Physical Characteristics Analysis of Complete Silage Made of Sorghum Forage, King Grass and Natural Grass

Paulus Klau Tahuk1*, Gerson Frans Bira2, Hendrik Taga3
1,2,3 Faculty of Agriculture, Timor University

Email: paulklau@yahoo.co.id

Abstract. The purpose of this study was to determine the physical characteristics of complete silage made from forage sorghum, king grass and natural grass. This research was conducted at the Faculty of Agriculture, Timor University, Kefamenanu-East Nusa Tenggara (NTT) for 3 months, including preparation, adaptation, and data collection. The study used a completely randomized design with 3 treatments and 4 replications. Each treatment included T1: sorghum 45% + lamtoro 20% + corn flour 25% + bran pollard 10%; T2: 45% natural grass + 20% lamtoro + 25% corn flour + 10% bran pollard and T3: king grass 45% + lamtoro 20% + corn flour 25% + bran pollard 10%. The parameters measured were the physical characteristics of complete silage in the form of color, texture, aroma, and the presence of fungus using panelists and the degree of acidity measured by a pH meter. Data were analyzed based on analysis of variance procedures. The results showed that the use of different forage sources as a base material in making complete silage had a significant effect (P <0.05) on the silage color and the presence of fungus but it did not affect the texture, aroma and acidity. It was concluded that the use of sorghum in making complete silage displayed the best physical characteristics characterized by natural green/yellowish green, dense textured, acidic (still fresh), pH 4.3 and the absence of fungus.

1. Introduction

Increased livestock productivity is largely determined by the availability of feed both in terms of quality, quantity and continuity. On dry land, the availability of feed is very volatile because of its dependence on seasonal changes. Forage production such as grasses and cereals will increase during the rainy season, which has an impact on increasing biomass production. Conversely, in the dry season, the production capacity decreases prominently. This condition also affects the productivity of livestock that is not continuous.

Seeing these conditions, it is necessary to look for alternative solutions in order to make sure that the availability of feed remains guaranteed throughout the year. One simple technology that can be done is the development of silage making technology, especially complete silage. Silage is animal feed preserved through the process of acylation, which is the process of preserving feed or forage by using the mechanism of spontaneous action of lactic acid fermentation under anaerobic conditions [1]. Making silage is intended to maintain the quality or even improve the quality of forage feed [2]. Silage can be made from a single material or a mixture of other materials or is called complete silage.
Complete silage can provide nutrients according to the needs of livestock as well as the presence of substrates that support the fermentation process. There are several factors that determine the quality of fermentation produced in the manufacture of complete silage, including the type of forage used, the water content of the ingredients and also the presence of additives. The types of forage that can be used in making complete silage are quite diverse such as the type of legume, cereal plants to the types of grasses such as sorghum, king grass and natural grass and what needs to be ascertained is the forage preferred by the livestock.

In this study, the forages used were natural grass, sorghum and king grass. Of the three silage-making materials, natural grass availability is very abundant during the rainy season, while sorghum development is still limited despite its potential as animal feed. In contrast, the king grass is better as animal feed, but the dry climate condition in East Nusa Tenggara gives an impact on the limited cultivation by farmers/ranchers. The use of basic materials for making complete silage is important because the type of feed material also influences the characteristics of the silage produced, including the response of livestock to consume it. Quality silage can be identified organoleptically in the form of texture, color, aroma, the presence of fungus and the degree of acidity.

The making of complete silage in this study is also intended to utilize the advantages of forage and nutrient content in forages and other animal feed ingredients, besides being able to be stored for a long period of time, especially used in the dry season where the availability of feed is very limited.

2. Materials and Methods

2.1. Location, Time and Research Design

This research was conducted at the Laboratory of the Faculty of Agriculture, Timor University. The equipments used included 40 kg capacity hanging scales with a precision of 10 g to weigh feed, machetes, buckets, 150-liter capacity plastic drums as silos, and assessment sheets. The materials used were sorghum, king grass, natural grass, lamtoro, corn flour flour and bran pollard. The research method used was a Completely Randomized Design (CRD) consisting of 3 treatments and 4 replications consisting of.

- **T1**: Natural Grass 45% + Lamtoro 20% + corn flour 25% + bran pollard 10%
- **T2**: Sorghum 45% + Lamtoro 20% + corn flour 25% + bran pollard 10%
- **T3**: King Grass 45% + Lamtoro 20% + corn flour 25% + bran pollard 10%

2.2. Variable Observation and Processing of Complete Silage

The research variables observed were the physical quality of complete silage consisting of color, texture, aroma, acidity, and fungal contamination. Making complete silage followed the stages which covered the harvesting of sorghum, king grass and natural grass at the beginning of the flowering period, then aired for 5 hours to reduce the water content (60-70%). The next process was the chopping of forage with a length of about 3-5cm. Chopped sorghum, king grass and natural grass were then spread on a plastic mat and mixed with lamtoro which had also been chopped with the similar size. The next stage was adding the additives which had been prepared according to each treatment of 25% milled corn flour and 10% bran pollard weighed and sprinkled evenly over the chopped forage (sorghum, king grass and natural grass). The choppings and additives were then mixed evenly, and inserted gradually into the fermentor silo (plastic drum) while compacted to release as much oxygen as possible. Fully filled silo (plastic drum) with forage mixture and additives were then stored indoors at room temperature for 21 days. After 21 days, the silo was opened and pH measurements of complete silage are done along with other physical quality assessments such as color, aroma, texture and the presence of fungus were given a score (1-3) involving 10 panelists for each treatment. The indicators of a complete silage physical quality assessment are presented as follows:
Table 1. Indicators of physical quality assessment of complete silage based on natural grass, sorghum and kinggrass

| Indicator | Level 1 | Level 2 | Level 3 |
|-----------|---------|---------|---------|
| Color     | 3. Natural green or yellowish green | 2. Dark green or brownish yellow | 1. Brown to black |
| Texture   | 3. Solid/dense | 2. Slightly soft | 1. Flabby/mushy |
| Aroma     | 3. Acid (keep fresh) | 2. Not acidic or not rotten | 1. Rotten |
| pH        | 3. 3.0-4.2 Very good | 2. 4.2-4.5 good | 1. 4.5-4.8 Medium |
| Fungus    | 3. None | 2. Enough | 1. Lots |

2.3. Data Analysis

The data obtained were processed using variance according to the Completely Randomized Design (CRD), followed by further tests using Duncan's Multiple Range Test [3].

3. Result and discussion

3.1. Color

Silage color describes the process of ensilage whether its running properly or not. The complete silage color scores are shown in Table 2 with a range between 2.6-2.9 or dark green or brownish yellow to natural green or brownish yellow after the ensilage process for 21 days. Statistical tests showed that there was an influence of the basic material (forage) used in making silage on the color of the resulting silage (P <0.05). It illustrated that the use of different based materials in the manufacture of complete silage would also influence the characteristics of the silage color. In general, the use of natural grass, sorghum and king grass produces pretty high quality colors. Quality silage is shown in bright green to brownish green where the color is highly dependent on the silage material used [4]. The dark green to bright green color illustrates that the ensilage process is carried out normally and is a good color criterion for silage [5].

Normal color of complete silage indicates that there was a short respiration in the silo during the ensilage due to the lack of oxygen trapped in the silo. It also illustrates that the compaction process of the mixture of feed ingredients in a silo was quite adequate. During the process of making silage, there should be no excessive or prolonged respiration in the silo. Prolonged respiration is usually due to the amount of oxygen trapped in the silo. As a result, the temperature inside the silo becomes high due to the breakdown of carboxyrates and proteins [6]. When the respiration process is prolonged, the silo temperature increases, which results in damage to the silage color [7].

Table 2. Complete Silage Quality in manufacturing using different forage-based materials

| Physical Characteristics | T1  | T2  | T3  |
|--------------------------|-----|-----|-----|
| Color                    | 2.6b| 2.9a| 2.7ab|
| Texture                  | 2.6 | 3.0 | 2.9 |
| Aroma                    | 2.6 | 3.0 | 2.8 |
| pH                       | 4.8 | 4.3 | 4.4 |
| Mushrooms                | 2.6b| 3.0a| 2.9a|
Note: Values with different superscripts in the same line show significantly different effects (P < 0.05); T1 = Complete Natural Grass Silage; T2 = Sorghum Forage Complete Silage; T3 = King Grass Complete Silage. Color (3. Natural green or yellowish green; 2. Dark green or brownish yellow; 1. Brown to black); Texture (3. Solid/dense; 2. Slightly soft; 1. Flabby/mushy), Aroma (3. Acid (keep fresh); 2. Not acidic or not rotten; 1. Rotten), pH (3. 3.0-4.2 Very good; 2. 4.2-4.5 Good; 1. 4.5-4.8 Medium), Funguss (3. None; 2. Enough; 1. Lots).

3.2. Texture
Textures produced as a result of the use of different forage base materials show a score of 2.6-2.9 or rather soft to dense texture. In general, the texture produced in the making of silage based on natural grass, forage sorghum and king grass is relatively the same and there is no real effect and categorized as a good quality complete silage. According to various reports, good silage has the characteristics of a clear texture like natural material that is dense textured and natural green [9].

3.3. Aroma
The aroma of complete silage is one indicator to determine the physical quality that is closely related to the fermentation process. The ensilage process that occurs optimally can be indicated by the distinctive aroma of silage. Statistically the aroma produced from complete silage made from natural grass, sorghum and king grass has no significant effect. In general, the aroma of silage that is produced using sorghum, king grass and natural shows a typically normal silage. Thus, judging by the aroma, the complete silage produced is in a good quality. Good silage has a fermented milk like aroma due to the presence of lactic acid, not a pungent aroma [10]. The complete silage with a criteria of good and excellent quality has an acidic aroma, while the complete silage criteria with medium category have a less acidic aroma [11]. In Table 1, although there is no real treatment effect, but in terms of quantity, it shows that the aroma produced by silage with sorghum forage is acidic (fresh) while the complete silage aroma with natural grass is slightly acidic. It relates to pH silage, where a slightly acidic aroma is caused by a low pH. However, complete silage for all treatments has good quality.

3.4. pH
Quality silage can be seen from its physical characteristics. One of them is by looking at the value of the degree of acidity (pH). The pH values produced from complete silage made from sorghum forage, king grass and natural grass are listed in Table 1 in the range of 4.3-4.8. Based on the results of statistical tests, the use of some forages as the basis for making complete silage produces a pH value that is relatively the same between treatments. Referring to the Ministry of Agriculture's directives [11] on silage quality, the pH value produced by complete silage based on forage sorghum and king grass is categorized very well, while complete silage made from natural grass is categorized as poor. The pH value of complete silage made from natural grass is high due to the low content of soluble carbohydrates in natural grass so that the addition of additives needs to be calculated as good as possible. Thus, the low dissolved carbohydrates from fresh cut forage can have an impact on the poor quality of fermentation produced [8]. Another factor that influences the pH value is the availability of lactic acid bacteria produced by complete silage of sorghum forage and king grass which is more than the complete silage of natural grass. The degree of acidity produced by lactic acid is the highest compared to the pH of other organic acids formed during the fermentation process. Therefore, the rate at which pH silage decreases is largely determined by the number of lactic acid bacteria formed [12]. The degree of acidity is closely related to the aroma, where the complete silage aroma of natural grass is slightly acidic (2.6) causing the resulting pH to be slightly acidic (4.8).

3.5. Fungus
The presence of fungus in complete silage can be caused by the presence of spoilage microbial activity during the fermentation process. This condition gives an indication that the ensilage process is not running optimally. Fungus illustrates that lactic acid bacteria are not optimal in inhibiting the
activity of spoilage bacteria [5]. Statistical test results showed significant effects (P <0.05) of different bases of complete silage (natural grass, forage sorghum and king grass) towards the presence of fungus. Complete silage of sorghum forage and king grass is not overgrown by fungus while the complete silage of natural grass is slightly overgrown with fungus on the surface. The growth of fungus on the surface of natural grass silage is caused by the presence of air which causes lactic acid bacteria to work unoptimally. The existence of this fungus is also related to pH. If the pH is low, then the production of lactic acid bacteria is high and causes the ensilage process to run normally. The growth of lactic acid bacteria will increase the production of lactic acid generating acid condition characterized by a decrease in pH [13].

4. Conclusion
It can be concluded that the use of sorghum in making complete silage displays the best physical characteristics which are characterized by natural green / yellowish green, solid textured, acid-aroma (fresh), pH 4.3 and the absence of fungus.

5. Acknowledgments
The author would like to thank the Research Institute and Community Service (LPPM) of Timor University for funding the implementation of this competency research; with contract implementation number: 004 / UN60 / LPPM / PP / 2019, March 27, 2019.

References
[1] Despal., I.G. Permana., S.N. Safarina dan A.J. Tatra. 2011. Penggunaan Berbagai Sumber Karbohidrat Terlarut Air untuk Meningkatkan Kualitas Silase Daun Rami. Media Peternakan. 34 (1): 69-76.
[2] Jasin, I. 2014. Pengaruh Penambahan Molasses dan Isolat Bakteri Asam Laktat dari Cairan Rumen Sapi PO Terhadap Kualitas Silase Rumput Gajah (Pennisetum purpureum). Agripet. 14 (1): 50-55.
[3] Steel, R.C. dan Torrie J. H. 1991. Prinsip dan Prosedur Statistika. Gramedia Pustaka Utama. Jakarta.
[4] Macaulay, A. 2004. Evaluating Silage Quality. http://www1.agric.gov.ab.ca/department/deptdocs.nsf/all/for4909.html [Diakses Juni 2019].
[5] Nahak, O.R., P.K. Tahuk, G.F. Bira, A. Bere dan H. Riberu. 2019. Pengaruh Penggunaan Jenis Aditif yang Berbeda terhadap Kualitas Fisik dan Kimia Silase Komplit Berbahan Dasar Sorgum (Sorghum bicolor (L) Moench). Journal of Animal Science. 4 (1): 3-5.
[6] Utomo, R., S.P.S. Budhi dan I.F. Astuti. 2013. Pengaruh Level Onggok Sebagai Aditif Terhadap Kualitas Silase Isi Rumen Sapi. Buletin Peternakan. 37 (3): 173-180.
[7] MacDonald, P. 1991. The Biochemistry of Silage. John Wiley and Sons. New York. p 340.
[8] Ridwan R., S. Ratnakomala., G. Kartina., dan Y. Widiastuti. 2005. Pengaruh Penambahan Dedak Padi dan Lactobacillus plantarum 1 BL-2 dalam Pembuatan Silase Rumput Gajah (Pennisetum purpureum). Media Peternakan. 28 (3): 117 – 123.
[9] Siregar, S. 1996. Pengawetan Pakan Ternak. Jakarta: Penebar Swadaya.
[10] Saun, R.J.V and Heinrichs, A.J. 2008. Troubleshooting silage problems: How to identify potential problem. Proceedings of the Mid-Atlantic Conference; Pennsylvania, 26–26 May 2008. Penn State’s Collage. p 2–10.
[11] Departemen Pertanian. 1980. Silase Sebagai Makanan Ternak. Departemen Pertanian. Balai Informasi Pertanian. Laporan Penelitian Ternak. Ciawi, Bogor.
[12] Thalib, A., J. Bestari, Y. Widiawati, H. Hamid dan D. Suherman. 2000. Pengaruh Perlakuan Silase Jerami Padi dengan Mikroba Rumen Kerbau terhadap Daya Cerna dan Ekosistem Rumen Sapi. Journal Indonesian Tropical and Veteriner. 5 (1): 276-281.
[13] Kurnianingtyas, I.B., P.R. Pandansari, I. Astuti, S.D. Widyawati dan W.P.S. Suprayogi. 2012. Pengaruh Macam Akselerator Terhadap Kualitas Fisik, Kimiawi, dan Biologis Silase Rumput Kolonjono. *Tropical Animal Husbandry*. 1 (1): 7-14.