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An evaluation of monopropionine as chemical additive to improve aerobic stability of corn silage

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Introduction One of the main problems on farm throughout the world is the aerobic deterioration of silages due to the action of yeast and others aerobic bacteria during the feed-out phase. High environmental temperatures may increase the growth rates of spoilage microorganisms, thereby intensifying the deterioration process (Borreani et al. 2018). Since yeasts are usually believed to initiate aerobic spoilage, additives containing antifungal components have been used to decrease their numbers and improve the aerobic stability (Da Silva et al. 2015). The aim of this study was to evaluate the effect of a new chemical additive, composed of a mixture of monoglycerides of short chain fatty acids, on the aerobic stability of whole crop corn silage.

Material and Methods Two trials were carried out on 40% dry matter (DM) whole crop corn. The fresh forage was untreated **(C)** or treated with a new additive [composed of a mixture of monoglycerides, mainly consisting of monopropionine and monobutyrin (SILO S.p.A., Firenze, IT)] applied at a rate of 0.5% fresh matter (FM) **(0.5%)**, 1.0% FM **(1.0%)** and 1.5% FM **(1.5%)**. The forages were ensiled in 20-L plastic silos with four replications and opened after 100 and 240 d of ensiling for Trial I and Trial II, respectively. At opening, the silages were analyzed for their DM content, pH, fermentative profile and microbial counts [lactic acid bacteria (LAB), yeast and mold. The DM content was determined at 60°C for 72 h, fermentative profiles was characterized in the acid extract by HPLC (Canale et al., 1984). The microbial counts were determined using the pour plate technique on MRS and YGC agar, for LAB, and for yeasts and molds, respectively. The weight losses due to fermentation were calculated as the difference between the weight of the forage placed in each plastic silo at ensiling and the weight at the end of conservation, and were expressed on a DM basis. After each opening, the silages were subjected to an aerobic stability test by continuously measuring the temperature during exposure to air. Aerobic stability was defined as the number of hours the silage temperature remained stable before increasing more than 2°C above room temperature. The aerobic stability tests were made at ambient temperature. The obtained data were analyzed for their statistical significance, via analysis of variance using version 24 of SPSS or Windows (SPSS Inc., Chicago, IL). The data were analyzed utilizing treatments as the fixed factor. When the calculated values of F were significant, the REGWF test (P<0.05) was used to interpret any significant differences among the mean values.

Results and Discussion The DM content, fermentative profile, yeast count and aerobic stability of the silages at opening are reported in Table 1. No practical differences were found in either trial concerning the pH value or the DM content between treatments. The fermentation was typical of corn silage with a 40% DM content, and showed a dominant homofermentative fermentation and a higher lactic-to-acetic-acid ratio than 4 in all the silages. The 1,2-propanediol was absent in all the silages. Butyric and propionic acids were below the detection limit (<0.01 g/kg DM) in the C treatment, whereas the treated silages revealed increasing amounts as the additive dose was increased. This was only due to an additive effect and not to microbial activity, since propionic and butyric acids were also detected immediately before ensiling after the addition of the additive (data not shown). Since the silage was extracted at pH 1.5, the additives were detected by the HPLC as free acids. The ethanol content was significantly reduced as a result of the increasing additive application in both trials. The addition of the SILO product decreased the LAB count at opening of the silage without negatively affecting silage fermentation. It could be hypothesized that the decrease in LAB occurred after they had fermented the main sugar in the plant 30 to 40 d after ensiling. The weight losses were affected by the treatments; the lower the DM losses, the higher the dose of monoglyceride additive applied. The addition of the additive decreased the yeast count below 3 $\log_{10}$ cfu/g in the treated silages,

whereas higher values than 4 log_{10} cfu/g were found in the C silages in both trials. The reduction in the yeast count was reflected in a higher aerobic stability in both trials. The higher the application dose of the additive was, the higher the aerobic stability. In Trial II, the aerobic stability of the silages was lower than in Trial I in all the treatments, when compared at the same number of yeast, and this is mainly attributable to a higher temperature during the aerobic stability test (27 vs. 21°C), as previously observed by Ashbell et al. (2002).

Conclusion A positive action of a mixture of monopropionine and monobutyrin as a silage additive to improve the aerobic stability of silages was found in a dose dependent manner. The higher environmental temperature during air exposure reduced aerobic stability. This new additive seems to be very promising to improve aerobic stability of corn silage and further investigation could be conducted to establish the cost effectiveness of the treatment and suitable management practices.

Table 1. DM, fermentative profile, yeast count and aerobic stability of corn silages in Trials I and II.

Parameters*	Trial I						Trial II					
	C	0.5%	1.0%	1.5%	*P*	SE	C	0.5%	1.0%	1.5%	*P*	SE
DM (g/kg)	40.0^{b}	41.1^{ab}	42.2^{a}	41.8^{a}	*	0.305	39.9^{b}	41.2^{ab}	42.0^{a}	41.5^{a}	*	0.277
pH	3.74^{a}	3.72^{b}	3.71^{b}	3.71^{b}	**	0.004	3.73	3.69	3.70	3.71	NS	0.0059
Lactic acid (g/kg DM)	49.2	42.1	44.2	43.9	NS	1.23	49.9	48.6	45.1	45.7	NS	0.946
Acetic acid (g/kg DM)	11.2^{a}	7.5^{b}	7.5^{b}	7.2^{b}	***	0.512	10.6^{a}	9.7^{ab}	8.8^{bc}	8.7^{bc}	**	0.259
Lactic-to-acetic ratio	4.4	5.6^{a}	5.9^{a}	6.1^{a}	***	0.212	4.7	5.0	5.1	5.3	NS	0.884
Propionic acid (g/kg DM)	0.0^{d}	1.5^{c}	3.0^{b}	4.2^{a}	***	0.494	0.0^{d}	1.2^{c}	3.0^{b}	4.2^{a}	***	0.507
Butyric acid (g/kg DM)	0.0^{d}	0.9^{c}	1.8^{b}	3.0^{a}	***	0.34	0.0^{d}	0.6^{c}	1.5^{b}	2.4^{a}	***	0.279
Ethanol (g/kg DM)	16.9^{a}	9.9^{ab}	7.4^{bc}	4.8^{bc}	***	1.39	26.8^{a}	18.4^{b}	8.8^{c}	5.7^{c}	***	2.64
LAB (log_{10} cfu/g)	6.29^{a}	5.66^{ab}	5.03^{b}	5.16^{b}	*	0.197	5.16^{a}	4.71^{a}	3.55^{b}	3.39^{b}	**	2.56
Yeast (log_{10} cfu/g)	4.29^{a}	1.83^{b}	2.81^{ab}	1.93^{b}	*	0.362	4.72^{a}	2.77^{b}	0.50^{c}	1.05^{b}	***	0.523
Aerobic stability (h)	89^{b}	141^{ab}	147^{ab}	207^{a}	*	15.6	52^{b}	67^{ab}	131^{ab}	173^{a}	*	18.5
Weight losses (% DM)	2.25^{a}	1.77^{ab}	1.38^{bc}	0.77^{c}	**	0.190	3.69^{a}	2.52^{ab}	1.53^{b}	1.16^{b}	*	0.391

*C = Control silage; 0.5, 1.0 and 1.5% = monopropionine and monobutyrin additive rate on fresh forage; DM = dry matter; LAB = lactic acid bacteria; SE = standard error of the mean.

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