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EFFECTS OF PARTICLE LENGTH ON ALFALFA BALED SILAGE QUALITY AND COLOR UNDER DIFFERENT STORAGE CONDITIONS

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Abstract

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The aim of the research was to determine effects of particle length on bale silage quality under different storage conditions. Field trial was done with two particle length (4-cm and 8-cm). Bales were formed using an Orkel GP model 1260 silage baler after the alfalfa dried to the approximate desired moisture content. Bales were kept under open air; semi closed and closed storage condition. Silage quality of all samples was determined after storage period. Dry matter (DM), pH, crude cellulose, (CC), ash, crude protein (CP), acetic acid (AA) and lactic acid contents (LA) were evaluated as silage quality parameters. Results of the chemical analysis of silages were found significant influence of storage conditions and particle length on bale silage quality. Silage color values were also measured in this research. According to results, silage quality was changed to be strongly dependent on particle length (*P<0.05). The best silage quality and desired silage color were obtained from the bales in particle length of 8 cm stored under closed storage.

Key words: Storage conditions, Alfalfa silage, particle length, silage quality, silage color
Abbreviations: OA: Open air storage condition, SC: Semi closed storage condition, CS: Closed storage condition, DM: Dry matter, CC: Crude cellulose, CP: Crude protein, AA: Acetic acid, LA: Lactic acid

Introduction

Baled silage is one of the most popular silage making and storing systems. Big bale silage, compared with other harvesting systems, has a greater flexibility with regard to the harvesting date, is less weather dependent. The technique of big-bale silage is, however, prone to spoilage, because of the high surface area ratio of the bale (Borreani and Tabacco, 2006; Forristal and O'Kiely, 2005).

Particle size influence lactic acid production in silage (Muck and Shinners, 2001). Different composition of baled silage can be explained dry matter content of material, chop length, compaction and air infiltration during ensilage (O'Kiely and Muck, 1998). The herbage in most baled silage is generally unchopped with a particle length of 5 cm, or longer, that is common with many conventional types of silage. This can result in a delayed onset of fermentation and lead to a more lactic-acid dominant fermentation (Seale et al., 1982).

One of the main parameter to determine silage

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quality is the color. The color is changing from light green to light brown according to source of feed materials. Black and dark colors are not desired. It means protein and cellulose are lower digestibility. Air inside silage is also resulting with dark color (Uygur, 2009). Toruk et al. (2009) reported that the color of the silage surface is affected by number of film layer, film color, and storage condition and particle length.

The aim of the research was to determine effects of particle length on bale silage quality under different storage conditions.

Material and Methods

Alfalfa was harvested at approximately 10% bloom with mower-conditioner. The silages were made from first-cut alfalfa *(Medicago sativa* L.*)*. Swaths were wilted and windrowed, then baled and stretch-wrapped for silage at the same date. Alfalfa was chopped to a length of the cut of 4 cm and 8 cm with a GP Orkel bale wrapper. Bales were wrapped with up to four layers white-polythene stretch film. The properties of bales film is shown in Table 1. Nutrient composition of the alfalfa before ensiling was given in Table 2.

Balers have been kept under three storage conditions; open air (OA), semi closed (SC) and closed storage condition (CS). Bales were opened on 95 day of ensiling for chemical analysis.

The silage surface color was examined by a

Table 1

The properties of film types

Color	150 µm
	White
Thickness, µm *	150
Extensibility, %**	488
O_2 permeability***	248

* DIN 53370 (1976)

**EN ISO 527 (1995/1996)

***DIN 5338 (1969)

Table 2

Nutrient composition of alfalfa (Medicago sativa) before ensiling

DM (db), %	CP	CC	Ash	pH
36.13	18.97	18.56	9.81	5.67

Hunter Lab D25LT device. The system used in the device was created by the International Commissions on Illumination (CIE) in 1976. L* represents brightness (0, black; 100, white), a* represents hues from red to green (+a*, red; -a*, green), b* represents hues from blue to yellow (-b*, blue;+b*, yellow). Yellowness (ýy*) indicates were also measured in the study. Yellowness is the main color that shows the effect of fermentation process on the silage color properties (Snell et al., 2003).

Pioneer® 1174 (*Lactobacillus plantarum* and *Enterococcus faecium*) was used as silage additive to enhance the lactic acid fermentation.

Alfalfa dry matter (DM) was determined by according to ASAE Standards 2002. The pH values of both fresh material and silage materials were obtained using the methods reported by Chen et al. (1994). Standard methods were used for determin-

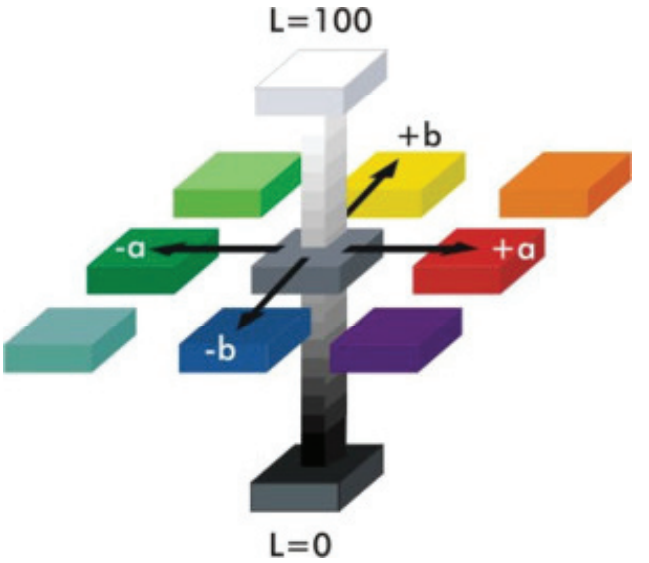

Fig. 1. Chromaticity diagram of the CIE system

ing ash and crude cellulose (CC) (AOAC, 1990). Total nitrogen (T) concentration was measured by a Kjeldahl procedure and Crude protein (CP) concentration was calculated as Nx6.25 (AOAC, 1990). Acetic acid (AA) and lactic acid (LA) were evaluated according to spectrophotometric method (Koc and Coskuntuna, 2003).

The experiment was organized in a 2 particle lengths (4 cm-8 cm) x 3 storage conditions (open air, OA; semi closed, SC; closed, CS). Three replications of each treatment combination with total of 18 big cylindrical (round) bales (1.5 m x 1.2 m) were done. The results were analyzed by using MSTAT computer program

Results and Discussion

The effects of particle length and storage condition on silage characteristics were significant (*P<0.05). The results are presented in Table 3.

The pH contents of silage made from the 8 cm particle length were 4.53, 4.36 and 4.30 at the three storage conditions of OA, SC and CS respectively, which is considered acceptable for alfalfa silages.

DM content of silage with 8 cm particle length was higher than the 4 cm particle length. DM contents were increased with increasing particle length. Similar results were reported by Jalæ et al. (2009) and McEniry et al. (2007). Seale et al. (1982) were also stated that particle length in the bale silage must be 5 cm and longer.

The ash contents of silage made from 4 cm were higher than made from 8 cm.

According to NRC (1989), the best favorable value of CC was 27. Values of CC which were obtained from 8 cm were found closer of 27 than from 4 cm. Silage which kept under CS with 8 cm was 27.19.

LA content of silage made from 4 cm particle length was lower than the 8 cm particle length. A similar trend for LA was shown by McEniry et al. (2007). Muck and Shinners (2001) also reported that particle size influence LA production in silage. Kung and Stokes (2009) were stated that the value of LA in alfalfa silage should be 3-8%. Concerning them LA values of this experiment were not sufficient. LA was higher in the CS compared with the SC and OA.

Values of AA in all silages were found below 1%. Kung and Stokes (2009) mentioned that the value of AA in alfalfa silage should be between 1

Table 3

The effects of particle length and storage condition on silage characteristics

Particle length, cm	Storage conditions						CV, %	LSD	SEM
	OA*		SC		CS				
	4	8	4	8	4	8			
pH, %	4.74 a	4.53 b	4.44 c	4.36 d	4.34 d	4.30 b	0.2	5.753	0.05
DM, %	30.79 e	32.87 b	30.32 e	31.84 c	31.32 d	38.28a	0.75	0.449	25.79
Ash, %	9.66 a	8.79 f	9.37 c	9.19 e	9.60 b	9.35 d	0.11	1819	0.21
CC, %	29.60d	28.82 e	31.03 a	29.96 c	30.14 b	27.19 f	0.03	3151	1.34
LA, %	0.82 e	0.87 d	0.99 c	1.09 b	1.11 b	1.17 a	1.9	2572	0.01
AA, %	0.59 d	0.89 b	0.45 e	0.71 cd	0.63 c	0.95 a	1.2	3151	0.16
CP, %	16.63 f	17.64 d	16.87 e	17.91 b	17.67 c	18.87a	0.05	1819	1.16

OA, Open-air storage condition; SC, semi-closed storage condition; CS, Closed storage condition,
CV, coefficient of variation; LSD, least significant difference; SEM, standard error of means
Values followed by the same letter in a given row indicate no statistical difference (p<0.05).

Table 4
Color of alfalfa (*Medicago sativa*) before ensiling

Brightness (L*)	Red-green (a*)	Yellow-blue (b*)	Yellowness (iy*)
27.88	-8.16	10.47	38.16

and the highest in CS storage condition with 8 cm particle length (52.83).

Silage in OA condition and with 4 cm length has the worst color results. Contrary, silage in CS condition and with 8 cm particle length has the best color results. This is also shown that fermentation of the silage was well done. Silage color was positively affected with increasing particle length.

Table 5
Effect of storage conditions and particle lengths on the color of silage surface

		Brightness (L*)	Red- green (a*)	Yellow-blue (b*)	Yellowness (iy*)
OA	4	23.90 c	0.90 c	10.25 f	45.72 f
	8	25.54 bc	1.38 a	11.59 e	46.77 d
SC	4	27.48 b	1.37 e	11.95 d	46.38 e
	8	30.58 a	0.92 c	13.70 c	51.34 b
CS	4	30.77 a	1.17 b	14.22 b	51.05 c
	8	31.16 a	0.84 d	14.41 a	52.83 a
	SEM	2.78	0.35	3.39	6.42
	CV (%)	1.83	2.52	0.23	0.06
	LSD	2.102	5.753	5.753	5.753

*OA, Open-air storage condition; SC, semi-closed storage condition; CS, Closed storage condition, CV, coefficient of variation; LSD, least significant difference;SEM, standard error of means
Values followed by the same letter in a given column indicate no statistical difference ($p<0.05$).

and 3%.

CP contents in silage with 8 cm were higher than in silage with 4 cm. The lowest CP content was found in OA condition with 17.13 and the highest in CS condition with 17.87. Similar values were found by Nasser et al. (2006).

The color values of alfalfa before ensiling are shown in Table 4. Effect of storage conditions and particle lengths on the color of silage surface was given in Table 5.

Effect of storage conditions and particle length was found to be significant on the color of silage surface (*$P<0.05$).

Brightness values (L*) were found below of the value (37.9) that mentioned by Snell et al. (2003). Red-green (a*) values varied from -8.16 to 1.38. The lowest yellowness (ýy*) was found in OA storage condition with 4 cm particle length (45.72)

Conclusion

All the measured silage quality values were affected by storage condition and particle length. The best silage quality and desired silage color were obtained from the bales in particle length of 8 cm and closed storage condition. Therefore, particle length with 8 cm and closed storage condition is recommended.

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