Influence of silage making or haymaking on different protein fractions

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Abstract

For silage making or haymaking, the forage is first wilted and then ensiled or dried. These different processes influence the nutrient content, especially differences in the protein fractions. In a trial with forage from the first and third cuts of a ley, silage, barn-dried and field-dried hay were produced. At different stages (fresh grass, pre-wilted grass, silage and hay), samples were taken and five protein fractions were analysed. Fraction A is non-protein nitrogen, fractions B1, B2 and B3 have different solubilities and fraction C is insoluble. The specific degradation processes of the protein fractions began during wilting in the field. Silage fermentation had the highest effect on this degradation process. In comparison to fresh grass, fraction A increased in silage from the first cut by 127% and in silage from the third cut by 100%. For the barn- and field- dried hay, fraction A was on average 30% higher for the first cut and 11% for the third cut in comparison to the fresh-cut grass.

Keywords: protein fractions, wilting, silage, barn-dried hay, field-dried hay

Introduction

Proteolysis results in the loss of true protein, causing an increase in the concentration of the soluble non-protein nitrogen (N) fraction in grass silage. This process occurs during wilting of grass for silage or hay, but to a greater extent during the fermentation process in silages (Hoedtke *et al.*, 2010). Five different protein fractions, based on the characteristics of solubility according to Licitra *et al.* (1996), can be distinguished. A review investigated the effect of silage making on the different protein fractions (Hoedtke *et al.*, 2010). However, only a few results have been reported for haymaking (Resch and Gruber, 2015). The present study investigated the effect of wilting time and the two conservation methods, silage making and haymaking, on the different protein fractions.

Materials and methods

In 2015, grass from a ley harvested for the first and third cuts was used. The cutting date for the first cut was 10 May and the cutting date for the third cut was 8 July. The experiment was conducted at Agroscope in Posieux, Switzerland (latitude: 46°46' N, longitude: 07°06' E, altitude: 650 m). Samples of fresh grass, pre-wilted grass before ensiling, pre-wilted grass before barn drying and field-dried hay were taken at three different places in the same plot and analysed separately. During the wilting process, the forage was tedded several times. Additionally, after three months of conservation the samples were taken from the conserved forage. A total of 42 samples were analysed.

Near-infrared reflectance spectroscopy (NIRS) was used to analyse the nutrient contents (ash, crude protein [CP], acid detergent fibre [ADF], neutral detergent fibre [NDF] and ethanol soluble carbohydrates [ESC] of the samples (Ampuero Kragten and Wyss, 2014). Furthermore, according to Licitra *et al.* (1996), the protein fraction A (non-protein N), fractions B1, B2 and B3 with different solubilities, and fraction C (insoluble) were also analysed. Data were analysed using analysis of variance and the Bonferroni test (Systat 13).

Results and discussion

During the wilting period in the field, the DM content of the grass increased. The amount of CP was not significantly different (Table 1 and Table 2). The different protein fractions were significantly influenced by the wilting process (Table 1 and Table 2). In the present study, fractions A, B3 and C increased ($P < 0.01$) and fractions B1 and B2 decreased ($P < 0.01$), which is in contrast to the results reported by Edmunds *et al.* (2012), who found that fraction A decreased and fraction B2 increased during the wilting process.

The two silages had significantly higher CP content in comparison to the barn-dried and field-dried hay (Table 3 and Table 4). This fact can be explained by the ESC, which was significantly reduced during the fermentation process (data not shown). The fermentation process had an effect on the protein fractions. Fraction A increased in silage from the first cut from 32.6% to 73.9% ($P < 0.01$); in silage from the third cut it increased from 27.7% to 55.3% ($P < 0.01$) (Table 3 and Table 4). In comparison, in the fresh-cut grass, fraction A increased in silage from the first cut by 127% and in silage from the third cut by 100%.

This degradation process also impacted the other protein fractions B1, B2, B3 and C. In the first cut, statistically significant differences were found between silage and hay for B1, B2, B3 and C (Table 3). For the third cut, statistically significant differences were found between silage and hay for B2 and B3 (Table 4).

In comparison to fresh-cut grass, the protein fractions in the hay only changed slightly. For the barn- and field- dried hay, fraction A was on average 30% higher for the first cut and 11% for the third cut in comparison to in the fresh-cut grass.

Table 1. Dry matter, crude protein and the five protein fractions A, B1, B2, B3 and C content during the field-drying period of the first cut.[1]

	Day	DM	CP	A	B1	B2	B3	C
	WT, h	%	g kg^{-1}	%	%	%	%	%
Fresh grass	0–0	16.0^{a}	123	32.6^{a}	26.6^{a}	34.8^{a}	3.9^{a}	2.1^{a}
Wilted grass	1–22	27.2^{b}	135	31.7^{a}	18.4^{b}	34.1^{a}	13.1^{b}	2.7^{ab}
Wilted grass	2–49	51.3^{c}	134	36.0^{b}	14.9^{b}	28.1^{b}	17.6^{c}	3.4^{b}
Wilted grass	8–192	78.5^{d}	132	42.6^{c}	7.4^{c}	29.7^{b}	16.7^{c}	3.6^{b}
SE		0.91	5.8	0.42	0.86	0.59	0.43	0.18
P-value		< 0.01	0.50	< 0.01	< 0.01	< 0.01	<0.01	< 0.01

[1] WT: wilting time, DM: dry matter; CP: crude protein; SE: standard error.

Table 2. Dry matter, crude protein and the five protein fractions A, B1, B2, B3 and C content during the field-drying period of the third cut.[1]

	Day	DM	CP	A	B1	B2	B3	C
	WT, h	%	g kg^{-1}	%	%	%	%	%
Fresh grass	0–0	24.9^{a}	137	27.7^{a}	21.3^{a}	38.6^{a}	7.4^{a}	5.0^{a}
Wilted grass	0–4.5	42.0^{b}	142	26.9^{a}	14.7^{b}	37.9^{ab}	15.0^{b}	5.6^{a}
Wilted grass	1–28.5	81.9^{c}	131	33.5^{b}	13.2^{b}	34.4^{c}	13.6^{b}	5.3^{a}
Wilted grass	5–123.5	90.0^{d}	137	29.4^{a}	13.0^{b}	37.3^{b}	13.5^{b}	6.8^{b}
SE		0.49	2.9	0.71	0.48	0.23	0.81	0.19
P-value		<0.01	0.14	<0.01	<0.01	<0.01	<0.01	<0.01

[1] WT: wilting time; DM: dry matter; CP: crude protein; SE: standard error.

Table 3. Dry matter, crude protein and the five protein fractions A, B1, B2, B3 and C content of the silage, barn- and field- dried hay of the first cut.[1]

	Day	DM	CP	A	B1	B2	B3	C
		%	g kg^{-1}	%	%	%	%	%
Silage	92	25.3^{a}	154^{a}	73.9^{a}	1.7^{a}	18.9^{a}	3.1^{a}	2.4^{a}
Barn dried hay	92	88.5^{b}	127^{b}	41.0^{b}	7.3^{c}	33.4^{b}	15.5^{b}	2.8^{b}
Field dried hay	92	87.3^{b}	132^{b}	43.7^{b}	5.4^{b}	32.7^{b}	14.9^{b}	3.4^{c}
SE		0.64	4.8	0.65	0.38	0.56	0.37	0.21
P-value		<0.01	0.02	<0.01	<0.01	<0.01	<0.01	0.05

[1] DM: dry matter; CP: crude protein; SE: standard error.

Table 4. Dry matter, crude protein and the five protein fractions A, B1, B2, B3 and C content of the silage, barn- and field- dried hay of the third cut.[1]

	Day	DM	CP	A	B1	B2	B3	C
		%	g kg^{-1}	%	%	%	%	%
Silage	90	39.9^{a}	152^{a}	55.3^{a}	5.7	27.5^{a}	6.0^{a}	5.6
Barn dried hay	90	89.2^{b}	139^{b}	31.7^{b}	9.3	38.0^{b}	15.1^{b}	5.9
Field dried hay	90	89.1^{b}	140^{b}	29.4^{b}	10.5	37.5^{b}	16.5^{b}	6.0
SE		0.46	1.9	1.16	1.31	0.78	0.41	0.31
P-value		<0.01	0.01	<0.01	0.09	<0.01	<0.01	0.58

[1] DM: dry matter; CP: crude protein; SE: standard error.

Resch and Gruber (2015) reported that fraction A only increased slightly in silage; however, in comparison to the present study, that study found higher proportions of fractions B3 and C as well as lower proportions of fractions B1 and B2.

Conclusion

Rapid wilting in good weather conditions reduces the degradation process of different protein fractions. Thus, the present study found that silage making has a greater impact on the protein degradation process than haymaking.

References

Ampuero Kragten S. and Wyss U. (2014) Futtermittel im Nah-Infrarotlicht (NIRS). *Agrarforschung Schweiz* 5, 204-211.

Edmunds B., Spiekers H., Südekum K.H. Nussbaum H., Schwarz F.J. and Bennett R. (2012) Effect of extent and rate of wilting on nitrogen components of grass silage. *Grass and Forage Science*, 69, 140-152.

Hoedtke S., Gabel M. and Zeyner A. (2010) Der Proteinabbau im Futter während der Silierung und Veränderungen in der Zusammensetzung der Rohproteinfraktion. *Übersichten Tierernährung* 38, 157-179.

Licitra G., Hernandez T.M. and Van Soest P.J. (1996) Standardization of procedures for nitrogen fractionation of ruminant feeds. *Animal Feed Science and Technology,* 57, 347-358.

Resch R. and Gruber L. (2015) Proteinfraktionen von Dauerwiesenfutter in Abhängigkeit von Konservierungsverfahren und Lagerdauer. *42. Viehwirtschaftliche Fachtagung*, 49-55.