FORMULATION AND EFFECTIVENESS STUDY OF MANGOSTEEN PEEL EXTRACT-BASED ORGANIC LOTION ON SKIN PH

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Abstract

Mangosteen (Garcinia mangostana L.) peel extract contains xanthones, a class of bioflavonoids known for their antioxidant, antibacterial, and antiallergic properties. This study aimed to formulate an organic lotion based on mangosteen peel extract and evaluate its physical characteristics and skin pH compatibility. The lotion formulations were prepared using the following ingredients: mangosteen peel extract, tea, stearic acid, cetyl alcohol, glycerin, propyl paraben, methyl paraben, strawberry fragrance, and distilled water. The resulting product exhibited typical organoleptic properties of a lotion, including appropriate texture, color, and odor, and was classified as an oil-in-water (O/W) emulsion type. pH evaluation revealed that formulation 2 had a pH value of 5, which falls within the safe range for human skin, compared to formulation 1 (pH 4) and formulation 3 (pH 6). Therefore, formulation 2 was identified as the most suitable in terms of skin pH compatibility. However, further evaluations—including adhesion, spreadability, viscosity, microbiological, and effectiveness tests—are required before the product can be considered ready for commercialization.

Keywords: *Mangosteen Peel Extracts, Xanthone, Lotion Formulation.*

INTRODUCTION

Indonesia is recognized as one of the world's richest countries in terms of biodiversity, offering enormous potential for the development of natural products for pharmaceutical and cosmetic applications. However, the utilization of these natural resources remains limited because their use has largely relied on traditional knowledge passed down through generations. Consequently, many medicinal plants have not been optimally explored for various applications, including the development of safe and environmentally friendly cosmetic products. One plant with considerable potential is mangosteen (Garcinia mangostana L.). Besides being widely appreciated for its edible fruit, mangosteen peel has long been used in traditional medicine to treat various ailments, including diarrhea, dysentery, leucorrhea, tonsillitis, hemorrhoids, and oral ulcers. Previous studies by Tambunan (1998) and Subroto (2008) reported that mangosteen peel possesses diverse biological activities, including anti-aging, antihypertensive, weight-reducing, antiviral, and antibacterial properties.

Recent scientific studies have further demonstrated that mangosteen peel contains various bioactive compounds, including xanthones, anthocyanins, tannins, and phenolic acids. These compounds are recognized as potent natural antioxidants capable of scavenging free radicals responsible for cellular damage, including damage to skin cells. Antioxidants protect biological

tissues by inhibiting oxidative reactions that lead to cellular degeneration. In recent years, synthetic antioxidants have become less desirable because of concerns regarding their potential toxic and carcinogenic effects. Consequently, naturally derived antioxidants have attracted increasing attention as safer, more effective, and environmentally sustainable alternatives.

Environmental factors such as air pollution, ultraviolet (UV) radiation, and extreme temperature fluctuations associated with global climate change contribute significantly to oxidative stress and skin damage. Excessive exposure to free radicals accelerates the loss of the skin's natural moisture, resulting in dryness and impaired barrier function. Under normal physiological conditions, the skin is protected by a slightly acidic surface film known as the acid mantle, which plays a crucial role in maintaining the skin's pH balance, moisture retention, and overall barrier integrity. Therefore, skin care products capable of preserving skin hydration while maintaining the natural pH of the skin are highly desirable.

Organic lotion represents one of the most promising cosmetic dosage forms for maintaining skin hydration. Lotion is generally formulated as an oil-in-water (O/W) emulsion, providing moisturizing, softening, smoothing, and nourishing effects on the skin. The incorporation of natural ingredients into lotion formulations is considered safer because such products are less likely to contain synthetic chemicals associated with skin irritation or allergic reactions. Mangosteen peel extract, when used as an active ingredient in organic lotion, is expected to provide both antioxidant and antibacterial activities, thereby contributing to improved skin health and protection against oxidative damage.

Accordingly, the development of an organic lotion formulated with mangosteen peel extract has the potential to produce a natural skin-care product capable of maintaining the skin's physiological pH while protecting against free radical-induced damage. Based on this rationale, the present study was conducted to determine an appropriate formulation for an organic lotion containing mangosteen (Garcinia mangostana L.) peel extract and to evaluate its effectiveness in maintaining skin pH. Specifically, the study focused on optimizing the lotion formulation, determining the emulsion type produced, and evaluating the pH of the resulting formulation.

The specific objectives of this study were to determine the optimal formulation of an organic lotion containing mangosteen peel extract, evaluate its organoleptic characteristics, identify the type of emulsion formed, and measure the pH of the final product to ensure its compatibility with the normal physiological pH of human skin. The findings of this study are expected to contribute both academically and practically. For the researchers, the study provides a deeper understanding of the formulation and physicochemical evaluation of natural cosmetic products. For educational institutions, the results are expected to serve as a scientific reference and provide a foundation for future research on the development of innovative, safe, and environmentally friendly natural cosmetic formulations.

METHOD

Research Design

This study employed a **quantitative descriptive research design**, which aims to describe and analyze the characteristics of the formulated product without making broader statistical

generalizations. The quantitative approach was adopted to generate numerical data that could be objectively measured and analyzed, thereby ensuring reliable and reproducible results.

Time and Location

The study was conducted at the **Pharmacy Laboratory, Politeknik Piksi Ganesha Bandung, Indonesia**, from **6 August to 3 October 2019**. All experimental procedures, including lotion formulation and physicochemical evaluations, were performed in this laboratory.

Lotion Formulation

The study involved the preparation of organic lotion formulations containing **mangosteen (*Garcinia mangostana* L.) peel extract** at three different concentrations: **5%, 10%, and 15%**. The extract served as the active ingredient, while triethanolamine (TEA) was used as the emulsifying agent. Cetyl alcohol and stearic acid constituted the oil phase, glycerin functioned as a humectant, methyl paraben and propyl paraben were incorporated as preservatives, fragrance was added as a perfume, and distilled water (aquadest) was used as the solvent to obtain a final volume of 100%.

Table 1. Formulation of Mangosteen Peel Extract Lotion

Ingredient	F1 (%)	F2 (%)	F3 (%)
Mangosteen peel extract	5	10	15
Triethanolamine (TEA)	2	2	2
Cetyl alcohol	4	4	4
Stearic acid	2.5	2.5	2.5
Glycerin	10	10	10
Propyl paraben	0.02	0.02	0.02
Methyl paraben	0.02	0.02	0.02
Fragrance	0.15	0.15	0.15
Distilled water	ad 100	ad 100	ad 100

Preparation of Lotion

Equipment

The equipment used in this study included **graduated cylinders, evaporating dishes, an analytical balance, a water bath, a mortar and pestle, a horn spoon, spatulas, and 100-mL bottles** for packaging the lotion formulations.

Materials

The primary material was **mangosteen peel extract**, while the auxiliary ingredients included **triethanolamine (TEA), glycerin, cetyl alcohol, stearic acid, methyl paraben, propyl paraben, fragrance, and distilled water**.

Preparation Procedure

The **oil phase**, consisting of cetyl alcohol and triethanolamine (TEA), and the **aqueous phase**, consisting of stearic acid, glycerin, and distilled water, were heated separately in a water bath at **65–75°C** for approximately **10 minutes** until homogeneous. The oil phase was then transferred into a mortar, after which the aqueous phase was gradually incorporated while continuously stirring until a homogeneous emulsion was obtained at approximately **40°C**. Subsequently, mangosteen peel extract, preservatives, and fragrance were added gradually while stirring until the temperature decreased to approximately **35°C**.

Evaluation of Lotion Formulations

Organoleptic Evaluation

Organoleptic properties were assessed by observing the **color, odor, and physical appearance** of each lotion formulation during **three days of storage** to evaluate its physical stability.

Emulsion Type Determination

The emulsion type was determined using the **dilution method** with distilled water. A formulation that remained homogeneous after dilution was classified as an **oil-in-water (O/W) emulsion**.

pH Measurement

The pH of each lotion formulation was measured using **universal pH indicator paper** and compared with the normal physiological skin pH range of **4.5–6.5**.

Data Analysis

The experimental data were analyzed descriptively based on the principles of emulsion theory. An ideal lotion formulation was considered one that exhibited good physical stability and formed an **oil-in-water (O/W) emulsion**, in which water serves as the continuous phase and oil as the dispersed phase. Emulsion stability was evaluated based on the effectiveness of stabilizing agents, particularly **triethanolamine (TEA)** and **cetyl alcohol**, in maintaining the homogeneity, consistency, and texture of the lotion formulations.

RESULTS

Lotion Formulation

Three lotion formulations (F1, F2, and F3) were prepared using different concentrations of **mangosteen (*Garcinia mangostana* L.) peel extract**, while the concentrations of all other ingredients were kept constant. The formulation compositions are presented in **Table 2**.

Table 2. Composition of Mangosteen Peel Extract Lotion Formulations

Ingredient	F1 (%)	F2 (%)	F3 (%)
Mangosteen peel extract	5	10	15
Triethanolamine (TEA)	2	2	2
Cetyl alcohol	4	4	4
Stearic acid	2.5	2.5	2.5
Glycerin	10	10	10
Propyl paraben	0.02	0.02	0.02
Methyl paraben	0.02	0.02	0.02
Fragrance	0.15	0.15	0.15
Distilled water	ad 100	ad 100	ad 100

For each formulation, a total batch size of **100 g** was prepared. The quantities of each ingredient were as follows:

- **Mangosteen peel extract:** F1 = **5 g**, F2 = **10 g**, F3 = **15 g**
- **Triethanolamine (TEA): 2 g**
- **Stearic acid: 2.5 g**
- **Cetyl alcohol: 4 g**
- **Glycerin: 10 g**
- **Methyl paraben: 0.02 g**

- **Propyl paraben: 0.02 g**
- **Fragrance: 0.15 g**
- **Distilled water:** F1 = **76.31 mL**, F2 = **71.31 mL**, and F3 = **66.31 mL**

Organoleptic Evaluation

The organoleptic evaluation was performed to assess the physical characteristics of the lotion formulations, including **odor, color, consistency, and texture**. Observations were conducted during the first three days of storage.

Table 3. Organoleptic Characteristics of Lotion Formulations

Formula	Odor	Color	Consistency	Texture
F1	Strawberry	Light pink	Thick	Smooth
F2	Strawberry	Light pink	Semi-thick	Smooth
F3	Strawberry	Light pink	Fluid	Smooth

All formulations exhibited the same **strawberry fragrance** and **light pink color**, whereas their consistency varied according to the concentration of mangosteen peel extract. Increasing the extract concentration resulted in changes in the viscosity of the lotion formulations, while the texture remained smooth in all formulations.

Emulsion Type

The emulsion type was determined using the **dilution method** with distilled water. All formulations remained homogeneous after dilution, indicating that they were **oil-in-water (O/W) emulsions**.

Table 4. Emulsion Type of Lotion Formulations

Formula	Before Dilution	After Dilution	Emulsion Type
F1	Homogeneous	Homogeneous	Oil-in-water (O/W)
F2	Homogeneous	Homogeneous	Oil-in-water (O/W)
F3	Homogeneous	Homogeneous	Oil-in-water (O/W)

The dilution test confirmed that water served as the continuous phase in all formulations, demonstrating successful formation of stable oil-in-water emulsions.

pH Evaluation

The pH values of the lotion formulations were measured using **universal pH indicator paper**. The measured pH ranged from **4 to 6**, which falls within or close to the normal physiological pH range of healthy human skin (**4.5–6.5**).

Table 5. pH of Lotion Formulations

Formula	pH	Interpretation
F1	6	Slightly alkaline
F2	5	Near skin physiological pH
F3	4	Slightly acidic

Among the three formulations, **F2**, containing **10% mangosteen peel extract**, exhibited a pH of **5**, which is the closest to the physiological pH of normal human skin. Therefore, this formulation is considered the most suitable for topical application, as it is expected to minimize skin irritation while maintaining the natural acid mantle of the skin.

In general, a lotion formulation consists of several essential components, including the **lipophilic phase, hydrophilic phase, emulsifying agents, humectants, preservatives, fragrances, and colorants**. In the present study, **mangosteen (*Garcinia mangostana* L.) peel extract** was incorporated as the active ingredient because of its antioxidant properties, which are expected to protect the skin against oxidative damage and promote the regeneration of dry and dull skin. Triethanolamine (TEA) was employed as the primary emulsifying agent at a concentration within the commonly recommended range (2–6%). **Cetyl alcohol** served as a fatty alcohol to increase the viscosity and improve the consistency of the lotion. **Glycerin** functioned as both a humectant and a viscosity enhancer, helping to maintain skin hydration by reducing transepidermal water loss.

Stearic acid was incorporated as a co-emulsifier in combination with TEA to stabilize the emulsion system and improve formulation consistency. To prevent microbial contamination during storage, **methyl paraben** and **propyl paraben** were added as preservatives. Strawberry fragrance was included to provide a pleasant sensory profile, while the natural pink coloration of the lotion was derived directly from the mangosteen peel extract, eliminating the need for synthetic colorants.

The organoleptic evaluation demonstrated that the combination of emulsifying agents and other excipients maintained the physical stability of the lotion formulations throughout the observation period. No noticeable changes in color, odor, or texture were observed after storage, indicating that no undesirable chemical interactions occurred between the mangosteen peel extract and the other formulation components. In general, chemical reactions within cosmetic formulations are often indicated by observable changes such as discoloration, precipitate formation, gas evolution, or temperature variation. The absence of these changes suggests that the formulations remained physically stable under the experimental conditions.

The emulsion type test confirmed that all three formulations produced **oil-in-water (O/W) emulsions**, as evidenced by their ability to remain homogeneous after dilution with distilled water. This result indicates that water constituted the continuous phase, whereas the oil phase was finely dispersed within it. The successful formation of stable O/W emulsions can be attributed to the synergistic action of **triethanolamine and stearic acid**, which effectively reduced interfacial tension and stabilized the dispersed oil droplets. Oil-in-water emulsions are generally preferred for cosmetic lotions because they exhibit a lighter texture, spread easily on the skin, and are readily removed with water.

The pH evaluation revealed differences among the three formulations. **Formulation F1** exhibited a pH of **6**, which is at the upper limit of the normal physiological skin pH range. **Formulation F2** demonstrated a pH of **5**, closely matching the natural pH of healthy human skin (4.5–6.5), thereby indicating excellent compatibility for topical application. **Formulation F3** exhibited a pH of **4**, representing the most acidic formulation among those tested. Although a pH of 4 is only slightly below the commonly accepted physiological range, it may increase the likelihood of irritation in individuals with sensitive skin if used repeatedly. Consequently, **Formulation F2**, containing **10% mangosteen peel extract**, was considered the most suitable formulation because it provided the most physiologically compatible pH while maintaining favorable organoleptic properties and a stable oil-in-water emulsion system.

Overall, the findings suggest that the incorporation of **10% mangosteen peel extract** produced the most balanced lotion formulation in terms of physical stability, emulsion characteristics, and pH compatibility. Therefore, this formulation demonstrates promising potential for further

development as a natural antioxidant-based cosmetic product for skin care applications.

CONCLUSION

Based on the formulation process and physicochemical evaluation of organic lotion containing **mangosteen (*Garcinia mangostana* L.) peel extract**, the following conclusions can be drawn:

1. **Optimal Formulation**
   Among the three formulations evaluated, **Formulation 2 (F2)** containing **10% mangosteen peel extract** demonstrated the most favorable characteristics. The optimized formulation consisted of **10% mangosteen peel extract, 2% triethanolamine (TEA), 4% cetyl alcohol, 2.5% stearic acid, 10% glycerin, 0.02% propyl paraben, 0.02% methyl paraben, 0.15% strawberry fragrance, and distilled water added to a final volume of 100%**.
2. **Organoleptic Properties**
   The formulated lotion exhibited satisfactory organoleptic characteristics, including a **uniform light pink color, a pleasant strawberry fragrance, a smooth texture, and a semi-thick consistency**. These findings indicate that the formulation components were well dispersed and produced a physically homogeneous and stable lotion.
3. **Emulsion Type**
   All formulations were identified as **oil-in-water (O/W) emulsions** based on the dilution test. This emulsion type is considered appropriate for topical lotion formulations because it provides a **light, non-greasy texture**, is easily absorbed by the skin, and can be readily removed with water.
4. **pH Evaluation**
   The measured pH values of the formulations were **4, 5, and 6** for Formulations 1, 2, and 3, respectively. Among these, **Formulation 2**, with a pH of **5**, was considered the most appropriate because it falls within the normal physiological pH range of healthy human skin (**4.5–6.5**). Therefore, Formulation 2 demonstrated the greatest potential as a safe and effective topical lotion formulation.

Overall, the findings suggest that **Formulation 2**, containing **10% mangosteen peel extract**, provides the most balanced combination of physical stability, desirable organoleptic characteristics, oil-in-water emulsion properties, and skin-compatible pH. Consequently, this formulation has promising potential for further development as a natural antioxidant-based cosmetic lotion.

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