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Effect of Temperature and Pressure in Producing Thick Cassava Chips Using Vacuum Frying

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ABSTRACT

Lampung province is one of Indonesia's cassava production centers. Lampung Province is currently Indonesia's largest cassava producing area, capable of producing 60 percent of the country's tapioca needs. Cassava chips are not a new product for Indonesians. Processing cassava into thick cassava chips using vacuum frying technology is a promising technology that can increase the economic value of cassava tubers while also meeting consumer demand for innovation in the shape and size of cassava chips. The problems investigated in this study include determining the optimal temperature required to produce thick cassava chips of the highest quality and the optimal pressure required to produce thick cassava chips of the highest quality. The aims of this study was to determine the optimum temperature and pressure required to produce thick cassava chips with the best quality at temperatures of 80 C, 85 C, and 90 C and pressures of -65 cmHg, -68 cmHg, and -72 cmHg. Data analysis in Microsoft Excel software using Anova analysis to determine the effect of temperature and pressure on frying time, moisture content, weight loss, and organoleptic test. The effect of temperature and pressure on the frying using vacuum frying in the manufacture of thick cassava chips was studied. Temperature and pressure affect the water content, length of frying, and organoleptic test of aroma, color, taste, and crispness. The best quality of thick cassava chips has the lowest moisture content of 3.01% and the shortest frying time of 38 minutes, as well as the favorite score of the hedonic aroma test 3.87, taste 4.37, color 4.17, and crispness 4.73 on a scale of 1-5 contained in the treatment with optimal temperature and pressure, temperature 90 C and pressure -72 cmHg.

1. Introduction

Cassava is an important commodity as a source of income for farmers who contribute to farmer welfare. Lampung Province is currently Indonesia's largest cassava producing region, capable of providing 60 percent of the country's tapioca needs. Apart from tapioca, Lampung Province is also known for its chip production, one of which is cassava chips.

Cassava chips are not a new product for Indonesian people. This product has been varied with several additional flavors and levels of spiciness. Processing cassava into thick cassava chips using vacuum frying technology is a novel breakthrough that can add economic value to cassava tubers while also meeting customer demand for innovative shapes and sizes of cassava chips. The processing of thick cassava chips requires several different treatments from tubers before the frying process. Additional processes such as boiling the cassava tubers first and storing them at low temperatures are processes that need to be passed in order to get cassava tubers in a frozen state. The temperature of the frying itself can have an effect on the product of the frying results.

According to Yang (1997), temperature can have a direct effect on the water content thereby affecting the crispness, color and taste. Another factor that can affect the results of frying is pressure. Therefore, it is necessary to do research to determine the effect of temperature and pressure of vacuum frying on the manufacture of thick cassava chips.

2. Materials and Methods

2.1 Research Sites

This research was conducted at the Postharvest and Bioprocess Engineering Laboratory, Faculty of Agriculture, Department of Agricultural Engineering and Integrated Laboratory from December 2021 to January 2022

2.2 Tools and Materials

The materials used in this study included cassava tubers harvested from farmers' gardens in Central Lampung Regency and Bimoli brand cooking oil. The tools used are vacuum frying, spinners, freezers, knives, ovens, pans, basins, scales and plastic zippers

2.3 Research Design

The research method used was an experimental design in the form of a Completely Randomized Design (RBD). The experimental factors in this study were temperature and pressure during frying. This study used nine treatment levels (P) with a combination of temperature and pressure respectively as follows:

P1 (80 ℃ : -65 cmHg), **P2** (80 ℃ : -68 cmHg), **P3** (80 ℃ : -72 cmHg), **P4** (85 ℃ : -65 cmHg), **P5** (85 ℃ : -68 cmHg), **P6** (85 ℃ : -72 cmHg), **P7** (90 ℃ : -65 cmHg), **P8** (90 ℃ : -68 cmHg), **P9** (90 ℃ : -72 cmHg). The treatment was carried out with a thickness of cassava slices of 0.5 cm. Each treatment was repeated (R) three times so that there were 27 experimental units.

Table 1. Groups of treatment

No	Treatment code	Group 1	Group 2	Group 3
1	P65T80 (A)	P72T80 (G)	P65T90 (C)	P72T85 (H)
2	P65T85 (B)	P65T90 (C)	P65T80 (A)	P65T90 (C)
3	P65T90 (C)	P65T85 (B)	P65T85 (B)	P65T85 (B)
4	P68T80 (D)	P68T90 (F)	P72T90 (I)	P68T90 (F)
5	P68T85 (E)	P65T80 (A)	P72T85 (H)	P65T80 (A)
6	P68T90 (F)	P72T85 (H)	P68T85 (E)	P72T80 (G)
7	P72T80 (G)	P68T85 (E)	P72T80 (G)	P68T85 (E)

8	P72T85 (H)	P72T90 (I)	P68T80 (D)	P68T80 (D)
9	P72T90 (I)	P68T80 (D)	P68T90 (F)	P72T90 (I)

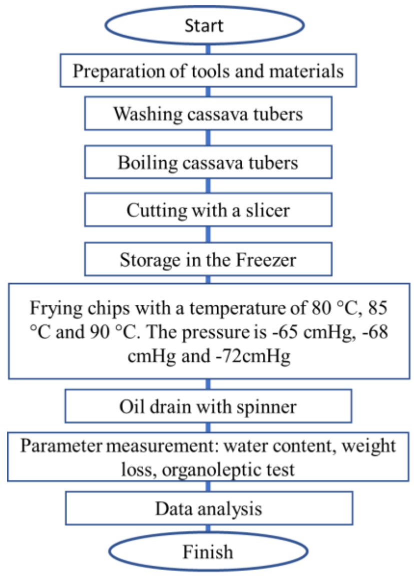

Figure 1. Research flowchart

2.3.1 Preparation of Research Tools and Materials

The tubers that have been sorted will be cleaned first, so that the tubers is not contaminated with bacteria and dirt. After that, boiling is done to soften the texture of the cassava root. After that, the tubers will be cut with a thickness of 0.5 cm. Tubers that have been sliced with uniform thickness will be weighed to obtain the initial weight. After that, the sliced and weighed tubers are put into the freezer overnight.

2.3.2 Manufacture of cassava chips

The manufacture of cassava chips uses two treatments, namely temperature and frying time. Cassava chips will be fried at -65 cmHg, -68 cmHg and -72 cmHg pressure and at 80 °C, 85 °C and 90 °C with 3 repetitions for each combination.

2.3.3 Oil separation

The chips are drained with a spinner to reduce the oil content in the chips and then packaged in plastic so that parameter measurements can be made.

2.4 Observation Parameters

2.4.1 Water content

Water content = $(B-A)-(C-A)/(B-A)\ x\ 100\ \%$ (1)

Information: A = Weight of cup, B = Weight of cup before drying, C = Weight of cup after drying

2.4.2 Weight loss

Weight change can be measured by the formula:

Weight Loss = (Initial Weight (g) − Final Weight (g) Initial Weight (g) x 100 % (2)

2.4.3 Organoleptic Test

Organoleptic test was carried out by hedonic rating test, based on the method of Meilgarard, et al. (1999). Some of the parameters that will be tested organoleptic namely, color, taste, crispness and preference for the product. The organoleptic test will be carried out by 30 untrained panelists.

Table 2. The hedonic test rating scale

Parameters	Criteria	Score
Aroma	Really like	5
	Like	4
	Rather like	3
	Dislike	2
	Very dislike	1
Taste	Really like	5
	Like	4
	Rather like	3
	Dislike	2
	Very dislike	1
Color	Really like	5
	Like	4
	Rather like	3
	Dislike	2
	Very dislike	1
Crispness	Really like	5
	Like	4
	Rather like	3
	Dislike	2
	Very dislike	1

2.2 Data Analysis

To determine the impact of temperature and pressure on frying time, moisture content, weight loss, and organoleptic tests, data was analyzed using ANOVA in Microsoft Excel software.

3. Results and Discussions

3.1 Water content

The highest water content was found in the frying treatment with a temperature of 80 ℃ and a pressure of -65 cmHg which was 4.39% and the smallest water content was found in the frying treatment with a temperature of 90 ℃ and a pressure of -72 cmHg which was 3.01%.

The results of the ANOVA analysis calculation performed on the thick cassava chips moisture content test with a confidence level of 95%, showed that the source of diversity in the temperature and pressure testing had a very significant effect on the water content while the interaction of temperature and pressure had no significant effect. Because the results of the ANOVA showed a very significant effect, it was continued with the Tukey test (Honest Standard Deviation) for sources of temperature and pressure variations as shown in Table 6. Tukey's further test results on sources of temperature diversity showed that at temperatures of 90 ℃, 85 ℃, and 80 ℃ very significantly different from each other in each treatment as evidenced by different values and symbols. This is accompanied by a source of pressure variation, as indicated by distinct values and symbols in the treatments -65 cmHg, -68 cmHg, and -72 cmHg.

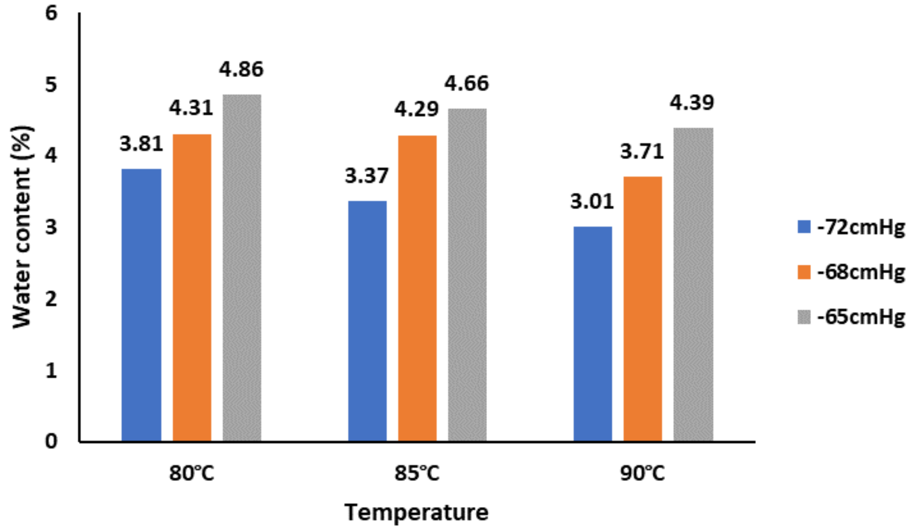

Figure 2. Graph of thick cassava chips moisture content

Table 5. Tukey's test for the effect of temperature and pressure on water content

Temperature	Average	Mark
90 °C	12.42	c
85 °C	11.95	b
80 °C	10.96	a
Pressure		
-65 cmHg	12.54	c
-68 cmHg	11.96	b
-72 cmHg	10.83	a

3.2 Weight loss

The results obtained from the calculation of weight loss data show that the largest weight loss is found in the frying treatment with a temperature of 90 °C and a pressure of -72 cmHg, which is equal to 45.67% and the smallest weight loss is found in the treatment of a temperature of 80 °C and 85 °C with a pressure of -65 cmHg and -68 cmHg of 45.00%. The graph above also shows that high temperature and low pressure cause weight loss happens to chips the higher. The drop in weight loss of thick cassava chips was caused by a decrease in the water content in the ingredients as a result of the vacuum frying process, which evaporated the water content in the ingredients. The weight loss values that have been calculated indicate that there are no significant differences from each treatment. This is directly proportional to the value of the water content contained in thick cassava chips after the frying process which also does not show much difference from each temperature and pressure treatment.

The results of the ANOVA analysis performed on the weight loss test of thick cassava chips with a confidence level of 95%, indicate that the source of diversity in group testing has a significant effect on weight loss while the treatment of temperature, pressure and the interaction of temperature and pressure has no significant effect. This is directly proportional to the graph above which showed no significant difference between the treatments. Because the results of the ANOVA 25 analysis showed a significant effect, it was continued with the Tukey test follow-up test for the source of group diversity.

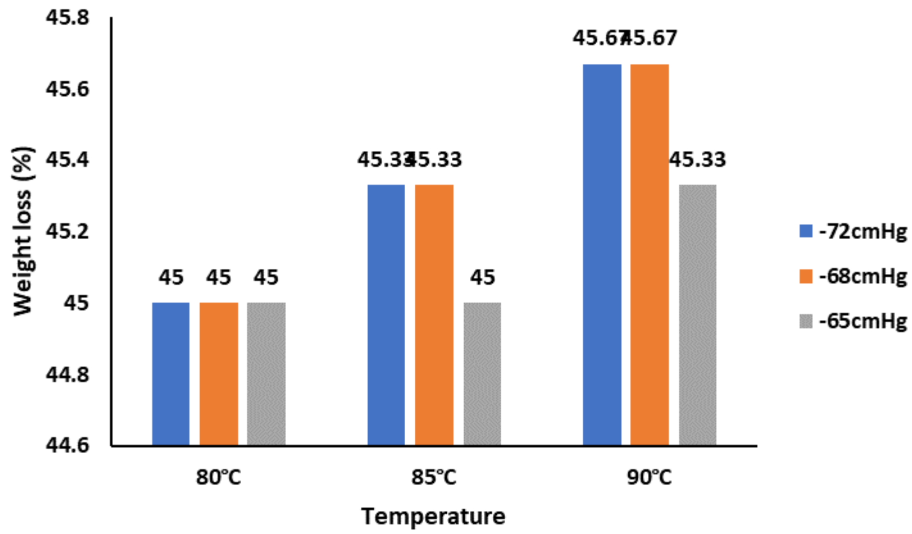

Figure 3. Weight loss of thick cassava chips

Table 7. Tukey test for group effect on weight loss

Groups	Average	Mark
1	0.50	c
2	0.45	a
3	0.48	b

3.2 Length of frying time

The longest frying time was found in the frying treatment with a temperature of 80 °C and a pressure of -65 cmHg, while the shortest frying time was found in the treatment with a temperature of 90 °C and a pressure of -72 cmHg, indicating that the high temperature causes a shorter time needed to fry the thick cassava chips.

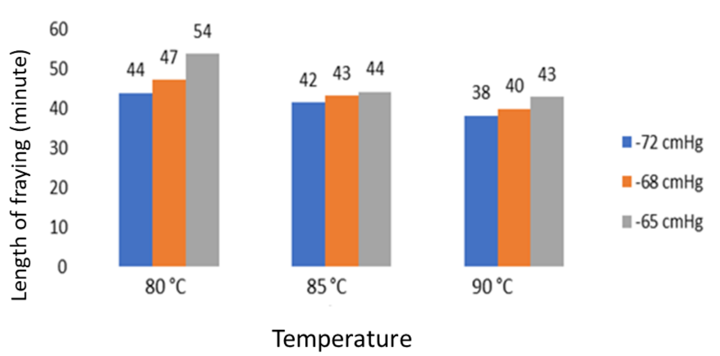

Figure 4. Length of time for frying thick cassava chips

This is confirmed by Suhan's (2014) claim that the higher the temperature, the faster the frying process. Temperature and pressure treatment influence the duration of frying time; high temperature and low pressure will accelerate the evaporation of water contained in thick cassava chips. This is what speeds up the frying process because the foam that indicates the water evaporation process is still active disappears quickly when the temperature is increased or when the temperature is higher than the previous temperature.

The results of the ANOVA analysis calculation performed on the measurement of the length of time of frying thick cassava chips with a confidence level of 95%, shows that the source of the variation of pressure has a significant effect on the length of time of frying and the source of the variation of temperature has a very significant effect on the length of frying time. Because the ANOVA analysis showed that there was a significant and very significant effect on the frying time, the Tukey test was carried out on sources of pressure and temperature variations.

Table 9. Tukey test for the effect of pressure on the length of frying time

Pressure	Average	Mark
-65 cmHg	47.11	bc
-68 cmHg	43.56	ab
-72 cmHg	41.33	a

Table 10. Tukey test for the effect of temperature on the length of frying time

Pressure	Average	Mark
80 °C	48.44	c
85 °C	43.11	ab
90 °C	40.44	a

The results of the calculation of the tukey test for the length/time of frying time can be seen that the pressure of -72 cmHg has a significant effect on the pressure of -65 cmHg, but is not significantly different from the pressure of -68 cmHg, while at a pressure of -68 cmHg it is not significantly different from the pressure of -72 cmHg and -65 cmHg . The results of the calculation of the TUKEY test for the length of frying time can be seen that the temperature of 90 °C is significantly different from the temperature of 80 °C, but not significantly different from the temperature of 85 °C. At 80 °C it is significantly different from the other two temperatures, namely 85 °C and 90 °C.

3.2 Organoleptic test

The organoleptic test was conducted using the hedonic technique, with the panelists filling out a questionnaire form. A total of 30 untrained panelists were handed a questionnaire form. Panelists tested thick cassava chips by seeing as an indicator of color, smelling as an indicator of aroma, and eating as an indicator of flavor and crunchiness. The pressure and temperature treatments were given a treatment code, P1 for a pressure of -72 cmHg, P2 for a pressure of -68 cmHg and P3 for a pressure of -65 cmHg, T1 for a temperature of 80 °C, T2 for a temperature of 85 °C and T3 for a temperature of 90 °C. The questionnaire was presented with a score level, level 5 for very like, 4 for like, 3 for somewhat like, 2 for less like and 1 for don't like. The treatment with the greatest preference score is pressure treatment - 72 cmHg and temperature 90 °C, which is directly proportional to the outcomes of the organoleptic score of aroma, taste, color, and crispness.

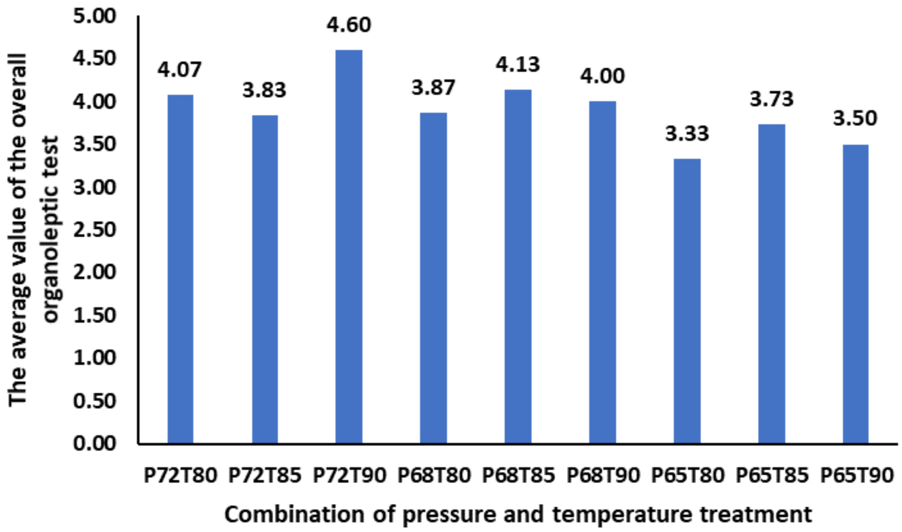

Figure 5. The overall preference value for thick cassava chips

4. Conclusions

Variations in temperature and pressure during the process of vacuum frying thick cassava chips affect water content, frying time, and organoleptic tests such as aroma, color, flavor, and crispiness. The best thick cassava chips have a moisture content of 3.01%, a frying time of 38 minutes, and a hedonic aroma test choice score of 3.87, taste of 4.37, color of 4.17, and crispness of 4.73 on a scale of 1 - 5. This also demonstrates that the higher the temperature and pressure, the better the results obtained and approved later by panelists or consumers. According to the findings of this research, the optimum temperature and pressure needed to produce the best quality thick cassava chips are 90 °C and -72 cmHg pressure.

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