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Fermented Cassava Peel Evaluation

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Abstract : Cassava Peel contains cyanogenic glycoside and it will result in glucose and cyanide (HCN) when oxidation caused by linamarase enzyme takes place. High cyanide in cassava peel can cause poisoning. Proper processing of cassava peel is necessary in order to avoid poisoning to those consuming it. One technique to get rid of cyanide and increase nutrient value of cassava peel is fermentation. Type of material used for cassava peel fermentation is cassava yeast. Fermentation takes 8, 9 and 10 days with 5% dosage. Cassava peel is incubated in room temperature or 30^0C. The results reveal that the most suitable time for cassava peel fermentation is 10 days and the dosage is 5 grams. It decreases 82.47% of HCN, or from 117.18 ppm into 20.53 ppm. Chemical composition is 31.60% of water, 11.22% of protein, 2.91% of fat, 8.87% of crude fiber, 10.23% of ash and 20.09% of starch.
Keywords: cassava peel, fermentation, yeast, HCN.

Introduction

Utilization of cassava peel has yet been maximum due to cyanide as anti-nutritive substance. Cyanide is chemical compound that contains one carbon atom and one nitrogen atom. Technical definition of cyanide is three bound molecules consisting of one +2 carbon atom and one nitrogen atom in oxidation state[1].

Hydrolysis reaction of cyanogenic glycoside that produces cyanide can be seen in Figure 1[2].

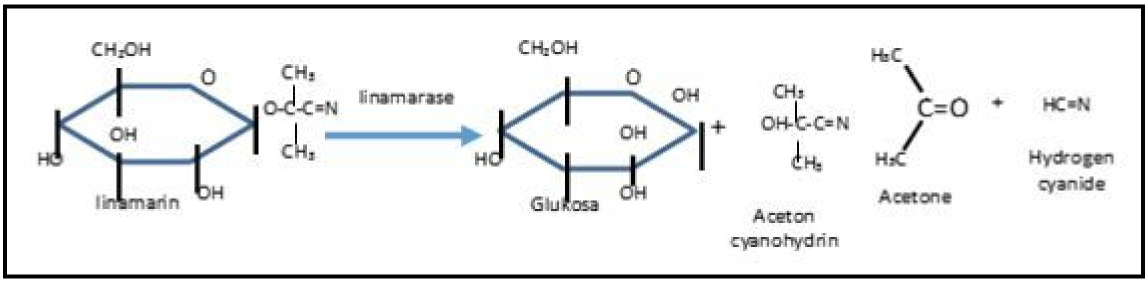

Figure 1. Linamarin Hydrolysis into Glucose, Acetone and Hydrogen Cyanide hidrogen sianida

Cyanogenic glycoside degradation consists of several steps, starting from separating half of sugar from aglycone/cyanohydrins by β-glycosidases, and cyanohydrins is separated into carbonyl compounds and hydrogen cyanide[3,4]. HCN can be reduced with physical and biological treatment. Some examples of physical treatment are heating, grinding and soaking[5,6]. Cyanohydrins can be minimized by controlling temperature and humidity that gradually decreases 58% of cyanohydrins in 38 weeks while 100% linamarin in cassava flour can be eliminated in 6 months[7]. Cyanogenic cannot be gotten rid of when temperature is either 30^0C or 50^0C. Repeated heating when temperature is 100^0C slowly reduces cyanogenic level. A five-hour heating reduces one and a half cyanide when temperature is 50^0C and 4 hours of sunlight also reduces one and a half cyanide. A twenty-four hour soaking reduces 39.6% of cyanogen and more than twenty-four hour soaking reduces 49.9% of the substance[8]. Cyanogen in cassava leaves can be minimized through a two-hour drying process under the sun, a five-hour drying process in shady place and when they are boiled for 10 minutes[8]. Fermentation can increase nutritional value of food[9]. Fermentation is reaction of oxidation reduction in biological synthesis that results in energy. Fermentation is one conventional method of producing cassava that decreases cyanogens glycoside such as linamarin[10,11].

Experimental

Materials

The main materials of the study are cassava peel and cassava yeast. Materials for HCN and proximate analysis are distilled water, NaOH, NH_4OH, Kl and $AgNO_3$. 1% H_2So_4 in H_2O, 1 N Reagen Folin-ciocalteu (regen phenol), methil orange, 2% Na_2CO_3 in 0.1 N NaOH, 4% borax acid, 2.7% Potassium Sodium Tartrate, and N-Hexane.

Preparation

Cassava peel is washed, cut into 0.5 cm lengthwise and dried at the temperature of 30˚C for two days. Furthermore, the cassava peel is ground into cassava flour.

Cassava Peel Fermentation

Cassava peel flour is fermented with cassava yeast with 5% dosage for 8, 9 and 10 days. The cassava peel flour is incubated anaerobically at the temperature of 30˚C.

Method of Analysis

HCN analysis uses silver nitrate titration[12], while proximate analysis used Kjehdahl's method[13].

Results and Discussion

HCN Content

Result of observation towards HCN level in cassava peel towards five samples is described in Figure 2.

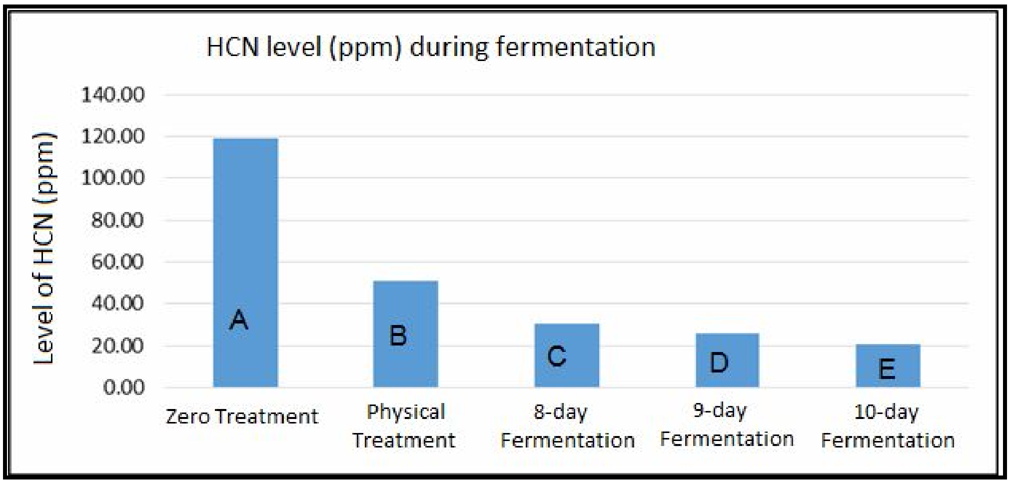

Figure 2. HCN Level (ppm) in Cassava Peel Flour

Figure 2 shows that physical treatment reduces 42.79 of HCN from 118.86 ppm into 50.86 ppm. Eight-day fermentation (C) can decrease 74.42% of HCN from 118.86 ppm into 30.41 ppm. Nine-day fermentation (D) reduces 78.45% of HCN from 118.86 into 25.61 ppm while ten-day fermentation (E) reduces 82.79% of HCN from 118.86 ppm into 20.46 ppm.

The study can reduce more HCN compared to the previous study[14] that reduces HCN level in "*onggok*" or solid waste from tapioca flour processing from 68.6 mg/kg into 47.3 mg/kg. It is also revealed[15] that fermentation can reduce HCN level up to 95%. Material and time are two aspects that influence how much HCN can be reduced.

It shows that the amount of fermentation time is more effective to reduce HCN, since fermentation at the temperature of 25-37˚C will result in excellent quality that influence linamarase enzyme activity in HCN release. Treatment B, C, D and E shows that HCN composition in cassava peel is decreasing compared to Treatment A. It happens because physical and biological process takes place in treatment B, C, D and E. Cutting cassava peel into small pieces increases possible contact between linamarin and linamerase. Cutting cassava peel into small pieces allows disintegration of tuber cell structure that enhances hydrolysis (cyanide release)[16]. Cutting the cassava peel into tiny pieces also facilitates evaporation (decreasing cyanide composition). Drying or heating will facilitate evaporation (decreasing cyanide composition), enhances dehydration and breakdown of cell structure so that degradation of lanamarin glycoside in cassava peel by lanamerase enzyme that produces glucose and acetone sinohidrin which eventually releases hydrogen cyanide happens. During fermentation, HCN composition in fermented cassava peel keeps on decreasing. At the earlier stage of fermentation, respiration of plant cells occurs in silo that releases heat[16]. In fermentation using cassava yeast, the process starts when saccaharomyces actively breaks down carbohydrates into alcohol and lactic acid. It is in line with previous study explaining that *Saccharomyces cerevisiae* can reduce linamarase activity that decreases level of sianogen in cassava peel so that influence of anti-nutritional substance can be reduced[18]. Another study[19] shows that lactic acid bacteria have role in decreasing cyanide. Decreasing cyanide in cassava peel silage occurs due to β-glucocyde enzyme activities as the result of lactic acid bacteria. Lactic acid bacteria can cause cyanide degradation and increase nutrient digestability of cassava peel. Yeast is catabolic or breaks down complex components into simpler one so that it can be digested easily.

Based on the result of fermentation, fermented cassava peel flour can be used as source of food because of HCN composition it has[20]. Cassava is not poisonous when HCN composition is less than 50 mg/kg of fresh cassava. Based on the findings of the study, once cassava peel starch has been fermented for 10 days, it can be alternative fish feed.

Physical Quality

Data about physical quality of fermented cassava peel flour that refers to amount of time needed for fermentation is described in Figure 3. Based on the findings of the study, it is revealed that 10 days are the most suitable fermentation time. Observation towards physical appearance of fermented cassava peel involves numbers of lump, odor, evaporation and the number of hyphae. Better physical appearance of the flour that is indicated by high physical appearance scoring means better fermentation process.

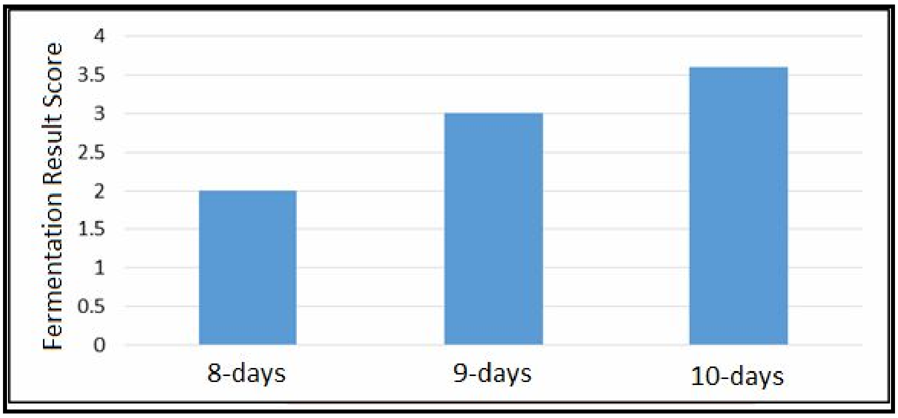

Figure 3. Cassava Peel Fermentation Score

Based on Figure 3, high score represents good fermentation process. Based on the findings, fermented cassava peel smells like acid and has distinctive fermented-like odor. It is in line with previous study[21] which reveals that good fermentation smells like acid and is fragrant. The cassava peel turns into brownish color. It is due to the temperature. Temperature during fermentation causes Mailard's reaction that turns cassava peel brown[22]. On the 8th or 9th day, texture or lumps on the media has been developed and hyphae is no longer developed on the 10th day. The hyphae are yellowish. Development of texture is also influenced by water and fat composition as well as type and amount of carbohydrate in a product.

Fermentation produces a lot of evaporated water outside fermentation media; it also is one of the indicators for the most suitable treatment. Steam produced in fermentation using cassava yeast is the effect of exothermic reaction during breakdown of organic materials. Fermentation produces CO_2 and heat as the effect of the breakdown of organic materials. PH score during cassava peel fermentation using cassava yeast also changes. It happens since microorganism breakdowns carbohydrate during fermentation. On the eighth day, pH decreases since microorganism breakdowns carbohydrate and produces organic acid. PH will keep decreasing during fermentation due to activities of microorganism. On the 9th day, PH will increase during fermentation as the indicator of protein breakdown and NH_3 production.

Fermented cassava peel has soft texture and it is neither moldy nor slimy as a previous study reports[23]. Fermented cassava flour contains 41.5-20.1% of starch. Starch composition change in all samples tends to be inconsistent. Changing starch is caused by washing as well as drying and in terms of fermented cassava peel it is due to microorganism that makes use of starch as carbon source.

Results of Proximate Analysis

The result of proximate analysis of fermented cassava peel flour can be seen in Table 1. It is as follow:

Table 1. Proximate Analysis of Cassava Peel Flour

Composition	TREATMENT				
	A	B	C	D	E
Dried Cassava Peel (%)*	23.92	86.59	76.71	69.95	68.40
Water (%)*	76.08	1.41	23.29	30.05	31.60
Ash (%)*	6.11	4.88	10.70	10.37	10.23
Protein (%)*	6.24	6.81	8.98	10.80	11.22
Fat (%)*	1.39	2.08	3.97	3.22	2.91
Crude Fiber (%)*	10.88	13.93	10.97	15.42	8.87
BETN (%)*	75.38	72.30	65.38	60.19	66.77
HCN (ppm)	118.86	50.86	30.41	25.61	20.46
Starch	56.72	41.50	24.18	21.37	20.09

*Analysis from Research Institute for Legumes and Tubers, Malang

Based on the result of proximate analysis, treatment E is considered as the most suitable one. The treatment results in the most preferable composition of protein, fat, fiber and HCN. The highest composition of protein (11.2%) is resulted after cassava peel flour is fermented for 10 days in treatment E followed by treatment D (10.80%), C (8.98%), and B (6.81%) consecutively. Non fermented cassava peel flour (treatment A) has the lowest level of protein (6.24%). Protein composition increases as microorganism breaks down carbohydrate the cassava peel contains. Microorganism in saccahromices produces enzyme that degrades complex compounds into less complex ones and synthesize protein so that protein substance in the material is increasing. According to a study[24], cassava peel can function as protein composition substrate. Cassava peels fermentation that uses *Saccaromycess* dan *candida* can increase crude fiber and once it is given additional source of nitrogen such as urea it produces twice amount of protein compared to fermentation process without added nitrogen. Fat composition in treatment A, B, C, D and E is still within threshold to use as source of energy; the need of fat for fish is 6-7%[25]. Fiber composition in treatment E is the lowest compared to treatment A, B, C and D. It happens since fermentation is application of microbial metabolism through vitamin and essential amino acid biosynthesis as well as to increase protein and fiber by reducing crude fiber composition. Cassava yeast can increase energy for metabolism and break down fiber composition in cassava roots. Aspergillus in cassava yeast produces ligno-cellulolytic enzyme cellulase suchas and xylanase that breaks down fiber and increases digestive fiber, reduces starch and increases amylopectin[26].

Based on the results of the study, ten-day fermentation of cassava peel flour gives the most satisfying result that the flour can function as alternative raw material for food. It is reported in several studies[24,27,28,12] stating that fermentation produces the highest composition of HCN and protein that is applied for livestock.

In conclusion, the best time for cassava peel flour fermentation using cassava yeast is 10 days and the dosage is 5 grams. The procedure decreases 82.79% of HCN or 20.46 ppm with the following chemical composition namely 31.60% of water, 11.22% of protein, 2.91% of fat, 8.87% of crude fiber, 10.23% of ash, and 20.09% of starch.

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