Comparison Between Portable and Static Types of Silo on Silage Quality of Total Mixed Ration Containing Ramie Leaves (*Boehmeria nivea*, L. GAUD)

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Abstract

Ensiling is an alternative method to optimize utilization of seasonal available ramie leaves (Boehmeria nivea, L. Gaud) in ruminant daily feed but there is still lack of information available on the impact of silo type to the silage quality. The study was aimed to compare portable tower silo (plastic container 200 l) and static trench silo (1 ton capacity) effects on physical (odor, texture, moisture, color and spoilage), fermentative (pH, DM, VFA, DMD, CP, NH3, CPD, WSC and fleigh number) and utilities (rumen ration fermentation and degradation) characteristics of silage produced. The results showed that trench silo was less effective in giving good physical characteristics of silage compare to the plastic container (9% vs 2.59% of spoilage respectively). Fermentative characteristic of silage produced in plastic container was excellent (fleigh number 118) while trench container produced good grade silage (fleigh number 74). All silage pH were less than 4.4. Utilities characteristic of silage were not affected by the type of silo. Both silage were highly fermentable and digestible to ruminant (>71% OMD). Plastic container produced better physical and fermentative characteristics of total mixed ration contained ramie leaves, but utilities characteristic of silage produced in both type of silo were equal.

Keywords: ramie leave, ruminant, silage, silo, total mix ration

Introduction

Productivity of cows in the developing countries was only 22% of cows in the developed countries (Speedy and Sansoucy, 1989). The first factor limiting the milk production and productivity was nutrition aspects such as increasing difficulty in providing the bulk, high price, and fluctuated availability and quality of feed required by cattle. Alternative source of seasonal available high quality agro-industrial by-product such as ramie leaves (*Boehmeria nivea*, L. Gaud) have been studied (Despal, 2007). The leaves contained 16% (Despal *et al*., 2011) to 21% of CP (Duarte *et al*., 1997), that is equal to lucerne or alfalfa (Ferreira *et al*., 2007; DeToledo *et al*., 2008).

Because of its seasonal availability, conservation technique should be applied (Mayne and O'Kiely, 2005). Several laboratory scale conservation methods of ramie leaves including time and additive used for ensiling (Despal *et al*., 2011a) and time and drying technique for hay making (Asti *et al*., 2009) have been optimized. Comparison of the nutrient values of ration containing dried and ensiled ramie leaves were also tested *in vitro* (Despal *et al*., 2011b). From the previous experiments, it is concluded that ensiling method conserved better nutrients of ramie leaves and produced better feed utilities for ruminant compare to drying method.

To be able to provide supply of nutrients required by dairy cattle continuously, ensiling the leaves as total mixed ration on larger capacity of silo can be an alternative. Unfortunately, there is limited available information of suitable silo types for smallholder dairy cattle farmer, especially in humid tropical developing countries.

The study was aimed at comparing portable tower silo (plastic container 200 l) and static trench silo (1 ton capacity) effects on physical characteristics of the silage produced (odor, texture, moisture, color and spoilage) and ensiling characteristics (pH, dry matter, volatile fatty acid, dry matter degradation, crude protein, ammonia, crude protein degradation, water soluble carbohydrate and fleigh number) as well as the silage utilization by ruminant (ruminal ration fermentation and digestibilities) *in vitro*.

Materials and Methods

Depending on capacity of the silo (100 kg for tower and 350 kg for trench silos), total ration have been mixed homogenously out of 58.8% of 2 cm length chopped elephant grasses, 24.5% of 2 cm chopped ramie leaves, 1.3% rice bran, 3.7% pollard, 5.6% corn meal, 2.4% soybean oil meal and 3.7% coconut oil meal to produce 32.36% dry matter (DM), 66% total digestible nutrients (TDN), 19% crude protein (CP), 1.71% calcium (Ca) and 0.4% phosphorus (P) of nutritional content of the ration. The mixed materials were placed into the silo. The airs were pushed out of the silo by compressing the materials manually. The silos were then sealed. Ensiling was let for 5 weeks anaerobically at room temperature.

Qualities of silage produced were compared based on physical characteristics (odor, texture, moisture, color and spoilage) descriptively. Ensiling characteristics of both silage were compared based on pH, DM, volatile fatty acid (VFA), DM degradation (DMDs), CP, ammonia (NH_3), CP degradation (CPD), water soluble carbohydrate (WSC) and fleigh number (FN) variables of the silages. Utilities characteristics of the silage for dairy cattle were compared based on ruminal fermentability of the silage to produce VFA and NH_3 and their DM digestibility (DMDr) and organic matter digestibility (OMD) *in vitro*.

Physical characteristics of the silage were described quantitatively. Scale (+1) were given to the least desired and (+4) to the most desired physical characteristic of the silage. Measurements of pH were done according to Naumann and Bassler (1997) procedure. The amounts of 10 g of silages were mixed with 100 ml distilled water using mid speed blender for 1 min. Supernatants were separated and the pH was measured using calibrated pH meter. The supernatants were stored frozen until it were used for determination of silage VFA (using steam distillation method) and NH_3 (using Conway micro diffusion method) concentrations.

Degradations of DM during ensiling were calculated by subtracting DM in the material from DM in the silage. Degradations of CP during ensiling were quantified from NH_3 produced from the degradations. Analyses of DM were conducted using oven heat, while CP contents were measured using Kjehldal method (Naumann and Bassler, 1997). Water soluble carbohydrates were determined using Phenol Method according to Singleton and Rossi (1965), while, FN were calculated according to formula described by Idikut et al. (2009), where NF = 220 + (2 x %DM – 15) – (40 x pH).

Ruminal fermentabilities were conducted according to General Laboratory Procedure (1966). The VFA ruminal concentrations were determined using steam distillation method, while ruminal NH_3 concentrations were determined using Conway micro diffusion method. *In vitro* digestibility trials were done following Tilley and Terry (1963) two-stage technique.

Observations of ensiling characteristics were conducted following completely randomised design, while utilities characteristics observation used randomised block design. Each treatment was repeated thrice. The data obtained were analyzed using Varian analysis if the assumptions were fulfilled. For those which were not, descriptive analyses were used instead.

Results and Discussions

Physical, ensiling and utilities characteristics of silage produced in tower (plastic container) and trench types of silo were showed in Table 1. Tower silo (plastic container) produced better physical characteristics of silage by means of lighter color, more acidic odor, better texture, less moisture and spoilage (Haustein, 2003). Ammonia odor was not found in the tower silo, but in the trench silo. Lower amount of clotted silage (0.003%) was found in the tower silo compare to the trench which was reach up to 1%. Ammonia odor and clotted silage found in trench silo showed spoilage microorganism activities during and after ensiling which was more favor in higher moisture silage (Saun and Heinrich, 2008). Therefore, moisture control to reduce water activity such as wilting or the use of absorbent substrate (Despal *et*

Table 1. Physicals, ensiling and utilities characteristics of the silages

Variables	Trench silo	Tower silo
Physical characteristics		
Color	+3 (Brownish green)	+4 (Yellowish green)
Odor	+3 (Acid + ammonia)	+4 (Acid)
Texture	+3 (3.5 kg clotted silage)	+4 (3 g of clotted silage)
Moisture	+3	+4
Spoilage	+2 (9%)	+4 (2,59%)
Ensiling characteristics		
pH	4.38 ± 0.10	3.60 ± 0.54
DM (%)	22.07 ± 0.46[b]	28.89 ± 1.19[a]
VFA (mM)	8.05 ± 2.72	5.12 ± 2.62
DMDs (%)	10.56 ± 0.46[a]	3.74 ± 1.19[b]
CP (%)	17.24 ± 6.97	19.03 ± 4.82
NH_3 (mM)	0.81 ± 0.40	0.84 ± 0.11
CPD (%)	4.69 ± 0.91	4.56 ± 1.04
WSC (% BK)	2.20 ± 0.12[a]	1.37 ± 0.08[b]
NF	74.00 ± 3.92[b]	118.78 ± 21.5[a]
Utilities characteristics		
VFA (mM)	201.65 ± 6.99	213.41 ± 30.7
NH_3 (mM)	19.25 ± 6.47	18.81 ± 0.72
DMDr (%)	71.06 ± 1.83	73.40 ± 1.17
OMD (%)	71.62 ± 1.67	73.25 ± 1.45

Different superscript in the same line means significantly different (P<0.05)

al., 2011a) might be possible to successfully control undesirable microorganisms sucs as *Clostridium*. In wet silages (22% DM), the most important microorganisms growing were bacterial strains which lead to higher ammonia-N and pH increases (Nussio, 2005) such as those were found in the trench silo.

Ensiling characteristics of the silage in tower silo were also better than those of the trench by means of higher DM and CP contents and NF value of the silage and lower pH, DMDs, CPDs, WSC and VFA content of the silage (significantly or just tent to). More rapid drop in silage pH was found in the tower silo than those in the trench. These were esensial for minimising proteolysis and successful ensiling (Saarisalo and Jaakkola, 2005). Lower degradation of DM and CP in tower silo was caused by more rapid decreasing of pH which was produced by more active convertion of WSC into lactic acid (mainly) by activity of lactic acid bacteria

(LAB). These condition inhibited harmful microorganism growth rate, therefore, less substances were degraded and higher nutrient could be conserved. These efficient forage conservation system that minimise quantitative and qualitative losses had always been the importance emphasised in ensiling research technique (Mayne and O'Kiely, 2005).

Degradation of DM (DMDs) in this study was 3.74% for tower and 10.56% for thrench silos. The lower DMDs in the tower type silo might also be caused by the higher bulk density of the tower (100 kg/200 l or equal to 500 kg/1000 l) compared to trench silo which was only 350 kg/m^3 or equal to 350 kg/1000 l. The equal losses of DM were observed by Ruppel (1992) which reported DM losses of 202 and 100 g/kg for silage bulk densities of 160 and 360 kg/m^3, respectively.

Silage value index described in NF value showed that silage produced in tower silo resulted in significantly higher NF score (118.78) than those in the trench silo (74.0). According to Idikut *et al*. (2009), silage produced in the tower silo could be categorized into very good silage (NF > 85), while trench silo produced good quality silage (60 < NF < 80).

Utilization of both silages by ruminant (*in vitro*) did not show statistical different in their characteristics. Both silages were categorized highly fermentable. Concentration of VFA found in rumen fluid after incubation of the total mixed ration were above optimum level of 80–160 mM for microbial growth requirement. Fortunately, the excess of VFA were synchronized by excess of NH_3 (> 12 mM) which were expected could improved microbial growth leading to higher microbial activities and protein synthesis. The high activity of feed degradation in the rumen were shown by high DMDr and OMD of the silage (> 70%).

Conclusions

Total mixed ration containing ramie leaves silage produced in both silos were in the grade of good to very good qualities with high effiency of forage conservation systems. Both silo produced equal utilities characteristics of silage for ruminant, however, tower silo (plastic container) produced better physical and ensiling characteristics of silage with higher nutrients could be conserved.

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