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Nutritional Quality and Fiber Fraction of Complete Feed Silage Based on Sago By-Products, *Imperata cylindrica* and *Leucaena leucocephala*

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ABSTRACT

This experiment aimed to know the nutrition quality and fiber fraction of complete feed silage based on sago by-products, *Imperata cylindrica*, and *Leucaena leucocephala* in different compositions which fermented for three weeks. The study was conducted at the Laboratory of Feed Engineering and Technology, Faculty of Agriculture, University of Pattimura which lasted for three week. The main ingredients used to make silage complete ration in this study consisted of sago pulp, *Imperata cylindrica* , *Leucaena leucocephala*, concentrate and plus coconut water. Complete ration silage was fermented using coconut water plus which is a mixture of urea 95% and coconut water 5%. This research conducted by using randomized complete design with five factors of silage compound those are P0 = 60% forages + 40% concentrate (for control) ; P1 = 10% sago by-products + 40% *Imperata cylindrica* + 10% *Leucaena leucocephala* + 40% concentrate ; P2 = 20% sago by-products + 30% *Imperata cylindrica* + 20% *Leucaena leucocephala* + 30% concentrate ; P3 = 30% sago by-products + 20% *Imperata cylindrica* + 30% *Leucaena leucocephala* + 20% concentrate ; dan P4 = 40% sago by-products + 10% *Imperata cylindrica* + 40% *Leucaena leucocephala* + 10% concentrate. Each treatment used four replicates. The variable observed were the percentage of water content, ash, crude protein, crude fat, crude fiber, NDF, ADF, and lignin. The results showed that sago by-products, *Imperata cylindrica* and *Leucaena leucocephala* can be used for basic materials of complete feed silage in ruminants feed because they have no difference quality of nutrition and fiber fraction compared with control P0.

Keywords: Nutrition quality, Fiber fraction, Sago by-products, *Imperata cylindrical*, *Leucaena leucocephala*

Introduction

The optimal use of local feed ingredients and the use of appropriate technology is a strategic choice to increase the nation's independence in the livestock sector. Local feed ingredients can be sourced from industrial or agricultural industrial waste. Sago by-products is a waste from the sago flour processing industry, which until now has not been used maximally as ruminant feed. Meanwhile, forages that have the potential are cogon grass because they are available in sufficient quantities in the tropics. Likewise, legumes tree such as *Leucaena leucocephala* has not been able to be fully utilized by farmers, although it is always available in large quantities.

Sago waste is a portion of local food for the Maluku region and has excellent potential to be used as local silage in Maluku. In all sago flour processing sites, it is seen that sago by-products still accumulates and pollutes the environment. Louhenapessy (1998) states that the potential area of sago in Maluku is around 47.600 ha. The amount of sago flour production in Maluku is 4,400 kg/ha. Thus, it can be calculated how much sago by-products waste production per ha, so that sago by-products has the potential to be used as a component of animal feed both ruminant and monogastric. Sago by-products can be used as an alternative feed for ruminants as a substitute for forages up to 30% in a complete feed of Balinese cattle without disturbing the balance of the rumen system (Sangadji, 2008). Besides, the use of sago by-products silage, additive molasses and tapioca flour increase growth of 22.92 and 19.65% in Boerka goats (Simanihuruk and Sirait, 2017). The use of fermented sago by-products in the labia male ducks up to about 10.6% was able to increase cellulolytic activity (Biyatmoko, 2002). The pH value, ammonia concentration and volatile fatty acid (VFA) of the rumen system both in vitro and in vivo indicate improvement of the rumen fermentation process by the addition of fermented sago by-products (Hung *et al.*, 2018; Sangadji *et al.*, 2016).

Cogon grass (*Imperata cylindrica*) is a tropical grass that is easy to grow aggressively and resistant to weather and extreme environments, and its production is widely regarded as a weed and a threat to other crops. Cogon grass contains 31.9% dry matter, crude protein 6.5%, crude fiber 39.4%, ether extract 1.9%, Ash 7% (Heuzé *et al.*, 2016), α-cellulose 40.22%, holocellulose 59.62%, hemicellulose (pentosan) 18.40%, and lignin 31.29% (Sutiya *et al.*, 2012). The high content of crude fiber and lignin in Cogon grass is a limiting factor for livestock, making this plant rarely used to improve livestock conditions. However, through the process of ammoniation (Dewantoro, 2016) or the use of microorganism culture (Mudita and Wirapartha, 2007), Cogon grass has potential as an alternative forage for silage. As animal feed, Cogon grass (adult-fresh) contains 1% EE, 35.4% CF, 48.2%, BETN, 5.4% CP, 2-2.5% digestible protein (for cattle, goats and sheep) and contain metabolic energy (ME) of 1.95-1.96% Mcal/kg (for cattle and sheep) (Hartadi *et al.*, 1997). The production of *Leucaena leucocephala* (*Leucaena leucocephala*) leaves high and is a high-quality animal feed, especially in the dry season. *Leucaena leucocephala* can be used as a source of fermentable nitrogen in the rumen and to supply bypass protein to the small intestine so that it is used as an ingredient to improve the content of animal feed ingredients. Giving *Leucaena leucocephala* and molasses can improve the chemical quality of elephant grass silage (Yunus, 2009).

Sago by-products have a high enough potential, but its low quality needs to be given a touch of technology. Cogon grass is a type of grass with extensive distribution and much production, even with low quality because of its high rough fiber. Meanwhile, *Leucaena leucocephala* is a high-quality tree legume. Although the three ingredients above have the potential to be used as animal feed and are capable of producing during the dry season, it is necessary to increase feed reserves during the dry season to maximize the utilization of an abundance of biomass production during the rainy season, especially for areas with the short rainy season and long dry season. Many studies have shown that giving a single feed to livestock does not provide maximum results. Combining sago by-products, cogon grass and *Leucaena leucocephala* into a complete feed through silage technology can be an excellent alternative to formula ration. Using fermentation technology to process these ingredients into complete feed silage is the right solution to produce quality feed.

Complete feed silage has several advantages including the availability of substrates that support good fermentation, so that it has a much lower failure rate when compared to silage made from a single ingredient and contains nutrients that are suitable for livestock needs (Bretschneider *et al.*, 2015). Addition of various sources of carbohydrates fermented using *Aspergillus niger* fungi can increase the crude protein content of oil palm frond silage (Wajizah *et al.*, 2015). In addition, the use of complete feed silage also improves the digestibility of dairy cows (Júnior *et al.*, 2014), sheep (Ekawati *et al.*, 2014), and increases milk production of dairy cows (Ramli *et al.*, 2009), growth of Boerka goats (Simanihuruk and Sirait, 2017).

This research is an applied research that aims to determine the quality of nutrients (water content, ash, fiber, crude protein, and crude fiber) and fiber fraction (NDF, ADF, and lignin) complete feed silage (complete feed) with the basic ingredients of sago by-products , cogon grass and *Leucaena leucocephala* which have different comparisons.

Materials and Methods

The study was conducted in the Laboratory of Feed Engineering and Technology, Faculty of Agriculture, Pattimura University, which lasted for three months. The main ingredients used to make complete feed silage in this study consisted of sago by-products, cogon grass, Leucaena leucocephala, concentrate and plus coconut water. Complete feed silage was fermented using Quality coconut water is a mixture of urea as much as 95% and coconut water 5% according to the method of research Sangadji *et al.* (2017).

Cogon grass and *Leucaena leucocephala* leaves were taken at the same time in the Pattimura University campus area, then cogon grass and *Leucaena leucocephala* leaves were chopped 3 cm in size and withered for 3 days. The stages of making complete feed silage include: (a) weighed the ingredients according to the specified weight, (b) mixed the forages (cogon grass and Leucaena leucocephala) that had been withered with sago by-products, and ofu waste, then added coconut water plus according to treatment needs, (c) stirred the mixture until it was mixed evenly. Then, (d) after the silage mixture was evenly mixed and homogeneous then it was put into a clear plastic bag measuring 10 kg and pressed until solid, after that, it was bound and must be ensured that the silage package was in the air absence conditions (anaerobic), and (e) silage stored for 21 days for the fermentation process. Before proximate analysis was carried out, the sample was dried until the sample was air dried. Then the sample was finely ground to analyze its nutritional content.

This study used a completely randomized design with 5 treatments and each treatment received 4 replications. The treatments in this experiment were as follows :

P0 = 60% Forages + 40% Concentrate (Control)

P1 = 10% Sago by-products + 40% Cogon grass + 10% *Leucaena leucocephala* + 40% Concentrate

P2 = 20% Sago by-products + 30% Cogon grass + 20% *Leucaena leucocephala* + 30% Concentrate

P3 = 30% Sago by-products + 20% Cogon grass + 30% *Leucaena leucocephala* + 20% Concentrate
P4 = 40% Sago by-products + 10% Cogon grass + 40% *Leucaena leucocephala* + 10% Concentrate.

All treatments were incubated for 3 weeks. The variables observed were: nutrient content (crude fiber, protein, fat, water, ash), and fiber fraction components (NDF, ADF, and lignin). The data obtained were analyzed by analysis of variance analysis, and if there were differences in treatment effects, further tests were carried out by DMRT (Duncan Multiple Range Test). Data analysis with the assistance of MINITAB software version 17.0.

Results and Discussion

The nutritional quality of complete feed silage based on sago by-products, cogon grass, and *Leucaena leucocephala* in this experiment is as shown in Table 1. The results of statistical analysis showed that the composition of the different silage constituent ingredients had a significantly different effect (P<0.05) on the content of water, ash, crude protein, and crude fiber, on the crude fat content of complete feed silage crude. P0 treatment data is silage with good quality. Because other silage treatments are not too different from P0 treatment, all silage can be used as feed, whether or not as feed must be tested on livestock. The amount of water content is very important to know because the quality of silage ingredients is determined by the amount of water contained in it. Complete feed silage made from local raw materials containing water content can help the process of ensilage, and the three weeks storage can increase acid total (Allaily *et al.,* 2011). Table 1 shows that there are significant differences (P<0.05) of the complete feed silage water content in each treatment in this study. DMRT test results showed that P0 treatment have a higher water content and is significantly different (P<0.05) compared to treatments P1, P2, P3, and P4, this is due to the replacement of forages with sago by-products, cogon grass, and *Leucaena leucocephala*, where the ingredients are dried and withered for 3 days. There are variations in water content of complete feed silage in treatments P1, P2, P3, or P4, but it statistically does not show any difference between the treatment pairs. This is presumably due to mixing the ingredients carried out manually. According to Winarno (1997), feed ingredients with a water content of less than 14% have a longer level of durability and shelf life, and are resistant to mold, so it can be said that complete feed silage in research is quite good because it has a water content of less than 14%.

The results showed that the complete feed silage which have the highest ash content is in the P4 treatment and the lowest is in the P0 treatment. The results of analysis of variance shows that there are significant differences in ash content (P<0.05) between treatments, and the results of the DMRT test shows that the P0 treatment is significantly different from P1, P2 and P4 but is not different from P3, P1 treatment is not different from P2 and P3 is not different from P4. P4 treatment have higher ash content than other treatments because the percentage of sago by-products is higher. Silage ash content is directly proportional to the percentage of sago by-products used as the base material, meaning that the higher the percentage of sago by-products used in this study, the higher the ash content.

Crude protein contains pure protein compounds and NPN compounds (non-protein nitrogen). Protein representing nitrogen was found bound in peptide bonds to form proteins while NPN compounds were derived from non-protein compounds. Statistical tests shows that the differences in the constituent components had a significant effect (P<0.05) on the protein content of complete feed silage. Based on the results of proximate analysis of complete feed silage studied, it is seen that the highest crude protein content in the P0 (13.60%) treatment, and significantly different (P<0.05) with other treatments based on the DMRT test results. However, there is no difference between the treatment pairs P1, P2, P3 and P4. The addition of fibrous materials such as sago by-products, cogon grass, and most importantly *Leucaena leucocephala* have an impact on the difference between the P0 treatment and other treatments. This is thought to be related to the activity of microorganisms during the anaerobic fermentation process, it is known that in the process of ensilage, proteolytic bacteria as one of the microorganisms that is able to produce protease enzymes that are able to remodel proteins into simple sugars and then decompose them into ammonia nitrogen, VFA, and CO_2 (Jamaluddin *et al.*, 2018).

The results showed that the crude fat content of complete feed silage based on sago by-products, cogon grass and *Leucaena leucocephala* ranged from 0.89 to 1.17%, and analysis of variance showed no difference (P>0.05) between the treatments tested. Sago by-products and cogon grass have high fiber, while *Leucaena leucocephala* is a source of protein and feed, but almost all of these ingredients have low crude fat content. Increased levels of fat during fermentation due to crude fat content derived from the mass of microbial cells that grow and multiply in the media during fermentation, where microbes present in the feed material reproduce; cellulolytic microbes will produce cellulase enzymes that are able to break lignocellulose bonds and lignohemicellulosa produce nutrient content on the feed ingredients including crude fat (Juwandi *et al.*, 2018).

Crude fiber in silage is a reserved sugar source that will be used when the easy-to-use carbohydrate source has been used up. Analysis of variance showed that the composition of

Table 1. Nutritional quality of complete feed silage based on sago by-products, cogon grass, and *Leucaena leucocephala*

Variable	Treatment				
	P0	P1	P2	P3	P4
Water content (%)	14.61[a]±0.46	11.28[b]±0.78	10.67[b]±0.67	11.04[b]±0.92	11.85[b]±0.77
Ash contents (%)	9.79[bc]±087	7.40[d]±0.57	8.41[cd]±0.58	10.75[ab]±1.33	12.03[a]±1.02
Crude protein (%)	13.36[a]±0.94	9.49[b]±1.34	9.96[b]±0.89	8.79[b]±0.49	7.79[b]±0.54
Crude fat (%)	1.17[a]±0.22	1.06[a]±0.16	0.96[a]±0.21	0.89[a]±0.11	1.17[a]±0.25
Crude fiber (%)	21.49[a]±0.58	23.48[a]±1.31	22.18[a]±2.56	21.26[a]±1.07	15.86[b]±1.39

Different superscripts on the same row show markedly different (P<0.05).
P0 = 60% Forages + 40% Concentrate;
P1 = 10% Sago by-products + 40% Cogon grass + 10% *Leucaena leucocephala* + 40% Concentrate;
P2 = 20% Sago by-products + 30% Cogon grass + 20% *Leucaena leucocephala* + 30% Concentrate;
P3 = 30% Sago by-products + 20% Cogon grass + 30% *Leucaena leucocephala* + 20% Concentrate;
P4 = 40% Sago by-products + 10% Cogon grass + 40% *Leucaena leucocephala* + 10% Concentrate.

different constituents had a significant effect (P<0.05) on the level of crude fiber silage of complete feed in this study. DMRT advanced test results showed that the percentage of crude fiber in the P4 treatment was significantly (P<0.05) lower than other treatments. The low crude fiber content in the P4 treatment is presumably due to the high percentage of *Leucaena leucocephala* and the low percentage of cogon grass used as a basic ingredient in the composition of complete feed silage. Yunus (2009) states that the addition of *Leucaena leucocephala* leaf tends to reduce the content of silage crude fiber because the *Leucaena leucocephala* leaf has a lower crude fiber content than other ingredients. Whereas, Cogon grass has a high fiber content, so the use of a small amount can reduce the level of crude fiber of complete feed silage.

Fiber components of complete feed Silage

Fiber contains cellulose, lignin, some, and other polysaccharides. The compound has a complex bond that is very difficult to break down by microorganisms. The components of complete feed silage fibers based on sago by-products, cogon grass, and *Leucaena leucocephala* in this study included the percentage of NDF, ADF, and lignin, as shown in Table 2.

The results of the analysis of variance showed that the differences in the components of the complete silage building material had a significant effect (P<0.05) on NDF levels. Silage in the control treatment (P0) significantly (P<0.05) had lower NDF levels than other treatments. The use of sago waste and *Imperata cylindrica* in the P1, P2, P3, and P4 treatments significantly increased the complete NDF content of the complete ration. The results of the study by Simanihuruk *et al.* (2014) stated that the NDF content of sago waste ranges from 43.55-47.78%, and if it is made into sago dregs silage, the NDF content ranges from 31.37-37.84%, while the NDF content of grass reaches 58.03% (Simanihuruk and Sirait, 2017). In this study, the use of *Imperata cylindrica* was 40% (P2 treatment), the NDF content of the complete ration silage was 54.77% and higher than other treatments.

The ADF content of complete feed silage of the study results ranged from 45.93-51.19%. Statistical test results showed that the different constituents' composition had no significant effect (P>0.05) on the silage ADF content. The results of this study indicate that the use of urea and coconut water in fermentation during the process of making complete feed silage is not enough to hydrolyze the ADF component of feed ingredients. This is in line with research by Syahrir and Novieta (2016), who used urea and molasses to ferment elephant grass and mulberry.

Analysis of variance showed that differences in components based on sago by-products, cogon grass, and *Leucaena leucocephala* had no significant effect (P>0.05) on the lignin content of complete feed silage. The results showed that the silage lignin content ranged from 4.79 to 6.61%. Lignin degradation in silage may be related to the use of fermentation materials and the length of incubation time. Lignin can be degraded by various materials, but the most effective is using microorganisms, especially from the fungus group (Villas-Bôas *et al.*, 2002). The longer the incubation time, the amount of lignin lost is more significant (Borreani and Tabacco, 2018; Fadilah *et al.*, 2008; Krishaditersanto, 2018) Therefore, it does not rule out the possibility of extending the incubation time will increase the amount of degraded lignin.

Table 2. Fiber faction of complete feed silage made from sago by-products, cogon grass and *Leucaena leucocephala*

Variables	Treatment				
	P0	P1	P2	P3	P4
NDF (%)	48.14[b]±3.89	52.73[a]±2.67	54.77[a]±3.36	53.83[a]±0.94	53.32[a]±2.56
ADF (%)	45.93[a]±3.59	48.97[a]±2.01	51.19[a]±2.23	49.48[a]±1.30	46.85[a]±3.93
Lignin (%)	5.41[a]±1.11	5.99[a]±0.66	6.14[a]±0.63	6.61[a]±1.03	4.79[a]±0.77

Different superscripts on the same row show markedly different (P<0.05)
P0 = 60% Forages + 40% Concentrate;
P1=10% Sago by-products + 40% Cogon grass + 10% *Leucaena leucocephala* + 40% Concentrate;
P2=20% Sago by-products + 30% Cogon grass + 20% *Leucaena leucocephala* + 30% Concentrate;
P3=30% Sago by-products + 20% Cogon grass + 30% *Leucaena leucocephala* + 20% Concentrate;
P4=40% Sago by-products + 10% Cogon grass + 40% *Leucaena leucocephala* + 10% Concentrate.

Conclusions

The nutritional quality and fiber fraction of complete ration silages made from sago, *Imperata cylindrica* and *Leucaena leucocephala* with different ratios is not much different from complete ration silages made from grass and concentrate (P0), so that the complete ration silages studied in this study are used as feed ruminants because it contained nutrients (ash content, crude protein, crude fat, and crude fiber) and fiber composition (NDF, ADF, and lignin) which did not differ significantly with the treatment of P0 (forage 60% + concentrate 40%).

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