THE REVIEW OF BIOCHEMISTRY ASPECTS OF MOCAL (MODIFIED CASSAVA FLOUR) PROCESS WITH SPONTANEOUS FERMENTATION

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Abstract

Cassava, also known as Manioc, and the Latin name is *Manihot esculenta,* is a annual tropical and sub – tropical plant derive from the family of *Euphorbiaceae*. The tuber is known as a staple food – producing carbohydrate, and its leaves can be made as a vegetable. In food industry, Cassava can be used to make cassava flour or tapioca for food. MOCAL is cassava flour that in production process through spontaneous fermentation. Biochemical changing takes place during the fermentation. This produces a better characteristic of modified MOCAL, so it can be used in a larger food industry. The application of MOCAL in the food industry has been applied, but a scientific study about the fermentation process of MOCAL has not been conducted. A scientific study about the biochemical changing during the fermentation process of MOCAL is needed. This research is an observation toward the biochemical changing of MOCAL. The basic ingredient is cassava varieties Paroka. It is obtained directly from the farmers in Lumajang. The cassava is about 7 – 9 months old. The research is conducted at Laboratory of Chemistry and Biochemical food product, department of agriculture product technology, Faculty of Agricultural technology, University of Jember. It began Mei 2007 until Mei 2008. In its design, MOCAL is produced in various time of fermentation process (0, 6, 24, 30 and 48 hours), then continues to analyze the biochemistry of MOCAL immersion water. Analyzing of the data uses descriptive methods. The result is shown in table, and graph or histogram is made to ease the data interpretation. The result of the research shows biochemical changing because of microbe activity and carbohydrate breaker enzymes during the fermentation process. The pH of the MOCAL water immersion decreases during the fermentation because of organic acids which is produced by the microbe during the fermentation process. The turbidity of MOCAL water immersion increases. It indicates the increasing amount of microbe during the fermentation process. During the fermentation process, the microbes produce enzymes that increase the amount of soluble protein. The activity of the carbohydrate – breaker enzymes such as cellulose and amylase in breaking cellulose increases during the fermentation process. These activities affect the texture of cassava chip which shows softening during the fermentation process.

Keywords : *MOCAL, fermentation, cassava*

Introduction

Population growth increasing every year makes the requirement for basic food, especially for energy source such as carbohydrate, also increasing. This can cause a danger of food insecurity if the production of cereals, especially rice as a staple food, can not balance the rapid growth of population. One alternative to overcome this situation is the

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diversification of food. For example, the utilization of other energy sources such as root crops, thereby it can reduce dependence on one staple food.

Modification of cassava starch manufacturing process used to improve the functional properties of cassava flour is expected to close its properties of wheat flour. Modification of cassava starch manufacturing process is carried out by spontaneous fermentation that was involving microbial metabolic enzymes work. Enzymes that play a role in the process of modification of cassava starch are the enzymes breaker of carbohydrate such as α-amylase and cellulose. A-amylase played a role in the degradation of amylose in cassava into maltose and maltotriose, whereas cellulose played a role as the breaker of cell walls of starch granules.

The length of fermentation affects how much work these enzymes in modifying cassava. It is not yet known the activity of microbes in the process so it needs a study to determine the time of fermentation producing optimal effects. Microbial activity observed includes activity in the breaking of cell walls of cassava and its activity in the breaking of starch granules affecting the liberation of starch. The benefits of this research are expected to develop technological diversification of food so it can to overcome the problem of food insecurity, to reduce dependence on flour in various food industries, to add economic value of cassava, and to stimulate the development of cassava flour industry.

Review References

Cassava, also known as cassava or manioc, is a tropical and subtropical annual tree from the family *Euphorbiaceae*. Its tubers are known as a staple food producing carbohydrates and its leaves as a vegetable. The cassava tubers are tubers or roots of trees with the physical length of an average diameter of 2-3 cm and 50-80 cm depending on the type of cassava planted. The tuber flesh is white or yellowish. Cassava tubers can not stand store though placed in the refrigerator. Cassava tuber is a rich source of carbohydrate energy but very poor in protein. A good source of protein is in cassava leaves because it contains amino acid methionine. Cassava production in the world was estimated to be 184 million ton in 2002. Most of the production was produced 99.1 million ton in Africa and 33 million ton in Latin America and the Caribbean (Anonymous, 2008).

Table 2.1 Chemical Composition of Cassava

Component		Total	
		White Cassava	Yellow Cassava
Carbohydrate	%	34.70	37.90
Protein	%	1.20	0.80
Fat	%	0.30	0.30
Calcium	(Mg / 100 g)	33.00	33.00
Phosphor	(Mg / 100 g)	40.00	40.00
Vitamin A	SI	-	385.00
Water	%	62.50	60.00

Sources: Suliantri-Winiati, Fermentation Technology Tubers and Cereals, 1990

MOCAL *(Modified Cassava Flour)* is derived products from cassava flour using the principle of modifying the cells of cassava with fermentation. The growing microbes will produce pectinolytic and cellulolytic enzymes that can break the cell wall until cassava starch liberation occurred. This liberation process will cause a change of characteristic of the produced flour. Furthermore starch granule will experience hydrolysis resulting monosaccharide as raw material to produce organic acids. This will be acid compounds in the material, and when the material processed will be able to cover the aroma and flavor of cassava that are less likely to please consumers. Technically, the production MOCAL very simple, similar to ordinary cassava flour but it is accompanied by fermentation (Subagio, 2006).

Table 2.2 Chemical Composition of MOCAL

Component	%
Water Content	6.9
Protein content	1.2
Ash content	0.4
Starch content	87.3
Fiber content	3.4
Fat content	0.4

Sources: Subagio et al, 2006

Methods

The research was done at the Laboratory of Biochemistry and Chemistry, Agricultural Technology Department, Faculty of Agricultural Technology, Jember University began in May 2007 to May 2008. Research material used is fermentation water of MOCAL. The chemicals used are citric acid, 0.1 M phosphate buffer solution of pH 7, 0.1 M citrate buffer solution pH 4.8; 2N NaOH solution, mix Lowry solution, a standard glucose solution, 0.1 M iodine solution, DNS solution, soluble starch, Folin. The tools used in this study were pH meter, test tubes, water bath, electric stove, beaker glass, micro pipettes, spectrophotometer, smart colorymeter, Dissolved Oxygen, rheotex, measuring cups and vortex.

This study is the observation of biochemical changes of MOCAL through spontaneous fermentation. The design will be done with the variation process of the length of fermentation in making MOCAL (0, 6, 24, 30 and 48 hours) then carried out biochemical analysis in its water immersion. Data analysis of research is using descriptive methods. Data observations are presented in tabular form then graphs and histograms are made to simplify the interpreting data. Observation parameters include the measurement of dissolved oxygen water immersion of MOCAL, the measurement of water immersion of MOCAL pH, the measurement of water immersion of MOCAL microbial growth, the measurements of the texture of cassava *chips,* soluble protein, the activity of cellulose, activity of amylase, the enzyme activity in softening cell wall of cassava.

Results and Discussion

Dissolved Oxygen

During the MOCAL fermentation process, it was occurred growth and increased microbial activity shown with changes in content of dissolved oxygen in water immersion of MOCAL. During fermentation, microbial was using oxygen in its activities and generating metabolites such as CO_2 gas and organic acids and some pectinolytic and cellulolytic enzymes. The fermentation process of MOCAL is fermentation process facultative anaerobes where oxygen is needed in small amounts.

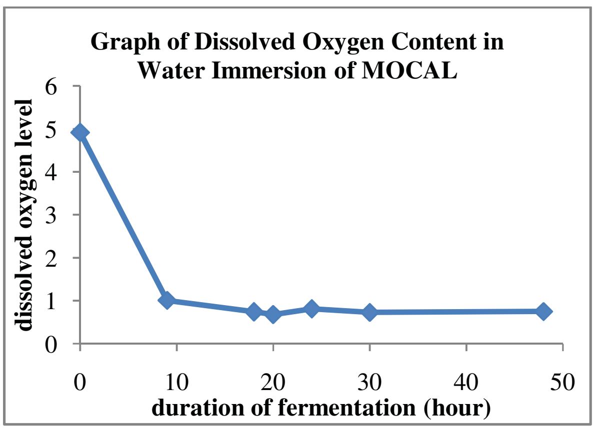

Figure 1. Graph of Dissolved Oxygen Content in Water Immersion of MOCAL

pH of the water immersion of MOCAL

Water immersion of MOCAL pH decreased during fermentation, it is caused by the compound of organic acids as a result of microbial metabolism during fermentation.

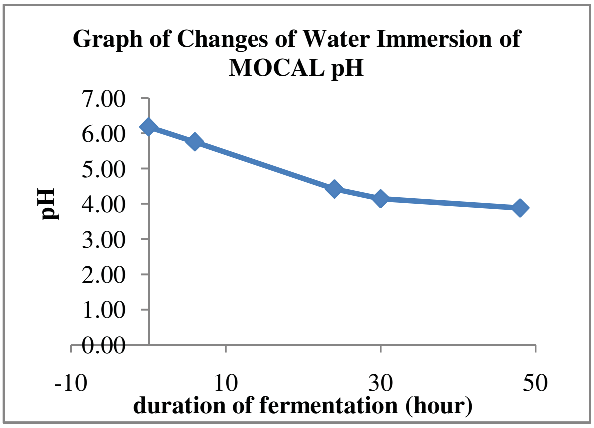

Figure 2. Graph of Changes of Water Immersion of MOCAL pH

Microbial Growth

Microbial growth was measured by turbidity water immersion of MOCAL. Turbidity values were converted into the total number of microbes using a conversion factor. During the fermentation process, there is an increase in the total number of microbes indicating microbial growth. Maximum microbial growth while the length of of fermentation reaches 30 hours and begun to decrease at 48 hours. This is caused the pH that was decreased to the limit of tolerance to be profitable for microbial, this would be toxic or lethal to the microbe.

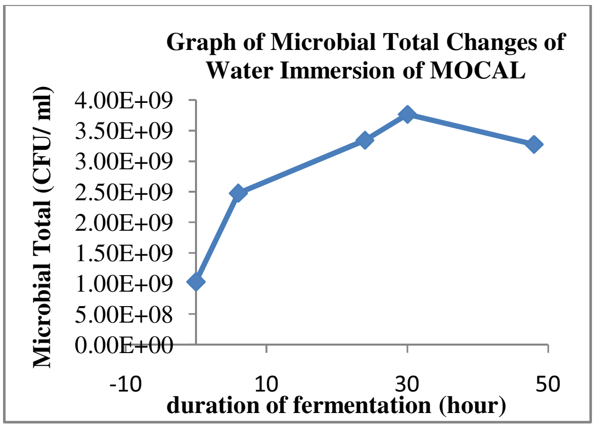

Figure 3. Graph of Microbial Total Changes of Water Immersion of MOCAL

Protein Dissolved

During the fermentation process, the breaking of cassava cell wall occurs which it causes the release of starch granules. In addition, proteins that had been trapped in the cell wall also liberated, resulting in increased content of soluble protein in the water immersion of MOCAL during fermentation.

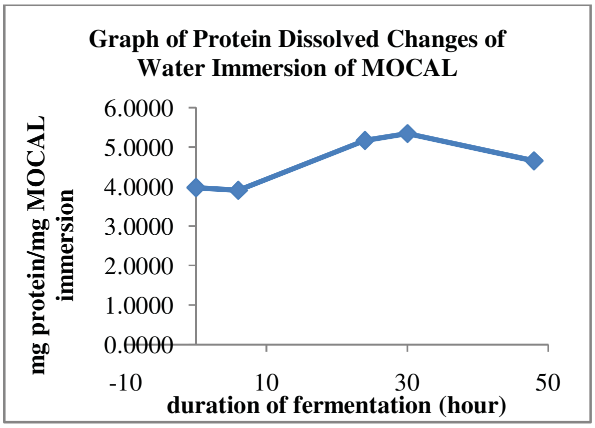

Figure 4. Graph of Protein Dissolved Changes of Water Immersion of MOCAL

Cellulose activity

Cellulose activity plays a role in degradation of cellulose in cell walls of cassava. The destruction of cell wall will affect the increasing number of granules that are separated out so it can affect some physico-chemical properties of cassava flour that will be generated. Cellulose activity was defined as the amount / concentration of glucose that is released (mg) per unit, while its specific activity is defined as the activity of cellulose per mg of protein sample. The longer duration fermentation process of MOCAL, cellulose activity is also higher.

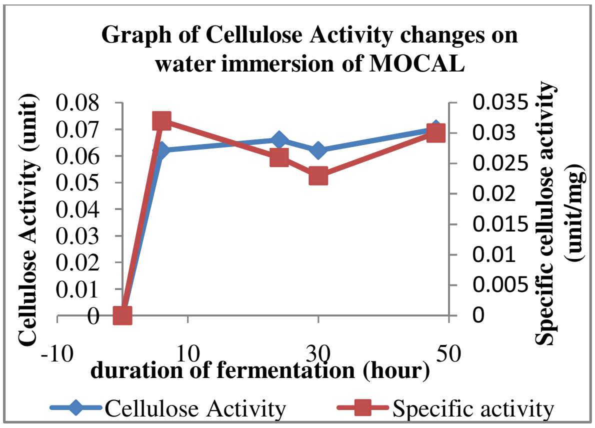

Figure 5. Graph of Cellulose Activity changes on water immersion of MOCAL

Amylase activity

One result of microbial metabolites produced during fermentation is MOCAL amylase enzyme. This enzyme specifically degrades amylase into simple sugars. Action of the enzyme amylase increased during the fermentation takes place and reaches a maximum at 30 hours the length of fermentation and then decreased during the fermentation process into 48 hours. This is caused by decreasing microbial growth and activity and also the reduced substrate (amylose) with increasing duration of fermentation.

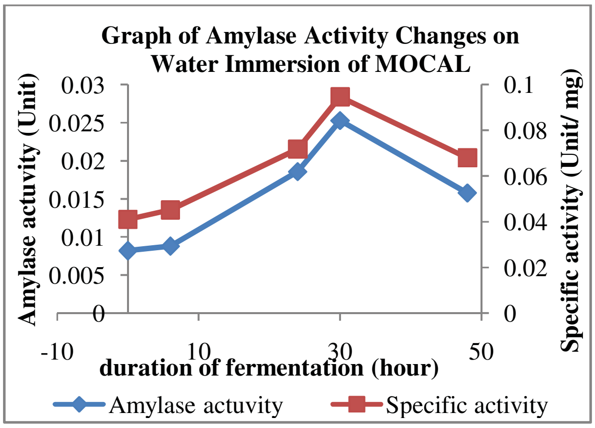

Figure 6. Graph of Amylase Activity Changes on Water Immersion of MOCAL

Measurements of Cassava Chips Texture

Pectinolytic and cellulolytic enzymes play a role in the breaking of the cell walls of cassava. These enzymes work are indicated by changes in the texture of cassava during fermentation. The texture of cassava more soften is growing along with the length of fermentation. While fermentation into 48 hours, the texture of cassava becomes too soft so it can not be measured.

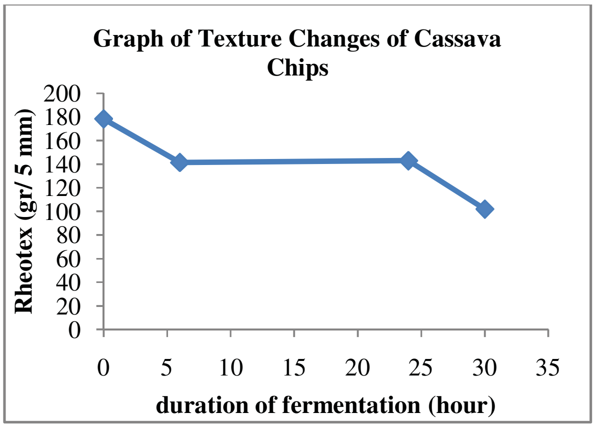

Figure 7. Graph of Texture Changes of Cassava Chips

Enzyme Activity in Softening Cell Wall

Pectinolytic and cellulolytic enzyme activity in breaking the cell walls are shown of the difference between the control texture with the samples texture. The greater differences between the two enzymes show their activity greater. At the time of fermentation lasted 6 hours, 24 hours and 30 hours, the activity of pectinolytic and cellulolytic enzymes are high then decreases when they enter the 48-hour fermentation. This is caused microbes entering the phase of stagnant and no longer actively producing pectinolytic and cellulolytic enzymes as before when they entered the 48-hour fermentation.

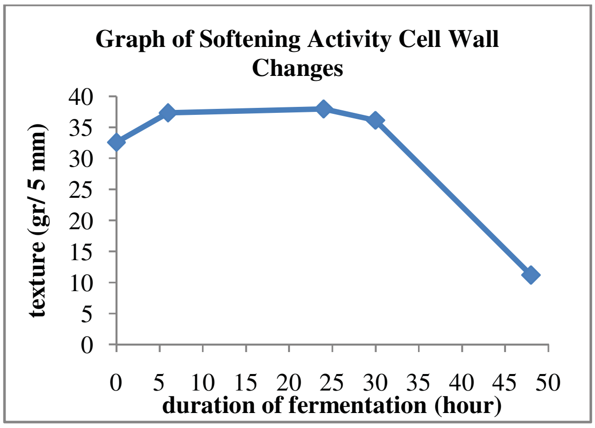

Figure 8. Graph of Softening Activity Cell Wall Changes

Conclusion

MOCAL fermentation process is a fermentation process where facultative anaerobic microbial growth reaches a maximum at 24-30 hours fermentation. During the fermentation of soluble protein content increased, the cellulose activity and amylase activity. During the process of fermentation, microbes produce pectinolytic and cellulolytic enzymes that play a role in cell wall degradation. The optimum fermentation time for enzyme activity was within 24-30 hours.

Suggestion

The study about the identification of microbes is required to play a role during the fermentation process of MOCAL. The studies about enzymes and other metabolites that may be produced during the microbial fermentation process are also required.

References

[1] ----------. , 2008. *Amylose.* http://id.wikipedia.org/wiki/Amilosa . accessed on March 20, 2008.

[2] ---------. , 2008. *Enzyme.* http://id.wikipedia.org/wiki/Enzim . accessed on March 20, 2008.

[3] Adney, B and Baker, J. 1996. *Measurement of Cellulose Activities.* LAP-006.

[4] Anonymous. 2007. *Food Resources - Starch.* [On line]. http://food.oregonstate.edu/-starch.html . Oregon State University Disclaimer. Accessed on January 1, 2008.

[5] Bennion, Marion. 1980. *The Science of Food.* New York : John Wiley & Sons.

[6] Buckle, K.A., R.A. Edwards, G.H. Fleet, M. Wootton. 1987. *Ilmu Pangan*. Jakarta : Universitas Indonesia Press.

[7] Caret, Denniston, Tooping. 1993. *Principles and Application of Inorganic, Organic and Biological Chemistry*. Wm.C.Brown Publisher : USA.

[8] Fardiaz, Srikandi. 1992. *Mikrobiologi Pangan I.* Jakarta : Gramedia Pustaka Utama.

[9] Gamman, K.B. Sherrington. 1994. *Ilmu Pangan : Pengantar Ilmu Pangan, Nutrisi dan Mikrobiologi*. Yogyakarta : Gajah Mada University Press.

[10] Giraud, E.A. Brauman, S. Keleke, L. Gosselin, and M. Raimbault. 2002. *A Latic Acid Bacterium With Potential Aplication in Cassava Fermentation*. Cassava Flour and Starch : Progress in Research and Development. Chapter 24.

[11] Riadi, L. 2007. *Teknologi Fermentasi*. Yogyakarta : Graha Ilmu.

[12] Subagio. 2006. *Ubi Kayu Subsitusi Berbagai Tepung-Tepungan*. Vol 1-Edisi 3. Food Review (April, 2006) : hal 18-22.

[13] Sudarmadji, S. 1998. *Prosedur Analisa Untuk Bahan Makanan dan Pertanian*. Yogyakarta : Liberty.

[14] Suliantari, Winiarti. 1990. *Teknologi Fermentasi Umbi-Umbian dan Biji-Bijian*. Bogor : Departemen Pendidikan dan Kebudayaan Direktorat Jenderal Pendidikan Tinggi Pusat Antar Universitas Pangan dan Gizi Institut Pertanian Bogor.

[15] Suwasono, S. 2006. *Teknologi Fermentasi*. Jember : Jurusan Teknologi Hasil Pertanian Fakultas Teknologi Pertanian Universitas Jember.

[16] Walker, JM. 2002. *The Protein Protocols Handbook 2nd Edition*. Human Press : New Jersey.

[17] West, Edward Staunton. 1961. *Textbook of Biochemistry*. New York : The Maxmillian Company.

[18] Winarno, F.G. 1995. *Enzim Pangan*. Jakarta : Gramedia Pustaka Utama.

[19] Winarno, F.G. 2002. *Kimia Pangan dan Gizi*. Jakarta : Gramedia Pustaka Utama.