Ensilability of different mixtures of legumes and grasses

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Abstract

In Switzerland, mixtures of grasses and white or red clover are sown for leys. However some other legumes, such as sainfoin, contain bioactive secondary metabolites like condensed tannins which can improve health, production efficiency and product quality in ruminants. In 2015 a trial was carried out to investigate the ensilability and the silage quality of eight different mixtures from the first and third growth. In addition to different grasses, two mixtures contained red clover or red clover as well as lucerne and six mixtures only sainfoin as legume. The forage was pre-wilted to 410 and 356 g kg^{-1} dry matter (DM) for the first and third growth, respectively, and ensiled in laboratory silos. Concerning the chemical composition and the fermentability coefficient of the forage at ensiling, differences were found between the two different growths and also between some mixtures. But there was no direct influence of sainfoin visible. No problems with butyric acid were observed and all silages showed a good to very good silage quality.

Keywords: grass/legume mixtures, sainfoin, silage quality

Introduction

Legumes offer important opportunities for sustainable grassland-based livestock production systems (Lüscher *et al.*, 2014). However, legumes are considered more difficult to ensile due to low contents of sugars and high buffering capacity (Pahlow *et al.*, 2001). In Switzerland, the mixtures for leys contain besides different grasses also white or red clover or both. Other legumes, such as sainfoin (*Onobrychis viciifolia)*, contain bioactive secondary metabolites like condensed tannins which can improve protein utilization in ruminant livestock and have the potential for combatting parasitic nematodes in ruminants (Lüscher *et al.*, 2014). Sainfoin is used in grass/clover mixtures, which are less intensively managed. The ensilability and the silage quality of different mixtures with legumes and grasses were investigated in a field experiment.

Materials and methods

n 2015 a trial with eight different mixtures of legumes and grasses was carried out. The mixtures were sown in 2013 as part of the testing program of Agroscope in Changins, Switzerland, in small plots with four replicates. In addition to different grasses, two mixtures contained red clover as well as lucerne and six mixtures only sainfoin (Table 1). The forage was cut four times a year. For the silage experiment, the forage of three replicates of the first and third growth was used. The forage was pre-wilted to attain DM contents of 350 to 400 g kg^{-1}, chopped and ensiled in laboratory silos each having a volume of 1.5 l. The silos were stored at room temperature (approx. 20 °C). Chemical parameters were analysed by NIRS (NIRFlex N-500 FT-NIR Büchi Switzerland) before ensiling and after a storage period of three months. Fermentation acids, ethanol, ammonia and pH were also analysed in the silage. Furthermore, the fermentability coefficient of the fresh material was calculated. This parameter summarizes the potential effects of dry matter (DM) as well as the ratio of sugar content and buffering capacity on the fermentation. The botanical composition of the different plots was assessed visually. Data were analysed using analysis of variance and Bonferroni-Test (Systat 13).

Table 1. Seed composition of the eight different mixtures (kg ha^{-1})

Mixtures	1	2	3	4	5	6	7	8
Trifolium pratense	2	5						
Medicago sativa	15							
Onobrychis viciifolia			100	100	100	100	100	100
Dactylis glomerata	6	5	5	12				5
Arrhenatherum elatius		10	10		20			
Festuca arundinacea						18		15
Festuca pratensis	12	10					18	
Phleum pratense	3		3					3

Results and discussion

The proportion of legumes varied between 42 and 80% for the first growth and between 25 and 83% for the third growth (Table 2 and 3). The forage of the first and the third growth had an average DM-content of 410 and 356 g kg^{-1}, respectively. Among the eight mixtures, there were significant differences concerning the DM- and nutrient contents of the first and the third growth, but there was no direct influence of the legume sainfoin visible.

All fresh mixtures of the first growth and most of the third growth had fermentability coefficients over 45. A value above 45 indicates good fermentability (Pahlow *et al.*, 2001). Also the investigations of the Legsil project (Pahlow *et al.*, 2001) showed, that wilting legumes to DM-contents about 400 g kg^{-1} is

Table 2. Proportion of legumes, DM, nutrient contents and silage parameters of the eight different mixtures of the first growth (g kg^{-1} DM).[1,2]

	1	2	3	4	5	6	7	8	SE	*P*-value
Green forage										
Legumes, %	80^{a}	52^{bc}	57^{bc}	60^{abc}	42^{c}	67^{ab}	65^{ab}	65^{ab}	4.1	<0.001
DM-content, g kg^{-1}	434	392	384	422	417	408	368	452	17.4	0.059
Ash	95^{a}	80^{ab}	77^{ab}	81^{ab}	72^{b}	80^{ab}	78^{ab}	81^{ab}	3.4	0.013
Crude protein	177^{a}	135^{b}	134^{b}	128^{b}	122^{b}	131^{b}	136^{b}	128^{b}	7.6	0.003
ADF	317	359	338	332	344	323	326	329	9.2	0.102
NDF	470	541	492	512	524	471	476	506	19.3	0.149
Sugar	71^{b}	99^{a}	98^{a}	102^{a}	100^{a}	113^{a}	105^{a}	106^{a}	3.1	<0.001
FC	51^{b}	53^{b}	53^{ab}	58^{ab}	58^{ab}	58^{ab}	53^{b}	62^{a}	1.8	0.004
Silage										
DM-content, g kg^{-1}	428	384	386	425	418	405	366	450	18.2	0.078
pH	5,5	5,2	5,2	5,2	5,2	5,4	4,9	5,5	0.1	0.065
Lactic acid	19	32	24	19	24	17	35	17	4.5	0.103
Acetic acid	6	7	2	3	4	2	6	2	1.1	0.020
Butyric acid	1	2	4	2	2	3	2	1	0.9	0.346
Ethanol	5^{b}	12^{ab}	16^{ab}	18^{ab}	22^{a}	15^{ab}	22^{a}	14^{ab}	3.1	0,024
NH_3-N of tot. N, %	6,7	7,2	6,1	4,2	7,1	6,0	6,0	5,7	0.6	0.059
DLG points	90	90	78	85	89	85	90	90	2.7	0.111

[1] Mixture 1: red clover, lucerne and different grasses; Mixture 2: red clover and different grasses; Mixtures 3 to 8: sainfoin and different grasses; SE: Standard error, FC: fermentability coefficient; NH_3-N, % tot. N: ammonia-N as a proportion of total N.

[2] In the rows, superscript letters indicate differences significant at $P<0.05$.

Table 3. Proportion of legumes, DM, nutrient contents and silage parameters of the eight different mixtures of the third growth (g kg^{-1} DM).[1,2]

	1	2	3	4	5	6	7	8	SE	*P*-value
Green forage										
Legumes, %	83^{a}	25^{c}	35^{c}	30^{c}	42^{bc}	35^{c}	60^{b}	33^{c}	4.0	<0.001
DM-content, g kg^{-1}	363^{a}	383^{a}	329^{b}	343^{a}	332^{b}	370^{a}	351^{a}	374^{a}	9.3	0.006
Ash	100	114	108	114	106	97	94	104	4.5	0.045
Crude protein	206^{a}	204^{a}	188^{abc}	188^{abc}	206^{a}	167^{bc}	203^{ab}	161^{c}	5.2	<0.001
ADF	266^{a}	256^{a}	258^{a}	267^{a}	230^{bc}	253^{ab}	226^{c}	247^{abc}	4.7	<0.001
NDF	419^{abc}	465^{ab}	422^{abc}	469^{a}	395^{bc}	469^{a}	363^{c}	477^{a}	13.2	<0.001
Sugar	78^{d}	91^{bcd}	101^{abcd}	86^{cd}	102^{abcd}	115^{ab}	127^{a}	111^{abc}	5.1	<0.001
FC	45^{b}	49^{ab}	46^{b}	46^{b}	47^{b}	54^{a}	53^{a}	54^{a}	1.2	<0.001
Silage										
DM-content, g kg^{-1}	363^{ab}	379^{a}	329^{b}	341^{ab}	334^{ab}	371^{ab}	349^{ab}	371^{ab}	9.3	0.009
pH	$4{,}8^{b}$	$5{,}0^{ab}$	$4{,}8^{b}$	$4{,}9^{ab}$	$5{,}0^{ab}$	$5{,}2^{ab}$	$5{,}2^{ab}$	$5{,}4^{a}$	0.1	0.003
Lactic acid	71^{a}	35^{bc}	49^{ab}	39^{bc}	43^{bc}	24^{bc}	24^{bc}	19^{c}	5.0	<0.001
Acetic acid	26^{a}	9^{b}	12^{b}	6^{b}	10^{b}	5^{b}	5^{b}	4^{b}	2.2	<0.001
Butyric acid	0	1	5	3	4	1	1	1	1.6	0.496
Ethanol	11	7	12	8	12	8	7	6	1.3	0.017
NH_3-N of tot. N, %	$8{,}4^{a}$	$5{,}3^{bc}$	$6{,}6^{ab}$	$5{,}2^{bc}$	$6{,}6^{ab}$	$4{,}2^{c}$	$3{,}8^{c}$	$4{,}3^{c}$	0.4	<0.001
DLG points	92	90	78	82	82	90	90	90	6.9	0.773

[1] Mixture 1: red clover, lucerne and different grasses; Mixture 2: red clover and different grasses; Mixtures 3 to 8: sainfoin and different grasses; SE: Standard error, FC: fermentability coefficient; NH_3-N, % tot. N: ammonia-N as a proportion of total N.

[2] In the rows, superscript letters indicate differences significant at $P<0.05$.

necessary to obtain fermentability coefficients over 45. The fermentation parameters of the silages of the first and third growth are indicated in Table 2 and 3. In all mixtures, relatively high pH-values were found. The lactic acid production was inhibited. In all silages only very little butyric acid was produced and the ammonia proportion was in all mixtures lower than 10%.

All mixtures showed a good to a very good silage quality concerning the calculated DLG points (DLG 2006). No significant differences concerning the DLG points between the mixtures were found for the first, neither for the third growth.

Conclusions

The investigation showed that by wilting mixtures of legumes and grasses it is possible to increase the fermentability coefficients and to obtain silages of a good quality. The mixtures with sainfoin showed more or less the some nutrient contents and silage quality as the two mixtures without sainfoin.

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