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The effects on nutrient digestibility of hay and silages made in different conditions in lambs

Pınar Tatlı Seven*, and İbrahim Halil Çerçi

The University of Firat, Faculty of Veterinary Medicine, Department of Animal Nutrition and Nutritional Diseases, Elazig, Turkey

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ABSTRACT

This study was conducted to determine the effects of silages and hay on feedlot performance and nutrient digestibility in lambs, and chemical differences in silages made in different media and forms. Twenty-four Akkaraman male lambs with an average mass of 27.93 kg and 8 months of age were used in the study. Lambs were assigned randomly to three groups. Barley-vetch (50/50%) was used as silo and for hay material two silos were installed. The control group was fed barley-vetch hay. Silo I was exposed to sunshine (group 1). Silo II was established in a long, closed hole which was open to air circulation and half underground (group II). Group III (control) consisted of barley-vetch hay. Dry matter levels were determined to be 33.20, 31.50 and 89.52% in group I-III, respectively. The pH, NH_3-N and lactic acid levels of silages were observed to be 4.62 and 4.55; 0.54 and 0.50%; 2.35 and 2.50%, respectively. Dry matter intakes (DMI) of lambs were 941.44, 894.60 and 1119.00 g in groups I-III, respectively ($P<0.05$). Live mass gains (LWG) were 141.67, 145.83 and 122.92 g/day in group I-III, respectively. Feed conversion ratios were 6.67, 6.14 and 9.20 g DMI/g LWG in groups I-III, respectively. Dry matter, crude protein and crude fibre digestibility were determined to be 65.67, 67.99 and 59.78%; 61.40, 65.81 and 58.40%; 64.27, 66.06 and 59.67% in groups I-III, respectively ($P<0.01$).

Key words: digestibility, environment, feedlot, hay, ensile

Introduction

Hay and silage are valuable as conserved forage for ruminants. Feed losses differ according to conservation techniques. Many studies have been carried out to obtain the most suitable conservation techniques (CHARMLEY and VEIRA, 1990; MESSMAN et al., 1994; COOPER and McGECHAN, 1996). Ensiling was found to be better than drying (JACHMOLA, 1983). Silage quality is affected by feed-type, vegetation, dry matter (DM)

* Contact address:
Doc. Dr. Pınar Tatlı Seven, Department of Animal Nutrition and Nutritional Disease, University of Firat, Faculty of Veterinary Medicine, 23119, Elazig, Turkey, E-mail: pintatli@hotmail.com

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level, water-soluble carbohydrate and protein, silo type, filling, toasting, sealing of silo and environment of silo (SIEFERS and BOLSEN, 1997; WEINBERG, 1997). In silage, preservation is accomplished by both the anaerobic environment and bacterial fermentation of sugars, which lowers pH primarily through the production of lactic and acetic acid (McDONALD, 1981; MUCK, 1988). If a silo is filled slowly or sealed imperfectly excessive respiration may occur, resulting in potential problems. Respiration causes loss of DM. The DM lost is rapidly fermentable carbohydrate (MUCK, 1988). Prolonged respiration delays the onset of pH decline and allows detrimental microbial activity to continue and increase silage temperature (MUCK, 1988). Ensiling with high environmental temperature accelerates involuntary fermentation (KILIÇ, 1997).

This study was planned to determine the changes in quality of silage prepared directly under sun, and without the direct effect of sun in regions with hot summers. For this purpose the effect of silages prepared in different heating media on food intake, feedlot performance and digestibility in lambs was investigated. Hay and silage made were also compared according to these parameters.

Materials and methods

Whole crop barley (50%, *Hordeum vulgare* L.) - vetch (50%, *Vicia sativa* L.) were harvested and used for ensiling and haymaking. The whole-crop barley-vetch at the milk-dough stage of maturity in March was ensiled in two heap silos. Silo I was exposed directly to environmental conditions (in the open air and not covered with a roof). Silo II was established in a long, closed hole which was open to air circulation where the silo covered with a roof. Silages were made under anaerobic conditions. Barley-vetch at the same maturity stage was dried. Fresh samples of whole crop barley-vetch were taken for chemical analysis. DM levels of fresh materials were determined immediately. Whole crop barley-vetch was ensiled with a preservative (1% NaCl) and 0.5% sugar). Silos were opened after 45 days. The samples of silage and hay (5 kg) were collected for laboratory analysis. Average air heating values were measured in the months of March, June, July and August during this study. Environmental heating of silage made under a roof, and silage made in the open air for the months of March, June, July and August were measured 17.9, 21.9; 22.7, 27.2; 27.6, 32.3; 34.4, 37.5 ^{o}C, respectively. Twenty-four male lambs with an average mass of 27.9 kg and 8 months of age were used in the study. The animals were divided into 3 groups of 8 lambs each and groups I, II and III were fed silage obtained from silo I, silage obtained from silo II and barley-vetch hay, respectively. Dry matter intake was recorded daily. Individual cages were used in the study. The lambs were weighed at two-week intervals. The faeces were collected from the lambs for a total of seven days during the present study, weighed, and sampled for determination of DM. Faeces was dried at 55 ^{0}C, pooled and stored for analysis. The experiment lasted for 60 days.

Chemical analysis. For chemical analysis, feed and faeces samples were oven-dried at 55 ^{0}C. The forages and faeces samples were used for analysis of DM, ash, organic matter (OM), crude protein (CP), ether extract analyses, which were determined according to AOAC (1990). Crude fibre (CF) was determined by CRAMPTON and MAYNARD (1970). Silage NH_3-N was determined according to ANNINO (1964). Silage lactic acid (PETIT and FLIPOT, 1992) and VFA (LEVENTINI et al., 1990) were determined by gas chromatography.

Statistical analysis. All data were subjected to analysis of variance on SPSS (1993). Treatment means were compared using Duncan's multiple range tests.

Results and discussion

The fresh material of whole crop barley-vetch contained lower DM, CP and CF than its silages, which agree with the results of CHARMLEY and VERIA (1990). The contents of CP, ash and ether extract of the silages were higher than that of hay, which agrees with the results of PETIT and FLIPOT (1992).

Table 1. Chemical composition of fresh silages and hay

	Fresh	In the open air	Under roof	Hay
DM	30.28	33.20	31.50	89.52
Ash*	9.87	15.20	14.52	9.08
OM *	90.13	84.80	85.48	90.92
CP *	7.43	8.17	8.95	7.87
CF *	26.00	26.50	26.60	30.12
Ether- Extract*	2.11	2.34	2.22	1.89
N-Free Extract *	54.59	47.79	47.71	51.04

* (DM basis). In the open air: Silage made in the open air directly in heap silo; Under a roof: Silage made not directly under sun in heap silo

Group II silage contained higher CP, OM, lower DM, ash and ether extract than group I silage, which may depend on bad fermentation that occurred due to increase of temperature in silage due to exposure to direct sun established for silo II (Table 2). ZAHAR et al. (2002) reported that fermentation was affected by environmental factors. The pH, NH_3-N and acetic acid of group II silage were lower. Lactic acid level was greater than that of group I (table 2) which might be due to better fermentation medium of group II silage. In fact, the different levels of these acids could probably be due to difference in temperatures in the silo which resulted in growth of bacteria that produced lactic, acetic and butyric acid (PITT and MUCK, 1993; COOPER and McGECHAN, 1996; HILL and LEAVER, 2002).

Table 2. Silage fermentation

	In the open air	Under roof
pH	4.62	4.55
NH_3-N (% DM)	0.54	0.50
Lactic acid (% DM)	2.35	2.50
Acetic acid (% DM)	1.34	1.25
Butyric acid	Not detectable	Not detectable

Dry matter intake (DMI) of hay was statistically higher than those in groups I and II ($P<0.05$) (Table 3). This could result from the higher level of DM of hay than of silage (PETIT and FLIPOT, 1992). Therefore, DMI may decline because water is a function of ballast matter (SARI and ÇERÇI, 1993). BOLSEN and BERGER (1976) reported that DMI of oat silage was lower than barley silage in lambs. They reported that this result might be due to DM level of oat silage being lower than that of barley silage. DMI were similar between silages, which may depend on similar DM contents of silages (OKINE et al., 1994). Live mass gain was similar between silage and hay groups, which agrees with the results of PETIT and FLIPOT, 1992. But the feed:gain ratio of the hay group was different from that of silage groups ($P<0.01$) due to higher leaf ratios and higher digestibility of silages than hays (NELSON and SATTER, 1990; PETIT and FLIPOT, 1992).

Table 3. Dry matter intake, live mass gain, feed: gain ratio of lambs

	In the open air (Group I)	Under roof (Group II)	Hay (Group III)	SEM
Silage Intake, g/d (DMI)	941.44^b	894.60^b	1119.00^a	27.76*
Initial live mass (kg)	28.12	28.25	28.00	0.27
Final live mass (kg)	36.63	37.00	35.37	0.37
Live mass gain (LWG)(g/d)	141.67	145.83	122.92	3.84
Feed: gain (g DMI/ g LWG)	6.67^b	6.14^b	9.20^a	0.37*

In the open air: Silage made directly in the open air in heap silo. Under a roof: Silage made not directly under sun in heap silo. Means: same line with different letter differ significantly. *$P<0.05$

Results were that fermentation of silage group made under a roof was better than the silage group made in the open air, as a numeral (Table 2). Ensiling under a roof was closely reflected in enhanced live weigh gain as numeral (Table 3). The results agree with the conclusion of MAYNE and STEEN (1993) that a poor correlation exists between conventional parameters of silage fermentation and animal performance with grass-silage based diets.

Table 4. Whole tract digestibility,% (DM)

	In the open air (Group I)	Under roof (Group II)	Hay (Group III)	SEM
DM	65.67[b]	67.99[a]	59.78[c]	0.80*
Ash	54.99[a]	56.00[a]	51.85[b]	0.47*
OM	67.58[b]	70.03[a]	60.56[c]	0.93*
CP	61.40[b]	65.81[a]	58.40[c]	1.40*
CF	64.27[b]	66.06[a]	59.67[c]	1.92*
Ether- Extract	79.30[a]	80.41[a]	76.16[b]	0.46*
N-Free Extract	70.27[b]	72.25[a]	60.85[c]	3.09*

Means: same line with different letter differ significantly. * P<0.01

The ash, CP and CF digestibility of group I were lower than that of other silage groups (P<0.01) (Table 4) which might have resulted from changes in fermentation density because of exposure to direct sun of this group. ÇERÇI and ŞAHIN (1995) reported a decline in ratio of total acid of silages made in cold-air conditions. OKUYAN et al. (1986) reported increased digestibility when lactic acid was high in silage content. The digestibility of hay was lower than silage groups, which agrees with the results of JACHMOLA (1983).

These results indicated that it was no determinable difference between silage groups for contents of nutrient, DMI and feedlot performance. The fermentation of silage group made under a roof was found to be better than other silage groups. Live mass gain did not increase statistically between groups. Feed conversion was found to be similar between silage groups. However, group I was found to be significantly different from the other silage group for nutrient digestibility. It was also found that results of silage groups were better than hay group. According to digestibility results we therefore suggest ensiling under a roof.

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SAŽETAK

Istraživanje je provedeno radi određivanja utjecaja silaže i sijena na tovnu sposobnost odnosno hranidbenu probavljivost u janjadi te utvrđivanja razlike u kemijskom sastavu silaže pripremljene na različite načine. U istraživanje su bila uključena 24 muška janjeta pasmine akkaraman s prosječnom tjelesnom masom od 27,93 kg i prosječnom dobi od 8 mjeseci. Janjad je metodom slučajnog odabira bila raspoređena u 3 skupine. Za pripremu silaže i sijena rabljeni su ječam i grahorica (50/50%). Kontrolnu skupinu činila je janjad hranjena sijenom ječma i grahorice. Silaža I bila je izložena suncu na otvorenom prostoru (skupina I). Silaža II bila je pripremljena u silo-jami tj. u zatvorenom prostoru s otvorima za strujanje zraka, čiju polovicu je činila jama iskopana u zemlji (skupina II). Skupina III (kontrola) bila je hranjena sijenom ječma i grahorice. Sadržaj suhe tvari u silaži I iznosio je 33,20%, u silaži II 31,50% te u sijenu 89,52%. Vrijednost pH u silaži I iznosila je 4,62, a u silaži II 4,55. Razina NH_3-N bila je u silaži I 0,54%, a silaži II 0,50%, dok je mliječna kiselina u silaži I iznosila 2,35%, a u silaži II 2,50%. Unosi suhe tvari u janjadi u skupinama I do III iznosili su 941,44, 894,60 i 1119,00 g ($P<0,05$). U istim skupinama (I do III) prirasti su iznosili 141,67, 145,83 i 122,92 g/dan, a utrošak hrane 6,67, 6,14 te 9,20 g suhe tvari/g prirasta. Probavljivost suhe tvari u skupini I iznosila je 65,67%, u skupini II 67,99%, a u skupini III 59,78%. Probavljivost sirovih proteina u skupini I iznosila je 61,40%, u skupini II 65,81% te u skupini III 58,40%, dok je probavljivost sirove vlaknine u skupini I bila 64,27, u skupini II 66,06 i skupini III 59,67 % ($P<0,01$).

Ključne riječi: probavljivost, okoliš, tov, sijeno, silaža