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FORMULATION, CHARACTERIZATION, AND ANTIOXIDANT ACTIVITY OF TRANSPARENT SOAP CONTAINING MUNG BEAN SEEDS AND SPROUTS (*Vigna radiata* L.)

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ABSTRACT

Background: Transparent solid soap is an innovative cosmetic product designed to improve aesthetic value and consumer acceptance. The incorporation of natural antioxidants has attracted growing interest due to their protective effects against free radicals. Mung bean (*Vigna radiata* L.), particularly its seeds and sprouts, exhibits antioxidant activity associated with flavonoid compounds, yet its application in transparent soap formulations remains limited. **Objective:** This study aimed to evaluate the physical quality and antioxidant activity of transparent soap formulations containing mung bean (*Vigna radiata* L.) seeds and sprouts. **Method:** Mung bean seeds and sprouts were dried, pulverized into powder, and subjected to phytochemical screening for flavonoid. Each powder was incorporated into transparent solid soap formulations. Antioxidant activity was evaluated in vitro using the DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging assay. Commercial soap with known antioxidant activity was used as a positive control, while soap base without mung bean powder served as a negative control. Physical quality evaluation included organoleptic, pH, wetting test, skin irritation test, and stability assay**. Results**: The addition of mung bean seed powder and sprouts affects the physical quality of transparent soap. Sprouts soap shows stronger antioxidant activity than mung bean seed soap, indicated by a smaller IC_{50} value. **Conclusion**: Transparent solid soap with the addition of mung bean sprouts has good physical quality and stronger antioxidant activity than mung bean seed soap, so it has the potential to be developed as a cleaning preparation with antioxidant benefits.

ABSTRAK

Latar belakang: Sabun padat transparan merupakan salah satu inovasi sediaan pembersih yang dikembangkan untuk meningkatkan daya tarik dan nilai estetika produk. Pemanfaatan bahan alam yang memiliki aktivitas antioksidan dalam formulasi sabun semakin diminati karena potensinya dalam menangkal radikal bebas. Kacang

hijau (*Vigna radiata* L.) diketahui memiliki berbagai aktivitas farmakologis, salah satunya sebagai antioksidan yang berasal dari flavonoid. **Tujuan**: Penelitian ini bertujuan untuk mengetahui mutu fisik dan aktivitas antioksidan sabun padat transparan yang diformulasikan dengan serbuk biji dan kecambah kacang hijau (*Vigna radiata* L.). **Metode**: Biji dan kecambah kacang hijau dikeringkan, kemudian diserbukkan, dan dilakukan skrining fitokimia untuk mengidentifikasi keberadaan senyawa flavonoid. Masing-masing serbuk kemudian diformulasikan ke dalam sediaan sabun padat transparan. Uji aktivitas antioksidan dilakukan secara in vitro menggunakan metode DPPH (2,2-diphenyl-1-picrylhydrazyl). Sabun komersial dengan aktivitas antioksidan digunakan sebagai kontrol positif, sedangkan basis sebagai kontrol negatif. Pengujian mutu fisik meliputi uji stabilitas, uji pH, uji daya pembasah, uji daya busa serta uji iritasi kulit. **Hasil**: Hasil Penambahan serbuk biji dan kecambah kacang hijau mempengaruhi mutu fisik sabun transparan. Sabun kecambah menunjukkan aktivitas antioksidan yang lebih kuat dibandingkan sabun biji kacang hijau, ditandai dengan nilai IC_{50} yang lebih kecil. **Kesimpulan**: Sabun padat transparan dengan penambahan kecambah kacang hijau memiliki mutu fisik yang baik serta aktivitas antioksidan yang lebih kuat dibandingkan sabun biji kacang hijau, sehingga berpotensi dikembangkan sebagai sediaan pembersih dengan manfaat antioksidan.

INTRODUCTION

At present, free radicals are increasingly recognized as potential compounds that threaten the viability of normal cells in the human body (Olivia et al., 2004). Sources of free radicals are broadly classified into two categories: endogenous sources derived from normal metabolic processes and exogenous sources, including air pollution, alcohol consumption, cigarette smoke, ultraviolet and X-ray radiation, pharmaceuticals, chemotherapy, and other environmental exposures (Nadesul, 2007). Therefore, to reduce the levels of free radicals in the body, antioxidant compounds are required (Olivia et al., 2004).

The skin plays a crucial role in protecting the body from harmful environmental factors and external damage. However, excessive or repeated exposure to these detrimental influences can lead to the formation of exogenous free radicals, resulting in skin wrinkling and accelerated premature aging. Premature skin aging is characterized by the early appearance of fine lines and wrinkles, loss of skin elasticity, uneven pigmentation, dryness, and a decline in overall skin structural integrity. Therefore, appropriate skin care and preventive interventions are essential (Yaar and Gilchrest, 2008).

Soap is a skin-cleansing preparation produced through saponification or neutralization processes (BSNI, 2016). Mung bean (*Vigna radiata* L.) is a rich source of protein, vitamins A and B1, and minerals, including calcium, sulfur, manganese, and iron. Following germination, mung beans become enriched with bioactive metabolites and exhibit enhanced biological activity. *Vigna radiata* L. has gained attention due to its

detoxifying properties and has been demonstrated to possess antioxidant activity as well as other pharmacological effects (Dongyan et al., 2014).

This study evaluated the physical quality and antioxidant activity of transparent soaps containing mung bean seed and sprout powders, which were obtained through drying, pulverization, and phytochemical flavonoid screening before formulation. Antioxidant activity was assessed in vitro using the DPPH radical scavenging assay, with commercial antioxidant soap as a positive control and soap base without mung bean as a negative control, while physical quality was evaluated through organoleptic properties, pH, wetting ability, skin irritation, and stability tests.

METHOD

The instruments used in this study included an oven, blender, analytical balance, vortex mixer, desiccator, water bath, 60-mesh sieve, pH meter, burette, and a UV–Vis spectrophotometer. The materials used in this study included mung bean seeds (*Vigna radiata* L.), stearic acid, sodium hydroxide (NaOH), virgin coconut oil (VCO), alcohol, glycerin, citric acid, sucrose, cocodiethanolamide, distilled water, aqua pro analysis (aqua p.a.), 70% ethanol, 70% methanol, magnesium, concentrated hydrochloric acid (HCl), amyl alcohol, chloroform ($CHCl_3$), ammonium hydroxide (NH_4OH), sulfuric acid (H_2SO_4), Mayer's reagent, ferric chloride ($FeCl_3$), acetic anhydride, petroleum ether, potassium hydroxide (KOH) solution, phenolphthalein indicator, methyl orange, acetone, DPPH powder, and a commercial soap with known antioxidant activity.

The mung bean plant (*Vigna radiata* L.) was taxonomically identified, and the seeds were collected to prepare seed powder and sprout powder. The powders were subjected to phytochemical screening and evaluated for antioxidant activity using the DPPH (2,2-diphenyl-1-picrylhydrazyl) method. Vitamin C used as a reference standard. The powders were then formulated into transparent soap preparations, which were subsequently evaluated for physical quality in accordance with the method described by Febriyenti et al. (2014).

Table 1. Formulation of Transparent Solid Mung Bean (*Vigna radiata* L.) Soap

Ingredient	Function	F1 (%)	F2 (%)
Mung bean seed powder	Active ingredient	10	-
Mung bean sprout powder	Active ingredient	-	10
Stearic acid	Foam stabilizer	6.3	6.3
VCO Virgin coconut oil (VCO)	Oil phase	17	17
Sodium hydroxide	Alkali	18	18
Ethanol 95%	Solvent	14.5	14.5
Glycerin	Humectant	10	10
Citric acid	pH adjuster	2	2
Sucrose	Additive	14	14
Cocamine DEA	Surfactant	2	2
Fragrance	Fragrance	qs	qs
Aquadest	Solvent	100	100

Note: F1 : Formulation of transparent solid soap containing mung bean seed powder
F2 : Formulation of transparent solid soap containing mung bean sprout powder

The physical quality evaluation consisted of organoleptic testing, pH, wetting ability test and foaming ability test. The formulation was also observed for skin irritation, as well as SNI-compliant tests including moisture content and total fatty matter (BSNI, 2016). The physical quality data were analyzed using the Independent Sample *t*-test and the Mann–Whitney *U* test in SPSS.

The antioxidant activity of the soap was evaluated using the DPPH (2,2-diphenyl-1-picrylhydrazyl) method based on the IC_{50} value, where a lower IC_{50} indicates higher antioxidant activity. The determination of antioxidant activity began with identifying the maximum wavelength (λmax) of a 60 ppm DPPH solution in the wavelength range of 510–520 nm. A 40 ppm DPPH solution and sample solutions at concentrations of 50, 100, 150, 200, 250, and 300 ppm were then prepared. For each concentration, 0.6 mL of the sample solution was mixed with 1.4 mL of 40 ppm DPPH solution, incubated for 10 minutes, and the absorbance was measured using a visible spectrophotometer at the maximum wavelength. The sample concentrations and absorbance values were used to calculate the percentage of inhibition using the following formula:

$$\%\ inhibition = \frac{Abs\ control - Abs\ sample}{Abs\ control}\ x\ 100\%$$

The percentage of inhibition and sample concentration were used to construct a linear regression curve to obtain the equation y = bx + a. The value of y was then set to 50 to determine the IC_{50}, where x represents the sample concentration required to produce 50% free radical scavenging activity.

RESULT

Plant identification was conducted at the UPT Materia Medica Batu, Malang. The results confirmed that the plant used in this study was mung bean (*Vigna radiata* (L.) R. Wilczek). Phytochemical screening of the extract, as presented in Table 2, showed positive results for flavonoids, alkaloids, tannins, saponins, and phenolic compounds.

Table 2. Phytochemical screening of Powders and Extracts from Mung Bean Seeds and Sprouts (*Vigna radiata* L.)

Phytochemical Screening	Results	
	Mung Bean Seed Extract	Mung Bean Sprout Extract
Flavonoids	+	+
Alkaloids	+	+
Tannins	+	+
Saponins	+	+
Phenols	+	+

A quantitative antioxidant activity assay using the DPPH (2,2-diphenyl-1-picrylhydrazyl) method was conducted on mung bean seed and sprout powders, with the results presented in Table 4. The maximum absorbance wavelength of DPPH was determined within the range of 510–520 nm and found to be 519 nm, which was subsequently used to evaluate vitamin C, mung bean seed and sprout powders, soap base, commercial vitamin C soap, mung bean soap, and sprout soap. Each sample was tested at concentrations of 50–300 ppm to calculate the percentage of inhibition. The IC_{50} values were determined using the linear regression equation $y = bx + a$. The results showed that the IC_{50} value of mung bean seed powder was 75.00 ppm, while that of mung bean sprout powder was 34.13 ppm.

Mung bean seed and sprout powders, which have been proven to possess antioxidant activity, were formulated into transparent solid soap preparations. The transparent soap formulations are presented in Table 1. The resulting products were subjected to physical quality evaluations, including pH, wetting ability, and foaming ability tests. The physical quality test results, as shown in Table 3, indicate that the transparent soaps containing mung bean seeds and sprouts met all physical quality requirements.

Tabel 3. Results of Physical Quality Tests on Transparent Solid Green Bean Soap (*Vigna radiata* L.).

Physical Quality Tests	Conditions	Results	
		F1	F2
pH	9 – 10.8	9,7	9,6
Wetting ability test	< 0,2 s	16,06	21,69
Foaming ability test in distilled water	1,3 – 22 cm	7,7	8,0
Foaming ability test in hard water	1,3 – 22 cm	1,1	1,1

Note: F1 : Formulation of transparent solid soap containing mung bean seed powder
F2 : Formulation of transparent solid soap containing mung bean sprout powder

According to the Indonesian National Standard (SNI) 2016, the maximum allowable moisture content of soap is 15%. The moisture contents of mung bean seed soap and mung bean sprout soap were 0.81% and 0.91%, respectively, indicating compliance with the SNI requirement. However, the minimum requirement for total fatty matter (TFM) in soap is 65%, while the total fat contents of mung bean seed soap and mung bean sprout soap were only 8.176% and 7.288%, respectively. Although these values do not meet the SNI requirement for conventional soap, the low fat content is advantageous for the production of transparent soap, as a lower proportion of oils and a higher proportion of transparency-enhancing ingredients facilitates light transmission through the soap matrix, resulting in improved transparency (Gunawan et al., 2016).

The results of the skin irritation test**,** conducted using the closed patch test method on the inner upper arm, showed that no irritation reactions were observed in any of the panelists**.** The test, which was performed over a period of three days on five panelists, revealed no signs of itching, redness (erythema), or edema at the tested skin sites.

The IC_{50} values presented in Table 4 indicate that mung bean soap and mung bean sprout soap exhibited stronger antioxidant activity than the soap base**.** The mung

bean soap showed an IC_{50} value of 11.94 ppm**,** while the mung bean sprout soap exhibited a lower IC_{50} value of 7.87 ppm**,** indicating higher antioxidant activity.

Table 4. Antioxidant Activity Test Results of Powders and Soaps Derived from Mung Bean Seeds and Sprouts (*Vigna radiata* L.)

Sample	IC_{50} (ppm)
Vitamin C	7.05
Commercial soap	8.54
Mung bean soap	11.94
Mung bean sprout soap	7.87

DISCUSSION

Plant determination is a process to confirm the taxonomic accuracy of the plant samples used in the study. In this study, the determination of mung bean was conducted at UPT Materia Medica Batu, Malang, and the results confirmed that the plant used was mung bean (*Vigna radiata* (L.) R. Wilczek).

The results of phytochemical screening of mung bean seeds and sprouts extracts are presented in Table 3. Based on the analysis, the extracts showed positive results for several classes of secondary metabolites, namely flavonoids, alkaloids, tannins, saponins, and phenolic compounds. Ethanol is an effective solvent for extracting secondary metabolites due to its ability to dissolve a wide range of polar and semi-polar compounds (Harborne, 1987). Furthermore, the phytochemical screening results obtained in this study are consistent with those reported in the literature, in which flavonoids, alkaloids, tannins, saponins, and phenolic compounds were also identified in mung bean extracts (Astarina, 2013). Metabolomic studies on soybean (*Glycine max*) have demonstrated significant differences in secondary metabolite profiles between seeds and sprouts, particularly in the flavonoid group. An increase in flavonoid content has been reported during the germination process, indicating that sprouting may activate the biosynthetic pathways of these secondary metabolites (Bi et al., 2022).

The antioxidant activity assay using the DPPH method was conducted to evaluate the antioxidant strength of mung bean seed powder and mung bean sprout powder. The results of the antioxidant activity test are presented in Table 4 as IC_{50} values. The IC_{50} value of mung bean seed powder was 75.00 ppm, while mung bean sprout powder exhibited an IC_{50} value of 34.13 ppm. According to the classification of antioxidant strength, compounds with IC_{50} values < 50 µg/mL are categorized as very strong antioxidants, those with IC_{50} values of 50–100 µg/mL as strong antioxidants, 101–150 µg/mL as moderate antioxidants, and > 150 µg/mL as weak antioxidants. Based on these results, mung bean sprout powder falls into the very strong antioxidant category, whereas mung bean seed powder is classified as a strong antioxidant. This difference in antioxidant activity indicates that mung bean sprout powder has a superior free radical scavenging capacity compared to mung bean seed powder, as reflected by its lower IC_{50} value. The flavonoid compounds present in mung bean seed and sprout extracts are presumed to be the primary contributors to the observed antioxidant activity. In addition, mung bean seeds and sprouts also contain other compounds, such as proteins, which may contribute to antioxidant activity (Santoso, 2009).

The mung bean sprout soap exhibited stronger antioxidant activity compared to mung bean seed soap. This finding is consistent with previous studies reporting that

mung bean sprout extracts possess higher antioxidant activity than seed extracts, which is attributed to the increased accumulation of bioactive compounds during the germination process (Ramesh *et al.*, 2011). This result is also in agreement with earlier evaluations of mung bean seed and sprout powders, which demonstrated that sprout powder exhibited greater antioxidant capacity than seed powder.

The mung bean seed and sprout powders, which have been proven to possess antioxidant activity, were subsequently formulated into a transparent soap preparation. The composition of the transparent soap formulation is presented in Table 1. Organoleptic evaluation revealed that the incorporation of the active ingredients in powder form affected the transparency of the soap. As a result, both mung bean seed soap and mung bean sprout soap did not exhibit the expected transparent appearance characteristic of transparent soap formulations. This phenomenon is presumably attributed to the incomplete solubility and dispersion of the powder particles within the soap matrix.

The results of the physical quality evaluation, including pH, *wetting ability*, and *foaming ability*, are presented in Table 3. Overall, both mung bean seed and sprout soap formulations met the required physical quality parameters. The pH values and *foaming ability* of the two formulations did not show significant differences, whereas a difference was observed in the *wetting ability* parameter, indicating variations in surface wetting performance between the two formulations, which may be influenced by the distinct physicochemical characteristics of the active ingredients used.

The safety of the formulation was evaluated through a skin irritation test using the closed patch test method on the inner upper arm area. The test was conducted on five panelists over a period of three consecutive days. The results showed that no subjective complaints such as itching or observable signs of skin irritation were reported in any of the panelists throughout the testing period. Based on these findings, the soap formulated from mung bean seeds and sprouts did not induce skin irritation under the conditions of this study**.**

Based on the results of this study, the plant used was identified as mung bean (*Vigna radiata* (L.) R. Wilczek). Phytochemical screening demonstrated that both mung bean seed and sprout extracts contained various secondary metabolites, including flavonoids, alkaloids, tannins, saponins, and phenolic compounds. Antioxidant activity evaluated using the DPPH method showed that mung bean sprout powder exhibited stronger antioxidant activity than seed powder, which is likely associated with increased accumulation of bioactive compounds during the germination process. Both mung bean seed and sprout powders were successfully formulated into soap preparations; however, the incorporation of the active ingredients in powder form affected the transparency of the formulations. Physical quality evaluation indicated that both soap formulations met the required standards for pH, foaming ability, and wetting ability, although a significant difference in wetting ability was observed between the two formulations. Skin irritation testing revealed no signs of irritation among the panelists, indicating that soaps formulated with mung bean seeds and sprouts are safe for use, with mung bean sprouts showing greater potential as a superior source of antioxidants.

CONCLUSION

The DPPH assay results demonstrated that mung bean sprout powder exhibited stronger antioxidant activity than seed powder, which is presumably associated with the

increased accumulation of bioactive compounds, such as flavonoids and phenolic compounds, during the germination process. Meanwhile, soap formulations prepared from both mung bean seed and sprout powders met the required physical quality standards, including pH, foaming ability, and wetting ability, although a significant difference in wetting ability was observed between the two formulations.

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