IMPROVEMENT OF CARBON-TO-NITROGEN (C/N) RATIO BY MAKING CASSAVA LEAF SILAGE AND ITS IMPLICATIONS IN DIGESTIBILITY IN GOAT

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ABSTRACT

  The study has been conducted in the laboratory and goats pen of the Department of Animal Husbandry, State Polytechnic of Lampung, Indonesia. The study lasted for six months with complete randomized design four treatments and six replications. A total of 24 local goats were used in this study. Treatment applied P1 = Silase with C / N ratio 17.88; P3 = Silage with C / N ratio 19.88; P2 = Silage with C / N ratio 18.88; and P4 = Silage with C / N ratio of 20.88. The observed variables of physical quality, nutrition, and nutrient apparent digestibility of cassava leaves silage. The result was material composition with C / N = 18,88 yielding physical characteristic of cassava leaves silage and the best nutrient apparent digestibility.

Keywords: C/N ratio, cassava leaves silage, goat, apparent digestibility

INTRODUCTION

  Silage-making process utilizes anaerobic bacteria from Lactobacillus class. These microorganisms are expected to grow rapidly resulting in lactic acid. The anaerobic microbial cell growth process is very complex, including the introduction of basic nutrients from the environment into cells, the conversion of nutrients to energy and various important constituents and breeding. Microbial growth can be characterized by an increase in the number and mass of cells, while the rate of growth depends on their physical and chemical environments (Silage-making process utilizes anaerobic bacteria from Lactobacillus class. These microorganisms are expected to grow rapidly resulting in lactic acid. The anaerobic microbial cell growth process is very complex, including the introduction of basic nutrients from the environment into cells, the conversion of nutrients to energy and various important constituents and breeding. Microbial growth can be characterized by an increase in the number and mass of cells, while the rate of growth depends on their physical and chemical environments (Manfaati, 2010).

  All microorganisms require basic nutrients as a source of carbon, nitrogen, energy, and minerals. Nutritional components of both quantities and types are essential for microbial growth. Carbohydrates especially sugars are used as energy sources, other components containing carbon are peptides, amino acids, and organic acids. The use of carbon components as a source of energy by lactic acid bacteria is 70% for growth and 30% for metabolic processes. Carbon provides a source of energy and a mass-forming mass of microbial cells. Nitrogen is an important component for the constituents of proteins, nucleic acids, enzymes, and amino acids needed for growth and microbial metabolism processes (Jin Bo, 2005).

  Elements of carbon and nitrogen are both needed as a source of energy for the growth of microorganisms. Therefore, the C / N ratio ranging from 20 to 30 is the optimum level in anaerobic digestion process (Bayuseno, 2009). The element C in the ratio is seen as biodegradable carbon. A low C / N ratio, or a high N content will increase emissions from nitrogen as ammonia. While the high C / N ratio, or relatively low C/ N elemental content will cause the fermentation process to be slower as a result of decreased production of microbial and nitrogen enzymes into inhibiting factors (Supriyanto, 2006).

  Carbon components in additive materials such as rice bran and corn flour as a substrate are energy sources and mass cell constituents that allow the growth and proliferation of lactic acid bacteria. Although rice bran and corn flour have high carbohydrate of 51.8% (Tarmudji, 2004), but to support the growth and breeding of microbes should be added other compounds such as nitrogen source. Cassava leaves contain 21% crude protein that can be used as a source of nitrogen in a mixture of cassava leaves-grass silage-corn bran for the synthesis of anaerobic microbial protein. Nitrogen elements are necessary primarily for the formation of nitrogen-containing cells and metabolites such as protein, nucleic acid, amino acids, and enzymes (Frazer and Westhoff, 1988).

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As previously explained that microbials require carbon and nitrogen elements for the benefit of the fermentation process in the optimal ratio. If anaerobic microbial nutrient needs are met then the growth will be more rapidly so that more and more lactic acid is formed. Increased lactic acid (organic acid) causes the anaerobic bacteria to die completely and the fermentation process is complete. This is very influential on the content of nutrients produced silage products. Anaerobic fermentation process that occurs in making cassava leaves silage with optimum C / N ratio is expected to produce cassava leaves silage with good physical, chemical, and biological nutritional value.

This research is directed to improve the C / N ratio of cassava leaves through the addition of rice bran and corn flour to be made silage and observed the physical quality, nutrition, and also the implication on the apparent digestibility of goats.

MATERIALS AND METHODS

The research has been carried out from March to August 2016 at the laboratory and goat pen of the Department of Animal Husbandry, Lampung State Polytechnic. The study was conducted in a complete randomized design with four treatments and six replications. A total of 24 local goats with average body weigh 21 kg ± 583 g were used in this study. The treatment applied was P1 = Silage treatment with C / N ratio 17.88; P3 = Silage with C / N ratio 19.88; P2 = Silage with C / N ratio 18.88; and P4 = Silage with C / N ratio of 20.88. The composition of cassava leaves silage substrate presented in Table 1. The calculation of C / N Ratio refers to the calculations of Richard and Nancy (1996).

$$R = \frac{Q1(C1 \times (100 - M1) + Q2J(C2 \times (100 - M2) + Q3 \times (100 - M3)}{Q1(N1 \times (100 - M1) + Q2(N2 \times (100 - M2) + Q3 \times (100 - M3)}$$

Information:
R	= C/N ratio	N1	= Nitrogen from cassava leaves
Q1	= Mass of cassava leaves (kg)	N2	= Nitrogen from rice brand
Q	= Mass of rice brand (kg)	N3	= Nitrogen from corn meal
Q3	= Mass of corn meal (kg)	M1	= Moisture of cassava leaves
C1	= Carbon from cassava leaves	M2	= Moisture of rice brand
C2	= Carbon from rice brand	M3	= Moisture of corn meal
C3	= Carbon from corn meal		

Table 1. The composition of cassava leaves silage substrate per 100 kg

Ingredients	Treatments (kg)			
	C/N = 17.88	C/N = 18.88	C/N = 19.88	C/N = 20.88
Cassava leaves	100.0	88.5	78.1	66.0
Corn meal	0.0	0.2	1.4	6.8
Rice bran	0.0	10.8	20.0	26.7
Molasses	0.0	0.5	0.5	0.5
Amount	100.0	100.0	100.0	100.0

The observed variables include physical (microscopic) qualities of cassava leaves silage product in accordance with the instructions of Syarifudin (2008) presented in Table 2 .

Table 2. Physical quality assessment of cassava leaves silage

Physical Characters	Score		
	3	2	1
Smell	Acid	Not Aid	Rotten
color	Light brown	Dark brown	Black
Moldy	Not	Medium	Much
Texture	Solid	Slightly	Soft

Observed variable:
(1) The chemical nutrients include dry matter, crude protein, crude fat, crude fiber, Ash, Ca, and P.
(2) Biological nutritional values by apparent digestibility include dry matter, organic matter, crude protein, and crude fat in goats.

Silage making process:
(1) Cassava leaves are chopping with 3-5 cm then wilting at room temperature for 24 hours.
(2) Cassava leaves mixed with rice bran, corn meal, and molasses.
(3) The result of the mixture is inserted into the plastic and then the air inside the plastic is removed by using the vacuum cleaner, then the plastic is closed and tied with a rubber strap.
(4) Stays in a safe place for four weeks.

RESULTS AND DISCUSSION

Various C / N Ratio against characteristics of physical properties of silage
The observed results of various C / N ratios on characteristics of silage physical properties are presented in table 3.

Table 3. Various C / N ratio to characteristic physical properties of silage

Treatment	Variables (C / N)			
	P0 = 17,88	P1 = 18,88	P2 = 19,88	P3 = 20,88
Smell	2[a]	3[b]	3[b]	3[b]
Color	1[a]	2[b]	3[c]	3[c]
Moldy	3[a]	3[a]	3[a]	3[a]
Texture	1[a]	2[b]	3[c]	3[c]
Dry matter(%)	51,33[a]	79,00[b]	73,17[c]	74,33[c]
pH	3,91[a]	3,37[b]	3,73b[a]	3,71[b]
Fleigh point	49,49[a]	71,58[b]	57,20[ac]	58,22[c]

Different superscripts on the same line showed significant differences (P <0.05)

Table 3 shows that the various C / N ratio of silage material has significant effect (P <0.05) on the physical quality of cassava leaves silage. The silage material with C / N = 18,88 resulted in better physical quality of silage than other treatments. This can be seen from the lowest pH value and the highest Fleigh (NF) value. The likelihood of pH occurring at treatment C / N = 18.88 was due to high lactic acid bacteria (LAB) activity with population of 1.7×10^9 (Table 4). This condition led to higher lactic acid concentration as a result of monosaccharide fermentation such as glucose and fructose performed by. According to Seglar (2003), lactic acid is the strongest acid among all the acids produced during the ensilase, making it more effective in lowering the pH.

Table 4. Various C / N ratio to lactic acid bacteria population

Treatment	Variables (C/N)			
	P0 = 17,88	P1 = 18,88	P2 = 19,88	P3 = 20,88
LAB (cfu/ml)	$1,58 \times 10^{9a}$	$1,7 \times 10^{9a}$	$1,33 \times 10^{9a}$	1.81×10^{9a}

Different superscripts on the same line showed significant differences (P <0.05)

The pH value of treatment C / N = 18.88; C / N = 19.88, and C / N = 20.88 has an ideal range of 4.0--4.5 (Santoso *et al*., 2009). While the C / N treatment = 17.88 has the highest pH value. Chamberlain & Wilkinson (1996) states that if during primary fermentation lactic acid produced low concentration and no critical pH value (4.5), secondary fermentation will occur.

The quality of silage can be seen from fleigh point. Fleigh point is characteristic index of silage fermentation based on dry matter value and pH of silage (Despal *et al*., 2011). Treatment C / N = 17.88 has the lowest fleigh point (P <0.01), whereas C / N = 18.88 has the highest value. Killic (1980) states that if the value of fleigh point 85--100 states the quality of silage is very good, 60-80 is the value of fleigh point for good quality silage, while silage with fleigh point 55--60 value is classified rather well. Silage with fleigh point value at 25--40 intervals is of medium quality, if fleigh point <20 is considered very bad. Silage products of different C / N ratios are presented in Figure 1.
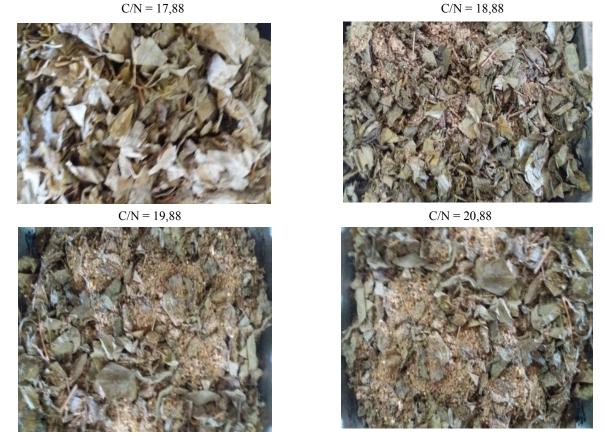
C/N = 17,88   C/N = 18,88

C/N = 19,88   C/N = 20,88

Figure 1. Silage of cassava leaves on different C / N ratio

Various C / N Ratio against Chemical Characteristics of cassava leaf silage
The observed results of various C / N ratios on chemical characteristics are presented in table 5.

Table 5. Various C / N ratio to the chemical characteristics of silage

Variables	Treatment (C/N)			
	P0 = 17,88	P1 = 18,88	P2 = 19,88	P3 = 20,88
Crude protein (%)	24.73[a]	19.13[b]	17.97[c]	18.32[c]
Crude fat (%)	2.47[a]	7.12[b]	5.55[c]	6.93[b]
Crude fibre (%)	17.57[a]	11.29[b]	12.50[b]	13.88[c]
Ash (%)	4.10[a]	8.67[b]	5.95[c]	6.39[c]

Different superscripts on the same line showed significant differences (P <0.05)

Table 5 shows that the variation of C / N treatment ratio causes a very significant difference to the crude protein content of silage. This difference is due to the rate of use of each different feed material according to the formulation to obtain the desired C / N ratio of the silage material. Consequently, each silage material contributes to different crude proteins. As a result the total content of crude protein silage differs between treatments. It also occurs in other nutrients.

Various C / N Ratio Against Apparent Digestibility Coefficient of Nutrition in Goats

The results of observation of various C / N ratio to apparent digestibility coefficient of nutrition in goats is presented in table 6.

Table 6. Various C / N ratios to apparent digestibility nutrient on goats

Variables	Treatment (C/N)			
	P0 = 17,88	P1 = 18,88	P2 = 19,88	P3 = 20,88
Dry matter (%)	0.8173^a	0.9167^b	0.8642^c	0.8883^d
Organic matter	0.8431^a	0.9099^b	0.8697^c	0.9051^b
Crude protein (%)	0.8634^a	0.9346^b	0.9383^b	0.9074^c
Crude fat (%)	0.6712^a	0.9606^b	0.9643^b	0.9391^c

Different superscripts on the same line showed significant differences (P <0.05)

Table 6 shows that the presence of various C / N ratio treatments led to very significant differences in nutrient apparent digestion coefficient. Treatment P0 (C / N = 17.88) showed lower nutrient digestibility compared with other treatments. Treatment P1 (C / N = 18,88) showed high performance of nutrient digestibility. The nutrient digestibility value of a feed material depends on several factors including livestock, age, feed, and nutrient content of feed, rough digestibility of raw protein, feed preparation (cutting, milling, and cooking), and the number of rations (Tillman *et al*. , 1991). Crude fiber is a major factor that affects the digestibility of nutrients. Treatment P0 (C / N = 17,88) had the highest crude fiber content of 17.57% (Table 6). This results in lower nutrient digestibility compared with other treatments. Sutardi (1979) states that dry matter digestibility is influenced by feed protein content, because each protein source has different solubility and degradation resistance. The digestibility of organic matter is an important factor that can determine the value of feed. Each type of ruminant has rumen microbes with different abilities in degrading the ration, resulting in different digestibility. The rumen microbes are unable to digest the crude fiber components contained in the feed optimally. The crude fiber content in the feed will cause a low degradation, since crude fibers in the form of cellulose and hemicellulose often bind to lignin and will be difficult to break down by digestive enzymes (Tillman *et al*, 1998).

CONCLUSIONS

Various C / N ratios in silage making yield different physical and chemical characteristics to cassava leaves silage product. The composition of the material with C / N = 18,88 yields the best physical characteristics of cassava leaves silage. Cassava leaves meal silage by C / N ratio = 18,88 has the best value of apparent digestibility nutrients in goats.

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