The use of heat delayers in maize silage

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Nowadays maize silage is fed a lot in summer. Losses due to heating are often caused by the fact that the open surface of the clamp is often large and desiling happens too slowly (less than 1.5m/week). According to recent research in the Netherlands more than 20% of the silages are showing losses due to heating.
Nowadays several products are on the market to prevent heating such as EM Silage (Agriton), Lalsil Fresh (Lallemand SAS) (micro-organisms) or Double Action Ecocorn (ECOSYL Products Ltd = Micro-organisms + chemical preservative). These products have proven their mode of action in foreign research. The circumstances in which these products were tested are often not similar: shape of the silage, dry matter % etc… Therefore a trial was set up by LCV in 2005 based on the method of Honig. The trial was set up in the experimental farm of Bottelare of the Hogeschool Gent.

1. Material and methods

The following objects were compared:
1. Control 1 (high density: 200 kg DM/m^3)
2. Control 2 (low density: 160 kg DM/m^3)
3. EM Silage (Agriton)
4. DAEcocorn of Double Action Ecocorn (ECOSYL Products Ltd)
5. Lalsil Fresh LB (Lallemand SAS)
6. Positive control inoculant (PCI)
7. Positive control propionic acid (PCP)

Information concerning the compared products :

Product	composition	Active ingredient	Principal aim	Dose
EM Silage	Lactic acid bacteria (LAB) and yeasts	*Un known*	Optimal fermentation (pH-decline etc.) and delay of heating	1x10^5 CFU/g maize
DAEcocorn	Homofermenta-tive LAB + preservative	*Lacotbacillus plantarum MTD1 + potassiumsorbate*	Optimal fermentation (pH decline etc.) and delay of heating	1x10^5 CFU /g maize
Lalsil Fresh	Heterofermentative LAB	*Lactobacillus buchneri (NCIMB 40788)*	Delay of heating and prevention of mould-development	3 x 10^5 CFU /g maize
Positive control Inoculant (PCI)	Homofermentative + Hetereofermentative LAB	*Lactobacillus buchneri*	Delay of heating and prevention of mould – development	1 x 10^5 CFU/g maize
Positive Control Propionic acid (PCP)	Propionic acid	99% propionic acid	Delay of heating and prevention of mould-development	0.005g/g maize

The normally chopped maize (36 % DM) was homogenised and spread on a plastic sheet. Every product was sprayed at a dosage of 1% or 150 ml on 15 kg of fresh material. After mixing, the material was ensiled in micro silos (figure 1 and 2). Every treatment consisted of 5 micro silos. One density was used: 200 kg DM/m³. The control was also ensiled at a lower density of 160 kg DM/m³. The weight dynamics of the silage was followed in regard to gas and dry matter losses. Finally at desiling, samples were taken for the analysis of organic acids and the feeding value. The closed gaps in the micro silos (Figure 2) were opened 47 days after ensiling in order to simulate the entrance of air into the silage. Desiling was done after 62 days. In the next 7 days temperature was measured three times a day: at 8 a.m., 11.40 a.m. and 4.40 p.m. with a temperature probe in the middle of the isolated container (Figure 3).

Figure 1 en 2: micro silages without and with closable gaps (Experimental farm Hogeschool Gent BIOT - CTO)

Figure 3: Measurement of the temperature after desiling (Aerobic Stability according to Honig (Experimental farm Bottelare Hogeschool Gent BIOT - CTO)

Table 1: Time-schedule of the experiment

Date	**Day**	**Action**
14/10/05	0	Ensiling
22/10/05	8	Weighing
28/10/05	14	Weighing
4/11/05	21	Weighing
10/11/05	27	Weighing
18/11/05	35	Weighing
25/11/05	42	Weighing
30/11/05	47	Aerobic stress
15/12/05	62	Desiling

2. Results

2.1. Colony Forming Units (CFU) of yeasts and Lactobacillus in the tested products and in the maize

From the products on a microbial basis, counts of the CFU/ml were performed in order to verify the correct dosing of the products (Table 2).

Table 2: Colony-forming Units (CFU/g) of yeasts and *Lactobacillus* in the used products and in the ensiled maize

Sample	Yeasts in CFU/g	*Lactobacillus* in CFU/g
EM silage	$2,0 \times 10^4$	$1,0 \times 10^4$
DAE cocorn	-	$2,8 \times 10^{11}$
Lalsil Fresh	-	$9,6 \times 10^9$
PCI	-	$1,8 \times 10^8$
Maize	$5,2 \times 10^8$	$6,0 \times 10^4$

2.2. Weight losses during the ensiling phase

In figure 4, the gas losses in the different silages are given. The highest gas-losses were observed in the silage with propionic acid. The lowest gas-losses were observed in the control silage with low density and in PCI. However, in the end the differences are small.

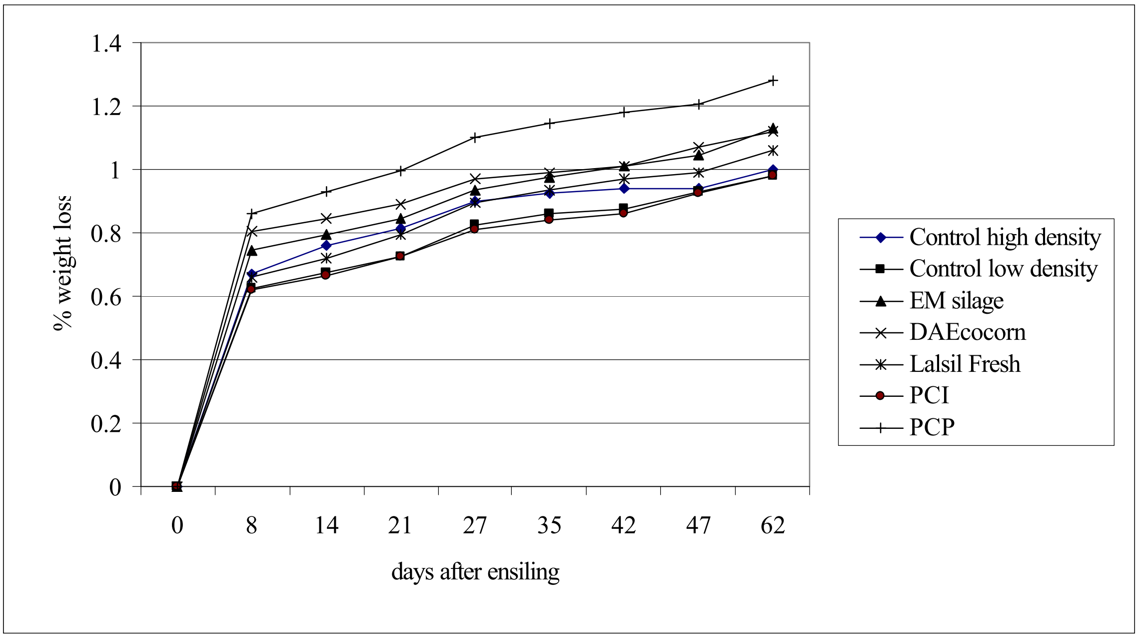

Figure 4: Gas losses in maize silage with different silage additives

2.3. Count of yeasts and moulds at desiling

Table 3: Analysis of the desiled maize

		MOULDS (CFU/g)	YEASTS (CFU/g)	pH	Acetic acid (% on F.W.)	Butyric acid (% on F.W.)	Lactic acid (% on F.W.)	Propionic acid (% on F.W.)
Control high Density	Mean	6753	14.400.000	4,15	0,50	0,0013	0,651	0,011
	St. dev	13498	9.506.489	0,03	0,06	0,0020	0,016	0,015
Control low Density	Mean	7669	9.193.333	4,15	0,51	0,0020	0,628	0,006
	St. dev	13277	7.476.104	0,03	0,03	0,0004	0,001	0,002
EM-silage	Mean	453	380.000	4,12	0,37	0,0026	0,634	0,002
	St. dev	632	326.333	0,01	0,02	0,0037	0,027	0,002
DAEcocorn	Mean	4	395.000	4,04	0,41	0,0018	0,595	0,005
	St. dev	1	538.238	0,02	0,02	0,0026	0,025	0,001
Lalsil Fresh	Mean	6	3.550	4,15	0,69	0,0000	0,581	0,012
	St. dev	2	1.353	0,03	0,09	0,0000	0,016	0,005
PCI	Mean	3878	1.365.750	4,06	0,51	0,0032	0,586	0,016
	St. dev	6194	2.230.055	0,02	0,35	0,0041	0,010	0,006
PCP	Mean	28	2.793	3,98	0,47	0,0019	0,633	0,422
	St. dev	48	2.400	0,03	0,13	0,0025	0,030	0,046
ANOVA	95%	- *	+*	+	-	-	+	+

* No normal distribution: analysis log (data)

As expected the number of yeasts was at the highest level in the control, comparable in the silages with high and low density (Table3). The maize ensiled with PCI showed also a high level of yeasts. De level of yeasts was significantly lower in the silages with PCP and Lalsil Fresh (see Table 4). This is a remarkable fact as heating is mainly caused by yeasts. A large number of moulds were measured in the control (low and high density). The lowest number of moulds was observed with DAEcocorn, Lalsil Fresh en PCP.

Table 4: Significant differences between the objects for the presence of yeasts (■ = significantly different according to Duncan (for P<0.05))

	conH	ConL	EM	DAEcocorn	Lalsil Fresh	PCI	PCP
ConH				■	■		■
ConL					■		■
EM					■		■
DAEcocorn	■						■
Lalsil Fresh	■	■	■			■	
PCI					■		■
PCP	■	■	■	■		■	

2.4. pH and concentration of organic acids at desiling

Both control silages and Lalsil Fresh had the highest pH (significantly higher than DAEcocorn, PCI en PCP). The pH of the maize ensiled with EM-silage was 4, 12 and was significantly higher than that of DAEcocorn of PCP. The maize from PCP had a pH of 3.98, significantly lower than all other objects except DAEcocorn.

For acetic acid and butyric acid, no significant differences were observed. The highest level of acetic acid was observed in the silages with Lalsil Fresh (0.69 % on a fresh matter), followed by both control silages.

For lactic acid, significant differences were observed. The concentration of lactic acid was 0.651% (on fresh matter) in the control silage with high density. This level was significantly higher than in the silages with Lalsil Fresh, PCI en DAEcocorn. The concentration of lactic acid of the control silage with low density and EM-Silage were not significantly different than the other silages. The concentration of propionic acid was significantly higher in PCP which, logic viewed the composition of the additive. EM silage and DAEcocorn had the lowest level for this parameter.

Table 5: Significant differences between the objects for pH
(■ = significantly different according to Duncan (P<0.05))

	conH	conL	EM-Silage	DAEcocorn	Lalsyl Fresh	PCI	PCP
ConH				■		■	■
ConL				■		■	■
EM-silage				■			■
DAEcocorn	■	■	■		■		
Lalsyl Fresh				■		■	■
PCI	■	■			■		■
PCP	■	■	■		■	■	

Table 6: Significant differences between the objects for lactic acid (% on fresh weight)
(■ = significantly different according to Duncan (P<0.05))

	conH	conL	EM-Silage	DAEcocorn	Lalsyl Fresh	PCI	PCP
ConH				■	■	■	
ConL							
EM-Silage							
DAEcocorn	■						
Lalsyl Fresh	■						■
PCI	■						■
PCP					■	■	

Table 7: Significant differences between the objects for propionic acid (% on fresh weight)
(■ = significantly different according to Duncan (P<0.05))

	conH	conL	EM-Silage	DAEcocorn	Lalsyl Fresh	PCI	PCP
ConH							■
ConL							■
EM-Silage							■
DAEcocorn							■
Lalsyl Fresh							■
PCI							■
PCP	■	■	■	■	■	■	

2.5. Evolution of temperature after desiling and aerobic stability

In figure 4, the evolution of temperature is given. The temperature of the control (low and high density) increased most rapidly. The control high density reached the highest temperature of all silages (± 33 C) 65 hours after desiling. The silage with Lalsil Fresh showed the slowest heating after desiling, temperature kept on increasing. The silage PCP had the lowest temperature 163 hours after desiling (± 24 °C) while this silage had the highest temperature 100 hours after desiling.

Table 8: Hours after desiling when temperature was 3 °C higher than room temperature (= aerobic stability)

Object	**# hours**
Control high density	41
Control low density	29
EM Silage	70
DAEcocorn	70
Lalsil Fresh	80
PCI	49
PCP	52

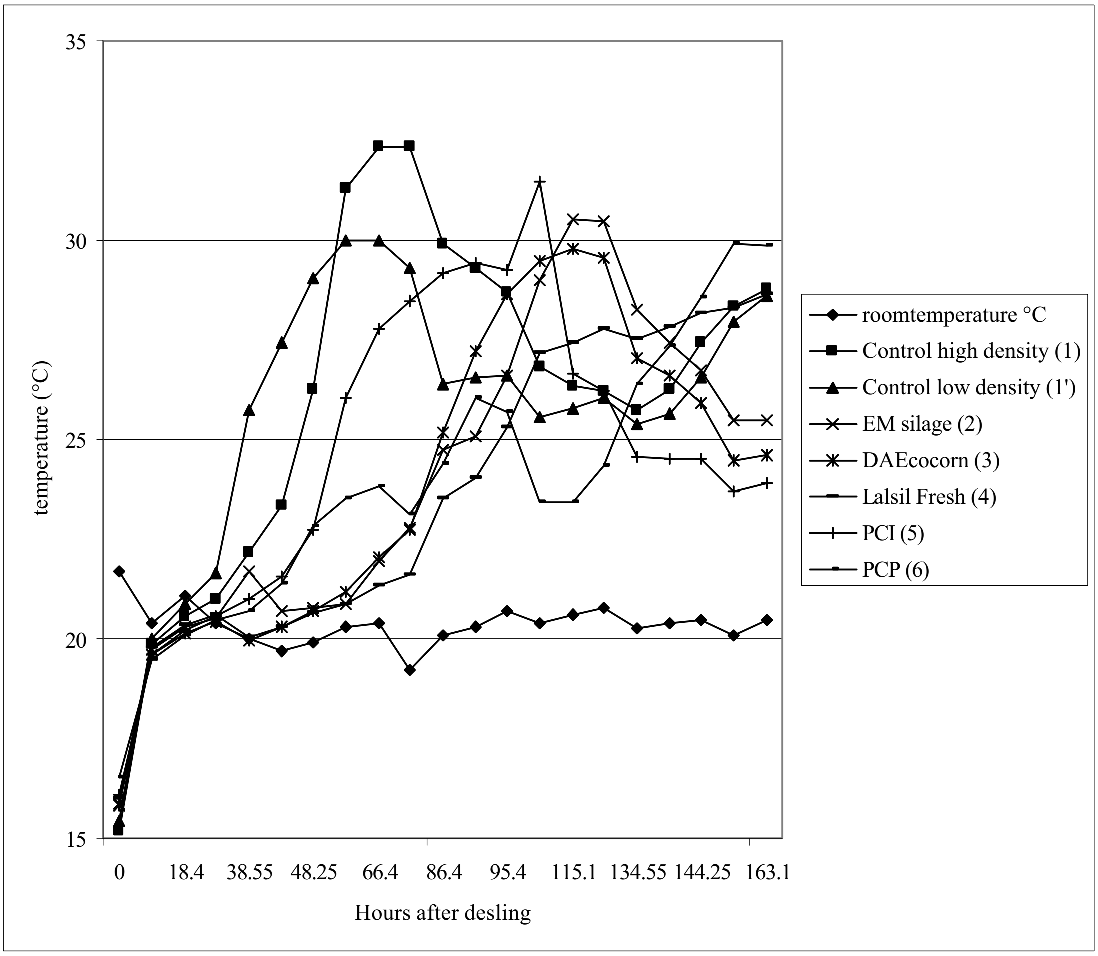

Figure 5: Evolution of temperature after desiling (°C)

In table 8 time after desiling (hours) is given when temperature was meanly 3 °C higher than room temperature. The objects "control high density" and especially "control low density" heated the quickest. The objects PCP en PCI showed also a quick heating (respectively 49 and 52 hours after opening). The silages treated with DAEcocorn en EM silage reached the limit of 3°C 70 hours after desiling. In the silage with Lalsil Fresh, it took 80 hours before the temperature rose 3°C above room temperature.

2.6. DM-losses in the ensiling period and after desiling (Table 9)

There were significant differences in dry matter content of the silages at desiling (table 4). The silage with PCP had the highest % of DM (32.83 %), this level was not significantly different from the DM-content of the silage with EM silage and the control silage with high density. The silage with Lalsil Fresh had the lowest % of DM (30.97 %), not significantly different from DAEcocorn (31.32%).

There were no significant differences in losses during the ensiling period between most objects. Only the control silage with the highest density and the silage with EM silage showed the lowest losses and were significantly lower than the other five silages.

The dry matter content 7 days after desiling is also given in table 9. On the contrary to the DM-content at desiling the control low density showed the lowest level (28.89%). The % of DM of PCP is still the highest (32.06%). The DM-loss in the first 7 days after desiling was significantly higher in the control silages compared to the other silages.

Table 9: % of DM at desiling, losses from ensiling, % of DM after 7 days and losses during the 7 days after desiling

Object	DM% at desiling	Loss from ensiling process in %	DM% 7 days after desiling	DM-loss in 7 days after desiling (%)
Controle hoge dichtheid	32.78 a	2.19 b	30.42 bc	7.19 a
Controle lage dichtheid	31.57 c	4.86 a	28.89 d	8.47 a
EM silage	32.64 a	2.15 b	31.76 a	2.65 b
DAEcocorn	31.32 cd	4.26 a	30.11 c	3.84 b
Lalsil Fresh	30.97 d	4.90 a	30.56 bc	1.33 b
Pos. Contrôle inoculant	32.18 b	3.61 a	31.35 ab	2.64 b
Pos. Controle propionzuur	32.83 a	4.92 a	32.06 a	2.12 b
1-Anova	***	***	***	****

2.7 Feeding value of the different silages (Table 10)

At desiling mix-samples were made to analyse the feeding value. No remarkable differences were observed. The percentage of crude fibre and crude ash was highest for the EM-silage (20.9%). The content of starch was also lowest for EM-silage. The digestibility was highest for the control silage with high density and lowest for the EM-silage (71.2). The differences in VEM, VEVI en DVE of the different objects were rather small . Statistical differences could not be observed as analyses were done on mix-samples.

Table 10: Feeding value of the different silages

	% CP[1]	% CF[2]	% as h on DM	% starch on DM	Digestibility [7] (% on OM)	VEM [3] (/kgDM)	VEVI[4] (/kg DM)	g DVE[5]/ kg DM	gOEB[6]/ kg DM
Control high density	7.5	19.4	4.6	33.19	73.2	916	950	44	-24
Control low density	7.6	19.9	4.5	33.68	72.6	907	937	43	-22
EM silage	7.3	20.9	4.8	30.61	71.2	894	920	43	-25
DAEcocorn	7.6	20.3	4.8	32.37	71.6	903	932	43	-23
Lallsil Fresh	7.5	19.6	4.5	33.41	72.8	913	945	44	-24
PCI	7.5	19.2	4.4	34.57	72.9	911	943	43	-22
PCP	7.7	19.8	4.7	32.73	72.5	912	944	44	-23

1 Crude protein (% on DM)
2 Crude fibre (% on DM)
3 Energy value for dairy cattle
4 Energy value for meat cattle
5 Digestible protein in the small intestine
6 Balance of degradable protein
7 Digestibility (cellulase-method De Boever) in % of organic matter

3.CONCLUSION

This trial shows that the use of specific silage additives with heating delay can give positive results. A significant lower level of yeasts was observed. This includes a minor risk for heating. The tested products considerably reduced the number of moulds. Heating after desiling was considerably delayed. Aerobic stability was enhanced with 30-40 hours. The use of these specific additives gave lower losses after desiling, a remarkable fact for practice.