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Formulation of Antioxidant Cream from Mung Bean (*Vigna radiata* L.) Seed Coat Extract

Formulasi Krim Antioksidan Ekstrak Kulit Ari Kacang Hijau (*Vigna radiata* L.)

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ABSTRACT

The skin is the body's primary barrier against free radicals, which can induce oxidative stress and premature ageing. Antioxidants neutralize these radicals. This study aims to formulate and evaluate a cream containing ethanol extract of mung bean (*Vigna radiata* L.) seed coat. Four formulations were prepared with extract concentrations of 10%, 15%, 20%, and 25%. Physical evaluations included organoleptic tests, homogeneity, pH, viscosity, cream type, spreadability, and adhesiveness. Antioxidant activity was measured using the DPPH method. All formulations met physical standards, and formula F4 (25%) showed the highest antioxidant activity with an IC_{50} value of 79.49 ppm. These findings indicate the potential of mung bean seed coat extract as an active antioxidant agent in topical preparations.

ABSTRAK

Kulit merupakan pelindung utama tubuh terhadap paparan radikal bebas yang dapat menyebabkan stres oksidatif dan penuaan dini. Senyawa antioksidan berperan dalam menetralkan radikal bebas. Penelitian ini bertujuan untuk merumuskan dan mengevaluasi krim yang mengandung ekstrak etanol kulit ari kacang hijau (*Vigna radiata* L.). Formula dibuat dalam empat variasi konsentrasi: 10%, 15%, 20%, dan 25%. Evaluasi fisik meliputi uji organoleptik, homogenitas, pH, viskositas, tipe krim, daya sebar, dan daya lekat. Aktivitas antioksidan diuji menggunakan metode DPPH. Hasil menunjukkan bahwa seluruh formula memenuhi kriteria fisik yang baik, dan formula F4 (25%) memiliki aktivitas antioksidan tertinggi dengan nilai IC_{50} sebesar 79,49 ppm. Penelitian ini menunjukkan bahwa ekstrak kulit ari kacang hijau berpotensi sebagai bahan aktif antioksidan dalam sediaan topikal.

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1. INTRODUCTION

The skin is the body's outermost organ and serves as the primary barrier against environmental stressors, including ultraviolet (UV) radiation, air pollutants, and microorganisms (Fodor & Ullmann, 2019). Its continuous exposure to such external factors increases the likelihood of oxidative stress, a condition in which reactive oxygen species (ROS) exceed the skin's antioxidant defense capacity, leading to cellular damage and premature ageing (Ahmad & Damayanti, 2018). Free radicals are highly reactive molecules with unpaired electrons that can disrupt cellular homeostasis and trigger the degradation of essential biomolecules such as proteins, lipids, and DNA (Suparmi et al., 2012).

To mitigate oxidative stress, antioxidants play a critical role by stabilizing free radicals and preventing further cellular damage. In recent years, considerable attention has been given to natural sources of antioxidants, particularly from plant-based by-products. The seed coat of mung bean (*Vigna radiata* L.) has been identified as a rich source of flavonoids, such as vitexin and isovitexin, and polyphenolic compounds known for their potent antioxidant properties (Cao et al., 2011; Suryani et al., 2023). Notably, the polyphenol content in the mung bean seed coat is significantly higher—ranging from 702 to 1296 mg GAE/100 g—than in the whole seed (Tajoddin et al., 2010). Despite its antioxidant potential, this plant material remains underutilized and is often discarded as agricultural waste (Zheng et al., 2020).

Topical delivery systems such as creams are widely used in dermatological and cosmetic applications due to their non-greasy texture, ease of application, and ability to deliver active compounds effectively to the skin (Yahya et al., 2022). Oil-in-water (O/W) emulsions are particularly suitable for incorporating hydrophilic plant extracts, facilitating the uniform distribution of active compounds across the skin surface. Previous studies have demonstrated the feasibility of using plant extracts in cream formulations to enhance antioxidant delivery while maintaining acceptable physical properties (Ermawati, 2017). The antioxidant activity in such formulations is commonly evaluated using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay, a rapid and reproducible method for quantifying free radical scavenging ability (Maesaroh et al., 2018). Based on the aforementioned evidence, this study aimed to formulate and evaluate a topical cream containing ethanol extract of mung bean (*Vigna radiata* L.) seed coat. The research focused on assessing the physical characteristics of the cream and its antioxidant activity using the DPPH method. The formulation was prepared with varying extract concentrations to determine the optimal dose for achieving strong antioxidant effects.

2. METHODS

2.1. Materials and Equipment

The primary raw material used in this study was the seed coat of green mung bean (*Vigna radiata* (L.) R. Wilczek, Fabaceae), which was taxonomically identified at the Botany Laboratory of the National Research and Innovation Agency (BRIN), Jakarta, Indonesia (Certificate No. B-1764/II.6.2/IR.01.02/4/25). The identification confirmed the species based on morphological characteristics. Additional materials included ascorbic acid (CSCP, China), 96% ethanol (Bratachem, Indonesia), absolute ethanol (Merck, Germany), DPPH (TCI, USA), stearic acid (Sumi Asih, Indonesia), cetyl alcohol (Ecogreen, Indonesia), liquid paraffin, methyl paraben and propyl paraben (UENO, Japan), triethanolamine (Petronas, Indonesia), glycerin (Wilmar, Indonesia), and distilled water (Bucofindo, Indonesia). All chemicals were of analytical grade.

The equipment used included: dehydrator (Getra, Indonesia), water bath (Memmert, Germany), UV-Vis spectrophotometer (Jasco V-730, Japan), Brookfield viscometer (USA), rotary evaporator (IKA RV10, Germany), microscope (Zeiss, Germany), analytical balance (OHAUS, USA), vortex mixer (VM-300, Taiwan), pH meter (Laqua, Japan), grinder (FOMAC FGD-Z1000, China), and general laboratory glassware (Iwaki and Haldenwanger brands).

2.2. Sample Selection, Extraction and Phytochemical Screening

Sample Selection. Fresh mung beans were selected based on bright green color, smooth seed coat without blemishes or moldy odor, and absence of physical defects such as cracks.

Extraction Process. The extraction was carried out via maceration using 36% ethanol at a 1:10 (w/v) ratio. A total of 100 g of seed coat powder was soaked in 1 L of ethanol for 3 days. The filtrate was collected, followed by a second maceration (re-maceration). The combined filtrates were concentrated using a rotary evaporator at 45 °C and 55 rpm, and the extract was further thickened in a water bath at 45 °C until a viscous extract was obtained.

Phytochemical Screening. Qualitative phytochemical screening was conducted to identify the presence of secondary metabolites in the ethanol extract of *Vigna radiata* seed coat, particularly flavonoids and polyphenolic compounds. Flavonoids were identified using the Shinoda test by adding magnesium powder followed by concentrated hydrochloric acid (HCl) to the extract solution, where the formation of red, orange, or pink coloration indicated a positive result. Polyphenolic compounds were identified using the ferric chloride ($FeCl_3$) test by adding a few drops of 1% $FeCl_3$ solution to the extract, with the appearance of dark green, bluish-black, or brownish coloration indicating a positive reaction. All phytochemical screening tests were performed in triplicate to ensure reproducibility, following standard procedures reported in previous studies (Pratiwi et al., 2021).

2.3. Cream Formulation

Cream formulations were prepared following a modified method by Gyawali (2020), using extract concentrations of 0% (F0), 10% (F1), 15% (F2), 20% (F3), and 25% (F4). The composition for each formulation is shown in **Table 1**.

2.4. Physical Evaluation of the Cream

The physical evaluation of the cream formulations included organoleptic assessment, homogeneity, viscosity, emulsion type, spreadability, pH, and adhesiveness. Organoleptic properties such as color, odor, and consistency were visually observed to ensure aesthetic acceptability (Awalludin et al., 2022). Homogeneity was determined by spreading a thin layer of cream on a glass slide and visually inspecting for any clumps or uneven distribution (Saryanti et al., 2019). Viscosity was measured using a Brookfield viscometer with spindle No. 5 at a constant speed of 20 rpm, which provided insight into the consistency and application properties of the cream (Rikadyanti et al., 2020).

Table 1. Composition of *V. radiata* Seed Coat Extract Cream Formulations

Ingredients	F0 (%)	F1 (%)	F2 (%)	F3 (%)	F4 (%)
Mung bean seed coat extract	0	10	15	20	25
Stearic acid	5	5	5	5	5
Cetyl alcohol	2	2	2	2	2
Liquid paraffin	2	2	2	2	2
Methyl paraben	0.18	0.18	0.18	0.18	0.18
Propyl paraben	0.02	0.02	0.02	0.02	0.02
Triethanolamine*	—	—	—	—	—
Glycerin	7.5	7.5	7.5	7.5	7.5
Distilled water (ad 100%)	qs	qs	qs	qs	qs

*Triethanolamine was added as 1 drop to each formula. All values are expressed in %w/w unless otherwise stated. F0 = base cream formula (without extract); F1–F4 = cream formulas containing 10%, 15%, 20%, and 25% mung bean seed coat extract, respectively. qs = quantum satis (sufficient quantity to make 100%).

To determine the emulsion type, a drop of methylene blue solution was added to the surface of the cream and examined under a microscope; the pattern of dye distribution indicated whether the formulation was an oil-in-water (O/W) or water-in-oil (W/O) emulsion (Pratasik et al., 2019). Spreadability was tested by placing 0.5 g of the cream between two glass plates and applying a 50 g load for one minute; the resulting diameter of spread was measured using a digital caliper (Hayati & Vanira, 2021). pH measurement was conducted by dispersing 0.5 g of cream into 5 mL of distilled water and using a calibrated pH meter to assess the formulation's skin compatibility (Hayati & Vanira, 2021). Lastly, the adhesiveness test involved pressing 0.5 g of cream between two glass slides under a 1 kg load for 5 minutes, after which the time needed for the plates to separate was recorded as an indicator of how well the cream could adhere to the skin surface (Rahayu et al., 2023).

2.5. Antioxidant Activity Assay (DPPH Method)

The antioxidant activity of the extract and cream formulations was evaluated using the DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging method, based on the procedure described by Muthia et al. (2019). A DPPH stock solution (1000 ppm) was prepared by dissolving 5 mg of DPPH powder in 5 mL of ethanol p.a., and subsequently diluted to 40 ppm to serve as the working solution. This solution was stored in a dark container to prevent degradation by light.

As a positive control, ascorbic acid was used. A stock solution of 1000 µg/mL was prepared and serially diluted to obtain six concentrations (4, 5, 6, 7, 8, and 9 µg/mL). One milliliter of each concentration was mixed with 3 mL of 40 ppm DPPH solution. The mixture was incubated in the dark for 30 minutes before measuring the absorbance at the determined maximum wavelength using a UV-Vis spectrophotometer.

The test extract was prepared similarly, starting with a 1000 µg/mL stock solution and diluted to six concentrations (2.56, 6.4, 16, 40, 100, and 250 µg/mL). The same procedure was followed as with the control group. For cream formulations, samples from F0 to F4 were dissolved in ethanol p.a. to achieve an extract-equivalent concentration of 1000 µg/mL. These were then serially diluted in the same manner as the pure extract. Each diluted sample was mixed with DPPH solution in a 1:3 ratio, incubated in the dark for 30 minutes, and the absorbance was recorded using UV-Vis spectrophotometry. All tests were performed in triplicate to ensure accuracy and reproducibility.

2.6. Data Analysis

All experimental data were analyzed descriptively and statistically. Qualitative phytochemical screening results were reported descriptively based on the presence or absence of characteristic color changes. Physical evaluation parameters of the cream formulations, including pH, viscosity, spreadability, and adhesiveness, were expressed as mean ± standard deviation from triplicate measurements. Antioxidant activity data obtained from the DPPH assay were used to calculate the percentage of radical scavenging activity, and IC_{50} values were determined by linear regression analysis of percentage inhibition versus concentration. Statistical differences among formulations were analyzed using one-way analysis of variance (ANOVA) followed by Tukey's post hoc test, with a significance level set at $p < 0.05$.

3. RESULTS AND DISCUSSION

3.1. Extract Yield and Phytochemical Screening

The extraction of 800 g of mung bean seed coat (*Vigna radiata* L. R. Wilczek) using the maceration method with 36% ethanol yielded 149.2 g of thick extract, corresponding to an extractive yield of 18.65% (**Table 2**). This result indicates efficient extraction, as the yield is relatively high for a polar solvent-based method and is consistent with previous findings that flavonoids and polyphenols in mung bean seed coats are readily soluble in polar solvents (Zhou et al., 2017).

Phytochemical screening of the ethanol extract showed the presence of flavonoids and polyphenols (**Table 2**, **Figure 1**). The presence of these compounds supports the potential antioxidant activity of the extract. These findings are in line with Cao et al.

(2011), who reported that the seed coats of mung beans contain antioxidant flavonoids such as vitexin and isovitexin. Tajoddin et al. (2010) also noted that polyphenols are most concentrated in the seed coat compared to other seed parts.

Table 2. Extract Yield and Phytochemical Screening Results

Parameter	Result
Weight of simplicia (g)	800
Extract weight (g)	149.2
Extract yield (%)	18.65
Flavonoids	+
Polyphenols	+

+: detected.

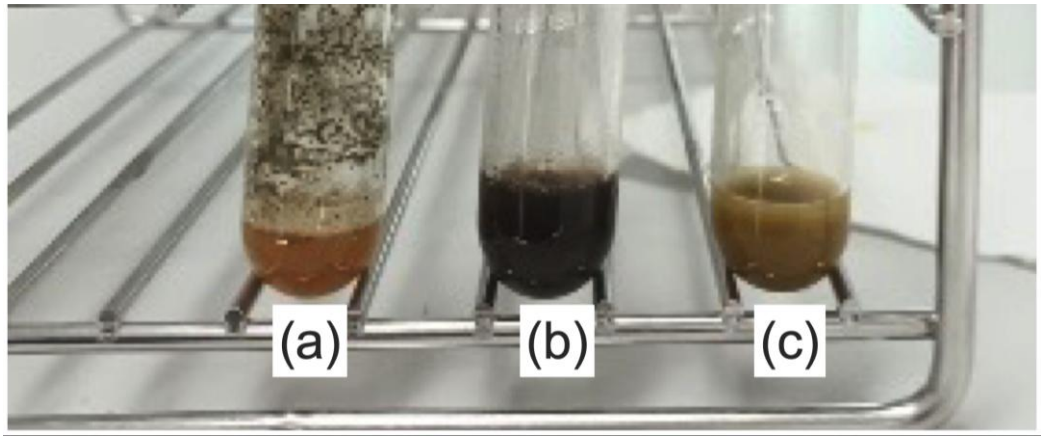

Figure 1. Visualization of Phytochemical Screening Results. (a) Flavonoid test showing the formation of a colored complex, (b) Phenolic test showing intense coloration due to ferric chloride reaction, and (c) Control showing no visible reaction.

3.2. Physical Evaluation of Cream Formulations

The physical characteristics of the cream formulations were evaluated based on several parameters. Organoleptic evaluation showed that the addition of extract led to noticeable changes in color and odor, ranging from white (F0) to darker brown hues (F4), with a characteristic mung bean scent becoming more prominent at higher concentrations (**Table 3**). These changes are expected due to the inherent properties of the ethanol extract. These visible differences in appearance among the formulations are illustrated in **Figure 2**.

Homogeneity tests confirmed that all formulations were smooth and consistent without clumps or phase separation, indicating even dispersion of extract across all formulations (**Table 3**).

Data presented in **Table 3** indicates that all formulas met the standard physical requirements for topical cream preparations. The pH values of all formulations ranged between 6.00 and 6.49, which are within the acceptable limits for topical applications (pH 4.5–6.5). The viscosity decreased with increasing extract concentration, which aligns with previous observations that polyphenolic compounds may interfere with the emulsion matrix, reducing consistency (Awalludin et al., 2022).

Spreadability and adhesiveness exhibited an inverse relationship with viscosity. As shown in Table 3, higher extract concentrations improved the spreadability but reduced the adhesiveness. However, all formulas still fell within acceptable ranges (spreadability: 5–7 cm; adhesiveness: >2 s), making them suitable for topical use.

All cream formulations were identified as oil-in-water (O/W) type emulsions, as shown in **Table 3**. This emulsion type is favorable for topical application because it offers a light, non-greasy texture and allows for easy spreadability and faster absorption into the skin (Yahya et al., 2022). The presence of water as the external phase supports the effective delivery of polar active compounds like flavonoids and polyphenols from the extract. Furthermore, O/W emulsions are generally preferred for cosmetic and pharmaceutical creams due to their better sensory acceptance and lower risk of pore clogging compared to water-in-oil (W/O) types.

3.3. Antioxidant Activity

The antioxidant activity of the ethanol extract of *Vigna radiata* seed coat (VRE), ascorbic acid (AA), and cream formulations (F1–F4) was evaluated using the DPPH radical scavenging assay. The IC_{50} values are presented in **Figure 3**. As shown, AA exhibited the strongest antioxidant activity ($IC_{50} \approx 5.57$ µg/mL), followed by VRE ($IC_{50} \approx 43.64$ µg/mL). Cream base (F0) showed no relevant activity, while formulations F1 to F4 exhibited a concentration-dependent decrease in IC_{50} values, from 175.90 µg/mL (F1) to 79.49 µg/mL (F4), indicating improved antioxidant performance at higher extract concentrations. Statistical analysis (Tukey's post hoc test, $p < 0.05$) confirmed significant differences among all tested samples, as marked by different superscript letters (a–f) in **Figure 3**.

Table 3. Physical Characteristics of Cream Formulations

Formula	Appearance	Odor	Homogeneity	pH	Viscosity (cPs)	Spreadability (mm)	Adhesiveness (s)	Type*
F0	Semi-solid	Odorless	Homogeneous	6.49	9586	57.60	16.60	O/W
F1	Light brown	Mild mung bean scent	Homogeneous	6.38	6960	57.40	12.58	O/W
F2	Light brown	Mild mung bean scent	Homogeneous	6.29	5013	59.86	6.93	O/W
F3	Brown	Noticeable bean scent	Homogeneous	6.20	3516	61.13	6.13	O/W
F4	Dark brown	Distinct bean scent	Homogeneous	6.00	2806	64.50	3.54	O/W

*O/W = oil-in-water

Figure 2. Visual appearance of cream formulations F0–F4 with increasing extract concentration.

These results align with prior studies indicating that *Vigna radiata* seed coats are rich in antioxidant compounds such as flavonoids (e.g., vitexin, isovitexin) and polyphenols, which act as radical scavengers (Cao et al., 2011; Zhou et al., 2017). The lower IC_{50} value of the VRE compared to earlier studies using 96% ethanol (e.g., Suryani et al., 2023; $IC_{50} \approx 91.36$ µg/mL) suggests that the use of 36% ethanol may enhance the extraction of polar antioxidant compounds. This is consistent with findings by Zhou et al. (2017), who noted that diluted ethanol better extracts hydrophilic antioxidants than absolute ethanol.

Furthermore, the antioxidant activity of the formulations, though lower than that of the extract alone, still falls within acceptable efficacy ranges. Based on Blois' classification, IC_{50} values <100 µg/mL are considered strong antioxidants (Suparmi et al., 2012). Hence, formulation F4, with an IC_{50} of 79.49 µg/mL, qualifies as having strong antioxidant potential, while F3 and F2 (117.85 µg/mL and 140.68 µg/mL, respectively) are classified as moderate. The lower activity in cream formulations can be attributed to matrix effects where the presence of excipients might hinder optimal diffusion of active compounds (Muthia et al., 2019).

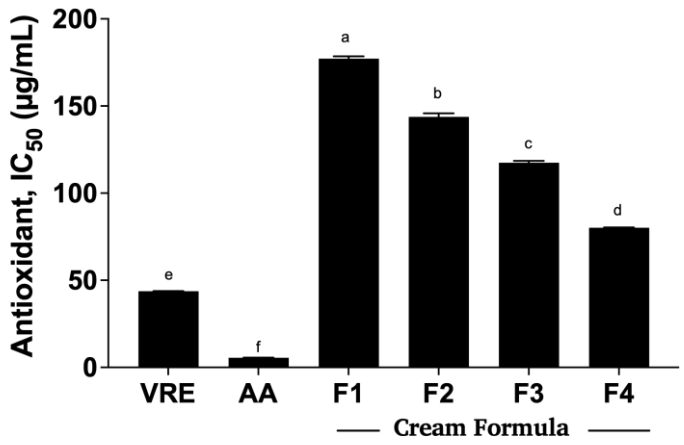

Figure 3. IC_{50} values of antioxidant activity measured by DPPH assay for VRE (*Vigna radiata* extract), AA (ascorbic acid), and cream formulations (F1–F4). Different lowercase letters (a–f) indicate significant differences based on Tukey's test at $p < 0.05$. Error bars represent standard deviation ($n = 3$).

4. CONCLUSION

This study demonstrated that ethanol extract of *V. radiata* seed coat can be successfully incorporated into cream formulations with acceptable physical characteristics, including pH, viscosity, spreadability, adhesiveness, and emulsion type. The creams remained homogeneous and stable, and exhibited increasing antioxidant activity with higher concentrations of extract. The 25% extract formulation showed the strongest antioxidant capacity, supporting the potential use of *V. radiata* seed coat extract as a natural antioxidant in topical applications. These findings highlight its promise as a valuable, locally sourced ingredient for the development of herbal skincare or cosmetic products aimed at preventing oxidative skin damage.

AUTHOR CONTRIBUTIONS

Conceptualization, H.E.H.; methodology, H.E.H. and L.H.; investigation, H.E.H., L.H., R.P., and D.A.P.; formal analysis, H.E.H. and R.P.; data curation, L.H. and D.A.P.; writing—original draft preparation, H.E.H.; writing—review and editing, H.E.H. and R.P.; visualization, D.A.P.; supervision, H.E.H.; project administration, H.E.H. All authors have read and agreed to the published version of the manuscript.

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INFORMED CONSENT STATEMENT

Not applicable.

DATA AVAILABILITY STATEMENT

Data supporting the findings of this study are available upon reasonable request from the corresponding author.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

DECLARATION OF GENERATIVE ARTIFICIAL INTELLIGENCE (AI) USE

During the preparation of this manuscript, the authors used ChatGPT (OpenAI) to assist in improving the clarity, structure, and readability of the text. After using this tool, the authors thoroughly reviewed, edited, and verified the entire content to ensure that it accurately represents their own ideas, data interpretation, and scientific conclusions. The authors take full responsibility for the integrity and originality of the published work.

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