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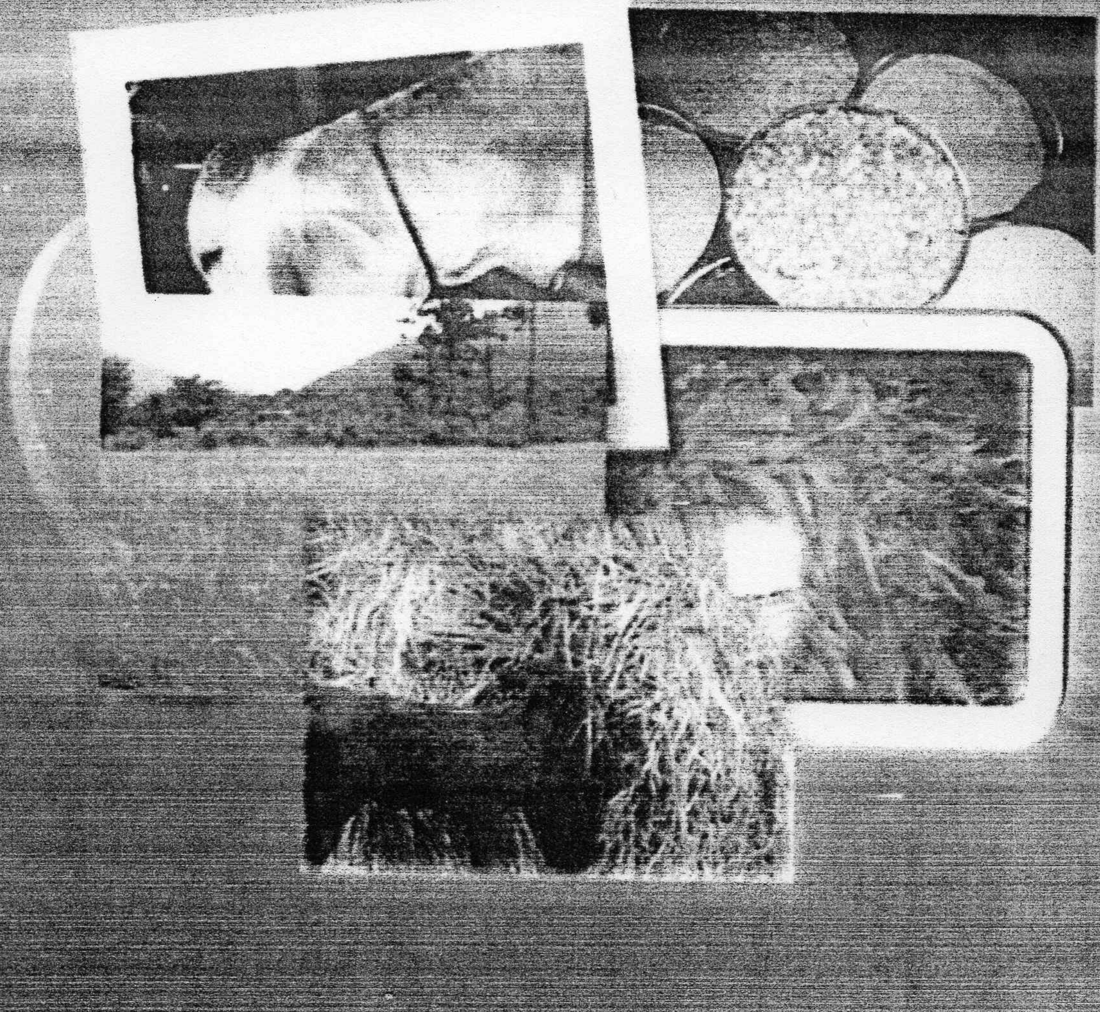
EMPOWERMENT OF LOCAL FEEDS TO SUPORT FEED SECURITY



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RUMINANT PAPERS

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THE INFLUENCE OF SULFUR AND RATIO OF STARBIO FERMENTED RICE STRAW AND CONCENTRATE ON RUMEN FERMENTATION PRODUCTS

by
F.M. Suhartati and Wardhana Suryapratama
Animal Science Faculty of Jenderal Soedirman University

ABSTRACT

An experiment was conducted to evaluate the influence of sulfur and ratio of Starbio fermented rice straw and concentrate on rumen fermentation products. The method of the experiment was in vitro using Completely Randomized Design3x3, factorial pattern. The first factor was ratio of Starbio fermented rice straw and concentrate (30:70; 40:60; 50:50), and the second factor was levels of sulfur supplementation (0.0%, 0.4% and 0.8%). Hence, there were nine treatments, and each treatment was replicated three times. Variables measured were the concentration of VFA, N-NH3 and rumen protein microbial synthesis. Data obtained were analyzed by analysis of variance continued with Orthogonal Polynomial Contrast. The results showed that treatments had no significant influence ($P>0.05$) on VFA concentration, but ratio of Starbio fermented rice straw to concentrate had highly significant influenced ($P<0.01$) on N-NH3 concentration and rumen protein microbial synthesis. Relationship between the ratio of Starbio fermented rice straw to concentrate and N-NH3 concentration was linear ($Y = 1.977 + 0.095 X$; $r^2=0.671$). Relationship between the ratio of Starbio fermented rice straw to concentrate and rumen microbial protein synthesis was also linear ($Y = 1637.36 - 8.33 X$; $r^2 = 0.32$). Because the treatment have no effects on VFA and the highest microbial protein synthesis in the rumen was obtained from rice straw and concentrate ratio of 30:70 added with 0.4% sulfur, so it can be concluded that the best ration can be produced by mixing Starbio-fermented rice straw and concentrate ratio added with 0.4% sulfur at 30:70.

Keywords:Rice straw and concentrate ratio, sulfur, VFA, N-NH3 and rumen microbial protein.

INTRODUCTION

The performance of ruminant depends on the rate of growing and productivity of rumen microorganism fermenting diet in the rumen and as protein sources for host. The low rate of growing rumen microorganism can limited rate of diet fermentation in the rumen (Bohnert *et al.*, 2002) and decrease rumen fermentation product and finally can decrease digestibility of crude fibre and availability of amino acid. Therefore, it influences growth of ruminant especially they fed forage containing low protein and fed non protein nitrogen only.

The availability of forage (grass) is very limited during the dry season. It is therefore necessary to find an alternative grass substitute that is obtainable the whole year, among others in the form of rice straw. Rice straw production varies, ranging from 12-15 tons per hectare in one single harvest. Overall, rice straw production in Indonesia reaches up to 128 million tons for an area of 10.7 million hectares (Badan Pusat Statistik Indonesia, 2005). The production displays that rice straw is extremely prospective as animal feed. As an agricultural waste, rice straw has one constraint, i.e. a low digestibility due to its high lignin. The constraint can be prevailed through fermentation using probiotics. Probiotic is a natural additive in the form of living microbes that are able to enhance the digestibility of plant cell walls. Cellulolitic microbes found on probiotics will create enzymes which will help in breaking the lignocellulosic linkage, in order to enhance the digestibility of rice straw (Syamsu, 2003), which in the process will raise VFA, N-NH_3 concentrates and microbic protein synthesis in the rumen fluid.

Probiotic fermentations, besides being able to amplify the digestibility are also capable of increasing the availability of protein for rumen microbes. To increase protein biosynthesis, which is essential for microbial growth, sulfur can be added. Sulfur is an essensial mineral in animal nutrition, lack of nutrient in the diet will cause physiological and metabolic disorders, inhibit rumen microbial protein synthesis, loss of production and can cause death of cattle (NRC, 2001). On the basis of the need for a study of the influence of sulfur and the ratio of starbio fermented rice straw and concentrate on rumen Fermentation products.

Sulfur is an essensial mineral in animal nutrition, lack of nutrients in the diet will cause physiological and metabolic disorders inhibit rumen microbial protein synthesis, loss of production and can cause death of cattle (NRC, 2001). Therefore, need for a study of the influence of sulfur and the ratio of starbio fermented rice straw and concentrate on rumen fermentation products.

MATERIALS DAN METHOD

Research Material

Rice straw, Starbio probiotic produced by the Lembah Hijau Multi Farm Surakarta, sulfur (sulfur purified manufactured by Merck), concentrates, rumen fluid from cows which was taken from the slaughter house immediately after slaughtering.

Research Method and Design

The method used was in vitro (methode of Tilley dan Terry, 1963) experiments with Completely Randomized Design, 3x3 factorial patterns. As the first factors were three ratio of rice straw fermentation with concentrate (30:70, 40:60 and 50:50), the nutrient contained in the treatment feed listed in Table 1. Three sulfur levels (0%, 0.4% and 0.8%) was second factor. Each treatment was repeated three times, so there were 27 units of experiment. The nine treatments were:

1. R1 = 30% rice straw fermentation, 70% consentrate + 0,0% sulfur
2. R2 = 30% rice straw fermentation, 70% consentrate + 0,4% sulfur
3. R3 = 30% rice straw fermentation, 70% consentrate + 0,8% sulfur
4. R4 = 40% rice straw fermentation, 60% consentrate + 0,0% sulfur
5. R5 = 40% rice straw fermentation, 60% consentrate + 0,4% sulfur
6. R6 = 40% rice straw fermentation, 60% consentrate + 0,8% sulfur
7. R7 = 50% rice straw fermentation, 50% consentrate + 0,0% sulfur
8. R8 = 50% rice straw fermentation, 50% consentrate + 0,4% sulfur
9. R9 = 50% rice straw fermentation, 50% consentrate + 0,8% sulfur

Table 1. Nutrient content in treatment diet

Treatment Diet	BK (%)	PK (%)	LK (%)	SK (%)	Abu (%)
Straw Fermentation 30%, Consentrate 70%	89.90	10.11	7.49	17.07	12.42
Straw Fermentation 40%, Consentrate 60%	90.03	9.46	5.96	19.26	13.45
Straw Fermentation 50%, Consentrate 50%	90.17	8.82	6.40	21.46	14.49

Table 2. Average VFA concentration (mM) in results of the in vitro experiment

The ratio of rice straw : consentrate	Sulfur Level		
	0.0 %	0.4 %	0.8 %
30:70	153.00 ± 3.61	142.70 ± 3.06	170.33 ± 19.14
40:60	159.30 ± 27.15	158.70 ± 8.08	150.70 ± 32.02
50:50	158.00 ± 12.49	162.00 ± 6.00	156.70 ± 1.15

Measured Variables

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1) VFA concentration using steam distillation technique (Department of Dairy Science. 1966).
2) N-NH3 concentration using the Conwey cup method (Department of Dairy Science. 1966).
3) Microbial protein synthesis of rumen fluid using the Zinn and Owens method (1995).

Data Analysis

The data obtained were analyzed using a analysis.of variance. Because the ratio of rice straw to concentrate affected the N-NH3 concentration and microbial protein synthesis of rumen fluid, an orthogonal polynomial test followed subsequently.

RESULTS AND DISCUSSION

Volatile Fatty Acid Concentrations of Rumen Fluid

The average of VFA concentration in rumen fluid ranges from 142.70 ± 3.06 mM to 19.14 mM ± 170.33 (Table 2). The average was within the range of results of research conducted by Suhartati and Bata (2008), namely from 131 mM to 214.33 mM. Khampa and Wanapat (2006) state that the normal concentration of rumen VFA in cows was 70-130 mM, thus the average VFA concentration in the research result was higher than the normal concentration required to support the ecosystem in the rumen. The high VFA concentration can measure the availability of energy in the form of ATP, although the high concentration of VFA may also be due to lack of absorption of VFA in the in vitro experiments. On ruminants, the VFA formed was absorbed through the rumen walls, then enter the bloodstream and become the main energy source for body cells.

Based on the results of variance analysis, VFA was not affected (P>0,05) by the balance of rice straw : concentrate, the addition of sulfur and the interaction between the balance of rice straw : concentrate. The essential fatty acids (VFA) were produced by certain bacteria and the amount depends on the number of bacteria in the rumen. Among the VFA components, acetic acid is the most widely produced by almost all types of bacteria, followed by propionate, butyrate and valerat acid. According to Haryanto et al. (2006), VFA composition in general contains 2-carbon (acetate), 3-carbon (propionic) and 4-carbon (butyrate) that has a molar proportion of the near constant 63: 21: 16. However, the content and type of organic material in the diet will cause changes in the molar proportion of short-chain fatty acids.

If in this study measurements of individual VFA were also conducted, there was a possibility of treatment effect. This is because the increased proportion of rice straw fermentation : concentrate caused an increase in crude fiber (Table 1), so although the total VFA were not affected, there was a possibility that the increase in acetic acid concentrations went in line with an increasing proportion of rice straw fermentation : concentrate.

N-NH3 Concentration in Rumen Fluid

The results show that the average of NH_3-N concentration ranges from 4.7 ± 0.2 mM up to 7.1 ± 0, 2 mM (Table 3). The average shows that the rations used for the most part provided ammonia in the rumen fluid in levels that were ideal for microbial rumen growth.

Table 3. Average N-NH_3 concentration (mM) as a result of the in vitro experiment

The ratio of rice straw : concentrate	Sulfur Levels		
	0.0 %	0.4 %	0.8 %
30:70	4.8 ± 0.2	5.3 ± 0.8	4.7 ± 0.2
40:60	6.4 ± 0.7	5.3 ± 0.6	5.3 ± 0.4
50:50	6.9 ± 0.5	6.5 ± 0.4	7.1 ± 0.2

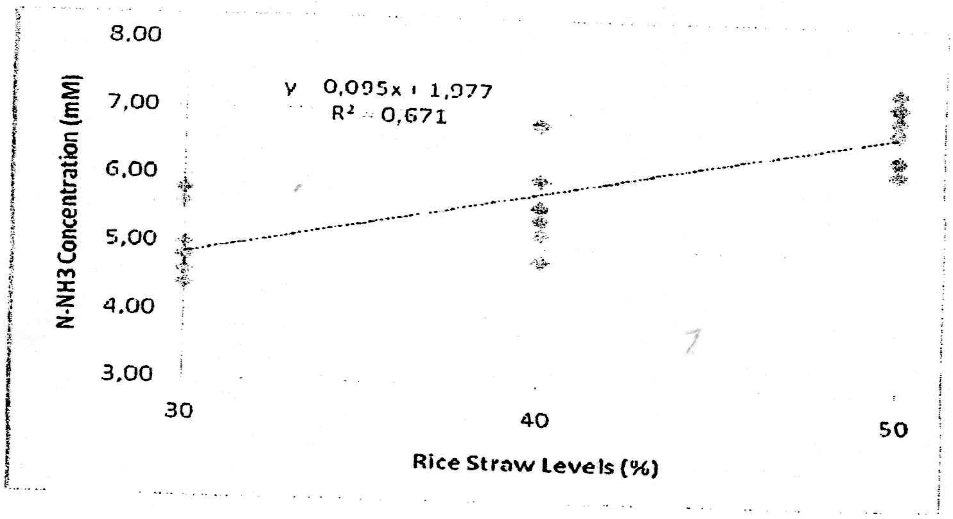

Figure 1. The relationship between rice straw levels in animal diet with N-NH3 concentration in rumen fluid

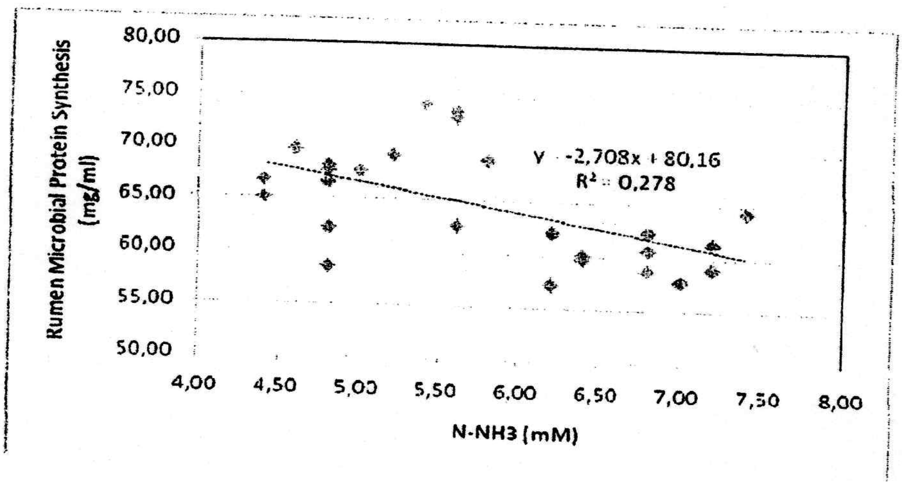

Figure 2. The relationship between N-NH3 concentration with microbial protein synthesis in rumen fluid

According to Khampa and Wanapat (2006), the optimal rumen N-NH3 to improve rumen ecology, microbial protein synthesis and the digestive capability of feed, is in the range of 15-30 mg/dl. Ammonia, both originating from the protein/peptide/amino acids or from non-protein nitrogen (NPN) such as urea, is the main precursor of nitrogen for microbial protein synthesis and an essential element for the growth of various rumen bacteria species (Dewhurst et al., 2000).

An analysis of variance shows that the balance of rice straw fermentation and concentrates highly significant effect ($P <0.01$), while the addition of sulfur and the interaction between the proportion of fermented rice straw and concentrate and the addition of sulfur had no effect ($P> 0.05$) on the average N-NH3 concentration in rumen fluid. Based on an orthogonal polynomial test, the balance of rice straw: concentrate demonstrates a linear effect and according to a linear regression test equation $Y = 1.977 + 0.095 X$, coefficient of determination ($r^2 = 0.671$) (Figure 1) was obtained. Increasing concentrations of N-NH3 in line with the increased level of fermented rice straw did not mean that a diet was more fermentable or more capable of providing N-NH3, but precisely because the N-NH3 was not utilized by rumen microbes for its protein synthesis.

Figure 2 shows that the decrease in rumen microbial protein synthesis was in line with the increasing N-NH3 concentration of rumen fluid, with the equation Y = 80.16-2.708 X, coefficient of determination (r^2) = 0.278. The increased level of rice straw led to the less utilization of N-NH3 by rumen microbes for its protein synthesis, as due to the increased amount of hay causes decreased of concentrates. In other words, reducing the supply of fermentable carbohydrates, and ultimately decreasing the amount of microbial protein synthesis.

Rumen Microbial Protein Synthesis

The average rumen microbial protein synthesis ranges from 58.25 ± 1.29 mg/ml to 69.74 ± 3.47 mg/ml (Table 3). The results show that rumen fluid that was fed with a balance of rice straw : concentrate 30:70 plus 0.4% sulfur produced the highest microbial protein synthesis. The high level of microbial protein synthesis was very profitable to the animal host. According to Vlaeminck et al. (2005), the protein available to ruminantias comes from the duodenal absorption supplied by bypass feed protein, the secretion of endogenous proteins and microbial proteins. Supply of microbial protein reaches 59% of the protein that are available to be absorbed. Microorganisms in the rumen degrade nutrients to produce VFA and microbial protein synthesis, as a source of energy and protein for ruminants (Calsamiglia et al., 2007)

An analysis variance influences of treatment on rumen microbial protein synthesis indicated that the balance of rice straw: concentrate obviously affected the microbial protein synthesis. Based on the orthogonal polynomial test the response took a linear form and a regression test produced the equation Y = 81.10-0.416 X, coefficient of determination (r^2) = 0.48) (Figure 2).

As described previously, the increased level of rice straw led to less rumen microbes utilizing N-NH3 for their protein synthesis, as increased level of rice straw led to the decreased of concentrate amount; in other words, reducing the supply of carbohydrates and ultimately the amount of protein synthesis decreased. The fact was in accordance with Ginting's (2005) opinion, which stated that the process of nutrient transformation into microbial protein requires an optimal rumen environment and conditions for microbial growth, including the availability of nutritional substances in the number, composition and time. N compounds, carbohydrates, vitamins, minerals, co-factors and various growth factors is an element of rumen microbial growth, but N compounds and carbohydrate are required in large numbers, and must be available simultaneously to encourage the rapid growth of microbes; in other words, there must be synchronization between the degradation of proteins (N) and energy (carbohydrates). The definition of synchronization can be associated with a positive-associative relationship, i.e. the increasing nutrient utilization when combined with other nutrients at the right time and amount. In connection with the rumen microbial nutrients, the nutrient that plays a central role is carbohydrate and protein (compound N). With few exceptions, rumen microbes generally use only carbohydrates as the energy source for growth. Carbohydrates are also needed as a source of carbon atoms (C) to form the framework of rumen microbial protein structures. Energy and carbon atoms (C) for microbial protein synthesis are derived from the degradation of carbohydrates. As a supplier of amino groups, ammonia is the primary as a result of protein degradation, a degradation of non-protein nitrogen compounds (NPN) in the animal feed material or a degradation of recycled urea. The degradation process of energy-producing substrate as well as the protein synthesis process by microbes is difficult to separate.

Table 4. The average of microbial protein synthesis in rumen fluid (mg/ml) as a result of the in vitro experiment

The ratio of rice straw : concentrate	Sulfur Levels		
	0.0 %	0.4 %	0.8 %
30:70	68.53 ± 1.01	69.74 ± 3.47	66.42 ± 1.34
40:60	62.46 ± 0.14	64.48 ± 4.06	68.61± 8.78
50:50	61.73± 2.26	58.25 ± 1.29	59.71 ± 1.48

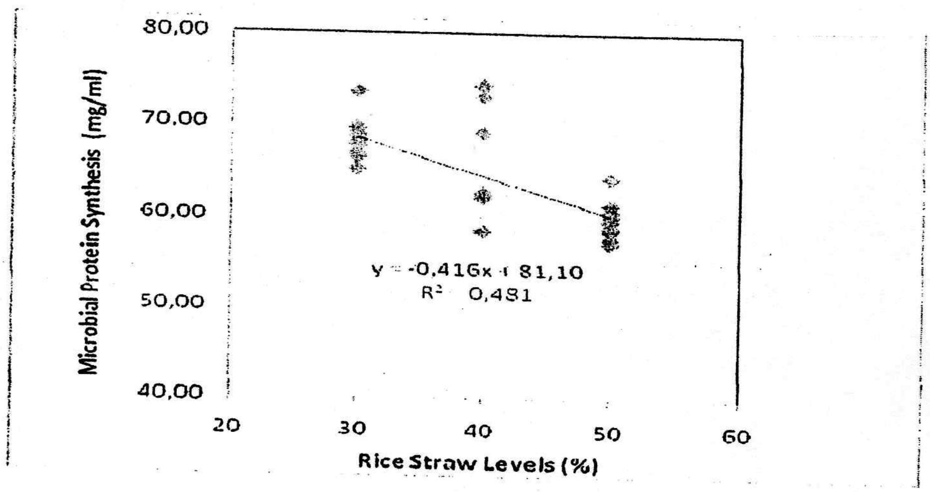

Figure 3. The Relationship between Rice Straw Levels in Animal diets with Microbial Protein Synthesis in Rumen Fluid

Microbial growth is supported by substrate fermentation, whereas substrate fermentation is done through microbial growth. This is no different from the opinion of Griswold (2003), who states that the rumen microbial growth depends on the availability of nitrogen in the form of peptides, amino acids and N-NH3. Microbial protein synthesis contributes 59% of amino acids that enters into the small intestine besides amino acids that are not degraded, and will complement the amino acid requirements of cattle to produce more quickly (Sniffen et al., 2004).

CONCLUSION

Rumen fluid which obtained diet a balance of rice straw: concentrate 30:70 added 0.4% sulfur produces the highest microbial protein synthesis.

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