Utilization of fermented rice straw biomass and soybean oil supplementation on digestibility, efficiency, and the bodyweight of local sheep

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Abstract. Improvement of the quality of rumen food must be supported by improvements that support bioprocess in the rumen because rumen is the largest part of the digestive system of ruminants. Nutrition addition is a must if the ration used is fibrous waste such as fermented rice straw. Feed processing technology must be integrated with the nutrient addition of microbial biomass synthesis precursors, such as nitrogen, sulfur, macro minerals and energy, and long-chain fatty acids. This research was conducted to evaluate the utilization of fermented rice straw biomass using soybean oil addition on digestibility, feed efficiency and daily gain in local sheep. Eighteen, male local sheep aged 6-8 months with an average live weight of 22.31 ± 2.20 kg, were fed with 15% rice straw and 85% concentrate as the basic feed. The study was conducted with an experimental method in vivo. The adaptation period was carried out for 2 weeks, preliminary for 21 days and a collection period of 5 days using individual cages. Three diet treatments were supplemented control 0% (R1), supplement with 3% soybean oil (R2) and supplement with soy oil 6% (R3) of total dry matter intake. The parameters measured were dry matter digestibility, organic matter, and daily gain. Based on the results of the study it can be concluded that the addition of 6% soybean oil in the sheep feed, with the balance of 15% fermented rice straw and 85% concentrate did not affect and interfere with the digestibility of dry matter and organic matter, and did not significantly influence the daily gain and efficiency of sheep feed.

1. Introduction

Forage availability in the dry season is difficult, but rice straw waste is available and has not been used optimally for animal feed. Rice straw is the largest agricultural waste in Indonesia. Indonesia's rice production was 75.397.841 tons in 2015, Central Bureau of Statistics (2015) [1]. According to the Agricultural Research and Development Data, 1 ton of dry unhusked rice can produce waste of 1.5 tons of straw, with a total potential of unhusked rice in Indonesia of 75.397.841 tons, the potential of rice straw is 113.096.762 tons. The potential of rice straw is as an animal feed. Rice straw contains high polysaccharides, lignin, and silica which limit the intake and reduce degradability by ruminant microorganisms [2]. Yanuartianto's research [3] significantly improved the digestibility of dry matter and organic straw fermented with Bacillus sp by decreasing crude fiber content. Straw without cutting
with the addition of 3% urea can increase feed intake, digestibility, rumen fermentation, and the efficiency of microbial N synthesis [4].

Improvement of feed efficiency in addition to improving pre-rumen feed quality must be supported by improvements that support bioprocess in the rumen because rumen is part of the ruminant digestive system. Bioprocess in the rumen is affected by rumen microbes. Optimal rumen microbial growth rates are achieved when the supply of all nutrients is available in sufficient concentrations [5]. Microbes are supported by substrate fermentation, while substrate fermentation is carried out by microbial development [6]. In the study, the addition of 4% soybean meal in straw increased the digestibility of crude fiber compared with straw 4% urea addition [7]. The addition of urease enzyme from peanut to straw with urea addition can increase the digestibility of crude fiber [8]. Therefore nutrition addition is a must if the feed used is fibrous waste such as fermented rice straw. Feed processing technology must be combined with nutritional precursor supplements for the synthesis of microbial biomass, such as nitrogen, sulfur, macro minerals, and energy and long-chain fatty acids.

The addition of oil in a feed as an energy source and essential fatty acids for optimal rumen microbial development can be seen through the increased concentrations of volatile fatty acid (VFA) [13]. The addition of soybean oil to feed will increase the concentration of VFA because the fat will undergo the hydrolysis process to produce fatty acids and glycerol. Glycerol will be used to form propionic acid. The increasing VFA will increase the development of rumen microbes. Soybean oil can also inhibit the development of protozoa. The reduced population of protozoa can increase the growth of feed degrading bacteria because protozoa are bacterial predators. Oil in animal feed can function as a defaunation agent. The defaunation process can dramatically reduce the protozoa population. Defaunation affects the metabolic activity of protozoa so that the activity of protozoa in the rumen is reduced [5]. If the oil is given in excessive amounts, it will also inhibit bacterial growth [14]. Soybean oil in animal feed will undergo lipolysis into fatty acids by lipase-producing microbes, especially Anaerovibrio lipolytic [15]. Fatty acids will be used by rumen bacteria for the synthesis of phospholipid cell membranes. Increasing the population and biodiversity of rumen bacteria will increase bacterial activity so that the digestibility of ration increases including digestion of dry matter and organic matter of ration [16]. This shows that soybean oil can increase the growth of rumen microbes to digest food; therefore a study was conducted to determine the effect of soybean oil addition in feed on the digestibility of dry matter and organic matter.

Increased consumption of dry ingredients does not guarantee that the digestibility of dry ingredients also increases. This can be caused by various internal and external factors, one of which is the composition of feed and the activity of microorganisms in the digestive tract. Consumption of organic matter is also related to the consumption of dry matter, the higher the consumption of dry matter, the higher the consumption of organic matter. The addition of soybean oil in feed was expected to increase the weight gain because of the increased energy intake. This study also tested the effect of soybean oil addition and fermented rice straw waste on feed efficiency in the body of thin-tailed sheep [12].

2. Materials and Methods

2.1 Materials in research

The material used was 18 male thin sheep with 6-8 months of age, with an average body weight of 22.31 ± 2.20 kg with a coefficient of the diversity of 9.87%. Feed ingredients consist of fermented rice straw and concentrate (corn 20%, pollard 25%, coconut cake 19%, dried cassava 14%, bran 20%, 1% salt and 1% mineral mix with 15% rice straw balance and 85% concentrate based on dry matter, addition of sulphur as much as 0.4% of the total dry matter, as well as soybean oil according to the treatment.
Table 1. Nutritional composition of treated feed

| Nutrient                  | Rice straw fermentation | Concentrate |
|---------------------------|-------------------------|-------------|
|                           | P0          | P1          | P2          |
| Dry Matter, %             | 90.85       | 86.781      | 89.781      | 92.781      |
| Crude Protein, % dry matter | 5.59       | 12.23       | 13.36       | 14.49       |
| Crude Fibre, % dry matter | 32.44       | 17.23       | 17.44       | 17.47       |
| Crude Fat, % dry matter   | 3.66        | 6.6493      | 7.2193      | 7.7993      |
| Ash, % dry matter         | 19.64       | 6.7888      | 6.9588      | 7.1288      |

2.2 Research Methods
The study was conducted with an experimental method in vivo. The adaptation period lasts for 2 weeks, preliminary for 21 days and a collection period of 5 days, using individual cages. The variables measured were dry matter digestibility and organic matter feed using the total collection method [17]. The study used a Completely Randomized Design (CRD). Treatment of soybean oil with a level of 0%; 3%; 6% of feed dry ingredients. Each treatment was repeated 6 times. In vivo research is divided into three stages, including the adaptation, preliminary and collection stages.

2.2.1 Adaptation Stage
The adaptation stage is carried out to familiarize experimental animals to the environment: cages, feed and other equipment needed during the study. The activities during the adaptation stage include: providing basic feed in the form of rice straw and concentrate 3 times per day; concentrate at 07:00, fermented rice straw at 10:00, and concentrate and rice straw at 15:30. During the adaptation stage, livestock is evaluated because the feed given is in the form of fermented rice straw which was not normally consumed by livestock before. During the adaptation stage, measurements were not carried out, but voluntary feed observations were made. The adaptation stage is 2 weeks.

2.2.2 Preliminary Stage
The preliminary stage is to eliminate the influence of previous feeds, familiarize the feed ingredients that are tested and minimize the diversity of consumption per animal. The preliminary stage of feeding was at 07:00, 11:00, and 15:30 in the form of concentrate and fermented rice straw as well as weighing and recording of feed consumption. Measurement of feed consumption aims to determine the consumption of voluntary feed that is used as guidelines in feeding. The preliminary stage is 21 days. At the end of the preliminary stage, it was found that voluntary feed with a balance between fermented rice straw and concentrate was 15-85%.

2.2.3 Collection Stage
The collection stage is when data are collected from the treatment to be tested. The collection stage is carried out for 5 days following the instructions from Schneider and Flatt [17]. Samples were taken for feed, leftover feed, and feces for 3% in each individual animal, dried at 600 °C for 48 hours. Total collection for 5 days was carried out in the following ways: 1) collecting and weighing of the treatment feed (given and remaining) to determine the daily consumption of each sheep; 2) collecting and weighing of the feces of each sheep every day; 3) taking feces samples and treatment feed (given and remaining) as much as 3% by weight collected every day; 4) spraying fecal samples using 10% formalin; 5) drying the feed and feces samples at 60 °C for 48 hours to be analyzed for dry matter which is then used for the analysis of organic matter. After that proceed with the determination of the digestibility of dry matter and organic matter. Dry feed analysis for consumption measurements was carried out every day during the collection stage. The collection stage was 5 days. The data obtained analyzed using variance analysis [18].
2.2.4 Analysis of Organic Materials

The digestibility of organic matter is part of organic material consumed by livestock that is not found in feces. Analysis of dry matter (AOAC, 1990) [19]:

\[
Water\ content = \left( \frac{X + Y - Z}{Y} \right) \times 100\%
\]

Description:
- \( X \) = weight of porcelain cup (g)
- \( Y \) = weight of the sample (g)
- \( Z \) = weight of porcelain weight and sample after oven drying (g)

Organic material analysis using AOAC (1990) [19]:

\[
Ash\ Content = \left( \frac{X - A}{Y} \right) \times 100\%
\]

Description:
- \( A \) = weight of porcelain cup and sample after entered to furnace (g)
- \( X \) = weight of porcelain cup (g)
- \( Y \) = weight of the sample (g)

Organic material content (\%) = 100\% \cdot \% \text{ of ash content}

\[
Dry\ weight\ content\ (\%) = 100\% - \%\ water\ content
\]

3. Results and Discussion

3.1 Intake and digestibility of dry matter

The highest dry matter intake was obtained at R1 806.1 gram/head/day treatment followed by R2 treatment at 751.4 gram/head/day and R3 treatment 749.4 gram/head/day. The average consumption of dry matter with soybean oil addition was shown in Table 2. Research from Machmuller [20] stated that the effect of animal feed containing 19%, 27%, and 10% of oil per kg of live weight reduces digestion. The addition of essential oils can cause digestive disorders, decreased performance and decreased consumption [15]. Dry matter ration consumption was not significantly different (P>0.05) between the tested feed treatments. Ueda et al. [22] stated that feeds supplementation based on 3% flax oil has no negative effect on digestion and can reduce livestock digestibility but not for sheep. Not significantly different means that the consumption of feed is not disturbed by the addition of soybean oil to the level of 6%. The ability to feed ingredients to provide nutrients in quality and quantity for rumen microbes and livestock can be determined from the digestibility of dry matter.

Table 2. Average Consumption and digestibility of the dry matter

| Variable                              | Level of soybean oil supplementation |
|---------------------------------------|--------------------------------------|
|                                       | 0%         | 3%        | 6%         |
| Consumption/Intake of dry matter      | 806.08±111,13 | 751.4±66,11 | 749.4±158,17 |
| [grams/head/day]                      |            |           |            |
| Dry matter feces [Grams/head/day]    | 286.24±56,20 | 257.01±51,02 | 264.72±65,90 |
| Digestibility [%]                    | 64.76±3.10  | 66.03±4.98 | 64.67±2.49  |
| Daily gain [Grams/head/day]          | 0.126±0.04  | 0.133±0.04 | 0.116±0.06  |
| Feed efficiency [%]                  | 0.02±0.00   | 0.02±0.00  | 0.01±0.01   |
Better digestibility of feed ingredients indicates that the feed provided is of good quality. The highest digestibility of dry matter in sheep research was achieved in R2 treatment which was $66.03 \pm 4.98\%$ then R3 at $64.76 \pm 3.10\%$ and R1 at $64.67 \pm 2.49\%$ [Figure 1].

Figure 1 shows that the digestibility of dry matter tends to decrease at a rate of 6%, but the analysis of the variability of dry matter digestibility showed not significantly different results ($P>0.05$). This shows that soybean oil addition to the level of 6% had not disturbed the digestibility of dry matter. Soybean oil was assumed to be used for rumen microbial growth when the feed rations had little nutrient content, especially fat content. Abou et al. [23] also stated that the addition of kapok seed oil at the level of 4% in feed with low nutrient content can increase the digestibility of dry matter.

### 3.2 Digestibility of organic matter

Digestion of organic matter is the percentage of protein, fat, vitamins and carbohydrates that are digested during the digestion process. The digestibility of organic matter can describe the availability of energy that can be used for livestock. The average digestibility of organic food is presented in Figure 2. The highest digestibility of organic matter ration was given in the treatment R2 $68.69 \pm 4.27\%$ then followed by treatments R3 and R1 which were $67.41 \pm 3.07\%$ and $66.79 \pm 2.38\%$ respectively. The digestibility of organic matter in feed with soybean oil addition was not significantly different ($P>0.05$) between the tested feed treatments. This means that it contradicts the hypothesis, high soybean oil addition, digestibility of organic matter is also high. This incompatibility is the same as dry matter digestibility, where dry matter digestibility is always accompanied by organic matter digestibility. Digestion of dry matter ration is related to the digestibility of organic matter ration because some components of dry matter consist of organic material so that the factors that affect the digestibility of high and low dry matter will also affect the digestibility of high or low organic matter ration. This study was in line with the research of Kucuk et al. [24] that the addition of vegetable oil in feed to a level of 9.4% did not affect the digestibility of organic matter.
The digestibility of organic matter decreased at the level of 6% soybean oil addition. This condition was suspected because of the use of soybean oil in the mixture reduces cellulolytic bacteria, so that feed containing fiber was more difficult to degrade. Digestion of dry matter was related to organic matter because some dry matter consists of organic matter, the difference is in the ash content. This statement was reinforced by the research of Suwandyastuti and Suparwi [25] which stated that feeds ingredients that have the same nutritional content allows the digestibility of organic matter to follow the digestion of dry matter, but differences often occur.

3.3 Weight gain

Weight gain is a manifestation of livestock growth and the growth rate is influenced by several factors, such as the ability of animals to consume rations, feed or ration conditions, and other external factors such as air temperatures and humidity [26] [27] [28]. Daily weight gain of sheep fed with a fermented straw and soybean oil addition did not show a significant difference (p>0.05). The highest daily weight gain was obtained at treatment R2 0.133 gram/head/day followed by R1 treatment 0.126 gram/head/day and R3 treatment at 0.116 gram/head/day. The average daily weight gain can be seen in Figure 3.

Low weight gain because of soybean oil or food containing CLA inhibits and can reduce fat in sheep was in line with the study of Ostroskwa et al. [29] that giving CLA containing feed to pigs can reduce the thickness of back fat. Tresiyati [30] stated that antioxidants in CLA suppress lipoprotein lipase that
inhibits fat storage and reduce cholesterol. Corino et al. [31] stated that CLA can reduce fat in pigs. The resulting low daily body weight can also be attributed to the limited nutrients that are digested so that it is less absorbed by the livestock. Machmuller [20] stated that feed containing 19%, 27%, and 10% oil per kg of live weight can reduce digestion. Several studies have concluded that the administration of essential oils can cause digestive disorders, decreased consumption, and decreased growth performance [21].

3.4. Feed Efficiency

Feed efficiency is an indicator used to measure the success of the livestock business. The efficiency of the ration is calculated by comparing the amount of weight gain with the consumption of dry feed in percent [27] [28]. Figure 4 shows the efficiency of sheep fed with fermented straw with soybean oil addition did not show a significant difference (p>0.05). This is due to the low weight gain compared to the level of feed consumption so the value of feed efficiency is low due to the low feed quality. Providing high-quality food and good management will result in a level of efficiency in rabbit feed ranging from 0.25 to 0.35 [32] [33].

![Figure 4. Average Feed Efficiency](image)

Feed efficiency ranges from 0.25 to 0.28 [34]. Ferreira et al. [35] stated that supplementation of soybean oil and fish oil did not affect average daily gain and high feed concentrate efficiency. Soybean oil supplementation in basal feed in this study did not have an impact on feed efficiency.

4. Conclusion

The results of the study concluded that the evaluation of fermented rice straw using soybean oil addition in local sheep feed up to the level of 6%, with a ratio of 15% rice straw and 85% concentrate had no significant effect and did not interfere with nutrient digestion in sheep. Evaluation of the use of fermented rice straw with soybean oil addition in local sheep feed at a rate of 6% with a ratio of 15% rice straw and 85% concentrate also cannot increase daily body weight gain and daily feed efficiency.

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