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Study of Physical, Chemical, and Sensory Characteristics of Modified Square Banana Flour (*Musa balbisiana*)

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Abstract

Amylose content related to the glycemic index, the higher the content of amylose the lower the glycemic index thus good for diets. Starch modification through fermentation using lactic acid bacteria can be used to increase amylose. In this experiment, modification of Square banana (*Musa balbisiana*) flour was conducted using *Lactobacillus fermentum* at certain concentration and fermentation time. This study used a Completely Randomized Factorial Designs (CRFD) with variation of fermentation time (24 hours, 48 hours, 72 hours) and concentration of bacteria starter (0.125%; 0.250%; 0.375% v/v) as the factor. Data were statistically analyzed using Two-Way ANOVA. The results showed that the variation of fermentation time and concentration of starter change physical, chemical, and sensory characteristic of the flour. Water absorption, protein content, and amylose content were increased. However whiteness index, swelling power, solubility, and moisture content were decreased. Pasting properties was change significantly after this modification process. Meanwhile, antioxidant activity and sensory characteristics did not significantly change. In conclusion, the characteristics of the modified flour offer opportunities for the development of square banana flour-based food products with high amylose which good for the diet.

Introduction

The importation of wheat flour in developing countries such as Indonesia is relatively high. One of the potential locally raw materials used for substituting the wheat is square banana. Square banana (*Musa balbisiana*) is one of wild banana since it has many seeds and diploid. Starch content of square banana is approximately 90%, amylose and protein content of square banana starch are 22.2% and 1.61% (Gutierrez, 2007). Amylose are closely related with glicemic index. The lower glycemic index related to high amylose content (Frei, 2003).

Modification of flour processing is one alternative to increase amylose and protein content. Fermentation is one modification alternatives that may change the rheological and chemical properties (Kohajdova, 2007; Ezekiel, 2010; Haydersah, 2012; Jenie, 2012; Hur, 2014). Meanwhile, the protein content of the flour could increase due to increasing biomass during lactic acid bacteria fermentation (Ezekiel, 2010).

Lactic acid bacteria fermentation have reported increase amylose and protein conternt (Haydersah, 2012; Yi, 2016). Modification method by fermentation also can change flour characteristics such as whiteness index, swelling power, solubility, water absorption, and antioxidant (Numfor, 1994; Obadina, 2013; Jayus, 2016). One of the lactic acid bacteria that can change flour characteristics and increase amylose content is *Lactobacillus fermentum* (Haydersah, 2012; Yi, 2016). In this experiments, a variation of fermentation time and starter concentration will be applied to square banana flour.

In order to identify the properties of square banana flour as an alternative of wheat flour subtitute, physics, chemical, and sensory atribute need to investigated. This study aim to understand the physics (whiteness index, swelling power, solubility, water absorption, and amylography), chemical (moisture content, protein content, and antioxidant activity), and sensory characteristics of square banana modified flour by variation of fermentation time and *Lactobacillus fermentum* starter concentration.

Materials and Methods
Material and Inoculant Preparation

Unripe square banana (*Musa balbisiana*) was obtained from Bakung, Klaten, Central Java. *Lactobacillus fermentum* FNCC 0322 was obtained from Food and Nutrition Culture Collection, Inter-University Center, Universitas Gadjah Mada Yogyakarta. The strain was stored at -80°C in de Man Rogosa Sharpe (MRS) broth (Merck), containing 20% (v/v) glycerol (de Man et al., 1960). Before experimental use, the bacteria were propagated consecutively in MRS *broth* at 37°C for 24 h. *Lactobacillus fermentum* FNCC 0322 was grown in MRS *broth* at 37°C for 48 h until 10^8 cell/mL for starter inoculum.

Square Banana Flour Production

Square banana flour production with and without fermentation according to Nurdjanah (2011) and Jenie (2012) with some modification method. Square banana was peeled and sliced with thickness 3-5 mm. The banana seed was included in the process. Sliced banana were submerged fermentation in 10^8 cell/mL (0.125%, 0.25%, and 0.375% v/v) *Lactobacillus fermentum* FNCC 0322 starter inoculum on each container with different fermentation time (24 h, 48 h, and 72 h). The sliced banana was dried at 50°C for 12 h then sieved 80 mesh. For the square banana flour control, the process was similar but without submerged fermentation.

Analysis
Physical Properties Analysis
Whiteness Index

Whiteness index assay was carried out using the method of Zarubica (2005). Chromameter (CL-200 Konica Minolta) was used to obtain *L,a,b* of the sample. Whiteness index were calculated using the following equations:

$$W_{(Stensby)} = L + 3a - 3b \quad (1)$$

Swelling Power

Swelling Power was carried out using the method of Leach (1959). 0.1 gram samples and added with 10 ml distilled water. Heated for 30 minute at 60°C then centrifuged at 2500 rpm for 15 minute. The supernatant was carefully decanted. The precipitate with the centrifuge tube was weighed. Swelling power (Sp) was calculated by this following equation:

$$Sp = \frac{\text{weight of paste (g)}}{\text{weight of dry flour (g)}} \quad (2)$$

Solubility

Solubility test was carried out using simple test method of Fardiaz (1992). Dried sample dilluted into 100 ml distilled water. The mixture filtered with filter paper, then

filter paper with residue were oven dried at 105°C for 3 hour. The dry filter paper and residue cooled in a desiccator for 15 minute.

Solubility (S) was calculated by this following equation:

$$S= 1 - \frac{(c-b)}{\frac{100-\% \text{ moisture content}}{100} \times a} \times 100\% \qquad (3)$$

Where a is weight of dried sample, b is weight of dried filter paper, and c is weight of filter paper and residue.

Water Absorption Capacity

Water absorption capacity test was carried out using simple test method of Lidiasari (2006). 3 g dried sample placed on filter paper, poured with 13 g warm water (40°C). Water that came out accommodated and then weighed

Water absorption capacity (%) was measured by this following equation:

$$\% = \frac{\text{Iww(g)} - \text{Dww(g)}}{\text{ws (g)}} \times 100\% \qquad (4)$$

where Iww is initial water weight, dww is discharge water weight and ws is weight of sample.

Amylography Properties

The amylography properties of starch was obtained from *Rapid Visco Analyzer* (RVA) method use viscometer (DV-II Pro, Brookfield). with 2.5 g dried sample dispersed in 25 ml of distilled water. A heating and cooling cycle was programmed in the following manner; the sample was heated from 50 to 95°C for ±30 min, held at 95°C for 2 min and cooled to 50°C within 3 min. The gelatinization parameters such as maximum gelatinization temperature, peak viscosity, holding strength, final viscosity, break down, and set back were determined.

Chemical Properties Analysis
Proximate analysis

The proximate analysis of native rice starch was performed according to the standard methods described in the AOAC (2005), i.e. moisture content and protein content. Protein content was estimated from nitrogen content by Kjeldahl method multiplied by 6.25.

Amylose Content

Amylose content analysis was carried out using *iodo colorimetry* method of Juliano (1971). 100 mg of sample were weighed into a 100 mL volumetric flask and mixed with 1 mL ethanol and 9 mL of 2 M NaOH. The samples were diluted and the iodine solution was added. After 10 min incubation at room temperature, the absorbance at 620 nm was analyzed with a spectrophotometer and the amylose content was calculated based on the standard curve.

Antioxidant Activity

Antioxidant activity analysis was carried out using modified method of Molyneux (2004). 50 mg sample was weighed into aluminum foil coated reaction tube and dilluted with 10 ml metanol. The solution was vortex 1 minute then stand for 24 hours. 1 ml of DPPH in methanol was added into 1 ml solution then stand for 30 minute. The absorbance measurement is given as 516 nm. Antioxidant activity (%) was measured by this following equation:

$$\% = \frac{\text{CA} - \text{SA}}{\text{CA}} \times 100\%$$

where CA is control absorbance, and SA is sample absorbance.

Sensory Properties Analysis

Sensory properties analysis with preference test used 25 untrained sensory panels.

Experimental Design

Each procedure described above, was conducted three times. The study was conducted using a complete randomized design with two factors, including variation of

fermentation length and starter inoculum concentration of *Lactobacillus fermentum* FNCC 0322, with two way analysis of variance (ANOVA) was performed to test the statistical significance of differences. ANOVA was followed by Duncan's multiple range test. The significance level was *P*<0.05 and the software used was SPSS 20 for windows.

Results and Discussion

Effect of fermentation time of square banana flour to whiteness index, swelling power, solubility, and water absorption as shown in **Table 1**, while the effect of starter concentration shown in **Table 2**. Whiteness index of square banana flour from variation of fermentation time and starter concentration of *L. fermentum* FNCC 0322 as shown in **Figure 1.**

Table 1. Effect of Fermentation Time on Whiteness index, Swelling power, Solubility, and Water Absorption Capacity

Fermentation Time (Hour)	Whiteness index	Swelling power (g/g)	Solubility (%)	Water Absorption Capacity (g/g)
Control	$58.19^b \pm 1.97$	$6.84^c \pm 0.41$	$23.51^b \pm 2.34$	$2.11^a \pm 0.11$
24	$52.34^a \pm 3.77$	$6.22^b \pm 0.97$	$19.86^a \pm 1.94$	$2.45^{ab} \pm 0.34$
48	$54.12^a \pm 3.08$	$5.96^{ab} \pm 0.68$	$18.56^a \pm 1.31$	$2.45^{ab} \pm 0.27$
72	$54.57^a \pm 3.04$	$5.69^a \pm 0.53$	$19.55^a \pm 4.11$	$2.57^b \pm 0.30$

Mean value ± standard deviation. Means within a column sharing followed by the same letters do not differ statistically from each other ($P < 0.05$).

Whiteness Index

Whiteness index of square banana flour is in **Figure 1** and **Table 1**. Based on the results, square banana flour modified with fermentation show whiteness index lower than the square banana flour control. The same result showed in **Table 2**, since variation of starter inoculum concentration gave whiteness index lower than square banana flour control. From the result, it can be shown that modification with fermentation can decrease whiteness index of square banana flour. In accordance with its low whiteness index, fermentation then led to Maillard reaction occurance between reduction sugar and amino acid, which resulted from *Lactobacillus fermentum* proteolytic activity (El-Ghaish, 2010; Fossi, 2013). The small particle from seed was also caused the formation of dark color on square banana flour. Therefore, the longer the fermentation and the higher starter concentration shown whiteness index increased. It can be assumed longer fermentation time and higher starter concentration produce more organic acid. In line with Anyasi (2017) that pretreatment with organic acid reducing browning of unripe banana flour.

Table 2. Effect of Starter Concentration on Whiteness index, *Swelling power,* Solubility and Water Absorption Capacity

Starter Concentration (%)	Whiteness index	Swelling power (g/g)	Solubility (%)	Water Absorption Capacity (g/g)
Control	$58.19^c \pm 1.97$	$6.84^c \pm 0.41$	$23.51^c \pm 2.34$	$2.11^a \pm 0.11$
0.125	$53.91^{ab} \pm 1.78$	$6.66^c \pm 0.61$	$19.65^b \pm 1.88$	$2.45^{ab} \pm 0.36$
0.250	$50.92^a \pm 3.58$	$6.02^b \pm 0.43$	$20.92^b \pm 2.45$	$2.58^b \pm 0.31$
0.375	$56.21^{bc} \pm 2.07$	$5.19^a \pm 0.26$	$17.38^a \pm 2.57$	$2.43^{ab} \pm 0.22$

Mean value ± standard k. Means within a column sharing followed by the same letters do not differ statistically from each other ($P < 0.05$)
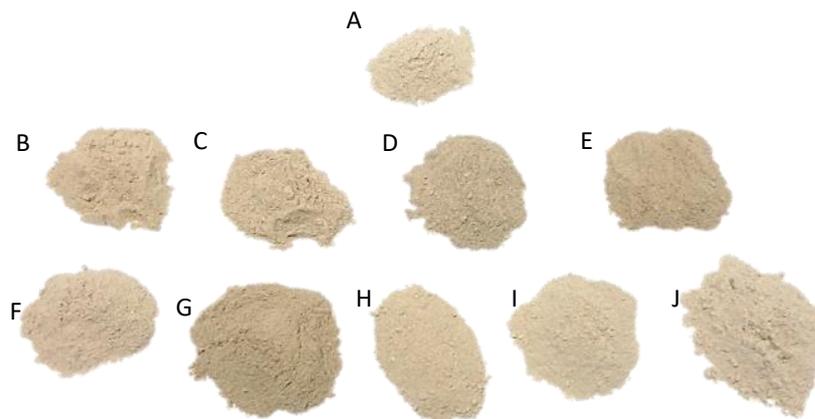
Figure 1. Whiteness index of square banana flour with variation of fermentation time and starter concentration of *L. fermentum* FNCC 0322: (A) Control, (B) 24 h; 0.125%, (C) 48 h; 0,125%, (D. 72 h; 0.125%, (E) 24 h; 0.250%, (F) 48 h; 0.250%, (G) 72 h; 0.250%, (H) 24 h; 0.375%, (I) 48 h; 0.375%, (J) 72 h; 0.375%**.**

Swelling Power

According to **Table 1** and **Table 2**, showed that fermentation time and starter inoculum concentration decreased swelling power. From the result, there is a correlation between longer fermentation time and higher starter concentration could be decreased swelling power. Among the effect of fermentation time and starter concentration, the drop in swelling power caused by enzyme and lactic acid from *Lactobacillus fermentum* which hydrolyzed the amorphous area of the starch granule (Sani, 2002; Santoyo, 2003; Fossi, 2011). The hydrolyzed process during fermentation caused less water uptake and decrease swelling power (Numfor, 1995).

There are many factor which influence swelling power, such as amylose, protein, lipid, phospor, and particle size (Aprianita, 2014). The results are line with Aprianita (2014) stated that amylose plays an important role in swelling power, which can strengthen the internal granule tissue and limit the ability to expand. As the result, there are correlation between swelling power was decreased while amylose content was increased (**Table 5** and **Table 6**).

Solubility

The solubility of flour determined as the weight ratio of the soluble flour to the dry flour sample. Based on the results **Table 1** and **Table 2**, solubility of square banana flour modified with fermentation was lower than control due to variation of fermentation time and starter concentration. According to Numfor (1995) stated that fermentation could be lowering solubility cause of during the fermentation process resulted metabolite which could change C, H, and O bonds of starch granule, there is possible intermolecular hydrogen-bonding of fragments, resulting in a reduction of the free hydroxy (OH) groups. Thus, the fragments could realign and form new hydrogen bonds, resulting in greater internal granule stability which reduced solubility (Numfor,1995).

Water Absorption Capacity

Water absorption indicates the ability of raw materials to absorb water and is associated with the amount of starch in a material. Based on results from **Table 1** and **Table 2**, showed the increase of water absorption on fermented modification square banana flour. From these results, it can be

assumed that fermentation of *Lactobacillus fermentum* produce ethanol which could make the surface tension decreased and replaced the water position during the fermentation process so that when square banana slice dried the process was more quickly dry. As these results loses of water, cause increased the hydrophilic properties in flour. From these results, it can be inferred that fermentation was influenced increasing

of water absorption capacity of square banana flour. Effect of fermentation time on amylography properties square banana flour as shown in **Table 3**, while the effect of starter concentration on amylography properties as shown in **Table 4**. Based on the results, there were significant change in pasting temperature, pasting time, peak viscosity, cold paste viscosity, and setback on square banana flour with pretreated fermentation.

Table 3. Effect of Fermentation Time on Amylography Properties Square Banana Flour

Fermentation Time (Hour)	Gelatinization		Peak Viscosity (cP)			Setback (cP)
	Temperature ($^\circ$C)	Time (menit)	Temperature ($^\circ$C)	Time (menit)	Viscosity (cP)	
Control	63.77[a] ± 17.01	10.00[a] ± 4.36	80.70	14.50	4,175.00 ± 1,088.94	2,196.67[ab] ±918.59
24	85.26[b] ± 3.72	15.89[b] ± 0.60	Td	Td	Td	2,687.78[b] ± 352.07
48	86.30[b] ± 4.29	16.00[b] ± 1.41	Td	Td	Td	2,271.11[ab] ± 746.81
72	89.72[b] ± 4.29	18.78[c] ± 2.49	Td	Td	Td	1,563.33[a] ± 806.87

Amylography Properties

Pasting temperature from square banana flour fermentation treatment showed a higher temperature than square banana flour control. Moreover, the pasting time from

required higher temperatures and longer time to be gelatinized (Noda et al., 2003). The results are in line increased the amylose content in **Table 5** and **Table 6**. Peak viscosity from control flour detected on 4175 cP; 80.70 ^{o}C; 14.50 minute. Meanwhile, peak viscosity of square banana flour with fermentation treatment can not be detected. This results correlated with amylose which could increased viscosity caused by amylose chain

square banana flour with fermentation treatment took longer than control. Increased of pasting temperature and pasting time caused by changes in starch structure influenced by higher amylose content, which

tended more stronger than amylopectin chain so that required high temperature and longer time to achived the maximum viscosity (Chung, 2011).

The setback is the result of a reduction in peak viscosity with cold viscosity. Overall setback from square banana with fermentation treatment showed decreased along with fermentation time and starter concentration.

Table 4. Effect of Starter Concentration on Amylography Properties Square Banana Flour

Fermentation Time (Hour)	Gelatinization		Peak Viscosity (cP)			Setback (cP)
	Temperature (°C)	Time (menit)	Temperature (°C)	Time (menit)	Viscosity (cP)	
Control	63.77[a] ± 17.01	10.00[a] ± 4.36	80.70	14.50	4,175.00 ± 1,088.94	2,196.67[a] ± 918.59
0.125	86.14[b] ± 3.90	16.56[b] ± 2.30	Td	Td	Td	2,533.33[a] ± 942.16
0.250	86.64[b] ± 5.07	16.89[b] ± 2.47	Td	Td	Td	2,014.44[a] ± 619.16
0.375	88.49[b] ± 3.36	17.22[b] ± 1.72	Td	Td	Td	1,974.44[a] ± 755.04

Mean value ± standard deviation. Means within a column sharing followed by the same letters do not differ statistically from each other ($P < 0.05$).

According to Soh (2006) stated that these have correlated with increased of amylose content which made flour were more diffilcult to be gelatinized so that the retrogradation can also be avoided. Starch-based on its gelatinization profile there are 4 types namely type A, B, C and D (Collado, 2001). From Rapid Visco Analyzer result showed there was change on gelatinization profile from type A on control flour into type C on overall square banana flour with fermentation treatment (**Figure 2**).
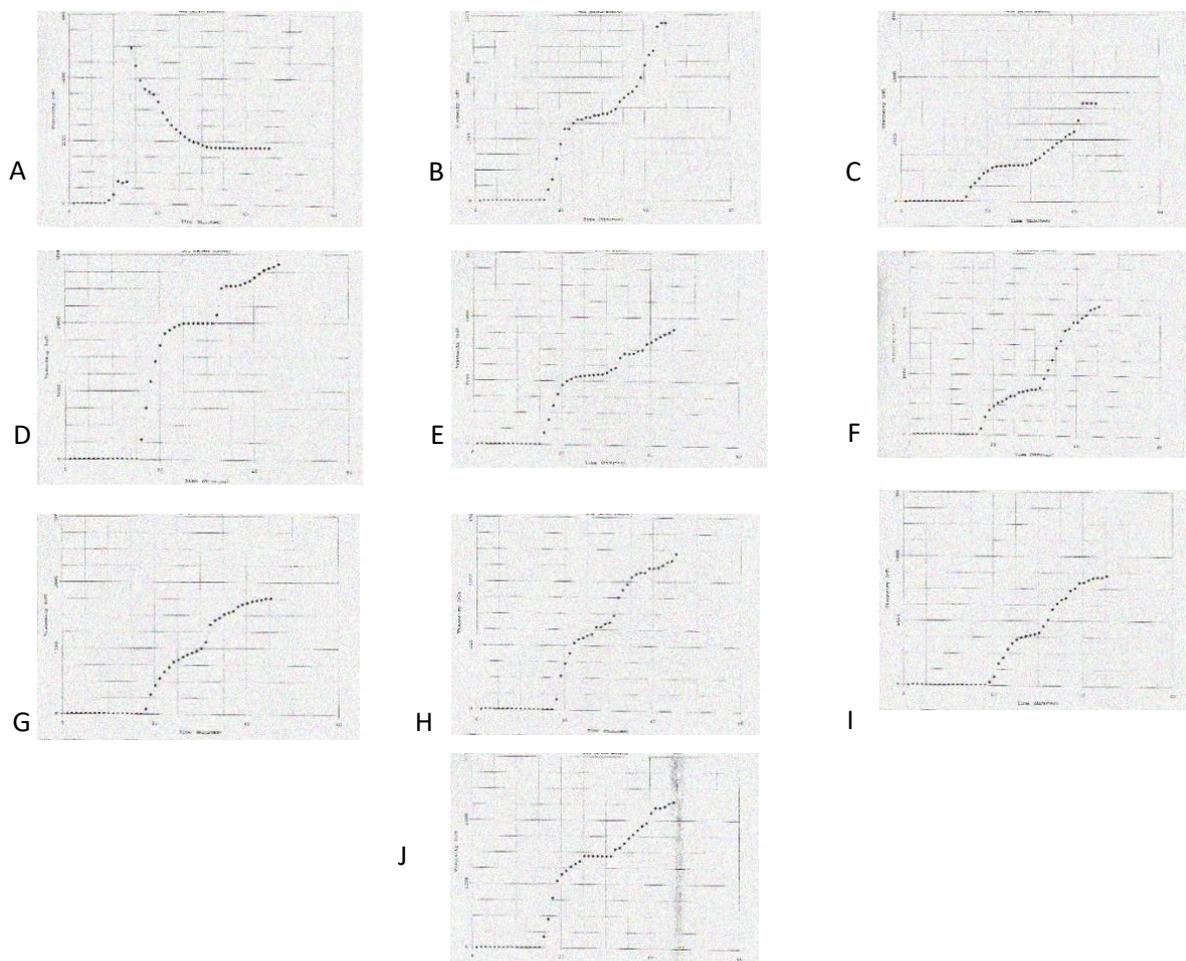
Figure 2. The pasting properties of Square Banana Flour with variation of fermentation time and starter concentration of *L. fermentum* FNCC 0322 : (A) Control, (B) 24 h; 0.125%, (C) 48 h; 0,125%, (D. 72 h; 0.125%, (E) 24 h; 0.250%, (F) 48 h; 0.250%, (G) 72 h; 0.250%, (H) 24 h; 0.375%, (I) 48 h; 0.375%, (J) 72 h; 0.375%.

Gelatinization profile starch type C has shown in the absence of maximum viscosity and shows high heat resistance with restricted swelling starches. Starch with type C gelatinization profile can be used for processed extrusion food products such as noodles.

Chemical Properties of Square Banana Flour

Effect of fermentation time of square banana flour to moisture content, protein content, amylose content and antioxidant activity as shown in Table 4, while the effect of starter concentration shown in **Table 5.**

Moisture Content

Moisture content from square banana with fermentation treatment and control presented in **Table 5** and **Table 6**. Based on the result there was significantly effect from fermentation process due to fluctuating result on moisture content. According to Yenrina (2015) stated that the small water binding capacity when drying process could be affect the moisture content. Furthermore, it can be assumed that the increased in fermentation time 72 h and starter concentration 0.375% caused by more water which absorbed into banana sliced during fermentation process.

Table 5. Effect of Fermentation Time on Chemical Properties of Square Banana Flour

Fermentation Time (Hour)	Moisture Content (%)	Protein Content (%)	Amylose Content (% db)	Antioxidant Activity (%)
Control	$10.16^{bc} \pm 0.53$	$3.94^{a} \pm 0.77$	$16.47^{a} \pm 1.11$	$15.85^{b} \pm 1.54$
24	$8.88^{a} \pm 1.59$	$5.05^{b} \pm 0.62$	$24.90^{b} \pm 4.88$	$14.80^{ab} \pm 1.80$
48	$8.26^{a} \pm 2.53$	$5.66^{b} \pm 0.96$	$23.17^{b} \pm 5.07$	$13.85^{a} \pm 2.05$
72	$10.84^{c} \pm 3.35$	$6.55^{c} \pm 1.82$	$29.36^{c} \pm 4.31$	$15.91^{b} \pm 2.43$

Mean value ± standard deviation. Means within a column sharing followed by the same letters do not differ statistically from each other ($P < 0.05$)

Protein Content

The protein content of square banana flour presented in **Table 5** and **Table 6**. The result showed that fermentation treatment process affects increased on protein content. From **Table 5** and **Table 6**, the highest protein content showed at fermentation time 48 h and starter concentration 0.250% v/v. It can be assumed that increased of protein content caused by biomass from *Lactobacillus fermentum* containt peptidoglycan which increased and counted as increased of protein content.

Table 6. Effect of Starter Concentration on Chemical Properties of Square Banana Flour

Starter Concentration (%)	Moisture Content (%)	Protein Content (%)	Amylose Content (% db)	Antioxidant Activity (%)
Control	$10.16^{b} \pm 0.53$	$3.94^{a} \pm 0.77$	$16.47^{a} \pm 1.11$	$15.85^{b} \pm 1.54$
0.125%	$7.77^{a} \pm 0.54$	$5.38^{b} \pm 0.53$	$24.76^{c} \pm 2.00$	$15.67^{b} \pm 0.86$
0.250%	$8.08^{a} \pm 1.17$	$6.93^{c} \pm 1.60$	$21.51^{b} \pm 4.74$	$13.22^{a} \pm 1.83$
0.375%	$12.15^{c} \pm 3.03$	$4.95^{b} \pm 0.79$	$31.16^{d} \pm 3.21$	$15.67^{b} \pm 2.05$

Mean value ± standard deviation. Means within a column sharing followed by the same letters do not differ statistically from each other ($P < 0.05$)

Amylose Content

Table 5 and **Table 6** showed amylose content from square banana flour with fermentation treatment increased the amylose content significantly. From the results, effect of fermentation time 72 h and starter concentration 0.375% give highest resulted in amylose content. Fermentation process could hydrolyze the starch, as the result it could increased amylose content (Numfor *et al.*, 1994; Tavea *et al.*, 2016). According to Mir *et al.*(2013) stated that high amylose content correlated with resistent starch and low glycemic index (GI). In addition, the high amylose content in foodstuffs has the potential to be used as raw material for instant food products such as noodles or extrusion products (Collado *et al.*, 2001).

Antioxidant Activity

Antioxidant activity of square banana flour presented in **Table 5** and **Table 6**. Statistically there was no significant effect of fermentation process on square banana flour. Although in fermentation time 48 h and starter concentration 0.250% found that antioxidant activity was decreased. The decreased in antioxidant activity was previously reported by Hunaefi *et al*.(2013) which suggest that fermentation process causes a decreased in antioxidant activity due to enzymatic and non enzymatic degradation of phenol. In fermentation time 72 h and starter concentration 0,375%, it was found that antioxidant activity was increased. It can be assumed that proteolytic by Lactobacillus fermentum influenced the increasing antioxidant activities. Rizello *et al.* (2017) reported fermentation increased antioxidant activity by releasing antioxidant peptides based on proteolytic activities.

Sensory Properties of Square Banana Flour

Based on **Table 7** dan **Table 8** showed that sensory properties include colour, aroma, texture, and overall. From the results of color content, highest color square banana flour control was showed on square banana flour control with preference 5,52. Color changed of square banana caused by Maillard reaction while drying between reduction sugar and amino acid resulted from *Lactobacillus fermentum* proteolytic activity (El-Ghaish, 2010; Fossi, 2013). The small particle from seed was also cause the formation of dark color on square banana flour.

Table 7. Effect of Fermentation Time on Organoleptic Properties of Square Banana Flour

Treatment	Colour	Aroma	Texture	Overall
Control	$5.52^b \pm 1.09$	$4.48^c \pm 1.48$	$5.32^b \pm 1.03$	$5.12^b \pm 0.97$
24	$4.29^a \pm 1.10$	$3.79^a \pm 1.19$	$4.52^a \pm 1.17$	$4.24^a \pm 0.93$
48	$5.24^b \pm 1.04$	$4.33^{bc} \pm 1.22$	$5.27^b \pm 1.04$	$5.07^b \pm 0.84$
72	$4.11^a \pm 1.52$	$3.97^{ab} \pm 1.27$	$4.68^a \pm 1.32$	$4.24^a \pm 1.15$

Mean value ± standard deviation. Means within a column sharing followed by the same letters do not differ statistically from each other ($P < 0.05$). Note : 1= extremely dislike; 2 = dislike; 3 = somewhat dislike; 4 = neutral; 5 = somewhat like; 6 = like; 7 = extremely like

The aroma can be used as an indicator of the occurrence of damage to the product. Fermentation time at 48 h give resulted highest between all of square banana flour with fermentation treatment, but the preference give no significantly effect to flour control. According to Santoyo *et al.* (2003) stated that fermentation of *Lactobacillus fermentum* produced ethanol and lactic acid. It can be assumed that ethanol and lactic acid could provided a distinctive aroma so that affected on panelist preference.

Table 8. Effect of Starter Concentration on Organoleptic Properties of Square Banana Flour

Treatment	Colour	Aroma	Texture	Overall
Control	$5.52^c \pm 1.09$	$4.48^b \pm 1.48$	$5.32^b \pm 1.03$	$5.12^b \pm 0.97$
0.125%	$4.20^a \pm 1.32$	$3.93^a \pm 1.12$	$4.77^a \pm 1.24$	$4.37^a \pm 1.05$
0.250%	$4.44^a \pm 1.44$	$4.12^{ab} \pm 1.28$	$4.93^{ab} \pm 1.17$	$4.51^a \pm 1.03$
0.375%	$5.00^b \pm 1.10$	$4.04^{ab} \pm 1.33$	$4.76^a \pm 1.26$	$4.67^a \pm 1.07$

Mean value ± standard deviation. Means within a column sharing followed by the same letters do not differ statistically from each other ($P < 0.05$)

Note : 1= extremely dislike; 2 = dislike; 3 = somewhat dislike; 4 = neutral; 5 = somewhat like; 6 = like; 7 = extremely like

Based on the results that square banana flour with variation fermentation time 48 h and starter concentration 0.250%, statistically showed no significant different with control. In line previous research done by Jayus *et al.*(2016), that fermentation could give smooth texture and porous flour. In overall parameter, showed that square banana flour control has the highest preference of panelist and it shown that fermentation treatment did not give significantly improvement of sensory properties.

Conclusion

Fermentation time and starter inoculum concentration of *Lactobacillus fermentum* FNCC 0322 gave significant change on physical and chemical characteristic such as swelling power, solubility, amylography properties, protein content, amylose content, and antioxidant activity of square banana flour. Amylography of square banana flour was change due to fermentation process. Variation of fermentation time and starter inoculum concentration were also change pasting properties into type C which can used as material for making noodles. Yet, the sensory properties (colour, aroma, texture, and overall) of square banana flour did not give significantly change.

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