THE POTENTIAL OF WATERMELON ALBEDO AS A RAW MATERIAL IN THE PRODUCTION OF SHEET JAM

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ABSTRACT

Watermelon (Citrullus lanatus) is generally used for its flesh, while the white part of the rind (albedo) is rarely used and often becomes waste. Albedo contains high levels of pectin, making it suitable for processing into food products such as sheet jam, which is an innovative thin sheet of jam that is practical to serve. This study aims to determine the effect of variations in pectin concentration and heating time on the physical and organoleptic characteristics of watermelon albedo sheet jam. The experimental design used a two-factor factorial: pectin concentration (0.5%; 1%; 1.5%; 2%; 2.5%) and heating time (1, 3, 5, 7, 9 minutes) with 25 treatment combinations. The parameters observed included moisture content, pH, syneresis, hardness, and organoleptic properties (color, aroma, taste). The results showed that an increase in pectin concentration and heating time had a significant effect on reducing moisture content, increasing hardness, reducing syneresis, and altering sensory perception. The best treatment was found in the 2.0% pectin and 5-minute heating sample, producing a firm but not too hard texture (247 g), low syneresis (1.82%), moisture content of 17.79%, and pH of 4.7. Watermelon albedo has the potential as a raw material for sheet jam with the right pectin and heating formulation.

Keywords: Heating Time, Pectin, Physical Characteristics, Sheet Jam, Watermelon Albedo

1. INTRODUCTION

1.1 Background

Watermelon (Citrullus lanatus) is one of the most popular fruits in Indonesia because it is rich in water content and has a sweet taste. Generally, the red or yellow flesh of the fruit is used for direct consumption or processed into various products, such as jam (Hukom et al., 2021 cited in Hutami, 2024). Watermelons have white flesh called albedo. Albedo is part of the watermelon rind that is white in color, with a slightly hard texture, a neutral or bland taste, and a relatively low water content. As a food ingredient, watermelon albedo is rarely consumed by the public and is mostly only used as animal feed and discarded as a household or industrial by-product (Haryu et al., 2016).

One way to utilize watermelon albedo so that it is not wasted as waste is to process it into food products, such as jam. With the increasing demand for jam in the market and considering the characteristics and nutritional content of watermelon albedo, the idea of developing it into jam emerged. Jam is a paste-like food product obtained from cooking fruit pulp, sugar, and can be added with acid and thickener (Huriah et al., 2019). Jam is a food product that is easy to find, both in modern and traditional markets, and can be produced by various business scales ranging from home industries to large industries because the manufacturing process is relatively simple.

However, the jams available on the market are generally spreadable jams in packages, which are not very practical to serve. Therefore, innovation is needed in the development of various types of jams, such as sheet jams. Sheet jam is a development of spreadable jam products made by processing fruit pulp, then molding it into sheets (Yulastri et al., 2022). Sheet jam has a semi-solid form that is usually molded to the size of bread, making it easier for consumers to serve, especially for those who often eat bread (Paramita et al., 2021).

Pectin is a polysaccharide that is abundant in plant cell walls and plays an important role in the thickening and gel formation processes. These characteristics make pectin widely used in the food industry, especially for making jam (Pramudita et al., 2024).

Based on the results of research by Mawarni & Yuwono (2018), the best treatment for sheet jam was obtained using the de Garmo method. The best treatment for sheet jam in terms of physical and chemical parameters was achieved by adding 2% carrageenan and cooking for 3 minutes.

The researchers then conducted research using different types of hydrocolloids, namely pectin and watermelon albedo as raw materials.

2. RESEARCH METHODS

Research methodology

2.1 Research Place

The research was conducted at the Bioindustry and Food Laboratory of the Lhokseumawe State Polytechnic, Department of Chemical Engineering.

2.2 Tools and Materials

2.2.1 Tools used

The equipment used in the research included: an oven, measuring cups, a refrigerator, a thermometer, an analytical scale, label paper, aluminum foil, a blender, baking pans, rubber spatulas, desiccators, a pH meter, a stove, a frying pan, spoons, and knives.

2.2.2 Materials used

The materials used in this study were: watermelon albedo, sugar, citric acid, margarine, pectin, and distilled water.

2.3 Experimental Treatment Design

2.3.1 Fixed Variables

- Watermelon albedo (%) : 50
- Sugar (%) : 25
- Citric acid (%) : 0.5
- Margarine (%) : 3
- Heating temperature (°C) : 90-95
- Drying temperature (°C) : 60
- Drying time (hours) : 8
- Mold size (mm) : 2-3

2.3.2 Independent Variables

- Pectin concentration (%) : 0.5; 1; 1.5; 2; and 2.5
- Heating time (minutes) : 1, 3, 5, 7, and 9

2.3.3 Dependent Variables

- Acidity level test (pH)
- Moisture content test (%)
- Syneresis test (%)
- Hardness test (gr)
- Organoleptic test (aroma, taste, and color)

2.4 Experimental and Testing Procedures

2.4.1 Making watermelon albedo sheet jam

1. Peel the watermelon rind from the watermelon albedo and place it in a blender for 1 minute at medium speed until a puree (mash) forms.
2. Heat the watermelon albedo puree with added sugar, margarine, citric acid, and pectin (0.5%, 1%, 1.5%, 2%, and 2.5%) at a temperature of 90-95°C for heating times of 1 minute, 3 minutes, 5 minutes, 7 minutes, and 9 minutes.
3. The next step is to pour the mixture into a baking pan or flat mold with a thickness of 2-3 mm and an area of 8x8 cm that has been lined with aluminum foil for easy removal.
4. Bake in an oven at 60°C for 8 hours. After drying in the oven, remove the jam.

5. Let it cool and harden at room temperature.
6. Repeat the above experiment for other pectin concentrations and heating times.

3. RESULT AND DISCUSSION

3.1 Research Results

Table 3.1 Data from Test Results and Observation Analysis

Heating Time (minutes)	Pectin Content (%)	Analysis			
		pH Value	Total Moisture Content (%)	Syneresis (%)	Hardnesss Value (gr)
1	0,5	4,2	12,75	1,56	89,5
	1,0	4,3	16,41	2,00	97
	1,5	4,5	17,35	2,55	110,5
	2,0	4,8	19,46	3,67	119
	2,5	5,1	21,77	4,02	124
3	0,5	4,2	12,71	0,90	92,5
	1,0	4,4	16,12	1,65	127
	1,5	4,7	16,13	2,00	141
	2,0	4,8	18,60	2,40	147,5
	2,5	5,0	20,69	3,12	150
5	0,5	4,1	9,93	0,79	143
	1,0	4,3	11,89	0,94	193
	1,5	4,4	12,87	1,63	229,5
	2,0	4,7	17,79	1,82	247
	2,5	4,9	19,42	2,26	355,5
7	0,5	4,5	5,78	0,19	47
	1,0	4,6	6,37	0,31	71
	1,5	4,7	9,06	0,92	81
	2,0	4,9	11,39	1,00	93
	2,5	5,0	13,28	1,25	100
9	0,5	4,4	5,01	0,13	98
	1,0	4,5	5,29	0,22	145,5
	1,5	4,7	6,07	0,29	154
	2,0	4,9	6,33	0,37	161
	2,5	5,1	7,88	0,54	188

3.2 Discussion

Sheet jam is a processed fruit product in solid or semi-solid form made from a mixture of main ingredients such as fruit puree, sugar, pectin, and acid.

3.2.1 Acidity level test (pH)

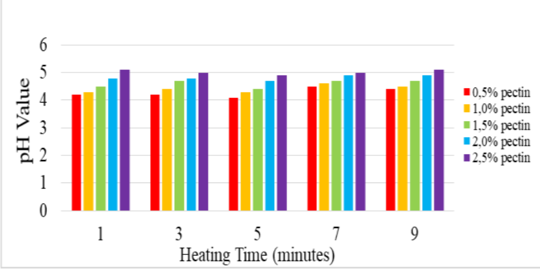

Figure 3.1 The Effect of Pectin Concentration Variations and Heating Time on pH Values

The pH value is one of the important chemical parameters in sheet jam products because it is related to stability, microbiological resistance, and gel formation ability, especially in products that use gel-forming ingredients such as pectin. In this study, variations in pectin concentration and heating time were carried out to see their effect on the pH value of sheet jam made from watermelon albedo.

Based on the analysis results in Figure 3.1, it shows an increase in pH along with an increase in pectin concentration. At a pectin content of 0.5-2.5% (1 minute), the pH value increased from 4.2 to 5.1. A similar increase also occurred at other heating times. This shows that the higher the pectin concentration used, the higher the pH value of the sheet jam.

This is also explained by Soerdirga & Tirto (2023), stating that the pH value is directly proportional to the concentration of carrageenan because there is a direct relationship between the amount of carrageenan used and the acidity level of the product. Although the gelling agents used are different, both belong to the hydrocolloid group which has active ionic groups, so they can affect the balance of H+ ions and have an impact on increasing the pH of the product.

3.2.2 Moisture content test

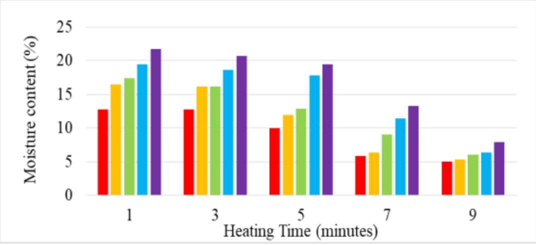

Figure 3.2 The Effect of Pectin Concentration Variations and Heating Time on Moisture Content

Moisture content testing aims to measure the amount of water contained in sheet jam after drying at a temperature of 105°C using an oven. According to SII standard No. 173 (1978) in Primaviera et al. (2024) on jam quality, the maximum amount of water is 35%.

Based on the analysis results in Figure 3.2 above, it shows that the water content tends to decrease as the heating time increases. At a pectin content of 0.5% and a heating time of 1 to 9 minutes, there was a sequential decrease from 12.75% to 5.01%. The same thing happened at other pectin contents and heating times. This decrease is due to the length of heating time during cooking. The water content of the sheet jam produced in each treatment in this study has met the quality requirements based on SII Number 173 (1978) in Primaviera et al. (2024), which sets a maximum water content limit of 35%.

However, here the increase in pectin concentration does not directly reduce the moisture content. In fact, the moisture content is slightly higher with the increase in pectin. This is thought to be because pectin has a high ability to absorb and retain water in the gel matrix that is formed. This finding is in line with the research by Mawarni & Yuwono (2018) on mixed sheet fruit jam, which also found that an increase in hydrocolloid concentration can increase the water content of the product, while longer cooking times cause greater water evaporation, resulting in a decrease in moisture content.

Increasing the pectin concentration will produce a gel with higher strength and lower water absorption capacity. This shows that the dense pectin gel structure is able to retain water more strongly, so that water does not easily escape or evaporate (Günter et al., 2020).

3.2.3 Syneresis test

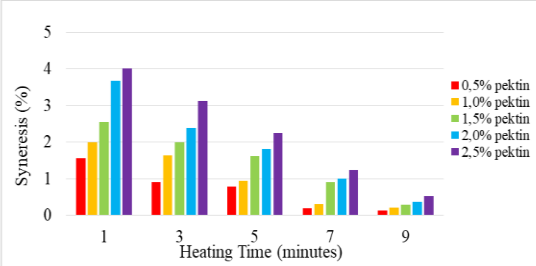

Figure 3.3 The Effect of Pectin Concentration Variations and Heating Time on Syneresis

Syneresis is the phenomenon of water separation from the gel structure due to instability in the network bonds. In sheet jam products, high syneresis values can cause the texture to become wet, loose, and easily damaged during storage. Low syneresis values indicate a stable gel that is able to retain water well.

Based on Figure 3.3, syneresis decreased as heating time increased, both at low and high pectin concentration. At 1 minute, the highest syneresis reached 4.02% (2.5% pectin), while at 9 minutes all treatments were below 1.0%. In general, higher pectin concentrations tend to produce greater syneresis during short heating (1–5 minutes), because gelation is not yet complete. Ardiansyah et al. (2019) explained a similar phenomenon, stating that the addition of excessive thickening agents can increase syneresis due to the pressure between gel molecules that pushes water out. Therefore, the pectin concentration needs to be adjusted to the optimal limit so as not to cause excessive water release, because after adequate heating, the gel formed is more stable and syneresis decreases.

3.2.4 Hardness test

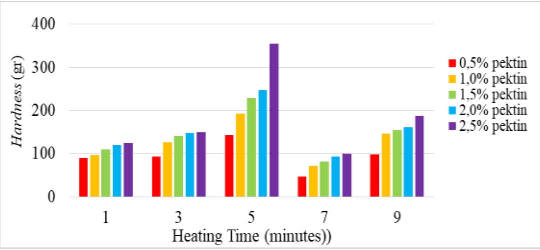

Figure 3.4 The Effect of Pectin Concentration Variations and Heating Time on Hardness

The hardness value of sheet jam shows variations influenced by pectin concentration and heating time. This parameter reflects the strength of the gel structure in withstanding pressure, so it can be used to assess the physical stability and final texture of the product.

the hardness value increased with increasing pectin content and heating time up to the 5th minute, with the highest value of 355.5 g at 2.5% pectin, then decreased at the 7th and 9th minutes. These results are in line with Ma'arif et al. (2021), who reported that the addition of 2% carrageenan produced the highest hardness, indicating that increasing the hydrocolloid to the optimal point can improve the physical characteristics of the product. The decrease during longer heating is thought to be due to gel softening due to excessive moisture loss or over-gelation.

However, at minutes 7 and 9, there was a decrease in hardness despite high pectin levels. For example, at 2.5% pectin, the hardness value decreased from 355.5 g (minute 5) to 100 g (minute 7) and 188 g (minute 9). This decrease is thought to occur because the gel structure softens due to excessive moisture loss or over-gelation, which causes structural fragility.

3.2.5 Organoleptic test

The organoleptic test in this study was conducted using the hedonic method to assess the panelists' level of preference for the aroma, color, and taste of the sheet jam. A total of 25 samples were tested by 25 panelists using a five-point preference scale, ranging from very dislike (1), dislike (2), slightly like (3), like (4) to very like (5). The assessment results were calculated by summing up all the panelists' scores, then averaging them to determine the level of preference for each treatment.

a. Organoleptic on Aroma

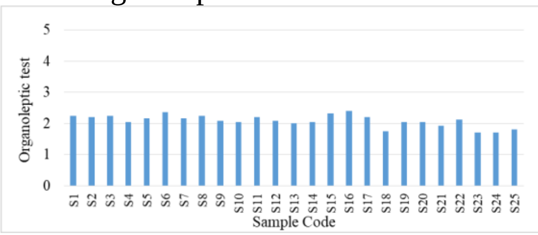

Figure 3.5 Organoleptic Test On Aroma

The organoleptic data on aroma shows that the average score obtained was in the range of 1.72-2.4 (less preferred category), while the research by Werdhosari et al. (2019) on jicama fruit leather with the addition of red dragon fruit obtained an aroma score of 2.80–3.56 (slightly liked to liked category). Although the range of values in this research was lower, the trend in both studies shows that the distinctive aroma characteristics of the main raw material can affect the level of acceptance by the panelists. The highest score obtained for the aroma attribute was 2.4 in sample 16, which was still classified as less preferred. This low level of preference is thought to be due to the absence of food flavorings, such as vanilla, which are commonly used to mask or neutralize the distinctive aroma of the main raw material.

In this case, the natural aroma of watermelon albedo used as the main raw material has characteristics that are quite distinctive and unfamiliar to some panelists. The absence of additional aromas such as vanilla extract or fruit flavoring causes the natural aroma to be more prominent and less appealing to the senses, thereby affecting the level of product acceptance in terms of aroma.

b. Organoleptic Test On Taste

Figure 3.6 Organoleptic Test On Taste

The organoleptic data on taste shows that the average score obtained is close to 4, indicating that most panelists liked the taste of the sheet jam produced. This is also shown in the research by Werdhosari et al. (2019), which obtained a hedonic taste quality score of 3.04–4.12, where the best treatment achieved an average score of 4.12 (like). This similarity shows that both research produced products with a fairly high level of taste acceptance. The highest score for the taste attribute was 4, obtained in samples 9 and 14. This high level of acceptance indicates that the product has taste characteristics that are quite in line with the panelists' preferences, in terms of sweetness, sourness, and overall taste. This good acceptance of taste is thought to be related to the composition of ingredients and the formulation process, which optimizes the balance of flavors without causing foreign or unusual tastes.

c. Organoleptic Test On Color

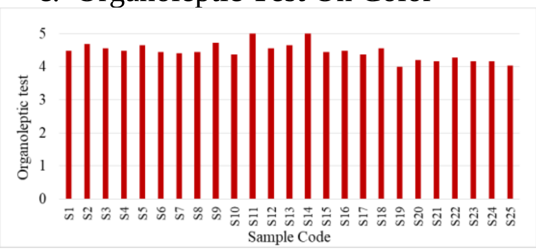

Figure 3.7 Organoleptic Test On Color

The organoleptic data on color shows that the average score is quite high, indicating that the color of the sheet jam is generally liked by the panelists. The highest score for the color attribute was 5, which was obtained in samples 11 and 14. The dominant yellow color in this product comes from the addition of margarine and sugar, which naturally give it a yellowish hue after heating. However, the longer the cooking time, the more the color changes to brownish yellow, resulting in a decrease in preference.

This is in line with the trend of Werdhosari et al.'s research (2019) on bengkuang and red dragon fruit fruit leather, where the best color was obtained with a low proportion of red dragon fruit, while an increase in the proportion of red dragon fruit resulted in a dark red color that was considered less appealing. Although the color differences produced in the two research studies are quite contrasting (yellow vs. red), the similarity in the results lies in the finding that color changes that are too far from the natural color expected by the panelists can reduce the level of acceptance.

4. CONCLUSION

4.1 Conclusion

Based on the results obtained in this research, the following conclusions were drawn:

1. Variations in pectin concentration (0.5%-2.5%) affect moisture content, pH, syneresis, texture (hardness), and panelist preference. Increasing pectin concentration results in a stronger gel structure, firmer texture, lower syneresis, and better organoleptic properties in terms of aroma, taste, and color.
2. Variations in heating time (1-9 minutes) affect the physical stability of the sheet jam, particularly moisture content, syneresis, and texture (hardness). Heating at the optimum time results in sufficient water

evaporation, leading to a more stable texture, low syneresis, and better organoleptic scores for aroma, taste, and color compared to heating that is too short or too long.

4.2 Suggestions

In research on watermelon albedo sheet jam with varying pectin concentrations and heating times, it is better to use additives such as vanilla or fruit flavoring to enhance the aroma and taste. This is because organoleptic test results show that panelists dislike the distinctive aroma of watermelon albedo without the addition of flavoring.

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