The Use of Fermented White Oyster Mushroom (*Pleurotus ostreatus*) Baglog Waste (BW) as Forage in Local Goat Feeding

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Abstract

White oyster mushroom (*Pleurotus ostreatus*) is a popular mushroom. Mushroom cultivation produces waste because baglog should be replaced every production cycle. In the location of mushroom cultivation, i.e Kutalimbaru Subdistrict, North Sumatra Province, every year BW are produces about 118 tons. This study was aimed to determine the use of fermented BW as forage in local goat feeding. BW were fermented at different times first, i.e. 7 until 28 days in order to know the best result on Crude Fiber, Crude Protein, Crude Fat and Ash Content. The best result was 21 days fermentation. The research then followed by in vivo of 21 days fermented BW as forage for local goat. The design was Completely Randomized Design (CRD) which was consisted of 4 treatments and 3 replications. Materials were 12 local goats, age 6 months, body weight were 12.23±1.51 kg. The result showed that fermented BW could be given up to 15% in the local goat feeding.

Keywords: baglog waste, fermentation, forage, local goat.

1. Introduction

Mushroom cultivation is an agricultural business that has recently developed very rapidly. White oyster mushroom is type of mushroom most favored by the people of Indonesia. Agrina [1] mentioned that public awareness to consume mushroom has positive effect on the increasing demand of supply which reaches 20-25% per year. Indonesian mushroom production in 2011 was 43,047,029 kg.

The development of mushroom cultivation generated abundant of waste. As in North Sumatera Province, all landfill are open dumping, it was recommended by Ginting et al. (2018) [2] that waste for example organic waste should be managed locally.

Mushroom cultivation produces waste which is baglog waste (BW). Baglog has to be replaced every production cycle, e.i 4 months. In Kutalimbaru sub district, North Sumatera Province, Indonesia, where mushroom cultivation was located, every year about 118 ton of BW was produced.

BW is formed by sawdust and other constituent materials such as rice bran, calcium oxide and gypsum. BW can be used for ruminants feed primarily as a source of fiber which expected to participate in supplying energy needs for livestock that consume them. However, this material has a high crude fiber and a poor odor. Therefore, it is necessary to process the material before being used as feed, one of which is through fermentation technology. Fermentation could improve and increase the nutritional value of the waste for example agricultural industry waste [3, 4] i.e.

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Crude Protein, Crude Fiber, Crude Lipid so that waste could be as feed for ruminants.

Goat are popular ruminants in Indonesia. In the past, mostly goat was kept unintensive but since decade live stockers chosed semi intensive ways as it gives more profit. Ion, C et al. (2015) [5] mentioned that semi intensive rearing system caused better on average daily gain and average total gain.

2. Materials and methods

A. Fermentation research of BW

This research was preceded by another research in order to know times of fermentation, i.e. 7 until 21 days. Ginting, and Pase (2018) [3] found that fermentation by using local microorganisms until days 6th, increasing on Crude Protein, Crude Fiber and Crude Lipid still had a linear trend while Mirwandono et al. (2018) [4] found fermentation until days 7th either by using local microorganisms or commercial microorganisms had increased Crude Protein, Crude Fiber and Crude Lipid. So in this research, time of fermentation was conducted until days 21th by using commercial micoorganisms (Starbio). The fermentation research was conducted at the Laboratory of Nutrition Feed of Goat Research Centre Sei Putih of Galang Subdistrict of North Sumatera Province, from October 2017 until December 2017. The materials used were oyster mushroom baglog, Starbio, molasses, rice bran, urea, water sufficiently, tarpaulin as a place for drying BW and materials for proximate analysis.

The design was completely randomized design with 5 treatments in the form of fermentation days and 4 replications. The treatments were as follows:

P0: BW without fermentation (control)
P1: BW fermented 7 days
P2: BW fermented 14 days
P3: BW fermented 21 days
P4: BW fermented 28 days

Parameters observed were the percentage of Crude Protein, Crude Fiber, Crude Fat and Ash Content. The analysis was based on AOAC [6].

B. In Vivo Research of 21 days fermented BW as forage on local goats

After the result of fermentation research was obtained, then in vivo research was conducted where fermented BW were applicatted as forage on local goats. The design was Completely Randomized Design (CRD) with 4 treatments and 3 replications. Materials were 12 local goats, age 6 months, body weight were 12.23±1.51 kg.

3. Results and discussion

A. Fermentation Research of BW

Fermentation is done by adding microorganism proteolytic, lignolytic, cellulolytic, lipolytic, and microorganism non symbiotic nitrogen fixation. Microorganisms in doing their work take time to produce optimal growth. The fermentation time depends on the type of media and the type of inoculum used.

3.1. Crude Protein

CP were fluctuated as time goes by fermentation. P0 was 4.87% because of the addition of urea. On 7 days fermentation there was a decrease in crude protein content to 4.19%. This was because the microorganisms just start into adaptation phase. Pasaribu et al. (2016) [7] showed that there was a decrease in the crude protein content in the fermented palm sludge with *Aspergillus niger*. Microbes degraded the protein compounds in the ingredients so that lowering the levels of crude protein. At 14 day fermentation, there was an increase in crude protein content to 4.57%. The increase continued to occur until the fermentation of 21 days into 5.56%. Soccol et al. (2017) and and Fardiaz (1992) [8, 9] stated that the increase in crude protein content during the fermentation process was due to an increase in the amount of microbial biomass. Then on 28 day fermentation, the crude protein content fell to 4.66%. This occurred because the microbes were in the stationary phase or the zero growth rate. According to Fardiaz (1992) [9], after the exponential phase was reached, the rate of growth continues to decline until it was zero (stationary phase). In this phase the cell number was constant so that the living cells were the same as the dead cells. Hamdat (2010) [10] also added that the microbes that were still alive in their growth using the existing food substances in the media. CP content of fermented BW using Starbio with different fermentation lengths tested by orthogonal polynomial can be seen in Figure 1.

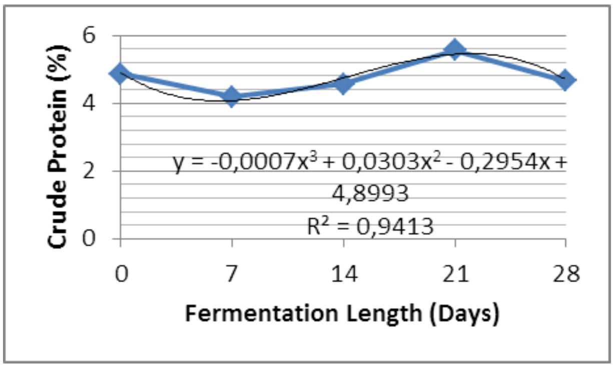

Figure 1. Graph of cubic regression of crude protein content of fermented BW

Based on the figure 1 it can be seen that the line representing the crude protein content forms a cubic curve with equation $y=-0.0007x^3+0.0303x^2-0.2954x+4.8993$ ($R^2=0.9413$). The curve shows a gradually changing value in which the crude protein content fluctuates with fermentation time and has a peak at 21 days fermentation with crude protein content of 5.56%.

Table 1. Crude Protein, Crude Fiber, Crude Fat and Ash Content of Fermented BW with different days

Treatment (days)	Parameters			
	Crude Protein (%)	Crude Fiber (%)	Crude Fat (%)	Ash Content (%)
0	4.87^b	39.92^a	0.23^c	16.64^d
7	4.19^d	39.68^b	0.26^c	18.25^a
14	4.57^c	39.59^b	0.43^b	17.62^c
21	5.56^a	38.78^c	0.79^a	18.09^b
28	4.66^c	38.03^d	0.87^a	18.06^b

Superscript with different letters in the same column shows a significant different effect ($P<0.05$)

3.2. Crude Fiber

The content of crude fiber has decreased over the course of fermentation time. This decrease in crude fiber content due to microbial activity that produces cellulase and other enzymes capable of breaking the complex bonds of crude fiber becomes simpler. Kamara et al. (2008) [11] mentioned that crude fiber consists of cellulose, hemicellulose and lignin used for microbe growth activity so that crude fiber will decrease. Syamsu (2006) [12] also added that Starbio was enzyme-producing anaerobic probiotics that work to break down carbohydrates (cellulose, hemicellulose, lignin) and proteins and fats.

Crude fiber content of fermented BW using Starbio with different fermentation lengths tested by orthogonal polynomial can be seen in Figure 2.

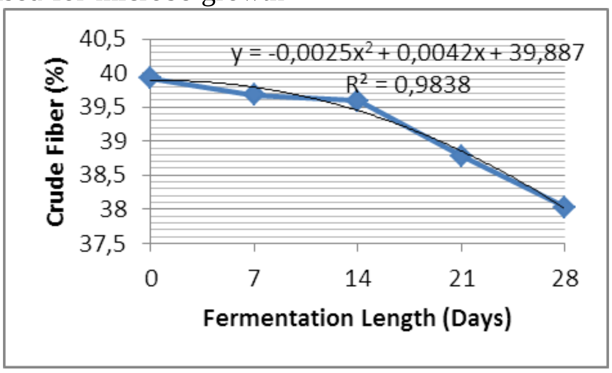

Figure 2. Graph of quadratic regression of crude fiber content of fermented BW

Based on the Figure 2 it can be seen that the line representing the crude fiber content forms a quadratic curve with the equation $y=-0.0025x^2+0.0042x+39.887$ ($R^2=0.9838$). The curve shows that BW fermented using Starbio has the effect of reducing crude fiber content.

3.3. Crude Fat

The crude fat content increased with time of fermentation. Increased crude fat content indicated the presence of fatty acid synthesis in the waste of the oyster mushroom media. The result of Hafizh (2016) [13] researched showed that the increase of crude fat content in complete feed based on sago pulp occurs due to the synthesis of fatty acids in the sago pulp. The decomposition of carbohydrates in the fermentation process can produce fatty acids, so the fat content in fermented materials can increase.

Crude fat content of fermented BW using Starbio with different fermentation lengths tested by orthogonal polynomial can be seen in Figure 3. Based on the figure 3 it can be seen that the line representing the crude fat content forms a linear curve with the equation $y=0.0259x+0.154$ ($R^2=0.9225$). The curve shows that BW fermented using Starbio has the effect on increasing the crude fat content.

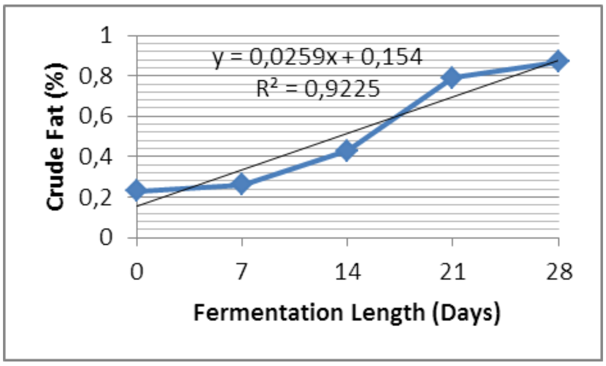

Figure 3. Graph of linear regression of crude fat content of fermented BW

3.4. Ash Content

The ash content fluctuated as time goes by fermentation. In the treatment of P0 (control), the ash content was the lowest of 16.64%. This occurs because there has been no degradation process by microorganisms so that the organic materials contained in the feed have not been used by microorganisms for its growth. Then ash content increased at treatment P1 to 18.25%. This was because of decreasing organic matter where microorganisms started to work by using organic materials in the feed. Ash content decreased at treatment P2 to 17.62%. This occurs due to the increased of organic material in the presence of material degradation process (substrate) by microorganisms. Then ash content increased again at treatment P3, where ash content of P3 and P4 showed unreal difference. Styawati et al. (2013) [14] stated that the more the degradable organic matter, the more the increased of ash content proportionally.

Ash content of fermented BW using Starbio with different fermentation lengths tested by orthogonal polynomial can be seen in Figure 4.

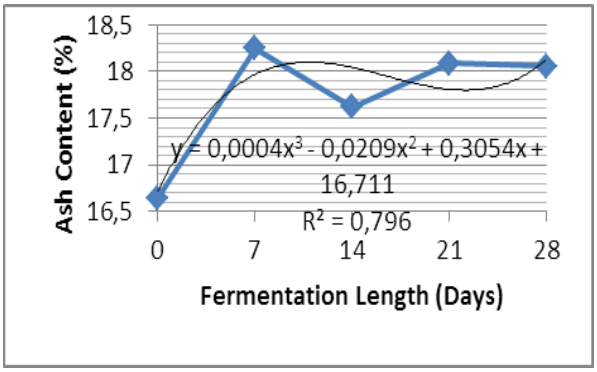

Figure 4. Graph of cubic regression of ash content of fermented BW

Based on the figure it could be seen that the line representing the ash content forms the cubic curve with the equation $y=0.0004x^3–0.0209x^2+0.3054x+16.711$ ($R^2=0.796$). The curve showed a gradually changing value in which the ash content fluctuated with the fermentation time and had the lowest point in the treatment without fermentation with ash content of 16.64%.

B. In vivo research of 21 days fermented BW as forage on local goats

Ration given in the form of four levels of 21 days fermented BW as follows: P0 (local grass 60%+concentrate 40%); P1 (local grass 45%+fermented BW 15%+concentrate 40%); P2 (local grass 30%+fermented BW 30%+concentrate 40%;) and P3 (local grass 15%+fermented 45%+concentrate 40%) (Table 2). The observed variables were feed consumption and daily body weight gain.

Table 2. Feed ingredients of 4 treatments of ration on local goats

	P0	**P1**	**P2**	**P3**
	%			
Local grass	60	45	30	15
21 days fermented BW	0	15	30	45
Rice bran	19.5	19.5	19.5	19.5
Soybean meal	10	10	10	10
Coconut meal	6	6	6	6
Molases	2	2	2	2
Salt	1	1	1	1
Ultra mineral	1	1	1	1
Urea	0.5	0.5	0.5	0.5
Total	100	100	100	100
Chemical compositions				
CP	13.43	13.68	13.93	14.18
CF	23.80	23.83	23.85	23.87
CL	3.19	3.14	3.09	3.04
Ash	7.90	8.33	8.75	9.18
BETN	51.68	51.03	50.37	49.72
TDN	71.69	71.46	71.24	71.01

Consumption

The consumption in dry matter of local goats were presented in Table 3.

Table 3. Consumption in dry matter (g/head/day)

Treatments	Repetitions			Average
	1	2	3	
P0	931.73	940.44	937.41	936.52[b]
P1	936.07	921.33	926.86	928.09[b]
P2	920.22	912.63	916.97	916.60[b]
P3	773.23	888.16	864.42	841.94[a]

Superscript with different letters in the same column shows a significant different effect ($P<0.05$)

The result of statistical analysis showed that feed consumption (in dry matter) per day from four treatments showed a difference ($P<0.05$). Feed consumption was influenced by food characteristics which include digestibility, palatability and nutrient balance in rations [15]. Local grass substitution by 21 days fermented BW at level 15% (ration of P1) and level 30% (ration P2) had an average value of consumption which was not significantly different with P0 ration (without 21 days fermented BW). This was supposed palatability value equally well. Local grass substitution by BW level of 45% (ration P3) caused the decrease of feed consumption. This was because ration P3 BW had fine particle size, the amount in the ration a lot more than local grass so that goats less like it. In addition, the content of BW was higher when compared with forage.

Average Daily Gain

Average daily gain of local goats after treatments was presented in Table 4. The results of statistical analysis showed that the daily weight gain of the four treatments was significantly different (P>0.05). Campbell et al. (2006) [16] stated that weight gain of the livestock body was always directly proportional to the level of feed consumption. P0 had the highest level of consumption so did average daily gain. While P1 and P2 have no significant different consumption with P0, however their daily gain was different with P0.

Table 4. Average daily gain of local goats after treatments (g/head/day)

Treatments	Repetitions			Average
	1	2	3	
P0	71.43	121.43	142.86	111.90^b
P1	71.43	135.71	57.14	88.10^b
P2	57.14	78.57	50.00	61.90^a
P3	35.71	50.00	64.29	50.00^a

Superscript with different letters in the same column shows a significant different effect (P<0.05)

This was occurred possibly due to anti-microbial growth in BW. In Indonesia, baglog are made by mixing several components include gypsum which contain $CaSO_4$ x $2H_2O$. According to FAO (1996) and Topp et al. (2008) [17, 18] mineral ions, heavy metals were included inhibitory/toxic materials for the growth of microorganisms. Mineral ions in light concentration were required by microorganisms to thrive, but excessive concentration will have toxic effects on microorganisms. The mineral ions include sodium, potassium, calcium, magnesium, ammonium, sulfur. FAO (1996) [17] stated sulphate at a concentration of 40,000 ppm to be an inhibiting material on the growth of microorganisms.

From the results of this research, it was suggested that level of BW that could be used as forage instead of local grass for goat feeding were as much as 15% and this was worthed for live stocker as in dry season as well as in extreme wet season, local grass were limited.

4. Conclusion

21 days was the best fermentation of white oyster mushroom baglog waste. In conclusion also, only 15% of baglog waste (BW) could be used as forage instead of local grass for local goats.

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