

Cosmetic Cream Formulation Containing Black Soybean Extract: Organoleptic Properties, Homogeneity, and pH During Storage

Senny Listy Kartika Falestin¹, Yanthy Susanti¹, Pra Panca Bayu Chandra¹, Yulius Evan Christian^{2*}, Lolita Intan Saputri¹

¹Pharmacy Study Program, IKIFA College Of Health Sciences, Jakarta, Indonesia

²Pharmacy Study Program, Faculty of Medicine and Health Sciences, Atma Jaya Catholic University of Indonesia, Jakarta, Indonesia

Corresponding Author: yulius.christian@atmajaya.ac.id

Received: 10 August 2026 / Accepted: 29 September 2026

ABSTRACT: Black soybean (*Glycine soja* (L.) Merr.) is a legume known to be rich in natural antioxidants, particularly anthocyanins, which contribute to its potential in skincare applications. This study aimed to evaluate the physical and chemical quality of cream formulations containing black soybean extract. Samples were obtained from Gunung Kidul. Extraction was performed using the maceration method with 96% ethanol, yielding a reddish-black viscous extract with a yield of 7.092% (w/w). Phytochemical screening confirmed the presence of anthocyanins. Two cream formulations were prepared: Formula 0 (F0), containing no extract, and Formula 1 (F1), containing 0.5% black soybean extract. Physical and chemical evaluations—covering organoleptic properties, homogeneity, spreadability, viscosity, emulsion type, and pH—were conducted over a 4-week period (from week 0 to week 4). Organoleptic tests showed that both formulations maintained stable appearance, color, and aroma throughout the study. Homogeneity tests confirmed uniform distribution without the presence of coarse particles. Spreadability test results fell within acceptable dermatological standards, with F1 exhibiting slightly lower spreadability due to higher viscosity. Viscosity measurements indicated that F1 had higher viscosity than F0, although both remained below the ideal range for pharmaceutical preparations. Emulsion type tests identified both creams as oil-in-water (O/W) emulsions. pH testing showed that both formulations remained within the safe range for topical application (pH 4.5–6.5) during the storage period. In conclusion, the cream containing black soybean extract demonstrated favorable physical and chemical characteristics for a cream preparation.

KEYWORDS: antioxidant; black soybean; cream formulation; phytochemical test; physical evaluation

1. INTRODUCTION

The skin is the largest organ of the human body and serves as the primary barrier against various external factors, such as ultraviolet (UV) radiation, air pollution, pathogenic microorganisms, and harmful chemicals. In addition to its role as a physical barrier, the skin also plays a vital role in maintaining fluid balance, regulating body temperature, and functioning as a sensory organ. These complex functions require proper care to ensure that the skin remains healthy and functions optimally. Excessive exposure to external factors can lead to oxidative stress on the skin, which is characterized by the overproduction of free radicals beyond the capacity of the endogenous antioxidant system. This condition can damage cellular and tissue structures, accelerating premature skin aging. Free radical accumulation may cause hyperpigmentation, inflammation, and reduced skin elasticity. Therefore, appropriate skincare is essential for maintaining skin health and preventing damage caused by environmental stressors [1,2].

The use of antioxidant agents is a preventive approach to mitigating the harmful effects of free radicals. Antioxidants neutralize free radicals before they cause further skin damage. In recent years, the use of natural ingredients as sources of antioxidants has gained considerable attention in the pharmaceutical and cosmetic fields, as they are generally safer, more environmentally friendly, and well-accepted by consumers. Black soybean (*Glycine soja* [L.]) has great potential as a natural antioxidant. Merr.) [3].

How to cite this article: Falestin SLK, Susanti Y, Chandra PPB, Christian YE, Saputri LI. Cosmetic Cream Formulation Containing Black Soybean Extract: Organoleptic Properties, Homogeneity, and pH During Storage. Journal of Natural Product for Degenerative Diseases. 2026; 4(1): 21-35.

Black soybeans contain bioactive compounds, such as anthocyanins, isoflavones, and flavonoids, which play significant antioxidant roles. Anthocyanins are water-soluble pigments belonging to the flavonoid group that can scavenge free radicals, inhibit lipid peroxidation, and chelate metal ions. Black soybean extract can protect the skin from UV-induced damage, promote collagen production, and improve dermal matrix structure [4,5]. These effects are attributed to the ability of anthocyanins to neutralize free radicals and inhibit oxidative processes that contribute to tissue damage. Therefore, black soybean extract holds promising potential as an active ingredient in topical formulations for the prevention and treatment of oxidative skin damage [3,6].

Topical creams are commonly used as delivery systems to deliver active ingredients to the skin. Creams are semisolid emulsions that are easy to apply, nonsticky, and capable of good skin penetration. O/W emulsions are widely preferred among the various types of emulsions due to their light texture, fast absorption, and suitability for all skin types. An ideal cream formulation should ensure physical and chemical stability by meeting parameters such as homogeneity, pH, spreadability, viscosity, and emulsion type to maintain the effectiveness of the active ingredient during storage and use. These factors are critical for ensuring that the product remains safe and effective throughout its shelf life [7]. Shifting consumer preferences toward natural ingredients are driving research into innovative bioactive combinations. One of the most promising phytochemical commodities is anthocyanins, which are valued not only for their diverse biological activities but also for the visual appeal of their colors [8].

The addition of plant extracts to cream formulations often affects the final product's physicochemical characteristics. Therefore, a comprehensive evaluation is needed to assess how the extract influences formulation quality. The novelty of this study lies in the use of black soybean extract as a natural antioxidant in a topical cream formulation and its impact on various physicochemical parameters. Few scientific reports have discussed the development of creams containing black soybean extract, particularly in terms of formulation stability and quality characteristics. This research aims to address this gap and contribute to the advancement of more effective development of cosmetic products. Furthermore, this study is expected to provide comprehensive data on the use of black soybean extract as a natural antioxidant in topical cream formulations [9].

This study aimed to develop and evaluate a cream containing black soybean extract (*Glycine soja* L.) Merr.) as a natural antioxidant. The evaluation focuses on parameters such as homogeneity, pH, spreadability, viscosity, and emulsion type. This research is important because of the antioxidant properties of black soybean extract, which can protect the skin from free radical damage. This study is expected to contribute scientifically to the development of innovative, safe, and effective natural-based topical products with potential applications in the pharmaceutical and cosmetic industries [10].

2. MATERIALS AND METHODS

2.1. Material and Instruments

Material

Black soybean extract (*Glycine soja* L.) Merr.), obtained from a local market in Gunung Kidul, Yogyakarta Special Region, Indonesia. The extraction process was performed independently in the laboratory. The cream formulation included: stearic acid (Brataco, Indonesia), cetyl alcohol (Dow Chemical Pacific, Singapore), white vaseline (Kimia Farma, Indonesia), Tween 80 (Sigma-Aldrich, USA), glycerin (Merck, Darmstadt, Germany), propylene glycol (Merck, Darmstadt, Germany), nipagin and nipazol (Sigma-Aldrich, USA), and distilled water as the solvent. All materials were used according to the pro-analysis grade specifications and without further purification.

Instruments

The following instruments were used: analytical balance (Ohaus, USA), magnetic stirrer (IKA® C-MAG HS seven, Germany), rotary evaporator (Buchi R-300, Switzerland), digital pH meter (Mettler Toledo, Switzerland), homogenizer (IKA Ultra-Turrax T25, Germany), Brookfield viscometer (Brookfield DV-E, USA), and vacuum oven (Mettler, Germany).

2.2. Procedure

Determination of the black soybean

Black soybeans (*Glycine soja* L.) Merr.) obtained from local farmers in Gunung Kidul, Yogyakarta Special Region. Before being used in the research process, the samples were subjected to botanical determination to confirm their authenticity and species identity. The determination was conducted at the Botany Division, Research Center for Biology, Indonesian Institute of Sciences (LIPI), Bogor, Indonesia, which is an authorized institution for plant taxonomic identification [11].

The determination process was performed by observing the plant's macroscopic morphological characteristics, including its shape, size, color, and seed surface. Observations were conducted based on standard botanical identification keys used in the classification of species-level plants. This step ensured the scientific validity of the plant material used and confirmed that it matched the intended species for the study [12].

Preparation of the Simplicia Formula

After obtaining the black soybean samples, the first step was to prepare the plant simplicia. The soybean seeds were cleaned from physical impurities and dried naturally in a shaded, well-ventilated area to reduce moisture content without damaging the active compounds. The dried seeds were then ground using a grinder to obtain a coarse powder. This powder was then sieved through a 100-mesh sieve to achieve uniform particle size and enhance extraction efficiency. The resulting simplicia was stored in dark-colored airtight containers at room temperature in a dry place to preserve the stability of the active compounds before the extraction process [13].

Extraction Process

The extract was prepared by maceration to obtain the active compounds from black soybean powder. The simplicia was weighed based on a solvent-to-solid ratio of 1:30 using 96% ethanol (pro-analysis grade) as the solvent. A 1 N citric acid solution was added to the ethanol in a ratio of 80:20 to stabilize the pH during the extraction. Maceration was performed in a dark-colored, closed container to prevent light exposure-induced degradation of the compound. The maceration lasted for 3×24 hours with daily stirring to improve the contact between the solvent and the plant material. The temperature was maintained at approximately 30°C to prevent the thermal degradation of the active compounds. The mixture was filtered through a Whatman filter after maceration. 1 filter paper to separate the filtrate from the residue. The filtrate was then concentrated using a rotary evaporator at a low temperature (40°C) to remove the solvent and obtain a thick extract. The resulting extract was stored in tightly closed, dark-colored containers to protect it from oxidation and photodegradation. Storage was performed in a refrigerator at 4°C until the extract was ready for formulation [14].

Anthocyanin Identification

Anthocyanin compounds in black soybean extract were analyzed to confirm the presence of flavonoid pigments that act as natural antioxidants. A total of 2 mL of extract was placed in a clean test tube, followed by the addition of 1 mL of 2 M HCl. Then, the mixture was heated at 100°C for 5 min using a water bath or dry block heater. A stable red color indicates a positive reaction, confirming the presence of anthocyanins under acidic conditions [15].

Next, 2 M sodium hydroxide (NaOH) solution was added dropwise to the mixture while observing the color change. A positive color shift to bluish-green, which gradually faded, indicated a positive reaction. This color change reflects the pH sensitivity of anthocyanins, which appear red in acidic environments and blue to green in alkaline conditions. This reaction served as a qualitative indicator of the anthocyanin content of the extract [11,16].

Cream formulation

The preparation of the cream formulation began with weighing all ingredients used for the cream base according to the predetermined formulation. These materials were then divided into 2 phases: the oil phase and the aqueous phase.

Table 1. Composition and function of ingredients used in the formulation of black soybean cream preparations for Formula F0 (without extract) and Formula F1 (with 0.5% black soybean extract)

Phase	Ingredients	Formula F0 (%)	Formula F1 (%)	Function
1	Emulgide	12	12	Emulsifying agent
	Lanolin	1	1	Emollient
	Capryl/Caprilic Triglycerida	3	3	Emollient
	Propyl Paraben	0,1	0,1	Preservative
2	Glycerin	3	3	Humectant
	Allantoin	0,2	0,2	Moisturizer
	Methyl Paraben	0,1	0,1	Preservative
	Aquades	80,6	80,1	Solvent
3	Black Soybean Extract	-	0,5	Active ingredient

The oil phase consisted of lanolin, fulgide, capryl/caprylic triglyceride, and propyl paraben, whereas the aqueous phase consisted of glycerin, allantoin, methyl paraben, and distilled water (aqua). Each phase was heated separately using a water bath until the temperature reached 70°C to ensure complete solubilization of all ingredients. Once fully dissolved, the aqueous phase beaker was placed in a basin filled with hot water to maintain its temperature. Subsequently, the oil phase was slowly added to the aqueous phase with continuous stirring using a homogenizer until a stable and homogeneous emulsion was formed. The active ingredient (black soybean extract), the extract was incorporated into the emulsion after cooling to room temperature. The extract was gradually added with continuous mixing to ensure even dispersion and to form a uniform cream mass. After the cream formation was complete, the final weight was adjusted and the formulation was transferred into a suitable, tightly sealed container to prevent contamination. Then, the cream was stored and observed for physical and chemical stability for up to 4 weeks (week 0–4) [17,18].

Evaluation of the Physical and Chemical Properties of Cream Formulation

Physical Evaluation

Organoleptic Examination (OLE)

Organoleptic testing was conducted to evaluate the visual and sensory characteristics of the cream, including color, aroma, and texture. Direct observations were performed using clean hands: visual inspection to detect changes in color or clarity, olfactory assessment to evaluate aroma consistency, and tactile assessment to evaluate texture. This testing aimed to detect signs of physical or chemical degradation during storage. The formulation was expected to exhibit a uniform color consistent with the extract concentration, without any stark color changes. The odor should remain mild and nonacid, and the texture should be smooth and consistent without phase separation or coarse particles. Observations were performed weekly on weeks 0, 1, 2, 3, and 4 [19].

Homogeneity test

The homogeneity test involved spreading a small amount of cream on a transparent glass surface and observing it visually. This study aimed to ensure that both active and excipient components were uniformly distributed throughout the cream base without segregation or clumping. The cream should appear homogeneous in texture and color, with no visible granules, crystals, or clots. No noticeable variations in color or texture should be observed across the applied surface. Weekly evaluations were conducted during storage (weeks 0–4) [17].

The spreadability test

This test measured the ability of the cream to spread over the skin surface. Exactly 1 g of cream was placed on a 20 × 20 cm glass plate, covered with a transparent plastic sheet (mica), and pressed with a 125 g weight. The spread diameter was measured using a Vernier caliper or ruler after 1 min. An acceptable diameter of spreadability of 5–7 cm. A lower value indicates difficulty in application, while excessive spreadability may lead to inefficient use of the active ingredient. The test was conducted weekly from weeks 0 to 4 to monitor stability [17].

Emulsion Type Test

The emulsion type was determined using the solubility method of MB dye. One gram of cream was placed on a glass slide, and one drop of methylene blue solution was added. The preparation was covered with a glass cover, and the dispersion of the dye was observed. If the dye was evenly dispersed, the emulsion was categorized as oil-in-water (O/W); if the dye was clumped or uneven, it indicated a water-in-oil (W/O) emulsion. The desired result was an O/W emulsion, indicated by uniform blue dye dispersion, which is preferred for cosmetic creams due to its light texture and easy rinsability. Observations were repeated weekly throughout the study [18].

Viscosity test

A viscosity test was performed to determine the cream thickness, which influences its physical stability and user acceptability. Approximately 200 mL of cream was placed in a 200 mL beaker, and the viscosity was measured at 0.5 rpm using a Brookfield viscometer with spindle No. 64. The spindle was gently immersed until fully submerged, and the viscosity reading was recorded once the value stabilized. Measurements were conducted at room temperature. The ideal viscosity of topical creams ranges from 10,000 to 30,000 cps. A lower viscosity may result in instability and runniness, whereas an excessively high viscosity may hinder application. The viscosity was monitored weekly over the 4-week storage period [18].

Chemical Evaluation

pH test

A pH test was performed to ensure that the cream's acidity was within the safe range for skin application. A calibrated digital pH meter and standard buffer solutions (pH 4 and 7) were used to ensure measurement accuracy. After calibration, the electrode was directly inserted into the cream until it was submerged, and the pH value was recorded. Measurements were performed under clean conditions at room temperature. To match the physiological skin pH, the target pH range for topical formulations is 4.5–6.5. Deviations may lead to irritation or disruption of the protective skin barrier. Weekly pH evaluations were performed to monitor stability over the storage period [19].

3. RESULTS

Collection of the black soybean samples

Black soybeans (*Glycine soja* L. Merr.) were successfully collected from selected local farms in Gunung Kidul, Yogyakarta, Indonesia. The selected sites offered optimal agroclimatic conditions, including sandy clay soil and sufficient rainfall, which are suitable for cultivating high-quality black soybeans. Harvested seeds were cleaned, separated from debris, and manually sorted to ensure only whole, undamaged, and pest-free seeds were included. All procedures followed standard protocols for laboratory-grade raw material collection.

Characteristics of the black soybean extract

The black soybean extract was obtained through a maceration process using 96% ethanol as the solvent and a small amount of citric acid to stabilize the pH. The extraction was carried out at the Phytochemistry Laboratory of STIKes IKIFA. The resulting extract showed a dark reddish-black color and viscous consistency (Figure 1), with a distinctive organoleptic profile and characteristic aroma of black soybean. The yield of extract obtained was 7.092% w/w, indicating that the extraction process was adequately efficient in isolating the active components from black soybean.



Figure 1. Black soybean extract showing a dark reddish-black color and viscous consistency

Phytochemical identification results

The phytochemical identification test confirmed the presence of anthocyanins in the black soybean extract. When treated with 2 M hydrochloric acid (HCl) and heated at 100°C for 5 minutes, the extract developed a red to dark reddish-black coloration, indicating an acidic environment. Upon the gradual addition of 2 M sodium hydroxide (NaOH), the solution transitioned to a greenish-black color. These observable changes are indicative of pH-sensitive pigments such as anthocyanins [20].

Table 2. Detection of anthocyanins in black soybean extract using color reaction tests with hydrochloric acid (HCl) and sodium hydroxide (NaOH).

No	Compound	Reaction	Observation	Result
1	Anthocyanin	Sample + 2 M Hydrochloric Acid, heated at 100°C for 5 minutes → Add 2 M NaOH drop by drop	Red color → Greenish-black	Positive



Figure 2. Testing for the presence of anthocyanins in the extract was conducted via color reactions using hydrochloric acid and sodium hydroxide reagents.

Evaluation of Black Soybean Cream Formulation

Organoleptic Test

The organoleptic evaluation assesses the cream formulation's physical quality based on visual and sensory characteristics, including color, odor, and texture (appearance). This test provides preliminary insight into the stability and acceptability of the product by detecting any noticeable changes during storage.



Figure 3. Visual appearance of the cream preparation observed during organoleptic testing. The cream exhibits a white, semi-solid consistency with a smooth texture. This test was performed to evaluate the physical quality of the cream through parameters such as color, odor, and texture.

Observations were conducted periodically on days 0, 7, 14, 21, and 28 to monitor the physical stability of the formulation during the storage period. The observation results are summarized in the following table.

Table 3. Mean Results of Organoleptic Evaluation of Formula 0 and Formula 1 from Week 0 to Week 4

Week	Formula	Color	Odor	Texture
0	F0	White	Odorless	Solid, smooth
	F1	Milky white	Characteristic soybean	Semi-solid, smooth
1	F0	White	Odorless	Solid, smooth
	F1	Yellowish white	Characteristic soybean	Semi-solid, smooth
2	F0	White	Odorless	Solid, smooth
	F1	Yellowish white	Characteristic soybean	Semi-solid, smooth
3	F0	White	Odorless	Solid, smooth
	F1	Yellowish white	Characteristic soybean	Semi-solid, smooth
4	F0	White	Odorless	Solid, smooth
	F1	Yellowish white	Characteristic soybean	Semi-solid, smooth

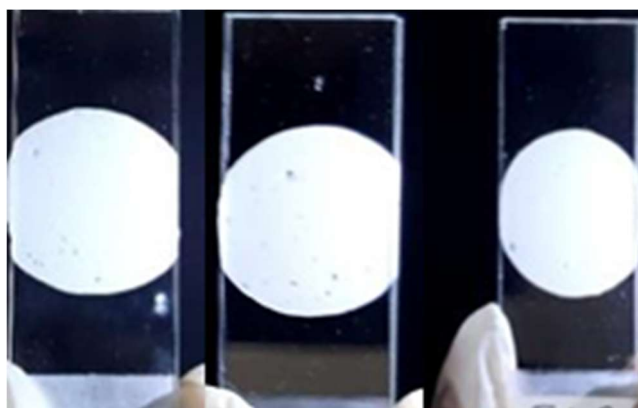
Organoleptic testing was conducted to assess the visual and sensory stability of the cream formulations over a 28-day storage period, with periodic evaluations on days 0, 7, 14, 21, and 28. The observed parameters included color, odor, and texture, which serve as early indicators of any potential physical or chemical degradation in the formulation. This test was applied to 2 formulations: Formula 0 (without black soybean extract) and Formula 1 (containing 0.5% black soybean extract).

Homogeneity Test

A homogeneity test was performed to evaluate the uniform distribution of all the cream formulation components and detect any phase separation or particle aggregation. Homogeneity is a critical parameter in assessing the physical stability of topical preparations, as it influences the effectiveness of delivery of active ingredients, user comfort, and cosmetic or pharmaceutical safety. A small amount of cream was placed between 2 transparent glass slides and observed under light to detect the presence of coarse particles, clumps, or uneven color distribution. A cream was considered homogeneous if it displayed a consistent color and no visible grains or sedimentation. Table 1 summarizes the homogeneity observation results during the 28-day storage period, assessed on days 0, 7, 14, 21, and 28.

Table 4. Homogeneity observation results of cream formulations with and without black soybean extract (0% and 0.5%) during storage on days 0, 7, 14, 21, and 28

Formula	Day 0	Day 7	Day 14	Day 21	Day 28
F0	Homogeneous	Homogeneous	Homogeneous	Homogeneous	Homogeneous
F1	Homogeneous	Homogeneous	Homogeneous	Homogeneous	Homogeneous

**Figure 4.** Homogeneity observation results of cream formulations with and without black soybean extract (0% and 0.5%) during storage on days 0, 7, 14, 21, and 28

Viscosity Test

Viscosity testing was conducted using a Brookfield viscometer with a #64 spindle to evaluate the consistency and stability of the cream formulations. Measurements were taken at various rotational speeds, with the final viscosity reading recorded at 0.5 rpm. The viscosity test results are presented in Table 5. The values for both F0 and F1 exceeded the typical ideal viscosity range for topical creams (30,000–70,000 cPs), indicating that both formulations are classified as high-viscosity creams. The addition of black soybean extract to F1 increased the viscosity compared to the control formula (F0).

Table 5. Viscosity values of cream formulations containing black soybean extract (0% and 0.5%) during storage from week 0 to week 4.

Week	F0 (cPs)	F1 (cPs)
0	147,813	237,013
1	149,257	238,078
2	148,233	239,136
3	148,632	238,321
4	148,643	238,652

Description:

F0 = Cream without black soybean extract

F1 = Cream containing 0.5% black soybean extract

Spreadability Test

The spreadability test was conducted to assess the ability of the cream to spread across the skin surface during application. On day 0, the results showed that Formula 0 (without black soybean extract) exhibited a spread diameter of **5.28 cm**, while Formula 1 (containing 0.5% black soybean extract) showed a spread diameter of **4.14 cm**. These findings indicate that Formula 0 had a greater spreadability compared to Formula 1.

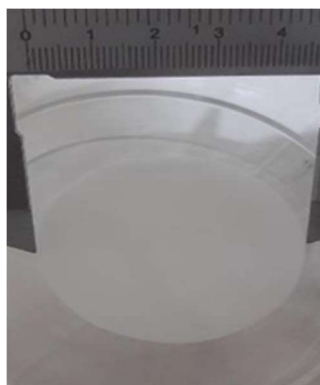


Figure 5. Measurement of Cream Spread Diameter Using a Vernier Caliper

Nevertheless, both values fall within the ideal spreadability range for topical creams, which is between 4 and 7 cm, suggesting that both formulations maintain acceptable physical properties and are suitable for topical application.

Emulsion Type Test

Emulsion type testing was conducted to determine whether the cream formulation resulted in an oil-in-water (O/W) or water-in-oil (W/O) emulsion. The test involved placing 1 g of the cream sample on a microscope slide, staining it with a drop of methylene blue solution, and observing the distribution of the dye under light. Observations from week 0 through week 4 revealed that both Formula 0 (without black soybean extract) and Formula 1 (with 0.5% black soybean extract) exhibited uniform dispersion of the methylene blue dye throughout the sample. This uniformity indicates that both formulations are oil-in-water (O/W) emulsions, in which water serves as the continuous phase and oil as the dispersed phase. The addition of black soybean extract did not alter the emulsion type of the cream.

Table 6. Emulsion type test of cream formulations containing black soybean extract (0% and 0.5%) during storage from week 0 to week 4

Week	F0	F1
0	(O/W)	(O/W)
1	(O/W)	(O/W)
2	(O/W)	(O/W)
3	(O/W)	(O/W)
4	(O/W)	(O/W)

Description:

F0 = Cream without black soybean extract

F1 = Cream containing 0.5% black soybean extract

O/W = oil-in-water

pH Testing

pH testing was conducted to determine whether the cream formulation falls within the physiological pH range of 4.5–6.5. A pH outside this range may cause irritation, discomfort, or even skin damage if used for prolonged periods. Therefore, maintaining pH stability throughout the storage period is a crucial indicator of the quality of a topical cream. The pH measurement in week 0 was performed using a digital pH meter (Cyberson pH 300), which had been calibrated using standard buffer solutions of pH 4.00 and pH 7.00.

Table 7. Average pH values of cream formulations containing black soybean extract (0% and 0.5%) during storage from week 0 to week 4

Week	F0 (pH)	F1 (pH)
0	5,30	4,87
1	6	5
2	6	5
3	6	5
4	6	5

Description:

F0 = Cream without black soybean extract

F1 = Cream containing 0.5% black soybean extract

The pH electrode was immersed in the cream formulation until a stable reading was obtained. From week 0 through week 4, pH levels were monitored using universal pH indicator paper as a comparative method. This test involved directly immersing the indicator paper into the cream, allowing the color change to occur, and then matching the resulting color against the pH scale provided on the indicator packaging.

4. DISCUSSION

Collection of the black soybean samples

The collection of black soybean samples under strict agroclimatic selection and hygienic protocols was crucial to ensure the quality and consistency of the raw material. Gunung Kidul's reputation as a traditional soybean-producing region is supported by its favorable environmental conditions, which enhance the biosynthesis of valuable phytochemicals such as anthocyanins, isoflavones, and flavonoids [12,19]. Selecting only mature and undamaged seeds minimizes variability in the phytochemical profile, which is essential for downstream applications in pharmaceutical and cosmetic research. Furthermore, adherence to laboratory-grade protocols supports reproducibility and compliance with quality standards for natural product research. This initial step establishes a strong foundation for producing high-purity extracts for antioxidant and bioactive compound analysis [13,21].

Characteristics of the black soybean extract

The black soybean extract was obtained through a maceration process using 96% ethanol as the solvent and a small amount of citric acid to stabilize the pH. The extraction was carefully performed to preserve the stability of the bioactive compounds present in black soybean, particularly anthocyanins, isoflavones, and flavonoids. The process was conducted at the Phytochemistry Laboratory of STIKes IKIFA using a rotary evaporator, allowing efficient solvent removal without degradation of the bioactive constituents. The resulting extract exhibited distinctive organoleptic properties. Visually, the extract appeared viscous with a dark reddish-black color, suggesting a high anthocyanin content [22]. The extract also exhibited a characteristic black soybean aroma, indicating no thermal degradation during the extraction process. These physical observations confirmed that the extraction preserved the integrity and potential functionality of the active compounds in black soybean (13). A yield of 7.092% w/w indicates that the extraction process was sufficiently efficient in isolating active compounds from black soybean. This value falls within a reasonable range for the extraction of polyphenolic compounds using ethanol as the solvent, considering the polar nature of anthocyanins, which are soluble in ethanol-water mixtures. The obtained yield also serves as a reference for determining the concentration of active substances to be incorporated into the topical cream formulation in subsequent stages [23].

Phytochemical identification results

The initial reaction was performed by mixing 2 mL of black soybean extract with 1 mL of 2 M hydrochloric acid (HCl), followed by heating the mixture at 100°C for 5 min. The solution exhibited a bright

red under these conditions, indicating an acidic environment. This red coloration confirms a positive result for anthocyanin compounds, as anthocyanins tend to be stable in acidic pH and form flavellum cation structures that produce a red hue. This stability is attributed to the predominance of methoxy groups resistant to degradation induced by low pH. Subsequently, 2 M sodium hydroxide (NaOH) solution was added dropwise to the mixture. A gradual color change from bright red to greenish-black was observed. This transition reflects a shift in pH from acidic to basic, altering the structure of anthocyanin into chalcone or other ionized forms. The greenish-black coloration in alkaline conditions is a characteristic indicator of anthocyanin instability, as anthocyanins degrade more readily in high pH environments due to the prevalence of hydroxyl groups. The presence of anthocyanins in the black soybean extract was confirmed by the specific color change in response to pH variation. The transition from red (acidic) to greenish-black (alkaline) serves as clear visual evidence of anthocyanin presence. The stability of anthocyanins in acidic conditions explains why formulations containing this compound are typically developed at low pH to preserve their efficacy and color stability [11,16].

The color change observed during the phytochemical assay reflects the typical behavior of anthocyanins, which are pH-sensitive flavonoid pigments. In acidic conditions ($\text{pH} < 4$), anthocyanins usually appear red due to the dominance of the flavylium cation form, which is the most stable structure in low pH environments. When exposed to alkaline conditions ($\text{pH} > 7$), these molecules undergo structural rearrangement, forming quinonoidal or chalcone forms, which cause a shift to greenish, bluish, or even colorless tones, depending on the pH and concentration.

This pH-dependent chromatic behavior not only confirms the presence of anthocyanins in the black soybean extract but also supports their structural stability under acidic conditions, which is essential for preserving their antioxidant potency. The heat-assisted HCl treatment helps hydrolyze glycosidic bonds, allowing clearer expression of anthocyanin aglycones, while the NaOH addition tests the compound's resilience under alkaline stress, which mimics potential formulation environments.

Moreover, the results underscore the importance of controlling the pH in downstream applications such as topical formulations or nutraceutical products, as anthocyanins may degrade or lose efficacy when exposed to non-acidic pH over time. The use of visual colorimetric tests offers a rapid and cost-effective preliminary screening tool in natural product research to validate the presence of phenolic compounds before conducting more specific quantitative analyses such as HPLC or UV-Vis spectrophotometry.

Thus, this finding confirms that the anthocyanins in the black soybean extract retain their chemical integrity, and the characteristic pH-responsive behavior suggests their potential utility as natural antioxidants or pH indicators in pharmaceutical and cosmetic formulations [16]. Based on research findings, the anthocyanins contained in black soybeans exhibit anti-inflammatory activity in keratinocytes [24].

Evaluation of Black Soybean Cream Formulation

Organoleptic Test

Formula 0 consistently exhibited a white color throughout the observation period, indicating the stability and absence of discoloration of the base cream components. In contrast, Formula 1 initially showed a milky white color, which began to shift to a yellowish-white color from the first week and persisted through to week four. This color change is likely attributable to the presence of bioactive compounds in black soybean extract, particularly anthocyanins, which are known to be sensitive to pH, light, and temperature. In emulsion systems, anthocyanins may undergo mild degradation during storage, resulting in slight color shifts. However, these changes are considered minor and do not reflect factors contributing to instability, as the color remained within a natural range without signs of browning or extreme fading [17].

Formula 0 exhibited no noticeable odor throughout the testing period, which is consistent with the base formulation's lack of aromatic active ingredients. Formula 1 demonstrated a characteristic black soybean aroma from the first week onward, which remained stable through week four. This consistent aroma suggests the presence of volatile components in the extract and their resistance to oxidation or degradation during storage. The absence of rancid or unpleasant smells further supports the stability of the lipid phase and the overall formulation quality. Regarding texture, Formula 0 maintained a solid and smooth consistency throughout the study period, reflecting good emulsion stability and effective homogenization during production. Formula 1 consistently exhibited a semisolid and smooth texture over the 28-day treatment

period. The consistency variation between the 2 formulations may be due to the addition of the liquid extract, which could slightly reduce viscosity and increase local moisture within the cream matrix, resulting in a softer texture. The texture remained uniform and smooth, with no signs of phase separation or coarse particles, indicating that the emulsion system remained physically stable. In conclusion, the organoleptic evaluation revealed that incorporating 0.5% black soybean extract into the cream formulation did not lead to detrimental changes in appearance, odor, or texture. The mild color change in Formula 1 was acceptable. The aroma remained characteristic without signs of degradation, and the physical form remained stable. Therefore, Formula 1 met the required organoleptic quality standards and is suitable for further physical and chemical evaluations [17].

Homogeneity Test

The test results indicated that both F0 and F1 formulations maintained a homogeneous condition throughout the 28-day storage period. No coarse particles, phase separation, or uneven color distribution was observed in either the base formulation (F0) or the black soybean extract-containing formulation (F1). This result demonstrates the good physical stability of the emulsion system. The use of base ingredients, such as fulgide and lanolin, as emulsifiers and emollients proved effective in maintaining uniform dispersion of the oil and water phases and ensuring that the active ingredients were evenly distributed. Moreover, the homogenization process played a crucial role in achieving thorough mixing of all components.

The addition of black soybean extract did not interfere with the homogeneity of Formula 1's system. This indicates that the extract was well-dissolved or well-dispersed within the cream matrix and did not cause aggregation or sedimentation during storage. Such stability is a strong indicator that the black soybean cream formulation has good physical quality and is suitable for topical application. The homogeneity test confirmed that both formulas met the criteria for good uniformity over the four-week storage period. The absence of coarse particles or phase separation supports the conclusion that both the formulation and preparation methods were appropriate and that the physical stability of the cream was not compromised by the addition of black soybean extract [18].

Viscosity Test

Viscosity testing aims to determine the thickness or consistency and flow properties of the cream formulation. Viscosity is a crucial parameter in topical formulations because it directly influences application comfort, formulation stability, and the release of active ingredients onto the skin. Higher viscosity results in a thicker cream that is harder to spread but more stable, whereas lower viscosity makes the cream easier to absorb but may increase the risk of phase separation. Testing was conducted using a Brookfield viscometer with a number 64 spindle. The spindle was immersed to the recommended depth into the cream sample, which was placed in a 200 mL beaker. Measurements were taken at various rotational speeds (rpm), with the final viscosity reading recorded at 0.5 rpm – a speed considered most representative for semi-solid creams. At week 0, the viscosity of Formula 0 (without black soybean extract) was 147,813 cps, while the viscosity of Formula 1 (containing 0.5% black soybean extract) was 237,013 cps. At week 4, the viscosity of Formula 0 was 148,643 cps, while the viscosity of Formula 1 was 238,652 cps. These results indicate that the addition of black soybean extract significantly increased the formulation's viscosity. However, both values exceeded the ideal viscosity range for topical creams (30,000–70,000 cps), indicating that both F0 and F1 were relatively thick formulations. The increased viscosity observed in Formula 1 can be attributed to interactions between the active compounds in the black soybean extract and the cream base – specifically the aqueous phase and the emulsifier.

Anthocyanins and phenolic compounds within the extract can form colloidal networks or interact with the hydrophilic groups of the cream base, resulting in a denser cream structure. Furthermore, active compounds such as flavonoids and proteins may contribute to the formation of molecular aggregates or strengthen intermolecular bonds, thereby increasing viscosity. Viscosity is also influenced by technical factors, including the stirring method and duration, mixing temperature, order of ingredient addition, particle size, and the oil-to-water phase ratio. Therefore, even though the initial viscosity exceeds general standards, periodic monitoring remains essential to ensure consistent physical quality during storage. Viscosity testing conducted from week 0 to week 4 demonstrated that the addition of black soybean extract increased the cream's thickness. Although the measured viscosity exceeded the ideal range, Formula 1 maintained a stable and uniform cream structure. This indicates that the addition of black soybean extract did not disrupt the emulsion system but rather reinforced the cream's internal structure [17,18].

Spreadability Test

The spreadability test was conducted to evaluate the ability of the cream to spread over the skin surface upon application. This parameter is essential because it directly influences user comfort, the effectiveness of the distribution of active ingredients, and the absorption of the product into the skin. An ideal topical cream should have sufficient spreadability to allow smooth application without requiring excessive force, while still maintaining enough consistency to adhere properly to the skin without becoming too runny. The spreadability test was conducted to assess the ability of the cream to spread across the skin surface upon application. This parameter is essential because it is directly related to user comfort, effective distribution, and absorption of active ingredients. An ideal cream should exhibit sufficient spreadability to allow even distribution on the skin without being overly fluid, thereby maintaining good adherence. Formula 0 (without black soybean extract) exhibited a spreadability diameter of 5.28 cm, whereas Formula 1 (with 0.5% black soybean extract) exhibited a spreadability of 4.14 cm. These results indicate that Formula 0 had a greater spreadability than Formula 1.

The ideal spreadability range of topical creams is 4–7 cm. Thus, both formulas fall within the acceptable range. However, the decrease in spreadability observed in Formula 1 suggests a physical alteration resulting from the extract's addition. The reduction in the spreadability of Formula 1 can be explained by the correlation between viscosity and spreadability. When pressure is applied, higher viscosity tends to limit flow and mobility, resulting in a smaller spread diameter. This finding aligns with the results of the viscosity test, which showed that Formula 1 had a higher viscosity (237,013 cps) than Formula 0 (147,813 cps). As viscosity increases, spreadability decreases because the cream becomes denser and more resistant to flow. Other factors that may influence spreadability include particle size, water and oil content, and the presence of additional active substances. The addition of black soybean extract, which is rich in bioactive compounds such as flavonoids and anthocyanins, likely increases the density and intermolecular cohesion of the cream matrix, thereby reducing its spreadability.

Nonetheless, the 4.14 cm spreadability observed for Formula One remains acceptable in the pharmaceutical and cosmetic fields. Slightly lower spreadability does not necessarily indicate poor quality as long as the cream remains easy to apply and maintains adequate skin adhesion. In conclusion, the spreadability test results demonstrate that although the inclusion of black soybean extract reduces the cream's spreadability, the values remain within an acceptable range. The decrease in spreadability corresponds to the increased viscosity, which is a typical response to the addition of active ingredients. Therefore, Formula 1 is still suitable for use and exhibits good physical stability during initial storage [17,18].

Emulsion Type Test

Identifying the emulsion type is a crucial step in evaluating the physicochemical stability, user experience, and efficacy of topical formulations. Oil-in-water (O/W) emulsions are generally preferred in dermocosmetic and pharmaceutical products because they provide a lightweight skin feel, a non-sticky texture, and greater user comfort. Test results indicate that both cream formulations—whether containing black soybean extract or not—maintained their O/W emulsion structure. These findings suggest that the addition of black soybean extract did not disrupt the internal architecture of the emulsion, thereby preserving the formulation's fundamental characteristics. The anthocyanins and flavonoids present in the extract could potentially interact with emulsifiers or surfactants, potentially leading to emulsion system instability. However, testing confirmed that such interactions—if they occurred at all—were not strong enough to alter the emulsion type, demonstrating compatibility between the extract and the base cream formulation. Maintaining the O/W emulsion type is beneficial for active ingredient delivery, as water-soluble compounds can be easily released into the skin from the continuous aqueous phase. Furthermore, O/W emulsions are more resistant to phase separation under standard storage conditions compared to W/O emulsions. Thus, the preservation of the emulsion type following the addition of the active compound serves as a positive indicator of the formulation's physical stability and durability. In conclusion, emulsion type testing demonstrates that the addition of black soybean extract does not compromise the structural or functional stability of the cream. This ensures the product retains the spreadability, appearance, and absorption characteristics appropriate for an extract-containing cream preparation [17].

pH Testing

Based on the results shown in the previous table, the initial pH value at week 0 for Formula 0 (without black soybean extract) was 5.30, while Formula 1 (with 0.5% black soybean extract) had a pH of 4.87. Both

values fall within the physiological pH range of human skin (4.5–6.5), indicating that the formulations are safe for topical application without causing irritation. During the storage period up to week 4, a slight increase in pH was observed in both formulas. Formula 0 increased to pH 6 and remained stable, whereas Formula 1 increased to pH 5 and remained stable. These changes are considered minor as they remain within an acceptable safety range. The slightly lower initial pH value of Formula 1 can be attributed to the mildly acidic nature of the phenolic compounds and anthocyanins present in the black soybean extract (25). A slight increase in pH over time may result from minor interactions between formulation components or the evaporation of acidic compounds. Overall pH stability during storage indicates an absence of chemical degradation leading to the formation of irritants or compounds with extreme pH levels. This reinforces the conclusion that both formulas possess good chemical stability. In summary, the pH evaluation demonstrated that Formulas 0 and 1 maintained stable and skin-compatible pH values throughout the 4-week storage period. The addition of black soybean extract did not disrupt the chemical integrity of the emulsion system, and the formulation remained safe for prolonged topical use [17,18].

5. CONCLUSION

Black soybean (*Glycine soja* L.) Merr.) extract was successfully developed into a cream preparation at a concentration of 0.5% using an O/W emulsion base. Physical and chemical evaluations conducted over a 4-week period demonstrated that the cream exhibited good stability, consistent homogeneity, stable pH (4.5–6.5), acceptable spreadability, viscosity, and organoleptic properties in accordance with topical preparation standards. Qualitative testing for anthocyanins confirmed their presence in the extract. These findings indicate that black soybean extract has potential as an active ingredient in cream formulations and can be successfully formulated into a cream. This formulation holds potential for further development as an antioxidant product.

Acknowledgements: -

Author contributions: Concept – S.L.K.F., Y.S., Y.E.C.; Design – S.L.K.F., Y.S., P.P.B.C.; Supervision – Y.S., Y.E.C.; Resources – S.L.K.F., P.P.B.C., L.I.S.; Materials – S.L.K.F., P.P.B.C.; Data Collection and/or Processing – S.L.K.F., P.P.B.C., L.I.S.; Analysis and/or Interpretation – S.L.K.F., Y.S., Y.E.C., L.I.S.; Literature Search – S.L.K.F., P.P.B.C., L.I.S.; Writing – S.L.K.F., Y.S., L.I.S.; Critical Reviews – Y.S., P.P.B.C., Y.E.C.

Initial penulis:

S.L.K.F. = Senny Listy Kartika Falestin; Y.S. = Yanthy Susanti; P.P.B.C. = Pra Panca Bayu Chandra; Y.E.C. = Yulius Evan Christian; L.I.S. = Lolita Intan Saputri.

Conflict of interest statement: Conflicts of Interest

The authors declare no conflict of interest regarding the publication of this manuscript. All authors have reviewed and approved the final version of the article and confirm that no competing financial or personal relationships could have influenced the work reported in this paper.

REFERENCES

- [1] A. Amalia, R. Kusumawinahyu, and I. R. Rohenti, "Study of the anti-aging potential of black soybean (*Glycine max* (L.) Merrill) Detam 1 variety extract through antioxidant activity assay," *War. Akab.*, vol. 45, no. 2, pp. 43–50, 2021. doi: 10.55075/wa.v45i2.29.
- [2] Y. E. Christian, P. P. B. C. Bayu, E. Hermawati, and D. F. Ismyama, "Quantitative analysis of total flavonoids in bidara (*Ziziphus mauritiana*) leaf extract as a basis for natural pharmaceutical product development," *Binawan Student J.*, vol. 7, no. 2, pp. 121–131, 2025. doi: 10.54771/v2zj1q78.
- [3] W. M. Rahayu, S. N. Rahmadhia, and Anggi, "Physicochemical and organoleptic properties of black soybean sprouts ice cream (*Glycine max* var. Mallika) with emulsifier variations," *J. Pangan*, vol. 33, no. 2, pp. 147–158, 2024. doi: 10.33964/jp.v33i2.792.
- [4] R. P. Harahap and Rahmadina, "The effect of verticulture planting system and plant spacing on the vegetative growth of two cultivars of black soybean (*Glycine max* L.)," *BIOEDUSAINS J. Pendidik. Biol. dan Sains*, vol. 6, no. 1, pp. 58–68, 2023. doi: 10.31539/bioedusains.v6i1.5287.

- [5] A. D. Putri, Rahmadina, and Z. Idami, "Growth response of black soybean microgreens (*Glycine max* (L.) Merr.) through addition of nutrients to young coconut water," *J. Sci. Res. Dev.*, vol. 6, no. 1, pp. 237–251, 2024. doi: 10.56670/jsrd.v6i1.315.
- [6] H. P. Juliasari, T. Islami, and A. S. Karyawati, "Effect of rice straw biochar and rhizobium application on the growth and yield of black soybean," *Agrotechnology Res. J.*, vol. 8, no. 2, pp. 130–138, 2024. doi: 10.20961/agrotechresj.v8i2.92796.
- [7] E. Chandra, Pra Panca Bayu Hermawati, D. F. Ismyama, and Y. E. Christian, "Analysis of body weight in hyperglycemic mice (*Mus musculus*) administered oral and gel preparations of okra fruit extract (*Abelmoschus esculentus* L. Moench)," *MEDFARM J. Farm. dan Kesehat.*, vol. 3, no. 2, pp. 247–256, 2024. doi: 10.48191/medfarm.v13i2.306.
- [8] P. Ara, C. Ribeiro, H. Oliveira, A. R. Pereira, N. Mateus, V. de Freitas, et al., "Anthocyanin-related pigments: Natural allies for skin health maintenance and protection," 2021
- [9] N. S. Widya Putri, A. Indrayati, and F. Leviana, "Potential of crude enzymes from black soybean tempeh (*Glycine soja* (L.) Merr.) as a natural fibrinolytic medicine with clot lysis in vitro method," *J. Sains dan Kesehat.*, vol. 5, no. 2, pp. 115–125, 2023. doi: 10.30872/jsk.v5i2.p115-125.
- [10] S. Y. Chalid, A. Muawanah, N. Radiastuti, S. A. Putri, F. Hartiningsih, and T. Rudiana, "Black soybean (*Glycine soja*) and white bean (*Phaseolus vulgaris* L.) tempeh as functional food with antioxidant properties," *Chim. Nat. Acta*, vol. 11, no. 3, pp. 106–114, 2023. doi: 10.24198/cna.v11.n3.47039.
- [11] D. C. Dewi, D. P. Dewi, G. D. N. Laili, and H. Hernawati, "The quality of black soybean milk seen from proximate level, antioxidant activity and anthocyanin level," *Ilmu Gizi Indones.*, vol. 4, no. 2, pp. 125–134, 2021.
- [12] Anisa, R. Budiasih, and L. Amalia, "The effect of natural plant growth regulator concentration derived from snails on the growth and yield of black soybean (*Glycine max* (L.) Merrill) variety Mallika," *OrchidAgro*, vol. 2, no. 2, pp. 31–34, 2022. doi: 10.35138/orchidagro.v2i2.433.
- [13] E. Palupi and M. Rahmatika, "Improvement of nutritional value of tempeh milk made from black soybean (*Glycine soja* Sieb)," *J. Ilmu Gizi dan Diet.*, vol. 1, no. 1, pp. 42–49, 2022.
- [14] M. Fawwaz, D. S. Muliadi, and A. Muflihunna, "Hydrolyzed black soybean (*Glycine soja*) as a source of total flavonoids," *J. Fitofarmaka Indones.*, vol. 4, no. 1, pp. 194–198, 2017. doi: 10.33096/jffi.v4i1.227.
- [15] S. K. Whardhani, I. A. Handayani, P. M. Loimalitna, P. P. B. C. Bayu, Y. E. Christian, "Determination of yield and flavonoid content of *Moringa* (*Moringa oleifera*) leaf extract using UV-Vis spectrophotometry," *J. Ris. Kefarmasian Indones.*, vol. 7, no. 3, pp. 491–506, 2025. doi: 10.33759/v7i3.773.
- [16] U. R. Hana and T. A. Sujono, "Literature review: Antioxidant activity of black soya beans," *Usadha J. Pharm.*, vol. 3, no. 4, pp. 453–464, 2024. <https://doi.org/10.23917/ujp.v4i2.436>.
- [17] D. S. Saryanti, I. Setiawan, and R. A. Safitri, "Optimization of oil-in-water (O/W) cream formulation containing kepok banana peel (*Musa acuminata* L.) extract," *J. Ris. Kefarmasian Indones.*, vol. 1, no. 3, pp. 225–237, 2019. doi: 10.33759/jrki.v1i3.44.
- [18] Deniansyah and A. Pujiastuti, "Formulation and physical quality assessment of karamunting leaf extract cream (*Rhodymytus tomentosa*)," *Indones. J. Pharm. Nat. Prod.*, vol. 5, no. 1, pp. 51–59, 2022.
- [19] S. N. Faiz, A. P. Santosa, D. N. Afifah, and A. M. Purnawanto, "Characteristics of yellow soyghurt (*Glycine max*) and black soybean (*Glycine soja* L.) synbiotic beverages with the addition of inulin at different concentrations," *Proc. Ser. Phys. Form. Sci.*, vol. 4, no. 1, pp. 405–413, 2022. doi: 10.30595/pspfs.v4i.529.
- [20] U. M. Farid, A. M. Romdhani, and M. Khalil, "The effectiveness of black soy tempe extracts on interleukin-6 in type 2 diabetes mellitus Wistar rats," *J. Jeumpa*, vol. 10, no. 2, pp. 195–203, 2023.
- [21] A. Sutrisno, J. P. Hutasoit, and A. Khamidah, "Ohmic heating of gluten-free bread based on black soybean-rice flour: Temperature and electrical power study," *J. Ilm. Rekayasa Pertan. dan Biosist.*, vol. 11, no. 2, pp. 246–255, 2023.
- [22] I. Ningrumsari, R. Budiasih, and P. Afrilliyanti, "Nutritional analysis study of black soybean (*Glycine soja* (L.) Merr.) fermented by *Rhizopus oligosporus*, *Aspergillus sojae*, and their consortium on carbohydrate and fat content," *AGRITIKH (J. Agribisnis dan Teknol. Pangan)*, vol. 2, no. 2, pp. 90–98, 2022. doi: 10.32627/agritikh.v2i2.72.

- [23] M. Suryaman, Y. Yulianto, and R. A. Amanah, "The potential of avocado seed extract for priming black soybean seeds in the germination phase under salinity stress," *Media Pertan.*, vol. 8, no. 2, pp. 97–110, 2023. doi: 10.37058/mp.v8i2.8659.
- [24] H. H. Lee, Y. H. Huang, J. J. Huang, and M. Y. Huang, "Exploring black soybean extract cream for inflammatory dermatitis – Toward radiation dermatitis relief," 2024.
- [25] S. A. N. Hartono, D. F. Rosida, and R. A. Anggreini, "Nutritional study of black rice (*Oryza sativa* L.) and black soybean (*Glycine soja* L. Merr.) cookies," *Indones. J. Microbiol.*, vol. 1, no. 4, pp. 1–12, 2025. doi: <https://doi.org/10.47134/ijm.v1i4.3382>.