EFFECT OF ADDITIVES ON ENSILING OF WILLOW LEAVES AND TWIGS

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Introduction

According to Hoffman,[1] ruminants can be classified as browsers ("concentrate selectors"), intermediate feeders, and grazers. Compared to grazers, browsers have different nutritional requirements to meet their specific digestive physiology needs.[2] In general, browse may contain higher amounts of secondary plant compounds and lower fiber concentrations than many grasses. In Rotterdam Zoo, browse often consists of willow leaves and branches. However, for year-round availability of browse, it needs to be preserved for winter and spring feeding. Browse can be conserved in three ways: freezing at -20^{0}C, natural or artificial drying, or ensiling. Ensiling (production of lactic acid from soluble sugars by anaerobic fermentation) is a new method of preservation of browse forages in temperate regions. It is unknown whether willow leaves and branches contain sufficient epiphytic lactic acid bacteria to obtain a rapid fermentation start. Another problem with willow branches is the low density that can be obtained, which hampers anaerobiosis. Therefore, the effect of different preservation methods on the fermentation quality of willow leaves and branches was studied in two experiments.

Materials and Methods

In the first experiment in September 2004, willow branches (diameter 2 to 4 cm), approximately 2 meter long, were cut and baled by a baling machine and double wrapped with plastic. Bales were 100 x 50 x 35 cm and between 45 and 50 kg. Branches were ensiled without a silage additive or with either molasses (25 l/ton), formic acid (3 l/ton), Bonsilage Plus Instant, (Schaumann Agri International GmbH, Pinneberg, Germany) (1 g/ton), or a mixture of molasses (25 l/ton) and Bonsilage Plus Instant (BPG) (1 g/ton). BPG contains 1 x 10^{11} lactic acid bacteria (*Pediococcus pentosaceus, Lactobacillus brevis, Lactobacillus buchneri, Lactobacillus plantarum* and *Lactobacillus rhamnosus*).

In the second experiment in May 2005, 5 polyethylene drums (200 L) were force-filled with 1.5 m long willow branches (diameter 2 to 4 cm). Branches were ensiled untreated or treated with N_2, BPG, or BPG + molasses. To improve anaerobiosis in the latter 2 treatments, drums also were flushed with N_2. After six weeks, bales (experiment 1) or drums (experiment 2) were sampled for analyses of organic acids and bacteria.

All tests were performed according the German analyse standards at the IS Forschunggesellschaft für Tierphysiology und Tierernährung MbH in Wahlstedt.

Results and Discussion

In experiment 1, favorable ensiling conditions were only apparent when BPG and molasses were combined (Table 1). This treatment resulted in a sufficiently low pH (4.3), reflecting the high concentration of lactic acid. The pH and concentrations of lactic acid in this silage were comparable with those normally observed in grass silages. Thus, it seems that the concentration of soluble sugars as well as the presence of epiphytic lactic acid bacteria was insufficient in untreated willow browse for successful ensiling. Surprisingly, also high concentrations of ethanol were observed when molasses was added. This indicates active yeast fermentation. Silages treated with BPG had relatively high concentrations of acetic acid, which will have a positive effect on aerobic stability. Acetic acid and 1,2-propanediol are fermentation products of *L. buchneri*.

In experiment 2, flushing with N_2 resulted in an improved fermentation process as can be concluded from the drop in pH and the increase in lactic acid concentration (Table 2). Adding BPG was only effective if this inoculant was combined with molasses. The analysed composition of this silage was comparable with the BPG + molasses-treated silage in experiment 1.

From these preliminary studies it can be concluded that ensiling willow leaves and branches with lactic acid bacteria and molasses under anaerobic conditions resulted in a browse that can be preserved until winter and spring. An earlier preliminary study (unpublished) revealed that okapis, giraffes, kudus, tuffed deer, and bongos preferred ensiled browse silage over frozen browse.

LITERATURE CITED

1. Clauss, M., E. Kienzel, and J.M. Hatt. 2003. Feeding practice in captive wild ruminants: peculiarities in the nutrition of browsers/concentrate selectors and intermediate feeders. A review. In Zoo Animal Nutrition vol. II. A. Fidgett et al. (eds.) Fürth. Germany 27-52.
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Table 1. Analyses of samples of willow silage (in plastic-wrapped bales) after incubating with different additives

	Not treated	Molasses	BPG	Formic acid	BPG[a] + molasses
Dry matter, g/kg	327	343	292	286	266
pH	5.97	4.95	5.43	5.36	4.30
Lactic acid, g/kg DM	0.2	0.9	1.7	2.1	52.5
Acetic acid, g/kg DM	1.2	4.7	15.7	3.1	10.5
Butyric acid, g/kg DM	0.9	1.5	1.0	2.1	< 0.8
1,2-Propanediol, g/kg DM	6	0.9	0.7	0.7	1.1
Formic acid	-*	2.9	-	2.1	-
Ethanol, g/kg DM	-	7.0	1.0	-	26.3
Bacteria, CFU[b] x 10^6/g	480	160	700	31	24
Fungi, CFU/g	< 100	200	< 100	2 x 10^5	200

[a]Bonsilage Plus Instant
[b]CFU: colony forming units
-*= no data

Table 2. Analyses of samples of willow silage (in sealed drums) after incubating with different additives

	Not treated	N_2	N_2 + BPG	N_2 + BPG[a] + molasses
Dry matter, g/kg	271	268	256	278
pH	5.5	5.2	5.2	4.7
Lactic acid, g/kg DM	9.3	19.7	12.5	25.2
Acetic acid, g/kg DM	6.7	6.3	17.9	24.8
1,2-Propanediol	5.2	5.5	-*	10.0
Ethanol	23.1	44.0	37.8	37.8
Butyric acid	2.2	4.1	5.5	-
Bacteria, CFU[b] x 10^6/g	200	600	<100	<100
Fungi, CFU/g	<100	500	-	<100

[a]Bonsilage Plus Instant
[b]CFU: colony forming units
-*= no data