Characterization of Wikau maombo Flour from Fermented Cassava (*Manihot utilissima*)

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***Abstract*—** Wikau maombo is a traditional food from Buton, Southeast Sulawesi. Cassava (*Manihot utilissima*) are processed and fermented into dried cassava known as "Wikau maombo". The manufacturing process of Wikau maombo flour includes peeling, washing, the immersion of sea water, fermentation, drying, milling and analyze the characteristic of Wikau maombo flour. The cassava was immersed for 3 h in sea water prior to fermentation in 1-4 days. Wikau maombo flours were characterized by FT-IR (Fourier Transform-Infra Red, XRD (X-Ray Diffraction) dan RVA (Rapid Visco Analyzer). FTIR analysis showed that the intensity of peaks in 1016, 1150, 1650, 2990 and 3390 cm^{-1} were found to decrease with a longer fermentation. Based on the XRD analysis, the crystallinity of Wikau maombo flour decreased as the fermentation time increase. RVA showed that Wikau maombo flour has a pasting temperature lower than wheat flour.

***Keywords*—** Wikau maombo, *Manihot utillisima*, cassava, fermentation, flour.

I. Introduction

Wikau maombo flour is one product that can be produced from cassava. Wikau Maombo flour is one of the utilization of cassava as local food, which manufacturing of Wikau maombo is easy. The process of Wikau maombo flour manufacturing through immersion in seawater, fermentation and then drying. Wikau maombo is a traditional food from Buton [12].

Cassava is directly marketed after being harvested and directly consumed without going through processing, nutritional value is still low. To improve the nutritional value of cassava, processing and modification of the cassava need to be done. Cassava products of major dietary importance in Ghana are gari, fufu, agbelima (cassava dough), kokonte and traditional starch production [2]. However, most of the introduced varieties have been abandoned because of poor cooking qualities [2]. The modification process of cassava is divided into two types namely: traditional and modern modifications [3]. Mocaf (Modified Cassava Flour) is flour derived from of cassava and modified it through a fermentation process, causing changes better characteristics, such as the increase in viscosity, gelation capability, power rehydration, and the ability to dissolve more quickly.

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Another example of fermented cassava product is Gari. Gari made from of cassava (*Manihot esculenta* Crantz) with the process steps are fermentation, pressing, and cassava mash sieved then fried [5]. Aryee et al. [10] reported that had made of cassava flour with 31 varieties, some examples of which is varieties of M82/00032, I93/0560, I82/0326, 91/02324 and 92/0427. The process of cassava flour manufacturing includes peeled manually with a knife, washed with tap water and chipped using a manual chipper, dried in a solar dryer, milled, and screened through a mesh sieve. Recently, manufacturing process of cassava flour has involved microorganisms in fermentation process. Some of microorganisms include *Rhizopus oryzae* [4], lactic acid bateria [5]-[9], *Aspergillus niger* [23] dan *Saccaromices cereviceae* [5].

Until now, the efforts to improve the quality of Wikau maombo flour are still very minimal done. So the study to improve the quality of Wikau maombo flour and analysis of flour characteristics is very important to do. This research will be conducted characterization of fermented Wikau maombo flour 1-4 days using FT-IR, XRD and RVA.

II. Materials and Methods

Cassava roots were obtained from Buton island, Southeast Sulawesi, Indonesia.

A. Immersion of cassava (Manihot utilissima) in sea water

The freshly harvested cassava roots were manually peeled with a knife, washed with tap water and chipped using a manual chipper. The pieces then immersed in seawater for 3 h. In order to remove mucus formed during immersion, cassava was washed with fresh water.

B. Fermentation of cassava

Cassava was fermented for 1, 2, 3 and 4 days. Fermentation of cassava was conducted by storing of cassava in closed condition. After fermentation was completed and then dried in oven at 60°C for 24 h.

C. Preparation of Wikau maombo flour

Preparation of flour Wikau maombo according to the procedure that have been conducted by Wahyuni et al. [12]. The process is grinding fermented cassava into powder, sieved (70 mesh) and dried at 60°C for 2 h. Fermented flour samples 1, 2, 3 and 4 days was denoted with WM1, WM2, WM3 and WM4, respectively.

D. Characterization of Wikau maombo flour

The IR spectrum was recorded in solid state condition using Fourier Transform Infrared spectroscopy (FTIR, Bruker IFS 113v) with the KBr/pellet ratio of 99 mg/1 mg.

The crystal phase of the fermented cassava was identified using X-ray diffraction (XRD, XDR JEOL JDX-3530) with Cu Kα (λ= 1.541 Å) radiation in 2θ from of 5-50° with scanning step of 0.04°/sec.

The pasting properties of the cassava flours upon heating and subsequent cooling were analysed by a rapid visco analyzer (RVA, Newport Scientific Warriewood, Australia) using RVA General Pasting Method (STD1). The experiment was carried out within 13 min in which the viscosity value was recorded every 4 seconds using Thermocline software as the temperature increased from 50 to 95 °C. The rotation speed was set to 960 rpm at the 10 sec initial and changed to 160 rpm until the end of the experiment. 3 g flour and 25 ml distilled water were placed into a canister. A paddle was then inserted and shaken through the sample before the canister was inserted into the RVA.

III. Result And Discussion

A. Preparation of Wikau maombo flour

Wikau maombo is a traditional food from Buton, Southeast Sulawesi. Buton's people process cassava with simple process is immerse in sea water and stored it for 24 h and then dried in the sun. In this study, the processing of Wikau maombo starting with clean the cassava and then cut into pieces. Pieces are immersed in seawater for 24 h until the texture of cassava is soft. Furthermore, cassava rinsed with fresh water to remove mucus formed during immersion. Furthermore fermentation in cassava conducted with variation of fermentation time 1, 2, 3 and 4 days.

Fermentation of Wikau maombo (10 cm) with storing cassava immersion results in basin using a cloth. In fermentation process of cassava involving lactic acid bacteria (LAB), which have amylolytic activity as has been reported by Putri et al. [7]. LAB addition to ferment the starch into lactic acid, also secrete extracellular amylase to hydrolyze starch into sugars that can be converted into lactic acid. The next process, fermented cassava reduced in size then dried at 60°C for 48 h. Furthermore, dried cassava milled to produce Wikau maombo flour with a size of 70 mesh. And then, flour obtained was characterized by FT-IR, XRD and RVA. Amirudin (2015) reported that Wikau maombo flour has moisture (%), ash, fiber (%), fat (%), protein (%) and carbohydrate contents (%) are 7.68, 1.05, 3.62, 0.63, 1:25 and 23:16, respectively.

B. FT-IR Analysis

FTIR analysis was used to determine the influence of the fermentation of starch through bond approach to the structure of the flour. The FTIR spectra of Wikau maombo flour are presented in Fig.1 in which all samples have the characteristics of peak in the band at 1016, 1150, 1650, 2990 and 3390 cm^{-1}. Kaewtatip dan Tanrattanakul [13] have reported that of cassava flour has a characteristic absorption at the band 3600–3000 (O–H stretching), 2933 and 2881 (C–H stretching of CH_2), 1190–950 (C–O stretching). Furthermore, the appearance of a strong absorption band at 1630 cm^{-1} confirms the presence of water [14]. The intensity of the peaks decreased as the fermentation time increased. Increasing the fermentation time caused amylolytic activity which can hydrolize the bonds of starch lowering the amount of the bonds in the samples. It can be note that 2, 3 and 4 days fermented sample reveal similar intensity.

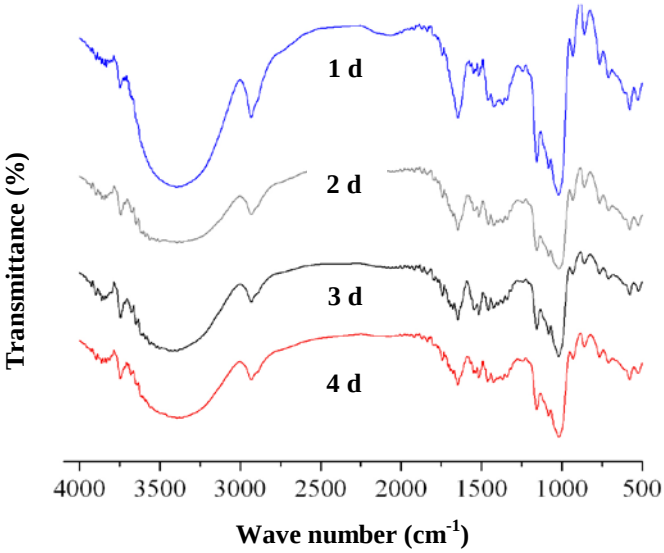

Fig. 1: FTIR spectra of Wikau maombo flour with fermentation time of 1–4 d.

C. XRD Analysis

The characteristic peaks of the Wikau maombo XRD pattern as given in Fig. 2. Peak characteristics of Wikau maombo flour at 2θ(°): 14.84, 16.64, 18.12 dan 22.88. Atichokudomchai et al.[16], Cavallini and Franco [17] and Gomes et al. [18] reported that Wikau maombo flour is a type A starch. The same results have been reported by Putri et al. [7] that cassava flour has characteristic peak at 2θ(°) i.e.: 15, 17, 18 and 23. Based on the diffractogram (Figure 2), the crystallinity was found to decrease (2θ: 14.84) with an increase in fermentation time indicating the sample became more amorphous during fermentation. Eliasson dan Gudmunsson [14] explained that the degradation of amylopectin as the starch component influenced the formation of crystalline parts in starch granules.

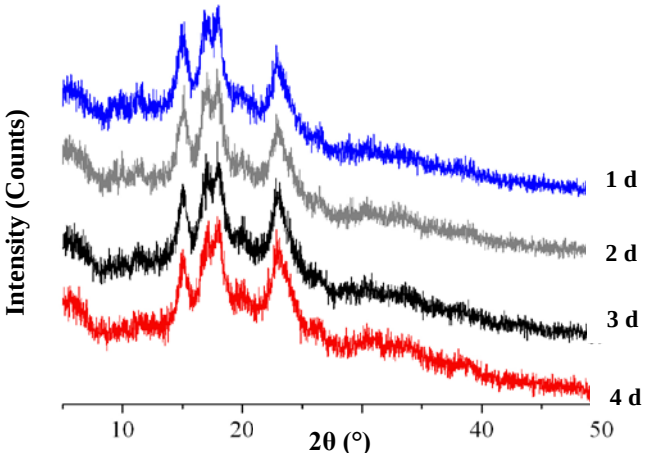

Fig. 2: XRD patterns of Wikau maombo flour with fermentation time of 1–4 d.

D. RVA Analysis

Gelatinization is a transition phase starch granules of regular shape to an irregular shape, during heating in excess water. The transition process involves a loss of crystallinity and birefringence and hydration of starch (Hermansson and Svegmark, 1996). Pasting is a phenomenon that follows gelatinization (Xie et al, 2006), shows the viscosity behavior that occur during process of heating and cooling at controlled stirring (Singh et al, 2003). Profile of pasta is one way to predict the functional properties of starch and its application in the development of optimal products (Chen, 2003). Pasting properties of cassava and wheat flour are shown in Table 1.

TABLE:I
PASTING PROPERTIES OF CASSAVA AND WHEAT FLOUR.

Samples	Peak viscosity (Cp)	Paste viscosity (Cp)	Final viscosity (Cp)	Breakdown (Cp)	Setback (Cp)	Pasting temp. (°C)	Peak time (min)
Wikau Maombo Flour							
WM1	3648	2236	3528	1412	1292	74.90	8.67
WM2	3709	2335	3549	1374	1214	74.90	8.47
WM3	3951	1628	2633	2323	1005	55.80	8.20
WM4	4148	1757	2841	2391	1084	76.90	8.13
Wheat Flour	2377	1254	2489	1123	1235	84.95	9.27

Based on Table 1 there was no significant relationship between the fermentation time with peak viscosity, paste viscosity, final viscosity, breakdown, setback and pasting temperature. Pasting temperatures associated with water imbibition and swelling granules. Peak viscosity showed granules ability to bind water and maintain swelling during heating [7]. Significant correlations shown by peak time and fermentation time, the longer the fermentation time, the lower of peak time value. The value of peak time expressed the time required for the sample granules swelling and binding water. If the longer fermentation, the starch granules less, so more quickly in water binding and swelling. The value of Wikau maombo peak time is lower than wheat flour, it is because wheat flour has higher protein content, so it has a greater ability to swelling and pasting temperature is high.

IV. CONCLUSION

Wikau maombo flour has been successfully produced from cassava (*Manihot utilissima*). Pasting temperature of Wikau maobo flour is smaller than wheat flour, so in manufacturing of products, Wikau maombo flour should be substituted with wheat flour to obtain better quality of product.

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REFERENCES

[1] F. I. Nweke, J. Aaleegoah, A. G. O. Dixon, O. Ajobo, B. O. Ugwu, and R. Al-Hassan, “Cassava Production In Ghana: A function of market demand and farmer access to improved product and processing technologies,” 1999 *COSCA-Collaborative study of cassava in Africa*, Working Paper No. 21, pp. 44–65.

[2] R. Tetebo, “Root, tuber crops and plantain at village and household leveis,” in *Proc. 1st National Workshop on Root, Tuber Crops and Plantation*, Ghana, 1991, pp. 71-78.

[3] Franco, Turmala, and L. Yusviani, “Sorpstion isothermis of shelled and unshelled kernels of candle nuts,” *Journal of Food Engineering*., vol. 75, pp. 447-452, 2012.

[4] G. Oboh, A. A. Akindahunsi, and A. A. Osodhi, “Nutrient and Antinutrient content of Aspergillus niger fermented cassava product (flour and gari),” *Journal of Food Composition and Analysis.*, vol. 15, pp. 617-622, 2002

[5] G. Oboh, and A. A. Akindahunsi, “Biochemical changes in cassava products (flour & gari) subjected to *Saccharomyces cerevisae* solid media fermentation.,” *Food Chemistry*, vol. 82, pp. 599-602, 2003.

[6] W. D. R. Putri, Haryadi, D. W. Marseno, and M. N. Cahyanto, “Effect of biodegradation by lactic acid bacteria on physical characteristics of cassava starch,” *International Food research Journal*., vol. 18, no. 3, pp. 1149-1154, 2011.

[7] W. D. R. Putri, Haryadi, D. W. Marseno, M. N. Cahyanto, “Role of Lactic Acid Bacteria on Structural and Physicochemical Properties of Sour Cassava Starch,” *APCBEE Procedia*, vol. 2, pp. 104 – 109, 2012.

[8] F. O. Ajibola, M. O. Edema, and O. B. Oyewole, “Enzymatic Production of Ethanol from Cassava Starch Using Two Strains of *Saccharomyces cerevisiae*,” *Official Journal of Nigerian Institute of Food Science and Techonology* NIFOJ., vol. 30, no. 2, pp. 114 – 121, 2012.

[9] F. F. Takizawa, G. O. da Silva, F. E. Konkel, and I. M. Demiate, “Characterization of Tropical Starches Modified with Potassium Permanganate and Lactic Acidm,” *Brazilian Archives Of Biology And Technology an International Journal*., vol. 47, no. 6, pp. 921-931, 2004.

[10] F. N. A. Aryee, I. Oduro, W. Ellis, and J.J. Oafuakwa, “The physicochemical properties of Flour samples from the roots of 31 varieties of cassava,” *Food Control*., vol. 17, pp. 916–922, 2006.

[11] Amirudin, “The Effect of Immersion Method and Fermentation Time on Quality of *Wikau Maombo* Flour (*Manihot utillisima*) and Determination of Shelf Life,” Final Project, Department of Food Science and Technology, Halu Oleo University, 2015.

[12] S. Wahyuni, Ansharullah, Saefuddin, Holilah, and Asranudin, “Effect of Fermentation on Physico-chemical Properties of Wikau maombo Flour,” *Journal of Food Measurement & Characterization*., Submitted Publication.

[13] K. Kaewtatip, and V. Tanrattanakul, “Preparation of cassava starch grafted with polystyrene by suspension polymerization,” *Carbohydrate Polymers.*, vol. 73, pp. 647–655, 2008.

[14] W. Tongdeesoontorn, L. J. Mauer, S. Wongruong, “Mechanical and physical properties of cassava starch-gelatin composite films,” *Journal of Polymeric Materials*., vol. 61, pp. 778–792, 2012.

[15] A. C. Eliasson, and M. Gudmunsson, “Starch: physicochemical and functional properties aspects,” in Carbohydrate in Food, A. C. Eliasson, ed. New York: Marcel Dekker, Inc, 1996, pp. 431-504.

[16] N. Atichokudomchai, S. Shobsngob, P. Chinachoti, and S. Varavinit, "A Study of some physicochemical properties of high-crystalline tapioka starch," *Starch/Starke*., vol. 53, pp. 577–581, 2001.

[17] C. M. Cavallini, and C. M. L. Franco, "Effect of acid-ethanol treatment followed by ball milling on structural and physicochemical characteristics of cassava starch," *Starch/Starke*, vol. 62, pp. 236–245, 2010.

[18] A. M. M. Gomes, C. E. Mendes da Silva, and N. M. P. S. Ricardo, "Effects of annealing on the physicochemical properties of fermented cassava starch (polvilho azedo)," *Carbohydrate Polymers*, vol. 60, pp. 1–6, 2005.

[19] A-M. Hermansson, and K. Svegmark, "Developments in the understanding of starch functionality – review," *Trends in Food Science & Technology*., vol. 7, pp. 345-353, 1996.

[20] F. Xie, H. Liu, P. Chen, T. Xue, L. Chen, L. Yu, P. "Corrigan, Starch gelatinization under shearless and shear conditions," *International Journal of Food Engineering*., vol. 2, pp. 5, Art.6, 2006.

[21] N. Singh, J. Singh, L. Kaur, N. S. Sodhi, and B. S. Gill, "Morphological, thermal and rheological properties of starches from different botanical sources–review," *Food Chemistry*, vol. 81, pp. 21 9-231, 2003.

[22] Z. Chen, "Physicochemical Properties of Sweet Potato Starches and Their Application in Noodle Products," Ph.D Thesis Wageningen University, 2003.

[23] A. O. Oso, L. Li, B. Zhang, R. Uo, J. X. Fan, S. Wang, G. Jiang, H. Liu, T. Rahu, M. C. Tossou, V. Pirgozliev, O. O. Oduguwa, and A. M. Bamgbose, "Effect of fungal fermentation with Aspergillus niger and enzyme supplementation on metabolisable energy values of unpeeled cassava root meal for meat-type cockerels," *Animal Feed Science and Technology*., Accepted Manuscript, 2015.