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Research Article

Optimization of Carrageenan Concentration as an Emulsifier in Banana Peel Extract Body Lotion with Irritation Assessment

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Abstract

Body lotion is a cosmetic used to soften and protect the skin. Ambon banana peel contains bioactive compounds with antioxidant potential that can be incorporated into body lotion formulations. This study aimed to evaluate the effect of carrageenan concentration as an emulsifier on the physical and chemical characteristics of ambon banana peel extract body lotion. The extract was obtained using the maceration method and formulated into three lotions containing carrageenan at concentrations of 1% (F1), 1.5% (F2), and 2% (F3). Each formulation was evaluated through organoleptic observation, homogeneity, pH, viscosity, adhesion, spreadability, and skin irritation tests. Statistical analysis included normality and homogeneity testing using the Shapiro–Wilk test and Levene's test, followed by One Way ANOVA to identify differences among formulations. The results demonstrated that variation in carrageenan concentration significantly influenced several physical properties of the lotion. Increasing carrageenan levels led to higher viscosity and adhesion, while spreadability decreased as concentration increased. In contrast, carrageenan concentration did not produce a significant effect on pH values. Based on the overall evaluation, the formulation containing 2% carrageenan (F3) was identified as the optimal formula. The results of the irritation test proved to be safe without causing an irritating effect on the skin.

Keywords: Ambon Banana peels, Body lotion, Carrageenan, Irritation test

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1 Introduction

Banana peels are waste from bananas, generally, people only consume the flesh of the fruit and throw away the peel, because it is considered rubbish or waste. Banana peels are rarely used by people even though banana peels contain a lot [1]. Banana peels, which are usually thrown away as organic waste or used as animal feed, contain quite a lot of nutrients, especially vitamins and minerals [2]. Research by Mukaromah [3], reported that banana peel has higher antioxidant activity than the flesh of the fruit. This is following research conducted by Adinata (2013) which states that Ambon banana peel has much higher levels of phenolic compounds, 73% -95% when compared to the flesh of the fruit, which contains antioxidants in the form of catechins, gallocatechols, and epicatechins which are a class of flavonoid compounds [4].

Previous research conducted by Chan & Sastra Winata (2021) reported that the content of flavonoid compounds in banana peels can help get rid of acne, smooth the skin, rejuvenate the skin, inhibit the premature aging process, maintain skin softness so that the skin looks younger and fresher, remove wrinkles and inhibit the aging process, premature aging moisturizes the skin by reducing water evaporation from the skin .Ambon banana peel extract can be formulated into cosmetic preparations. In the pharmaceutical sector, banana peels can be utilized by developing them into dosage formulations in the form of body lotion, gel, ointment, and others [5]. Body Lotion is a skin moisturizing cosmetic preparation that is included in the emollient (softener) group [6]. The lotion has several advantages including being easy to spread evenly, easy to use or easy to apply, does not give a greasy feeling, having a cooling effect, easy to wash off with water, and works directly on local tissue and the expected therapeutic effect is easier to achieve [7].

The factor that can influence the stability of the body lotion is the use of appropriate additional ingredients. The stability of body lotion can be maintained by adding stabilizers. An example of a stabilizer that is safe and environmentally friendly is carrageenan. Carrageenan is a type of hydrocolloid produced from red seaweed (Rhodophyceae) and is used as a stabilizer, thickener, emulsifier, gelling agent, and suspension agent [8]. Carrageenan has the advantage of functioning as a humectant that can retain skin moisture. The use of carrageenan is also intended to reduce the chemical composition in the formulation [8]. The novelty of this research is the difference in the percent carrageenan and the irritation test.

2 Method

2.1 Materials

Ambon banana peel extract, methanol (repacking by Agung Jaya Surakarta), stearic acid (repacking by Kimia Market Bandung), liquid paraffin (repacking by Kimia Market Bandung), carrageenan (repacking by Kimia Market Bandung), glycerin (repacking by Kimia Market Bandung), triethanolamine (TEA) (repacking by Kimia Market Bandung), phenoxyethanol (repacking by Kimia Market Bandung), perfume (repacking by Kimia Market Bandung).

2.2 Tools

Rotary evaporator (IKA, Germany); Oven (Memmert UN 55, Germany); Viscometer (Brookfield LV, USA); glassware (Pyrex Iwaki, Japan); scales (Metler Tedele, Swiss).

2.3 Sample Preparation and Extraction

Sampling was carried out by separating the banana peel from the fruit and taking the inside of the banana peel. 100 grams of Ambon banana peel simplicia were macerated using 500 mL of methanol solvent using a ratio of 1:5. Maceration was carried out for 3 days and stirring was carried out every day. The extract is calculated by comparing the weight of the dry extract obtained to the amount of simplicia used in the extraction process. Phytochemical testing on the methanol extract of Ambon banana peel includes testing for flavonoids, alkaloids, steroids, saponins, and tannins.

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2.4 The Formula of Body Lotion

The formula of body lotions with banana peel extract with a variation of carrageenan can be seen in Table 1.

Table 1. The Formula of Body Lotion with Variation of Carrageenan

Material	Ingredients (%)		
	F1	F2	F3
Peel Banana Extract	4	4	4
Stearic Acid	2.5	2.5	2.5
Liquid Paraffin	7	7	7
Carrageenan	1	1.5	2
Glycerin	5	5	5
Triethanolamine	1	1	1
Phenoxyethanol	0.1	0.1	0.1
Perfume	0.1	0.1	0.1
Aquadest	Add 100	Add 100	Add 100

2.5 Procedure

The oil phase (liquid paraffin, stearic acid, and phenoxyethanol) and the water phase (Ambon banana peel extract, glycerin, TEA, carrageenan solution, and distilled water) were placed in separate evaporating dishes and heated at 70°C while stirring occasionally. The melted oil phase is mixed with the water phase at a temperature of 70°C and stirred until homogeneous while the mixing temperature is lowered. At a temperature of 35°C perfume is added and stirred until a homogeneous lotion mass is formed.

2.6 Physical and Chemical Test of Body Lotion

This physical stability test was carried out for 4 weeks by observing changes that occurred including organoleptic tests (color, odor, and consistency of body lotion preparation), homogeneity tests, pH tests, viscosity tests, adhesion tests, and spreadability tests.

2.7 Irritation Test

This research was completed with ethical clearance No: 1.393/XI/HREC/2022. Each rat that had been acclimatized had hair shaved on the back with an area of 3x3 cm. Mice as test animals were divided into 4, namely positive control, Replication I, II, and III. After 24 hours, a sample of the best body lotion with extracted banana peels was applied to the shaved area, covered with gauze and plaster, left for 24 hours then opened and rinsed with water. Observations were made after 40 minutes by observing redness and swelling on the surface of the test animal's skin. The skin surface was observed for any visible changes in redness and swelling starting 24, 48, and 72 hours after administering the body lotion. Irritation test results are determined by the irritation index score including erythema, and edema, and obtained in each test animal [9].

2.8 Data Analysis

The data was tested for normality and homogeneity using the Shapiro-Wilk test and Levene's test. If the data was normally distributed and homogeneous then it was continued with the one-way ANOVA test to test the average comparison of data for each group. The test continued post hoc. LSD (Least Significant Difference) to determine significant differences between groups. If the data does not meet the requirements for normality and homogeneity tests, then the analysis is carried out using Kruskal Wallis to see significant differences between groups and continued with the Mann-Whitney post hoc test.

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3 Result and Discussion

3.1 Extraction Process

Simplicia of banana peel (100 grams) was diluted with 500 mL methanol. Maceration was carried out for 3 days and stirring was carried out every day. The purpose of repeated stirring is to speed up the time for the filter solution to extract the sample [10]. The resulting macerate is then evaporated using a rotary evaporator and a thick extract is obtained. The methanol extract of Ambon banana peel (Musa paradisiaca L.) produced was 40 grams with a yield of 4.44% (w/w). The results of phytochemical tests on the methanol extract of Ambon banana peel show that there are bioactive compounds, namely flavonoids, alkaloids, steroidal saponins, and tannins.

3.2 Physical and Chemical Test of Body Lotion

3.2.1 Organoleptic Test

The body lotion color was light brown with a characteristic banana smell. Based on the research results, show that all the treatments showed a homogeneous appearance of body lotion. Homogeneous body lotion when applied to a petri dish does not feel like there is any solid material in the petri dish. The preparation is said to be homogeneous if there are no other particles and the lotion is evenly distributed [11].

3.2.2 pH Test

The pH value for cosmetic products or products used for external use that are in direct contact with the skin must be following the skin's acceptable pH of 4.0-8.0 [12]. The research results showed that all lotion formulas showed a pH in the range of 5-7 and complied according to SNI 16-4399-1996, namely between 4.0-8.0 [12]. The higher the concentration of carrageenan used show higher the resulting pH value [13]. If the pH of the preparation is higher than the physiological pH, it can cause irritation and dry skin [14]. The results of the pH test of this research can be seen in Table 2.

The data has met the prerequisite tests for normality and homogeneity and can be continued to the One Way ANOVA Test and the results obtained are that there are no significant differences between the formulas as indicated by a significance value of 0.3 > 0.05. This shows that the use of carrageenan does not have a significant effect on the pH of body lotion preparations. This is to research conducted by Hudairah et al [15] (2021) which stated that varying the concentration of carrageenan in hand body lotion did not have a significant effect on the pH of hand body lotion.

Table 2. The Result of the pH Test

Formula	Hari ke-				p-value
	7	14	21	28	
F1	7	7	7	7	
F2	7	7	7	7	0.272
F3	7	7	7	7	

3.2.3 Viscosity Test

The viscosity test of the preparation describes whether the preparation is runny or too thick. This parameter is set to ensure the dosage remains stable and consistent during storage and remains within the required viscosity range (2000-50000 Cps) [12]. Based on the results of viscosity testing carried out on body lotion, the viscosity value of body lotion for all formula 3 meets SNI 16-4399-1996 as a quality requirement for skin moisturizers, namely between 2000-50,000 cP. The test results show that formula 3 has the greatest viscosity when compared to the other formulas. The higher the concentration of carrageenan used, the higher the viscosity value of the body lotion produced [8]. The results of the viscosity test can be seen in Table 3.

There was a significant difference in the ANOVA test, then it was continued with the Post Hoc test and the results were obtained that there was a significant difference in the adhesive strength values

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between F1, F2, and F3. These results are by research conducted by [13] and [16] which state that the concentration of carrageenan affects the viscosity of hand body lotion where the greater the concentration of carrageenan added, the viscosity of hand body lotion increases.

Table 3. The Result of the Viscosity Test

Formula	Hari ke-				p-value
	7	14	21	28	
F1	2005 cP	2286 cP	2412 cP	2645 cP	
F2	2818 cP	3156 cP	3568 cP	3884 cP	0.000
F3	3894 cP	4226 cP	4628 cP		

3.2.3 Adhesion Test

Based on the adhesive test results for the three formulas, the test results show that Formula 1 has the smallest stickiness and does not meet the requirements because it has the lowest viscosity. Meanwhile, formula 3 has the greatest stickiness because it has the greatest viscosity. The results of the adhesion test can be seen in Table 4. Because there is a significant difference in the ANOVA test, then continued with the Post Hoc test and the results obtained were that there was a significant difference in the adhesive strength values between F1, F2, and F3. These results follow research conducted by Rohmani and Anggraini [8] which stated that variations in the concentration of carrageenan influenced the existence of significant differences in adhesion between formulas, where the higher the concentration of carrageenan used, the higher the stickiness of the body lotion.

Table 4. The Result of the Adhesion Test

Formula	Hari ke-				p-value
	7	14	21	28	
F1	1 detik	2 detik	3 detik	3 detik	
F2	3 detik	4 detik	4 detik	5 detik	0.005
F3	4 detik	5 detik	6 detik	detik	

3.2.4 Spreadability Test

The requirement for the spreadability of lotion is that the power is 5-7 cm [17]. Based on the data obtained, the lotion preparation that was made had good spreading ability and was by the specified range, where the area of the test preparation was proportional to the additional load. This is because lotion is a cosmetic preparation in the form of an emulsion that contains more water[18]. The results of the speadability test can be seen in Table 5. Because there were significant differences in the ANOVA test, it was continued with the Post Hoc test and the results were obtained that there were significant differences in dispersion power values between F1, F2, and F3. These results follow research conducted by Rohmani & Anggraini(2019) which stated that differences in the concentration of carrageenan in each formulation provide different spreadability where the higher the carrageenan used, the lower the spreadability of body lotion.

Table 5. The Result of the Spreadability Test

Formula	Hari ke-				p-value
	7	14	21	28	
F1	5 cm	5 cm	6 cm	5 cm	
F2	5 cm	6 cm	5 cm	4 cm	0.005
F3	5 cm	5 cm	4 cm	cm	

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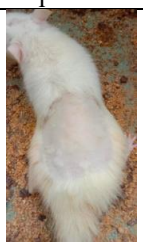
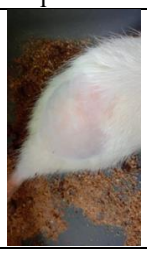
3.2.5 Irritation Test

The irritation test was carried out in vivo on rat test animals. Observations were carried out at 24, 48 and 72 hours to determine the possibility of a delayed skin irritation reaction. The level of irritation is calculated based on the calculation of scores assessing the level of edema and the level of erythema [19]. The primary irritation index value is shown by F3 with 3 replications and the positive control is 0. This shows that the best Ambon banana peel methanol extract body lotion does not irritate the skin and is safe to use. This is following the ingredients in the formulation, each of which does not have irritating properties. The results of the irritation test can be seen in Table 6.

Table 6. The Result of the Irritation Test in Rat

Kontrol	Replication 1	Replication 2	Replication 3
			

4. Conclusion

Based on the results of the analysis of tests on the difference in carrageenan concentration in the body lotion affects the characteristics of the body lotion, where the higher the concentration of carrageenan, the higher the viscosity and stickiness of the body lotion, while the spreadability of the body lotion decreases. The formula with a carrageenan content of 2% (F3) shows the best results, the results of the irritation test proved to be safe without causing an irritating effect on the skin.

5. Declarations

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5.2 Author contributions

ADM: data curation, methodology, supervision, and conceptualization drafting, and manuscript writing; MFZ, RK: was responsible for data collection, analysis; AW, J: collected data and analyzed data.

5.3 Ethics

Ethical clearance was issued by Moewardi Surakarta Hospital with the number 1.393/XI/HREC/2022.

5.4 Conflict of Interest

The authors have no conflicts of interest regarding this investigation.

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