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ARTICLE

THE EFFECT OF STIRRING TIME ON THE PHYSICAL PROPERTIES OF CREAM WITH COCONUT WATER COCOS NUCIFERA L. AS THE ACTIVE INGREDIENT

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Abstract

Coconut water (Cocos nucifera L.) contains natural compounds that are beneficial for skin health, making it a promising ingredient in cream formulations. Mixing duration is an important factor in cream preparation because it affects homogeneity, stability, and texture. This study evaluated the effect of mixing times (15, 20, and 25 minutes) on the physical properties of coconut water–based creams. The formulations were tested for organoleptic properties, homogeneity, pH, spreadability, adhesion, viscosity, and stability. Results showed that mixing duration influenced viscosity, spreadability, and homogeneity, while pH remained within the normal skin range (4.5–6.5). A mixing time of 20 minutes produced the most optimal cream characteristics. Therefore, proper mixing duration is essential for achieving stable and high-quality cream formulations.

Keywords: Coconut Water, Cream Formulation, Mixing Duration, Physical Properties, Stability.

A. INTRODUCTION

Cream is a semi-solid dosage form widely used in cosmetics and pharmaceuticals as a carrier medium to deliver active ingredients onto the skin surface. The quality and effectiveness of a cream are determined not only by its ingredient composition but are also strongly influenced by the manufacturing process. One key factor in this process is mixing time. An appropriate mixing duration helps produce a homogeneous cream with suitable viscosity, good spreadability, and a stable emulsion. Mixing for too short a time may result in an uneven mixture, whereas excessive mixing may trigger undesirable physical changes, such as increased thickness or even phase separation. Therefore, controlling mixing time is an essential step to obtain a cream with optimal physical characteristics (Prastia & Wijaya, 2024).

Coconut water (Cocos nucifera L.) is known to contain various bioactive compounds, including lauric acid, vitamin C, and minerals that are beneficial for skin health. When used as an active ingredient in a cream formulation, the mixing process plays an important role in ensuring uniform distribution of the active substances so that the product remains stable and comfortable to use. Nevertheless, overly long mixing can lead to excessive increases in viscosity and a decrease in pH, which may affect user comfort and product stability (Puspita et al., 2023).

Previous studies have shown that variations in mixing time can influence the physical properties of creams. Prastia and Wijaya (2024) reported that differences in mixing time in a cream containing ethanolic papaya leaf extract affected homogeneity, spreadability diameter, pH, and viscosity. As mixing time increased, viscosity tended to rise while spreadability and pH decreased. These findings highlight the importance of optimizing mixing time to achieve a balance between homogeneity and other key physical properties. Another study by Rekayasa dan Manajemen Agroindustri et al. (2020) also found that mixing temperature and mixing time affected spreadability, adhesiveness, and emulsion stability. Longer mixing may reduce particle size and thereby improve stability, although outcomes remain dependent on the composition of the oil phase.

Because coconut water has a high water content, cream formulation must be performed using appropriate techniques to maintain product stability. A suitable mixing time helps the active ingredient blend evenly, enhances ease of absorption into the skin, and supports product durability during storage. Conversely, uncontrolled mixing can alter the cream's texture, reduce pH, and ultimately affect user comfort and product stability (Margono et al., 2022).

Although several studies have examined the effect of mixing time on various cream formulations, research focusing specifically on coconut-water-based creams remains relatively limited. Therefore, this study aims to systematically analyze the effect of mixing time on the physical properties of a cream formulated with coconut water as the active ingredient. The research approach combines qualitative observation of texture and visual appearance with quantitative measurement of physical parameters such as viscosity, particle size, emulsion stability, and droplet distribution using standard laboratory equipment (Septiana, 2022).

The findings of this study are expected to contribute to the development of natural-ingredient-based cream formulations, particularly those using coconut water, while addressing the need for cosmetic and pharmaceutical products that are safe, effective, and skin-friendly. In addition, this research is expected to serve as a reference for future studies and provide useful information for industry in improving product quality.

B. LITERATURE REVIEW

Emulsion Cream and Physical Stability (microstructure–stability)

Topical creams are essentially semi-solid emulsion systems, and their final quality is strongly determined by the microstructure (e.g., droplet/particle size distribution) and by instability mechanisms that may arise during storage, such as coalescence, flocculation, phase separation, and sensory changes. Physical stability refers to the system's ability to maintain its characteristics (appearance, homogeneity, and performance during use) over a certain period, even though emulsions are thermodynamically inclined to separate. From a modern formulation perspective, cream quality is not only a matter of ingredient composition, but also of how processing builds a consistent internal structure so that the response to forces (spreading/shear) and to storage becomes more predictable. For this reason, changes in physical parameters such as viscosity, spreadability, and sensory attributes are often treated as "signatures" of microstructural changes. Controlling process parameters (including mixing duration) is therefore crucial because it influences microstructure formation and the stability observed in the final product (Herbig et al., 2023; Chow et al., 2024; Simões et al., 2019).

Indicators (operational, brief points):

- Organoleptic properties: color, odor, visual appearance/texture
- Homogeneity: presence/absence of coarse particles; uniform or not
- Emulsion type (if tested): O/W or W/O
- Physical stability: phase separation/creaming after storage or stability testing
- pH: within a skin-safe range and relatively stable

Rheology of Topical Semi-Solid Formulations (viscosity flow thixotropy)

Rheology explains how a cream flows and changes structure under applied force, providing the scientific basis for interpreting parameters such as viscosity, ease of spreading, and skin feel. Semi-solid formulations typically exhibit non-Newtonian behavior (often shear-thinning), meaning viscosity can decrease as shear rate increases—this is directly relevant to both the mixing process and application on the skin. The rheological profile is also viewed as a "fingerprint" of microstructure; small changes in the internal network (e.g., due to longer mixing) can lead to noticeable changes in thickness, yield behavior, or structural recovery. In cream development, rheology is not merely a quality attribute, but a bridge connecting manufacturing process → structure → performance (e.g., spreadability, adhesiveness, stability). Therefore, rheological evaluation is recommended as an important component for understanding the consistency and stability of topical semi-solid dosage forms (Chiarentin et al., 2023; Herbig et al., 2023).

Indicators (operational, brief points):

- Viscosity (mean value/flow curve if available)
- Consistency during spreading (practical shear-thinning behavior)
- Thixotropy/structural recovery (if tested)
- Spreadability (cm) as a proxy for ease of application
- Adhesiveness (seconds) as a proxy for retention on the skin surface

Quality by Design (QbD): CPP CQA in the Cream Formulation Process

Quality by Design (QbD) views product quality as the outcome of scientific understanding and process control, rather than merely "end-product testing." In QbD, desired quality characteristics are first defined as the Quality Target Product Profile (QTPP), then translated into Critical Quality Attributes (CQA) for example pH, viscosity, homogeneity, and stability that must be kept consistent. Process variables such as mixing duration are treated as Critical Process Parameters (CPP) when changes in their values are shown to meaningfully affect the CQA. QbD also emphasizes using risk assessment and experimental evidence to establish a safe operating range (a "design space") and realistic control strategies in the laboratory. With this framework, your study gains stronger justification: mixing duration is positioned as a CPP whose impact on cream CQAs is systematically evaluated (ICH, 2009; Yu et al., 2014; Simões et al., 2019).

Indicators (operational, brief points):

- QTPP (target cream profile): skin-safe, pleasant to use, stable
- CQA: pH, homogeneity, viscosity, spreadability, adhesiveness, physical stability
- CPP: mixing duration (and, if recorded: mixing speed, processing temperature)
- Simple risk assessment: mapping which CPP most strongly influences CQA
- Control strategy: standardized mixing procedure + defined checkpoints for CQA testing

C. RESEARCH METHODOLOGY

The object of this study is a cream preparation containing coconut water (*Cocos nucifera* L.) as the active ingredient, formulated with variations in stirring time to determine the physical characteristics and stability of the preparation. The research samples consist of several coconut-water cream formulas prepared using different stirring durations: 15 minutes, 20 minutes, and 25 minutes. Each formula is produced in three replications (triplicate) to enhance the validity of the results. The sampling technique employs purposive sampling based on the freshness and purity of the coconut water.

The data collected comprise both qualitative and quantitative data. Qualitative data include organoleptic and homogeneity tests, while quantitative data include measurements of pH, viscosity, spreadability, and adhesiveness. Data collection is conducted through an experimental method in the Pharmacy Laboratory, involving the stages of cream formulation,

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evaluation of physical properties, and observation of product stability.

Instruments and Materials Used

The instruments used in this study include an analytical balance, beaker glass, graduated cylinder, Erlenmeyer flask, stirring rod, hot plate or water bath, filter paper, cream containers, a pH meter or pH paper, a viscometer, a stopwatch, filter paper, a camera or smartphone, labels, a notebook, and apparatus for spreadability and adhesiveness testing.\

The materials used include coconut water as the active ingredient, stearic acid, triethanolamine (TEA), glycerin, liquid paraffin, cetyl alcohol, methyl paraben, propyl paraben, and distilled water as the aqueous phase.

Cream Formulation Procedure

Table 1. Cream Preparation Formulation

Ingredients	***I***	***II***	***III***	***Standard***	**Uses**	***Literatur***
Coconut Water	10	10	10	-	Active Ingredients	Prastia et al., 2024
Stearic Acid	5	5	5	2-10 %	Emulgators and	Sari et al., 2018
Cetyl Alcohol	2	2	2	1-5 %	Cream Stabilizers	Indrayani et al., 2019
Glycerin	3	3	3	2-10 %	Thickeners and Emulsifiers	Zhang et al., 2020
riethanolamine	0,5	0,5	0,5	0,5-2,5 %	Moisturizers	Yuliana et al., 2020
(TEA)	5	5	5	5-15 %	(Humectants)	Fitri et al., 2018
Liquid Paraffin	0,1	0,1	0,1	0,1-0,3 %	Emulsifiers	Sari & Widodo, 2021
Methyl Paraben	0, 05	0, 05	0, 05	0,02-0,1 %	Emollients	Sari & Widodo, 2021
Propyl Paraben	24,35	24,	24,	-	Preservatives	-

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35	35

Source: Processed by Researchers, 2026

Description:
The preparation is made in a 30 gram volume.
Formulation I, stirring time is 15 minutes.
Formulation II, stirring time is 20 minutes.
Formulation III, stirring time is 25 minutes.

Research Procedures

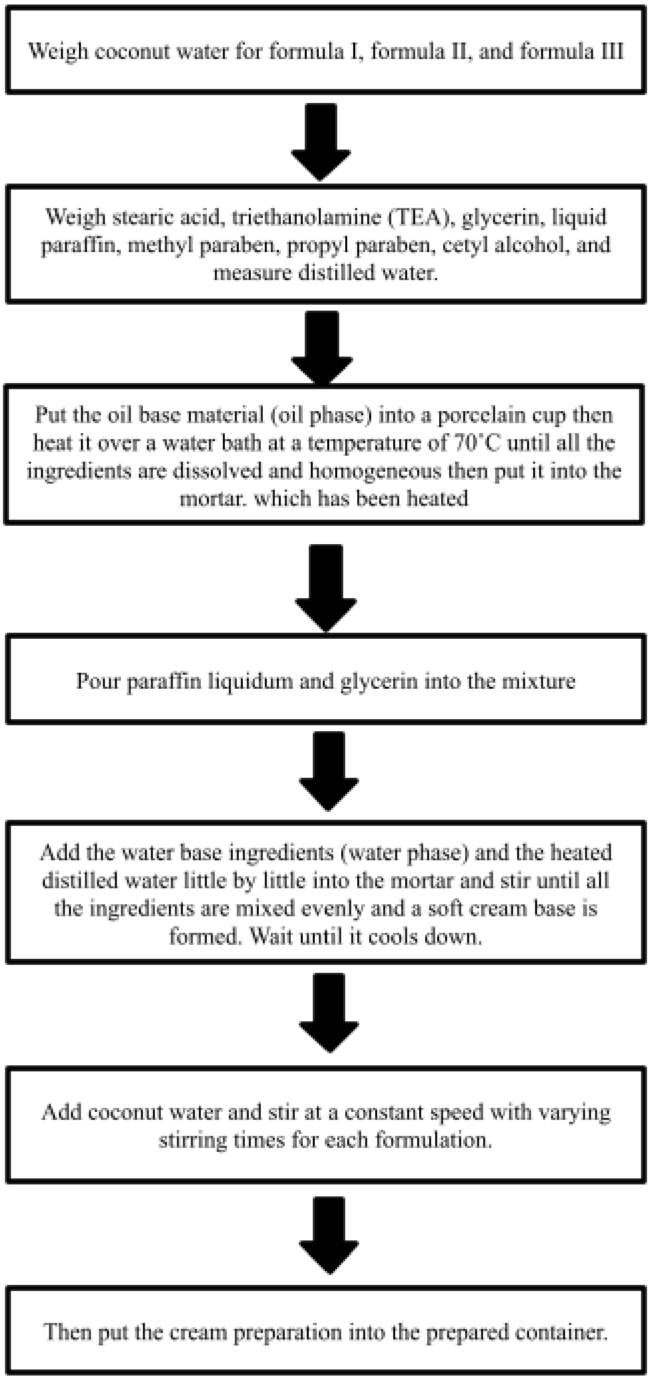

Figure 1. Coconut Water Cream Preparation Scheme
Source: Processed by Researchers, 2026

Physical Properties of Cream Preparations

- Organoleptic Test: An organoleptic test is performed to visually observe the shape, color, odor, and texture of the cream. This test is important as a preliminary parameter in evaluating the stability of the preparation (1).
- Homogeneity Test: Observing a cream sample applied to a glass slide to ensure there are no coarse grains or separated phases, as uniformity affects comfort during use (2).
- Adhesive Test: Weighing 0.25 grams of cream is performed and placed on one side of a glass slide with a string attached to the bottom to tie a weight. Then, attach it to the other glass slide. The weight used is 50 g for 2 minutes. Afterward, observe and record the time required for the two glass slides to detach (3).
- pH Test: Creams of each type and concentration are prepared, then the pH is measured using a pH meter and the color change is observed. Record the pH value for each formula. The ideal pH value is 4.5-6.5 (4)
- Spreadability Test: This is done by weighing 0.5 grams of cream and then placing it on a watch glass. The sample is covered with another glass of the same size, then given a graduated load (50 g, 100 g, and spread out). Good spreadability is 5.25-5.91 (5)
- Emulsion Type Test
- Dilution Method

This test is conducted by taking a small amount of cream and dissolving it in distilled water. After that, the solution is shaken slowly. If the cream can be mixed with water, then the emulsion is an oil-in-water (O/W) type. Conversely, if it does not mix, then the cream is a water-in-oil (W/O) type (6).

- Physical Stability Test: This test is conducted on cream preparations to determine whether there are any changes in physical properties during storage. The examination includes organoleptic, homogeneity, pH, spreadability, and adhesive strength to ensure the cream remains stable, comfortable to use, and of good quality (7).
- Viscosity Test: This test is conducted to determine how thick the cream preparation is, because this level of viscosity affects the ease of the cream when applied and its stability during storage. Storage. Testing is conducted using a viscometer, where the spindle is dipped into the cream sample and the instrument is run at a certain speed until a stable viscosity value is achieved, which is then recorded and analyzed (8).
- Irritation Test

An irritation test is conducted to determine whether the cream preparation causes negative skin reactions, such as redness, itching, or swelling (9).

- Hedonic Test

Hedonic testing is conducted to determine the level of panelists' liking or preference for a product. Assessments are conducted by several panelists who provide a preference score, thus determining how much the product is liked by users (10).

D. RESULT AND DISCUSSION

Physical Properties Testing of Cream Preparations

Evaluation of physical properties is a crucial part of topical cream development because they significantly determine the overall product quality, including storage stability and skin comfort. In this study, a cream made with coconut water (Cocos nucifera L.) as the active ingredient was evaluated to determine how varying stirring times affected the cream's physical properties. The primary objective of this test was to determine the relationship between stirring duration and changes in the cream's physical parameters and to determine the optimal stirring time for a stable and comfortable cream (Tungadi et al., 2024).

The parameters tested included organoleptic (such as color, odor, and texture), homogeneity, pH, viscosity, spreadability, and adhesiveness. Organoleptic observations provide an initial overview of the product's sensory aspects, which are important for consumer acceptance, while homogeneity testing indicates the extent to which the active ingredients and constituents are evenly distributed throughout the cream. The cream's pH needs to be within a range compatible with skin pH to minimize potential irritation, and viscosity directly affects the cream's consistency and comfort when applied. Additionally, spreadability and adhesion provide information on the cream's ability to spread evenly and persist on the skin surface during application. Similar parameters were also analyzed in recent literature on the physical evaluation of topical creams (Sunnah et al., 2024).

Organoleptic Testing

Organoleptic testing was conducted to directly observe the cream's physical properties, including color, odor, and dosage form. The results of the organoleptic testing can be seen in the table below.

Table 2. Organoleptic Test Results

Replication	***Organoleptis***	***Formula I***	***Formula II***	***Formula III***
	Shape	Half solid	Half solid	Half solid
1	Color	White	White	White
	Smell	Special Coconut Water	Special Coconut Water	Special Coconut Water
	Shape	Half solid	Half solid	Half solid
2	Color	White	White	White
	Smell	Special Coconut Water	Special Coconut Water	Special Coconut Water
	Shape	Half solid	Half solid	Half solid
3	Color	White	White	White
	Smell	Special Coconut Water	Special Coconut Water	Special Coconut Water

Source: Processed by Researchers, 2026

Description:

Formula I : Stirring time 15 minutes
Formula II : Stirring time 20 minutes
Formula III : Stirring time 25 minutes

Based on organoleptic observations, all cream formulas in each repetition showed a uniform physical appearance, namely a semi-solid form, white color, and a characteristic coconut-water aroma. These consistent characteristics indicate that the manufacturing process and ingredient mixing were carried out properly, producing a cream that is visually and sensorially stable. The absence of changes in shape, color, or odor during testing suggests that the cream preparation has good consistency and did not undergo physical deterioration.

The stability of these organoleptic properties also indicates that the ingredient composition in each formula was able to maintain its physical characteristics throughout the manufacturing process and during observation. A cream whose appearance and aroma remain consistent tends to be more readily accepted by users because it conveys a good impression of quality from the first use. This also suggests that coconut water as the active ingredient can be evenly dispersed within the cream base without causing undesirable changes in appearance.

In general, the organoleptic test results can serve as an initial indication that the resulting cream preparation meets basic physical quality criteria. Consistency in appearance and aroma is an important factor in topical product development because it is directly related to user comfort during application and to users' perceptions of product quality.

PH Test

The pH test of the cream preparation was conducted to determine the acidity level of the formulation, because pH plays an important role in compatibility with skin pH and in determining the safety and comfort of topical product use. A pH value that matches skin pH helps minimize the risk of irritation and maintains the skin barrier function, enabling safe use of the cream over a certain period. pH measurement is also part of stability evaluation, because changes in pH during storage may indicate degradation or instability of the preparation. Previous studies evaluating cream pH have shown that pH is typically controlled to remain compatible with the slightly acidic pH of the skin, and minimal changes in pH during the testing period are often considered an indicator of the physical and chemical stability of the cream formulation. The test results are presented in the table below:

Table 3. PH Test Results

Replication	*Formula I*	*Formula II*	*FormulaIII*
1	6	6	6
2	6	6	6
3	6	6	6

Source: Processed by Researchers, 2026

Based on the pH test results, all cream formulas showed a pH value within the neutral range and within the skin's natural pH range. This indicates that the resulting cream formulations have a safe acidity level for topical use. A pH match with the skin is important for maintaining comfort during application and helps maintain the skin's barrier function. Preparations with a pH within the normal range are less likely to cause adverse reactions when applied.

Conversely, creams with a pH that is too acidic or too alkaline have the potential to disrupt the skin's balance. This pH imbalance can cause dryness, peeling, or irritation. Therefore, controlling the pH in cream formulations is a crucial parameter for ensuring the safety and comfort of topical preparations, as reported in previous research, which stated that the cream's pH should be within the normal skin pH range (Thomas et al., 2024).

Homogeneity Test

The homogeneity test is conducted to ensure that all components in the cream formulation are evenly mixed, resulting in a uniform formulation. Good homogeneity indicates that the active ingredients and base ingredients are consistently distributed throughout the formulation. Based on the test results, the resulting cream showed no coarse grains or phase separation, indicating that the mixing process was successful.

A homogeneous cream preparation is crucial because it affects physical stability and dosage uniformity when applied to the skin. Even distribution of ingredients helps ensure that each portion of the cream has the same quality, thus maintaining effectiveness and comfort. Therefore, the results of this homogeneity test indicate that the cream formulation meets one of the basic physical quality requirements for topical preparations. The test results can be seen in the table below:

Table 4. Results of Homogeneity Test

Replication	*Formula I*	*Formula II*	*Formula III*

1	Homogen	Homogen	Homogen
2	Homogen	Homogen	Homogen
3	Homogen	Homogen	Homogen

Source: Processed by Researchers, 2026

The homogeneity evaluation results showed that all cream formulations had an even blend of ingredients. This was evident from the uniform color of the preparation and the absence of coarse grains on the cream's surface. This indicates that the formulation process produced a homogeneous preparation with good physical stability.

Homogeneity is a crucial parameter in evaluating topical preparations because it directly relates to ease of application and the even distribution of the cream on the skin. Inhomogeneous preparations can cause uneven distribution of ingredients, affecting comfort and effectiveness. Therefore, the results of this test indicate that the formulated cream meets the homogeneity requirements required for topical use, as reported in previous research (Silvyana et al., 2022).

Adhesion Test

The adhesion test was conducted to determine the cream's ability to adhere to the skin surface for a specified period of time. Good adhesion indicates that the cream can remain on the application area longer, allowing the active ingredients to work optimally. Based on the test results, the cream demonstrated fairly good adhesion, indicating that the formulation has a consistency suitable for topical use.

The cream's adhesive properties also relate to the comfort of use and the effective distribution of active ingredients on the skin. A preparation with adequate adhesive properties does not easily come off after application, thus helping maintain contact between the cream and the skin surface. Therefore, the adhesion test results indicate that the formulated cream meets one of the important physical quality parameters for supporting the performance of topical preparations. The test results can be seen in the table below:

Table 5. Adhesion Test Results

Load	***T (Seconds)***			
	FI	**FII**	**FIII**	**Average**
50	5,0	5,2	5,5	5,2
100	5,8	5,6	6,1	5,8
150	6,2	5,9	6,5	6,2

Source: Processed by Researchers, 2026

The adhesion test results showed that each cream formula had improved adhesion when subjected to a greater load. The adhesion time obtained for all formulas indicated that the cream remained adhered to the surface for a considerable period. This indicates that the cream formulation has a consistency that supports stable contact between the preparation and the skin surface during application.

Good adhesion is important in topical preparations because it helps maintain the cream at the application site, allowing the active ingredients to work optimally. Creams with adequate adhesion tend to be resistant to detaching after application, thus increasing effectiveness and comfort. These results align with previous research that stated that good adhesion is an indicator of the physical quality of a cream preparation (Pratasik et al., 2019).

Spreadability Test

The spreadability test was conducted to determine the ability of the cream preparation to spread on the skin surface during application. Good spreadability indicates that the cream can be spread easily without excessive pressure, thus providing comfort during application. Based on the test results, all cream formulas demonstrated good spreadability, indicating that the preparation's consistency is suitable for topical application.

The ability of a cream to spread evenly plays a crucial role in ensuring the distribution of active ingredients across the skin's surface. A formulation with optimal spreadability helps increase effectiveness by evenly covering the application area. Therefore, the spreadability test results indicate that the cream formulation meets one of the physical quality parameters that support the performance and comfort of topical formulations. The test results are shown in the table below:

Table 6. Spreadability Test Results

Load	*FI*	*FII*	*FIII*	*Average*
50	5,0	5,1	5,2	5,1
100	5,2	5,0	5,3	5,2
150	5,4	5,2	5,5	5,4

Source: Processed by Researchers, 2026

The spreadability test results showed that the cream's spreadability increased when a greater load was applied. All formulas exhibited a spreadability within the appropriate range, allowing the cream to be easily spread evenly across the skin surface. This indicates that the consistency of the formulation supports the application process without requiring excessive pressure, thus providing comfort during use.

Good spreadability indicates that the cream is able to evenly cover the application area. Optimal spreadability facilitates the distribution of active ingredients throughout the skin, thus supporting the effectiveness of the formulation. Therefore, the results of this spreadability test indicate that the cream formulation meets the physical quality criteria required for topical formulations, as reported in previous research (Ramdhan & Yusuf, n.d.).

Viscosity Test

Viscosity testing was conducted to assess the viscosity of the cream formulation, as this property plays a crucial role in determining ease of application, comfort of use, and product stability during storage. The test results showed differences in viscosity between the formulas, indicating that variations in ingredient composition affect the formulation's consistency. Appropriate viscosity allows the cream to be applied easily without causing excessive stickiness. Furthermore, proper viscosity helps maintain the cream's physical structure, ensuring the product remains stable during use and storage. Therefore, viscosity testing is a crucial parameter to ensure the cream performs well in terms of both comfort and physical quality. The test results are shown in the table below:

Table 7. Viscosity Test Results

Replication	***Formula I***	***Formula II***	***Formula III***
1	3,7395	4,7596	5,8056
2	3,1223	3,9813	4,6349
3	2,9413	3,7293	4,4977
Average	3,1010	4,1667	4,9961

Source: Processed by Researchers, 2026\

Description:
Formula I: Stirring time 15 minutes
Formula II: Stirring time 20 minutes
Formula III: Stirring time 25 minutes

Viscosity test results showed that each cream formula had a different viscosity level after repeated measurements. This difference in average viscosity values illustrates that each formulation treatment produced different consistency characteristics. This variation indicates that the duration of the stirring process plays a role in determining the resulting cream viscosity.

To confirm whether the observed viscosity differences were truly caused by the formulation treatment and not simply measurement variations, a statistical analysis was performed using the one-way ANOVA method. The analysis results showed a significance value below the established limit, indicating that the viscosity differences between the formulas were statistically significant. This finding confirms that the stirring process is an important factor influencing the rheological properties of the cream.

E. CONCLUSION

Based on the research results, varying the stirring time in the preparation of coconut water-based creams was shown to affect the physical properties of the resulting formulations. All formulas demonstrated good physical quality in terms of organoleptic properties, homogeneity, pH, spreadability, adhesion, and viscosity, thus the formulations were deemed suitable for topical use. Differences in stirring time resulted in different consistency characteristics, particularly viscosity, which was later confirmed statistically as having a significant effect.

Overall, the stirring process is a crucial factor in cream formulation because it plays a role in the formation of the formulation's structure and its physical stability. Controlling these process parameters is necessary to obtain a cream with consistent quality, comfortable use, and meeting the quality requirements of topical formulations.

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