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Chemical composition, and ruminal and post-ruminal protein disappearance of lucerne silage treated with formic acid

A Vakili, M Danesh Mesgaran, J Tavallaee, H Nassirimoghadam
Ferdowsi University, Mashhad, Iran
Email: vakili_ar@yahoo.com

Introduction Greater feeding value of lucerne silage than lucerne hay has been a common finding of ruminant feeding studies in tropical countries. However, during ensiling, a large proportion of the crude protein (CP) in lucerne is broken down to non protein nitrogen (NPN), (Broderick *et al.*, 1995). Additives such as formic acid may reduce proteolysis during lucerne ensiling. The objective of the present experiment was to compare the nutrient content, and ruminal and post-ruminal dry (DM) matter and protein disappearance of lucerne silage treated with urea and formic acid.

Materials and methods Lucerne (30% DM) was harvested, chopped and mixed with different levels of formic acid and urea, then ensiled for 40 days (four replications per each treatment). The treatments were lucerne silage (LS), LS treated with urea (4 g/kg DM) + formic acid (8 ml/kg DM), (LSu+f), and LS treated with formic acid (8 ml/kg DM), (LSf). Formic acid was carried on and used under the safety protocol of Ferdowsi University of Mashhad, using special instruments. The acid was diluted with water (acid:water 1:4, vol/vol), then mixed with the forage. Chemical composition (CP, NPN, and DM) was determined (AOAC, 1980). pH was measured directly in silage extract. Silage DM was determined using air-forced oven (60 °C, 48 h). The ruminal and post-ruminal disappearance of dry matter and protein of samples were determined using the mobile nylon bag procedure (Danesh Mesgaran, 2005). Four Holstein steers (400 kg) fitted with rumen fistula and T-shaped cannulae were used. For the ruminal disappearance studies, the experimental samples were milled (2 mm) and weighed (1.2 g DM) into bags (3 × 6 cm) made of polyester cloth with 50 µm pore size (12 bags per each sample). The bags were incubated in the rumen for 12 hours. After removal from the rumen, six bags were washed using cold water and dried in a forced-air oven (58 °C, 48 h) for determining rumen disappearance and other bags were inserted into the small intestine via the cannulae at the rate of one bag every 30 min and removed from the voided faeces, rinsed in cold running water. Finally, the bags were dried in a forced air oven (58 °C, 24 h), then weighted to determine the dry matter disappearance. The kjeldhal technique was used for nitrogen analysis. Data were analysed using the GLM procedure of SAS.

Results Chemical composition of LS and LS treated with urea and formic acid is shown in Table 1. formic acid and urea caused to reduce pH, NPN and increased CP ($P < 0.05$). Ruminal and post-ruminal disappearance of CP and DM are summarized in Table 2.

Table 1 Chemical composition (g/kg DM) of lucerne silage treated with urea and formic acid

Item	Treatments			SEM	P-value
	LS	LSu+f	LSf		
pH	4.78	3.93	3.75	0.5	0.2
CP	177	196	169	14.0	0.1
NPN	18	15	16	1.5	0.3
DM	292 ^a	395 ^b	349 ^{ab}	51.6	0.03

^{a,b} Means in the same row for each variable with different superscript letters differ ($p < 0.05$)

Table 2 Ruminal and post-ruminal CP and DM disappearance (g/kg) of lucerne silage treated with formic acid and urea

Item	Treatment			SEM	P-value
	LS	LSu+f	LSf		
Ruminal DM disappearance	536 ^a	524 ^{ab}	512 ^b	12.0	0.01
Ruminal protein disappearance	767	763	767	23.0	0.9
Post-ruminal disappearance of ruminal-undegraded DM	432 ^a	472 ^{ab}	482 ^b	26.5	0.01
Post-ruminal disappearance of ruminal-undegraded protein	868	875	881	65.0	0.8

^{a,b} Means in the same row for each variable with different superscript letters differ ($p < 0.05$)

Conclusions The results of the present study demonstrated that formic acid improved the nutritional value of the LS, however, the difference between the treatments was not statistically significant. formic acid might reduce proteolysis during ensiling by either reduction of pH or by providing additional substrate to enhance the reduction of pH. Variation in ruminal and post-ruminal dry matter disappearance of treatments maybe attributed to differences in DM and neutral detergent fiber (NDF) of these silages.

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