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Effect of Fermentation Time for a Combination of Rice Straw and Tithonia (*Tithonia diversifolia*) on the NDF, ADF, and Cellulose Content as Ruminant Feeding

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ABSTRACT

This research aims to examine the effect of fermentation time for rice straw and tithonia (*Tithonia diversifolia*) on local microorganisms in the rumen of cows. This research was carried out using a Completely Randomized Design with four treatments and 4 replications. Treatments consisted of P0 (Combination of rice straw and tithonia without local microorganisms), P1 (Combination of rice straw and tithonia with 0 Day Incubation), P2 (Combination of rice straw and tithonia with 7 Day Incubation), and P3 (Combination of rice straw and tithonia with 14 Day Incubation. The variables measured are NDF, ADF, and Cellulose. The results of the analysis of variance showed that the effect of fermentation of rice straw and tithonia with local microorganisms in the rumen content had a very significant effect (P<0.01) on NDF, ADF, and Cellulose. Based on this research, it shows that the combination of rice straw and tithonia can increase the content of NDF, ADF, and Cellulose.

Keywords: Rice straw, tithonia (Tithonia diversifolia), fermentation, local microorganisms, fiber fraction.

INTRODUCTION

The feeding needs for maintenance of livestock, growth, reproduction, and production. Feed availability for ruminants must be sufficient, contain good nutrients, and be sustainable throughout the year. Field grass as the main forage source for ruminants generally fluctuates according to seasonal patterns, where production is abundant in the rainy season and conversely limited in the dry season (Lado, 2007). Limited forage can be overcome by utilizing by-products from agricultural and plantation production. Rice straw availability is quite abundant, especially at harvest time. In particular, the Solok area is famous for its production of Bareh Solok which has a delicious taste when made into rice, so rice has become an icon for the Solok area. This straw can be used as animal feed to replace forage. The amount of straw in Solok City in 2019 with a rice field area of 23,438 (ha) was 13686.6 (tons) and the amount of straw in Solok Regency in 2019 was 17583.07 (tons) with a land area of 875.95 ha (BPS Solok City and Regency, 2020). This condition causes a fairly abundant amount of straw as a by-product of the rice harvest. The availability of straw reaches around 55 million tons a year and only 31-32% is used as animal feed (Syamsu, 2006). 37% of rice straw waste is burned, 36% is used as compost and cage bedding, and only 15% - 22% is used as a source of animal feed (Agricultural Research and Development, 2012). The straw as feed has a low nutritional content. According to Jorgensen and Olsson (2006), rice straw contains 35-50% cellulose, and 25-30% hemicellulose. Meanwhile, according to Srithongkham, et al, (2012), the contents of rice straw are 30-35% cellulose, 25-30% hemicellulose, 15-25% lignin, and 4.7% ash. Meanwhile, according to Drake et al, (2002), rice straw has a crude protein content of 2-7%, lignin 6-7%, and silica 12-16%. The nutritional content of rice straw is less efficient if used as a sole forage source, it needs to be combined with other types of forage that can increase the nutritional value of rice straw, one of which is Tithonia (*Tithonia diversifolia*). There are cultivated in West Sumatra can produce as much as 30 tons of fresh material or 6 tons of dry material per year on a land area of around 1/5 ha. (Hakim, 2001). The only a little bit using Tithonia as compost or natural pesticide, and it is not widely used as animal feed, especially ruminants. The nutritional content of tithonia is dry matter 25.57%, crude protein 22.98%, crude fat 4.71%, crude fiber 18.17%, NDF 61.12%, ADF 40.15%, Hemicellulose 20.97%, Cellulose 34.59%, and Lignin 4.57% (Jamarun et al., 2017). According to Fasuyi et al. (2010), tithonia leaves contain complex amino acids. The content of tithonia amino acids such as lysine, arginine, aspartate, glutamate, methionine + cystine, isoleucine, tyrosine, and phenylalanine is high compared to other amino acids. However, besides tithonia having a fairly high nutritional content, this plant has limiting factors that are a problem in its use in livestock rations, namely phytic acid, tannins, saponins, oxalates, alkaloids, and flavonoids.

Because of the limiting factors of rice straw and Tithonia (*Tithonia diversifolia*), it is necessary to use animal feed processing technology that is cheap and easy to use before being used as a feed ingredient, one of which is fermentation technology. Many studies on the fermentation of feed ingredients have been carried out using fungi, bacteria, yeast, and other commercial products that can be found on the market. However, some of them require a fairly complicated rejuvenation process and are quite expensive. In this research, fermentation will be carried out using local microorganisms.

Local microorganisms are fermentation solutions made from various available resources, which contain several microorganisms that have the potential to transform organic materials. Research by Astuti (2012) states that the bioprocess using Local microorganisms is simpler compared to fermentation with bacteria or mold which is usually done because fermentation with Local microorganisms does not require rejuvenation and making inoculum media. Fermentation of banana peels with local microorganisms in the rumen can increase the digestibility of banana peel organic matter from 45.08% to 57.34%. Rumen contents are slaughterhouse waste which can pollute the environment. The availability of rumen contents is abundant, which can be seen based on the number of cattle and buffalo slaughtered at the slaughterhouse. Cow rumen fluid apart from containing rumen microbes and enzymes secreted by rumen microbes, contains food substances resulting from the breakdown of rumen microbes and enzymes, as well as vitamins and minerals that dissolve in rumen fluid. is 9.29% water; 8.45% crude protein; 1.23% crude fat; 33.53% crude fiber; 0.20% Ca; 0.45% P; 16.19% ash; and 31.60% NFE, and vitamin B12 contained in the rumen has the potential as a feed additive (Wizna et al. 2008). This study aims to determine the fiber fraction content in rice straw combined with tithonia (Tithonia diversifolia) fermented using local microorganisms with different incubation times.

RESEARCH METHODS

This research using a method is an experimental Completely Randomized Design with four types of treatment and four replications. The treatments in this study were as follows: P0 = Combination of rice straw and tithonia without local microorganisms (without incubation), P1 = Combination of rice straw and tithonia with mole without incubation (0 days), P2 = Combination of rice straw and tithonia with mole without incubation for 7 days, P3 = Combination of rice straw and tithonia with mole without incubation for

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14 days. The parameters measured in carrying out this research are Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), and Cellulose Content.

The process of making local microorganisms

1. The contents of the rumen taken from the slaughterhouse are mixed with water soaked in soybeans and molasses in a tightly closed jar.
2. Make a hole in the lid of the jar and connect it with a small cross to the bottle containing the distilled water.
3. The lid of the jar is wrapped with duct tape to prevent air from entering.
4. Then fermented for seven days.

Fermentation Process

1) Rice straw and tithonia waste which will be used as animal feed according to needs are ground using a chopper machine.
2) Rice straw and tithonia waste that will be used for fermentation are weighed with 75% and 25% treatment respectively.
3) Then put it in a plastic bag and mix it with a 20% mole solution of the sample material, then stir until evenly mixed.
4) After that, compaction (air compression) is carried out, then tied with pieces of rubber and incubated for 7 days and 14 days.
5) After 7 and 14 days, the plastic bag is opened and then aired. After that, it is dried in an oven at a temperature of 600C and crushed for laboratory testing.

RESULTS AND DISCUSSION

The average content of NDF, ADF, Cellulose, and Hemicellulose in a combination of rice straw and tithonia (Tithonia diversifolia) fermented with different incubations can be seen in Table 1. Based on the results of statistical analysis, showed that fermentation of rice straw and tithonia using local microorganisms source rumen content of cow with different incubation times had a highly significant effect ($P<0.01$) on the NDF content. This is because microorganisms need different amounts of time for each substrate, to produce fiber-digesting enzymes optimally.

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Table 1. Average NDF Content of ADF, Cellulose, and Hemicellulose in a combination of fermented rice straw and tithonia (*Tithonia diversifolia*).

Perlakuan	NDF (%)	ADF	Selulosa
P0	61.98[a]	51.44 [a]	39.20 [a]
P1	58.58 [b]	45.61 [b]	35.39 [b]
P2	63.19 [a]	53.26 [a]	40.22 [a]
P3	63.54 [a]	54.59 [a]	40.46 [a]
SE	0.72	0.70	0.78

Note:
Different superscripts (a, b) in the same column indicate very significantly different (P<0.01).
P0 = Combination of rice straw and tithonia without local microorganisms (not fermented).
P1 = Combination of rice straw and tithonia with without incubation for 0 days.
P2 = Combination of rice straw and tithonia fermentation with incubation for 7 days.
P3 = Combination of rice straw and tithonia fermentation within incubation for 14 days.

According to Rahayu, (1990), the speed of fermentation determines the amount of enzyme produced, the longer the fermentation time used, the more material will be broken down by the enzyme. The results of further tests using DNMRT showed that the NDF content in treatment P0 was significantly different from P1 but was not significantly different from treatments P2 and P3 while P2 was not significantly different from P3. Treatment P1 has the lowest NDF content. It is suspected that in this treatment some of the hemicellulose was dissolved during the incubation process because hemicellulose is part of the NDF. The low NDF content in treatment P1 was due to the treatment of rice straw and tithonia which added 20% mole without incubation. It is suspected that the microbes which are abundant in the mole have begun to absorb the nutrients needed in preparation for the fermentation process, but have not yet achieved maximum results from the fermentation product.

The greater the number of microbes, the more substrate nutrients are used. Astuti's research results (2020) showed that the highest number of fungal colonies was found in rumen-content as local Microorganisms with the addition of oil palm fronds, as much as 655.83x104 CFU / ml. In treatment P2, it was seen that there was an increase in NDF content with increasing incubation time to 7 days. According to Yunus (2017), the longer the fermentation time, the longer the activity of microorganisms degrades easily digestible cell wall components such as cellulose and hemicellulose. The increase in NDF levels indicates that cellulolytic microbial activity is insufficient in breaking down complex compounds into simpler compounds. Cellulolytic microbes that are not optimal cause the work of the cellulase enzyme to renovate cell walls (NDF), which mostly contain cellulose and lignin, into simpler compounds, which is not enough so that the portion of the cell wall (NDF) increases. Judoamidjojo et al. (1989) stated that the cellulase enzyme produced by cellulolytic microbes is used to hydrolyze cellulose. The results showed that the average NDF increased with increasing fermentation time. Cellulolytic fermentation occurs due to the activity of microorganisms that produce cellulase enzymes which function to break down complex compounds from their substrates. Akmal's (2003) opinion stated that the decrease in NDF content was caused by the breaking of lignocellulose bonds during fermentation by the growing microbial activity.

The results of statistical analysis showed that rice straw and tithonia fermentation treatments using rumen-content as local microorganism with different incubation times had hight significant effects ($P<0.01$) on ADF content. This is due to the influence of the high N in ADF which cannot be degraded by enzymes produced by microbes, so that soluble carbohydrates are reduced in availability in the feed material substrate. These carbohydrates are utilized by rumen microbes to maintain their lives so that their number decreases resulting in the components that make up ADF proportionally increasing followed by an increase in ADF levels. Following the opinion of Judoamidjojo (1989), the growth rate of microbes decreases due to a reduced supply of substrate nutrients.

The results of further tests using DNMRT showed that the ADF content in treatment P3 was higher than in treatments P2, and P0, and treatment P1 was significantly lower than P3. The low ADF content in treatment P1 was due to the increase in lignin in plants which resulted in a decrease in hemicellulose. The decrease in the average ADF level in treatment P1 is thought to have occurred due to cell wall remodeling during the fermentation process. Dissolution of some cell wall proteins and hemicellulose in acidic detergent solutions, thereby increasing the portion of ADS and causing a decrease in ADF levels. This is the opinion of Arief (2001) who stated that the decrease in NDF and ADF was caused because during fermentation there was a stretching of the lignocellulose bonds and hemicellulose bonds which caused the bound cell contents to dissolve in the neutral detergent solution. This causes the cell content (NDS) to increase, while the feed components that are insoluble in the detergent solution (NDF) decrease. Tanuwijaya (1987) stated that biological degradation during the fermentation process is one way of changing materials containing fiber components such as cellulose and lignin into useful materials such as monosaccharides, disaccharides, or cellobiose. The easily digested component of ADF is cellulose, while lignin is difficult to digest because it has double bonds. If the lignin content in the feed is high then the digestibility coefficient of the feed will be low (Sutardi, 1990). The ADF value is related to the energy content, where the higher the ADF value, the lower the digestible energy content. In this study, the fermentation of rice straw and tithonia which had the lowest value was P1. The difference in average ADF levels is caused by fermentation treatment which can loosen lignocellulose bonds so that they are easily digested by enzymes secreted by bacteria, which causes the dry matter and crude fiber content to decrease so that ADF levels decrease. In this research, in the P3 treatment, which obtained an average ADF content result of 54.59%, there was an increase in the average ADF content result in the P3 treatment of 57.46% according to the research results of Usman (2019).

Cellulose is the main structural component of the cell walls of green plants.

The results of the statistical analysis showed that the combination treatment of rice straw and tithonia fermentation had a hight significant effect (P<0.01) on the Cellulose content, the average results of the Cellulose content ranged from 35.39% to 40.46%. The results of further tests using DNMRT showed that the cellulose content in treatment P1 was lower than in treatments P0, P2, and P3. Treatment P3 was significantly higher than treatment P1. The level of fermentation time had a very significantly different effect on the cellulose content of rice straw and tithonia. This is thought to be because the carbohydrates used by microorganisms are unable to produce the cellulase enzyme which functions to degrade cellulose into glucose. This is by the opinion of Singgih et al., (2013) that the cellulase enzyme is an enzyme that digests crude fiber components which will increase the digestibility value of crude fiber. According to Anggorodi (1979), cellulose cannot be digested and cannot be used as a feed ingredient except in ruminant which have cellulolytic microorganisms in their rumen. These microbes can digest cellulose and allow the final results of digestion to be beneficial for ruminants. Also supported by the opinion (Church et al, 1998) that ruminant microorganisms can produce quite a lot of cellulase enzymes, so ruminants can digest and utilize cellulose well. Most cellulose is associated with lignin, therefore it is often called lignocellulose. Cellulose, hemicellulose, and lignin are produced from the photosynthesis process. According to Amnur (2015), the cellulase enzyme is an enzyme produced by microorganisms that functions to degrade cellulose into glucose while Fogarty (1983) stated that cellulose is the main component that makes up plant cell walls, apart from hemicellulose and lignin. Cellulose is part of the fiber fraction that is difficult to destroy in the digestive system, however, because rumen microorganisms produce quite a lot of cellulase enzymes, ruminants can digest and utilize cellulose well. The average cellulose content in this study was obtained in the P3 treatment at 40.46% compared to research conducted by Karim (2014), the average cellulose content increased with the highest value obtained in the P5 treatment at 33.06%. Based on the results of the research that has been carried out, it can be concluded that the effect of fermentation time for rice straw and tithonia has a very significantly different effect. (P<0.01) on the content of NDF, ADF, and Cellulose.

CONCLUSION

Based on the results of the research that has been carried out, it can be concluded that fermentation time for rice straw and tithonia has a hight significant effect (P<0.01) on the content of NDF, ADF, and Cellulose.

REFERENCES

Akmal. 2003.Pemanfaatan Wastelage Jerami Padi Sebagai Bahan Pakan Sapi FH Jantan. Tesis. Pasca Sarjana Insititut Pertanian Bogor. Bogor.

Amin, M., S.D. Hasan, O. Yanuarianto dan M. Iqbal. 2015. Pengaruh lama fermentasi terhadap kualitas jerami padi amoniasi yang ditambah probiotik *Bacillus Sp*. Jurnal Ilmu dan Teknologi Peternakan Indonesia. 1 (1) : 8-13.

Amnur, F. Y. 2015. Fraksi Serat Silase Daun Sagu Menggunakan Komposisi Substrat dan Lama Fermentasi Berbeda. Skripsi. Fakultas Pertanian dan Peternakan. Universitas Islam Sultan Syarif Kasim Riau. Pekanbaru

Anggorodi, R. 1979. Ilmu Makanan Ternak Umum. Jakarta: Gramedia

Arif, R. 2001. Pengaruh Penggunaan Jerami pada Amoniasi terhadap Daya Cerna NDF, ADF, dan ADS Dalam Ransum Domba Lokal. Jurnal Agroland volume 8 (2) : 208 –215.

Arief, R.W., I. Irawati., dan Yusmasari. 2011. Penurunan Kadar Asam Fitat Tepung Jagung Selama Proses Fermentasi menggunakan Ragi Tape. Lampung. Seminar Nasional Serelia 2011.

Astuti, T. 2012. Bioproses Optimalisasi Pemanfaatan Kulit Pisang dengan menggunakan Mikroorganisme Lokal (MOL) Sebagai Pakan TernakRuminansia. Laporan hibah bersaing. Universitas Muara Bungo.

Astuti, T. 2020. World Journal Of Advanced Research And Reviews. 08 (02). 314-317

BPS. Badan Pusat Statistik Kabupaten Solok. 2020.

Badan Pusat Statistik Kota Solok. 2020.

Drake, D.J., G. Nader and L. Forero. 2002. *Feeding Rice Straw to Cattle. ANR Publication 8079. University of California*.

Fasuyi, A.O., Dairo, F.A.S. and Ibitayo, F.J. 2010. *Ensiling wild sunflower (Tithonia diversifolia) leaves with sugar cane molasses. Livestock Research Rural Development*. http//www.Irrd.org/Irrd22/3/fasu220.htm.

Hakim, N. 2001. Kemungkinan Penggunaan Tithonia (*Tithonia diversifolia*) Sebagai Sumber Bahan Organik dan Nitrogen. Laporan Penelitian Pusat Penelitian Pemanfaatan Iptek Nuklir (P3IN) Unand.

Jamarun, N., Elihasridas., R. Pazla, and Fitriyani. 2017. In vitro nutrient digestibility of the combinations tithonia (*Tithonia difersivolia*) and Napier grass (*Pennisetum purpureum*). Proceedings of the 7th International Seminar on Tropical Animal Production. Yogyakarta. Indonesia.

Jeya, M., Y.W. Zhang, I.W. Kim, and J.K. Lee. 2009. Enhanced saccharification of alkali-treated rice straw by cellulase from Trametes hirsuta and statistical optimization of hydrolysis conditions by RSM. Bioresour. Technol.100 (21): 5155-5161. https://doi.org/10.1016/j.biortech.2009.05.040

Jorgensen, H. and L. Olsson. 2006. Production of cellulases by Penicilliumbrasilianum IBT20888 – Effect of substrate on hydrolytic performance. Enzyme and Microbial Technology. 38 (34): 381-390. https://doi.org/10.1016/j.enzmictec.2005.06.018

Lado, L . 2007. Evaluasi Kualitas Silase RumputSudan(*Sorghumsudanense*)pada Penambahan Berbagai Macam Aditif arbohidrat Mudah Larut.Tesis. Pascasarjana Program Studi Ilmu Peternakan. Universitas Gadjah Mada, Yogyakarta.

Litbang Pertanian, 2012. Fermentasi Jerami untuk Pakan Ternak Sapi Edisi 19-25 September 2012 No.3474 Tahun XLIII www. litbang. pertanian. go.id/.../Fermentasi Jerami-untuk-Pa.pdf

Rahayu,K. 1990. Teknologi nzim.PenerbitPusat Antar Universtas Pangan dan Gizi Universitas Gajah Mada. Yogyakarta

Srithongkham, S., L. Vivitchanont, and C. Krongtaew. 2012. Starch/cellulose biocomposites prepared by high shear homogenization/compression molding. J Mater SciEng. B 2 (4): 213222.

Syamsu, A. J. 2006. Teknologi Pengolahan Jerami Padi sebagai Pakan Ternak. Gorontalo Post, Gorontalo.

Wizna, H., Abbas, Y., Rizal, I.P., Kompiang, & Dharma, A.2008. Improving the quality of sago pith and rumen content mixture as poultry feed through fermentation by Bacillus amyloliquefaciens. Pakistan Journal of Nutrition, 7(2): 249-254