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Effect of Polythene Film on Grass Silage Quality as Investigated under Ambient Conditions

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ABSTRACT

Study was conducted to determine the effect of different polythene films on quality parameters of ensiled silage under ambient conditions. The experiment was arranged in a Complete Randomized Design (CRD) with four treatments with three replicates per treatment. CO-3 grass (*Pennisetum perpureum X P. americarnum)* silage was filled, sealed and packed four different polythene films and stored under ambient conditions. Treatments were, 1 kg of silage ensiled in high density polythene (HDP) film (T_1), 1 kg of silage ensiled in poly ethylene (PE) film (T_2), 1 kg of silage ensiled in poly propylene (PP) film (T_3), 1kg of silage ensiled in low density polythene (LDP) film (T_4). Silage was opened after four weeks. Then sensory evaluation and quality parameters were analyzed. Sensory evaluation was conducted using 20 untrained people. Quality parameters were analyzed by taking silage samples from each replicate. Sensory evaluation was indicated significant different in LDP film (T_4) by giving brown/black color and mouldy and putrid aroma silage. HDP polythene film had optimum level of moisture content (%), pH, dry matter (%), crude fiber (%) and ash (%) content. Overall results indicated that significantly higher pH (8.223), moisture content (77.29), crude protein (20.123), ash (20.64) and low dry matter (22.71), crude fiber (23.666) was available in LDP film. Accordingly, it can be concluded that PP, PE and HDP film can be used for silage packaging with best quality preserving. Moreover, LDP film is not suitable for silage preservation by ensiling due to spoilage and low quality.

KEYWORDS: Ensiling, Polythene films, Quality parameters, Sensory evaluation, Silage

INTRODUCTION

Silage is a fermented forage having high moisture content produced by natural preservation that is used to feed the ruminants (Food and Agriculture Organization, 2008). Generally, green materials are used for preparing silage. Grasses, forage legumes, tree legumes and field crops are used as green materials. Preservation method of silage filling and compacting is called as ensiling (Moran, 2005). Successful ensiling can be obtained by following several basic principles. Silage should contain 65-70% moisture and 30% dry matter content, length of chopping should be fine (1-3 cm long) and time taken for filling the stack should be quicker for not getting dry or mouldy (Moran, 2005). Fermentable energy such as molasses or root crops can be added to enhance anaerobic fermentation by providing suitable substrate (National Dairy Development Board, 2012).

Silage needs fermentation under the anaerobic condition which reduces activities of aerobic microorganisms (Setapar *et al.*, 2012). These anaerobic microorganisms ferment plant soluble carbohydrate or sugar into the lactic acid and acetic acid. Higher amount of lactic acid and lesser amount of acetic acid production reduces the pH of silage that inhibits the growth and activity of spoilage microorganisms (Food and Agriculture Organization, 2008).

Silage production preserve feed with minimum nutrient losses while remaining stable composition of feed in longer period and routing feed supplement increase productivity of the animal (National Dairy Development Board, 2012). If not followed basic principles of silage preparation and ensiling, it results poor quality, unpalatable and off flavor silage (Moran, 2005).

In Sri Lanka, ruminant feed can't be found required amount throughout the year due to seasonal changes of *Yala* and *Maha*. These changes give lack of forage in dry season. In wet season, forage growth exceeded the animal's requirement. Thus, excess fodder is conserved by preparing silage for dry season feeding.

Silo is the container that silage is ensiled and stored for conservation and preparation which ranges from large scale to small scale (Saxe, 2007). Small scale farmers, who own less than 10 ruminants, need small amount of silo for farm requirement and it allows think about mini silos that ensiled small quantities of silage (Saxe, 2007).

Bag silos that are made from polythene consider as new method which is recommended due to possibility of getting rid of almost all air contain inside the bag. Bag silo conserve small quantities of forage over a long period of time and demanded sizes for the bags could be depending up on the farmer requirements (Saxe,

2007). As well as, easy transportation, easy handling, low space requirement and low cost are the benefits that a farmer could acquire by using bag silo (Food and Agriculture Organization, 2008).

Small scale livestock farmers in Sri Lanka are being used different types of polythene films in order to prepare silage by using bag silos irrespective of type of polythene film used. This may cause low quality and considerable amount of spoiled silage. Thus, this study was carried out with the objectives of finding the effect of polythene film on quality of silage that has been ensiled as bag silos and finds the best polythene film that can be used to produce bag silos by the small scale livestock farmers in Sri Lanka.

MATERIALS AND METHODS

Experimental Site

Study was carried out from January to May 2016 at the Faculty of Agriculture and Plantation Management with the collaboration of Faculty of Livestock, Fisheries and Nutrition, Wayamba University of Sri Lanka, Makandura, Gonawila which located in the Low country Intermediate Zone. The monthly mean temperature at Makandura during the experimental site was 31.4 °C. Relative Humidity was ranged from 70-75%.

Silage Preparation

Hybrid Napier (CO-3) grasses were selected to use as green material to produce silage due to giving high yield potential, high dry matter, crude protein content and high palatability than other green materials (Pathmasiri *et al.*, 2014). Plant parts (stems and leaves) were cut and chopped in to small pieces (1-3 cm long). Then, molasses were added to silage lot according to the weight basis (3-5% on wet basis; Moran, 2005). Silages were filled, and compacted into bag silos as possible as removing air and without wasting much time.

Treatments and Field Layout

Four different treatments were used in this study (Table 1). Treatments were arranged in Complete Randomized Design (CRD) with three replicates per treatment. Total amount of polythene bags with 4 different polythene films were 12. Each bag was filled with 1 kg of silage.

Data Recording

Several silage samples were taken just after preparing silage and they were used to analyze quality parameters (pH and proximate parameters). During the storage, weekly inspection was done to observe changes occurred in silage such as mould growth, insect, rodent and livestock attack or holes on the polythene bags. After one month silages were opened and samples were taken from each replicate for sensory evaluation and test the quality parameters.

Table 1. Tested combinations of treatments

Treatments	Description
T_1	1 kg of silage + High Density Polythene (HDP)
T_2	1 kg of silage + Poly polythene (PE)
T_3	1 kg of silage + Poly propylene (PP)
T_4	1 kg of silage + Low Density polythene (LDP)

Sensory Evaluation

Portion of each silage sample was taken for sensory evaluation. Silage samples were asked to comment about their physical appearance, texture, color and aroma by 20 untrained people. Among the factors that were commented, crucial two factors of color and aroma were analyzed. There were six color ranges (1- very dark olive green, 2- dark olive green/brown, 3- light green to green/brown, 4- Pale green/straw yellow, 5- brown, 6- dark brown). There were six aroma ranges (1- pleasantly acidic sour, 2- milk or natural yoghurt smell, 3- sweet fruity alcoholic aroma, 4- rancid butter, putrid aroma, 5- flavor of burnt, 6- mouldy aroma; Kaiser *et al.*, 2003).

pH and proximate parameters (Australian Fodder Industry Association lab manual, 2007) was conducted to the each collected silage sample to determine the quality of silage (initial samples and stored treatments-including replicates). Sample preparation was done to analyze the proximate parameters.

Quality Parameters

Acid Level

Silage sample (5 g) was added to 25 mL of distilled water and allowed to remain 30 min. Solution was filtered and pH was measured using pH meter (995414, Romania, Europe).

Proximate Analysis

Sample Preparation

Collected silage samples were dried in an oven at 80 °C for 24 h. Dried samples were ground using mortar and pestle and sieved 0.5 mm sieve to obtain powdered samples.

Moisture Content (MC%) and Dry Matter (DM%)

Collected Silage samples were weighted and dried in oven (oven dry method) at 105 °C for 24 h. Calculations were done to obtain MC% and DM%.

Crude Protein (CP%)

Oven dried samples were weighted and Kejeldha method was run to estimate crude protein by using block digester (DK6), distillation unit (UDK129) and final titration series. Data were used to calculate the CP%.

Crude Fiber (CF%)

Oven dried samples at were weighted and Weende method (AFIA, 2007) used to measure crude fiber by using fiber analyzer (VELP SCIENTIFICA FIWE). Calculations were done using raw data.

Ash (%)

Oven dried samples at were weighted and used in Muffle furnace (HD230) at 560-600 °C to obtain ash.

Statistical Analysis

Quality parameter data were analyzed by analysis of variance (ANOVA) and followed by mean separation through GLM (General Liner Model) procedure using SAS system (9.4).

RESULTS AND DISCUSSION

Silage samples that were taken from initial silage lot were analyzed and the data of pH and proximate parameters are presented in Table 2. The treatment effect was considered as a main variable at the experimental site while the other factors were considered as remain constant.

Table 2. Initial silage quality parameters

pH	M C (%)	DM (%)	CP (%)	CF (%)	Ash (%)
5.80	73.96	26.04	14.96	26.8	12.1

MC- moisture content, DM- dry matter, CP- crude protein, CF- crude fiber

Sensory Evaluation

Observations based on color and aroma are subjective while providing extra support to get decision in laboratory tests.

Colour

Evaluators were given 85% of highest value for T_4 observing brown, brown /black color. More extensive heating, high proportion of damaged protein, inadequate compaction and delayed sealing cause brown color silage (Kaiser *et al.*, 2003). Quality grass silage was given light green to green brown color (Kaiser *et al.*, 2003). Light green to green brown colour was observed in T_1, T_2 and T_3. Among those treatments, highest light green to green brown colour was observed in T_1 (75%; Table 3).

Aroma

Highest percentage of pleasantly acidic sour aroma was observed in T_3 (90%) followed by T_1 (85%) and T_2 (75%) treatments (Table 3). Pleasantly acidic sour smell gives in quality grass silage (Kaiser *et al.*, 2003). Treatment four indicated that 75% of mouldy aroma and 25% of rancid butter, putrid aroma (Table 4). Kaiser *et al.*, (2003) reported that poor compaction and sealing results aerobic spoil on silage. This is the cause of mouldy and putrid odor.

Quality parameters

pH Level

High pH indicates poor fermentation due to dry condition of silage while low pH indicates high amount of acid production that can be detrimental to ruminants (Keady, 2011). pH is generally around 3.8-4.4 in quality silage (Food and Agriculture Organization, 2008). Treatment one (4.06), T_2 (4.233) and T_3 (4.483) pH values ranges between correct pH range. Treatment four gave significantly ($p<0.05$) highest (8.223) pH value (Table 5).

Proximate Parameters

Moisture Content (MC%) and Dry Matter (DM%)

Reduction of moisture and increment of dry matter gives more energy and protein to silage due to moisture has no energy or protein values (Keady, 2011). Significantly low dry matter limits the intakes of animals (Keady, 2011). In this study, results are in agreements with Food and Agriculture Organization, (2008). MC% was significantly ($p<0.05$) higher (77.290) while DM% was significantly ($p<0.05$) lower (22.71) in T_4 (Table 5). High moisture content results poor fermentation and low quality silage (Food and Agriculture Organization, 2008). Moisture increment occurs due to poor sealing and damages on silos (National Diary Development Board, 2012.

Crude Protein (CP%)

Crude protein percentage represents total nitrogen in silage which enhances nutrition level of ruminants to their activities of maintenance, lactation, growth and reproduction Keady, 2011). Significantly ($p<0.05$) higher (20.123) CP% was observed in T_4. Treatment one also recorded significantly higher (13.883) CP% level.

Crude Fiber (CF%)

Crude fiber percentage is one of crucial parameter of silage due to high CF% enhance the ability of palatability and amount of metabolic energy intake by animal while low CF% indicate deterioration of silage (Keady, 2011). Treatment three and T_4 was significantly ($p<0.05$) different from T_1 and T_2 (Table 5).

Table 3. Sensory evaluation of color in CO-3 grass silage tested after four week

Treatments	Color%					
	1	2	3	4	5	6
T_1	0	10	75	15	0	0
T_2	0	20	50	30	0	0
T_3	0	10	70	20	0	0
T_4	0	0	0	0	15	85

T_1- 1kg of silage + High Density Polythene (HDP), T_2- 1kg of silage + Poly Ethylene (PE), T_3- 1kg of silage + Poly Propylene (PP), T_4- 1kg of silage + Low Density Polythene (LDP). 1- Very dark olive green, 2- Dark olive green/brown, 3- Light green to green/brown, 4- Pale green/straw yellow, 5- Brown, 6- Dark brown

Table 4. Sensory evaluation of aroma in CO-3 grass silage tested after four week

Treatments	Aroma%					
	1	2	3	4	5	6
T_1	85	10	5	0	0	0
T_2	75	5	5	15	0	0
T_3	90	0	10	0	0	0
T_4	0	0	0	25	0	75

T_1- 1kg of silage + High Density Polythene (HDP), T_2- 1kg of silage + Poly Ethylene(PE), T_3- 1kg of silage + Poly Propylene (PP), T_4- 1kg of silage + Low Density Polythene (LDP). 1- Pleasantly acidic sour, 2- Milk or natural yoghurt smell, 3- Sweet fruity alcoholic aroma, 4- Rancid butter, putrid aroma, 5- Flavor of burnt, 6- Mouldy aroma

Table 5. pH and Proximate parameters of CO-3 grass silage tested after four week

Treatment	Parameters					
	pH	MC %	DM %	CP %	CF %	Ash %
T_1	4.060 ± 0.05^c	73.910 ± 0.33^b	26.090 ± 0.33^a	13.883 ± 0.20^b	29.666 ± 0.77^b	12.076 ± 0.11^b
T_2	4.233 ± 0.02^c	73.363 ± 1.58^b	26.636 ± 1.58^a	12.540 ± 0.44^c	30.666 ± 1.52^b	12.026 ± 0.43^b
T_3	4.483 ± 0.21^b	73.050 ± 0.75^b	26.950 ± 0.75^a	12.366 ± 0.40^c	32.666 ± 0.57^a	12.573 ± 0.09^b
T_4	8.223 ± 0.05^a	77.290 ± 1.85^a	22.710 ± 1.85^b	20.123 ± 0.46^a	23.666 ± 1.15^c	20.640 ± 0.78^a

Mean with standard deviation in a column with the same latter are not significantly different at the 0.05. level. T_1- 1kg of silage + High Density Polythene (HDP), T_2- 1kg of silage + Poly Ethylene (PE), T_3- 1kg of silage + Poly propylene (PP), T_4- 1kg of silage + Low Density polythene (LDP)

The highest crude fiber percentage was observed in T_3 (32.666) while T_4 was crude fiber level (Table 5).

Ash (%)

Ash is the parameter that indicates mineral content in silage. High ash% is observed due to poor fermentation of silage (Keady, 2011). The results of tested parameters of ash indicated that T_4 was significantly ($p<0.05$) higher (20.640).

According to the Table 6 proximate parameters of T_1, T_2 and T_3 compatible with standard ranges that is in agreements with Premarathna *et al.* (2014). Treatment four proximate parameters were significantly ($p<0.05$) different from Table 6 values. Among T_1, T_2 and T_3, best results were shown in T_1.

Table 6. Standard ranges of proximate parameters

MC%	DM%	CP%	CF%	Ash%
65-75	25-35	12-15	34-37	9-12

MC-moisture content, DM- dry matter, CP- crude protein, CF- crude fiber

CONCLUSIONS

The results of this study revealed that HDP, PP and PE polythene films had a positive effect on preserving silage. Also pale green color and acidic sour aroma have given ensurance that HDP, PP and PE polythene films were suitable for silage packing. Among them, HDP polythene film had optimum level moisture content, pH, dry matter, crude fiber and ash content. Overall results indicated that significant higher pH, moisture and low dry matter indicated deterioration of packed silage. Meantime, spoilage of packed silage was mainly due to facilitation of aerobic fermentation in LDP films. Accordingly, it can be concluded that PP, PE and HDP materials can be used for silage packaging with best quality. Moreover, LDP polythene film cannot be used for silage preservation by ensiling due to spoilage and low quality.

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