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THE EFFECT OF BAKING TIME ON PHYSICOCHEMICAL AND SENSORY CHARACTERISTICS OF CRUNCHY POTATO DONUT PRODUCTS PROCESSED FROM POTATO DONUT WASTE

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ABSTRACT: *Donuts are one of the most popular food products in the Horeka industry. One of the donut variants sold in the market is potato donuts, which is a donut made from potato tuber substitution. The weakness of this product is that it has a short shelf life, so if it is not sold it will become industrial waste. One way of handling food processing industrial waste that can still be utilized is by reprocessing it into products of economic value. This study aims to examine the effect of baking time on the physicochemical and sensory characteristics of crunchy potato donut snacks produced from potato donut industry waste. The treatments used in this study were differences in baking time, namely P1 (2 minutes), P2 (4 minutes), and P3 (6 minutes). The results showed that the baking time significantly affected the crispness, color, protein content, carbohydrate content, fat content, ash content, moisture content, and dietary fiber as well as hedonic testing which included color, aroma, taste, texture, and overall. The optimum baking time that can produce a product with good and acceptable quality is 4 minutes (P2).*

Keywords: *Crunchy potato donuts, snack product, baking time, food waste*

INTRODUCTION

Food waste is the largest contributor to waste. According to the 2017/2018 National Waste Management Information System (SIPSN) data, food waste contributed 46.75% of the total waste in Indonesia (Muliawati, 2021). In addition to the household sector, the Horeka industrial sector (hotels, restaurants, and cafes) is one of the industrial sectors that contribute food waste in large quantities. Products that are not sold will become waste, and generally, the type of food produced by this industrial sector is food that has a relatively short shelf life or expiration date. Therefore, in order not to become a big problem, the Horeka industrial waste needs to be handled seriously. One way of handling food and beverage processing industrial waste that can still be utilized is by reprocessing it into products that have economic value.

One of the food products in the Horeka industry is donuts. Donuts are one of the most popular pastry products. Generally, this product is made from wheat flour. Currently, donuts are not only made from wheat flour but can also be made from other materials such as tubers. One of the donut variants that are widely sold in the market is potato donuts, which are donuts made by substituting part of wheat flour with potato tubers.

Besides being rich in carbohydrates, potatoes also contain other nutrients needed by the body, such as protein, fat, vitamins (A and B), minerals (potassium, phosphorus, iron), and dietary fiber (Mudawamah, 2012; Azmi *et al*., 2015). In addition, Fajiarningsih (2013) also reported that the potassium or potassium content in potatoes is quite high, namely 396 mg/100g, so it is good for consumption for people with hypertension because potassium can help lower blood pressure.

Some cafes, convenience stores, or the franchises industry make potato donuts as their flagship product. However, often the donuts produced are not sold out. Donuts that are not sold out will be thrown away and become waste. This is because donuts have a short shelf life or expiration date. Therefore, one way that can be done to reduce donut waste in the Horeka industry is to reprocess the unsold donuts into products that have economic value and are useful. One of them is a snack of crunchy potato donuts.

One of the factors that affect the quality of crunchy potato donuts is the baking process, namely the temperature and baking time. According to Muchtadi and Muchtadi (2013); Meilita (2019), baking temperature and time can affect the physicochemical characteristics and palatability of the resulting product. Based on this description, the purpose of this study was to examine the effect of baking time on the physicochemical and sensory characteristics of the crunchy potato donut snack product produced from potato donut industrial waste.

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METHODOLOGY

Materials

In this study, the major material used was potato donuts that had been left at room temperature for 24 hours. After letting it left, the potato donuts are cut horizontally with a thickness of 0.5 to 0.7 cm each. then the baking process was carried out using an oven (Memmert UF 260, Germany) at a temperature of 160°C. The treatment in this study was the baking time with a combination of P1 (2 minutes), P2 (4 minutes), P3 (6 minutes). While the chemical reagents used for analysis include: HCl, HCl indicator, litmus paper, boric acid, NaOH, concentrated H2SO4, and N-hexane obtained from PT. Merck Tbk, Indonesia and Sigma Aldrich. The instruments used are colorimeter (Portable Colorimeter 3nh NH310, China), texture analyzer (Shimadzu EZ-SX, Japan), electric furnace (Nabertherm B 180, Germany), analytical balance (OHAUS PA114, USA), etc.

Crispness (texture) and color determination

Texture analysis was performed using a texture analyzer, using a single probe. The speed of the probe of 1 mm/s, and has a sensitivity of 10%. While the color analysis was carried out using a colorimeter. The parameters observed in the color analysis were the values of L* (brightness), a* (red-green chromatic), b* (yellow-blue chromatic), and h* (hue).

Proximate and total dietary fiber determination

Proximate analysis was carried out using the AOAC (2005) method on water, protein, fat, and ash content. Protein analysis was carried out using the Kjeldahl method, fat content using the Soxhlet method, ash content using the ashing method using a furnace, moisture content using an oven at 105°C. the calculation of carbohydrate content was carried out using the by difference method. While the analysis of dietary fiber was carried out using the enzymatic method.

Sensory analysis

Sensory analysis was performed using a hedonic test on 31 untrained panelists. The parameters observed in the sensory analysis were color, aroma, taste, texture, and overall using a scale of 1-9, where a score of 1 is very disliked until 9 for very much like.

Data analysis

Data analysis was carried out using ANOVA (Analysis of Variance Test) with SPSS program version 25.0 and continued with Duncan Multiple Range Test (DMRT) with 95% confidence level ($\alpha = 0.05$).

RESULT AND DISCUSSION

The effect of baking on crispness (texture)

The crispness of the product is one of the important parameters of food products that show resistance to breaking due to the applied compressive force (Istinganah *et al.*, 2017). The results of the crispness analysis on crunchy potato donut snack products are presented in table 1.

Table 1. The crispness (texture) of crunchy potato donut snack products

Sample	Hardness force calc. at entire areas (N/mm^2)
P1	21.22 ± 0.88^{c}
P2	13.63 ± 0.81^{b}
P3	10.31 ± 0.46^{a}

The numbers followed by letters with different lines were significantly the same based on the DMRT test ($p<0.05$).

In table 1, it can be seen that the crunchy potato donut snack product with a baking time of 2 minutes produced a product that was harder than the other treatments, or conversely a product with a baking time of 6 minutes produced a crispier product than the other treatments. According to Larmond (1976), the level of crispness is closely related to the level of ease of the product to break or crumble during the storage process. The results of the analysis of the level of crispness in this study are in line with Meilita (2019) who said that the temperature and baking time will affect the hardness of the resulting cookies. The smaller the water that evaporates due to the baking process will cause the texture to be harder because the water is still bound in the product so that it forms a texture that is not brittle. Meanwhile, the greater the evaporation of water, the more brittle the texture will be because the water that binds the bonds in the pastries evaporates, so the bonds become weak.

The Effect of baking on color

The results of color analysis using a colorimeter are presented in table 2. In the table it can be seen that the difference in baking time has a significant effect on the brightness (color) of the resulting product. Based on the results, it can be seen that the longer the baking time, the greater the value of ΔE. The baking process causes the product to undergo a non-enzymatic browning process, namely the Maillard reaction. Reactions occur between proteins and reducing sugars that are influenced by temperature, time, and humidity (Eduardo *et al.,* 2013).

Table 2. The effect of baking on color

parameters	Sample		
	P1	P2	P3
L*	70.58 ± 2.7[b]	64.12 ± 1.44[a,b]	65.04 ± 0.22[a]
a*	1.84 ± 0.93[a]	3.85 ± 0.83[b]	13.57 ± 1.23[c]
b*	19.97 ± 2.57[a]	21.31 ± 0.51[a]	33.23 ± 1.41[c]
c*	20.05 ± 2.63[a]	21.62 ± 0.37[b,c]	35.68 ± 1.75[c]
h*	92.12 ± 0.24[b]	91.61 ± 0.21[b]	89.73 ± 0.2[a]
ΔE	21.83±0.81[b]	26.44±0.93[c]	29.27±0.5[d]

The numbers followed by letters with different lines were significantly the same based on the DMRT test (p<0.05).

Proximate and total dietary fiber content

The results of the proximate analysis of crunchy potato snacks in this study are presented in table 3. Heating food causes a decrease in water content (Sundari *et al.,* 2015). The decrease of water content in products treated with the baking process is influenced by temperature and heating time. The longer the heating time and the higher the temperature, the more water molecules will be released from the product, as a result, there will be a decrease in the water content (Wulandari, 2018). In table 3 it can be seen that the longer the baking time, the lower the water content of the resulting product). The heating process causes protein denaturation, changes in solubility and hydration, breaking peptide bonds, and cross-linking. The baking process causes the protein to denature so that it forms a simpler structure and causes a decrease in protein content. It will increases with increasing baking time (Dewi, 2016).

The fat damage in the product is influenced by the length of time used during the processing process (Tapotubun *et al.*, 2008). The longer time used in the high-temperature processing, the higher the fat damage. Fats will be broken down into volatile products such as aldehydes, ketones, alcohols, acids, and hydrocarbons (Dawood *et al.*, 2015).

Table 3. Proximate and total dietary fiber content

Parameters	Sample		
	P1	P2	P3
Crude protein (%)	8.45 ± 0.15[b]	8.32 ± 0.11[a,b]	7.84 ± 0.84[a]
Karbohydrate total (%)	59.55 ± 0.007[a]	59.71 ± 0.03[a]	62.99 ± 0.07[b]
Crude fat (%)	29.1 ± 0.09[c]	25.87 ± 0.07[b]	24.72 ± 0.09[a]
Crude ash (%)	1.37 ± 0.01[a]	1.41 ± 0.01[b]	1.41 ± 0.01[b]
Water content (%bb)	5.89 ± 0.05[c]	2.1 ± 0.01[b]	1.3 ± 0.01[a]
Total dietary fiber (%)	5.15 ± 0.01[b]	4.63 ± 0.04[a]	4.62 ± 0.3[a]

The numbers followed by letters with different lines were significantly the same based on the DMRT test (p<0.05).

The Effect of baking on sensory analysis

The results of the sensory analysis of the crunchy potato donut snack products are presented in table 4. The higher score of the panelists' level of preference, the more preferred the crunchy potato donut snack product. In the table it can be seen that, the baking time affects the level of sensory acceptance of the crunchy potato donut snack product produced.

Table 4. The Effect of baking on sensory analysis of crunchy potato donut snacks

Samples	Sensory parameters				
	Color	Aroma	Taste	Texture	Overall
P1	6.32±1.376[a]	6.35±1.226[a]	6.16±1.128[a]	5.39±1.174[a]	6.26±1.032[a]
P2	7.39±0.989[b]	7.29±0.02[b]	7.16±1.003[b]	7.84±0.735[b]	7.58±0.502[b]
P3	6.87±1.118[a,b]	7.13±1.056[a,b]	7.10±1.399[b]	7.68±1.013[b]	7.58±0.720[b]

The numbers followed by letters with different lines were significantly the same based on the DMRT test ($p<0.05$).

The temperature and time of baking will affect the color of the resulting crunchy bread, too low a temperature will produce crunchy bread with a pale color, while a temperature that is too high will cause the crunchy bread to become scorched or too browned so that the color of the crunchy bread does not change. Interesting (Muchtadi and Muchtadi, 2013). The non-enzymatic browning and caramelization reactions that occur during the baking process also affect the color, aroma and taste of the resulting product (Solekah, 2019). Meanwhile, (Kasim *et al.,* 2019) stated that the longer the baking time, the greater the evaporation of water content that occurs, causing the total dissolved solids to increase and in the end will cause the product texture to be harder and denser. Overall, the panelists' acceptance of this crunchy potato donut snack product was very good (above the average value).

CONCLUSION

The conclusion of this study is that the difference in baking time affects the quality of the resulting product. From the three variations of time used in this study, it was found that the baking time that gave optimal results was baking for 4 minutes (P2).

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