The Effect of *Salak* (*Salacca zalacca*) Leaf Silage in Complete Feed on Digestibility and Characteristics *In vitro* Fermantation

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Abstract. The purpose of this study is to establish the best proportion of salakleaf silage utilisation in complete feed based on dry matter digestibility, organic matter digestibility, pH value, VFA generation, and NH3 concentration. The method used in this study was experimental with a 4 x 4 Randomized Block Design (RBD), using four distinct treatment ratios and 4 times rumen fluid collection as a repeat group. The percentage of *salak*leaf treatments in complete feed were: P0 (15% elephant grass in complete feed), P1 (15% *salak*leaf in complete feed), P2 (30% *salak*leaves in complete feed) and P3 (45% *salak* leaves in complete feed). The observed variables consisted of dry matter digestibility, organic matter digestibility, pH value, VFA production, and NH_3 concentration. The mathematical model used is an analysis of variance and if there are differences between treatments it is continued with the DMRT (Duncan's Multiple Range Test) test (Steel and Torrie, 1991). The results revealed that the treatment ration had no significant (P>0.05) influence on pH value and had a very significant effect (P<0.01) on dry matter digestibility, organic matter digestibility, VFA production, and NH_3 concentration. This study concluded that using 30% silage of *salak*leaves in complete feed could maintain the pH value and increase the dry matter digestibility, organic matter digestibility, pH value, VFA production, and NH_3 concentration.

Keywords: *Salak* leaves silage, complete feed, digestibility, fermentation characteristics, *in vitro*

Abstrak. Penelitian ini bertujuan untuk mengevaluasi persentase terbaik dalam pemanfaatan silase daun salakdalam pakan komplit terhadap kecernaan bahan kering, kecernaan bahan organik, nilai pH, produksi VFA dan konsentrasi NH_3. Metode yang digunakan dalam penelitian ini adalah metode eksperimen dengan Rancangan Acak Kelompok (RAK) 4 x 4, dengan 4 macam ransum perlakuan dan 4 kali pengambilan cairan rumen sebagai kelompok ulangan. Persentase perlakuan daun salakdalam pakan komplit adalah: P0 (15% rumput gajah dalam pakan komplit), P1 (15% daun salakdalam pakan komplit), P2 (30% daun salakdalam pakan komplit), dan P3 (45% daun salakdalam pakan komplit). Peubah yang diamati adalah terdiri dari kecernaan bahan kering, kecernaan bahan organik, nilai pH, produksi VFA dan konsentrasi NH_3. Model matematis yang digunakan ialah analisis sidik ragam dan apabila terdapat perbedaan antar perlakuan dilanjutkan dengan uji DMRT (Duncan’s Multiple Range Test). Hasil penelitian menunjukkan bahwa ransum perlakuan tidak berpengaruh nyata (P>0,05) terhadap nilai pH dan berpengaruh sangat nyata (P<0,01) terhadap kecernaan bahan kering, kecernaan bahan organik, produksi VFA dan konsentrasi NH_3. Kesimpulan dari penelitian ini bahwa dengan penggunaan 30% silase daun salakdalam pakan komplit dapat mempertahankan nilai pH dan meningkatkan kecernaan bahan kering dan bahan organik serta produksi VFA dan konsentrasi NH_3.

Kata kunci: Silase daun salak, pakan komplit, kecernaan, karakteristik fermentasi, *in vitro*

Introduction

The productivity of ruminant livestock is largely determined by the availability of feed both in terms of quantity and quality. One type of ruminant feed that is used as a strategy to support ruminant production is forage feed. Forage crops can be developed by breeders so that they are one of the local feed ingredients. However, the availability of forage often fluctuates due to seasonal changes. In the dry season, the availability and quality of forage nutrients decrease sharply, so farmers often experience difficulties in meeting the needs of their livestock. In the long dry season, livestock productivity in the form of increased body weight and fertility can decrease, while the mortality rate has the potential to increase. Therefore it is necessary to develop a feed supply system that allows the availability of alternative forage substitutes for forage so that feed can be available throughout the year.

In this context, alternative materials in the form of residues, by-products, or plant wastes can be potential feed sources. Cultivation of zalacca plants produces by-products in the form of fronds and leaves of *salak* which comes from pruning zalacca plants every 2 months. Biomass in the form of pruned *salak* leaves is a potential source of feed for ruminants. Some breeders have used fresh *salak* leaves as fodder for goats or cattle, but most of the pruned fronds and leaves have not been used and only sit in the *salak* plantations. The quality of *salak* leaves as feed is relatively low as indicated by the low protein and high fiber content. Besides quality issues, the availability of *salak* leaves needs to be managed so that they can be used throughout the year, especially during the dry season when the availability of forage decreases. According to Djaafar *et al.* (2015), fresh *salak* leaves contain 9.91% crude protein, 2.39% crude fat, and 22.9% crude fiber. Also according to research by Rikardo *et al.* (2018), *salak* leaves contain 28.45% cellulose, 11.74% hemicellulose, and 18.49% lignin.

The silage process aims to maximize preservation by maintaining the nutritional content contained in fresh forage so that it can be stored for a long period. The addition of an additive in the form of EM4 in the silage process also aims to increase the effectiveness of the fermentation process because it contains 90% LAB and some cellulose-decomposing bacteria so that it can increase metabolism and production of organic acids which are expected to increase digestibility. Feeding in the form of complete feed is expected to be able to provide a source of forage and concentrate in one ration as a source of energy and protein for livestock and rumen microbes. The rumen's ability to balance NH3 and VFA production will boost microbial protein synthesis. The combination of *salak* leaves and concentrate in complete feed silage is thought to increase the efficiency of rumen microbial protein synthesis, where this will also indicate an increase or development of rumen microbes which in turn can lead to increased nutrient digestibility and the formation of VFA and NH_3.

The purpose of this research is to find the optimal level of salak leaf silage utilisation in a complete diet to supplement local feed supplies to promote ruminant livestock production.

Materials and Methods

This study began at Padang Sidempuan and continued at the IPB University Dairy Animal Nutrition Laboratory. This research was conducted for 3 months (January-March 2023). The materials used in this study were *salak* leaves, concentrate, molasses, EM4, rumen fluid, McDougall's solution, as well as chemicals for *in vitro* analysis, dry matter digestibility, organic matter digestibility, pH value, VFA production, and NH_3 concentration. The equipment used in this study included tools for the process of making *salak* leaf silage, tools for taking rumen fluid, tools for *in vitro* digestibility measurements, tools for making McDougall's solution, and a set of other laboratory tools for analysis of dry matter digestibility, organic matter digestibility, pH value, VFA production, and NH_3 concentration. Forage samples (elephant grass and *salak* leaves) were collected from community plantation areas in Padang Sidempuan City.

The elephant grass (*Pennisetum purpureum*) used is 70 days old. As for the *salak* leaves used, the *Salacca Sumatrana* (Becc) Mogea variety, where the *salak* leaves used are the lower (old) midrib of 2-3 fronds from each 1 plant. Concentrate samples (bran, corn, palm kernel meal, fish meal, minerals, and molasses) and EM4 were obtained from the poultry shop. The proximate analysis of the sample refers to the procedure that has been prepared by AOAC (2005) and the fiber fraction refers to the Van Soest method (Goering and Van Soest, 1970). The observed variables were dry matter digestibility, organic matter digestibility, rumen fluid acidity (pH), rumen fluid volatile fatty acid (VFA), and rumen fluid ammonia (NH_3).

The variable was calculated using the formula:

$$\text{Dry matter digestibility (\%)} = \frac{DM\ sample - (DM\ residue - DM\ blank)}{DM\ sample} \text{ x } 100$$

$$\text{Dry matter digestibility (\%)} = \frac{OM\ sample - (OM\ residue - OM\ blank)}{OM\ sample} \text{ x } 100$$

$$\text{NH3 (mg/100ml)} = \frac{ml\ titration\ x\ N\ H2SO4\ x\ 17}{ml\ sample} \text{ x } 100$$

VFA (mM) = {[ml HCl blank titration (5 ml NaOH) – ml sample titration x N HCL x 1,000/5}] mM

The method used in this study was experimental (Tilley and Terry, 1963) with a 4 x 4 Randomized Block Design (RAK), with 4 (four) types of treatment rations and 4 (four) times of taking rumen fluid as a repeat group. The treatment arrangements were: P0 (15% elephant grass in complete feed), P1 (15% *salak* leaves in complete feed), P2 (30% *salak* leaves in complete feed), and P3 (45% *salak* leaves in complete feed). Mathematical model of design was according to Steel and Torrie (1991).

Results and Discussion

Dry Matter Digestibility and Organic Matter Digestibility

The treatment exhibited a highly significant (p<0,01) influence on the digestibility of dry matter and organic matter, according to the analysis of variance. In this study, the digestibility of dry matter was determined was above the normal range from 63.88 to 69.10% according to the statement of Preston and Leng (1987) that the normal range for the digestibility value of dry matter was between 63 to 65%. The digestibility value of organic matter in this study was above the normal range from 63.03 to 68.36% according to the statement of Firsoni *et al.* (2008) that the normal range for the digestibility value of organic matter in a feed ingredient range from 48.26 to 53.75%.

The highest average dry matter digestibility was found in P0 and P2, while the lowest was in P1 and P3. The high value of dry matter digestibility at P0 and P2 was due to the maximum rumen microbial activity due to the balance of energy and protein content in the complete feed. This shows that P0 and P2 are thought to be able to meet the availability of nitrogen and energy in the rumen fluid which are used by microbes as nutrient intake so that optimal growth can further increase fermentation activity with high digestibility of dry matter in the rumen. This corresponds to the opinion of Andini *et al.* (2015), the higher energy availability of the ration would increase the energy supply and optimize the growth of rumen microbes so that the amount of feed that could be degraded would increase and would increase the digestibility of dry matter.

The highest average organic matter digestibility was found in P0 and P2, while the lowest was in P1 and P3. The high value of organic matter digestibility at P0 and P2 is thought to be due to the optimal balance of complete feeds in increasing nutrient digestibility.

Table 1. Dry Matter Digestibility and Organic Matter Digestibility Average (%)

Variable	P0	P1	P2	P3
Dry Matter Digestibility	69.10^{cd}	65.06^{ab}	68.70^{c}	63.88^{a}
Organic Matter Digestibility	68.36^{cd}	64.47^{ab}	67.94^{c}	63.03^{a}

Notes : P0 (15% elephant grass); P1 (15% *salak* leaves); P2 (30% *salak* leaves); P3 (45% *salak* leaves); The superscript different in the same column shows a significant effect (P<0,01)

This increase is also caused by the nutritional content contained in the ration which is needed to increase digestibility. Supported by the opinion of Riswandi (2015), dry matter digestibility in ruminants demonstrates a large amount of nutrients that can be digested by microbes and digestive enzymes in the rumen. The higher the proportion of dry matter digestibility of a feed ingredient, the higher the feed item's quality. A high digestibility number represents the amount of a nutrient's supply to cattle, whereas a low digestibility value indicates that the feed is less able to preserve nutrients for basic life and animal production objectives.

The combination of complete feed with a certain composition allows for an optimal supplementation effect where the nutritional value deficiency of one food ingredient can be covered by the nutritional value of another food ingredient. Differences in digestibility results are also due to the amount or proportion of mixed ingredients used which are also different. According to Ramaiyulis (2018), the increase in the digestibility of dry matter and organic matter was due to an increase in soluble carbohydrates and nitrogen.

This is also in line with the high value of dry matter digestibility at P0 and P2. The increase in the digestibility of dry matter is always accompanied by an increase in the digestibility of organic matter. As opined by Pazla and Adrizal (2021), the average organic matter digestibility is directly related to the average dry matter digestibility. Organic matter digestibility is closely related to dry matter digestibility in that some dry matter is composed of organic matter. This conclusion agreed with others who stated that organic matter digestibility and dry matter digestibility are linked, as dry matter is made up of two substances, organic matter and inorganic material.

Fermentation Characteristics (pH, VFA, and NH_3)

The analysis of variance data revealed that the therapy had no significant effect (P>0.05) on the pH of rumen fluid. The pH value of the rumen fluid in this study was in the normal range between 6.86 to 6.94 according to Indrayanto's statement (2013) that the pH value generally ranges from 6.5 to 7.0 to maintain the fermentation process in the rumen.

The degree of rumen acidity (pH) obtained in each treatment was relatively constant and it was proven that the results obtained were not significant (not significantly different). This condition is influenced by the balance of VFA and NH_3 production, according to Usman (2013) that rumen microbes will effectively degrade fiber feed if the pH value is in the range of 6.5-7 and fiber digesting activity will slow down if the pH is at a value of 6.2. The lower the pH value indicates the higher the level of fermentation by rumen microbes. This indicates that the rumen environment is in a state of balance, so the fermentation process runs in balance.

The results of the analysis of variance showed that the treatment had a very significant effect (P<0.01) on VFA production and NH_3 concentration. Rumen fluid VFA production in this study was above the normal range, namely 109.997 to 135.89 mM in accordance with Sari *et al.* (2019), who stated that the optimum VFA production in supporting the development of rumen microbes is around 70-150 mM.

Table 2. Avarage pH, VFA and NH_3

Variable	P0	P1	P2	P3
pH	6.86	6.94	6.86	6.90
VFA	134.22^{c}	109.997^{a}	135.89^{cd}	111.90^{ab}
NH_3	12.90^{cd}	10.55^{ab}	11.87^{c}	10.05^{a}

Ket: P0 (15% elephant grass); P1 (15% *salak* leaves); P2 (30% *salak* leaves); P3 (45% *salak* leaves); The superscript different in the same column shows a significant effect (P<0,01) on VFA production and NH3 concentration.

The rumen fluid NH_3 concentration in this study was above the normal range, namely 10.05 to 12.90 mg/100 ml, which follows the opinion of Jamarun and Zain (2013) that the normal range for NH_3 concentration ranged from 5 mg/100 ml of rumen fluid or equivalent to 3.74 mM.

The highest average VFA production was found in P0 and P2, while the lowest was in P1 and P3. This was also followed by high values of dry matter and organic matter digestibility at P0 and P2. The increase in the digestibility value of dry matter and organic matter which is in line with the increase in the formation of available energy, will then be used for rumen microbial protein synthesis using VFA which is formed as a carbon framework. In accordance with the opinion of Riswandi (2014), the digestibility of dry matter and organic matter which has a very significant effect will also determine the level of availability of nutrients for microbial activity in the rumen. The availability of carbohydrates by microbes will produce VFA.

The highest average NH_3 concentrations were found at P0 and P2, while the lowest were at P1 and P3. The high concentration of NH_3 at P0 and P2 is thought to be due to the high rate of protein degradation which lowers the Crude Protein value (Table 6) at P0 and P2. The increase in NH_3 production showed that rumen microbes were optimal in degrading feed protein. It is in line with Izzatullah *et al.* (2018), who stated that the concentration of NH3 showed a high or low content of crude protein broken down by rumen microbes.

Factors that affect VFA production include the number and type of microbes in the rumen, feed fermentability, rumen pH, digestibility of feed ingredients, and the number of soluble carbohydrates. Rahayu *et al.* (2018). In line with the opinion of Anggraeny *et al.* (2015) that high nutrient digestibility with optimum total VFA production indicates a balance between the availability of energy and protein sources in the degradation process in the rumen. The existence of a balance of energy and protein in the ration can increase the efficiency of microbial protein synthesis so that nutrients that can be digested and absorbed after the rumen also increase.

Factors that affect NH_3 concentrations include the amount of feed and solubility, incubation time, carbohydrates in the feed, and rumen pH (Rahayu *et al.,* 2018). This increase in nutrient digestibility, followed by an increase in microbial protein synthesis in the rumen, is suspected of synchronizing the release of energy and NH_3 in the rumen, which is mainly due to the rate of energy production from *salak*leaf silage synchronous with the formation of NH_3 resulting from protein degradation from the complete feed.

Likewise, Rafleliawati *et al.* (2016) stated that N is the main precursor in the process of microbial protein synthesis and C is used as a carbon and energy framework. Uddin *et al.* (2015) stated that rumen microbes play a crucial role in providing protein to ruminant animals. They also suggested that balancing energy and nitrogen in the diet could be an effective way to increase the growth rate of these microbes. This nitrogen-energy balance can be interpreted as an increased availability of nitrogen combined with energy at the right time and in the right amount.

Conclusions

*Salak*leaves which are processed into silage can be used as a feed component in complete feed for ruminants. Complete feed silage containing 30% *salak*leaves could maintain the pH value and increased dry matter digestibility, organic matter digestibility, VFA production, and NH_3 concentration

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