Nutrient content of coffee berries husk fermented with different inoculants

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Abstract. Nutrient content of coffee berries husk can be improved through a fermentation process using inoculants. A study was conducted to determine the nutrient content of the coffee berries husk fermented with different types of inoculant. The study used fruit skin of Robusta produced by farmers in the village of Senda Subdistrict Tabanan regency. A completely randomized design (CRD) consisting of 4 treatments and 6 replications was adopted in the study. The treatments were coffee berries husk without fermentation (K1), coffee berries husk fermented with Aspergillus niger (K2), coffee berries husk fermented with yeast tempe (Rhizopus oryzae) (K3), and coffee berries husk fermented with yeast tapai (Saccharomyces cerevisiae) (K4). The observed parameters were the contents of (1) dry matter, (2) crude protein, (3) gross energy, (4) crude fat, (5) organic matter, (6) ash, (7) crude fiber, (8) calcium and (9) phosphorus. The results showed that the highest crude protein content was resulted from K2 treatment (10.23%), while the lowest crude fiber content was resulted from K3 treatment (27.17%). This study suggested that the fermentation process able to increase the crude protein content of the coffee berries husk.

1. Introduction
Coffee husk is a waste of coffee beans production from coffee berries. Nowadays, the husk of coffee berries has not been used maximally and only dumped in the plantation area [1]. This not only causes environmental problem, but also become a media for coffee plant disease to grow and spread. Coffee husk is about 48% of coffee berries production [2]. With the production of coffee bean in Bali at 17,317.81 tonnes [3], it will produce about 8312.55 tons /year of coffee berries husk.

On the other hand, as livestock population increase the need for feed is also increased. However, lack of land for forage production results insufficient feed supply for livestock. Therefore, it is necessary to utilize plant residues and crop by products as feed for livestock. Utilization of agriculture by-products will minimize external input and increase farm efficiency and profitability.

Coffee berries husk are categorized as a wet waste because it contains 75-80% moisture. Thus it can be spoiled quickly if not immediately processed [4]. In addition, coffee berries husk also contains some anti-nutritional substances such as caffeine and tannins.

Fermentation can improve the nutritional value of a substrate by breaking-down a complex compounds into simpler compounds that more digestible for the animal gut. It is reported that fermentation using A. niger can increase nutrients content of coffee berries husk and decrease the anti-
nutritional substances [2]. Fermentation process using *R. oryzae* and *S. cerevisiae* for 48 hours able to increase the crude protein content and decrease the crude fiber content of coffee berries husk [5].

Based on those previous studies, different inoculants used in the fermentation will differently changing nutrient content of fermentation product. Therefore, it is necessary to investigate the nutritional content of the coffee berries husk which fermented with different inoculants. Results of this study will provide information for utilization of coffee berries husk as feed for livestock.

2. Materials and methods

The experiment was conducted in the Sanda village, Pupuan subdistrict, Tabanan regency and in the Laboratory of the Livestock Research Center Ciawi from June 2015 to September 2015. Coffee berries husk that used in this study is produced by Robusta coffee plant ages 5 years old. A completely randomized research design was applied in this study, which consisting of 4 treatments and 6 replications. The treatments were non fermented coffee berries husk (K1), coffee berries husk inoculated with *A. niger* (K2), coffee berries husk inoculated with yeast tempe (*R. oryzae*) (K3), and coffee berries husk inoculated with yeast tapai (*S. cerevisiae*) (K4).

Fermentation was carried out as follows: one percent (w/v) of each inoculant was dissolved in water containing sugar 1%, 1% urea, and NPK 0.5% (w/v). The solution was mixed then aerated and incubated closely for 24 hours. After incubation for 24 hours, that each solution of inoculant was sprayed on coffee berries husk evenly. Fermentation is carried out in an-aerobic condition and incubated for 5 days. After 5 days coffee berries husk was dried and then milled to get a coffee husk powder. Two hundreds gram of fermented coffee husk were sampled for nutrition content analysis in the laboratory. The observed parameters were the contents of dry matter, crude protein, gross energy, crude fat, organic matter, ash, crude fiber, calcium and phosphorus. Determinations of dry matter, organic matter, and ash contents were carried out according to the method of the Association of Official Analytical Chemist. Determination of crude protein was according to Semi Micro Kjeldahl method. Crude fiber analysis was performed by gravimetric method. Determination of gross energy was using a bomb calorimeter. Ca and P contents were determined using Spectrophotometer with Bray 1 extractor. Data were analyzed by analysis of variance using a completely randomized design (CRD) followed by Duncan's multiple range test at 5% of significant for means analysis.

3. Results and discussion

Result of chemical analysis showed that coffee berries husk contains nutrients as required in animal feed, especially for goats. Fermentation reduced dry matter (DM) content of coffee berries husk, however this was not statistically significant (P>0.05) (Table1). This result was similar to previous study where *A. niger* inoculation in fermentation has no significant effect on the dry matter [6]. Decreased in DM content after treatment due to DM degradation by microorganisms in the fermentation that indicate the fermentation process is running well by microorganisms growth in the substrate.

Fermentation increased the protein content and decreased crude fiber content. The highest CP was resulted in K2 (10.23%), which was significantly higher (P <0.05) than K1, but it was not significantly different (P> 0.05) to K3 and K4 treatments. Similarly, the CP content in K3 treatment was significantly higher (P <0.05) than K1. However, CP content in K4 treatment was not significantly different (P> 0.05) to K1. This results indicated that the fermentation using *A. niger* and *R. oryzae* able to increase the CP content of coffee berries husk.

Many microorganisms, bacteria and fungi, able to hydrolyze cellulose and use it as a source of energy. *A. niger* has ability to utilize organic and inorganic compound for cell's protein synthesis. This bioconversion results in the increase of protein content of fermented substrate. Single cell protein or cell biomass is containing about 40-65% of protein [9] *R. oryzae* that was used in K3 treatment, produces amylolytic, lipolytic, and proteolytic enzymes that digesting carbohydrates, fats, proteins and other compounds into smaller molecules [7]. This biodegradation might resulted in decrease of nutrient contents of fermented substrate, such as DM, OM, and CF. The length of fermentation is
associated with the number of microbial population to produce enzymes for substrate degradation that affect composition the final product. Longer fermentation process increase the amount of nutrient in substrates which used by microbes for cell metabolism. In this study, fermentation was run for 5 days that likely was not an optimum length of fermentation for CP content improvement in the coffee berries husk. In a protein binding complex model, fermentation longer than 48 hours seems decline the crude protein content as non-optimal microbial activity [5]. The declining of CP content declining is caused by free amino acids conversion into amine compounds and not utilized for protein synthesis by microbes.

Table 1. Nutrient content of coffee berries husk fermented with different inoculants

| Nutrient (%)                        | Treatments | K1   | K2   | K3   | K4   |
|-------------------------------------|------------|------|------|------|------|
| Dry matter                          |            | 88.92| 86.86| 85.81| 86.53|
| Crude protein                       |            | 8.76 | 10.23| 10.10| 9.53 |
| Gross energy (Kcal/kg)              |            | 3892 | 3829 | 3777 | 3802 |
| Fat                                 |            | 1.29 | 1.14 | 6.58 | 1.35 |
| Organic matter                      |            | 91.85| 92.04| 92.15| 92.35|
| Ash                                 |            | 8.15 | 7.96 | 7.85 | 7.65 |
| Crude fiber                         |            | 29.65| 29.46| 27.17| 28.85|
| Calcium (Ca)                        |            | 0.53 | 0.42 | 0.42 | 0.40 |
| Phosphorus (P)                      |            | 0.10 | 0.12 | 0.10 | 0.09 |

* Means with different superscripts are significantly different (P<0.05)

Crude fiber is main component of cellulosic substrates that used as an energy source for microorganism cells growth and resulting in a reduction in crude fiber content of the substrate. Crude fiber degradation is depend on the secretion of microbial cellulase enzymes that break down cellulose in the substrate into more simple compounds, such as cellubiose and glucose. Several microorganism species, such as A. niger used in K2 treatment, not only produce cellulolytic enzymes, but also amylolytic enzymes such as amylase and glucoamylase [8]. Similarly, fungus S. cerevisiae able to degrade hemicellulose into glucose that may indirectly reduce the content of crude fiber through a secondary pathway activity [5].

In this study, crude fiber contents of coffee husk were not significantly affected by treatments. This indicated that the inoculants used in the treatment did not have hight activity in crude fiber degradation. This result was similar to [9], that did not find significant effect of fermentation to crude fiber contents, especially lignin, cellulose and hemicellulose of coffee berries husk. This not significant effect might be due to lignin content in the husk that is resistant from enzymes microbes digestion [10]. Among the fibrous parts of plants, lignin is the most resistant to microorganisms degradation that resulted in slight decreased of crude fiber content. Fermentation process could decrease lignin content of coffee berries husk that reached 31.12%, however lignin content of berries husk was still very high, namely 45.04% [13].

Protein is an essential nutrient for the growth and differentiation of animal cells. Protein content in feedstuffs will define the quality of feed. High quality diet should have high crude protein content. In contrast, High content of crude fiber in the diet decrease feed consumption and digestibility. Thus high crude fiber content in feedstuffs decreased diet quality.

4. Conclusions
Fermentation using different inoculantsable to increase the crude protein content of coffee berries husk. The highest crude protein was resulted in fermentation using A. niger.

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