INVESTIGATION OF NUTRIENT CONTENT AND FERMENTATION OF DIFFERENT FOLIAGE SILAGES

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ABSTRACT
The aim of the research was to investigate ensilage, nutrient content and fermentation characteristics of elder (*Sambucus nigra*), black locust (*Robinia pseudo-acacia*), blackberry (*Rubus spp.*) and hawthorn (*Crataegus spp.*) shoots. Early summer shoots were collected, wilted (4-6 h), chopped, mixed with 20% dried corn (*Zea mais*) and then ensiled (n=5), with the same packing density of 600 kg/m^3 (200kg/m^3 DM). The fresh, the wilted pre-ensiled material were sampled immediately and the silages were sampled after 70 days of fermentation. Dry matter-, crude protein-, crude fibre- and NDF- content were determined in each sample, pH, lactic acid, acetic acid, propionic acid, butyric acid and ethanol were measured in silages (n=5). CP/CF and CP/NDF rate were calculated (MÁTRAI ET AL., 2002). The dry matter content of elder- and blackberry silages was optimal for fermentation (no significant difference P>0.05). Relatively high DM was found in the case of black locust- and hawthorn- silages (P≤0.05). Crude protein results of elder- and black locust were higher and differed significantly from the other two (P≤0.05). Similar and low crude fibre contents were found in elder-, black locust- and hawthorn silages (P>0.05), blackberry had a higher CF content (P≤0.05). NDF content of black locust and blackberry were similar (P>0.05), with elder silage lower, and hawthorn higher NDF values were found (P≤0.05). All four silages differed significantly in CP/CF and CP/NDF ratios (P≤0.05). It is recommended to use NDF-content and CP/NDF ratio of the shoot silages in further investigations, as NDF analyses give more adequate data for fibre content. The pH values were relatively high and the total amount of fermentation products was low in the silages. The fermentation intensity was low in all cases. Fermentation quality was optimal in elder- and blackberry silages. In the case of black locust and hawthorn silages presence of unfavourable fermentation products was found. To improve fermentation quality, DM must be kept between the optimal 30-40% values. In conclusion elder and black locust young shoots mixed with dried cracked corn seemed to be the best raw materials for shoot silage making and can be effectively preserved by fermentation providing good rules for ensiling are followed. These foliage mixed silages could provide high quality and nutritious feedstuffs for wild ruminants.

Keywords: shoot silage, wild ruminants, ensiling, supplemental feeding, foliage silage

INTRODUCTION

The aim of the research was to investigate the ensilage, nutrient content and fermentation character of shoots derived from some of the preferred plant species by wild ruminants. Arboreal shoots are the main components in the diet of wild ruminants (GEBERT ET AL., 2001). In terms of biomass supply in habitats used by ungulates elder (*Sambucus nigra*), black locust (*Robinia pseudo-acacia*), blackberry (*Rubus spp.*) and hawthorn (*Crataegus spp.*) are dominant species (MÁTRAI, 1994; MÁTRAI ET AL., 2000; MÁTRAI ET AL., 2002)., Positive seasonal preference was found for black locust, elder and blackberry by investigating the diet of wild ruminants (MÁTRAI AND SZEMETHY, 2000). Preference for these species could be a result of favourable nutrient content. MÁTRAI (2002) used crude protein/crude fibre rate to evaluate nutrient content (MÁTRAI ET AL., 2002). In this study we followed this practice. High crude protein and relatively low crude fibre content was determined in shoots of elder and black locust by investigating nutrient content (SZEMETHY ET AL., 2000; SZEMETHY ET AL., 2003). Ruminal degradability and nutritive value of tetraploid black locust was investigated in China. These results confirmed; black locust is a potential forage species for ensiling (CHEN ET AL., 2011; ZANG ET AL., 2010).

MATERIAL AND METHOD

Elder (*Sambucus nigra*), black locust (*Robinia pseudo-acacia*), blackberry (*Rubus spp.*) and hawthorn (*Crataegus spp.*) were studied as silages. Dried cracked corn (20%) was applied in order to reduce the hazard of effluent production and un-desirable fermentation processes, moreover to increase energy content of shoot silages, as winter feed for game. Collecting and ensiling of the raw materials was executed in June 2010 (elder, black locust: 7th; blackberry, hawthorn: 8th). After collecting, the fresh shoots were wilted (4-6 hours), chopped with a compost-shredder, mixed with 20% dried corn and then ensiled in buckets (elder, black locust, n=5, respectively) and in model silos (blackberry, hawthorn, n=5, respectively) with a packing density of 600 kg/m^3 (200kg/m^3 DM). The fresh, the wilted raw material and the silages were sampled (on the 70th day of fermentation) and analyzed (n=5). Dry matter-, crude protein-, crude fibre- and NDF- content were determined in each sample. Additionally, pH, lactic acid, acetic acid, propionic acid, butyric acid and ethanol were determined in silages to evaluate the fermentation quality. Total volatile fatty acid, organic acid and lactic acid/acetic acid (LA/AA) ratio were calculated. Crude protein/crude fibre (CP/CF) and crude protein/NDF (CP/NDF) ratio were used (MÁTRAI ET AL., 2002) to estimate nutritive value of the silages. One way ANOVA and Tukey-Kramer Multiple Comparisons Test were used for statistical analysis of the results.

RESULTS

Nutrient content

The dry matter (DM) contents of elder- and blackberry silages were about optimal. There was no significant difference between the results of these two silages (P>0.05). Relatively high dry matter content was found in the case of black locust- and hawthorn- silages. They differed significantly from elder and blackberry and also each other (P≤0.05). Crude protein content of elder- and black locust silages were similarly higher (P>0.05) and differed significantly from blackberry and hawthorn (P≤0.05). Relatively low crude fibre (CF) content was found in elder-, black locust- and hawthorn silages (P>0.05). CF content of blackberry silage was significantly higher than the others (P≤0.05). By measuring NDF content of the silages, no difference was found between the results of black locust and blackberry (P>0.05). Significantly lower NDF content was found in elder silage (P≤0.05). Hawthorn silage differed from all the others significantly with an extremely high value (P≤0.05). All four silages differed significantly in CP/CF and CP/NDF rates (P≤0.05). Nutrient content of the different foliage silages (+20% dried corn) are shown in Table 1.

Table 1. Nutrient content of the different foliage silages mixed with 20% dried cracked corn (n=5)

		Elder + 20% corn		Black locust + 20% corn		Blackberry + 20% corn		Hawthorn + 20% corn	
		mean	**SD**	**mean**	**SD**	**mean**	**SD**	**mean**	**SD**
DM	g/kg	**351,6a**	17,61	**430,2b**	26,56	**386,2a**	26,20	**518,9c**	20,80
Crude protein	g/kg DM	**159,1a**	10,00	**165,4a**	13,64	**119,1b**	6,90	**124,9b**	4,63
Crude fibre	g/kg DM	**118,0a**	15,76	**102,3a**	12,41	**203,3b**	33,01	**119,9a**	12,42
NDF	g/kg DM	**230,5a**	21,30	**342,2b**	13,61	**354,2b**	56,49	**481,5c**	31,54
CP/CF	g/g	**1,35a**	0,11	**1,62b**	0,20	**0,59c**	0,08	**1,04d**	0,07
CP/NDF	g/g	**0,69a**	0,03	**0,48b**	0,03	**0,34c**	0,05	**0,26d**	0,01

Different letters show significant differences at level of P≤0.05

Fermentation

Lower pH values of elder- and blackberry silages differed significantly from the results of black locust and hawthorn (P≤0.05). No-significant difference was found between the lactic acid (LA) values of black locust- and hawthorn silages (P>0.05). The highest LA value was found in elder (P≤0.05) blackberry differed significantly from all the others (P≤0.05). Also the highest acetic acid (AA) value was found in elder silage (P≤0.05). Black locust and blackberry had the similar values (P>0.05), in hawthorn significantly less AA was found (P≤0.05). In elder and blackberry similarly low propionic acid (PA) content was found (P>0.05). PA was the highest in black locust silage (P≤0.05). In the case of hawthorn no difference was found from the others (P>0.05). The ethanol content of elder silage was significantly lower than all the others (P≤0.05). The other three silage had the same ethanol content (P>0.05). Volatile Fatty Acid (VFA) content of elder silage was significantly higher than the others (P≤0.05). VFA content in black locust and blackberry was similar (P>0.05). The lowest VFA content was found in hawthorn silage (P≤0.05). Organic acid (OA) content of black locust- and hawthorn silages were similarly low (P>0.05). The highest OA content was found in elder silage (P≤0.05). Blackberry had lower OA content and differed from all the others (P≤0.05). In the case of fermentation products similar ranking was found in VFA. Similarly a high LA/AA rate was found in elder- and blackberry silages (P>0.05), and they differed significantly from the results of black locust and hawthorn (P≤0.05). No significant difference was found between LA/AA rates of black locust and hawthorn (P>0.05).

Fermentation profiles of the different foliage silages (+20% dried corn) are found in Table 2.

Table 2. Fermentation profile of the different foliage silages mixed with 20% dried corn (n=5)

			Elder + 20% corn	Black locust + 20% corn	Blackberry + 20% corn	Hawthorn + 20% corn
pH		mean	**4,4a**	**5,7b**	**4,6a**	**5,7b**
		SD	0,10	0,18	0,06	0,06
Lactic acid	g/kg DM	mean	**25,4a**	**5,5b**	**17,2c**	**2,1b**
		SD	5,32	3,34	2,97	0,61
Acetic acid	g/kg DM	mean	**10,5a**	**4,7b**	**5,2b**	**1,7c**
		SD	1,12	1,28	1,24	0,43
Propionic acid	g/kg DM	mean	**0,2a**	**0,6b**	**0,2a**	**0,3ab**
		SD	0,05	0,21	0,11	0,10
Butyric acid	g/kg DM	mean	**0,0a**	**0,6b**	**0,0a**	**0,6b**
		SD	0,00	0,24	0,00	0,32
Ethanol	g/kg DM	mean	**4,6a**	**12,0b**	**8,5b**	**9,9b**
		SD	0,49	0,44	0,76	4,03
Volatile fatty acids	g/kg DM	mean	**10,7a**	**5,9b**	**5,4b**	**2,5c**
		SD	1,15	1,25	1,28	0,69
Organic acids	g/kg DM	mean	**36,1a**	**11,4b**	**22,5c**	**4,6b**
		SD	5,71	3,97	4,05	0,84
Fermentation products (organic acids and ethanol)	g/kg DM	mean	**40,7a**	**23,5b**	**31,0b**	**14,6c**
		SD	6,11	3,90	4,57	4,46
LA/AA ratio	g/g	mean	**2,4a**	**1,1b**	**3,4a**	**1,3b**
		SD	0,52	0,51	0,62	0,60

Different letters show significant differences at level of $P \leq 0.05$

DISCUSSION

Nutrient content

It can be concluded, that crude protein content of the silages derived from the examined species can reach a substantial level above other common forages. Only the blackberry reached the average crude fibre content of common forages (like alfalfa or maize silage), in all the other cases CF was much lower (about half) of this value. From the results of MÁTRAI (2002) we can conclude, that wild ruminants try to optimize CP/CF rate by reducing CF intake, so the relatively low CF value of these silages can be optimal for these ruminant species. The high crude protein and low crude fibre level provided an advantageous CP/CF and CP/NDF ratio. Earlier studies, related to CP/NDF ratio of these species, are poor. The CP/CF ratio of elder-, black locust- and hawthorn silages were in the same range as found by MÁTRAI (2002). It is recommended to use NDF-content and CP/NDF ratio of the shoot silages in further investigations, as NDF analyses give more accurate data for fibre content and digestibility of forages.

Fermentation

According to the pH values and fermentation profile, it can be concluded that the fermentation intensity was low in all silages, especially in black locust and hawthorn silages. The pH values were relatively high in the above mentioned two silages. The amount of lactic acid was considerably lower than 60g/kg DM (minimum level in well fermented maize and alfalfa silages) in all inspected cases. Acetic acid content was lower than 15g/kg DM in all cases (applied maximum level in well fermented maize and alfalfa silages). Butyric acid values were undetectable or low. The LA/AA ratio was found close to the optimal 3:1 in elder- and blackberry silages. The LA/AA ratios were significantly lower in the case of black locust and hawthorn as compared to elder- and blackberry silages. The total amount of fermentation products in foliage silages were less than in maize- or alfalfa silages with similar dry matter content. Fermentation quality based on the LA/AA ratio and the amount of different unfavourable volatile fatty acids were optimal in elder- and blackberry silages. In the case of two species (black locust, hawthorn) butyric acid- and ethanol content were relatively high compared to the other two silages. However, the quantity of these unfavourable fermentation products is negligible. The low quality and intensity of fermentation was a consequence of high dry matter content (black locust: 43% and hawthorn: 52%), so it is suggested to keep the dry matter content within the optimal range of 30-40%.

CONCLUSIONS

According to the results of nutrient content (CP/CF ratio) and fermentation quality, it can be summarized that elder and black locust young shoots mixed with dried cracked corn seemed to be the best raw materials for making shoot silage and can be effectively preserved by fermentation provided good ensiling techniques are followed. These foliage mixed silages could provide high quality and nutritious feedstuffs for wild ruminants. However, further investigations are proposed (ensiling of large quantities, investigation of ruminal degradability, feeding experiments, determination of microbiological status and aerobic stability, inoculation to improve fermentation quality and therefore palatability). It is recommended to use NDF-content and CP/NDF ratio of the shoot silages in further investigations.

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