Chemical and Microbiological Properties of Mogaf (Modify Garut Flour) from Arrowroot Tuber (*Maranta Arundinaceae* L.) Fermented Spontaneously with Different Time

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Abstract

This study aims to determine the effect of fermentation time toward chemical and microbiological properties of MOGAF flour that produced. This research conducted at the Laboratory of Agricultural Technology in Andalas University. The first step in this research is the making of MOGAF flour then continue with chemical and microbiological analysis. This research design in Completely Randomized Design (CRD) with five treatments and three replications. Data were analyzed statistically using ANOVA and if significantly different, followed by a test of Duncan's New Multiple Range Test (DNMRT) at 5% significance level with treatments: A (unfermented), B (fermentation time 24 hours), C (fermentation time 48 hours), D (fermentation time 72 hours) and E (fermentation time 96 hours). Observations on MOGAF flour include chemical and microbiological analysis. The results showed that fermentation time had a significant effect on the chemical properties of MOGAF flour. Based on chemical analysis, the best MOGAF flour is MOGAF with treatment E (fermentation time 96 hours) with a water content of 4.80%, 1.50% protein, 3.68% fat, 1.35% ash, 1.30% crude fiber, acid degree of 24.97%, 60.79% starch, 30.17% amylose, 30.62% amylopectin, 514.20 kcal energy, initial and final pH solution of 6.59 and 3.87, and the total lactic acid bacteria in fermentation solution of 3 , 5x1016cfu / ml.

Keywords: Fermentation, MOGAF, chemical properties, microbiological

Introduction

Society in general trade on rice and wheat as main food so that make their price increased. In Indonesia, many plants are able to thrive as a producer of carbohydrates such as sweet potato, canna, cassava and arrowroot. Arrowroot plant is a kind of tubers that grow wildly because not much use and cultivate. Though this arrowroot is plant potential as an alternative source of carbohydrates.

One of the advantage of arrowroot plant is it does not require special land to cultivate because it is able to grow on the shady ground, the quantity of harvest is also quite a lot. According Karjono (1998), productivity of arrowroot as raw material of flour is quite high, which is about 12.5 to 31 tons / ha. Besides, between the many sources of carbohydrates arrowroot tubers has the lowest glycemic index (Marsono, 2002). However, arrowroot tubers are rich in fiber so that if it used as the main matterial of flour it will has a low yield and the flour can not apply to all of food products as flour produced coarse and fibrous. And the appearance of the flour is not attractive because of less white.

Lately been developed mocaf (Modified Cassava Flour) which is made by fermented cassava before flouring and the flour that produced has a much better characteristics than other cassava flour, but the fermentation is done by using a starter that difficult to apply in general public. Because of that, it needs to appliy the modification of arrowroot tubers with spontaneous fermentation to produce MOGAF (Modified Garut Flour), with the hope to obtain a better flour than the usual arrowroot flour.

Based on the preface research that has been done known that the fermentation in less than 24 hours has not effect on the arrowroot tubers, while the fermentation more than 96 hours make arrowroot tubers more soft and has a sharper alcoholic aroma.

Methodology

Place and Time

This research was conducted at the Laboratory of Agricultural Technology Andalas University in February - April 2014.

Materials and Equipments

Raw materials used in this study is a fairly old arrowroot tubers with pretty large size and some existing scales are chipped, sugar and water. Arrowroot tubers derived from Talang Petai district. V Koto, Regency of Muko-Muko Bengkulu province. Chemicals used are distilled water, MgO and other materials for analysis.

The equipment used in this study include the blender and grinder, 80 mesh sieve, trays, basins, centrifuse, and ColorFlex EZ.

Research Design

This study used a completely randomized design (CRD) with 5 treatments and 3 replications. Data were analyzed statistically by F test and if significantly different, followed by Duncan's Multiple Range Test Test (DNMRT) at 5% significance level. The treatment in this study is the duration of fermentation of arrowroot tubers, as follows:

A = Without fermentation
B = fermentation time 24 hours
C = fermentation time 48 hours
D = fermentation time 72 hours
E = fermentation time 96 hours

Making MOGAF

Arrowroot tubers harvested and shelled then cleaned, followed by cutting the arrowroot tubers ± 1 cm, weighed 500 grams, added sugar 1% of the weight of tubers which are then dissolved in water at a ratio of tubers and water 1: 2 (w / v) covered and fermentation spontaneous performed according to the treatments, then do first draining and soaked with 5% salt water for 10 minutes, then do the second draining and then dried at 40ºC for 2 days until arrowroot tubers can be broken by hand, followed by flouring and sieving using 80 mesh sieve, then packed with aluminum foil.

Observation

The observations in this research are chemical analysis include moisture content (Sudarmadji *et al*, 1997), ash content (Sudarmadji *et al.*,1997), fat content (Sudarmadji *et al.*,1997), protein content (Sudarmadji *et al.*,1997), carbohydrate *by difference* (Winarno, 2002) , crude fiber (SNI 7622-2011, Tepung MOCAF), starch content (Sudarmadji *et al.*,1997), energy value (Almatsier, 2004), acid degree (SNI 7622-2011, Tepung MOCAF), pH, and amylose and amylopectin content (Apriyantono *et al.*, 1998) and also mycrobiological analysis total lactic acid bacteria (Fardiaz, 1993) in fermentation solution.

Results and Discussion

Analysis of Raw Materials

Arrowroot tuber as a raw material in the making of MOGAF firstly analyzed as a reference to see the nutritional value of MOGAF flour that produced later.

Table 1. Proximate Analysis Results Bulbs Garut

Arrowroot Tuber Content	Level (%)
Moisture Content	77,23
Ash Content	0,11
Fat Content	0,40
Protein Content	1,91
Carbohydrate Content	15,59
Crude Fiber	5,16

According to Koswara (2013) fresh arrowroot tuber as food and source of carbohydrate, having a chemical composition as follows: 69-72% water, 10.2-2% protein, fat content of 19.4-21.7%, fiber 0.6- 1.3%, and ash 1.31-1.4%.

Chemical Analysis of MOGAF Flour

Table 2. Proximate Analysis Result of MOGAF flour

Treatments	Moisture Content(%)	Protein Content(%)	Fat Content(%)	Ash Content (%)	Carbohydrate Level (%)	Crude Fiber Content (%)
A	4,80 ± 0,06 a	0,95 ± 0,03 a	0,43 ± 0,04 a	1,35 ± 0,09 a	85,01 ± 0,11 a	1,30 ± 0,14 a
B	5,38 ± 0,13 b	1,12 ± 0,06 a	0,48 ± 0,09 a	1,80 ± 0,23 b	88,67 ± 0,38 b	1,71 ± 0,22 b
C	5,69 ± 0,38 b c	1.17 ± 0,27 a	0,98 ± 0,15 b	2,18 ± 0,04 c	89,15 ± 0,14 b	2,11 ± 0,08 c
D	5,83 ± 0,05 c	1,41 ± 0,19 b	2,25 ± 0,09 c	2,24 ± 0,12 c	89,96 ± 0, 19 c	2,71 ± 0,23 d
E	10,29 ± 0,03 d	1,50 ± 0,42 b	3,68 ± 0,44 d	3,30 ± 0,18 d	90,32 ± 0,41 c	4,15 ± 0,23 e
CV (%)	3,39	10,28	10,05	6,80	0,31	7,80

The numbers in the same column followed by the same lowercase letter are not significantly different according to DNMRT at 5% significance level The numbers in the same column followed by the same lowercase letter are not significantly different according to DNMRT at 5% significance level

The longer the fermentation time was found to reduce the water content in MOGAF flour because during the process of fermentation the degradation of starch by microorganisms that are capable of causing a material decline in retaining water. The longer the fermentation time, the more increase starch degrading enzyme activity so that more number of bound water liberated, resulting soft and porous texture (Agustawa, 2012). This situation can increase the evaporation of water during the drying process takes place, thus water levels will decrease in the same duration of drying.

The low water content contained in the MOGAF flour with fermentation time 96 hours is able to extend the shelf life of MOGAF flour. In addition, the low water levels also can reduce the risk of damage to the MOGAF flour. According to Deman (1997), the water content in the material may affect the reduction in chemical and microbiological quality. Some of the damage that may occur is microbial growth, browning reaction and hydrolysis of fats which cause rancidity. The water content of MOGAF flour that produced in this research meet the SNI standard of MOCAF flour and the standrard of MOCAF flour that made by the Cooperative Loh Jinawi Tranggelek is a maximum of 13%.

In Table 2, it is known that the different duration of fermentation is able to give effect to the protein content of the flour MOGAF flour that produced. Protein content of these products when compared to the standrard of MOCAF flour that made by the Cooperative Loh Jinawi Tranggelek that maximum protein content of 1.0% only treatment A that meets the standard, but the high protein content of the flour is also a nutritional supplement ingredients to flour value itself. High levels of protein in MOGAF with treatment E also due to lower water levels so that the other components of the higher concentration. In addition, during the process of fermentation the protein level was also able to increase with the increasing of cell mass of microorganisms that grow during fermentation takes place so as to increase the protein level MOGAF flour that produced (Wang, 1979).

MOGAF flour produced in this study has the highest fat content contained in treatment E of 3.68% and the lowest in treatment A is equal to 0.43%, when compared with the levels of fat in the standrard of MOCAF flour that made by the Cooperative Loh Jinawi Tranggelek which only ranged between 0,4 to 0.8% this MOGAF flour is higher in fat content from 0.43 to 3.68% contained in flour MOGAF. Based on the analysis of variance known that duration of fermentation had a significant effect on fat content generated. The longer the fermentation time the fat content of product become higher because the longer the fermentation time, the weight of the material decreases water so that the concentration of other components increased.

Ash content of MOGAF flour that produced ranges from 3.30% - 1.35%, when compared with SNI standard of MOCAF flour and the standrard of MOCAF flour that made by the Cooperative Loh Jinawi Tranggelek maximum ash content is 1.3% and 0.2% where MOGAF flour in this research had ash content the ranged of 1.35 to 3.30% this result indicates mineral content in MOGAF flour more than mocaf flour.

Results of analysis of variance showed that long fermentation time generally had a significant effect on the ash content of MOGAF flour, the longer fermentation the lower ash content of product it is estimated that the during fermentation process takes place many elements are also dissolved in water. According to Andy *et al,* (2013) long immersion can make the most of minerals dissolved in water. In addition, the longer the contact with the mineral acid solution then the possibility of water-soluble minerals will also be higher. According to Tan (1986), a mineral acid solution is able to create a material so fragile in the longer soaking in the mineral acid solution it will be more likely to be fragile so many minerals that are lost along with the decrease of water content, so the longer the fermentation time, the ash content of a material will tend to diminish.

Unlike the ash content, carbohydrate content of MOGAF flour increases with longer fermentation time. This is presumably due to lower water levels so that other components are more concentrated, in addition to the carbohydrate content of MOGAF raw material is high. In addition to fiber degradation is quite high on arrowroot tubers during the fermentation process takes place so as to increase the carbohydrate content of the MOGAF flour that produced. Increased levels of carbohydrate is in line with the decline of crude fiber content and water content, as well as increased energy value of MOGAF flour.

Based on the table 2 MOGAF flour fiber content ranged from 4.15% - 1.30%, these results compared with SNI standard of MOCAF flour and the standrard of MOCAF flour that made by the Cooperative Loh Jinawi Tranggelek respectively has a maximum of 2.0% and 1.9 to 0 , 8% it means that fiber content in MOGAF flour with treatment A and B meet both standards. From the analysis of variance known that long fermentation time had a significant effect on levels of crude fiber of product. The longer the fermentation time, the crude fiber content will decrease is due to the activity of microorganisms capable of producing cellulolytic enzymes of degrading crude fiber into simpler compounds. When compared to the results of the analysis MOGAF flour with MOCAF flour, the only treatment D and E, which meets SNI standard of mocaf is a maximum of 2.0%.

Table 3. Analysis Result of Acid Degree, Starch Content, Amylose and Amylopectin, dan Energy Value of MOGAF

Treatments	Acid Degree (%)	Starch Content (%)	Amylose (%)	Amylopectin (%)	Energy Value (Kcal)
A	9,38 ± 0,26 a	60,79 ± 0,09 a	30,17 ± 0,32 a	30,62 ± 0,28 d	341,90 ± 0,20 a
B	12,19 ± 0,11 b	63,63 ± 0,30 b	33,47 ± 1,54 b	30,17 ± 0,89 c d	361,40 ± 0,20 b
C	14,33 ± 0,69 c	64,87 ± 0,09 c	35,63 ± 0,63 c	29,24 ± 0,54 c	438,40 ± 0,20 c
D	20,11 ± 0,22 d	68,35 ± 0,34 d	40,97 ± 0,22 d	27,38 ± 0,23 b	442,10 ± 0,10 d
E	24,97 ± 0,25 e	74,21 ± 0,30 e	49,40 ± 0,35 e	24,57 ± 0,30 a	514,20 ± 0,20 e
CV (%)	3,52	1,32	2,16	1,79	0,04

The numbers in the same column followed by the same lowercase letter are not significantly different according to DNMRT at 5% significance level The numbers in the same column followed by the same lowercase letter are not significantly different according to DNMRT at 5% significance level

The results of the analysis of the acid degree showed MOGAF flour had the highest degree of acid in the treatment E of 24.97% while the lowest is in treatment A is equal to 9.38%. Of all the treatments none that meet due to SNI standard of MOCAF flour maximum of 4.0 1 N / mg samples. Based on the analysis of variance at 5% level is known that fermentation time had a significant effect on the acid degree of MOGAF flour. The longer the fermentation time, the acid degree of product is also higher this is in line with the decrease in pH during the fermentation process takes place. The number degradation occurred by microorganisms that produce organic acids and the increasing acid content can also be determined by the more acidic aroma of the final product produced.

Based on the above table it can be seen that the highest starch content contained in treatment A that is equal to 78.62%. This figure is quite low compared to the starch levels of the standrard of MOCAF flour that made by the Cooperative Loh Jinawi Tranggelek that range 82-87%. Low levels of starch produced in treatment E (fermentation 96 hours) is due to the decomposition of starch into sugars which are simpler and the final result of the decomposition of the formation of organic acids, this is in line with the acid degree of MOGAF that produced by the longer time of fermentation while the starch level of MOGAF flour tends to decrease.

Starch degradation was also used by microorganisms to grow and produce acids mainly lactic acid as the dominant because the dominnat bacteria that growth is lactic acid-producing bacteria (Oktavia, 2010). Based on the analysis of variance at 5% level concluded that fermentation time gives effect to the starch content of the flour that produced.

Based on Table 3 it can be seen that the highest amylose content contained in treatment A that is equal to 49.40% and the lowest in treatment E is equal to 30.17%. Long fermentation time has significant effect of a decrease in amylose content this is caused by the decomposition of starch during the fermentation process so that the amylose and amilopekten broke ties that make a lot of water-soluble components especially amylose which is soluble in water. The reduced amylose content is also in line with the decreasing levels of starch due to the activity of microorganisms to degrade starch into simpler compounds that amylose starch as a constituent also decompose and disappear along with the water when the filtering process takes place. Based on the analysis of variance at 5% level is known that the duration of fermentation had a significant effect on levels of amylose of MOGAF flour that produced.

Amylopectin analysis performed by calculation the difference between the levels of starch and amylose content to obtain the levels of amylopectin. Based on the results of the calculation known that amylopectin content increasing along with the longer fermentation time. This increasing level of amylopectin is because amylopectin is insoluble in water so as to hold out in its arrangement. Besides, amylopectin is a compound that concentrated due to declining of water levels along with the length of fermentation that takes place. Based on the analysis of variance is known that the duration of fermentation had a significant effect on amylopectin level of MOGAF.

Based on the analysis results of energy value of MOGAF flour, it can be seen that the highest energy value contained in the treatment E (fermentation time 96 hours) in the amount of 514.20 kcal and the lowest energy value in treatment A is equal to 341.90 kcal. The longer the fermentation time, the hihger the energy value that produced, this is in line with the levels of fat, protein and carbohydrates of product that also increased with the longer duration of fermentation. Sources of energy that produced from those three macro compounds so that the energy value of MOGAF flour that produced is also increased. Based on the analysis of variance of 5% is known that the duration of fermentation had a significant effect on energy value of MOGAF flour.

Table 4. Analysis Results of pH Value

	pH	
Treatments	**Initial pH**	**Final pH**
D	6,52 ± 0,08 a	3,88 ± 0,04 b
E	6,59 ± 0,11 a b	3,87 ± 0,03 b
C	6,72 ± 0,12 b	3,47 ± 0,12 a
B	6,73 ± 0,02 b	3,61 ± 0,14 a
CV = 2,56%		

The numbers in the same column followed by the same lowercase letter are not significantly different according to DNMRT at 5% significance level The numbers in the same column followed by the same lowercase letter are not significantly different according to DNMRT at 5% significance level

Base on the table above it can be seen that the initial pH value of the fermentation solution ranged from 6.52 to 6.73 shows the initial pH tends to neutral. While at the end of fermentation solution pH values ranged from 3.47 to 3.88 tend to be more acidic. Decreasing of pH value during the fermentation process due to the growth of microorganisms and degradation of sugar into organic acids and is in accordance with the number of acid degree which tends to increase during the fermentation takes place.

Microbiological Analysis

Lactic acid bacteria are bacteria that utilize sources that contain sugar to produce lactic acid. In the fermentation process of making this MOGAF flour is expected to grow lactic acid bacteria because the bacteria are also capable to degrade cell wall and fiber of arrowroot tubers because it produces pectinolytic and sellulolytic enzymes (Rachmadi, 2011). The presence of lactic acid bacteria that produce lactic acid also gives a distinctive aroma.

Table 5: Results of Analysis Total Lactic Acid Bacteria

Treatments	Total Lactic Acid Bacteria
B	$\pm 2{,}7 \times 10^{14}$
C	$\pm 2{,}8 \times 10^{17}$
D	$\pm 1{,}5 \times 10^{17}$
E	$\pm 3{,}5 \times 10^{16}$

Based on the table, it can be seen that the total lactic acid bacteria on the first day of fermentation (24 hours) ± 2.7 x 10^{14} and then on day 2 (48 hours) and day 3 (72 hours) the number increase to ± 2, 8 x 10^{17} and 1.5 x 10^{17}, this is assume as the peak of growth phase so that on the 4th day (96 hours) the amount of lactic acid bacteria begin to decline to be ± 3.5 x 10^{16} the decline is in line with the increasing degree of acid.

Conclusion

Spontaneous fermentation on arrowroot tubers flour can improve the nutritional value of arrowroot tubers. Long fermentation time on MOGAF flour can lowers the pH of fermentation solution and increase the total of Lactic Acid Bacteria and give significant effect to the moisture content, ash content, protein content, fat, carbohydrates, crude fiber content, starch, amylose and amylopectin content, energy value, and the acid degree of the MOGAF flour that produced. MOGAF flour that produced in this study have a moisture content from 4.80 to 10.29%, protein content from 0.95 to 1.50%, fat content from 0.43 to 3.68%, ash content 1,3 to 3.30%, carbohydrates from 85.01 to 90.32%, crude fiber content from 1.30 to 4.15%, acid degree from 9.38 to 24.97%, starch level from 49.18 to 78.62%, amylose and amylopectin content from 29.48 to 49.04% and from 19.70 to 29.57%, energy values from 341.90 to 514.20 kcal and initial pH 6.52 to 6.73 and the final pH of 3.47 -3.88. Best MOGAF flour by chemical analysis is in treatment E (Fermentation Time 96 Hours) with a water content of 4.80%, 1.50% protein content, fat content of 3.68%, 3.30% ash content, carbohydrates 90.32 %, crude fiber content of 1.30%, 24.97% acid degree, 49.18% starch, amylose and amylopectin content of 29.48% and 29.57% and 514.20% of energy value.

Advice

It is suggested in the manufacture of MOGAF flour with spontaneous fermentation should be done for 96 hours. For next researchers suggested to do research on raw materials HCN content, digestibility, and shelf life, and also the application of MOGAF flour as a substitute for another flour in the manufacture of certain food products.

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