



THE EFFECT OF FRYING TEMPERATURE AND TIME IN VACUUM FRYING MACHINE ON THE IMPROVEMENT OF THE QUALITY OF APPLE CRISPS

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ABSTRACT

The frying temperature in the frying process using a vacuum frying machine can be designed according to your needs. Usually used for frying at low temperatures so that damage to aroma and taste can be avoided. The purpose of this study was to analyze the effect of temperature and frying time on a vacuum frying machine on improving the quality of apple chips so that apple chip products can be obtained according to consumer desires. The temperatures used for frying are 50, 55, and 60°C with time variations of 40, 50, and 60 minutes. This aims to avoid changes in color and taste to obtain optimal quality apple chips. The water content of fried apples is 85% - 86.5%. The maximum capacity of the frying tube is 2 kg with a requirement of 12 liters of cooking oil. The main processed ingredients used in this study were *manalagi* varieties of apples. The resulting chips have a delicious, sweet, crispy texture, and have a yellow color. The higher the temperature and the longer the frying time, the air content tends to decrease. This is caused by higher heat which causes greater evaporation of air from inside the material. The results of the fried ingredients are more crunchy because evaporation at a low boiling point allows more air content to evaporate.

Keyword: Frying time, Optimization temperature, Quality of apple chips, Vacuum frying machine

INTRODUCTION

Apple has been cultivated in Indonesia since 1934 and is currently a fruit favored by Indonesians [1]. The benefits of apples (*Malus Domestica*) include blood sugar stabilizers, anti-cancer agents, lowering blood cholesterol, lowering blood pressure, and dieting programs [2]. Apples are a fruit with a fairly high total

sugar content, which is around $14.19 \pm 1.18\text{g}/100\text{ml}$ [3]. Apples also contain vitamin C as much as 2mg/100g, phenolic compounds such as quercetin, and epicatechin which function as antioxidants and can reduce the risk of developing cancer. The content of vitamin C in apples makes apples easily damaged if stored in free air because vitamin C is susceptible to heat and air [4]. Therefore, apples must be processed and become an indicator of other products so



that they are more durable and have added value. The resulting product is a natural product without sweeteners and preservatives. Apple chips are a byproduct of using apples which can be used as snacks. This is a new business opportunity. Apple chip entrepreneurs can take advantage of apples to be processed apple chips with new flavor variations. It can serve variations by sprinkling additional ingredients on the apples. For example, various flavors to provide different taste sensations.

One of the technologies that can be used for the manufacture of apple chips is a vacuum frying machine that can maintain the nutritional value of vegetables and fruits. With a vacuum frying machine, fruits or vegetables are dehydrated without browning or the product becoming charred [5]. Frying using a vacuum frying machine is carried out in a vacuum in a closed room with a low-pressure condition of around 70cmHg. Some of the advantages obtained from frying using a vacuum frying machine is that the color, taste, and aroma do not change much, have high fiber content, and are durable even though they do not use preservatives. Under vacuum, the frying temperature can be lowered by 50°C-60°C or 5-6 decades, due to a decrease in the boiling point of water [6]. Besides, vacuum frying technology is an effort to reduce oil in the products produced [7].

Vacuum frying has been widely studied in fruit chip frying and the results of the research show that different basic ingredients for chips have different frying temperatures and times when fried using vacuum frying. In the research conducted by Tumbel and Manurung on the production of pineapple chips, the quality of chips following SNI was obtained by a treatment

temperature of 90°C and a time of 50 minutes [8].

Research conducted by Iswari on the production of sapodilla chips obtained the best temperature and time results from the vacuum frying of sapodilla chips is a temperature of 80°C for 60 minutes [9]. Based on the research of Wijayanti et al on the study of the engineering process of empty frying and the feasibility of producing banana chips, it was concluded that the best quality of banana chips was obtained at a frying temperature of 80°C for 60 minutes [9]. Meanwhile, the organoleptic test results of guava chips in a study conducted by Firyanto et al. Showed that guava chips were the most preferred by panelists which were processed at 90°C and 40 minutes [10]. Based on the above background, the research aims to determine the frying time and temperature.

RESEARCH METHOD

The research method used in this research is experimental research. The type of research aims to determine the relationship between factors or variables by giving treatment to one or more experimental groups with different treatment conditions.

The equipment needed to make apple chips includes a basin, a cotton pad, a slicer, a stainless steel knife, a plastic bucket, a frying pan, a vacuum frying, a sealer, a stove, or gas stove, container, plastic container, polypropylene (PP) plastic with a thickness of 0.8 mm or aluminum foil and labels.

The tool used in this study was a vacuum frying machine with a material capacity of 2 kg which is presented in Figure 1.



Figure 1. Vacuum Frying Machine with a capacity of 2 kg of material

Table 1. Specifications of the Vacuum Frying Machine

Dimensions	9800 mm x 710 mm x 1150 mm
Material	Food Grade Stainless Steel
Thick Frying Tube Material	2 mm
Cook Time	40 – 60 minutes
Temperature Control Features	Automatic Thermostat Control
Heater	LPG Gas Stove (Furnace) Rinnai R1 - 511E
Fuel	Liquid Petroleum Gas
Oil Capacity	12 L
Cooling System	Water Circulation
Cooling Water Capacity	± 250 L
Power	220 Volt 400 Watt
System	Vacuum Frying
Vacuum Drive	2 Inch

Research Materials

The ingredients needed to make apple chips are as follows:

1. Apples

Manalagi variety is the raw material for making apple chips.

2. Clean water

Apples to be made into chips must be washed using water that meets the requirements for

drinking water and clean water, according to the standards of the Minister of Health of the Republic of Indonesia No. 416/MENKES/PERK/IX/90. According to the standards of the Minister of Health of the Republic of Indonesia, drinking water and clean water must be colorless, tasteless, odorless, and contain no harmful substances.

3. Cooking oil

Coconut oil or palm oil is used for frying. For the quality of chips to be excellent and durable,



the cooking oil must meet good quality according to SNI 01 - 3741 - 2002.

4. Sodium sulphite (Na_2SO_3)

So that the apples do not turn brown, use a solution of sodium sulfite (0.3% - 0.5%) or pieces of betel leaf. For the texture, taste, and appearance to be attractive, food additives (BTP) can be added with their use as recommended.

Making apple chips, using food additives referring to SNI 01 0222-1995. Those ingredients are:

a. Sugar

Granulated sugar serves to give a sweet taste to apple chips. First, granulated sugar is made into a syrup with a ratio of 1: 5, one kilogram of granulated sugar is dissolved in 5 cups of water. The quality of the sugar used must be of good quality, meeting the standard of white crystal sugar (SNI 01-3140-2001).

b. Kitchen salt

Iodized table salt (SNI 01 - 3556 - 2000) serves to give a salty taste.

Vacuum Frying Mechanism

The working mechanism of the vacuum frying machine includes:

- a. Apples as a chip ingredient are put into a vacuum fryer. Vacuum frying will remove the moisture content in the fruit and replace it with oil. The frying temperature ranged from 50oC - 70oC and a pressure of 76cmHg, with a frying time of 40 minutes to 60 minutes. A vacuum frying machine can lower the boiling point below 90oC so the chips don't burn.
- b. The cooking oil needed for one fry is about 12 liters. The structure of the cooking oil content is not easily damaged by decreasing

the boiling point below 90oC, thus saving the use of oil because it can be used to fry chips up to 100 times. For good results, you should use branded and clear cooking oil because low-quality cooking oil will affect the color and aroma of fruit chips. Chips fried using a vacuum frying machine can last up to half a year. In addition, the quality of the packaging will affect the durability of the chips.

Apple Chips Processing

Peel the skin of fresh apples using a knife until clean, or you can also use a fruit peeler to make it faster. The peeled apples are washed with clean water. Then the apples are sliced thinly using a knife or you can use a slicer to make it faster and easier. Then soaked using Sodium Bisulfite Solution. After the brown color on the apple slices has faded a bit, the apple slices are removed from the marinade.

The apple slices are put into a vacuum frying machine. The apple slices are fried in enough oil so that all the ingredients are submerged. Every 1 kg of apple slices requires 3 liters of cooking oil. During frying, stir gently. Frying is done until the chips are quite dry and crispy. The result of frying is called apple chips. To get apple chips with a sweet taste, sprinkle them with powdered sugar.

The apple chips that have been fried are removed and drained using an oil drainer. Provision of Food Additives To serve consumers who have different tastes, various flavors of apple chips can be created, such as sweet apple chips, salty apple chips, and spicy apple chips. Next, the apple chips are cooled to normal temperature or room temperature and ready to serve. For storage, apple chips can be stored in an airtight container so that the crispness is maintained.



Main Research Design

The variables that will be observed in this study are:

1. Temperature and frying time which are independent variables.
2. The quality of apple chips is the dependent variable (not independent) whose value depends on the independent variable.

The research design consisted of three treatments with two replications. The study used two factors, namely temperature and frying time, with three repetitions. Temperature using three levels, namely 50, 55, and 60°C. Time using three levels, i.e., 40, 50, and 60 minutes.

Research Stage

The research carried out consisted of preliminary research and primary research. The initial research aims to determine the optimal frying temperature and time ranges used in the frying process. The best results from the preliminary analysis are used in the main study. The observations made in the primary research were subjective observations of the color and crunchiness of apple chips.

Experiments in this preliminary research will be carried out on a trial and error basis. In the initial

study, empty frying was carried out at a temperature of 50oC to 60oC and frying time of 40 minutes to 60 minutes with an input capacity per process of 2 kg. The results of the preliminary study were further developed at various levels of residence time so that the best temperature and frying time obtained from this preliminary study subjectively from the observation of the color and crispness of apple chips are temperatures of 50, 55, and 60oC with time for 40, 50, and 60 minutes.

Data Retrieval Technique

This study uses direct observation using data collection methods by making direct observations on the tested Vacuum Frying Machine and recording the results of the observations. The best frying temperature and time result from an organoleptic test with a weighting test. Level of preference for apple chip products, using an organoleptic test. Fifteen panelists were asked for their opinion on the level of discretion with four quality parameters, namely aroma, taste, crispness, and color. Ten panelists were asked to rank each parameter according to its importance. The organoleptic test form can be seen below:

Table 2. Organoleptic Test Form

Name :				
Test Date :				
Instruction : State your assessment by writing your favorite score (1-7) in the following column in which the ordering is 7 (really like), 6 (like), 5 (rather like), 4 (neutral), 3 (slightly disliked), 2 (disliked), and 1 (very disliked).				
Sample	Color	Taste	Crunchiness	Aroma
A1B1				
A1B2				
A1B3				



A2B1				
A2B2				
A2B3				
A3B1				
A3B2				
A3B3				
Information :				
A = Frying Temperature (°C)		B = Frying Time (minute)		
A1 = Temperature 50°C		B1 = Time 40 minutes		
A2 = Temperature 55°C		B2 = Time 50 minutes		
A3 = Temperature 60°C		B3 = Time 60 minutes		

Table 3. Organoleptic Test Form of Importance

Name :				
Test Date :				
Instruction :				
State your assessment by writing your favorite score (1-4) in the following column in which the ordering is 4 = very important, 3 = important, 2 = moderately important, and 1 = not important.				
Sample	Color	Taste	Crunchiness	Aroma
A1B1				
A1B2				
A1B3				
A2B1				
A2B2				
A2B3				
A3B1				
A3B2				
A3B3				
Information :				
A = Frying Temperature (°C)		B = Frying Time (minute)		
A1 = Temperature 50°C		B1 = Time 40 minutes		
A2 = Temperature 55°C		B2 = Time 50 minutes		
A3 = Temperature 60°C		B3 = Time 60 minutes		

RESULTS AND DISCUSSION

This research was conducted to determine the effect of temperature and frying time on quality and organoleptic parameters and to determine the optimal frying temperature and time seen from the weighting test.

Hedonic test (preference) using an organoleptic test involves the assessment of several panelists about the properties of the product. In this test, the panelists gave responses about liking or disliking chips. This test uses a score with seven favorite scales, namely 1 (dislike very much), 2 (dislike), 3 (somewhat not), 4 (neutral), 5 (somewhat like), 6 (like), and 7 (very much like).

The parameters tested organoleptically from these apple chips were a taste, color, aroma, and crunchiness. The following is a data table and graph of the organoleptic test on apple chips is:

- a. Taste of apple chips
- b. Crispiness of apple chips
- c. Aroma of apple chips
- d. Color of apple chips
- e. Level of importance of apple chips

Table 3. Organoleptic Data on the Taste of Apple Chips

Panelists	50 minutes			55 minutes			60 minutes		
	40°C	50°C	60°C	40°C	50°C	60°C	40°C	50°C	60°C
	A1B1	A1B2	A1B3	A2B1	A2B2	A2B3	A3B1	A3B2	A3B3
1	3	3	3	5	7	4	5	6	7
2	3	5	5	4	7	6	6	7	6
3	5	6	5	6	6	7	6	7	7
4	4	4	3	7	7	6	7	5	7
5	6	4	5	4	6	6	4	7	7
6	2	5	2	6	6	5	7	5	6
7	5	6	3	5	5	6	3	7	7
8	2	3	4	3	5	6	5	7	6
9	3	6	4	6	6	6	4	6	7
10	3	3	2	4	5	4	5	6	6
11	4	3	4	5	6	5	5	6	7
12	3	5	6	4	4	7	5	7	7
13	5	5	4	5	6	4	6	5	7
14	4	3	6	4	5	6	4	7	7
15	4	4	5	7	7	6	7	6	6
Total	56	65	61	75	88	84	79	94	100
Average	3.73	4.33	4.07	5.00	5.87	5.60	5.27	6.27	6.67

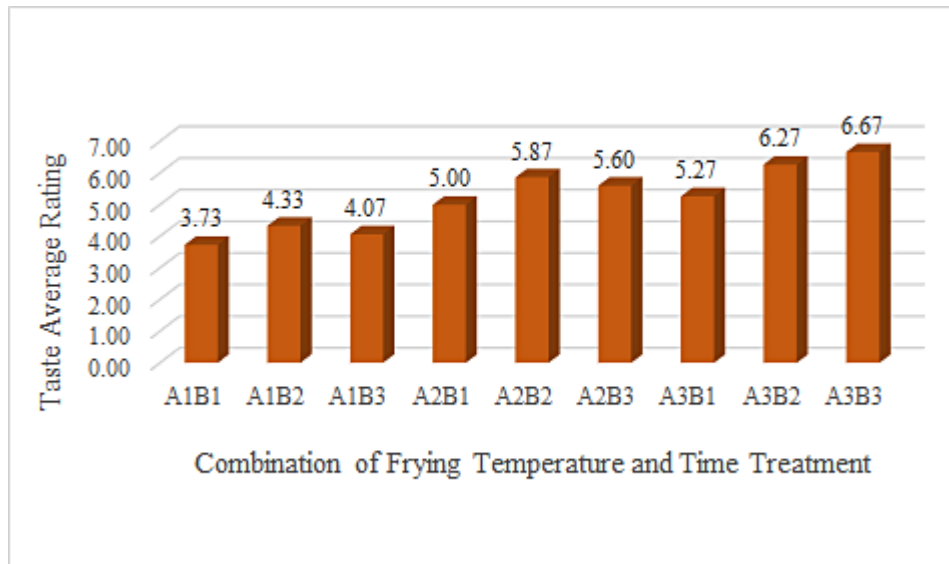


Figure 2. Graph of the Influence of Temperature and Frying Time on the Reception of Apple Chips Flavor

Table 4. Organoleptic Data on The Crispiness of Apple Chips

Panelists	50 minutes			55 minutes			60 minutes		
	40°C	50°C	60°C	40°C	50°C	60°C	40°C	50°C	60°C
	A1B1	A1B2	A1B3	A2B1	A2B2	A2B3	A3B1	A3B2	A3B3
1	3	5	4	5	5	7	7	7	6
2	4	3	5	5	7	6	6	7	7
3	5	6	5	6	5	7	4	7	7
4	4	4	6	6	6	7	6	7	7
5	6	5	5	6	6	6	6	6	7
6	3	4	5	5	6	6	5	7	7
7	4	4	5	6	5	6	4	6	6
8	4	3	5	4	5	7	4	6	7
9	4	4	5	5	7	6	6	6	7
10	5	5	6	4	5	7	7	6	6
11	4	3	4	6	5	5	7	7	7
12	4	6	7	4	5	7	5	7	6
13	4	5	5	4	5	6	5	6	7
14	4	3	5	5	6	6	6	7	6
15	3	5	6	6	6	7	4	6	7
Total	61	65	78	77	84	96	82	98	100
Average	4,07	4,33	5,20	5,13	5,60	6,40	5,47	6,53	6,67

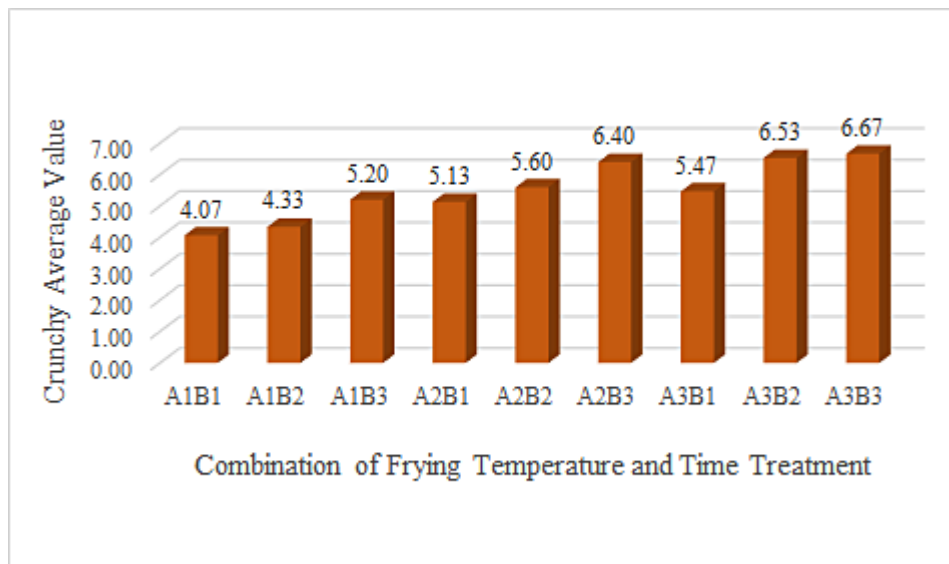


Figure 3. Graph of the Influence of Temperature and Frying Time on the Acceptance of Apple Chips Crunchiness

Table 5. Organoleptic Data on The Aroma of Apple Chips

Panelists	50 minutes			55 minutes			60 minutes		
	40°C	50°C	60°C	40°C	50°C	60°C	40°C	50°C	60°C
	A1B1	A1B2	A1B3	A2B1	A2B2	A2B3	A3B1	A3B2	A3B3
1	2	3	6	6	6	6	6	7	7
2	5	5	6	4	6	6	6	6	6
3	5	4	7	5	4	6	5	6	6
4	4	3	5	5	6	5	6	6	7
5	6	5	6	5	4	5	7	6	7
6	3	5	6	5	5	7	6	5	7
7	3	4	6	3	5	6	7	6	7
8	4	4	5	4	6	7	7	7	7
9	5	6	6	4	4	6	6	6	7
10	6	7	7	3	5	4	7	7	7
11	2	4	6	4	5	6	6	6	7
12	4	6	6	5	5	5	5	6	7
13	4	6	5	4	5	6	7	6	7
14	3	3	5	5	7	6	5	7	6
15	3	5	6	6	5	7	5	6	7
Total	59	70	88	68	78	88	91	93	102
Average	3,93	4,67	5,87	4,53	5,20	5,87	6,07	6,20	6,80

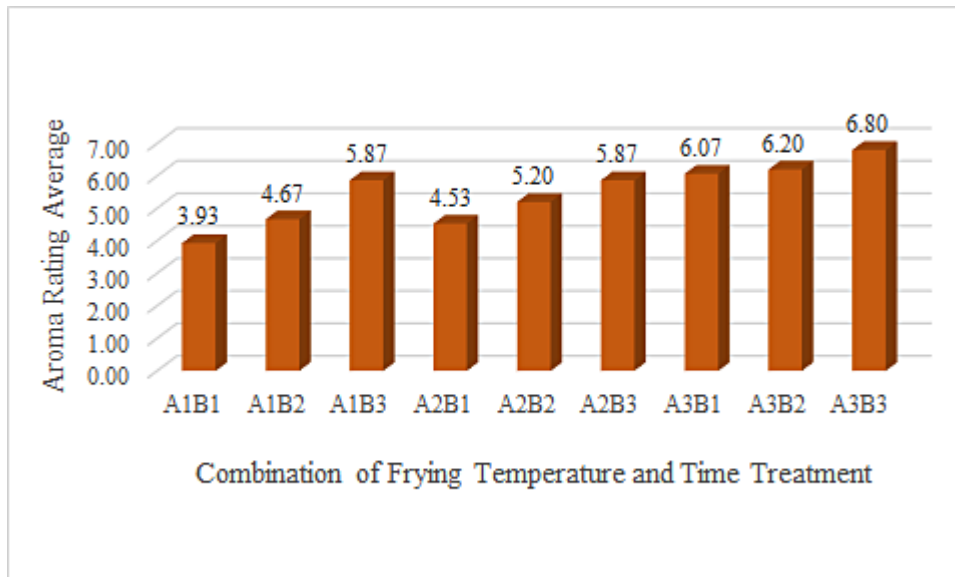


Figure 4. Graph of the Influence of Temperature and Frying Time on Reception of Kepok Apple Chips Aroma

Table 6. Organoleptic Data on The Color of Apple Chips

Panelists	50 minutes			55 minutes			60 minutes		
	40°C	50°C	60°C	40°C	50°C	60°C	40°C	50°C	60°C
	A1B1	A1B2	A1B3	A2B1	A2B2	A2B3	A3B1	A3B2	A3B3
1	4	7	4	5	5	5	5	6	5
2	4	4	6	5	6	5	6	6	5
3	6	6	7	5	7	7	7	6	6
4	5	5	5	5	6	6	6	5	5
5	7	5	7	3	6	5	5	4	5
6	4	7	6	6	6	7	6	6	7
7	2	3	6	3	3	5	4	6	5
8	4	6	7	6	6	7	5	5	5
9	4	5	6	6	6	6	4	5	5
10	6	6	5	5	6	5	5	7	6
11	6	5	4	6	5	6	4	7	4
12	5	4	6	6	7	5	5	4	6
13	6	5	4	6	6	6	6	6	7
14	5	6	6	6	6	6	6	6	6
15	7	6	5	6	6	5	5	5	6
Total	75	80	84	79	87	86	79	84	83
Average	5,00	5,33	5,60	5,27	5,80	5,73	5,27	5,60	5,53

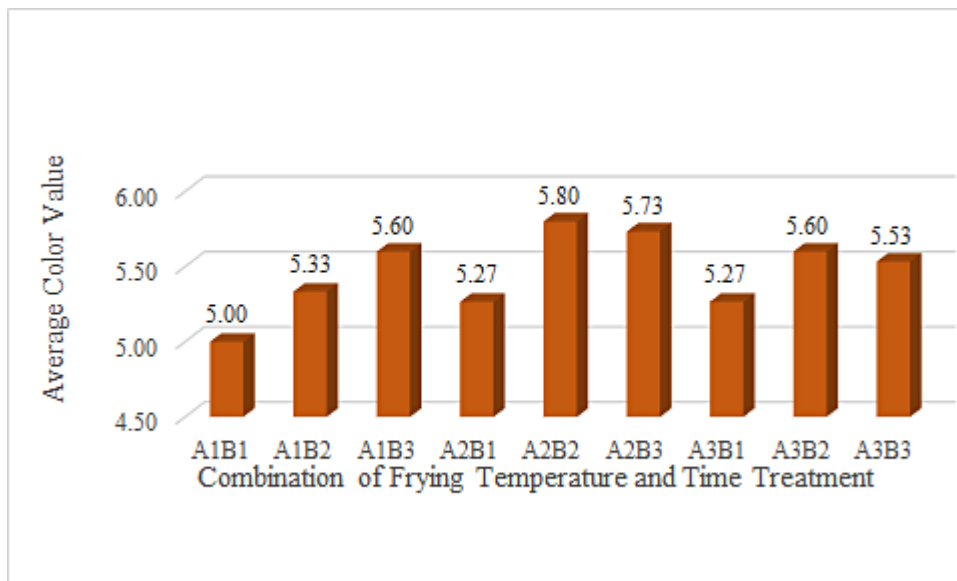


Figure 5. Graph of the Influence of Temperature and Frying Time on the Color Acceptance of Apple Chips

Table 7. The Test Results of The Level of Importance of Apple Chips

Panelists	Taste	Crunchy	Aroma	Color
1	4	4	3	2
2	3	4	2	1
3	3	3	2	3
4	4	3	1	1
5	4	3	3	2
6	3	4	3	2
7	3	4	2	2
8	4	4	1	2
9	4	3	2	2
10	3	4	2	1
11	3	3	3	1
12	3	4	2	1
13	3	4	3	2
14	4	3	3	2
15	3	3	1	1
Total	50	53	33	25
Average	3,33	3,53	2,20	1,67
Weight (%)	33,3	35,3	22,00	16,7

Organoleptic test in this study used 15 panelists with 4 quality parameters, namely aroma, taste, crunchiness, and color. It can be seen in Figure 2 that the product with the highest panelist acceptance for taste was found in the 60°C treatment for 60 minutes while the lowest was found in the product with a temperature treatment

of 50°C for 40 minutes. The higher the frying temperature and time, the higher the panelists assessment for the taste of the chips. Aromatherapy parameters, the highest value is also found in products with frying treatment at 60°C for 60 minutes, and the lowest is in products with frying treatment at 50°C for 40 minutes. As for the color,

it can be seen in the graph that the values for all treatments are not much different, and for crispness, the highest value is found in products with frying treatment at 60°C for 60 minutes. While the lowest was found in the treatment with a temperature of 50°C for 40 minutes. When viewed from the graph, the higher the frying temperature and time, the higher the panelist's assessment of crispness. This corresponds to the water content value. Where the lower the water content, the panelists like the product more. This means that the lower the water content, the crunchier the product is and the more space the oil will fill. Meanwhile, the panelists prefer the crispiness of the products with the frying time for 60 minutes. Likewise, the crispness value for all products with frying treatment for 60 minutes is almost not much different.

CONCLUSIONS

The conclusions are as follows:

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