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© 2020 Scholars Journal of Agriculture and Veterinary Sciences | Published by SAS Publishers, India 35 Scholars Journal of Agriculture and Veterinary Sciences Abbreviated Key Title: Sch J Agric Vet Sci ISSN 2348 – 8883 (Print) | ISSN 2348 – 1854 (Online) Journal homepage: <https://saspublishers.com/sjavs/> Improving Rumen Fermentability and Fiber Fraction Digestion of Fermented Rice Straw with A Cattle Feed Supplement and A Concentrate Ramaiyulis\*, Eva Yulia, Nelzi Fati, Salvia, Nilawati Animal husbandry study program, Agriculture Polytechnic Payakumbuh, 26271, Indonesia DOI: 10.36347/sjavs.2020.v07i02.003 | Received: 08.02.2020 | Accepted: 15.02.2020 | Published: 18.02.2020 \*Corresponding author: Ramaiyulis Abstract Original Research Article This study aimed to obtain the best ration with the use of fermented rice straw (RF) as a basal feed for cattle farms. The RF was made by fermenting rice straw using *Rhizopus oligosporus*. The concentrate consisted of many locally available feed ingredients.

The supplement was composed of several feeds as a multinutrient to supplement any deficiencies in the ration. There were 4 treatment rations: RF = 100% RF (control), RFS = RF + 10% supplement, RFSC = RFS + 10% concentrate, and RFSC2 = RFS + 20% concentrate. The rations were tested by in vitro digestion using bovine rumen fluid and 48 hours of incubation at 39 °C under anaerobic conditions.

The results showed that the addition of the supplement significantly increased the digestibility of the dry matter, organic matter, crude protein, and hemicellulose, while the addition of the concentrate significantly increased the concentration of VFAs and the digestibility of NDF and cellulose. The best composition was an 80:10:10 (% DM) mixture of RF, supplement and concentrate. Keywords: fermented rice straw, supplement, concentrate, cattle ration, digestibility.

Copyright @ 2020: This is an open-access article distributed under the terms of the Creative Commons Attribution license which permits unrestricted use, distribution, and reproduction in any medium for non-commercial use (NonCommercial, or CC-BY-NC) provided the original author and source are credited. INTRODUCTION The Indonesian government targets beef self-sufficiency in 2020 by stimulating domestic beef production which currently only reaches 68% [1].

Development of beef production through small-scale community farms is limited by the availability of grasslands and pasture fields for supplying forage continuously. Extensively raising of cattle in the districts of Pesisir Selatan and Sijunjung, fulfilling forages for cattle by releasing cattle roaming the highways and house yards which disturb farmers' horticultural gardens and leading to the pollution of the environment [2].

Therefore, it is necessary to develop alternative forage feed sources from local resources. Optimization of the use of rice straw agricultural waste has several factors limiting its use as forage. Rice straw mostly (> 60%) consists of cell walls composed of cellulose, hemicellulose, lignin, and silica [3].

The limiting factor of rice straw use as forage is its low nutritional value and digestibility; thus, it is unable to provide adequate nutrition for high-producing ruminants [4]. Rice straw contains high silica (12-16%) and lignin (6-7%) contents, which inhibit rumen microbial degradation during the digestive process [5]. Rice straw must undergo pretreatment before it is turned into animal feed.

Pretreatment of rice straw with fungi is a practical, low-cost and environmentally friendly way to increase the nutritional value and straw digestibility [6]. Processing straw by fermentation can increase the nutritional value and digestibility of rice straw as a forage feed [7]. Rice straw can be used as a substitute forage feed, although it cannot be used as a complete ration, and its use must be supplemented with a concentrate [8].

Feed originating from local sources such as sago pith, bran, cassava, and coconut pulp, as a concentrate of inexpensive, valuable energy sources. The addition of concentrate to fermented rice straw is expected to provide a readily available carbohydrate source that can be used for microbial growth and digestive activity in the rumen [9].

The addition of concentrate with the cattle feed supplement reported by [10] can interact positively to increase the digestibility of low-quality forage. The cattle feed supplement is reported to be able to optimize the rate of microbial biomass production in the rumen [11] so that more microbes will participate in the digestion process. The



(3%), and gambier leaf residue (5%).

The supplements were produced by heating brown sugar at a temperature of 90 °C until the sugar melted; then, it was poured into a mixture of ingredients according to the composition in the formula. Dough was molded into pellets that were 5 mm in diameter with a pellet machine and dried in an oven at 60 °C. The concentrate consist of local feed ingredients, namely, sago pith (30%), bran (30%), cassava (20%), and coconut pulp (20%), is shown in Table 1.

The fermented rice straw, cattle feed supplement, and concentrate were utilized in the combinations shown in Table 1 and were evaluated in 4 replications. In Vitro experiment An in vitro experiment was carried out following the method of [12] using the rumen fluid of Bali beef cattle (*Bos sondaicus*) obtained after animals were slaughtered in abattoirs. Rumen liquid was mixed with McDougall buffer solution consisting of 19.6 g NaHCO<sub>3</sub>, 7.42 g Na<sub>2</sub>HPO<sub>4</sub>·7H<sub>2</sub>O, 1.14 g KCl, 0.94 g NaCl, 0.24 g MgSO<sub>4</sub>·7H<sub>2</sub>O and 0.08 g CaCl<sub>2</sub>·2H<sub>2</sub>O per liter of distilled water at a ratio of 1:4 and a pH of 6.8.

The allocation of the in vitro treatments followed a randomized complete block design with individual rumen fluid donors as blocks. A feed sample of 2.5 grams was put into an Erlenmeyer flask, 250 ml of a mixture of rumen fluid and McDougall buffer was added, and 2 Erlenmeyer flasks were made for each treatment unit. Then, the mixture was purged for 30 seconds with CO<sub>2</sub> gas to create an anaerobic environment in the Erlenmeyers, which were then covered with a ventilated rubber cap. The Erlenmeyers were placed in a water-bath shaker Ramaiyulis et al.,

Sch J Agric Vet Sci, Feb, 2020; 7(2): 35-40 © 2020 Scholars Journal of Agriculture and Veterinary Sciences | Published by SAS Publishers, India 37 (Precision, USA) and were incubated at 39 °C for 48 hours. Fermentation was stopped by immersing the Erlenmeyers in cold water. Parameter measurements After completing incubation, the pH of the rumen fluid was measured using a pH meter (Hi9807- phep).

Next, the samples were centrifuged (Hitachi CR21, Japan) at 3,000 rpm for 15 minutes at 4 °C. The supernatant was used for NH<sub>3</sub> analysis by the Conway microdiffusion method and volatile fatty acids (VFA) analysis by the steam distillation method [13]. The residue was washed twice with distilled water, centrifuged again and then filtered using Whatman 41 filter papers before being dried in a 60 °C oven for 24 hours.

Then, proximate analysis [13] was performed to determine the content of dry matter, organic matter, crude protein and crude fiber in the residue. Fiber fraction analysis was performed following the method of [14] to determine the contents of the neutral

detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL), hemicellulose (NDF-ADF) and cellulose (ADF-ADL). NDF was determined by boiling 0.5

g of sample with 100 ml of a neutral detergent solution (NDS) for 1 hour. The NDS consisted of disodium ethylene diaminetetra acetate, sodium lauryl sulfate, sodium tetraborate, monoglycoether, sodium dihydrogenphosphate, and distilled water. Then, the sample was filtered in a glass crucible (coarse porosity 1), dried in a 105 °C oven and weighed.

The ADF was determined in the same way but using an acid detergent solution (ADS), which consisted of cetyl trimethylammonium bromide, sulfuric acid, and distilled water. An addition of 72% H<sub>2</sub>SO<sub>4</sub> was used to separate ADL. Statistical analysis Measured parameters were analyzed using Statistical Package for Social Science (SPSS, version 13.0, SPSS Inc., and Chicago, IL).

Single-factor analysis of variance (ANOVA) was used to analyze data following a statistical model:  $Y_{ij} = \mu + t_i + \beta_j + e_{ij}$  where  $Y_{ij}$  is the observed value,  $\mu$  is the overall mean,  $t_i$  is the effect of the different treatments,  $\beta_j$  is the effect of the different blocks, and  $e$  is the residual random error. If a significant effect was expressed at the probability level of  $P < 0.05$ , it was followed by Duncan's new multiple range test to determine the average value that was significantly different at  $P < 0.05$ .

**RESULTS AND DISCUSSION** Rumen fermentability The in vitro rumen fermentability of fermented rice straw (RF) with the addition of a supplement and concentrate is shown in Table 2. The addition of the supplement to the RF did not significantly influence the VFA concentrations, but the addition of 10% the concentrate increased the VFA concentrations ( $P < 0.05$ ).

The VFA concentration of rumen fluid is closely related to the rate of rumen fermentation, especially the degradation of carbohydrates that produce carbon chains and protein degradation, which liberates carbon chains that are reflected in the VFA concentrations in rumen fluid [15]. The addition of concentrate consisting of raw materials of sago pith, bran, and cassava supplied soluble carbohydrates, thereby increasing the degradation of carbohydrates and increasing the concentration of VFAs in the rumen.

VFAs are the most important source of metabolic energy in ruminants and supply 55-60% of the energy needed [16]. In addition, VFAs are needed by rumen microbes as a source of carbon chains for microbial protein synthesis [17]. The RFS ration produced the highest NH<sub>3</sub> concentration ( $P < 0.01$ ) compared to that of all other rations.

NH<sub>3</sub> is the end product of crude protein degradation and NH<sub>3</sub> deamination in the rumen. The condensed tannin content in supplements acts as protein protection from rumen microbial degradation [18]. Tannin is a polyphenol compound that is capable of binding and precipitating proteins, thus protecting them from rumen microbial degradation, which causes a decrease in NH<sub>3</sub> in the rumen [19]. Therefore, the production of NH<sub>3</sub> in this study came from the breakdown of urea contained in supplements to NH<sub>3</sub>.

Table-2: Concentrations of VFA, NH<sub>3</sub>, and pH in the rumen in vitro of fermented rice straw with the addition of supplements and concentrates

Treatment	Ration	SE	P-value	RF	RFS	RFSC	RFSC2	VFA, mM	NH <sub>3</sub> , mM	pH
	130.00b	130.50b	142.50a	148.75a	8.09	0.028	3.50b	5.17a	4.08b	4.33b
	0.23	0.008	6.99	6.99	6.98	6.92	0.02	0.051		

a,b,c differences in superscripts indicate significantly different mean values VFA: volatile fatty acids; SE: standard error of mean; P: probability RF: 100% fermented rice straw; RFS: RF + 10% supplements; RFSC: RFS + 10% concentrate; RFSC2: RFS + 20% concentrate NH<sub>3</sub> is the main nitrogen source used by rumen microbes to live and breed and to produce microbial proteins [20]. The effectiveness of NH<sub>3</sub> use must be accompanied by the synchronization of NH<sub>3</sub> Ramaiyulis et al.,

Sch J Agric Vet Sci, Feb, 2020; 7(2): 35-40 © 2020 Scholars Journal of Agriculture and Veterinary Sciences | Published by SAS Publishers, India 38 concentrations with the availability of carbon chains [21]. The high NH<sub>3</sub> content in the RFS treatment was due to the hydrolysis of urea to NH<sub>3</sub> in the rumen occurring faster than its use by rumen microbes.

The lack of availability of carbon framework sources causes slow use of NH<sub>3</sub> by microbes. The low VFA concentration in the RFS treatment indicated the lack of availability of carbon frameworks that can be used by microbes in forming microbial proteins with NH<sub>3</sub> as the amide group. The addition of a supplement and a concentrate did not affect the pH of the rumen fluid (P > 0.05).

Rumen acidity indicates the condition of the rumen environment and ensures an optimal environment for the rumen microbes. Cellulolytic bacteria that ferment straw live in the rumen under neutral pH conditions and are sensitive to a low rumen pH [22]. A decrease in pH usually occurs because of the fast rate of fermentation of concentrate feed that is easily degraded, but the addition of concentrates up to 20% did not cause a decrease in the rumen pH.

Nutrient digestion Table 3 shows the digestibility of nutrients in the in vitro rumen of

the fermented rice straw with the addition of supplements and concentrates. The lowest digestibility of dry matter and organic matter was found in the RF rations (control) and increased with the addition of the supplement (RFS), and the highest digestibility was found with the addition of 20% concentrate (RFSC2) ( $P < 0.01$ ).

The digestion of dry matter and organic matter in the rumen showed the percentage of nutrients available to livestock as a result of fermentation by microbes in the rumen. Rumen digestion constitutes 85% of the total digestion of nutrients in the digestive tract of ruminants [15]. Table-3. Digestion of rumen in vitro of fermented rice straw with the addition of supplements and concentrates

Digestibility Parameters	Treatment	Ration	SE	P-value						
DMD	RF	RFS	RFSC	RFSC2	26.28c	30.69b	34.18b	41.43a	0.01	0.003
OMD	RF	RFS	RFSC	RFSC2	28.52c	32.71b	34.77b	43.38a	0.02	0.008
CPD	RF	RFS	RFSC	RFSC2	44.98b	57.53a	61.42a	59.49a	0.04	0.048
CFD	RF	RFS	RFSC	RFSC2	24.19	24.08	22.86	24.82	0.02	0.520

a,b,c differences in superscripts indicate significantly different mean values DMD: dry matter digestibility; OMD: organic matter digestibility; CPD: crude protein digestibility; CFD: crude fiber digestibility; SE: standard error of means; P: probability RF: 100% fermented rice straw; RFS: RF + 10% supplements; RFSC: RFS + 10% concentrate; RFSC2: RFS + 20% concentrate Crude protein digestibility was found to be lowest in the control rations, and supplementation increased ( $P < 0.05$ ) the digestibility of crude protein, while the addition of the concentrate had no significant effect.

The supplement contained easily degradable urea and carbohydrates as an available energy source, which allows for optimization of rumen microbial growth [11]. The protein content of the rations was relatively low, ranging between 9.82 and 11.21%, while the standard of SNI for fattening beef cattle ration contains at least 13% crude protein [23].

The addition of the supplement and concentrate on the fermented rice straw did not significantly affect the digestibility of crude fiber in the rumen ( $P > 0.05$ ). The fermented rice straw exhibited high lignin content (8.99%) (Table 1), and lignin bonding with crude fiber inhibits the action of cellulase enzymes to digest crude fiber.

The addition of the supplement and concentrate was not able to remove the limitation of crude fiber digestibility in the fermented rice straw. Fiber fraction digestion In Table 4, the in vitro digestibility of the fiber fraction of the rations showed that the NDF and cellulose digestibility increased due to the addition of the concentrate ( $P < 0.05$ ), while the addition of the supplement had no significant effect. NDF showed the cell wall fraction content in the rations.

Rice straw contains high amounts of silica (12-16%) compared to those in other

agricultural wastes (only 3-5%) [5], and a high silica content inhibits the digestion of NDF. The addition of the supplement **did not significantly influence the** digestibility of NDF, **while the addition of** the concentrate was able to increase the digestibility of NDF. The concentrate contained a fast available energy source that could be used **for microbial growth and** activity in the rumen, increasing NDF digestion [24].

The **physical, chemical and biological** treatment of straw can break lignocellulosic bonds and increase the digestibility of NDF and cellulose in fermented rice straw [6]. Table-4: Digestion of fiber fractions **of fermented rice straw** with the addition of supplements and concentrates

Fiber fraction	Digestibility	Treatment	Ration	SE	P-value
NDF	13.31b	16.95 b	20.95 a	20.56 a	0.02
ADF	21.89 b	23.43 b	24.86 b	29.53 a	0.02
Cellulose	34.26 b	39.11 b	45.47 a	52.16 a	0.02
Hemicellulose	23.91 b	34.53 a	36.45 a	36.87 a	0.04

a,b,c differences in superscripts indicate significantly different mean values NDF: neutral detergent fiber; ADF: acid detergent fiber; SE: standard error of means; P: probability RF: 100% fermented rice straw; RFS: RF + 10% supplements; RFSC: RFS + 10% concentrate; RFSC2: RFS + 20% concentrate

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The digestion of hemicellulose increased with the addition of the supplement (P <0.05) but **was not affected by** the addition of the concentrate.

Hemicellulose is known to be more easily digested than **other cell wall components** due to its amorphous structure and lower polymerization levels [25]. Increased digestibility of hemicellulose with the addition of the supplement and increased digestibility of cellulose with the addition of the concentrate showed that both the supplement and concentrate played a synergistic role in **increasing the digestibility of cell wall components as a source of** energy for livestock.

ADF digestibility only increased with the addition of 20% concentrate (P <0.05). The constituent components of ADF bind strongly to lignin, which makes ADF components difficult to penetrate by rumen microbial enzymes [26]. At the 20% concentrate level, the starch content was increased, and the starch content in rations is known to be positively correlated with the ability of microbes **to digest plant cell walls** [27].

The addition of the supplement and concentrate decreased the fiber fraction content of the ration, thus increasing the content of food substances that were easily degraded in the ration. The availability of easily degraded food substances increases the ability of microbes to digest fiber fractions, thereby **increasing the digestibility of** fiber fractions



[28]. CONCLUSIONS In vitro rumen digestibility of fermented rice straw can be improved by the addition of supplements and a concentrate.

Supplements can increase the digestibility of dry matter, organic matter, crude protein, and hemicellulose, while the addition of concentrate can increase the digestibility of NDF and cellulose. The best ration composition with the use of fermented rice straw was an 80:10:10 ratios (% DM basis) of fermented rice straw, supplement, and concentrate.

ACKNOWLEDGMENTS We would like to acknowledge and thank the Agriculture Polytechnic Payakumbuh for the funding given to our research program with contract number: 27/PL25/PL.00.02/2019 and the facilities provided at the Nutrition and Feed Technology Laboratory. REFERENCES 1. Sulaiman AA, Inounu I, Torang S, Maidaswar. SIWAB Solusi Cerdas Swasembada Daging Sapi dan Kerbau. Jakarta: Sekjen Kementan RI. 2017; 96. 2.

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