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*Research Article*

# Ethnobotanical Study and Hedonic Evaluation with Cost Analysis of Banana (*Musa paradisiaca* L.) Stem Serum Preparation as an Anti-Aging Solution

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## Abstract

In skincare, particularly facial serums, the utilization of natural ingredients is crucial in addressing various skin issues, notably combating the effects of free radicals that contribute to wrinkles. This study explores the potential of banana (*Musa paradisiaca* L.) stem extract as an active ingredient in serum formulation due to its rich anthocyanin content known for antioxidant properties. Hedonic testing and cost analysis serve as initial steps in the marketing mix of a product. This research aims to assess the hedonic preferences of various *M. paradisiaca* stem serum formulations and analyze the production costs. A descriptive research method employing survey and observational techniques was utilized for data collection and descriptive analysis. Hedonic testing was conducted to gauge the personal preferences of panelists toward *M. paradisiaca* stem serum formulations. Three formulations (F1 with 4%, F2 with 8%, and F3 with 12% *M. paradisiaca* extract) were evaluated by 40 panelists. Cost analysis of serum production employed quantitative descriptive analysis, computing the cost per unit using a variable costing method. The hedonic evaluation results showed that F1 formulation was highly preferred (79.3%), followed by F2 (73.2%), and F3 (66.8%). Cost analysis using the variable costing method revealed a total production cost of IDR 614,000.00 for 10 packages of *M. paradisiaca* stem serum formulation, translating to an approximate unit price of IDR 61,400.00.

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## INTRODUCTION

The human skin, serving as the body's outermost barrier, is constantly exposed to environmental stressors. Chief among these are ultraviolet (UV) radiation and pollutants, both of which can inflict significant damage[1]. Furthermore, daily activities can contribute to the development of skin concerns, particularly in the facial area[2]. Improper facial cleansing and skincare routines can lead to the accumulation of dead skin cells, potentially hindering collagen production and ultimately accelerating the formation of wrinkles and fine lines[3].

Antioxidants have emerged as promising tools in the fight against skin aging and damage[4]. These molecules act by neutralizing free radicals, a class of highly reactive species containing unpaired electrons in their outer shells. Free radicals' inherent instability compels them to seek stability by stealing electrons from surrounding molecules, thereby causing cellular damage and contributing to various skin concerns[5]. By donating electrons and stabilizing free radicals, antioxidants offer protection against this cellular damage[6].

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Natural antioxidants have gained significant interest for their potential benefits in topical skincare formulations. Topical application of antioxidants can offer protection against UVA radiation, a key contributor to skin darkening and premature aging[7]. These antioxidants can also help combat the damaging effects of UVB radiation, including wrinkles and inflammation[8]. Moreover, serums formulated with natural ingredients are generally considered safer for consumers compared to synthetic alternatives[9]. This study investigates the development of an antioxidant serum derived from banana (*Musa paradisiaca*) extracts as a potential option to shield the skin from free radicals and their associated signs of aging.

*Musa paradisiaca* thrives in tropical climates, making Indonesia a prime location for its cultivation[10]. Interestingly, *M. paradisiaca* stems hold potential as a natural antibiotic, and their use in wound healing is a traditional practice among some Indonesian communities[11]. Scientific studies have corroborated these traditional practices, demonstrating the effectiveness of *M. paradisiaca* stem extracts in inhibiting the growth of pathogenic bacteria like *Staphylococcus aureus*[12,13]. Building upon Dewi *et al*.[14] on formulating *M. paradisiaca* stem extract into serum preparations and evaluating their physical and antioxidant properties, this study aims to investigate two key aspects. Firstly, we assess the organoleptic properties of the serum preparation, including taste, aroma, and color, to gauge its acceptability among potential users. Secondly, we analyze the production costs associated with *M. paradisiaca* stem serum preparations.

## MATERIALS AND METHODS

### *Materials*

*Musa paradisiaca* stems were obtained from East Duda Village, Selat, Karangasem, Bali, Indonesia (**Figure 1**). The botanical identification was confirmed by the Plant Conservation Center of the Indonesian Institute of Sciences (LIPI), Eka Bedugul Botanical Gardens (voucher specimen number B-337/IPH.7/AP/XII/2020). Other materials used in this study included 70% ethanol (Brataco®), xanthan gum, glycerin, potassium sorbate, sodium benzoate, distilled water, and DPPH (2,2-diphenyl-1-picrylhydrazyl). The following equipment was used in this research included rotary evaporator, glassware (Pyrex®), flannel cloth, gram scale (accuracy 0.1 g), digital analytical balance (accuracy 0.0001 g), and glass jar. A questionnaire was developed to assess the level of acceptance of different *M. paradisiaca* stem serum formulations by participants. Additionally, the questionnaire aimed to gather information regarding production costs.

**Figure 1.** *Musa paradisiaca*.

### *Methods*

*Preparation of extracts and phytochemical screening*

*Musa paradisiaca* stems were thoroughly sorted and chopped into small pieces. The chopped *M. paradisiaca* stem was then subjected to maceration extraction using 70% ethanol as the solvent. The maceration process was carried out for three cycles of 24 hours each, with occasional stirring. The macerate was stored in a light-protected environment throughout the extraction period. Following each maceration cycle, the mixture was filtered using a flannel cloth to separate the filtrate (extract) from the residue. The remaining residue was then re-extracted with fresh 70% ethanol using the same maceration procedure. The combined filtrates from all maceration cycles were concentrated using a rotary evaporator under vacuum until a thick extract was obtained.

*Preparation of serum*

An oil-in-water (O/W) type serum formulation was prepared as detailed in **Table I**. Xanthan gum was dispersed in 20 parts of distilled water under constant stirring until an emulsion base formed. Glycerin was then gradually added to the mixture with continuous stirring. Potassium sorbate, sodium benzoate, and *M. paradisiaca* stem extract were incorporated sequentially into the mixture with continued slow stirring until a homogeneous product was obtained. Finally, distilled water was added to reach a final volume of 100 mL while stirring continuously. The homogeneous serum (**Figure 2**) was then stored in a pre-prepared container.

**Table I.** *Musa paradisiaca* stem serum formulation.

| Material Name | Function | Concentration (%) | | |
|---|---|---|---|---|
| | | F1 | F2 | F3 |
| *Musa paradisiaca* stem extract | Active ingredients | 4 | 8 | 12 |
| Xanthan gum | Thickener | 0.5 | 0.5 | 0.5 |
| Glycerin | Humectant | 10 | 10 | 10 |
| Potassium sorbate | Preservative | 0.1 | 0.1 | 0.1 |
| Sodium benzoate | Preservative | 0.1 | 0.1 | 0.1 |
| Distilled water | Solvent | Ad 100 | Ad 100 | Ad 100 |

a b c

**Figure 2.** *Musa paradisiaca* stem serum F1 (**a**), F2 (**b**), and F3 (**c**).

*Serum evaluation*

The physical properties of the *M. paradisiaca* stem extract serum were assessed using the following methods: organoleptic test, transferred volume test, pH test, and homogeneity test[15], as described in detail below.

*Organoleptic test*: The organoleptic properties of *M. paradisiaca* stem serum preparations were assessed visually. This evaluation included observations of consistency, color, and smell.

*Transferred volume test*: The transferred volume test is performed to ensure that the *M. paradisiaca* stem extract serum retains its designated dosage volume (100 mL) after transfer from its original container. This test verifies that at least 95% of the prepared serum volume can be effectively transferred. The test involves transferring the entire *M. paradisiaca* stem extract serum preparation to a measuring cup. The transferred volume is then measured, and the percentage of the initial volume is calculated.

*pH test*: The acidity of the *M. paradisiaca* stem extract serum was determined using a pH meter. Five milliliters of the extract serum were transferred to a clean, dry beaker. The pH meter electrode was immersed into the sample solution, ensuring good contact without stirring. The pH reading was allowed to stabilize and recorded. The electrode was then rinsed thoroughly with deionized water and patted dry with a lint-free tissue before further measurements.

*Homogeneity test*: The homogeneity of *M. paradisiaca* stem extract serum was assessed visually. A small amount of the extract serum was placed on two clean glass slides. The presence or absence of coarse particles on both slides was evaluated to determine homogeneity. The extract serum was considered homogeneous if no coarse particles were observed on either slide. Conversely, the presence of coarse particles on either slide indicated inhomogeneity.

*Hedonic test sampling technique*

This study employed a non-probability sampling approach, specifically utilizing a combination of incidental sampling and quota sampling techniques. Incidental sampling involved recruiting participants who met the inclusion criteria on an opportunistic basis. These criteria included being between the ages of 20 and 30 years old, identifying as male or female, having a self-reported healthy body condition, and expressing willingness to participate. Quota sampling ensured that the final sample composition reflected pre-determined proportions based on gender (female/male). A total of 50 participants were recruited using this combined approach. All participants provided written informed consent after being thoroughly briefed about the study's objectives, procedures, and potential risks/benefits. This study received ethical approval from the Health Research Ethics Committee at STIKES Bina Usada Bali (approval No. 052/EA/KEPK-BUB-2024).

*Hedonic test data collection technique*

A questionnaire was used to collect data from this study's participants. The questionnaire, accessible via a Google Form link (https://forms.gle/yPKt8TBMe7UtJxPi6), was distributed to a sample of 50 panelists at Universitas Mahasaraswati Denpasar. A production cost analysis was conducted for each *M. paradisiaca* stem serum formula. This involved identifying and analyzing each cost component associated with the production of each formula. The analysis considered the market price of similar serums (IDR 100,000.00) as a reference point.

***Data analysis***

Hedonic testing was conducted to evaluate the sensory acceptability of the *M. paradisiaca* stem serum product by a panel of 50 assessors. Panelists evaluated the color, taste, and aroma of the serum using a standardized checklist with a four-point hedonic scale: highly preferred (4), preferred (3), less preferred (2), and not preferred (1). The data were tabulated according to frequency distribution and analyzed descriptively using percentages. Results are presented in both narrative and chart formats. Production cost analysis employed quantitative technical methods, including calculations, interviews, record-keeping, and observations. This process aimed to determine the cost of producing the *M. paradisiaca* stem serum preparation.

## RESULTS AND DISCUSSION

Organoleptic evaluation revealed that all *M. paradisiaca* stem extract serum formulations (F1, F2, and F3) displayed a consistent appearance: a slightly thick, brown liquid with a characteristic *M. paradisiaca* stem extract odor. This coloration and aroma are inherent properties of the *M. paradisiaca* stem extract itself. Visual assessment of homogeneity confirmed the absence of coarse particles in all formulations, indicating good physical stability. The pH of each formulation was measured to ensure compatibility with the skin's natural acidic range (pH 4.5-6.5). All formulations exhibited a pH of 6, suggesting minimal potential for skin irritation. Finally, a transferred volume test was conducted to assess the delivered dosage volume from each formulation. All formulations (F1, F2, and F3) achieved transferred volumes exceeding the 95% minimum requirement, with values of 98%, 98%, and 97%, respectively. Previous studies from Syarifah *et al.*[16] showed similar results for serum from *M. paradisiaca* fruit skin, indicating the stability of serum produced from *M. paradisiaca* parts. Detailed results for all evaluations are presented in **Table II**.

**Table II.** Organoleptic test results of *M. paradisiaca* stem serum.

| Test parameters | F1 | F2 | F3 |
|---|---|---|---|
| Consistency | Slightly thick liquid | Slightly thick liquid | Slightly thick liquid |
| Color | Light brown | Dark brown | Dark brown |
| Smell | Characteristic smell of extract | Characteristic smell of extract | Characteristic smell of extract |
| Transferred volume (%) | 98 | 98 | 97 |
| pH | 6 | 6 | 6 |
| Homogeneity | Homogeneous | Homogeneous | Homogeneous |

Panelists evaluated the sensory attributes (aroma, texture, stickiness, and viscosity) of *M. paradisiaca* stem serum formulations (F1, F2, and F3) using a scoring. Formulations received consistently high scores (4) for aroma, texture, and stickiness across all groups, indicating overall panelist satisfaction with these aspects. Formulations F1 and F2 received high viscosity scores (4), suggesting a preference for their consistency compared to F3. Regarding color, panelists showed a mild preference for F1 (score 3) compared to F2 and F3. As Palmer and Schloss reported[17], people have a tendency towards products with their favorite colors. In this case, the color of the *M. paradisiaca* stem extract may not be liked by the panelists. Overall, formulations F1 and F2 were favored by the panelists based on the combined hedonic scores, as shown in **Table III**.

**Table III.** Hedonic test results of *M. paradisiaca* stem serum.

| Formulas | Aroma | Viscosity | Texture | Color | Sticky effect | Whole products |
|---|---|---|---|---|---|---|
| F1 | 4 | 4 | 4 | 3 | 4 | 4 |
| F2 | 4 | 4 | 4 | 2 | 4 | 4 |
| F3 | 4 | 3 | 4 | 2 | 4 | 3 |

Note: 4: highly preferred; 3: preferred; 2: less preferred; 1: not preferred

Panelist satisfaction with various parameters of the *M. paradisiaca* stem extract serum formulations was assessed using a hedonic test (**Table IV**). Panelists indicated a high degree of satisfaction (96%) with the aroma across all formulations. Basically, aroma is one of the main factors in panelists' preference for topical products such as serum[18]. However, responses regarding viscosity, texture, color, and stickiness revealed a preference for formulation F1 compared to F2 and F3. The concentration of *M. paradisiaca* stem extract significantly impacted the color of the serum preparations. The hedonic test results from 50 panelists evaluating five parameters suggest that panelists found F1 to be more aesthetically pleasing than F2 and F3. This difference in color preference can be attributed to the varying concentrations of the extract across the formulations[19]. The F1, containing the lowest concentration of *M. paradisiaca* stem extract (4%), exhibited a lighter brown color compared to F2 (8% extract) and F3 (12% extract). In the context of facial serums, a lighter color is generally considered more desirable[20,21]. Therefore, higher concentrations of the extract, while potentially increasing the product's efficacy, may lead to a less visually appealing[22].

**Table IV.** Level of likeness for *M. paradisiaca* stem serum.

| Formulas | Aroma (%) | Viscosity (%) | Texture (%) | Color (%) | Sticky effect (%) | Whole products (%) |
|---|---|---|---|---|---|---|
| F1 | 96 | 96 | 98 | 80 | 98 | 93 |
| F2 | 96 | 96 | 96 | 62 | 96 | 88 |
| F3 | 96 | 83 | 94 | 46 | 96 | 83 |

Determining the production cost of *M. paradisiaca* stem serum is crucial for establishing a sustainable and commercially viable product. Production cost directly influences the selling price, which is a key factor influencing market competitiveness[23]. Three primary cost components are considered in production cost analysis: raw materials, labor, and factory overhead[24]. Accurate recording and classification of these costs are essential. For this study, we employed variable costing, a method that considers only variable production costs. This approach is particularly suited for small-scale production[25], such as the research-oriented production of *M. paradisiaca* stem serum preparations employed here. Variable costs fluctuate in direct proportion to the volume of production and include raw materials, direct labor, and variable factory overhead costs. By utilizing variable costing, we can gain a more accurate understanding of the cost associated with each unit of serum produced[26].

Raw materials, the unprocessed components used in a product's manufacture, represent a significant cost factor in production processes. They are directly incorporated into the final product and can be physically identified within it[26]. A detailed breakdown of the raw material costs for the *M. paradisiaca* stem serum formulations is presented in **Table V**.

**Table V.** Raw material costs for 10 bottles of *M. paradisiaca* stem serum.

| Raw materials | Quantity (g) /100 mL | Price (g/L) | Total cost @1 bottle (IDR) | Total cost 10 bottles (IDR) |
|---|---|---|---|---|
| *Musa paradisiaca* stem | 4 | 5000 | 20,000.00 | 200,000.00 |
| Xanthan gum | 0.5 | 1000 | 200.00 | 2,000.00 |
| Glycerin | 10 | 100 | 1,000.00 | 10,000.00 |
| Potassium sorbate | 0.1 | 300 | 30.00 | 300.00 |
| Sodium benzoate | 0.1 | 200 | 20.00 | 200.00 |
| Distilled water | Ad 100 | 5000 | 500.00 | 5,000.00 |
| **Total** | | | **21,750.00** | **217,500.00** |

Direct labor costs are those directly attributable to the production process and can be readily traced back to the finished product (as detailed in **Table VI**). These costs are typically calculated based on factors such as working hours, working days, or product units[27]. In this study, direct labor costs encompassed laboratory rental and plant identification expenses. Utilizing a rented laboratory space was necessary due to the small-scale nature of the research. Additionally, costs associated with plant identification were incurred to ensure the precise identity of the plant materials used.

**Table VI.** Direct labor costs for 10 bottles of *M. paradisiaca* stem serum.

| Direct labor | Costs (IDR) |
|---|---|
| Laboratory rental | 75,000.00 |
| Determination | 240,000.00 |
| **Total** | **315,000.00** |

Factory overhead costs encompass indirect manufacturing expenses incurred during production, excluding direct labor costs and raw materials[28]. In this study, factory overhead costs included expenses associated with packaging materials (drop bottles for serum, dosage packaging) and graphic design (sticker design). A detailed breakdown of the factory overhead costs for the *M. paradisiaca* stem serum formulations is presented in **Table VII**.

**Table VII.** Factory overhead costs for 10 bottles of *M. paradisiaca* stem serum.

| Factory overhead | Costs (IDR) |
|---|---|
| Bottle | 22,500.00 |
| Preparation packaging | 35,000.00 |
| Sticker design | 25,000.00 |
| **Total** | **82,500.00** |

The total cost of producing *M. paradisiaca* stem serum preparations, as detailed in **Tables V** to **VII**, was IDR 614,000.00. Using a variable costing approach, the cost per bottle of *M. paradisiaca* stem serum in a 10-bottle batch translates to IDR 61,400.00 per 10 mL bottle. A separate consumer survey (**Table VIII**) revealed that the preferred price for a bottle of *M. paradisiaca* stem serum was IDR 55,000.00, which falls below the calculated production cost. This discrepancy between production cost and consumer preference highlights the need for further cost reduction strategies or the exploration of methods to enhance the perceived value of the M. *paradisiaca* stem serum product[29].

**Table VIII.** Survey results of 86 respondents in determining the price of *M. paradisiaca* stem serum per 10 mL bottle.

| The desired price for a 10 mL bottle | Voters (n (%)) |
|---|---|
| 50,000.00 | 18 (21) |
| 55,000.00 | 42 (49) |
| 60,000.00 | 8 (9) |
| 65,000.00 | 14 (16) |
| 70,000.00 | 4 (5) |
| **Total** | **86 (100)** |

## CONCLUSION

In conclusion, the sensory evaluation results demonstrated a strong preference for F1 compared to F2 and F3. Panelists rated F1 highest (80% satisfaction) for aroma, viscosity, texture, color, and stickiness. The addition of higher extract concentrations in F2 and F3 appears to have negatively impacted these sensory attributes. The variable costing method revealed a total production cost of IDR 614,000.00 for 10 bottles of *M. paradisiaca* stem serum preparations, translating to an estimated price per product of IDR 61,400.00.


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## AUTHORS' CONTRIBUTION

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## DATA AVAILABILITY

None.

## CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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