Effect of Maceration on *in Sacco* Degradability and Energy Content of Low-Moisture Round Bale Alfalfa Silage

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Abstract

The aim of this study was to determine the effect of maceration on *in sacco* degradability and energy content of low-moisture alfalfa (*Medicago sativa* L.) silage. The results of two treatments were compared: 1) maceration, in which the alfalfa was processed through a large- scale forage mat maker prior to wilting to approximately 50% DM content (FM treatment), and 2) conventional conditioning, in which the alfalfa was tedded and wilted to the same DM content as that in the FM treatment (CC treatment). Silage bales were chopped in 20-mm pieces for each experiment. *In sacco* degradabilities of DM, CP and NDF of silage stems were estimated with two fistulated cows incubated for 3, 6, 12, 24, 48 and 72 h. DE and ME contents of FM- and CC-treated silage were measured using a respiration chamber with two dry cows. *In sacco* DM degradability was similar for both FM- and CC-treated silage, but CP degradability of FM-treated silage was higher than that of CC-treated silage. There were no differences between FM- and CC-treated silage in DE, ME and TDN contents. These results suggested that maceration increased the degradable fraction of CP in the alfalfa stem. However, in chopped silage, maceration has no effects on digestibility and metabolizability of energy.

Keywords: Alfalfa, maceration, *in sacco* degradability, digestible energy, metabolizable energy

Introduction

Harvesting of high-quality alfalfa is dependent on weather conditions. Under typical harvesting conditions, total mechanical losses amount to a dry matter loss of 6 to 27% during field curing of alfalfa (Koegel et al., 1985). To reduce dry matter loss and improve forage quality, several forage mat makers have been developed (Koegel et al., 1986; Savoie et al., 1993; Nishizaki et al., 1997). Nishizaki et al. (1997) reported that maceration with a prototype mat maker increased the field-drying rate of alfalfa in Japan. Furthermore, mechanical deciduous losses after harvesting were significantly lower for the macerated alfalfa (15.2%) than for alfalfa conventionally conditioned by a rotary tedder (60.0%). Charmley et al. (1997) suggested that maceration might improve apparent digestibility of forage. This has been shown in studies using hay (Petit et al., 1994), in studies using precision-chopped silage no such increase in digestibility has been observed (Mertens and Koegel, 1992; Frost et al., 1995).

The objective of this study was to determine the effect of maceration on *in sacco* degradability of the stem of low-moisture alfalfa silage. The effects of maceration on digestibility and energy value of low-moisture alfalfa silage for cows were also examined.

Material and Methods

First cut alfalfa was harvested at the 10% bloom stage (average plant length of 71 cm and average cutting height of 14 cm). The harvested alfalfa was then treated by 1) maceration, which involved processing the alfalfa through a large-scale forage mat maker (Nishizaki et al., 1997) prior to wilting to approximately 50% DM content (FM treatment), or 2) conventional conditioning, which the alfalfa was tedded by a rotary tedder and wilted to same DM content as that in FM treatment (CC treatment). When the forage in the field was at the target DM content, forage was baled in large round bales, and the bales were wrapped with 6 layers of black polyethylene stretch film. After being stored for 3 months, the silage bales were

chopped into 20-mm pieces using a forage harvester and re-ensiled in 180-liter silo for each experiment. The degradation characteristics *in sacco* of silage stems DM, CP and NDF were measured with two fistulated cows. Three grams of ground (5-mm) silage stems were placed into nylon bags and incubated for 3, 6, 12, 24, 48 and 72h. The results were fitted to the exponential equation of Orskov and McDonald (1979): $p = a + b\ (1 - e^{-ct})$. The effective degradability (ED) of each constituent of the silage stems was given by the equation $ED = a + bc / (c + k)$, where k is the estimated rate of outflow from the rumen (0.05/h). Silage digestibility, total digestible nutrients (TDN), digestible energy (DE) and metabolizable energy (ME) contents of silages treated by both of the above-described methods were measured using a respiration chamber. Two dry cows, 515-643 kg in weight, were assigned to two dietary treatments for 14 days in a crossover experiment. The first 7 days were used for ration adaptation and data were collected from day 8 to day 14. The Cows were fed an all-forage diet. The amount of feed given was adjusted to 110% of the requirement for maintenance on a TDN basis.

Results and Discussion

In the climatic condition of Hokkaido, maceration did not reduce the field-drying time to reach baling DM of 50%. The FM-treated alfalfa was ready for baling after 50 h of field drying whereas the CC-treated alfalfa was ready after 49 h. Leaf contents (on a dry basis) of FM- and CC-treated silage were 57.2% and 32.9%, respectively. Weed contents (e.g., annual bluegrass) of FM- and CC-treated silage were 7.0% and 35.8%, respectively. Therefore, the CP content of FM-treated silage was higher than that of CC-treated silage, and the fiber content such as ADF or NDF, of FM-treated silage was lower than that of CC-treated silage. These results were thought to be due to deciduous loss caused by frequent tedding of CC or to the tines of the tedder plucking bottom weeds. *In sacco* degradability of stems is shown in Table 1. DM degradability was similar for silages treated by FM and CC. The ED

value of CP was significantly ($p<0.01$) higher in FM-treated silage than in CC-treated silage, whereas the ED value of NDF was 2.6 point ($p<0.05$) lower in FM-treated silage than in CC-treated silage. Hong et al. (1988) and Sirohi et al. (1988) found that shredding alfalfa stems increased *in vitro* digestibility of NDF. The reason for the opposite result in this study is that the digestible NDF fraction of macerated alfalfa stems was consumed for silage fermentation. Apparent digestibility and energy value of silage are shown in Table 2. The CP content of FM-treated silage was 5.0% higher than that of CC-treated silage, and the ADF and NDF contents of FM-treated silage were 3.5% and 8.9% lower, respectively, than those of CC-treated silage. However, apparent digestibility of DM, CP, ADF and NDF were not affected by the maceration. Furthermore, DE, ME and TDN contents of FM- and CC-treated silages were similar. Research with hay has shown that maceration can increase the digestibility of forage (Petit et al., 1994). However, research with precision-chopped silage showed that maceration had no effect (Frost et al., 1995; Charmley et al., 1997) or a negative effect (Mertens and Koegel, 1992). We found that maceration had no effect on digestibility and energy content in low-moisture silage. It was thought that 20-mm chopping negates any possible benefits of maceration.

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Table 1- Rumen degradation characteristics of alfalfa silage stems

	FM	CC	s.e.	Probability
Dry matter				
a (%)	26.88	32.09	1.08	*
b (%)	49.59	43.62	0.86	**
c (%/h)	0.077	0.058	0.005	*
ED (%)	56.89	55.29	0.49	NS
Crude protein				
a (%)	66.42	59.61	0.52	**
b (%)	23.52	28.01	0.55	**
c (%/h)	0.064	0.071	0.004	NS
ED (%)	79.64	75.98	0.23	**
Neutral detergent fiber				
a (%)	-11.60	1.52	1.14	**
b (%)	68.65	57.48	1.10	**
c (%/h)	0.062	0.046	0.003	**
ED (%)	26.40	28.96	0.59	*

NS, no significant; *$P < 0.05$; **$P < 0.01$.

FM, macerated; CC, conventionally conditioned. Degradation characteristics were expressed as constants in equation $p=a+b(1-e^{-ct})$; *a*, soluble potentially degradable fraction; *b*, insoluble potentially degradable fraction; *c*, rate of degradation. ED = $a + bc / (c + k)$, where k is the particle flow rate constant assumed to be 0.05.

Table 2 - Apparent digestibility and energy content of alfalfa silage.

	FM	CC	s.e.	Probability
Chemical composition				
Dry matter (%)	47.7	54.1	0.67	NS
Organic matter (DM%)	86.3	89.0	0.05	*
Crude protein (DM%)	21.2	16.2	0.21	*
Ether extract (DM%)	4.0	3.3	0.44	NS
Acid detergent fiber (DM%)	31.6	35.1	0.11	*
Neutral detergent fiber (DM%)	38.5	47.4	0.21	*
Daily DM intake (kg/d)	6.6	8.6	0.61	NS
Apparent digestibility				
Dry matter (%)	69.4	69.8	0.57	NS
Organic matter (%)	71.4	71.0	0.78	NS
Crude protein (%)	76.7	72.6	0.80	NS
Ether extract (%)	69.6	69.8	2.17	NS
Acid detergent fiber (%)	63.6	64.6	1.12	NS
Neutral detergent fiber (%)	64.1	66.0	1.20	NS
Energy content				
Gross energy (MJ/kg)	18.36	18.75	0.02	*
Digestible energy (MJ/kg)	13.00	13.07	0.29	NS
Metabolizable energy (MJ/kg)	9.91	10.49	0.31	NS
Total digestible nutrients (DM%)	63.9	66.1	1.04	NS
Apparent digestibility of GE (%)	70.8	69.7	1.57	NS
Metabolizability of GE (%)	54.0	56.0	1.68	NS

NS, not significant; *$P < 0.05$; **$P < 0.01$. FM, macerated; CC, conventionally conditioned.