Modified cassava flour (MOCAF) content of cassava (*Manihot esculenta* CRANTZ) in North Sumatera

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Abstract. Research on Modified Cassava Flour (MOCAF) content in three cassava genotypes has been carried out at Laboratorium Sekolah Tinggi Penyuluh Pertanian, Jl. Binjai Km 10 Medan in November 2014. The research objective was to determine the MOCAF yield produced based on cassava genotypes in North Sumatra. Two genotypes and one variety of cassava were used as samples, Adira-1 (V1) variety, Malaysia (V2) and Merah/Gondoruwo (V3) genotypes. Fermentation using BIMO-CF starter with 24 hours soaking time. The results showed that MOCAF yield of three genotypes/varieties ranged from 33-38%. The highest yield was found in Malaysia genotype, followed by Merah/Gondoruwo and Adira-1, respectively 38%, 35% and 33%.

1. Introduction

Modified Cassava Flour (MOCAF) comes from cassava flour which has been modified with fermentation treatment. According to [1] MOCAF is different from cassava flour which is produced without fermentation, for example cassava flour and tapioca flour. Modified Cassava Flour has several advantages including having higher protein content and better physicochemical properties.

Currently MOCAF is one of the superior products processed by cassava which can support national food security. The characteristics of this flour resemble to wheat. Fermentation process during cassava processing makes MOCAF as a flour that has good quality, such as odourless, smoother, whiter and longer lasting. Therefore, MOCAF can be used as a substitute for the role of wheat flour in the range of 30-100% depending on the type of product to be produced [2].

The discovery of MOCAF manufacturing technology has made a very important contribution to Indonesia considering that Indonesia has long been a country that import wheat flour. Throughout 2012, Indonesian imported 6.3 million tons with a value of US $ 2.3 billion. In 2010 it still imported 4.8 million
tons with a value of US $ 1.4 billion, so that within 2 years there had been an increase in imports of 1.5 million tons or US $ 0.9 billion [3]

MOCAF industry optimization in North Sumatra needs to be supported by the increasing production of fresh cassava materials [4]. Increasing cassava production needs to be continued with various efforts, such as through the selection of genotypes or varieties that have high yield potential.

There were at least 8 genotypes/varieties of cassava widely cultivated in North Sumatra. The MOCAF manufacturing units in Deli Serdang and Serdang Bedagai Districts, North Sumatra Province generally do not determine cassava genotypes as sources raw material [5]. Basically, all types of cassava can be processed into MOCAF. According to [6] in terms of quantity, the yield of MOCAF produced from fresh storage root was 25-30%. Differences in characteristics among cassava genotypes allow for differences in producing MOCAF. Therefore, it is necessary to examine the levels of MOCAF that can be produced by cassava genotypes or varieties so that it can be used to determine which genotypes or varieties have the most potential as an optimization effort for MOCAF industry in North Sumatra.

2. Materials and methods

The study was conducted at the Laboratory of Agricultural Extension College, Binjai Road Km 10 Medan in November 2014. The purpose of the study was to analyze the levels of MOCAF produced based on cassava genotypes/varieties in North Sumatra.

The material used in this study was 1 kilogram of fresh storage root which has been peeled from three types of cassava plants, namely Adira-1 variety (V1), Malaysia genotype (V2) and Merah/Gondoruwo (V3) genotype, harvested at 10 months after planting. The material used for fermentation was the Starter Biologically Modified Cassava Flour (BIMO-CF). The tools used were knives, chopper, plastic buckets, scales and slats for drying.

The research method is quantitative by calculating the MOCAF levels produced per 1 kilogram of fresh storage root harvested at the age of 10 months.

As much as 1 kilogram of peeled fresh storage roots were chopped using a slicer. The chips were soaked into 1 litre of water which has been added 1 gram BIMO-CF Starter. Soaking was carried out for 24 hours. Chips were drained and dried (approximately 4 days of actual sun drying). The thin and dry cassava slices called cassava chips are ready to be processed into MOCAF by fine pounding and sifting. The stages of MOCAF flour production follow the procedure of [7]: 1) Sorting and Weighing, 2) Stripping, 3) Washing, 4) Slicing/chipping, 5) Fermentation/Soaking, 6) Washing, 7) Drying, 8) Weighing, 9) Siege, 10) Sifting.

3. Results and discussions

The results of the MOCAF yield analysis produced from Adira-1 variety, Malaysia genotype and Merah/Gondoruwo genotype harvesting age of 10 months after planting were presented in Table 1.

Table 1. MOCAF levels per 1 kilogram fresh storage roots from three cassava genotypes 10 months after planted (MAP)

| Genotypes            | Rendemenet (kg) | Total | Average | Stdv | %  |
|----------------------|-----------------|-------|---------|------|----|
|                      | I   | II  | III | IV  |     |    |      |
| V1 (Adira-1)         | 0.30 | 0.30 | 0.33 | 0.39 | 1.31 | 0.33 | 0.04 | 33  |
| V2 (Malaysia)        | 0.39 | 0.36 | 0.37 | 0.39 | 1.50 | 0.38 | 0.02 | 38  |
| V3 (Merah/Gondoruwo) | 0.34 | 0.36 | 0.32 | 0.39 | 1.41 | 0.35 | 0.03 | 35  |

Table 1 shows that in one kilogram of fresh storage root can be produced between 0.33 to 0.38 kg of MOCAF depending on genotype. Malaysia genotype produced the highest MOCAF which was 0.38 ± 0.02 kg, followed by Merah/Gondoruwo genotype of 0.35 ± 0.03 kg and Adira-1 variety 0.33 ± 0.04 kg. Overall, the cassava genotypes/variety studied were able to produce MOCAF 33-38%. This result is
higher than [8] statement which yields 25-30%. [9] analyzed 4 varieties of cassava (Manggu, UJ-5, Butter, Perelek) by using BIMO-CF as starter with 18-hour immersion. The study resulted in a yield of Manggu, UJ-5, Butter and Perelek sequentially at 23.90%, 24.40%, 25.29% and 24%.

The level and quality of MOCAF is determined by many factors, including the genotype/variety of cassava [9], the age of harvest, the duration of soaking fermentation [10], the starter [11]. The material used in this research were Adira-1, Malaysia and Merah/Gondoruwo cassava plants which were planted in January 2014 and harvested in November 2014 (age 10 months). Determination of the measurement of MOCAF levels at the age of 10 months on this study was based on the results of several studies on the relationship of harvest age with starch levels in cassava. MOCAF levels are strongly related to cassava water content. [12] explained the difference in water content in cassava harvested at different ages. The longer the age of cassava harvested, the smaller water content contained in it. The increase in harvest age is followed by the increase in starch granules and other non-starch components, thereby reducing water content.

Research related to the quantity and quality of MOCAF had been widely carried out. [11] using *Saccharomyces cerevisiae*, *Rhizopus oryzae* and *Lactobacillus plantarum* by soaking for 3-5 days could increase the average protein content of 5.19%, fat 3.4% and reduce HCN levels by 2.48 mg/kg. [13] reported the duration of fermentation did not affect the water content but affected the yield, starch content and texture. [14] increasing immersion time up to 72 hours could increase protein content of 3.39%.

[15], [16] explained that fresh cassava has an average moisture content of about 60%, 35% starch, 2.5% crude fibre, 1% protein, 0.5% fat and 1% ash. Cassava was classified as a potential carbohydrate source as food. Fresh storage root also contains cyanogenic glucoside compounds and produces glucose and cyanide acid (HCN) in oxidation process by linamarase enzyme which are marked with blue spots. This compound is toxic especially when HCN levels more than 50 ppm.

Decreasing HCN levels and MOCAF quality improvements have been carried out through research. According to [17] immersion could reduce HCN levels of clones/varieties of CMM 99008-3, OMM 9908-4, at 54% and 43%. [11] stated that HCN levels in MOCAF tend to decrease during the fermentation process. The lowest HCN content in fermented MOCAF using *Lactobacillus plantarum* was obtained in 5 days fermentation, which was 1,800 mg/kg, while *Saccharomyces cerevisiae* and *Rhizopus oryzae* were obtained in 3 days fermentation, 2,850 mg/kg and 2,775 mg/kg consecutively. The same research was also reported by [10].

Processing of storage root into MOCAF increases the function of cassava as a food base. The characteristics of MOCAF that resembles to wheat flour open up opportunities as substitutes for making flour-based foods, such as cakes, biscuits, cookies and others. Further research on cassava genotypes/varieties in North Sumatra needs to be done. In addition to the MOCAF rendering percentage it is very important to know the quality of MOCAF produced by each genotype/variety. Processing of cassava into MOCAF is the best alternative to reduce dependence of Indonesia on wheat imports. With intensive research, it is expected that MOCAF can play a role as a substitute for flour in order to realize food sovereignty in Indonesia.

4. Conclusion
Adira-1 variety, Malaysia genotype and Merah/Gondoruwo genotype harvested at 10 months, fermented with BIMO-CF starter for 24 hours produced MOCAF yields of 33-38%. Malaysia genotype produced the highest percentage followed by Merah/Gondoruwo and Adira-1 genotypes, respectively 38%, 35% and 33%.

References
[1] Darmawan R M, Andreas P, Jos B and Sumardiono S 2013 Modifikasi ubi kayu dengan proses fermentasi menggunakan starter *Lactobacillus casei* untuk produk pangan [Cassava modified through fermentation process by *Lactobacillus casei* for food product] *Jurnal Teknologi Kimia dan Industri* 2 pp 137-45
[2] Agribusiness, Biotechnology and Agricultural Machinery Consultant 2012 Mengolah singkong menjadi tepung mocaf (Processing cassava into mocaf flour) http://www.agrotekno.net/2013/09/mengolah-singkong-menjadi-tepung-mocaf.html (Accessed on January 12, 2014)

[3] Badan Pusat Statistik [Statistic Beureu] 2013 Sumatera Utara, Indonesia

[4] Badan Pusat Statistik [Statistic Beureu] 2014 Sumatera Utara, Indonesia

[5] Kardhinata E H 2011 Inventarisasi dan identifikasi jenis-jenis ubikayu di dataran rendah dan dataran tinggi Sumatera Utara [Inventory and identification of lowland and upland cassava in North Sumatra] [Doctoral Program Agriculture] (Medan: Universitas Sumatera Utara)

[6] Suismano 2003 Hasil-hasil penelitian pengembangan industri pengolahan ubi-ubian (ubi kayu dan ubi jalar) dengan teknologi pedesaan [The results of research on the development of processing industries of cassava (cassava and sweet potato) with rural technology]. Makalah Pertemuan Koordinasi Pengembangan Produksi Umbi-umbian (Ubi kayu dan Ubi jalar) [Paper Production Development Coordination Meeting Papers (Cassava and Sweet Potato)] (20–21 Oktober 2003, Bandar Lampung)

[7] Damardjati D S, Sutrisno, Santosa, Widowati S and Suismano 1994 Petunjuk praktis pembuatan tepung kasava (pembangunan jangka panjang) [Practical guide for modified cassava production (Long term development)] Balitlit Sukamandi [Sukamandi Research and Development Board]

[8] Suismano 2003 Hasil-hasil penelitian pengembangan industri pengolahan ubi-ubian (ubi kayu dan ubi jalar) dengan teknologi pedesaan [Research for processing industrial development of tuber crops (cassava and sweet potato) by rural technology] Makalah Pertemuan Koordinasi Pengembangan Produksi Umbi-umbian (Ubi kayu dan Ubi jalar) [Conference paper of tuber crops production development coordination (cassava and sweet potato)] (Bandar Lampung)

[9] Lestari S 2017 Kajian pengolahan tepung MOCAF pada empat varietas ubi kayu menggunakan starter bimo-cf dan lama perendaman 18 jam [Study of MOCAF flour processing on four cassava varieties using bimo-cf starter and 18-hour soaking time] Prosiding Seminar Nasional Agroinovasi Spesifik Lokasi Untuk Ketahanan Pangan Pada Era Masyarakat Ekonomi ASEAN [Proceedings of the Specific Location Agro-innovation national seminar for food security in the ASEAN economic community]

[10] Amanu F N and Wahono H S 2014 Pembuatan tepung MOCAF di Madura (kajian varietas dan lokasi penanaman) terhadap mutu dan rendemen MOCAF [Production MOCAF flour in Madura (study of varieties and location of planting) on the quality and yield of MOCAF] Jurnal Pangan dan Agroindustri 2 pp 161-9

[11] Kurniati L I, Nur A, Setiyo G and Tri W 2012 Pembuatan MOCAF (Modified Cassava Flour) dengan proses fermentasi menggunakan Lactobacillus plantarum, Saccharomyces cerevisiae, dan Rhizopus oryzae [Processing of MOCAF through fermentation with Lactobacillus plantarum, Saccharomyces cerevisiae and Rhizopus oryzae] Jurnal Teknik Pomits 11 pp 1-6

[12] Susilawati S, Nurdjanah and S Putri 2008 Karakteristik sifat fisik dan kimia ubikayu (Manihot esculenta) berdasarkan lokasi penanaman dan umur panen berbeda [Characteristics of physical and chemical properties of cassava (Manihot esculenta) based on the location of planting and different harvest ages] Jurnal Teknologi Industri dan Hasil Pertanian 13 pp 59-72

[13] Nusa M I, Budi S and Alfiah 2009 Pembuatan tepung MOCAF melalui penambahan starter dan lama fermentasi (Modified Cassava Flour) [Production MOCAF flour through the addition of a starter and time of fermentation (Modified Cassava Flour) Jurnal Agrium 17 pp 210-17

[14] Tandrianto J, Doniarta K M and Setiyo G 2014 Pengaruh fermentasi pada pembuatan MOCAF (Modified Cassava Flour) dengan menggunakan Lactobacillus plantarum terhadap Kandungan Protein [ Effect of fermentation on the manufacture of MOCAF (modified cassava flour) using Lactobacillus plantarum for protein content] Jurnal Teknik Pomits 3 pp 143-5

[15] Bradbury J H and Holloway W D 1988 Chemistry of Tropical Root Crops (Canberra) (Australia: Australian Centre for International Agricultural Research) pp 101-19
[16] Cardoso A P, Mirione E, Ernesto M, Massaza F, Cliff J, Haque M R and Bradbury J H 2005 Processing of cassava roots to remove cyanogens J. Food Compos. Anal. 18 pp 451-60

[17] Yulianti R and Erliana G 2011 Karakteristik tepung MOCAF dari beberapa varietas/klon ubi kayu [Characteristics of MOCAF flour from some varieties/clones of cassava] Seminar proceeding result of various peanut and tuber crops research pp 621-9