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EFFECT OF FRYING TEMPERATURE OF SWEET POTATO CHIPS ON VACUUM FRYING TYPE VACUUM PUMP

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Abstract

Food processing with cooking needs a special way to keep the content of the nutrition of the food. This research aimed to test the temperature Frying of sweet potato chips in vacuum frying (vacuum pump type). Therefore, research had been conducted using factorial randomized block design with one factor, i.e., frying temperature (75 °C, 85 °C, and 95 °C). Parameters observed were loss of oil, water content, and organoleptic values. The results showed that temperature significantly affected the loss of oil, water content, and organoleptic value. The best result was found in the frying temperature of 95 °C.

Keywords: chips, sweet potatoes, temperature, vacuum frying

1 Introduction

Indonesia is a country rich in natural products because it is supported by arable land. Various plants thrive, both cultivated and grown wild. Because agricultural products are very abundant, especially in the high season, agricultural products will experience an unnatural decline in prices, requiring farmers to sell their agricultural products at low prices (Arifin, 2013; Hansen, 2019; Suharjo, Ahmady, & Ahmady, 2013). Besides, agricultural products have physical properties that are perishable (Ahumada & Villalobos, 2011; de Keizer et al., 2017; Du, Leung, Zhang, & Lai, 2013), voluminous (require a large space or space) (Stjepanovic, Popovic, Bosnjak, & Zoric, 1988), and bulk (take up a lot of space, making it difficult to move because of their weight and nature physically a bit stiff) (Bin & Jun, 2008; Jun & Bin, 2009; Krokida, Karathanos, & Maroulis, 1998).

One of the agricultural products that have this characteristic is purple sweet potato (*Ipomoea Batatas* L) (Diamante & Munro, 1993). Purple sweet potatoes are large and heavy, so they need a large enough space for storage and transportation. Therefore, many home industries carry out the processing of sweet potatoes instead of selling them in the raw form (Stathers, Bechoff, Sindi, Low, & Ndyetabula, 2013) both in Indonesia (Aeni, Rifin, & Tinaprilla, 2017; Fauziyah, Maflahah, & Hidayati, 2017; Hutahayan, 2019) and abroad (Lingohr, 2007; Nwaru, Okoye, & Ndukwu, 2011; Odebode, Egeonu, & Akoroda, 2008).

Sweet potatoes contain important substances, such as carbohydrates, protein, fat, calcium, phosphorus, vitamins, and other mineral substances (Mu, Tan, & Xue, 2009; Purcell, Swaisgood, & Pope, 1972). Among these substances, some are easily damaged, such as vitamins. Therefore, to keep the contents from being lost, certain processing techniques are needed (Diamante & Munro, 1993). Several stages of processing agricultural materials that are often carried out are removing unwanted outer layers (peeling), cutting, grating, division and softening, squeezing, emulsification, fermentation, cooking (boiling, frying, steaming, roasting), spray drying, pasteurization, and packing.

The use of conventional frying techniques at a temperature range of 160-180 °C for agricultural products such as vegetables and fruit will lower quality (Chiang et al., 2011). Frying at high temperatures will impact the color change of the product (browning reactions) so that conventional fried vegetables and fruits will lose most of the vitamins they contain (Da Silva & Moreira, 2008; Keikotlhaile, Spanoghe, & Steurbaut, 2010; Setyawan, Sugiyarto, & Susilowati, 2013). To keep the color and vitamin content attractive, it is best if fruits and vegetables are fried at a lower temperature. One technique that can be used is to reduce air pressure. The frying temperature can occur in the range 82-85 °C when the air pressure is at 66 mmHg (Dueik, Robert, & Bouchon, 2010; Garayo & Moreira, 2002; Yagua & Moreira, 2011).

Sweet potato is a popular agricultural product in Indonesia. Various kinds of food can be made from these ingredients. Food that is no less interesting than sweet potatoes is in the form of chips. We often encounter cassava chips, but the

low-temperature frying method's sweet potato chips are still scarce. In fact, chips with low-temperature frying can contain more vitamin A.

At the time of processing by cooking, cooking techniques are required to maintain the food ingredients' content so that they are not completely lost when cooked. For example, when frying, using high temperatures will remove most of the ingredients' vitamins. Therefore, frying temperatures not exceeding 100 °C should be combined under vacuum. This is following the research report of Yang, Wu, and Cheng (2011), who stated that the fruit's damage occurred due to physical treatment. For example, because of cooling (chilling injury). It can also be due to the heating process (case hardening), which damages the use of high temperatures in the processing process. Therefore, this paper aims to examine the effect of frying temperature on several cassava chips' properties using a vacuum frying pump type.

2 Methodology

2.1 Research Materials

The materials used in this study were sweet potatoes, cooking oil, water, and fuel in the form of gas. The tools used include vacuum frying type vacuum pump, knife, bucket, scale, stove, spinner, thermometer, barometer, stopwatch, stationery, and camera as documentation tools. This study used a non-factorial completely randomized design method with three frying temperature treatments, namely at (T1) 75 °C, (T2) 85 °C, and (T3) 95 °C. The design model is presented in Equation 1 (Crosa et al., 2014; Ikegwu, Okorie, Odo, & Nwobi, 2018; Sothornvit, 2011).

$$Y_{ik} = \mu + T_i + \varepsilon_{ik} \quad (1)$$

Where Y_{ik}-the results of observations from the temperature treatment at level-i and at repetition-k, μ-mean data, T_i-the effect of i-treatment, ε_{ik}-effect of experimental error from temperature treatment at stage-i and repetition-k.

2.2 Research Parameters

Oil loss is the difference in the weight of chips before and after draining (Dueik et al., 2010). Losing oil is obtained by weighing the chips that have been fried before being drained and drained using a draining machine. The percentage of oil loss can be calculated using Equation 2.

$$O_l = \frac{W_{OB} - W_{OA}}{W_{OB}} \times 100\% \quad (2)$$

Where O_l-oil losses, W_{OB}- weight of chips before draining with a spinner (g), W_{OA}- weight of chips after draining with a spinner (g).

The moisture content of the material shows the amount of water content per unit weight of the material. The moisture content was calculated using 5 grams of each treatment in aluminum foil with a known empty weight. Then they were dried in an oven at 105 °C for 4 hours or until their weight was constant (Yagua & Moreira, 2011). Then leave it until the temperature is the same as the ambient temperature and after that, do the final weighing. The moisture content is then calculated using the formula Equation 3.

$$M_C = \frac{W_i - W_A}{W_i} \times 100\% \quad (3)$$

Where M_C-moisture content (%, w.b.), W_i-initial weight (g), W_A-weight after drying.

According to Basuny, Arafat, and Ahmed (2012), this organoleptic test is usually performed on chips, including taste, crunchiness, and color. This test was carried out using a panel of 10 people. One panelist conducted an organoleptic test for all samples where, after completing the test on one sample, the panelist drank water to neutralize the taste. Then proceed with the next panelists. The test is carried out by sensory organoleptic, which is determined based on a numerical scale.

Table 1. Organoleptic value for overall acceptance

Overall acceptance hedonic scale	Hedonic crispness scale	Score
Liked extremely	Very crunchy	4
Liked	Crunchy	3
Intermediate liked	Little crunchy	2
Disliked extremely	Hard	1

3 Results and Discussion

In general, temperature treatment affects the loss of cooking oil and moisture content. It affects the organoleptic values, namely taste, crunchiness, and overall acceptance of the potato chips' quality. This can be seen in Table 2. It can be seen that the highest loss of cooking oil was found in T1 treatment, while the lowest was in T3 treatment. Meanwhile, the highest water content was found in the T1 treatment, and the lowest was in the T3 treatment. The highest taste organoleptic value was found in T3 treatment, and the lowest was in T1 treatment. The highest organoleptic crispness value was in T3 treatment, and the lowest was in T1 treatment. The highest overall acceptance organoleptic value was found in T3 treatment, and the lowest was in T1 treatment. This is in line with the results of research Su, Zhang, and Zhang (2016), who studied the effect of low temperature on the microwave-assisted vacuum frying of potato chips.

Table 2. Effect of frying temperature on observed parameters

Treatment (°C)	Losing Cooking Oil (g)	Moisture content (%)	Organoleptic Test		
			Taste	Crunchy	Overall acceptance
T1	106.67	55.26	1.37 (intermediate liked)	1.03 (intermediate liked)	1.30 (intermediate liked)
T2	45.00	9.74	1.47 (intermediate liked)	1.40 (intermediate liked)	2.00 (Liked)
T3	20.00	3.60	3.33 (liked extremely)	3.07 (liked extremely)	3.37 (liked extremely)

3.1 Loss of Frying Oil

From Table 3, it can be seen that temperature treatment has a very significant effect on oil loss in vacuum frying. The test results using the Least

Significant Range (LSR) analysis showed the effect of temperature on oil loss in vacuum frying for each treatment. Table 3 shows that the highest oil loss in vacuum frying was obtained in the T1 treatment, which was 106.67 g, and the lowest was in the T3 treatment, namely 20.00 g. The T1 and T2 treatments had a very significant effect on T3 treatments. This is in line with the research results by Dueik et al. (2010), who reported on the effect of using vacuum frying to reduce oil absorption in fried products.

Table 3. Effect of temperature on oil loss (gr)

Range	LSR		Treatment	Mean	Notation	
	0.05	0.01			0.05	0.01
-	-	-	T3	20.00	a	A
2	39.25	59.45	T2	45.00	a	A
3	40.61	62.51	T1	106.67	b	B

Note: different notations in the same column indicate that the treatment has a significantly different effect at the 5% level and very significant at the 1% level.

The relationship between frying temperature and oil loss in vacuum frying is presented in Figure 1. This shows that the greater the frying temperature, the less oil loss occurs (vice versa). The relationship between frying temperature, which causes oil loss has a powerful correlation equal to 0.9437.

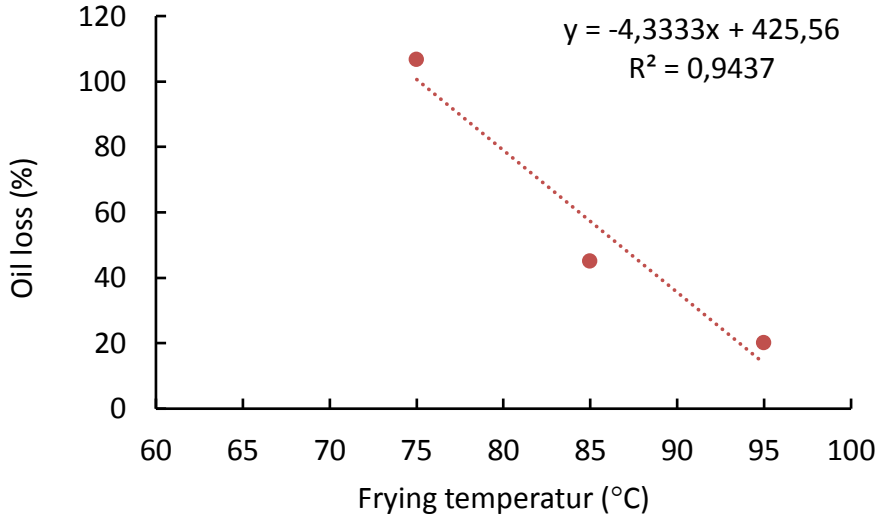

Figure 1. The relationship between frying temperature and oil loss

3.2 Moisture Content

The results of variance in Table 4 can be seen that the frying temperature treatment has a very significant effect on water content. The test results using the Least Significant Range (LSR) analysis showed the effect of temperature on each treatment's moisture content. Table 4 shows that the highest moisture content was obtained in the T1 treatment, which was 55.26%, and the lowest was in the T3 treatment, which was 3.60%. The T1 treatment had a very significant effect on all treatments. This is in line with the research results by Diamante, Savage, and Vanhanen (2012), who reported the results of research using response surface methodology to optimize vacuum frying on gold kiwifruit slices product one of the parameters is moisture content.

Table 4. Effect of temperature on moisture content (%)

Range	LSR		Treatment	Mean	Notation	
	0.05	0.01			0.05	0.05
-	-	-	T3	3.60	a	A
2	1.981	3.001	T2	9.74	b	B
3	2.050	3.155	T1	55.26	c	C

Note: different notations in the same column indicate that the treatment has a significantly different effect at the 5% level and very significant at the 1% level.

The relationship between frying temperature and water content can be presented in Figure 4. This shows that the higher the frying temperature, the lower the water content. This is because the higher the temperature, the lower the sweet potato chips' water content. The relationship between frying temperature and moisture content of the chips has a robust correlation equal to 0.8377.

3.3 Organoleptic Test

The results of variance in Table 5 can be seen that the frying temperature treatment has no significant effect on the taste, so that the Least Significant Range (LSR) test is not continued. This indicates that the frying temperature being tested does not affect the taste of the chips produced. This is following the research results of Belkova et al. (2018), who studied the Impact of vacuum frying on the

quality of potato crisps and frying oil. One of the parameters is the sensory characteristics of the product produced.

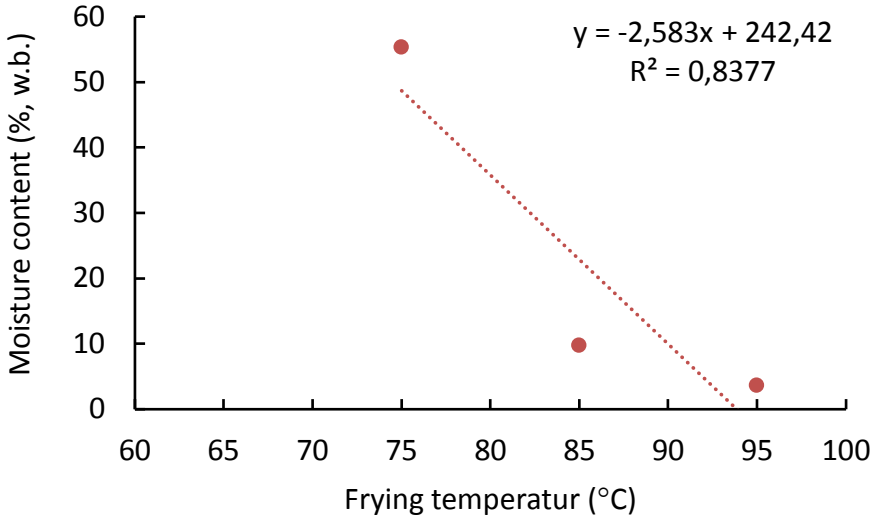

Figure 2. The relationship between frying temperature and moisture content

Table 5. Analysis of variance in taste organoleptic values

Source	**Df**	**Mean Square**	**F**	**$F_{table0.05}$**	**$F_{table0.01}$**
Treatment	2	0.527	0.182	5.143 ^{ns}	10.924 ^{ns}
Error	6	8.673			
Total	8	9.200			

Note: ns-not significant

The relationship between frying temperature and flavor organoleptic value can be seen in Figure 3. This shows that the higher the frying temperature, the greater the organoleptic value of the taste of the chips produced. This is due to the higher the temperature, the lower the water content in the sweet potato chips, the chips to be preferred by panelists. This is in line with the SNI for the quality of sweet potato chips, which states that the chips' water content should be a maximum of 5% (w.b.).

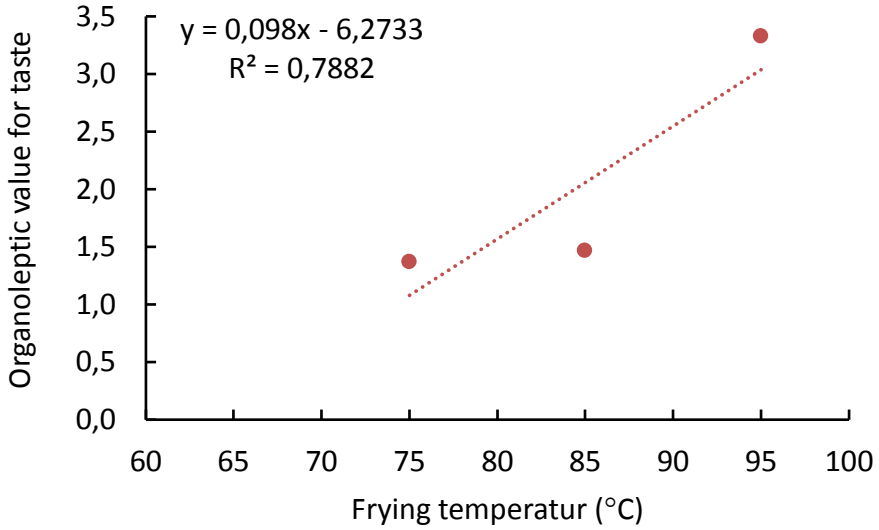

Figure 3. The relationship between frying temperature and taste

The results of variance in Table 6 can be seen that temperature treatment has a very significant effect on crispness. The test results using the Least Significant Range (LSR) analysis showed the effect of temperature on each treatment's crispness. Table 6 shows that the highest organoleptic crispness value was obtained in T3 treatment, namely 3.07 (very crunchy), and the lowest in T1 treatment, namely 1.03 (Little crunchy). The T1 and T2 treatments had a very significant effect on T3 treatments. This result is in line with the research of Su et al. (2016), who reported the effect of low temperature on the microwave-assisted vacuum frying of potato chips on their crispiness.

Table 6. Effect of temperature on the organoleptic value of crispness

Range	LSR		Treatment	Mean	Notation	
	0.05	0.01			0.05	0.05
-	-	-	T1	1.03	a	A
2	0.618	0.937	T2	1.40	a	A
3	0.640	0.985	T3	3.07	b	B

Note: different notations in the same column indicate that the treatment has a significantly different effect at the 5% level and very significant at the 1% level.

The relationship between frying temperature and crispness can be seen in Figure 4. This shows that the higher the frying temperature, the greater the

organoleptic value of the crispiness. This is because of the higher the temperature, the lower the water content in the sweet potato chips, which causes the chips to get crunchier. This follows the SNI for sweet potato chips' quality, which states that the sweet potato chips' moisture content is a maximum of 5% (w.b.).

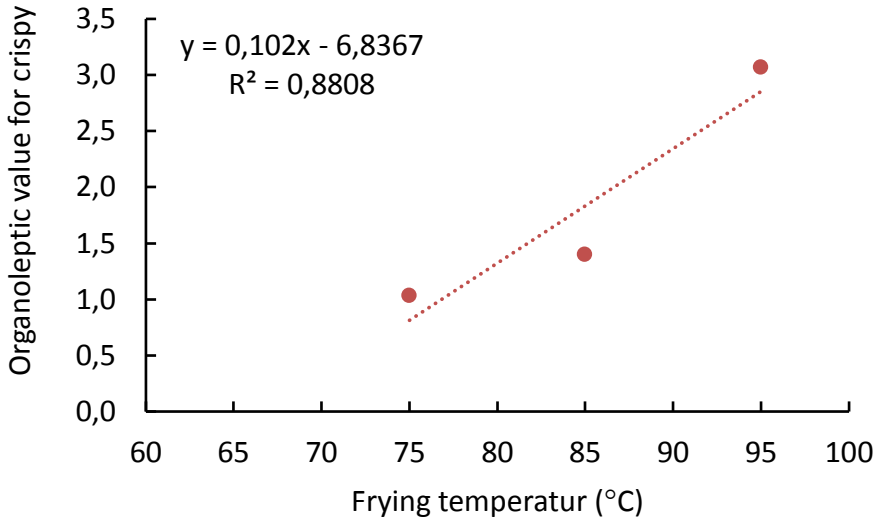

Figure 4. The relationship between frying temperature and crispness

The results of variance in Table 7 can be seen that the temperature treatment has a very significant effect on the overall acceptance organoleptic value. The test results using the Least Significant Range (LSR) analysis showed the effect of temperature on each treatment's overall acceptance organoleptic value. Table 7 shows that the highest overall acceptance organoleptic value was obtained in the T3 treatment, which was 3.37 (liked extremely), and the lowest was in the T1 treatment, which was 1.03 (intermediate liked). The T1 and T2 treatments had a very significant effect on T3 treatments.

The relationship between frying temperature and organoleptic test for overall acceptance is presented in Figure 5. This shows that the higher the frying temperature, the greater the overall organoleptic value of acceptance. This is because the overall acceptance organoleptic value is determined by several panelists, where the possibility of sensory assessment for each panelist is

different. This is in line with the results of Basuny et al. (2012), who reported that if the quality of food ingredients, including fruit, were measured through the ability of the human sense organs directly, the assessment would directly be organoleptic. This assessment, which is also called sensory evaluations, is subjective in nature. The parameters assessed include appearance, flavor, and texture.

Table 7. Effect of temperature on the overall acceptance organoleptic value

Range	LSR		Treatment	Mean	Notation	
	0.05	0.01			0.05	0.05
-	-	-	T1	1.30	a	A
2	0.873	0.903	T2	2.00	a	A
3	1.322	1.390	T3	3.37	b	B

Note: different notations in the same column indicate that the treatment has a significantly different effect at the 5% level and very significant at the 1% level.

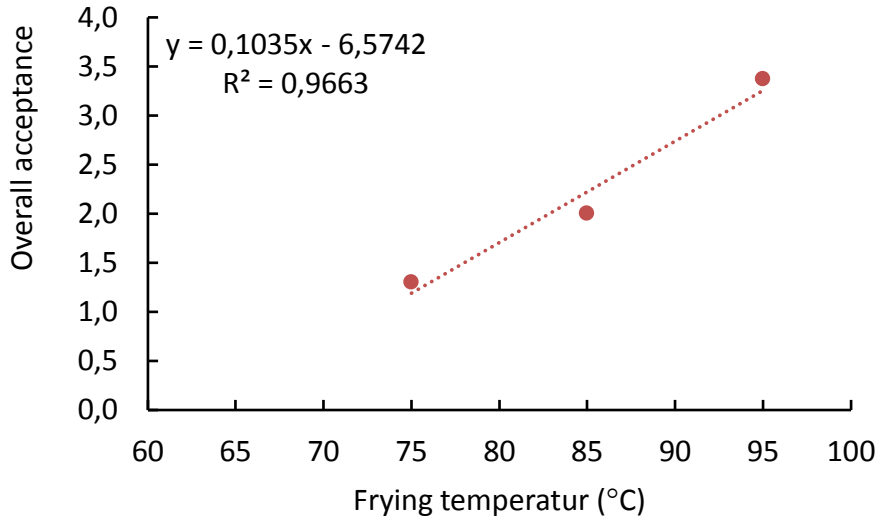

Figure 5. The relationship between frying temperature and overall acceptance distillation

4 Conclusion

The temperature difference has a significant effect on the loss of cooking oil and water content to affect the organoleptic value, namely crunchiness and overall acceptance. The highest loss of cooking oil was obtained in T1 treatment,

namely 106.67 g, and the lowest in T3 treatment, namely 20 grams. The highest water content was obtained in the T1 treatment, namely 55.26%, and the lowest in the T3 treatment, namely 3.60%. The highest organoleptic value for crispiness was obtained in T3 treatment, namely 3.07 (very crunchy), and the lowest in T1 treatment, namely 1.03 (hard). The overall acceptance organoleptic value obtained in the T3 treatment was 3.37 (liked extremely), and the lowest was in the T1 treatment, which was 1.03 (intermediate liked).

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