Effects of Microbial Inoculants on Quality of Whole Crop Wheat and Maize Silage

KALDMÄE H., OLT A., KÄRT O., OTS M.
Estonian University of Life Sciences, Department of Nutrition and Animal Products Quality, Kreutzwaldi 46, 51006 Tartu, Estonia. Tel:+372-7-313473, e-mail: helgi.kaldmae@emu.ee

Introduction

Silage of whole crop cereals and maize were a good supplementation to legume-rich silage in the ration of lactating dairy cows. Maize silage has a good value of metabolizable energy, which is why it is cultivated even in the Nordic country where conditions are suboptimal for growth. The quality of silage depends on fermentation of the material, but the ensiling procsess can be optimised with the use of additives.

Several different biological additives can be used for making silage. The described research was aimed at finding silage additives suitable for treating whole crop wheat (WCW) and maize cultivated under Estonian climatic conditions. Their effects on silage fermentation characteristics, losses of dry matter, nutritive value and digestibility were also investigated.

Material and Methods

The whole crop wheat and maize were ensiled in 3-litre glass jars. The number of replicates was three. The first trial comprised six treatments (untreated control, four inoculants and chemical additive); and the second trial four treatments (untreated control and three inoculants). The additives were commercial products (inoculants 1 to 4; Table 1).

Table 1: Inoculants used in the trials

Number/Code	Inoculant	Source
Bonsilage(BO)	*L. plantarum*, *P. pentosaceus*, *L. rhamnosus*, *L. brevis, L. buchneri*	Schaumann Agri Austria GmbH & Co KCo KG
Lalsil MS01(LA)	*L. plantarum* MA18/5M, *P. acidilactici* MA 18/5M, *P. acidipropionici* MA	Lallemand Animal Nutrition, Blag nac, France
SilAll (SI)	*L. plantarum, E. faecium, P. acidilactici, L. salivarius*	Alltech Biotechnoligy Centre, Co. Meath, Ireland
Ecocorn (EC)	*L. plantarum* MTD1 + potassium sorbate	Ecosyl, Yorkshire, UK

After 90 days the jars were opened for analysis.

The pH value was measured with a Hanna Instruments Mikroprocessor pH meter 210, ammonia nitrogen was determined using an adjusted Kjeltec 2300 (FOSS) analyser. The ethanol, lactic acid and volatile fatty acids contents were determined chromatographically using a Agilent Technologies 7890A GC system with a column packed with 80/120 Carbopack B-DA/4% carbowax 20 M (Faithfull, 2002).

Samples were dried and analysed for the DM, crude protein, and crude fibre (AOAC, 2005). Crude protein was analysed by Kjeldahl method with Kjeltec 2300 analyser (FOSS Tecator Technology). *In vitro* digestibility of OM (IVOMD) were determined after incubating for 48 h using a DAISY II Incubators and NDF ANKOM Analyzer and to ashes in a furnace (ANKOM Technology, Fairport, NY USA). The NDF and ADF concentrations of the samples and digested residues were determined with amylase pretreatment using an ANKOM 220 Fiber Analyzer (ANKOM Technology) (Van Soest *et al*., 1991).

The content of DM of maize was 316 g/kg, CP 76 g/kg, NDF 443 g/kg and of WCW 359 g/kg, 90 g/kg, 619 g/kg respectively. The buffering capasity of maize was 30,3 g/kg LA in DM and wheat was 28,8 g/kg LA respectively. Statistical analysis was performed for each cut separately with the generalized linear model procedure of SAS. The effects of treatment were tested by means of orthogonal contrasts. Analysing the traits containing zero values, ranks of values were used; other traits were transformed to their logarithmic values.

Results and Discussion

Chemical compositions of the whole crop wheat and maize silage were significantly different.

Chemical composition and nutritive value of silages are given in Table 2. Maize silage contained more metabolizable energy than WCW silage. Organic matter digestibility of additives silages did not show any difference for the different silages in first and second trials (P<0.05).

Table 2: Chemical composition (in DM) and digestibility (OMD) and losses of whole crop wheat (WCW) and maize silages.

Treatment	Dry matter, g/kg		Crude protein g/ kg		NDF g/ kg		ADF g/kg		ME MJ/kg		OMD %	
	WCW	MAIZE	WCW	MAIZE	WCW	MAIZE	WCW	MAIZE	WCW	MAIZE	WCW	MAIZE
Control	313	303	95	79	622	442	346	242	9.1	10.8	67.7	69.3
BO	320	294	92	76	636	449	342	259	9.0	10.7	67.1	70.4
LA	318	–	92	–	629	–	357	–	9.0	–	66.5	–
SI	320	298	90	77	630	441	350	247	9.0	10.7	65.2	69.9
EC	326	300	86	78	618	447	339	257	9.0	10.8	65.6	69.7
CHEM	334	–	95	–	585	–	348	–	9.1	–	67.5	–

The positive effect of inoculants on silage fermentation but not on digestibility has been reported by Weinberg & Muck (1996).

Fermentation characteristics, pH, ammonia nitrogen in total nitrogen, organic acids and ethanol contents, and dry matter losses are given in Tables 3 and 4.

Table 3: Fermentation characteristics of the whole crop wheat silages in dry matter

Treatment	Dry matter losses, %	pH	Ammonia-N, % of total N	Lactic acid, g/kg	Acetic acid, g/kg	Butyric acid, g/kg	Ethanol, g/kg
Control	15.4	4.7	7.4	3.7	7.5	20.3	46.8
BO	11.9	3.8	6.0	98.2	29.5	1.3	24.0
LA	12.1	3.9	5.5	24.1	42.5	4.2	23.4
SI	11.7	4.0	6.5	26.7	11.6	8.6	46.5
EC	10.0	3.9	5.3	51.9	16.1	6.0	39.8
CHEM	7.5	4.5	8.8	37.9	24.4	0.9	26.6
Significant difference, *P*							
C vs BO	<0.001	<0.001	0.021	0.013	<0.001	<0.001	0.019
C vs LA	0.017	<0.001	0.005	0.011	0.003	<0.001	0.019
C vs SI	<0.001	<0.001	0.059	<0.001	0.019	<0.001	0.490
C vs EC	<0.001	<0.001	0.003	0.027	0.005	<0.001	0.252
C vs CHEM	<0.001	0.033	0.002	0.023	0.002	<0.001	0.159

Table 4: Fermentation characteristics of the maize silages in dry matter

Treatment	Dry matter losses, %	pH	Ammonia-N, % of total N	Lactic acid g/kg	Acetic acid g/kg	Butyric acid g/kg	Ethanol g/kg
Control	4.6	3.8	3.7	90.5	19.4	0.8	12.0
BO	7.4	3.8	3.7	97.2	31.7	0.0	3.3
SI	6.2	3.8	3.7	85.5	19.9	0.0	9.3
EC	5.3	3.8	3.7	99.1	20.2	0.2	12.1
Significant difference, *P*							
C vs BO	0.038	–	–	0.288	<0.001	0.029	<0.001
C vs SI	0.026	–	–	0.314	0.241	0.029	<0.001
C vs EC	0.124	–	–	0.223	0.149	0.069	0.445

DM losses during fermentation were the lowest in the WCW silages treated with CHEM additive (7.5%), in silages treated with biological additives these values were 10-12.1% and in untreated silage (15.4%) (Table 3).

In the first trial, the characteristics of silages treated with CHEM differed from those of silages inoculated with biological additives as well as from the uninoculated control silage by the lower content of organic acids (<0,01), but higher ammonia nitrogen (<0,01) concentration. AIV Pro contained ammoniumformiate (30.3%). This explains the high ammonia nitrogen concentration in the CHEM silages. This was predictable, as chemical additives have an inhibiting effect on fermentation. Compared to the control WCW silage, the lactic and acetic acid contents were higher in silages treated with additives, while the butyric acid content was lower (P<0.001). Ammonia nitrogen, pH, lactic and acetic contents of maize silages, were not different from those of the control silages (Table 4).

Conclusions

The use of inoculants or chemical additive at ensiling whole crop wheat material improved fermentation and silage quality: pH, the content of butyric acids, ethanol and ammonia nitrogen showed a decrease, whereas the lactic and acedic acids were increased. All commercial biological additives – Bonsilage, Sil-All, Lalsil MS01 and Ecocorn – improved the fermentation of whole crop wheat silage under the given conditions.

The maize fermentation was good whithout additive in Estonian conditions.

References

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