

# Formulation and Evaluation of Herbal Vitamin C Serum from Orange Peel Extract

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## Abstract

Herbal skincare products are increasingly favoured due to their efficacy and minimal side effects. The skin, as the largest and most exposed organ, is particularly susceptible to environmental stressors and lifestyle changes. Vitamin C serum, a topical formulation rich in ascorbic acid, offers multiple dermatological benefits, including stimulation of collagen synthesis, reduction of fine lines and wrinkles, improvement of skin tone and texture, and protection against oxidative damage and photoaging. In this study, a herbal Vitamin C serum was developed using orange peel extract, leveraging its natural antioxidant properties. The formulation ensures enhanced penetration into the deeper layers of the skin for optimal efficacy. Factors such as active concentration, composition, and synergistic ingredients were carefully optimized to maximize benefits while minimizing irritation, with Vitamin C concentrations maintained within the safe and effective range of 5–20%. The serum demonstrated favourable physicochemical properties, stability, and biocompatibility, making it suitable for routine topical application. Proper usage involves applying a few drops to cleansed, dry skin once or twice daily, preferably with sunscreen during daytime, to achieve maximum skin protection and rejuvenation. This study highlights the potential of agro-waste-derived extracts in developing effective, safe, and sustainable cosmetic formulations.

**Keywords:** Vitamin C serum; Orange peel; Herbal skincare; Antioxidant; Anti-aging; Topical formulation.

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## 1. INTRODUCTION

Herbal cosmetics, referred to as "products," are defined as formulations that utilize various approved cosmetic ingredients as a base in which one or more herbal components are incorporated. These herbal ingredients are included specifically to deliver certain cosmetic benefits. Therefore, products that meet this criterion are classified under the term "herbal cosmetics" <sup>[1]</sup>. Cosmetics are

products designed for application on the body to enhance beauty, cleanliness, and overall appearance. They include a wide variety of items such as toothpaste, shampoos, conditioners, mascara, aftershave lotion, styling gels, creams, lotions, powders, perfumes, lipsticks, and nail polish, among others. "Makeup" specifically refers to cosmetic items intended to change one's appearance through color. According to Schneider et al., skincare products, a subset of cosmetics, comprise synthetic or natural compounds used to improve the body's appearance or scent. These articles are typically applied to the human body to promote attractiveness or cleansing, without altering physical structure or function [2]. The rising interest in natural and sustainable skincare has prompted the cosmetic and pharmaceutical sectors to investigate plant-derived ingredients, particularly those with significant bioactive effects. Vitamin C, or ascorbic acid, stands out due to its recognized antioxidant, brightening, and hydrating abilities, positioning it as a crucial component in contemporary skincare products. Synthetic sources of vitamin C typically encounter challenges related to stability and have restricted bioavailability [3].

Orange peels, a significant by-product of the citrus industry, are abundant in vitamin C, flavonoids, and essential oils, which contribute to various dermatological benefits. These benefits include anti-aging properties, enhancement of skin tone, and increased skin hydration. The use of orange peel extract not only adds value to agricultural waste but also supports green chemistry principles and sustainable development [4]. Herbal serum has been formulated with orange peel extract as its primary source of natural vitamin C, aimed at improving skin brightness and hydration. This development targets consumers looking for both effective and gentle skincare options. The study investigates the serum's physicochemical properties, stability, antioxidant activity, and compatibility with skin, establishing a scientific foundation for its potential application in cosmeceuticals [5].

### 1.1 Anatomy of skin

Skin anatomy is essential for understanding its functions and behaviors, providing context for common skin disorders discussed later in the paper. Knowledge of skin components aids in identifying dysfunction and planning appropriate treatment. The skin performs several crucial roles, including physical and chemical protection, prevention of excess water loss, and thermoregulation [6].

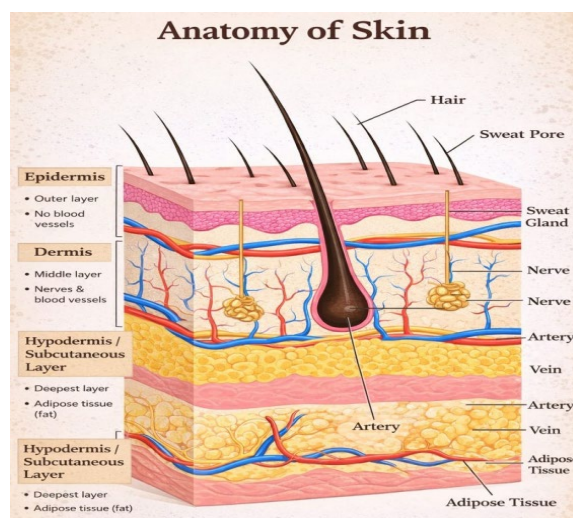


Figure 1. Anatomy of skin

**Three layers of skin:**

1. Epidermis
2. Dermis
3. Hypodermis

**1. Epidermis:** The epidermis is primarily composed of stratified squamous epithelium and lacks blood vessels. Its thickness varies, measuring less than 0.1 mm in most areas, while remaining consistent at certain locations, such as the palms and soles, due to the continual division of cells in the basal or germinative layer [7].

**Layers of Epidermis:**

- Stratum corneum
- Stratum lucidum
- Stratum granulosum
- Stratum spinosum
- Stratum basale (Stratum germinativum)

**2. Dermis:** The dermis is located between the epidermis and the subcutaneous layer and houses various types of sensory receptors that detect touch, pressure, vibration, pain, and temperature [8].

**3. Hypodermis:** Subcutaneous tissue, also referred to as Sub-Q, is characterized by its composition of loose connective tissue that includes both collagen and elastic fibers. This layer plays a vital role in providing support and elasticity to the skin [9].

**2. MATERIAL AND METHOD****2.1 Ingredients****2.1.1 Coconut oil**

**Botanical Name:** *Cocos nucifera* Linn.

**Family:** Arecaceae

**Chemical Constituents:**

Coconut oil is composed primarily of saturated and unsaturated fatty acids. The major fatty acids include:

- **Oleic acid** – a monounsaturated fatty acid known for its moisturizing and skin-nourishing properties.
- **Myristic acid** – a saturated fatty acid that provides emollient and texture-enhancing effects in topical formulations.
- **Palmitic acid** – a saturated fatty acid that helps in skin barrier protection and acts as a stabilizer in cosmetic preparations.

**Uses:**

Coconut oil is widely used in cosmetic and pharmaceutical industries due to its emollient, moisturizing, and protective properties. It is commonly incorporated in skin care preparations such as creams, lotions, ointments, and hair care products to maintain skin hydration, improve texture, and provide a protective barrier against environmental damage [10].

**2.1.2 Vitamin E**

**Chemical Name:** Tocopherols and Tocotrienols

**Chemical Constituents:**

Vitamin E is a group of fat-soluble compounds that include tocopherols and tocotrienols, characterized by a chromanol ring and a hydrophobic side chain. It is rich in phenolic compounds,

which exhibit potent antioxidant activity by scavenging free radicals, thereby preventing oxidative damage to cellular membranes, lipids, and proteins.

**Uses:**

Vitamin E is extensively used in cosmetic and pharmaceutical formulations due to its skin-beneficial properties. It acts as a moisturizer, improves skin hydration, and helps maintain skin elasticity. Additionally, its strong antioxidant activity contributes to anti-aging effects by reducing the formation of wrinkles, fine lines, and other signs of premature skin aging. Vitamin E is commonly incorporated into creams, lotions, serums, and other topical skin care products to protect the skin from environmental stressors and promote overall skin health <sup>[11]</sup>.

**2.1.3 Rose water**

*Rosa centifolia* (*Rosa centifolia* L.)

**Family:** Rosaceae

**Chemical Constituents:**

- Rich in **citronellol** – a monoterpenoid alcohol with antioxidant, anti-inflammatory, and skin-soothing properties.
- Contains **geraniol** – a natural compound with fragrance and antioxidant activity, contributing to skin protection and rejuvenation.

**Uses:**

- **Fragrance:** Provides a pleasant, floral aroma in cosmetic and skincare products.
- **Soothing Effect:** Helps calm and comfort irritated or sensitive skin.
- **Anti-inflammatory:** Reduces skin inflammation and redness.
- **Antioxidant:** Protects skin from oxidative stress and environmental damage <sup>[12]</sup>.

**2.1.4 Glycerine****Biological Source:**

- Obtained from vegetable oils (such as coconut, palm, and soybean oils) and animal fats through hydrolysis or saponification processes.

**Chemical Constituent:**

- **Glycerol (tri-hydroxy alcohol):** A simple polyol compound containing three hydroxyl (–OH) groups, which contribute to its strong hydrophilic and moisturizing properties.

**Uses:**

- **Humectant:** Attracts and retains moisture in the skin, preventing dryness.
- **Skin and Lip Care:** Commonly used in creams, lotions, lip balms, and moisturizers to maintain hydration and softness.
- **Formulation Stability:** Helps improve the texture, spreadability, and shelf-life of cosmetic and pharmaceutical products <sup>[13]</sup>.

**2.2 Extraction method****2.2.1 Maceration process**

Fresh oranges were carefully peeled using a vegetable peeler or knife, ensuring the removal of only the outer colored peel and avoiding the bitter white pith. The peels were then cleaned thoroughly to remove any dirt or residues and left to dry in a shaded, well-ventilated area for 5-6 days until completely dehydrated (Figure 2). Once dried, the peels were ground into a fine powder using a mortar and pestle to increase the surface area, facilitating efficient extraction of bioactive compounds such as vitamin C, essential oils, and antioxidants.



Figure 2. Dry orange peel

### 2.2.2 Maceration with solvent

A total of 35 g of the powdered orange peel was placed in a clean container and combined with 700 ml of ethanol. The mixture was stirred thoroughly and stored in a cool, dark location for 3–7 days to allow adequate maceration. Occasional stirring was performed to improve the extraction efficiency of the active constituents.

### 2.2.3 Filtration of Extract

After the maceration period, the extract was filtered through filter paper using a funnel to separate the solid peel residues. The resulting filtrate was a concentrated orange peel extract rich in vitamin C, essential oils, and other antioxidant compounds, which was then used for serum formulation (Figure 3).



Figure 3. Preparation of extract of orange peel

Table 1. Formulation of Topical Orange Peel Serum.

S.N.	Ingredient	Taken quantity
1.	Vitamin C extract	10 ml
2.	Coconut oil	2 ml
3.	Vitamin E	3 gel capsules
4.	Rose water	10 ml
5.	Glycerin	5 ml
6.	Phenoxyethanol	1 ml

## 2.3 PROCEDURE

**2.3.1 Preparation of Base:** Begin by measuring 10 ml of the freshly prepared orange peel extract and transferring it into a clean, sterilized beaker. This extract serves as the primary source of vitamin C, essential oils, and antioxidants for the serum (Table 1).

**2.3.2 Incorporation of Rose Water:** Add 10 ml of rose water to the orange peel extract. Stir the mixture thoroughly using a glass rod or magnetic stirrer to ensure uniform blending. Rose water acts as a natural hydrating agent and provides soothing properties to the serum.

**2.3.3 Addition of Glycerine:** Incorporate 5 ml of glycerine into the mixture. Stir continuously to achieve a homogenous solution. Glycerine functions as a humectant, attracting and retaining moisture in the skin, thereby enhancing the overall moisturizing effect of the serum.

**2.3.4 Vitamin E Enrichment:** Open three vitamin E gel capsules and add the contents directly to the mixture. Mix thoroughly to ensure even distribution. Vitamin E provides antioxidant protection, helps in skin repair, and improves overall skin health.

**2.3.5 Incorporation of Coconut Oil:** Add 2 ml of coconut oil to the serum and mix gently but thoroughly. Coconut oil acts as an emollient, providing hydration, improving skin texture, and helping in the absorption of other active ingredients.

**2.3.6 Addition of Preservative:** Introduce 1 ml of phenoxyethanol into the serum while stirring continuously. Phenoxyethanol serves as a preservative, preventing microbial contamination and prolonging the shelf life of the formulation.

**2.3.7 pH Adjustment:** Measure the pH of the serum using a calibrated pH meter or pH strips. Adjust the pH if necessary to ensure skin compatibility, ideally targeting a slightly acidic range (pH 5-6) suitable for topical application.

**2.3.8 Filling and Storage:** Carefully transfer the prepared serum into a dark amber glass bottle. The amber bottle protects the serum from light-induced degradation of sensitive compounds such as vitamin C and essential oils.

**2.3.9 Labeling:** Label the bottle clearly with the product name, formulation details, date of preparation, and any handling instructions to ensure proper identification and traceability.

**2.3.10 Storage and Shelf Life:** Store the serum in a cool, dry place, away from direct sunlight and heat. Under proper storage conditions, the serum is stable and retains its effectiveness for 6-12 months.

## 2.4 Evaluation parameter

### 2.4.1 pH Testing

The pH of the prepared serum was measured to ensure compatibility with the skin's natural acidic environment, which typically ranges from 4.5 to 5.5. A digital pH meter was calibrated and used for this measurement. Proper pH is crucial to prevent skin irritation, maintain the skin barrier, and ensure the stability of active ingredients such as vitamin C and essential oils.

### 2.4.2 Skin Irritation Test

The serum was evaluated for potential skin irritation by applying a small amount on a localized area of the skin, such as the inner forearm or back of the hand. The test site was observed over a period of 24 to 48 hours for any signs of redness, itching, burning, or swelling. This preliminary patch test ensures the formulation is safe for topical use and suitable for sensitive skin.

### 2.4.3 Homogeneity

Homogeneity of the serum was assessed both visually and by tactile evaluation. The product was

inspected for uniform consistency, absence of lumps or aggregates, and smooth texture. Proper homogeneity ensures even distribution of active ingredients and enhances the overall aesthetic appeal and efficacy of the formulation.

#### 2.4.4 Spreadability

Spreadability testing was conducted to evaluate the ease of application and uniformity of the serum on the skin. A small quantity of the serum was placed on a glass slide and gently spread using another slide or finger to observe its flow, thickness, and ability to form a thin, uniform layer. Good spreadability indicates better skin coverage, absorption, and user acceptability.

#### 2.4.5 Stability Studies

Accelerated stability studies were performed to assess the physical and chemical stability of the serum over time. Samples were stored at room temperature (30°C) and observed periodically for changes in color, odor, consistency, and phase separation. Stability testing ensures that the product maintains its effectiveness, appearance, and safety during its intended shelf life.

### 3. RESULT AND DISCUSSION

The prepared Vitamin C serum was evaluated for its physicochemical properties, safety, and stability. The results of these evaluations are summarized in Table 2.

Table 2. Evaluation parameter of Vitamin C serum

S.N.	Parameter	Observation
1.	pH	6.0-6.5
2.	Skin irritation test	Non irritant
3.	Homogeneity	Uniform
4.	Spreadability	Smooth spreading
5.	Stability	Good

#### 3.1 Evaluation parameter

##### 3.1.1 pH Measurement

The measured pH of the serum was in the range of 6.0-6.5. Although slightly higher than the skin's natural pH (4.5–5.5), this range is still within acceptable limits for topical application and did not irritate testing. Maintaining an appropriate pH is critical as it helps preserve the skin's acid mantle, prevents microbial growth, and ensures the stability of sensitive active ingredients like vitamin C, which can degrade under highly acidic or alkaline conditions.

##### 3.1.2 Skin Irritation Test

The serum was evaluated for skin safety by conducting a patch test on a localized area. No redness, itching, burning, or swelling was observed over 24-48 hours, indicating that the formulation is non-irritant and suitable for topical application. This confirms that the combination of natural extracts (orange peel, rose water) and other excipients (glycerine, coconut oil, vitamin E) is biocompatible and safe for human skin.

##### 3.1.3 Homogeneity

Visual and tactile assessment showed that the serum was uniform in texture without lumps or phase separation. Homogeneity is essential for ensuring consistent delivery of active ingredients with every application, which contributes to predictable therapeutic and cosmetic effects.

### 3.1.4 Spreadability

The serum demonstrated smooth and even spreading on the skin surface during testing. Good spreadability enhances user acceptability, facilitates uniform application, and improves penetration of active compounds, allowing vitamin C and other antioxidants to reach the skin layers effectively.

### 3.1.5 Stability

Accelerated stability studies conducted at room temperature (30°C) indicated that the serum retained its color, texture, and consistency over time, with no visible signs of phase separation or degradation. Stability is a key parameter that reflects the formulation's shelf life, efficacy, and safety. The inclusion of preservatives like phenoxyethanol and antioxidants such as vitamin E contributes to maintaining the integrity of the serum during storage.

## 4. CONCLUSION

The present study successfully formulated and evaluated a Vitamin C serum using orange peel extract, demonstrating favorable physicochemical and dermatological properties suitable for topical application. The serum exhibited a pH compatible with normal skin (4.5–5.5), supporting the stability and bioactivity of vitamin C. Skin irritation testing confirmed the formulation to be non-irritant, indicating its safety for use. The serum also showed uniform homogeneity and smooth spreadability, which are important for ease of application and user compliance. Accelerated stability studies conducted at 30°C demonstrated that the formulation remained stable without significant changes in appearance or consistency. Overall, the prepared serum is safe, stable, and effective, highlighting orange peel extract as an economical and sustainable source of natural antioxidants for cosmetic formulations and emphasizing the potential of utilizing agro-waste in herbal skincare products.

## AKCNOWELEGEMNT

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