Physico-Chemical and Sensory Properties of Kelanting Made From High Quality Cassava Flour

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Abstract. Kelanting, a traditional snack food, usually made from fresh cassava roots. In this study we tried to modified the kelanting processing by replacing fresh cassava roots with high-quality cassava flour in order to improve the processing method primarily in raw material stocking. Kelanting produced from high-quality cassava flour were subjected to sensory evaluation using attributes included color, aroma, crispiness, taste, and overall acceptance on a 10-point scoring scale. The best kelanting was found in a 210 and 240 min of drying, with the sensory mean scores of 8.15, 7.15, 6.75, 6.8, and 7.7 were obtained correspondingly for crispness, color, aroma, crispiness, taste, and overall acceptance. Scores for these attributes indicated that the kelanting were acceptable. The study showed the suitability of high quality cassava flour for replacing the cassava roots in kelanting processing

1. Introduction

Indonesia's cassava production in 2015 was 21.8 million tons. While the Lampung region contributed to cassava production of 7.38 million tons with a harvest area of 279 thousand hectares[1] (BPS, 2016). Cassava plants are spread throughout the Lampung region, one is in Palas District, South Lampung Regency with a harvest area of 302 ha and a productivity of 6,531 tons, includes both of industrial and sweet cassava types. Although there is no specific data on total production, fresh sweet cassava (HCN content of less than 40 mg / kg) has long been used as a raw material for snacks such as kelanting processing.

The use of fresh cassava as a raw material for kelanting has various disadvantages. For example fresh cassava roots are very susceptible to postharvest physiology deterioration, and it only has a shelf life of between 3-4 days [2,3,4,5,6]. In addition, the quality could be changed due to differences in harvest time[7]. One alternative to prolong cassava shelf life is processing them into flour. This is because flour has a low moisture content which is around 12% (SNI 01-2997-1992). So that in the form of flour the availability of raw materials is more guaranteed in term of uniformity of quality and continuity.

However, traditionally processed cassava flour often has unfavorable qualities when used as raw material for processed food. Cassava flour is often musty-smelling and brownish in color which affects the quality of its end processed products. Another example is tiwul or oyek products which are processed from traditional cassava flour which hardens after it has cooled. The emergence of musty smell can be caused by further reactions of the cyanogenesis process. While the texture hardening is caused by the amylose retrograde process[8,9].

Efforts to improve the quality of tuber flour have been carried out, including screening of varieties and genetically modified[10,11,12]; MOCAF[13] fermentation, enzymatic[14], Heat-Moisture Treatment / HMT [15], and chemical additions. Chemical modification is not a favourable option because of its potential long-term effects, not good for health[16]. Whereas variety screening and genetic engineering, enzymatic treatment and HMT physical treatment are relatively difficult to be applied by small and medium scale industry (MSME) industries. Therefore, we need a simple technology for cassava flour modification technique that is easily adopted. The research was aimed to modify the technique of making cassava flour through crushing, pressing, re-crushing then drying at 50ºC by direct stirring simultaneously using a hot plate. The flour is expected to be suitable when used as a raw material for kelanting processing to replace the traditional method where kelanting is made from fresh cassava. It is expected that replacing fresh root with flour, will provide uniformity and continuous availability of raw materials. The urgency of this research is to provide alternatives for small or home food industries such as kelanting industry or similar products which usually use fresh cassava for raw materials which cannot be stored for a long time after harvest.

2.Materials and Methods

The cassava (Manihot esculenta C.) with a variety of Mentega, age of 7-8 months after planting was obtained from the District of Palas, South Lampung Regency, and the chemicals P.A. grade used for the analysis were purchase from local supplier.

Some of the equipments used were shader, hydraulic press, analytical balance, SEM, Brabender Viscoamylograph, deep frying pan , desiccator, furnace oven, , Soxhlet extraction, and micro Kjeldahl apparatus.

2.1 *High quality cassava flour preparation*

The process of making cassava flour starts with sorting cassava to get cassava with good quality. Cassava used was fresh cassava with a harvest age around 8 months. After being harvested, cassava was transported to the Laboratorium (about 2 h-journey) stripped to remove the outer skin and inner skin using a knife and then washed, and grated using a cassava grater machine. Then grated cassava was pressed with 10 Ton hydraulic presser machine until no water comes out from the crushed cassava. Furthermore, the cassava was sifted so that there was no lumps of cassava which are then dried at around 50 °C on top of a toaster. The dried cassava flour is sifted with a 60 mesh siever.

2.1.1 C*hemical analysis of flour.* Chemical analysis: Proximate compositions of cassava high quality cassava flour including moisture, ash, protein and fat contents were determined by following standard methods of AOAC[17].

2.1.2 *SEM analysis.* Granule micrographs were acquired using FEI Scanning Electron Microscope (SEM) type Inspect S50, EDAX AMETEK. Sample powder was placed in a double-sided carbon taped holder, then coated with Au-Pd using sputter coater (Emitech SC7620). The micrographs were obtained with an accelerating voltage of 15.00 kV.

2.1.3 *Pasting properties.* The pasting properties were measured using Brabender Viscograph E (USB) Version 4.4.1. About 30 g moisture-free sample (db) was suspended in 470 ml distilled water to prepare slurry in a large beaker. The suspension of the starch was mixed thoroughly and poured into the measuring bowl of the Brabender Viscograph. The test was run at a speed of seventy five (75) revolution per minute with a measuring range of 700 cmg. The temperature profile of the analysis was programmed to commence measurement at a temperature of 50°C with heating at the rate of 1.5°C/min up to a temperature of 92°C. The temperature of the sample was held constant for 15 minutes and then cooled at the rate of 1,5°C/min to a temperature of 50°C. This temperature was also held constant for ten (10) minutes. The parameters recorded from the curve include: the time, temperature and viscosity at the beginning of gelatinization, maximum viscosity, start of holding period, start of cooling period, end of cooling period, and at the end of final holding period as well as breakdown and set back viscosities [18]. The measurements were done in two replications

2.2 Kelanting preparation

Kelanting was prepared by mixing cassava flour with water and finely ground garlic and salt. The ingredients then were mixed thoroughly and then homogenised using hands until smooth dough was formed. Then the homogeneous dough was shaped like a ball weight approximately of30 grams , then steamed for 30 minutes. Furthermore, the cooked dough was allowed to stand until it cools for about 30-60 minutes. After cooling, the dough was passed into a grinder machine to form long cylindrical strands, then they were cut into 10 cm- long strands using scissors. The strands were form into a zero-shape manually, then dried in an oven at 50°C for 90 minutes, 120 minutes, 150 minutes, 180 minutes, 210 minutes and 240 minutes. After drying process, the kelanting were allowed to stand for 30 minutes at room temperature then deep fried , drained, and packed for further analysis.

2.2.1 Sensory analysis. The sensory analysis was performed on texture, taste, aroma, color and overall acceptance. Assessment of texture, taste, aroma, color were done using a scaling test while for overall acceptance was done by a hedonic test. Sensory tests were conducted by 50 untrained panelists for the hedonic test and 20 semi-trained panelists (students who had taken a sensory test course) for the scaling test [19].

2.2.2 Experimental design, The experiment was arranged in a completely randomized block design with 4 replications, except for SEM and the pasting properties. The treatments were 6 levels of heating time of kelanting, which were were 90 minutes (P1), 120 minutes (P2), 150 minutes (P3), 180 minutes (P4), 210 minutes (P5) and 240 minutes (P6). The data, except for pasting properties, were analyzed using Analysis of variance (ANOVA) to test the effect of the treatments, then further tested using Duncan Multiple Raange Test at $p<0.05$ to see significant differences among treatments. The pasting properties data were calculated for their standard deviation because we only did two replications, and therefore not valid for ANOVA analysis.

3. Results and Discussion

3.1 *Chemical and physicochemical properties of flour*

The chemical and physicochemical of the yellow cassava flour processed using pressing machine then roasted PRF), or processed traditionally through sun-dried cassava chip (SDF) , and starch were shown in Table 1.

Table 1. Chemical and physicochemical characteristic of yellow cassava flour and strach

Parameters	Yellow pressed and roasted cassava flour (PRF)	Yellow Sun-dried cassava flour (SDF)	Yellow Cassava starch
Moisture (%, db)	10.90 ± 0.67	10.63 ± 0.76	8.73 ± 0.69
Ash (%,db)	1.20 ± 0.02	1.13 ± 0.02	1.06 ± 0.01
Starch (%, db)	74.74 ± 4.16	75.74 ± 3.6	94.51± 3.3
Amylose (%,db)	7.12 ± 0.41	7.51 ± 0.51b	9.03 ±2.71
Swelling power (%0	54.24 ± 3.76	55.64 ± 4.24	56.05 ± 4.16
Solubility (%)	0.08 ± 0.006	0.07 ± 0.009	0.07 ± 0.008
Total carotenoid µg/g	3.56	0.26	Not detected

3.2 *SEM of granular appearance of flour*

Scanning electron micrographs of pressed and roasted-cassava flour (PRF), sun-dried cassava flour (SDF) , and cassava starch did not show structural differences. The average particle size was16 µm. The flour contains starch granule which are round, spherical with different size, and surrounded by cell wall material (Figure 1 a, b,c).

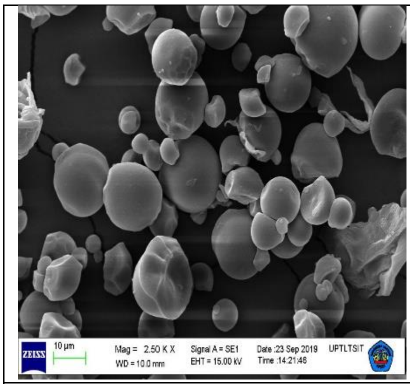

Figure 1a. Yellow Pressed cassava flour

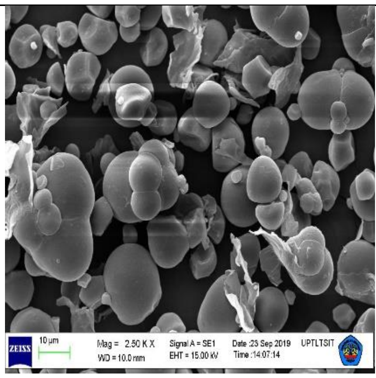

Figure 1b. Yellow Sun-dried cassava flour

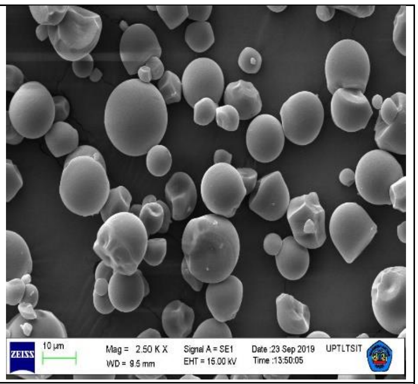

Figure 1c.Yellow Cassava starch

3.3 *Pasting properties of flour*

The pasting properties of PRF, SDF, and cassava starch are shown in Table 2. The beginning of gelatinization temperature varied slightly between 69.8 and 69.9 °C for PRF and SDF, whereas that of for starch was slightly lower (68.5°C) ,. The maximum viscosity of PRF showed the highest, followed by that of starch and SDF. Maximum viscosity shows the maximum swelling of the starch granule prior to disintegration, the peak viscosity is achieved when swelling and breakdown of the granules are in equilibrium stage. The higher peak viscosity in PRF could be caused by contribution of cellulose and other cell wall materials such as hemicellulose and pectin in absorbing water and swelling ability.

Table 2. Parting properties of PRF, SDF , and cassava starch

Sampel	PRF	SDF	Cassava starch
Start of gelatinization temperature °C	69.8 ± 0.4	69.9 ± 0.3	68.5 ± 0,2
Maximum viscosity	480 ±1.9	334 ±1.5	408 ± 1.6
Start of holding period	416 ±0.9	333 ±1.1	321 ±1.2
Start of cooling period	276 ±0.6	235 ±0.7	195 ±0.8
End of cooling period	446 ±1.1	358 ±0.9	285 ±0.9
End of final period	452 ±1.2	342 ±1.2	275 ±0.4
Breakdown	204 ±0.9	99 ±0.5	213 ±0.4
setback	170 ±0.5	123 ±0.6	90 ±0.3

3.4 *Moisture content and sensory properties of kelanting*

3.4.1 *Moisture content.* The moisture content of dry-unfried kelanting made from PRF was significantly affected by drying time ($p<0.05$). In general, the longer the drying time resulted in lower the moisture content (Table 3). This difference is thought to be due to the shorter drying time causes the less movement of water from the material to the environment. Drying is influenced by temperature and drying time, where drying with low temperature and short drying time causes the water bound in the material does not evaporate optimally so that the moisture left in the material is still higher compared to other treatments exposed to longer drying time.

Table 3. Moisture content of kelanting made from PRF dried at different drying time

Treatments (min)	Moisture (%, db)
90	22.7^{f}
120	18.79^{e}
150	16.65^{d}
180	15.6^{c}
210	14.1^{b}
240	12.64^{a}

3.4.2 *Sensory properties of kelanting.* Table 2 presents the mean scalar-scoring for the attributes of crispness, color, aroma, taste, and overall acceptance. Various drying time at 50°C significantly affected crispness and overall acceptance, but did not affect color, aroma and tase of kelanting made from PRF ($p<0.05$). The highest or full scalar-score of 10 (1= hard and 10= very crispy) was used as the reference sampel taken from commercial kelanting. The result indicates texture in term of crispness is a main attribute that influence the overall acceptance of kelanting. The crispness of kelanting dried for 90 min, 120 min, and 150 min had scores of 5.31-6.76 , described as less crispy while those of dried for 180 min, 210 min, and 240 min had scores of 7.4-8.61 described as crispy. This infers that the crispness of the kelanting processed from PRF was generally acceptable to the panellists. The significant difference of the cripness among kelanting was due to the moisture content in the ingredients. The amount of water evaporated during frying affects crispness of the kelanting. The water which was not evaporated during frying will cause the kelanting less crispy or even hard. Heating with a shorter time did not maximally evaporate the water in the material, and this lead to the hardness of the kelanting. high water content in products can affect the texture and volume expansion. Crispness in fried kelanting arises due to the formation of air cavities in the development process during the frying process. This can be caused by the vapor pressure formed during frying, the water content in kelanting due to an increase in temperature when frying causes the kelanting structure to form a product that expands but is easily broken, or called crispy.

Results showed that drying time did not affect the color of kelanting. The scalar-scores of kelanting color were in the range of 6.46-7.19 and described as slightly yellow. This was partly due content of beta-carotene in cassava variety of Mentega. In addition to cassava carotene content, the slight yellow color was also caused by non-enzimatic browning reaction due to frying.

The aroma and the taste of kelanting were not affected by drying time. The aroma of kelanting ranged from 6.45 to 6.79 (typical of cassava), and the taste scalar-scores were between 6.45 - 6.79. These infer that flavor components of cassava was only slightly degraded during processing of kelanting.

The results showed that drying time significantly affected the acceptance of kelanting made from PRF. Overall acceptance score of kelanting dried for 90 min, 120 min and 150 min were between 5.58-6.56 , described as like while those heated for 180 min, 210 min, and 240 min had the score of 6.89-7.95 , described as like very much. The acceptance for kelanting is directly proportional to the crispness .

Table 2. Sensory evaluation of texture, color, aroma, taste and overall acceptance of kelanting*

Treatment (min)	Texture/Crispness	Color	Aroma	Taste	Overall acceptance
90	5.3 ^{e}	6.4^{a}	6.5^{a}	6.4^{a}	5.8 ^{e}
120	6.1^{d}	6.5^{a}	6.5^{a}	6.5^{a}	6.2^{dc}
150	6.8^{cd}	6.5^{a}	6.6^{a}	6.6^{a}	6.6 ^{c}
180	7.4^{bc}	6.7^{a}	6.7^{a}	6.7^{a}	6.9 ^{bc}
210	7.9^{ab}	7.1^{a}	6.7^{a}	6.8^{a}	7.5^{ab}
240	8.4^{a}	7.2^{a}	6.8^{a}	6.8^{a}	7.9 ^{a}

*Kelanting produced by home industry was used as standard, and given scalar-score of 10 for all sensory parameters tested

4. Conclusions

Kelanting, a traditional snack food, usually made from fresh cassava roots. In this study we tried to modified the kelanting processing by replacing fresh cassava roots with high-quality cassava flour in order to improve the processing method primarily in raw material stocking. Kelanting produced from high-quality cassava flour were subjected to sensory evaluation using attributes included crispness, color, aroma, taste, and overall acceptance on a 10-point scoring scale. The best kelanting was found in a 210 and 240 min of drying, with the sensory mean scores of 8.15 7.15, 6.75, 6.8, and 7.7 were obtained correspondingly for crispness, color, aroma, taste, and overall acceptance. Scores for these attributes indicated that the kelanting were acceptable. The study showedthe suitability of high quality cassava flour for replacing the cassava roots in kelanting processing

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References

[1] BPS 2016. Data produksi ubi kayu Indonesia http://bps.go.id/ linkTableDinamis/ view/id/ 880. Diakses tanggal 2 Agustus 2018.

[2] Sanchez T, Dufoura D, Morenoa JL, Pizarroa M, Aragona IJ, Domingueza M and Ceballosa H 2013. Changes in extended shelf life of cassava roots during storage in ambient conditions. Postharvest *Biology and Technology 86,* 520– 528.

[3] Njoku DN, Amadi CO, Mbe J and Amanze NJ 2014. Strategies to overcome post-harvest physiological deterioration in cassava (Manihot esculenta) root*: A review. Nigeria Agricultural Journal* 45, 51– 62.

[4] Onyenwoke CA and Simonyan KJ. 2014. Cassava post-harvest processing and storage in Nigeria: A review. *African Journal of Agricultural Research* 9, 3853– 3863

[5] Harris KP, Martin A, Novak S, Kim SH, Reynolds T and Anderson CL. 2015. Cassava bacterial blight and postharvest physiological deterioration – Production losses and control strategies. Evans School Policy Analysis and Research, EPAR Brief No. 29

[6] Raju S, Stephen R, Ravi , Madhavineelakantan S, Makasana J and Chakrabarti SK. 2015. Evaluation of postharvest physiological deterioration in storage roots of cassava (Manihot esculenta) genotypes. *Indian Journal of Agricultural Sciences* 85, 1279– 1284.

[7] Nurdjanah S, Susilawati dan Sabatini, M.R. 2008. Prediksi Kadar Pati Ubi Kayu (*Manihot Esculenta*) pada Berbagai Umur Panen Menggunakan Penetrometer. *Jurnal Teknologi dan Industri Hasil Pertanian.*12(2):65-73.

[8] Li H, Prakash S, Nicholson TM, Fitzgerald MA and Gilbert RG. 2015. The importance of amylose and amylopectin fine structure for textural properties of cooked rice grains. *Food Chemistry*, doi: http://dx.doi.org/10.1016/j.foodchem.2015.09.112

[9] Patindol J, Gu X and Wang YJ. 2010. Chemometric analysis of cooked rice texture in relation to starch fine structure and leaching characteristics. *Starch* Stärke, 62(3-4): 188-197.

[10] Sánchez T, Dufour D, Moreno IX and Ceballos H. 2010. Comparison of pasting and gel stabilities of waxy and normal starches from potato, maize, and rice with those of a novel waxy cassava starch under thermal, chemical, and mechanical stress. J. *Agric. Food Chem* 58:5093–5099. doi: 10.1021/jf10 01606

[11] Sánchez T, Mafla G, Morante N, Ceballos H, Dufour D, Calle F, Moreno X, Pérez JC and Debouck D . 2009. Screening of starch quality traits in cassava (Manihot esculenta Crantz). *Starch*/Stärke 61: 12-19.

[12] Ceballos H, Sánchez T, Morante N, Fregene M, Dufour D, Smith AM, Denyer K, Pérez JC,. Calle, Mestres C. 2007. Discovery of an amylose-free starch mutant in cassava (Manihot esculenta Crantz). *Journal of Agricultural and Food Chemistry*, 55(18):7469-7476.

[13] Subagio A. 2008. Standard Operating Procedures on Cluster Based Production of Mocaf. National Competitive Research, Staple Food Diversification. SEAFAST Center. IPB, Bogor

[14] Yadav AR, Mahadevamma S, Tharanatha RN and Ramteke RS. 2007. Characteristics of acetylated and enzyme-modified potato and sweet potato flours. *Food Chem.* 103:1119–1126.

[15] Pranoto Y, Haryadi dan Rakshit SK. 2009. Karakterisasi Pati Ubi Jalar Varietas Tipikal lndonesia dan Modifikasi Sifat Reologisnya Dengan Heat-Moisture Treatment (HMT) Untuk Pembuatan Rerotiane. Laporan Akhir Hasil Penelitian Hibah Pekerti (Tahun Kedua) . Universitas gajah Mada.

[16] Tetchi FA, Rolland-Sabate A, Amani GN and Colonna P. 2007. Molecular and physicochemical characterisation of starches from yam. cocoyam, cassava, sweet potato and ginger produced in the Ivory Coast. *J. Sci. Food Agric*. 87:1906–191

[17] AOAC 1990. Official Methods of Analysis 15th Edition. Association of Analytical Chemists, *Association of Analytical Chemists*, Washington DC. 17, 18–6

[18] Nurdjanah S N, Yuliana N, Astuti S, Hernanto J and Zukryandry Z. 2017. Physico Chemical, Antioxidant, and Pasting Properties of Pre-Heated Purple Sweet Potato Flour. *Journal of Food and Nutrition Sciences* 5(4), 140-146.

[19] Kemp S E, Hollowood T and Hort J. 2011. Sensory Evaluation: A Practical Handbook. John Wiley & Sons. Pp 208