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Texture, Water Absorption, a_w and Hedonic Quality Flakes White Millet (*Panicum miliaceum*) with Addition of Pumpkin Flour (*Cucurbita moschata*)

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Abstract

This research investigated the effect of pumpkin flour on texture, water absorption, a_w, and hedonic quality of white millet flakes. The research design used Completely Randomized Design with one factor of pumpkin flour concentration. White millet, sugar, salt, and pumpkin flour were used as materials. Pumpkin flour was added to the flakes' dough at a concentration of 0, 10, 20, and 30% (w/w). The results showed that the pumpkin flour provided a significant effect ($p < 0.05$) to texture, water absorption, and hedonic quality of flakes, but did not provide significant affect ($p > 0.05$) to a_w. The most optimal concentration of pumpkin flour was 10% proved by texture of 395 gf, water absorption of 95%, a_w of 0,25, and best organoleptic properties which were slightly yellow color, slightly fragrant aroma of pumpkin, a slight taste of pumpkin, and crispy texture. As conclusion, the utilization pumpkin flour to the dough may affected to the physical appearance in the flakes.

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Introduction

Flakes are a type of ready to eat breakfast cereal with low water content and crispy texture that can be consumed with the addition of milk, water, or yogurt (Susanti et al., 2017; Febrianti *et al.*, 2015). Since the its physical appearance is thin, it may easily broke, golden brown, crispy texture, and may absorb water (Winarti *et al.*, 2016).

White millet is one of the small seed cereals and usually used as bird feed, while the utilization in the field of food is still rare in documentation. This is due to the difficulty of separating the skin and millet seeds (Atmaja and Sari, 2017). White millet has potent use because of its easiness to find in commercial market (Marta *et al.*, 2016). The yellow color contained in the pumpkin can be used as a natural coloring product for flakes. The yellow color in pumpkin derived from beta-carotene as a source of pro-vitamin A, however the flour has a distinctive aroma, color, and taste (Farida et al., 2016). In pumpkin flour, the amylose content is 20-25% and the amylopectin content is 75-80% (Putri *et al.*, 2019). The high amylopectin characteristic in pumpkin flour influences the texture and structure of the flakes product. The addition of pumpkin flour to white millet flakes is expected to increase consumer appeal.

For these reasons, it is necessary to find out the characteristics of the flake produced from the pumpkin flour and may improve physical properties and hedonic quality. Since less study in pumpkin flour as food, this research may provide benefit for providing information about the use of pumpkin flour in the flakes as food diversification.

Materials and Methods

A 200-gram white millet obtained from local market of Rasamala, Banyumanik and yellow pumpkin were used in this research. Salt, sugar, water, distilled water was used as material. Texture analyzers (Brokfield CT-3, USA), pasta machines (Atlas, Italy), rice cookers (Miyako, Indonesia), ovens (Kris, Indoneisa), sieve shakers (Gilson SS-14F, USA), cabinet dryers (Memmert, Jerman), aw meters (Novasina, Swiss) and organoleptic test questionnaire were also used.

Pumpkin Flour Manufacture

Pumpkin skin and seed were removed then washed prior to sliced into 1-2 mm of thickness. The sliced pumpkin was dried using 50°C cabinet dryer for 6

hours, then crushed with a blender followed by sieving using 80 mesh sieve shaker machine (Purnamasari and Putri, 2015).

White Millet Flakes Manufacture

White millet was washed and soaked in water for 60 minutes then followed by blending prior to water addition with 1:1 ratios. The mixture was then cooked using a rice cooker until it was done about 20 minutes. Next, the cooked millet was added with 12 g sugar, 1.2 g salt, and added with a 5.34, 10.68, and 16.02 g of pumpkin flour as treatments. The dough was grounded using a roller and flattened using local manufactures hand pasta machine. The dough was then cut into rectangles prior to put into baking tray. Oven at 120°C for 20 minutes was then applied (Purnamayati *et al*., 2019).

Texture Measurement

The texture was measured using a texture analyzer as stated by previous researcher (Mariana and Yulianto, 2013).

Water Absorption Measurement

Water absorption was measured by calculation the flakes weight differences between immersion in 100 ml of water for 10 minutes and the initial weight of the flake before immersion. The result was obtained from the weight subtraction between immersion in 100 ml of water for 10 minutes and the initial weight then divided by the initial weight and then multiplied by 100% (Nurcahyono and Zubaidah, 2015).

Water Activity Measurement

Water activity(a_w) was measured using a_w meter and was done according to the method done by previous researcher (Dipowaseso *et al*., 2018).

Organoleptic Properties Test

A 25 semi-trained panelist from Food Technology Department, Faculty of Animal and Agricultural Sciences, Diponegoro University was used in this test. The organoleptic properties of flakes were tested including color, taste, aroma, texture using score 1 to 4 that represented less intensity to high intensity. Overall preference that was with a score ranged from 1 to 4 that was indicated the less to the most preferred product.

Analysis Data

Data of texture, water absorption, and water activity content was analyzed by Analysis of Variance (ANOVA) with a significance level of 5% and continued the Multiple Region Test Duncan if there were statistical differences. Data results hedonic quality were analyzed by Kruskal-Wallis nonparametric statistical method and continued with Mann-Whitney test if there were statistical differences.

Results and Discussion

Texture Analysis

The texture of white millet flakes (Table 1) showed the higher in hardness, the less in crispness due to the increase in pumpkin flour. Pumpkin flour had low protein content, hence less ability of pumpkin flour to bind water and produced high water content flakes (Ningtyas, 2018) resulting the decrease in flakes crispness. According to Purnamasari and Putri (2015), the water content of pumpkin flour also quite high at 7.55% and has hygroscopic properties.

Water Absorption

Water absorption of white millet flakes as can be seen in Table 1, showed high water content due to increase in pumpkin flour. Pumpkin flour had high crude fiber content, then crude fiber might bound water in the dough. The higher fiber content absorbed water easily resulting the water absorption with ease (Permana and Putri, 2015; Tejosaputro *et al*., 2017). The average crude fiber content of white millet flakes in all treatments ranged from 12.25 to 19.38%. This showed that the crude fiber content of white millet flakes was quite high. The crude fiber content of white millet flakes depends on the material used, which in this research used white millet and yellow pumpkin flour. Based on the analysis that has been done, pumpkin flour had crude fiber content of 4.27%, while white millet was 12.23%

Table 1. Physical properties of white millet flakes using pumpkin flour as materials

Parameters	Pumpkin Flour (%)			
	0	10	20	30
Texture hardness (gf)	255.70 ± 32.86^{a}	395.20 ± 21.46^{b}	456.60 ± 30.13^{c}	553.20 ± 57.44^{d}
Water absorption (%)	80.92 ± 20.60^{a}	95.62 ± 15.64^{ab}	106.88 ± 6.69^{b}	133.64 ± 10.32^{c}
Water activity (a_w)	0.272 ± 0.03^{a}	0.254 ± 0.02^{a}	0.238 ± 0.02^{a}	0.253 ± 0.02^{a}

Note: Results are mean±standard deviation. Different superscript letters in the same row indicates the significant differences ($p<0.05$).

Table 2. Organoleptic properties and hedonic quality of white millet flakes using pumpkin flour as materials

Hedonic Attributes	Pumpkin Flour (%)			
	0	10	20	30
Color	1.16 ± 0.37^{a}	3.08 ± 0.64^{b}	3.68 ± 0.56^{c}	3.56 ± 0.51^{c}
Aroma	1.20 ± 0.50^{a}	2.56 ± 0.87^{b}	2.72 ± 0.84^{b}	2.88 ± 0.83^{b}
Taste	1.16 ± 0.47^{a}	2.76 ± 0.83^{b}	3.08 ± 0.76^{b}	2.84 ± 0.69^{b}
Texture	3.52 ± 0.51^{a}	3.40 ± 0.65^{a}	3.08 ± 0.64^{b}	2.32 ± 0.80^{c}
Overall	2.24 ± 0.93^{a}	3.04 ± 0.98^{b}	2.96 ± 0.84^{b}	2.40 ± 0.71^{a}

Note: Results are mean ± standard deviation. Different superscript letters in the same row indicates the significant differences ($p<0.05$).

Water Activity

Water activity of white millet flakes as can be seen in Table 1, showed that pumpkin flour provided no significant effect to aw value ($p>0.05$). Low aw value in flakes was prerequisite requirement for good quality of flake due to the flakes are grouped as dry food products, thus common preparation in flakes were roasted or heated to remove water in the product. The average result of flakes water activity was 0.254, conform its requirements, and close to the results of previous studies by Oktavia (2007), which was in the range of 0.1-0.55. The research of Lindriati and Maryanto (2016) stated that the water activity of cassava with variations of koro flakes was 0.21-0.29. At water activity value 0.2-0.3 microorganisms such as fungi, bacteria, and mold were difficult to grow, fat oxidation also run very slowly, then the material tended to be more durable (Lindriati and Maryanto, 2016).

Organoleptic and Hedonic Analysis

The result of the organoleptic test of flakes on color, aroma, taste, texture, and overall quality were presented in Table 2. The higher in addition of pumpkin flour, the higher in color score. The color in flakes was appeared due to carotenoid pigment in pumpkin flour (Putri *et al*., 2019). Beta-carotene is a pigment that gives an orange color to fruits and vegetables (Trianto *et al*., 2014). The roasting process results dark color due to the carbonyl group from the reducing sugars and the amino protein reaction that may produce melanoidin, which are known as Maillard reaction generating brown compounds (Purnamasari and Putri, 2015; Cahyaningtyas *et al*., 2014).

Addition of pumpkin flour increased aroma value of the product (Table 2). Flakes produced a distinctive aroma of pumpkin flour which could bind the flavor system of food ingredients (Wulandari *et al*., 2019). Taste of white millet flakes with the addition of pumpkin flour showed a higher score than the one without the addition due to its distinctive taste. However, the distinctive taste in pumpkin flour may be reduced by heating which provided sweet taste to the flakes (Purnamasari and Putri, 2015). The addition of other ingredients such as sugar might reduce a distinctive taste due to the caramelization process during roasting (Wulandari *et al*., 2019).

The more addition in pumpkin flour decreased the crunchy texture of the flakes due to the high water content and low protein content in pumpkin flour. The water content of pumpkin flour was quite high that might produce hard and damaged easily due to fast absorption in water (Cahyaningtyas *et al*., 2014). Low levels of pumpkin flour protein caused an increase in ability to bind water (Ningtyas, 2018).

Overall, hedonic analysis showed that the best panelist preference was the addition of 10% pumpkin flour and 20% addition of pumpkin flour which showed the highest criteria, produced slight yellow color, and crunchy texture, whereas in the treatment of the addition of pumpkin flour of 20% provided yellow/golden color but less crispy texture. This preferences characteristics of flakes that was stated by previous researcher was golden color, crispy texture, low moisture content, and easy to absorb water (Winarti *et al.,* 2016).

Conclusion

The higher concentration of pumpkin flour produced the increase in the hardness and water absorption value of white millet flakes. The most optimal addition of pumpkin flour was 10% resulting desirable organoleptic properties which were slightly yellow color, slightly aroma, best taste of pumpkin, and crispy texture.

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