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An approach for determination of quality in hay bale and haylage

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Abstract. In this study, a new approach for faster determination of quality in hay bale and haylage was aimed. To this end, the relationships between bale densities, dry matter (DM), pH content and penetrometer values in hay bale and haylage were investigated. The mixture of caramba (*Lolium multiform cv* Caramba) and berseem clover (*Trifolium alexandrinum* L) was used as forage material. It was harvested by using two different harvesting methods and stored as dry hay and haylage. The penetrometer values were measured at four different points on bales. It was obtained that the pH content decreased with increase in bale density ($R^2 = 0.86$) and with decrease in DM content ($R^2 = 0.86$). The values measured at vertical-middle point gave higher correlation with density and pH contents.

Key words: Forage quality, bale density, pH, dry matter content.

INTRODUCTION

Forage crops play an important role for on farm ruminant production. 40–90% of forage requirements are supplies as roughage. It is important to add roughage to the feeding ration at winter time for meat/milk yield and quality (Charmley, 2001). However, the storage of the roughage is one of the important problems. Whether haylage or hay bale, they must be harvested and stored with protection of nutrient elements. Since, the losses are quite high in hay bale, haylage recently comes to the fore for ruminant feeding (Wilkonson et al., 1996; Yıldız et al., 2008; Yaman, 2011).

The quality of roughage is foremost parameter for purchasing and adding to the feeding ration. Dry matter content, pH content, crude protein and relative feed value can be listed as most important quality parameters. Although there are a lot of methods for determination of quality, it is another necessity for farmers to use fastest methods. Because, chemical analysis are costly and take times. There are methods without chemical analysis but, the results of these methods can change relatively depends on the person who makes decision.

From this point of view, in this study, the relationships between bale densities, dry matter (DM), pH content and penetrometer values in hay bale and haylage were investigated. Thus, a new approach for faster determination of quality in hay bale and haylage was aimed.

MATERIALS AND METHODS

In the research, the mixture of caramba (*Lolium multiform cv* Caramba) and berseem clover (*Trifolium alexandrinum* L) was used as forage material. Forage were harvested at the end of flowering stage of berseem clover. The harvesting and storage systems investigated in the research were given in Table 1. For haylage bales were wrapped by using PE material with 25 µ thickness in white color as four layers. The bales weight varied in between 18–20 kg for hay and 40–50 kg for haylage. Applications were left fermentation for 60 days for haylage.

Table 1. Harvesting and storage systems

System code	Machines used in harvesting	Storage technique
S1	Mower+round baler	Dry hay
S2	Disc mower with conditioner+round baler	Dry hay
S3	Mower+round baler+wrapping machine	Haylage
S4	Disc mower with condationer+round baler+wrapping machine	Haylage

The randomized block design was used for analysis the effect of systems and penetrometer values on bale densities, DM and pH content. Duncan's multiple range test was used to compare the means. Each experiment was replicated 3 times. The pH values of plants were obtained as reported by Chen et al. (1997). The dry matter (DM) content of plants was determined by drying to constant weight at 105 °C according to the ASAE standards (AOAC, 1990). The bale density was calculated as the ratio of bale mass to volume.

The penetrometers values were measured by using Shimpo mark (FGC-50B) hand penetrometer at 25 cm depth from two point of bale as shown Fig. 1.

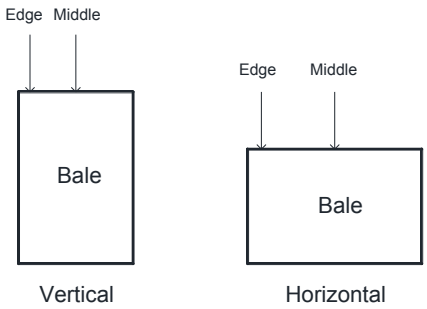

Figure 1. Measurements points of penetrometer values.

RESULTS AND DISCUSSION

According to the variance analysis, it was found that storage technique (hay bale and haylage) has significant effect on bale density and pH content at 1% probability level, while the harvesting methods (mover and disc mover) have no effect statistically. Haylage has lower pH content and approximately 3 times higher bale densities comparing hay bale. DM contents ranged from 88.76% to 89.61% and from 51.38% to 48.49% for hay bale and haylage, respectively. The penetrometer values taken at vertical-middle point showed differences among the storage methods at 5% probability level according to the Duncan's Multiple Range Tests results (Table 2).

Table 2. Variance analysis results of Penetrometer values, bale densities, DM and pH contents

Parameters		Penetrometer Values (N)				pH	Bale Density (kg m^{-3})	DM (%)
		Horizontal		Vertical				
		Middle	Edge	Middle	Edge			
P values		ns	ns	*	ns	**	**	**
Harvesting and Storage systems	S1	261.08	317.21	54.33 b	80.88	5.7 a	134.37b	88.76a
	S2	368.06	350.43	93.15 b	94.67	5.7 a	143.16b	89.61a
	S3	205.95	205.94	138.93 a	91.77	4.9 b	305.66a	48.49b
	S4	306.83	231.64	204.98 a	124.67	5.0 b	336.37a	51.38b
P(%)		0.2	0.09	0.03	0.5	0.006	0.0001	0.0001
$LSD_{(0.05)}$		-	-	92.98	-	0.46	42.19	6.16
CV (%)		30.0	23.3	37.99	37.50	3.58	7.3	3.75

In each column, means with the same letters are not significantly different at 0.01 level of significance using Duncan's Multiple RangeTest

There is no doubt that foremost parameter for quality is pH under any harvest and storage conditions. Kilic (2010) and Huhnke et al. (1997) reported that higher pH contents are expected in haylage (around 6.5) than conventional silage (around 3.9 and below). From this point of view, while evaluating quality in haylage, another parameters must be considered. So, the penetrometer values can be one of these parameter. According to the results, it was obtained that the pH content decreased with increase in bale density ($R^2 = 0.86$) and with decrease in DM content ($R^2 = 0.86$). The penetrometers values measured at vertical-middle point changed linearly with bale density ($R^2 = 0.59$). Moreover, it was found that it decreased with increase in DM contents ($R^2 = 0.47$) (Table 3).

Table 3. Correlation equations

	x values	y values	R^2	Equation
Horizontal-edge*density	Horizontal-Edge	Density	0.41	y = -0.6899x+420.63
Vertical-middle*pH	Vertical-Middle	pH	0.44	y = -0.004x+5.8305
Horizontal-edge*DM	Horizontal-Edge	DM	0.45	y = 0.157x+26.446
Vertical-middle*DM	Horizontal-Edge	DM	0.47	y = -0.2061x+95.138
Vertical-middle*density	Horizontal-Edge	Density	0.59	y = 1.0603x+99.808
DM*pH	DM	pH	0.86	y = 0.0189x+4.0132
pH*density	pH	Density	0.86	y = -208.83x+1343.8
Density*DM	Density	DM	0.95	y = -0.212x+118.6

CONCLUSION

Consequently, bale density in other words penetrometer values can be another parameter for determining quality. However, in this study, the values measured at vertical-middle point gave higher correlation with density and pH contents. It can be highlighted that higher penetrometer values refer to higher bale density and lower pH contents. So that, the penetrometer values measured at this point can be considered as quality indicator.

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