FORAGE AND FERMENTATION QUALITY OF RE-ENSILED PRESS CAKES FROM BIOREFINING OF GRASS SILAGES

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INTRODUCTION

The need for more sustainable feed production and protein self-sufficiency are becoming more important (European Parliament, 2011), so green biomass fractionation is also attracting great interest in protein feed production. According to Kromus et al. (2004), biorefinery is a sustainable processing of biomass into a spectrum of marketable products and energy. As part of the international research project Farm4More (LIFE18CCM/IE/001195), three different types of pre-wilted grassland forage (preliminary trial 2020: 1 - grass-rich; main trial 2021: 2 - grass/clover, 3 - red clover) were ensiled into round bales in work package C.5.1 at AREC Raumberg-Gumpenstein and biorefined after fermentation using a practical screw press. This paper does not deal with the protein-rich press juice, but with the fiber-rich press cake, which was ensiled again as residue of the biorefining and can be fed to ruminants. In the following, it will be clarified to what extent the press cake differs from the original grass silage, whether re-silaging is possible and to what extent a renewed fermentation influenced the contents and silage quality of the press cake.

MATERIAL AND METHODS

The used forage came from the 1st growth of grassland at the organic station Lambach (Upper Austria) of AREC Raumberg-Gumpenstein. The round bales transported to Gumpenstein weighed between 900 to over 1,000 kg, were stored for at least 6 weeks, and were mixed in a mixing wagon with a vertical cutter for 30 minutes before baling and chopped to about 5 cm theoretical chop length. DM content was determined from the mixture using the microwave method of Losand and Waldmann (2003), and the amount of water required to dilute to 230 g DM/kg FM was calculated. The required amount of water was added to the silage during the mixing process. After pressing, approximately 45 kg of each fresh press cake was ensiled into 60-liter plastic barrels. The average storage density in the barrels was 275 to 281 kg DM/m³. The containers were hermetically sealed with a plastic lid with a metal clamp. Storage of the filled barrels was at about +20 °C until the silo opening. The storage period was 62 days in the preliminary test (2020) and 52 to 56 days in the trial of 2021. The sample draw on the contents of the opened barrels was performed vertically from top to bottom using stainless steel cylinders (diameter 50 mm) and 2 punctures per container. The composite sample of each variant (4 barrels × 2 punctures) was immediately cooled. Subsequently, further sample preparation was performed according to the analytical method. Chemical analyses were performed according to VDLUFA method book III (1976). The validated data were variance-analyzed using the statistical program Statgraphics Centurion XVII (version 17.1). Mean comparisons were made using the Tukey-HSD method at p-level 95%.

RESULTS AND DISCUSSION

The DM contents of the grass silages differed significantly before watering. Pressing of the watered grass silages resulted in a uniform increase of the DM content in the press cakes to about 370 g/kg FM. The chemical composition of the press cakes changed significantly, compared to the original silage. NDF content increased by about 100 g/kg DM. According to Resch (2016), the high levels of NDF due to biorefining are corresponding to a phenological stage at seed maturity. Almost reductions in protein (-11 to -24%), minerals (-25 to -30%), sugars (-50%), and fermentation products (-55 to -57%) were significant (table 1).

Fermentation products increased significantly with re-ensiling, compared to fresh press cake. Re-ensiling caused pronounced lactic and acetic acid fermentation, which significantly lowered pH values below the critical pH and provided very good fermentation quality. The second fermentation consumed nearly all sugars and also parts of NFC of the press cakes.

CONCLUSIONS

In the international research project Farm4More (LIFE18CCM/IE/001195) we observed that re-ensiling of biorefined press cakes, from grass silage of different forages, worked successfully by triggering a new lactic acid fermentation, even if the fresh press cake was exposed to air for several hours. The feed value of the press cakes was significantly lower than that of grass silage, because much protein, minerals, sugars and fermentation products were added to the press juice by the pressing process. The press cakes contained about 100 g more NDF/kg DM than the origin grass silage.

Table 1: Nutrients, minerals and fermentation quality of grass silage vs. re-ensiled press cake from the biorefinery depending on the used forage

		grass silage			re-ensiled press cake of biorefinery		
parameter	unit	grass	grass/clover	red clover	grass	grass/clover	red clover
dry matter	g/kg FM	419.6^{C}	316.3^{B}	249.4^{A}	372.0^{a}	369.2^{a}	372.3^{a}
nutrients, cell wall substances and ammonia							
crude protein	g/kg DM	135.1^{A}	145.8^{A}	158.8^{B}	101.7^{a}	116.2^{b}	126.0^{c}
ammonia	g/kg DM	1.8^{A}	2.3^{AB}	2.7^{B}	1.2^{a}	1.3^{a}	1.2^{a}
NH_4 of N_{total}	%	8.3^{A}	9.8^{A}	10.3^{B}	7.3^{b}	6.7^{ab}	6.0^{a}
NDF	g/kg DM	496^{C}	390^{B}	343^{A}	635^{c}	493^{b}	440^{a}
ADF	g/kg DM	336^{C}	295^{A}	309^{AB}	434^{a}	403^{a}	412^{a}
ADL	g/kg DM	41.0^{A}	32.9^{A}	39.3^{A}	49.3^{b}	40.5^{a}	47.6^{b}
sugars	g/kg DM		86.7^{B}	40.4^{A}		6.5^{a}	5.5^{a}
crude fat	g/kg DM	21.6^{B}	17.5^{A}	22.3^{B}	22.0^{a}	28.1^{b}	27.1^{b}
crude ash	g/kg DM	87.1^{A}	106.7^{B}	110.7^{C}	63.0^{a}	81.2^{b}	88.4^{b}
minerals							
calcium (Ca)	g/kg DM	8.4^{A}	12.3^{B}	14.5^{C}	6.3^{a}	10.2^{b}	12.3^{c}
phosphorus (P)	g/kg DM	3.1^{A}	3.0^{A}	3.0^{A}	1.8^{a}	1.5^{a}	1.5^{a}
potassium (K)	g/kg DM	28.1^{A}	30.2^{AB}	31.7^{B}	13.4^{a}	17.2^{b}	18.1^{b}
iron (Fe)	mg/kg DM	900^{B}	447^{A}	519^{A}	1087^{a}	676^{a}	743^{a}
fermentation quality							
pH-value		4.68^{A}	4.75^{A}	4.58^{A}	4.16^{b}	4.10^{a}	4.22^{c}
lactic acid	g/kg DM	35.8^{A}	36.5^{A}	56.9^{B}	57.1^{a}	75.3^{b}	71.3^{ab}
acetic acid	g/kg DM	11.0^{A}	11.4^{A}	14.2^{B}	11.9^{a}	14.0^{b}	13.4^{b}
propionic acid	g/kg DM	1.5^{AB}	1.5^{A}	2.1^{B}	0.8^{a}	1.0^{a}	1.0^{a}
butyric acid	g/kg DM	2.2^{A}	3.5^{A}	6.0^{B}	1.6^{a}	2.9^{b}	3.9^{b}
ethanol	g/kg DM	10.7^{A}	6.1^{A}	6.7^{A}	5.1^{a}	4.9^{a}	4.2^{a}
VOC total	g/kg DM	61.2^{A}	59.1^{B}	85.9^{C}	76.5^{a}	93.7^{b}	98.0^{b}

indices: capital letters show significant differences between grass silage variants
lower case letters show significant differences between re-ensiled press cake variants

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