Nutrient Content of Cassava Dregs and Rice Bran Fermented with Aspergillus niger

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Abstract— The aim of the present study was to investigate the nutrient content and the potential application as feed from cassava dregs and rice bran fermented with *Aspergillus niger*. The research used a One-Way Completely Randomized Design on two substrate treatments including cassava dregs and rice bran fermented with *Aspergillus niger*, each with 3 replicates. The obtained data between control and substrate fermented with *Aspergillus niger* were analyzed using t-test. Both cassava dregs and ricebran substrates were suitable for *Aspergillus niger* fermentation, but crude protein increase was higher in ricebran (8.44%) while crude fiber decrease was higher in cassava dregs (20.93%) followed by increasing 19.53% nitrogen free extract (NFE). It was concluded that ricebran fermented with *Aspergillus niger* is a potential protein feed with 31.54% crude protein, while cassava dregs fermented with *Aspergillus niger* is a potential energy feed with 67,37% NFE.

Index Terms— Nutrient, Cassava Dregs, Rice Bran, Fermentation, *Aspergillus niger*.

1 Introduction

Harvested area of cassava in Indonesia in 2015 was 0.95 million ha, with 21.80 million ton production and 22.95 ton/ha productivity. In 2016, it was estimated to be 1.11 million ha harvested area and 20.23 ton/ha productivity, therefore the expected cassava production was 25 million tons [1]. Indonesia is the fourth leading country that produce cassava among Nigeria, Brazil, Thailand and Kongo. Approximately 60% of worldwide cassava is produced from the five countries [2]. The manufacture of tapioca powder made of cassava produces 10-15% dregs. (Figure 2)[3].Each ton of cassava produce 250kg tapioca and 114kg cassava dregs [4]. The nutrient content of cassava dregs includes 1.88% crude protein, 1.15% ash, crude fat 0.25%, crude fiber 15.62%, Ca 0.31%, P 0.05% and nitrogen free extract (NFE) 81.10%[5].Metabolic energy of cassava dregs is 3000 kcal/kg with high cyanide by 1.75 mg/g [6]. Over a period of days, cassava dregs will emit acidic and rotten odor due to high water content, thereby polluting the environment. In order to reduce the pollutant, cassava dregs can be utilized as cattle feed.

The nutrient content of cassava dregs consists of low crude protein and high crude fiber; therefore, the usage is limited to poultry feed. High fiber feed is voluminous or bulky and may cause the gizzard full quickly. This type of feed has longer transit time in digestive tract, so the animal will reduce feed intake due to the limited digestive capacity. It brings detrimental effect on the chicken growth because physiologicallyit loses feed nutrients [7]. Cassava dregs for poultry feed has not been optimized. In broiler ration, cassava dregs should not exceed 6%, otherwise the growth will decline [8].

Rice bran is the dregs from rice mill, after the paddy grains are ground into rice on the first dehusking with brownish yellow color and coarse texture (Figure 2), while rice polish is the dregs from the second dehusking with brownish white color and soft texture. Rice production in Indonesia reached 75.36 ton dry unhusked rice [9]. Rice mill produced 65% rice, 23% husk and10% rice bran and rice polish [10]. Nutrient content in rice bran is 12-14% protein, 7-9% fat, 8-13%crude fiber and 9-12%ash [11]. High fat content makes the rice bran easily spoiled (pungent odor). The limiting factor of rice bran utilization is low amino acid, vitamin and mineral, and high crude fibre approximately 13.0% and phytate substance that binds protein mineral so it is not utilized by digestive enzyme [12].

Improvingthe nutritive quality of cassava dregs or rice bran needs efforts to increase crude protein and decrease crude fiber through fermentation with *Aspergillus niger*, for example.The well-growth mold is expected to produced plenty cellulose enzyme in order to degrade and decrease crude fiber [13]. *Aspergillus niger* can produce celullase, xylanase, ß-glucanase, and protease that are active in neutral and acidic condition [14]. The use of *Aspergillus niger*mould as a starter in the fermentation process was considered as the most suitable and appropriate with the purpose of fermentation, that is to decrease fiber content and increase crude protein content of cassava dregs and rice bran [15]. Therefore, it is important to conduct a study on the nutrient content of cassava dregs and rice bran fermented with*Aspergillus niger* inoculum.

2 METHOD

The study was conducted on Laboratory of Basic Nutrition and Laboratory of Chemistry MercuBuana Yogyakarta University between 1 November 2016 to 10 December 2016. One-way *Completely Rendomized Design* (CRD) was used to 2 substrates (T_1 = cassava dregs, T_2 = rice

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bran) each with 3 replicates. The observed variables were nutrient content, (chemical properties) including water content, ash, crude protein, crude fat / extract ether and crude fiber.

The main ingredient was inoculum of *Aspergillus niger*mould obtained from Laboratory of Microbiology MercuBuana Yogyakarta University. The substrates were cassava dregs and rice bran and additional ingredients including urea, molases, mineral-mix, 70% alcohol and aquadestthat were bought from local market in Yogyakarta, Indonesia.

The main apparatus consisted of autoclav, laminer, Memert® incubator oven, Sharp® refrigerator, Miyako® blender, pH meter, termometer, stove and a set of proximate analysis apparatus.

The stages of the study included: A) Rejuvenating*Aspergillus niger*culture, *B).* Making solid substrate inoculum from *Aspergillus niger, C).* Fermenting cassava dregs and rice bran using the solid inoculum of*Aspergillus niger* incubated for 3 days then cabinet-dried at 60°C for 1 day (completely dry), and at last proximate analysis that examined water content, ash, crude protein, crude fat and crude fiber.

A. Rejuvenation of*Aspergillus niger* culture

Rejuvenating *Aspergillus niger* culture started by preparing the sterilized reaction tube and filled with steril*Potato DextroseAgar* (PDA) solution, then sealed the tube with sterile gauze dressing and stored in tilted position. Pure *Aspergillusniger* was inoculated (using ose needle) into a reaction tube filled with steril*Potato DextroseAgar* (PDA) in zigzag movement, then incubated at 35°C for 120 hours [16]. However, the incubation in this study was 48h to obtain a medium-aged *Aspergillusniger* with an intact mould structure and faster cell multiplication and mould growth. Figure 1 shows the spores of *Aspergillus niger*.

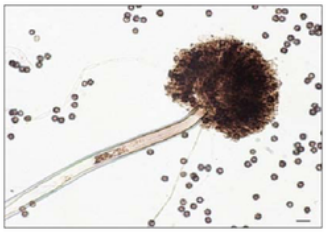

Fig. 1. *Aspergillus niger* (400x)

B. Solid-state fermentation of *Aspergillus niger*inoculant:

1. All materials including 1000 gram of each substrate cassava dregs or rice bran with 70% water content, 11.4 gram mollase(1.2%), 5 gram urea (0.5%) and 12.5 gram mineral (1.25%) were sterilized in autoclave at 120°C and 1 atm pressure for 15 minutes,
2. Upon sterilization, all materials were mixed to until homogenous with *Aspergillus niger*mould that was previously suspended with aquadest,
3. The well-mixed materials were incubated at 35°C for 72h,
4. Substrate in which mould had grown was oven-dried at 60°C until the ingredients were completely dry, then crushed into powder to be used as the solid inoculant.

C. Method of fermenting cassava dregs and rice bran[17]

1. All materials (B.1.) were sterilized in autoclave at 121° C under 1 atm pressure for 15 minutes,
2. After being sterilized, the materials were cooled until the temperature was 30-35C,
3. Dry matter content of the substrate was measured,
4. Water demand of both cassava dregs and rice bran (to obtain 70% water content) was measured for fermentation process and all ingredients were mixed until homogenous,
5. With the same method, 12 samples were prepared (2 treatments and 2 control of each substrates with 3 replicates) the inoculated with 10% (w/w) *Aspergillus niger* (B.4.) [18],
6. *Aspergillus niger*-inoculated cassava dregs and rice bran were stored in mica plastic bag with hole on top to obtain anaerob condition,
7. Incubation lasted for 3 days in a container with partition for each treatment at room temperature (28°C),
8. After incubation, cassava dregs, rice bran and each control (fermentation product) was weighed, dried in cabinet dryer and taken the sample for proximate analysis [19].

The obtained data from control vs fermented substrate from both cassava dregs and rice bran were subject to t-test statistical analysis fermented [20].

3 RESULT AND DISCUSSION

Result of t-test showed a significant difference (P<0.05) in nutrient content between control (without *Aspergillus niger*inoculum) and substrates incubated with *Aspergillus niger,* in both fermented cassava dregs and rice bran.

Analysis of t-test result indicated that the use of *Aspergillus niger*inoculum starter significantly affected (P<0.05) ash content in fermented rice bran (Table 1). Ash content increased (6,10%) assumedly due to the additional mineral for *Aspergillus niger*growth [21]. Ash content in feed indicated the level of mineral in feed [22].

T-test analysis showed that the use of *Aspergillus niger*inoculumsignificantly affected (P<0.05) to crude protein offermented cassava dregs and rice bran compared to that of control (Table 1).The increase of crude protein as observed in this research was assumedly due to the optimum fermentation of *Aspergillus niger*with the enzyme activity of *Aspergillusniger*mould such as cellulose that released the protein bound in lignin. The increase of crude protein might due to the ability of *Aspergillusniger*to convert non protein nitrogen (urea) into nitrogen needed for cell growth, enzyme production and protein synthesis [23]. The increase of protein linear to the growth of *Aspergillus niger*was due to several nitrogen-bearing elements in the mould; moreover, the enzyme produced by the fungus was also protein [24]. Bacteria and fungus can produced enzyme that loosen the ligno-cellulose and ligno-hemicellulose bond, so the protein bound in lignin will release [25]. The increased protein may

be attributed to the higher biomass of *Aspergillusniger*where most of the cells were protein (*Single Cell Protein*) [26].

Resul of t-test showed that the use of *Aspergillus niger*inoculum significantly affected (P<0.05) the decreasing fat content in the fermented cassava dregs and rice bran compared to that of control (Table 1). Research result indicated that fat content of fermented rice bran and cassava dregs was 5.65% and 1.33%, respectively, compared to than of control. The deceased fat was contributed to the dry matter loss during fermentation and mould growth and development to form fat-containing cell mass. The decreased crude fiber of fermented substrate was because the substrate contained glucose that promoted the growth of mould biomass; consequently, more lipase enzyme was produced to degrade crude fat. Lipase enzyme produced by *Aspergillusniger*can degrade lipid into fatty acid and glycerol that will be used as energy source for growth [27].

Resul of t-test showed that the use of *Aspergillus niger*inoculum significantly (P<0.05) lowered crude fiber in fermented cassava dregs and rice bran (Table 1).Crude fiber decreased by 20.93% in cassava dregs and 12,51% rice bran substrates. It was in line with [28] thatcrude fiber and crude protein decreased in cassava dregs fermented by *Aspergillus niger*for 72h.

The complete result of nutrient content of rice bran and cassava dregs fermented with *Aspergillusniger*compared to that of control is presented in Table 1.

TABLE 1.
Composition of Nutrient Cassava dregsand Rice bran Fermented by *Aspergillus niger* at doses 10% (w/w)

Nutrient Dry-matter basis (%)	Substrat			
	Cassava dregs		Rice bran	
	control T1	T1	control T2	T2
Ash	7.44[a]	7.43[a]	13.08[p]	19.17[q]
Crude protein	9.20[a]	11.94[b]	23.10[p]	31.54[q]
Crude fat	1.62[b]	0.29[a]	9.47[q]	3.82[p]
Crude fiber	33.92[b]	12.98[a]	27.26[q]	14.75[p]
NFE	47.83[a]	67.37[b]	27.29[p]	30.71[q]
Dry matter	100	100	100	100

[a,b], values bearing different superscript within rows show significant difference(P<0.05)
[p,q], values bearing different superscript within rows show significant difference(P<0.05)
Control T1 = fermented Dregs of cassava without Aspergillus niger inoculum
T1 = fermented Dregs of cassava with Aspergillus niger inoculum
Control T2 = fermented rice bran without Aspergillus niger inoculum
T2 = fermented rice bran was with Aspergillus niger inoculum

Table 1 shows that fermented cassava dregs could increase crude protein by 2,74% but lowered crude fiber by 20.93% and increasedNFEby 19,53%. However, in rice bran substrates between control T2 (without inoculation) vs T2 rice bran inoculated with*Aspergillus niger* crude protein increased by 8,44% and the crude fiber deceased by 12,51%.

Physical difference between cassava dregs before fermentation (CD) and after *Aspergillus niger* fermentation (FCD) and between rice bran (RB) solid in the market before fermentation andthe rice bran fermented with*Aspergillus niger* (RBF) is presented in Figure 2.At the initial study, the ingredient was apparently whiter, while the fermented was blackish brown (because the color of *Aspergillus niger*spores is black with additional brownish molasses.

Fig. 2. Cassava dregs (CD) vs fermented cassava dregs (FCD) and rice bran (RB) vs fermented rice bran (FRB),(Photo: private document)

4 Conclusion

It was concluded that 10% w/w *Aspergillusniger* inoculum in the fermentation of cassava dregs and and rice bran could increase crude protein and NFE and lowered crude fat and crude fiber. Cassava dregs fermented with *Aspergillus niger*as energy source contained 67,37% nitrogen free extract (NFE), while rice bran fermented with*Aspergillus niger*could serve as protein source with 31.54% crude protein.

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