

Nutrient Composition of Fermented Coffee Husk and its Potency as Sunda Porcupine Feed in Captivity
(Kandungan Nutrien Kulit Kopi Terfermentasi dan Potensinya sebagai Pakan Landak Jawa di Penangkaran)

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ABSTRACT

Several studies have been published that coffee husk was feasible used as animal feed. But, coffee husk also has anti nutritional content that diminish acceptability and palatability. One of methods that effectively reduce anti nutritional is biofermentation. The aim of this study was to determine the effect of fermentation of coffee husk on nutrient composition as Sunda porcupine feed. The coffee husk was fermented with *Aspergillus niger*. Then, twelve Sunda porcupine were used and fed with control ration (T0), control with 10% fermented coffee husk (T1), control with 20% fermented coffee husk (T2), and control with 30% fermented coffee husk (T3). Variables observed were fresh matter intake, dry matter intake, body weight measurement and feed efficiency. Fermented coffee husk by *A. niger* decreased dry matter, organic matter, ether extract, and crude fiber. Meanwhile, crude protein and NFE rose sharply. The amount of dry matter intake in the treatments –was significantly different ($P<0.05$). Dry matter intake of 20% fermented coffee husk (T2) was the lowest. The dry matter intake of the porcupines in T0, T1, T2, and T3 were 2.37%, 2.11%, 2.02%, and 2.05% of liveweight, respectively. Feed efficiency of T2 ration was not significantly different compared to T3 ration ($P>0.05$). Yet, T3 ration had the lowest feed efficiency index than others. In conclusion, fermentation with *Aspergillus niger* may improve nutrient composition of coffee husk. Thus, the fermented coffee husk was potential to be used as porcupines feed in captivity with tolerable of coffee husk until 30%.

Keywords: coffee husk, fermentation, Sunda porcupine, captivity

ABSTRAK

Beberapa studi telah dipublikasikan terkait kelayakan kulit kopi sebagai pakan satwa. Namun demikian, kulit kopi juga memiliki kandungan antinutrisi di dalamnya yang dapat mengurangi palatabilitasnya. Salah satu metode yang efektif mereduksi kandungan antinutrisi pada pakan adalah melalui biofermentasi. Tujuan dari penelitian ini adalah untuk menentukan efek fermentasi kulit kopi pada kandungan nutrisinya sebagai pakan landak Jawa di penangkaran. Kulit kopi difermentasi dengan *Aspergillus niger* selama 5 hari. Selanjutnya, 12 ekor landak Jawa digunakan sebagai hewan coba dan diberikan pakan kontrol (T0), pakan kontrol dengan 10% kulit kopi terfermentasi (T1), pakan kontrol dengan 20% kulit kopi terfermentasi (T2), dan pakan kontrol dengan 30% kulit kopi terfermentasi (T3). Variabel yang diamati adalah konsumsi pakan segar, konsumsi pakan kering, pengukuran bobot badan, dan efisiensi pakan. Fermentasi kulit kopi dengan *A. niger* menurunkan kandungan kadar bahan kering, bahan organik, lemak kasar, dan serat kasar. Sementara itu, kandungan protein kasar dan bahan ekstrak tanpa nitrogen meningkat. Jumlah konsumsi bahan kering pada tiap perlakuan berbeda secara nyata ($P<0,05$). Konsumsi bahan kering pakan T2 adalah yang terendah dibandingkan perlakuan lainnya. Konsumsi bahan kering landak Jawa pada T0, T1, T2, dan T3 masing-masing sebesar 2,37%, 2,11%, 2,02%, dan 2,05% terhadap bobot badan. Efisiensi pakan T2 tidak berbeda nyata dibandingkan pakan T3 ($P>0,05$), namun pakan T3 memiliki efisiensi pakan yang lebih kecil. Kesimpulan dari studi ini adalah fermentasi dengan *Aspergillus niger* dapat meningkatkan kandungan nutrien kulit kopi. Sehingga, fermentasi kulit kopi berpotensi digunakan sebagai pakan landak dengan toleransi jumlah kulit kopi terfermentasi hingga 30%.

Kata Kunci: kulit kopi, fermentasi, landak Jawa, penangkaran

INTRODUCTION

Coffee is one of agriculture commodity that play an important role in economy in Indonesia. Indonesia is among the world's coffee producing and exporting countries, with total production of coffee and export are 713,921 tons and 279,961 tons respectively (BPS 2019). The composition of coffee fruit consists of 40% of pulp, 20% of mucilage, and bean for the rest (Ernawati *et al.* 2008). During a coffee bean separation from its skin, a large quantity of by-products produced such as coffee hull and coffee husk. These by-products are the major solid residues and constitutes a major environmental pollution (Oliveira & Franca 2015).

Coffee husk is a residue obtained after dehulling coffee fruit in dry coffee processing. Dry processing is a common technique that is used in large farms since it needs no equipments. Franca & Oliveira (2015) stated that every 1 kg of coffee bean processed, approximately 1 kg of coffee husks are produced and dumped. Several studies have been published that coffee husk was feasible used as animal feed (Gemechu & Muluaem 2020). Franca & Oliveira (2015) reported that coffee husk was considered as a corn substitute up to 25% for sheep. They also stated that coffee husk as a supplement in cow diet might be used varies from 30-40%.

Although many studies reported the potential uses of coffee husk as animal feed, Dinata & Utami (2019) contrary stated that coffee husk also has anti-nutritional components such as caffeine and tannins. In line with Mazzafera (2002), the presence of tannins and caffeine diminish acceptability and palatability of coffee husk by the animal. However, it is possible to reduce the effect of anti-nutrient compound in coffee husk. Physical, chemical, as well microbiological treatment may contribute in reducing caffeine and improve animal performances (Brand *et al.* 2000). Fermentation may reduce dry matter content of coffee husk (Dinata & Utami 2019). Fermentation also increases protein level and decrease the crude fiber content.

Sunda porcupine (*Hystrix javanica* Cuvier, 1823) is an endemic species in Indonesia. Due to its popularity as an aphrodisiac (Anita *et al.* 2015) and health beneficial, this species are

hunted and consumed because the physical characteristics of the meat consumed are very likely to be liked by the people Farida *et al.* 2012; Farida 2013)

Even this animal listed as protected, people are still possible to utilize the animal from captivity. Once the animal being captivated, it is compulsory to provide feed management that adequate their nutrient requirement and may increase animal performances. The aim of this study was to determine the effect of fermentation of coffee husk on nutrient composition as sunda porcupines feed.

MATERIALS AND METHODS

This research was conducted in the Small Mamalian Captivity, Zoology Division, Research Center for Biology-Indonesian Institute of Sciences, Cibinong. Nutrient feed analysis was carried out in the Laboratory of Nutrition, Zoology Division, Research Center for Biology -Indonesian Institute of Sciences, Cibinong.

Arabica coffee husks were collected from a coffee hulling plant in Lembang, West Java. Then, coffee husks were air-dried and fermented using the comercial *Aspergillus niger*. The fermentation was carried out using a method from Palinggi (2008). 10 g of *A. niger* was diluted with ratio 1 kg of coffee husk : 1 L of water. The coffee husks were placed on tarpaulin sheet and sprayed with *A. niger* solution. Next, the mixture was closed tightly and placed in a growing room with the temperature of 24-28°C and relative humidity of 60-80% for 5-days incubation. The fermented coffee husks were opened an air-dried for 3 days and used as feed.

This research has been approved by ethical clearance for the life sciences committee in the Indonesian Institute of Sciences no. B-15897/IPH/KS.02.04/XII/2019, date of issuing December 30th, 2019. Twelve Sunda porcupine with a range of 1.71 to 6 kg body weight (BW) were used and grouped into 3 groups, specifically low BW group (K1), middle BW group (K2), and high BW group (K3). During the study, the animals were placed in individual cage with the size 2.00 (l) x 2.25 (w) x 2,50 (h) cm in 8 weeks. Feed treatments consisted of control diet (T0), control diet with the addition of 10% of fermented coffee husk (T1), control

diet with the addition of 20% of fermented coffee husk (T2), and control diet with the addition of 30% of fermented coffee husk (T3). The ingredient compositions of experimental diets were calculated using WinFeed 2.8. The diet had iso-protein and iso-energy. The composition and calculated nutrient content of experimental diets are shown in Table 1. The diets were given, as complete ration, at 04.00 p.m. The amounts of feed consumed and remained were weighed and recorded every day, as well as the amount of feces produced using the total collection method (Tillman *et al.* 1991). Water were given *ad libitum* during the experiment. Variables observed were fresh matter intake, dry matter intake, and body weight measurement.

Proximate analysis of feeds were carried out according to standard procedure of AOAC (2005). The gross energy of feeds were determined using adiabatic bomb calorimeter (Parr Instrument 1266, Illinois, USA). A randomized block design was used to allocate three BW group as block and four dietary composed of different fermented coffee husk levels. Data were subjected to one-way analyses of variance followed by Duncan Multiple Range Test (Steel & Torrie 2003).

RESULTS

The changes of nutrient content of the fermented coffee husk are listed in Table 2. There were decreases of dry matter, organic matter, ether extract, and crude fiber after 5d-fermentation about 1.15%, 3.26%, 0.95%, 19.05% respectively. Meanwhile, crude protein, gross energy, and NFE rose sharply.

The porcupines consumed more control diet compared to diet with coffee husk. Dry matter intake as well as fresh matter intake of control ration was higher than those of coffee husk addition. Environmental conditions of the captivity, such as temperature and humidity will greatly affect the feed intake and the condition of porcupine. As reported by Church & Pond (1988), feed consumption can be influenced by several factors, namely (1) internal factors (physiological status of animals), (2) external factors (feed and temperature), and (3) the environment. Similar to that, Matthews (1983) also stated that the palatability is determined by the taste, smell, appearance, temperature, and texture of the feed. The result of average temperature and humidity measurements during the study at 00.00 a.m., 08.00 a.m., and 04.00 p.m. are 23.27 °C and 93.64%, 25.68 °C and 95.78%, and 27.73 °C and 81.31% respectively.

Based on the calculation of dry matter

Table 1. The composition and nutrient content of experimental diets

No	Composition	T0	T1	T2	T3
		(% as fed)			
1	Corn	26	23	20	18
2	Coconut	15	13	12	11
3	Water spinach	32	41	36	30
4	Bean sprout	9	9	8	7
5	Guava	4	4	4	4
6	Fermented coffee husk	-	10	20	30
Nutrient Content (100% DM)					
Dry Matter (%)		30.67	30.87	32.77	33.80
Organic Matter (%)		94.85	92.39	89.48	88.43
Crude Protein (%)		18.71	18.65	18.66	18.04
Ether Extract (%)		30.00	19.55	10.98	9.43
Crude Fiber (%)		16.87	15.96	22.86	22.38
NFE (%)		29.28	38.22	36.98	38.59
Gross Energy (cal/g)		4134	4,121	3931	3914
Ca (%)		0.32	0.36	0.40	0.44
P (%)		0.32	0.35	0.38	0.41

consumed by porcupines, it is known that the dry matter intake of the porcupines in T0, T1, T2, and T3 are 2.37%, 2.11%, 2.02%, and 2.05% of liveweight, respectively (Table 3). Figure 1 represents the body weight changes during the study. Body weight gain is associated with the amount of feed given (Farida & Ridwan 2011). The high intake of dry matter by the porcupines of T0 (Table 3) have shown higher body weight changes compared with T2 and T3. Overall the study, there were increments of body weight for each treatments week by week. T3 ration had the lowest BW gain rather than other treatments.

Feed efficiency is a ratio of body weight gains to feed intake (Saputra *et al.* 2013). T3 ration had a lowest feed efficiency index, while T0 ration had the highest feed efficiency index. From the statistical analysis, T3 ration was significantly different than T0 ration (P<0.05).

Table 2. Nutrient content changes of fermented coffee husk before and after 5d-fermentation (as 100% dry matter)

Nutrient Component	Before fermentati	After 5d-fermentati	Changes
DM (%)	93.00	91.85	-1.15
Organic Matter (%)	88.49	85.23	-3.26
CP (%)	13.15	19.83	+6.68
EE (%)	2.08	1.14	-0.95
CF (%)	43.63	24.57	-19.05
NFE (%)	29.62	39.68	+10.06
GE (cal/g)	3296	4073	777

Notes: DM = Dry Matter, CP = Crude Protein, EE = Ether Extract, CF = Crude Fiber, NFE = Nitrogen Free Extract, GE = Gross Energy.

Table 3. Daily intake of fresh matter, dry matter and feed efficiency of Sunda porcupine

Parameter	T0	T1	T2	T3
FMI(g)	418.03 ^c	346.75 ^b	218.52 ^a	265.98 ^a
DMI (g)	128.21 ^d	107.04 ^c	71.61 ^a	89.90 ^b
BW (g)	5400	5077	3537	4387
ADG (g)	20.54 ^c	14.76 ^b	9.58 ^{ab}	7.74 ^a
DMI % BW	2.37 ^b	2.11 ^a	2.02 ^a	2.05 ^a
Feed Efficiency (%)	16.02 ^b	13.79 ^{ab}	13.38 ^{ab}	8.61 ^a

Notes: Means in the same row with different superscript differ significantly (P<0.05). FMI = Fresh Matter Intake, DMI = Dry Matter Intake, BW = Body Weight, ADG = Average Daily Gain, T0 = control diet (without fermented coffee husk), T1 = control diet + 10% fermented coffee husk, T2 = control diet + 20% fermented coffee husk, T3 = control diet + 30% fermented coffee husk.

DISCUSSION

Biofermentation is one of method that effectively reduce the anti nutritional content of animal feed. 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 (Dinata and Utami 2019). A fungal strain, in particular *Aspergillus niger*, had ability to degrade tannin about 65% (Kassu *et al.* 2014). Brand *et al.* (2000) confirmed that strain *Aspergillus* sp. showed a good prospect for detoxification of coffee husk.

From Table 1, organic matter, ether extract, and crude fiber were decreased due to biofermentation. Many microorganisms, bacteria and fungi, were able to hydrolyze cellulose and use it as a main source of energy *Aspergillus niger* is capable of producing cellulolytic enzyme. This enzyme would degrade cellulose and hemicellulose produced simple carbohydrates that are more soluble (Mangisah *et al.* 2010). Other than that, fat content tended to decrease after 5d-fermentation. Lipase enzyme produced by fungi affects crude fat content after the fermentation process because the enzyme lipase will remodel fat to be used by *A. niger* as an energy source (Yohanista *et al.* 2014). Organic matter also diminished after fermentation. The decrease of organic matter was due to the utilization of carbohydrate as an energy source for growth and formation of fungus cell biomass and production of citric acid as well (Mangisah *et al.* 2010).

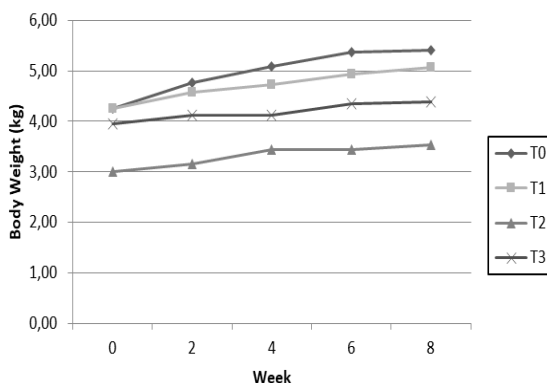


Figure 1. Changes in body weight of Sunda porcupine during the study

Dry matter loss was 2.10% in the present study. In every process of fermentation, dry matter loss of the substrate is unpreventable. Decreased in DM content after fermentation due to DM degradation by microorganisms that designate the fermentation process is running well and by microorganism growth optimized in the substrate (Dinata & Utami 2019; Naing *et al.* 2019). Based on that theory, that biodegradation might resulted in decrease of nutrient contents of fermented substrate, such as DM, OM, EE, and CF. Similar result in DM, OM, EE, and CF contents of *A. niger* treated coffee husk has also been reported by Dinata & Utami (2019).

Nevertheless, crude protein, gross energy, and nitrogen free-extract content of fermented coffee husk was improved. The improvement of CP of fermented coffee husk was due to the destruction of the protein in the presence of protease enzyme produced by *A. niger* that convert CP into amino acids. It was then utilized for the growth of the fungi. On the other hand, the increased protein content could also be due to the increase of sporulation resulting from the biomass increment. *A. niger* has the ability to utilize organic and inorganic compound for protein cell synthesis. This bioconversion consequence in the rise of protein content of fermented substrate (Dinata & Utami 2019). Ihtifazhuddin *et al.* (2016) stated that increment of protein content after the fermentation process probably derived from the fungi which has synthesized the urease enzyme to break the urea into ammonia and CO₂. This ammonia was then used to constitute amino acids. The increased GE and NFE after fermentation due to glucose increment as a result of *A. niger* fermentation hydrolyze cellulose (Ihtifazhuddin *et al.* 2016). *A. niger* also synthesizes β -glucosidase enzyme to accelerate the conversion of cellobiose broaden glucose (Juhasz *et al.* 2003). Porcupines need high protein diet that helps the animal grow the quills (Roze 2012).

Feed palatability factors are important for measuring feed intake in animals (Tomaszewska *et al.* 1991). Porcupine consumed more control ration than fermented coffee husk-contained ration. Thus, control ration was more palatable than other treatments. Fermentation feed

affected appetite of the animal since it might be associated with aroma and flavor (Mujiono *et al.* 2015). Ihtifazhuddin *et al.* (2016) reported that aroma of fermented soybean husk using *A. niger* was slightly sour and fragrant due to acid formed at day 2 and 4 fermentation process. Abelhadi *et al.* (2005) also reported that a sour and fragrant aroma indicate a good fermentation result.

Based on analysis of variance, the amount of dry matter intake in the treatments was significantly different ($P < 0.05$). Dry matter intake of T0 ration was higher than fermented coffee husk ration and dry matter intake of 20% fermented coffee husk (T2) was the lowest. Hence, the feeding using 20% fermented coffee husk had the greater effect i.e. more nutrients were used by the porcupine for the maintenance. Generally, an increase in consumption leads to an increase in live weight, suggesting that it is more convenient to express consumption as a function of liveweight (Santos *et al.* 2017). Statistically, T2 ration was not significant difference compared to T3 ration ($P > 0.05$).

The dry matter content of a ration refers to the amount of dry material available in a given ration. A number of factors influence the average daily dry matter consumption include liveweight (their required maintenance energy requirements), body condition, energy concentration of the ration, health status, and ration palatability. Forster (2011) stated that a basic guide for estimating dry matter consumption of feedlot animals is to calculate 2.0% to 3.0% of their liveweight. Therefore, all the treatments given were suitable for standard of rationing in dry ingredients. From the figure 1, the increasing intake of dry matter is a result of body weight increased. Despite that the porcupines of T2 were younger than T3, so that the body growth is still high. T3 ration had the lowest BW gain rather than other treatments.

On the other hand, feed efficiency of T3 ration was the lowest than others. According to McDonalds *et al.* (2011), feed will be more efficient by animal if the amount of feed is less consumed, but results in a high body weight gain. This is certainly related to lower average daily gain obtained by porcupines of T3 and lower dry matter intake as well. Compared to T2 ration, there was no significantly different in

feed efficiency of T3 ration ($P>0.05$). Thus, this showed that the dry matter intake of porcupine with 30% fermented coffee husk was more efficient than those porcupines with other ration.

CONCLUSION

From the result, it can be concluded that fermentation may improve nutrient composition of coffee husk. Thus, the fermented coffee husk was potential to be used as porcupines feed in captivity with tolerable of coffee husk until 30%.

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AUTHOR CONTRIBUTION

APS is the lead author, DD and WRF contributed to supervisor and quality assurance, THH, assisted lab analysis and US assisted in animal husbandry operations in the field

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