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Rice Straw Fermented with White Rot Fungi as an Alternative to Elephant Grass in Goat Feeds

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Abstract: The objective of thispaper was to evaluate the possibility of substituting elephant grass (*Pennisetum purpureum*) with rice straw that has been fermented with white rot fungi in goat. A total of 12 goats were randomly assigned to feed on one of treament diets according to completely randomised block design. The animals were divided into three blocks according to their initial body weight. The treatments were: R1 = 100% Elephant grass, R2 = 70% Elephant grass + 30% fermented rice straw, R3 = 30% Elephant Grass + 70% fermented rice straw and R4 = 100% fermented rice straw. Parameters measured were dry matter and organic matter digestibility, feed consumption, average daily gain and feed eficiency of goats. Data analysis indicated that the DM and organic matter digestibility significantly decreased when the level of fermented rice straw increased in the ration. Inclusion of fermented rice straw up to 70% in the ration did not signifcantly alter DM and OM digestibily but substituting grass with 100% fermented rice straw markedly decreased DM and OM digestibilities. The best feed efficiency was found in the goats given R3 (0.15) followed by R2 (0.10), R1 (0.09) and R4 (0.04). In conclusion, rice straw that has been fermented using white rot fungi can be used to subtitute elephant grass up to 70% in the ration of goats. Future work is to optimize the use of agro-industrial waste into quality feed with fermented by white rot fungi.

Key words: Fermented rice straw · White Rot Fungi · Feed Substitution · Goats

INTRODUCTION

The main problem faced in ruminant production system is availability of feedstuff, especially in dry season. Therefore knowledge in utilizing agroindustry byproduct as feedstuff to meet nutrient requirement of animals is important when the conventional feeds are scare. The potency of agriculture and agro-industry byproduct as ruminant feeding, which is locally available, is great [1,2]. Utilization of this materials can be regarded as good strategy to minimize the cost of feeding because in animal production system, 60-70% of total production cost is spent for feedstuff. Many studies have been carried out in order to improve nutritive values of this materials. However, In order to its use as feedstuff, it must meet the aspects of quantity, quality and continuity. Paddy by product, rice straw and processing waste such rice brand, contributes significantly to the availability of feed supply because it is abundantly available. Rice straw is a leftover from harvesting rice consisting of the stem and some leaves. The yield of crop plant byproduct can be estimated from the size on land area of the harvested crop [3].

However, utilization of rice straw as feed is generally limited by several factors such as the low nutritional quality due to high fiber content and lignification process (hardening). Lignin and cellulose commonly form lignosellulose bounds, a very strong bound, in plant cell

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walls [4]. Lignin is an aromatic polymer compound of phenilpropanoid, the synthesis conyferyl, synaphyl, p-coumayl alcohol [5]. Ester bonding and covalent bonds between lignin, polysaccharides from coarse fiber protein, naturally form bonds intrinsic to most coarse fiber structure and is a major barrier to degradation, both cellulose and hemicellulose degradation [6-8]. The older the plant, the higher the lignin content resulting in lower digestibility as lignification increase. Therefore rice straw must be processed before using as animal feeding. Processing of rice straw can be done physically, chemicaaly, or biologically. Each method has own its advantages as well as disadvantages. One biological method that can be used in rice straw processing is by utilizing white rot fungi. This fungi is well known to actively break down lignin content of straw [9].

Some of fungi that live in soil have the ability to degrade lignin and cellulose compounds. These fungi produce ligninase, an enzyme that can degradate lignin compounds and cellulase, an enzyme that can degradate cellulose. Example is the fungus *Fusarium proliferatum, Peniciilium decumbens* P6 [10], *Penicillium simplicissimum* [11]. Whereas cellulose decomposing fungi such as *Aspergillus niger*, *Chaetomium globosum*, *Scopulariopsis brevicaulis*, *Trichoderma koningii* and *Trichoderma roseum* [12] and *Mucor hiemalis* [13]. Some cellulolytic fungi isolates such as *Aspergillus sp*, *Penicillium sp*, *Trichoderma Viridae*, *Trichoderma sp spiralis* and *Chatomium*, known efficient in decomposing straw and other crop residues [14]. The objective of this study was to test the possibility of substituting elephant grass (*Pennisetum purpureum*) with rice straw that has been fermented with white rot fungi as feeding for goat.

MATERIALS AND METHODS

Preparation of Fermented Rice Straw: In the previous study, the various levels of *Coprinus comatus* isolats were added to rice straw substrates and fermented at different incubation time. It was found that the optimum level and fermentation time that can be applied to optimally increase the quality of rice straw in terms of improving nutritive quality and in vitro digestibility of rice straw substrat was 10% (w/w) for 30 days. Therefore, in this experiment that level was applied in preparing fermented rice straw.

The rice straw was chopped into small size (2-5 cm length) then mixed homogenously with 10% (w/w) of *Coprinus comatus* isolat. The mixture then was put into plastic bag and fermented for 30 days under anaerobic condition. Before feeding to animal, the fermented rice straw was exposed to ambient temperature. The *Coprinus comatus* isolat was prepared according to procedure of [15].

Animal and Feeding: The experiment was conducted according to completely randomised block design. Twelve goats were divided into three groups according to initial body weight (four animal/group). Each animal in every group was randomly given one of four treatment diets, namely: R1= 100% Elephant grass (Control), R2= 70% Elephant grass + 30% fermented rice straw, R3 = 30% Elephant grass + 70% fermented rice straw and R4= 100% fermented rice straw. In addition, each animal was also given concentrate at the rate of 1.5% of body weight. Each animal was kept in individual metabolism crate and has a free access to drinking water.

The study was carried out for 30 days which was divided into three periods: preliminary period, adaptation period and sampling period. Preliminary time was intended to observe the average amount of feed consumed by each animal. The second period was intended to give chance to animal adapting to experimental diet and the last period was for data collection which was lasting for ten days. Animal was fed on twice a day; 07.30 and 16.00 and each animal was given experimental diet around 89 to 104.9/ $BW^{0.75}$ Each animal was fed daily, but all leftover feed from previous day was removed from the feed bunk before adding the fresh feed. The amount of feed and refused feed was recorded to calculate feed consumpotion.

Sample Collection: During the sampling period (10 days), the quantity of diet (fermented rice straw and concentrate) offered and refused (if any) were recorded every morning and a sub-sample was bulked for further analysis.

The daily fecal collection was put in plastic bags and weighed. The bags, with feces, were labeled and stored at 5°C. At the end of each collection, feces collected daily from each sheep over the 5-day period were bulked on an individual animal basis, mixed thoroughly and a sub-sample was oven dried (100°C) to determine dry matter of the feces. Another sub sample (10%) was taken and kept frozen for subsequent laboratory analysis.

Laboratory Analysis: The feed samples (fermented rice straw and concentrate) and feces were analyzed for dry matter (DM), ash, total N, neutral detergent fibre (NDF) and acid detergent fibre (ADF). All samples were ground to pass 1-mm screen prior to analysis.

DM content was determined by drying at 100°C in the oven for 24 h. The percentage of ash was determined by igniting the samples for 6 h at 550°C. Organic matter (OM) was calculated as 100-%ash (DM). Fibre composition (ADF and NDF) was analyzed according to the procedure of [16].

Parameters Measured: The dry matter (DM) and organic matter (OM) intake were determined by substracting the amount of DM and OM of feed offered with the DM and OM digestibilities which were determined using formula:

DM digestibility = (DM intake(g)-feces DM (g))/DM intake (g) x 100%

OM Digestibility = (OM intake(g) - Feses OM (g))/OM intake (g) x 100%

Feed Efficiency = Average daily gain(g)/daily DM intake (g)

Statistical Analysis: All data were subjected to analysis of variance for completely randomiseblock design using the General Linear Model (GLM) procedure of SPSS. The difference among the treatment means was determined by Duncan Multiple Range Test [17].

RESULTS AND DISCUSSION

In general, condition of the experimental animals was in good condition throughout the study. DM and OM digestibilities were significantly affected by the treatments (Table 1). DM intake decreased as the level of fermented rice straw in the ration increased, ranging from 571.64 g/d (R1) to 275.54 g/d (R4). Similarly OM intake decreased from 522.71 g/d (R1) to 220.58 g/d (R4). DM and OM digestibilities were affected ($P<0.05$) by the treatments (Table 1). Further test indicated that DM and OM of goats receiving R1, R2, R3 were significantly higher than that of R4, while R1, R2, R3 were similar ($P>0.05$). Average daily gain of goats given R1, R2 and R3 was significantly higher than that of treatment R4. Similarly, feed efficiency for treatments R1, R2, an R3 was better compared to that of the treatment R1.

Feed intake can be used as an indicator of the palatability of the diets. The average value of goats receiving 100% fermented rice straw (R4) is 275.535 g / day in (Table 1). This value is lower than the reccomended level for feed intake for goat which is 89 - 104.9 g/ ($BW^{0.75}$). Average consumption in these experiments ranged from 275.54 g/day (100% rice straw fermented) to 571.64 (100% elephant grass). Feed consumption of the goats in this study was lower than that reported by [18] who reported feed intake ranging from 529.0 to 547.9 g/day by using a feed containing Probion, rumen microbes of buffalo and catalytic supplements.

Table 1: The mean for DM and OM intake, DM and OM digestibilities and feed efficiency for each treatment

	Ration Treatment			
Parameter	R1	R2	R3	R4
Feed intake (g/day)				
Dry Matter	571.64^{c}	483.63^{bc}	377.82^{ab}	275.54^{a}
Organic Matter	522.71^{c}	437.18^{bc}	322.64^{ab}	220.58^{b}
Digestibility (%)				
Dry Matter	65.96^{b}	64.30^{b}	67.14^{b}	44.21^{a}
Organic Matter	67.07^{b}	66.44^{b}	65.92^{b}	39.65^{a}
Daily Weight Gain (g/h/d)	52.78	50.00	55.56	9.67
Efficiency of feed	0.09	0.10	0.15	0.04

a,b Means followed by different superscript at similar row were significantly different ($P<0.05$). R1 (100% Elephant grass), R2 (70% Elephant grass + 30% fermented Rice Straw), R3 (30% Elephant grass + 70% Fermented rice Straw Fermentation) and R4 (100% Fermented Rice Straw).

Even though the feed intake of R2 is slightly lower than that of R1, but both statistically similar indicating. But feed intake of R3 and R4 is lower than In other word inclusion 30% of fermented rice straw to substitute elephant grass does not negatively affect the intake of animals but subtituting elephant grass with 100% fermented rice straw significantly deteriorates the intake of animals. This phenomenon might be related to low palatability of straw as well as low digestibility (Table 1). One physical factor determining the level of intake of animal is the volume of rumen. Straw is very bulky materials. Therefore the the animal receiving only fermented rice straw requires more room in the rumen for the same amount of diets than animal receiving only grass or combination of grass and fermented rice straw. Another factor detrmining the intake of animals is when the need for energy has been met. According to [19], consumption of the ration is basically intended to meet the energy needs of animal, so the animals will stop eating when they have been feeling its energy needs have been fulfilled. But they also will stop eating when the rumen is full even though the energy requirement is not met yet.

Utilization of fermented rice straw to substitute elephant grass at the level of 30% or 70% do not cause a decrease on the digestibility of the ration compared to that of R1 (elephant grass without fermented rice straw). This implies that utilization of fermented rice straw up to this level has no negative effects on digestibility, but giving 100% fermented rice straw markedly decrease the DM and OM digestibilities. One possible reason for this is that there is a positive associative effects by mixing the grass with fermented rice straw up to that level. Providing only fermented rice straw might be not enough to support optimum fermentation in the rumen resulting a significant decrase in the digestibility. DM and OM digestibilities are ranging from 44.21% to 67.14% and from 39.65% to 67.07%, respectively. DM and OM digestibilities of R1, R2 and R3 were similar, averaging (65.96, 64.30, 67.14).% and (67.07, 66.44, 65.92)% for DM and OM respectively. According to [20], the digestibility of dry matter in the range of 55-65% is high and could be expected to improve livestock growth. In vivo digestibility of fermented rice straw in this study is 44.21%, which is lower than that measured in vitro (48.09%). This is in agreement with one reported by [21] who said that the in vitro digestibility is higher than digestibility of in vivo studies. Some factors that can contribute to this differences are the presence of ingredients derived from the body so that nutrients contained in the feces is an enzyme that is secreted into the digestive tract that is not absorbed back, as well as materials that scraping cells from the walls of the digestive tracts [22].

Average daily gain and feed efficiency of the goats having R1, R2, R3 were similar and significvantly higher than those receiving R4. The average daily gain for R1, R2 and R3 was 52.78 g/d. Similarly feed efficiency of the goats given R1, R2, R3 were similar. Despite the decrease trends of feed intake as the fermented rice straw increase in the ration, body weight is not affected when subtituting grass up to 70% with fermented rice straw. This implies the animals can well utilize the nutrient contents of the diet containing fermented rice straw up to 70%. The value of feed efficiency is ranging from 0.04 (R4) to 0.15 (R3). This shows that for every 1 kg of ration treatments can increase the weight by 4 to 15 grams. Numerically, the highest feed efficiency is achieved when 70% of elephant grass is substitute by fermented rice straw. For R3, to achieve 1 kg of body weight gain, it requires 6.67 kg feed. The value is lower when compared with that reported by [23], in which that to increase the weight of 1 kg lamb takes ± 12.66 kg of dry matter.

CONCLUSION

Fermentation of rice straw with white rot fungi can be used to subtitute Elephant Grass (*Pennisetum purpureum*) up to 70% for goat feeding without deteroriating the performance of the goats. This implies that fermented rice straw can be used as a beneficial feedstuff to meet nutrient requirement of animals when the conventional feeds are scare.Future work is to optimize the use of agro-industrial waste into quality feed with fermented by white rot fungi.

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