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Increasing the Quality of Rice Straw from IR Rice for Beef Feed Through Organic Fertilization

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Abstract.

This study aimed to determine the nutrient content and rumen fermentation product in-vitro of rice straw from rice of the IR variety fertilized using organic and inorganic fertilization. This research used experimental methods. This study examined two paddy fields located in Datar Village, Sumbang District, Banyumas. Land A used inorganic fertilizer (urea and phonska) and Land B used organic fertilizer from cattle dung. Both of those lands were planted with IR variety rice. Samples were 20 points on each land obtained by random sampling so that all parts of the field were represented. All samples were dried in the oven at 60^{0}C. Variables measured were nutrient contents such as crude protein (CP), crude fiber (CF) and rumen fermentation product in-vitro of volatile fatty acids (VFA) and ammonia nitrogen (N-NH_3). Statistical analysis used t-test. Result showed that CP and CF contents and rumen fermentation products of VFA of rice straw from organic fertilizer were higher ($P<0.05$) compared to inorganic fertilizer. There was no significant difference ($P>0.05$) in the rumen fermentation product of N-NH_3 between organic and inorganic fertilizer. It can be concluded that rice straw quality from IR variety rice can be improved through organic fertilization.

Keywords: organic, fertilizer, rumen, nutrient, rice straw

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1. Introduction

Rice production in the world especially in Asian countries has been increased after green revolution combined with insensitive irrigation and use of inorganic fertilizers and pesticides. However, the effect of using inorganic fertilizers has resulted in contamination of ground water and decreased the productivity of soil, which in turn affects the rice production in long term [1]. Intensive pesticides utilization and chemical fertilizer caused several iil effects in human health and environmental hazard. Therefore, use of organic manure may help to regain the soil health to provide the essential nutrients to achieve optimal growth and food safety. Application of organic manures gives significant effect on development of crop plants and growth [2].

The use of organic manure from cattle farms for rice and the use of rice straw as a source of feed through an integrated pattern is a mutually supportive and mutually beneficial process because it can improve land and plant fertility and increase feed availability throughout the year, thereby increasing livestock production and productivity [3, 4, 5, 6]. The integration pattern of rice and cattle will create an efficient, zero waste and profitable agricultural and cattle production process. This approach is known as low external input sustainable agriculture (LEISA) which is applied to agriculture and livestock which is very intensive. And this pattern also needs to be developed for small and medium scale (people's farms) to prevent conflicts that often occur due to management that is not based on zero waste and improve the quality of food products (rice) and efforts to build a sustainable livestock and agriculture business.

Currently, there is a trend of increasing demand for agricultural products such as rice which is produced from the use of organic fertilizers. The use of beef cattle feces as a basic material for composting for rice fertilization has been proven to produce quality products. However, there is a lot of quality information of rice straw especially nutrient content and digestibility levels in the cattle rumen. This information is very important for regulating additional feed or concentrate so as to produce optimal cattle performance. This study aims to examine the effect of using organic fertilizers from beef dung and inorganic on nutrient content and in-vitro rumen fermentation products.

2. Materials and Methods

The application of fertilizers in this study consisted of two kinds of fertilizers, namely the application of organic and inorganic fertilizers. Organic fertilizer came from livestock waste, namely cow manure that has been composted. Composting was done by adding an activator (EM4), ash, dolomite lime, sawdust, and phosphate, then the materials was left to stand for 1 month. The compost was sprinkled into paddy fields at a dose of 2,0 tonnes / ha [7] 10 days before planting rice. The inorganic fertilizers used were urea and NPK with doses commonly used by farmers. Fertilizer was applied on the 7th and 35th day after planting rice.

Sampling method was carried out by taking rice straw by taking 4 points on 5 different rows randomly in one rice field so that 20 samples were obtained. The distance between cutting rice at the time of harvesting was ± 10 cm above the ground. The sample was cut into ± 3 cm and then dried in an oven at 60^{0}C for 4 days. After drying, all samples were blended and sieved through 1 mm a screen filter.

Rumen fluid was taken from 3 cattle that are slaughtered at the Bantarwuni Slaughter house (RPH), Purwokerto. The rumen fluid was extracted after cutting by using a flask which was previously filled with warm water and the water is removed just before entering the liquid into the flask through filtering with a panel cloth. The procedure for VFA and N-NH3 in-vitro analysis use method according to [8] that has been modified by [9].

Analysis of dry matter, crude fiber and crude protein on rice straw samples resulting from organic and inorganic fertilization was carried out according to [10]. Measurement of VFA concentration in the rumen fluid from the in-vitro test was carried out by steam distillation technique [11] and N-NH3 concentrations according Conway Micro diffusion method [12].

To determine the effect of the treatment on the tested variables, the T test was carried out. As a treatment, the IR variety of rice straw was planted using organic and inorganic fertilizers, each treatment consisting of 20 samples, as follows:

P_0 = IR varieties of rice straw resulting from organic fertilization

P_1 = IR varieties of rice straw resulting from inorganic fertilization

3. Results and Discussion

3.1. Crude Protein (CP) and Crude Fiber (CP) of rice straw

The average CP and CF data of IR rice straw resulting from organic and inorganic fertilization were listed in table 1. The T test results showed that the CP level of IR fertilized rice straw (P0) was higher (P <0.05) than that of the IR variety produced by inorganic fertilization (P1). One of the factors that influence the high and low levels of CP is the nitrogen supply from the fertilizers used. According to [13] said that nitrogen content in the soil plays a role in forming protein. The results of soil analysis showed that the content of land given organic fertilizers was higher than the N content of land treated with inorganic fertilizers (0.386% vs 0.332%) (Table 2).

The plant protein content was also influenced by absorption. The absorption of N elements in organic fertilized rice straw was higher than that of inorganic fertilized rice straw, resulting in high crude protein content. This was in accordance with the statement of [14] which states that high absorption of elemental N from organic fertilizers will have an effect on the high crude protein content. The high absorption of nitrogen in plants will affect the growth of cell protoplasm in plants. According to [15] stated that the protoplasm functions as a metabolic center in plants that spurs cell division and elongation. The large number of protoplasm will result in more and larger cells resulting in an increase in photosynthesis which results in photosynthetic. High photosynthetic results in the development of leaf meristem tissue. Thus the proportion of leaves becomes more than the stems and leaves had a higher protein content than the stems, so that the protein content of rice straw is higher.

TABLE 1: Nutrient content (CP and CF) and Rumen Fermentation Product (VFA and $N\text{-}NH_3$) of IR rice straw fertilized with organic and inorganic.

Variables	Fertilizer		SEM	P
	Organic (P0)	Inorganic (P1)		
CP (%)	8.37^{a}	6,45^{b}	0.625	0.023
CF (%)	23.05^{a}	20,63^{b}	1.294	0.031
VFA (mM)	158.20^{a}	120.20^{b}	7.283	0.001
$N\text{-}NH_3$ (mM)	18.20^{a}	17.93^{a}	0.635	0.765

Note: CP=crude protein, CF=Crude Fiber, VFA=Volatile Fatty Acids, $N\text{-}NH_3$=Nitrogen Ammonia, SEM=standard error of mean, P=probability. ^{ab}Means the same row not having at least one common superscript

TABLE 2: Soil of N, P and K content from land fertilized with organic and inorganic fertilizer

No.	Sample	N total (%)	P_2O_5 total (%)	K_2O total (%)
1.	Organic Fertilizer	0,386	0,271	0,060
2.	Inorganic Fertilizer	0,332	0,253	0,074

Leaf development is also influenced by other nutrients, namely phosphorus (P). Phospor elements help the photosynthesis process which causes a large number of leaves so that crude protein is high. This is in accordance with the statement of [16], namely that the elements N and P play a role in forming new cells and the main components of organic compounds in plants that have an impact on vegetative growth, especially the increase in the number of leaves. Based on soil analysis (Table 2), it was found that the P content of organic fertilized soil was higher than that of inorganic fertilized soil (0.271% vs 0.253%). Lasamadi et al. [17] reported that organic fertilizers are useful for making fresher leaves, increasing chlorophyll in leaves, and adding protein in plants. Nitrogen is also beneficial in influencing leaf width. The more leaves and the width means that they contain high protein. This is as stated by [18], a wide leaf has a wide surface so that the absorption of sunlight on the stomata will be higher. The better the nitrogen supply to the leaves, the photosynthesis process is stable so that more crude protein is formed.

Another factor that causes the CP straw content in inorganic fertilizers to be lower than organic fertilization is the age of the harvest. Crude protein contained in leaves has lignin which decreases with age of the plant. This is as reported by [19] that the longer the rice harvest, the CP level of rice straw will decrease. IR fertilized rice straw with inorganic fertilization was harvested at the age of 110 days, while rice straw with organic fertilization was harvested at 94 days.

The crude fiber content of IR variety rice straw in organic fertilization was higher ($P < 0.05$) than IR variety rice straw on inorganic fertilization. Crude fiber in rice straw is supplied from the nitrogen content in the soil. Lasamadi et al. [17] reported that the element N in fertilizers is useful for stimulating plant growth, especially on stems. The condition of the older plants, the lignin content in the stems is greater than the lignin in the leaves. This means that the crude fiber on the stems is higher than the leaves.

Lignin is found in cell walls, which is the main component of plant dry weight. According to [20], the increase in plant dry weight is due to the thickening of the cell walls when the plants enter old age. Along with the increasing age of the plant, it will enter a generative phase which results in the N element from the soil being focused on the formation of flowers and seeds, so the vegetative phase does not work optimally so that the cell walls will experience thickening which indicates an increase in the plant's crude fiber. Soil analysis (Table 2) showed that the percentage of nitrogen in organic land is higher than in inorganic land, that is, the potential for nitrogen uptake is higher in organic land. As plant age increases, the absorbed nitrogen is used for the development of plant cell walls so that the portion of the stem is larger, therefore the crude fiber content in organic land is higher than in inorganic land. This is in accordance with the statement of [20], the older the plant, the cell wall will be higher than the protoplasm (content) of the cell, which indicates the large amount of plant dry matter content such as lignin and polysaccharide compounds.

3.2. Volatile Fatty Acid (VFA) and Nitrogen Ammonia (N-NH_3) rumen production

The mean VFA and N-NH3 production were presented in Table 1. The T test showed that the VFA production of IR rice straw from organic fertilization was higher ($P < 0.05$) compared to the VFA production of IR rice straw resulted from inorganic fertilization, however, the N-NH3 production was not different ($P > 0.05$). It was assumed that organic fertilizers provide complete nutrients for plants, so that the plants and straw produced have better quality. This is reflected in the higher N or protein content of rice straw resulting from organic fertilization (Table 1). The quality improvement was reflected in the increase in crude protein and crude fiber content in rice straw (Table 1). The availability of sufficient energy causes rumen microorganisms to be able to utilize NH3 quite high, so that the NH3 levels in P0 and P1 are relatively the same, even though the P0 protein content is higher (P <0.05) compared to P1.

The high VFA product in P1 was also due to the higher availability of nitrogen or protein which is a source of nitrogen for microorganisms. Protein and non-protein nitrogen (NPN) by rumen microorganisms are degraded into ammonia and carbon skeleton. The two metabolites are directly used as a source of nitrogen and carbon skeleton for microbial protein synthesis if energy is available from carbohydrate fermentation. Deficiency of rumen degradable protein as nitrogen source for microbs in dairy cows can decrease total-tract digestibility of fiber and DMI [21, 22]. With the high availability of energy generated from Po, the utilization of NH3 is also high. The increased utilization of NH3 by these microorganisms causes the production of ammonia produced from P0 and P1 to be relatively the same (P> 0.05) although the protein content of rice straw P1 is higher than P0. One factor that influence concentration of NH3 in the rumen is the amount of feed protein entering to the rumen. High of protein content in diets with high degradability will produce a high NH3 concentration in the rumen [23].

Concentration of N-NH_3 obtained in the study ranged from 17.93 - 18.20 mM, so the N-NH_3 production had met the ammonia adequacy standard in the rumen according to [23] reported that the concentration of ammonia in the rumen varies widely, ranging from 6 - 21 mM. Nitrogen requirements of ruminal microbs had been reviewed by [24] from the literature as followed (1) ruminal ammonia concentrations of 5 to 11 mM for maximum microbial growth were needed; (2) optimum concentration of ruminal ammonia appeared to be diet dependent and influenced by factors such as type of N supplements and carbohydrate fermentability and possibly factors affecting passage rates (e.g., DMI); (3) increasing ammonia concentrations will impact on ruminal N lossis; (4) ammonia concentrations are needed to maximize ruminal OM digestion to maximize ruminal synthesis of microbial protein; and (5) not only was average ammonia concentration important, but also the time the concentration fell below some critical level.

4. Conclusion

Quality of rice straw quality from IR variety rice can be increased as feed for beef cattle through organic fertilization.

5. Acknowledgement

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