excipients to obtain a stable topical preparation. The formulated gel was evaluated for various physicochemical parameters including appearance, color, homogeneity, pH, viscosity, spreadability, washability, extrudability, and stability. Antioxidant activity was also assessed using suitable in-vitro methods to determine the effectiveness of the formulation.

**AIM**

- To formulate a herbal antioxidant gel using extract of Butterfly Pea (Asian Pigeonwings).
- To evaluate the physicochemical properties of the formulated gel such as pH, viscosity, homogeneity, spreadability, washability, and stability.
- To study the antioxidant activity of the herbal gel using suitable in-vitro evaluation methods.

- To develop a safe, stable, and effective topical herbal formulation for skincare applications.
- To explore the potential of natural plant-based antioxidants as an alternative to synthetic antioxidant formulations.

**OBJECTIVES**

- To prepare and formulate a herbal antioxidant gel using extract of Butterfly Pea (Asian Pigeonwings), which is rich in natural antioxidant compounds such as anthocyanins and flavonoids.[10]
- To evaluate the physicochemical properties of the formulated gel including color, appearance, pH, viscosity, homogeneity, spreadability, washability, and extrudability for ensuring formulation quality and stability.[11]
- To determine the antioxidant activity of the prepared herbal gel using suitable in- vitro antioxidant methods for assessing free radical scavenging potential.[12]
- To study the stability of the antioxidant gel under different storage conditions to ensure product safety and effectiveness during storage.[13]
- To develop a safe, effective, and economical herbal topical formulation that may help protect the skin from oxidative stress and free radical damage.[14]
- To promote the use of plant-based herbal formulations as alternatives to synthetic antioxidant skincare products.[15]

**PLANT PROFILE**

**Biological Source:** Scientific name: Clitoria ternatea

**Family:** Fabaceae

**Common names:** Asian pigeonwings, Butterfly pea, Aparajita (India)

**Geographical Source:** Native to tropical regions of:India Sri Lanka Thailand Malaysia Widely cultivated in Asia for medicinal and ornamental purposes.

**Microscopic Characters**

- **Leaf microscopy**

Epidermis with unicellular trichomes Paracytic stomata.

- **Stem**

Collenchyma below epidermis Vascular bundles arranged in ring.

- **Root**

Well-developed xylem and phloem.

- **Flower**

Pigment cells rich in anthocyanins.

**Chemical Constituents**

- Major phytochemicals include:
- Anthocyanins (ternatins) – responsible for blue color
- Flavonoids – kaempferol, quercetin
- Alkaloids
- Saponins
- Tannins
- Cyclotides (bioactive peptides)

**Pharmacological Activities**

- Neuroprotective (used in Alzheimer's disease research)
- Anxiolytic & antidepressant
- Antimicrobial
- Anti-inflammatory
- Antioxidant
- Antidiabetic

**Uses (Traditional & Modern)**

- Memory enhancer (Ayurvedic brain tonic)
- Treatment of stress, anxiety
- Skin and hair care formulations
- Natural food colorant (blue pigment)
- Used in herbal teas and nutraceuticals

**Fig. Flower.**

## LITERATURE REVIEW

### 1. Herbal Medicines and Antioxidant Therapy

Herbal medicines have been used since ancient times for the prevention and treatment of various diseases. In recent years, there has been growing interest in herbal formulations due to their natural origin, fewer side effects, affordability, and therapeutic effectiveness. Antioxidants obtained from medicinal plants are important because they protect the body against oxidative stress caused by free radicals.[16] Free radicals are unstable molecules that damage cellular components such as proteins, lipids, and DNA, resulting in aging, inflammation, cancer, and skin disorders.[17] Plant-based antioxidants are therefore widely used in cosmetic and pharmaceutical preparations for maintaining skin health and preventing oxidative damage.

Natural antioxidants mainly include flavonoids, phenolic acids, anthocyanins, tannins, and vitamins. These compounds neutralize free radicals by donating electrons and reducing oxidative reactions.[18] Compared to synthetic antioxidants, herbal antioxidants are considered safer and more biocompatible. Hence, the development of herbal antioxidant formulations has become an important area of research in pharmaceutical sciences.

### 2. Medicinal Importance of Butterfly Pea

Clitoria ternatea L., commonly known as Butterfly Pea or Asian Pigeonwings, is a perennial herb belonging to the Fabaceae family. The plant is commonly found in tropical and subtropical regions and has been widely used in Ayurvedic medicine for its therapeutic properties.[19] The flowers are blue in color due to the presence of anthocyanin pigments known as ternatins. These compounds possess strong antioxidant activity and contribute to the medicinal value of the plant.[20]

The plant contains various phytoconstituents such as flavonoids, anthocyanins, tannins, alkaloids, glycosides, saponins, and phenolic compounds.[21] These constituents are responsible for several pharmacological activities including antioxidant, antimicrobial, anti-inflammatory, analgesic, anti-diabetic, hepatoprotective, neuroprotective, and wound healing effects.[22] Due to these medicinal properties, Clitoria ternatea has gained significant attention in herbal pharmaceutical and cosmetic research.

### 3. Antioxidant Activity of Clitoria ternatea

Many studies have reported the antioxidant potential of Butterfly Pea flower extracts.

Kazuma et al. identified several anthocyanins called ternatins in Clitoria ternatea flowers and reported their strong free radical scavenging activity.[23] Anthocyanins are natural pigments that possess antioxidant properties by inhibiting lipid peroxidation and reducing oxidative stress.

A study conducted by Marpaung et al. demonstrated that aqueous and ethanolic extracts of Clitoria ternatea flowers showed significant antioxidant activity due to the presence of phenolic and flavonoid compounds.[24] Similarly, other researchers reported that the plant extract exhibited high DPPH radical scavenging activity, indicating its potential as a natural antioxidant source.[25] These findings support the use of Butterfly Pea extract in topical antioxidant formulations.

## 4. Topical Herbal Gel Formulations

Topical drug delivery systems are widely used for the treatment of skin disorders and for cosmetic applications because they deliver active constituents directly to the site of action. Among various topical dosage forms, gels are preferred due to their non-greasy nature, ease of application, transparency, and better patient compliance.[26] Gels provide a cooling effect on the skin and allow uniform distribution of active ingredients.

Herbal gels containing medicinal plant extracts have become increasingly popular because they combine the therapeutic benefits of herbal medicine with the advantages of topical gel formulations.[27] Herbal gels can improve skin hydration, reduce inflammation, protect against microbial infections, and provide antioxidant effects. The incorporation of antioxidant-rich plant extracts into gel bases enhances skin protection against environmental stress and aging.

## 5. Polymers and Excipients Used in Gel Formulation

Various polymers such as Carbopol, Hydroxypropyl Methylcellulose (HPMC), Sodium Carboxymethyl Cellulose (Na-CMC), and Poloxamers are commonly used in gel formulations.[28] These polymers provide suitable viscosity, consistency, and stability to the formulation. Excipients such as propylene glycol, glycerin, preservatives, and neutralizing agents are also added to improve spreadability, stability, and patient acceptability.

The selection of appropriate gelling agents and excipients is important for achieving desirable physicochemical properties including pH, homogeneity, viscosity, spreadability, and extrudability.[29] Stable gel formulations ensure proper release and activity of herbal

constituents.

### 6. Evaluation Parameters of Herbal Gels

Evaluation of herbal gels is essential to ensure their quality, stability, and therapeutic effectiveness. Important evaluation parameters include physical appearance, color, odor, pH, viscosity, spreadability, homogeneity, washability, extrudability, and skin irritation tests.[30] Stability studies are also carried out under different temperature and humidity conditions to determine the shelf-life of the formulation.[31] Antioxidant activity of herbal gels is generally evaluated using in-vitro methods such as DPPH radical scavenging assay, hydrogen peroxide scavenging assay, and ferric reducing antioxidant power (FRAP) assay.[32] These methods help determine the free radical scavenging potential of the formulation.

### 7. Research Gap and Need for Study

Although several studies have reported the antioxidant and medicinal properties of Clitoria ternatea, limited research is available on the formulation and evaluation of antioxidant herbal gels using Asian Pigeonwings flower extract. Most studies focus on the extract alone rather than its incorporation into stable topical formulations. Therefore, there is a need to develop an effective herbal antioxidant gel using Clitoria ternatea extract and evaluate its physicochemical and antioxidant properties. Such formulations may provide safer and economical alternatives to synthetic skincare products.

## MATERIALS AND METHODS

### MATERIALS

The materials used for the preparation of antioxidant herbal gel were flower extract of Butterfly Pea (Asian Pigeonwings), Carbopol 934 as gelling agent, propylene glycol as humectant, glycerin as moisturizing agent, methyl paraben and propyl paraben as preservatives, triethanolamine as pH adjusting agent, and distilled water as vehicle. All chemicals and reagents used in the study were of analytical grade.[33,34]

### METHODS

#### 1. Collection and Preparation of Plant Material

Fresh flowers of Butterfly Pea were collected and authenticated by a pharmacognosist. The flowers were washed with water to remove impurities and shade dried at room temperature. The dried flowers were powdered using a mechanical grinder and stored in an airtight container for further use.[35]

### 2. Preparation of Extract

The powdered flower material was extracted by aqueous extraction method. About 50 g of dried powder was mixed with distilled water and heated at 60–70°C for 30–45 minutes with continuous stirring. The extract was filtered using muslin cloth followed by Whatman filter paper. The filtrate was concentrated on a water bath until a semisolid extract was obtained.[36]

### 3. Formulation of Antioxidant Gel

Carbopol 934 was dispersed in distilled water and allowed to hydrate completely. Methyl paraben and propyl paraben were dissolved in propylene glycol and added to the hydrated polymer solution. The prepared extract and glycerin were incorporated slowly with continuous stirring. Triethanolamine was added dropwise to adjust the pH and obtain the required gel consistency. The formulation was mixed thoroughly to obtain a homogeneous antioxidant herbal gel.[33,37]

### 4. Evaluation of Gel

The prepared gel formulation was evaluated for various physicochemical parameters such as appearance, color, homogeneity, pH, viscosity, spreadability, washability, and stability using standard procedures.[34] Antioxidant activity was determined by DPPH free radical scavenging assay using UV-visible spectrophotometric analysis.[38]

## METHODS OF PREPARATION

### 1. Collection and Authentication of Plant Material

Fresh flowers of Butterfly Pea (Asian Pigeonwings) were collected from a local garden or herbal source during the flowering season. The collected flowers were authenticated by a botanist or pharmacognosy expert to confirm the identity of the plant material [39]. The flowers were washed thoroughly with distilled water to remove dust, dirt, and other impurities. Clean flowers were shade dried at room temperature for about 7–10 days until complete drying was achieved. Shade drying was preferred to prevent degradation of heat-sensitive phytoconstituents such as anthocyanins and flavonoids.[40]

The dried flowers were powdered using a mechanical grinder and passed through a sieve to obtain uniform particle size. The powdered material was stored in an airtight container protected from moisture and light until further use.[41]

## 2. Preparation of Plant Extract

### Aqueous Extraction Method

About 50 g of dried flower powder of Clitoria ternatea was accurately weighed and transferred into a clean beaker. Approximately 500 mL of distilled water was added to the powder and the mixture was heated at 60–70°C for 30–45 minutes with continuous stirring.[42] Heating helps in the extraction of water-soluble phytoconstituents such as anthocyanins, flavonoids, and phenolic compounds.

After heating, the mixture was cooled to room temperature and filtered first through muslin cloth to remove coarse particles and then through Whatman filter paper to obtain a clear filtrate.[43] The filtrate was concentrated using a water bath at controlled temperature until a semisolid extract was obtained. Excessive heating was avoided to prevent degradation of active constituents. The concentrated extract was transferred into a clean container and stored in a refrigerator at 4°C for further formulation studies.[44]

## 3. Preparation of Gel Base

Carbopol 934 was used as the gelling agent for the preparation of the antioxidant gel. Required quantity of Carbopol 934 (1%) was slowly sprinkled into distilled water with continuous stirring to avoid formation of lumps.[45] The dispersion was allowed to stand for 24 hours for complete hydration and swelling of the polymer. Proper hydration of Carbopol is essential for obtaining smooth gel consistency and uniform viscosity.[46]

## 4. Preparation of Preservative Solution

Required quantities of methyl paraben and propyl paraben were accurately weighed and dissolved in propylene glycol using gentle heating.[47] Propylene glycol acts as a solvent as well as a humectant and penetration enhancer in topical formulations. The preservative solution was cooled before incorporation into the gel formulation.

## 5. Incorporation of Herbal Extract

The prepared semisolid extract of Clitoria ternatea was mixed with glycerin to improve dispersion and moisturizing properties. This mixture was then added slowly to the hydrated Carbopol gel base with continuous stirring to ensure uniform distribution of the extract throughout the formulation.[48] Continuous stirring was maintained to avoid air entrapment and ensure homogeneity of the gel.

### 6. Preparation of Final Gel

After complete incorporation of the extract, the preservative solution containing methyl paraben and propyl paraben was added slowly to the formulation with constant stirring. Triethanolamine was then added dropwise to neutralize the Carbopol dispersion and adjust the pH of the gel to skin-compatible range (approximately pH 6–7).[49] Neutralization causes thickening of the dispersion and conversion into gel form.

The final formulation was stirred continuously until a smooth, transparent, and homogeneous gel was obtained. Care was taken to avoid formation of bubbles during mixing. The prepared antioxidant gel was evaluated visually for appearance, consistency, color, and homogeneity.[50]

### 7. Packaging and Storage

The prepared antioxidant herbal gel was transferred into clean, dry, airtight containers or collapsible tubes and properly labeled. The formulation was stored at room temperature away from direct sunlight and moisture until further evaluation studies such as pH determination, viscosity, spreadability, stability testing, and antioxidant activity assessment.[51]

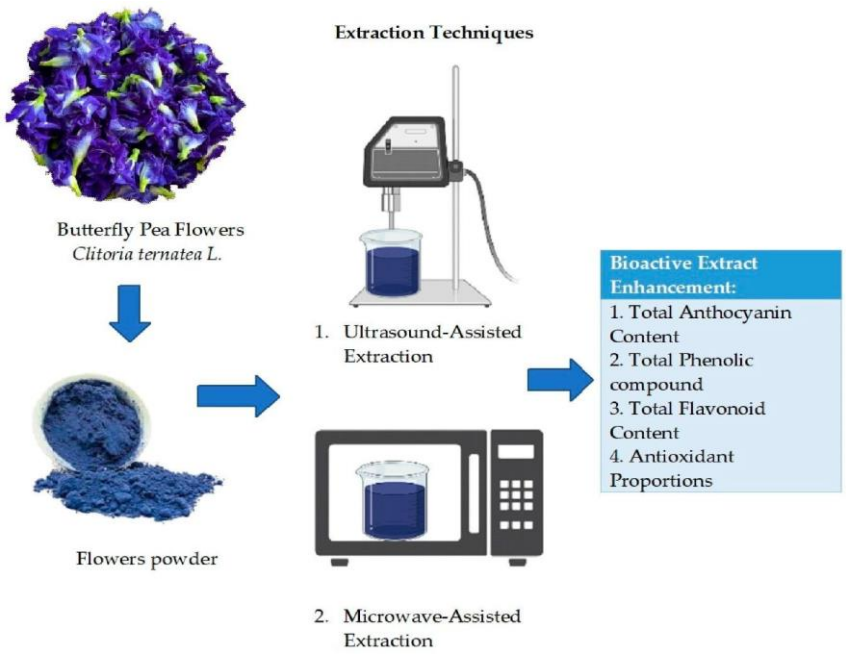


**Fig. Method of preparation.**

## EVALUATION PARAMETERS OF ANTIOXIDANT GEL

### 1. Physical Appearance

The formulated gel was visually inspected for color, appearance, clarity, consistency, and

presence of any aggregates or phase separation. A good herbal gel should possess smooth texture and uniform appearance.[52]

**2. Homogeneity**

Homogeneity was evaluated by visual inspection after the gel was set in the container. The formulation was checked for uniform distribution of ingredients and absence of lumps or coarse particles.[53]

**3. pH Determination**

The pH of the gel was determined using a calibrated digital pH meter at room temperature. About 1 g of gel was dispersed in distilled water and measured to ensure compatibility with skin pH and avoid irritation.[54]

**4. Viscosity**

Viscosity of the prepared gel was measured using a Brookfield viscometer at suitable spindle speed. Viscosity is an important parameter affecting spreadability and stability of the formulation.[55]

**5. Spreadability**

Spreadability was determined by placing a small quantity of gel between two glass slides and applying a specific weight. The diameter or time taken for spreading was measured. Good spreadability ensures easy application on the skin.[56]

**6. Washability**

Washability was evaluated by applying the gel on the skin and checking the ease of removal using water. A good gel formulation should be easily washable without leaving residue.[57]

**7. Extrudability**

Extrudability was determined by measuring the amount of gel extruded from a collapsible tube upon application of pressure. It indicates the ease with which the gel can be removed from the container.[53]

**8. Stability Study**

The stability study of the prepared gel was carried out by storing the formulation at different temperature conditions and observing changes in color, pH, viscosity, and phase separation over a specific period according to ICH guidelines.[57]

### 9. Antioxidant Activity

The antioxidant activity of the gel was evaluated using DPPH free radical scavenging assay. The decrease in absorbance was measured using a UV-visible spectrophotometer, and percentage inhibition was calculated to determine antioxidant potential.[58]

### 10. Skin Irritation Test

The formulated gel was applied to the skin surface and observed for redness, itching, irritation, or inflammation. This test was performed to ensure safety.[56]


**Fig. evaluation parameter.**


**Fig. formulation of gel.**

**BATCHES TABLE**

Formulation Batches Table for 20 g Antioxidant Herbal Gel Ingredients are as follows

| INGEDIENTS | B1 (20 g) | B2 (20 g) | B3 (20 g) |
|---|---|---|---|
| Butterfly pea flower extract | 0.2 g | 0.4 g | 0.6 g |
| Carbopol 934 | 0.2 g | 0.2 g | 0.2 g |
| Propylene Glycol | 2 g | 2 g | 2 g |
| Glycerine | 1 g | 1 g | 1 g |
| Methyl Paraben | 0.002 g | 0.002 g | 0.002 g |
| Propyl Paraben | 0.004 g | 0.004 g | 0.004 g |
| Triethanolamine | q.s. | q.s. | q.s. |
| Distilled Water | q.s. to 20 g | q.s. to 20 g | q.s. to 20 g |

Description of Batches

B1 = 1% extract concentration B2 = 2% extract concentration B3 = 3% extract concentration

Different batches were prepared to evaluate the effect of varying concentrations of herbal extract on the physicochemical properties, stability, and antioxidant activity of the gel formulation.[1,2]

**OBSERVATION TABLE**

Observation Table for Evaluation of Antioxidant Herbal Gel are as follows

| EVALUATION PARAMETER | B1 | B2 | B3 |
|---|---|---|---|
| Color | Light purple | Purple | Dark purple |
| Appearance | Smooth | Smooth | Smooth |
| Homogeneity | Good | Good | Good |
| pH | 6.4 | 6.6 | 6.8 |
| Viscocity (cPs) | 4200 | 4500 | 4800 |
| Spreadability(g/sec) | 5.8 | 6.2 | 6.5 |
| Washability | Good | Good | Good |
| Extrudability | Excellent | | Good |
| Stability | Stable | Stable | Stable |
| Antioxidant Activity (% inhibition) | 68% | 75% | 82% |
| Skin Irritation Test | No irritation | No irritation | No irritation |

**RESULT AND INTERPRETATION**

**RESULTS**

The antioxidant herbal gel containing extract of Butterfly Pea was successfully formulated. All batches (B1, B2, and B3) showed smooth texture, good homogeneity, and acceptable appearance without phase separation. The color of the gel changed from light blue to dark blue with increase in extract concentration.

The pH of all formulations was found within the acceptable range for skin application (6.4–

6.8). Viscosity and spreadability studies indicated good consistency and easy application of the gel. Washability and extrudability of all batches were satisfactory. Stability studies showed no significant changes in color, pH, viscosity, or homogeneity during storage conditions.

The antioxidant activity evaluated by DPPH assay showed that F3 formulation possessed the highest percentage inhibition among all batches due to higher concentration of herbal extract. No signs of skin irritation such as redness or itching were observed during the skin irritation study.

**Interpretation**

The study indicated that the formulated herbal gel possessed suitable physicochemical properties for topical application. The acceptable pH suggested that the formulation is safe and compatible with skin. Good viscosity and spreadability confirmed effective gel consistency and ease of application.

Increase in antioxidant activity with higher extract concentration demonstrated that Butterfly Pea extract contains active phytoconstituents such as flavonoids and anthocyanins responsible for free radical scavenging activity. The stability results indicated that the prepared gel remained stable under storage conditions without physical changes. The absence of skin irritation confirmed the safety of the formulation for topical use. Overall, the results suggest that the prepared antioxidant herbal gel may serve as a safe, stable, and effective natural formulation for skincare applications.

**DISCUSSION**

The antioxidant herbal gel containing extract of Butterfly Pea was successfully formulated and evaluated. The prepared gel showed good appearance, homogeneity, suitable pH, satisfactory viscosity, and good spreadability, indicating its suitability for topical application.

The antioxidant activity increased with higher concentration of herbal extract, with F3 showing the best antioxidant effect due to the presence of flavonoids and anthocyanins. Stability studies showed no significant changes in the formulation, and no skin irritation was observed. Overall, the study confirmed that the formulated herbal gel is stable, safe, and possesses effective antioxidant activity, making it a promising natural skincare formulation.

## CONCLUSION

The present study successfully formulated and evaluated an antioxidant herbal gel containing extract of Butterfly Pea. The prepared gel showed satisfactory physicochemical properties such as good homogeneity, suitable pH, viscosity, spreadability, and stability.

The formulation exhibited significant antioxidant activity due to the presence of natural phytoconstituents such as flavonoids and anthocyanins in the plant extract. No skin irritation or instability was observed during evaluation studies.

Thus, the developed herbal antioxidant gel can be considered a safe, stable, and effective topical formulation with potential applications in skincare and cosmetic preparations as a natural alternative to synthetic antioxidant products.

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