Minimum temperature for successful silage making

T. M. Pauly and R. Spörndly
Swedish University of Agricultural Sciences (SLU), Department of Animal Nutrition & Management, 753 23 Uppsala, Sweden. Email: Thomas.Pauly@slu.se

Introduction For farmers, who produce silage in climatic zones, in which low temperatures (below 0°C) are common at the end of the growing season, information on the minimum temperature for the successful ensilage of forage corn would be helpful. However, this kind of information is hard to find in literature. If ambient temperature at ensilage is too low, the fermentation process is impeded. As long as temperatures stay sub zero, the unfermented forage might not markedly deteriorate. However, when temperatures rise again, maybe months later, there is an apparent risk that the forage might not properly ferment but heat up and eventually mould. The goal with this project was to get an indication on the minimal temperature for the successful fermentation of corn silage.

Materials and Methods During two successive years, fresh whole crop corn was obtained from local farmers (N 59° 58’, E 17° 31’). The forage was chopped in a precision-chop harvester and ensiled in laboratory silos (1.7 L glass jars with water-filled air locks mounted on lids). The forage was kept at a low temperature (2-6°C) until all silos were filled. After homogenizing and sampling of the fresh forage, 10 or 14 silos per storage temperature were filled and moved into climate chambers or ventilated refrigerators set at 3 or 4 different temperatures. During the first year, mean storage temperatures were 6°, 12° and 18°C and during the second year, mean silage temperatures were 2.6°, 6.7°, 13.6° and 21.1°C. In the first year, 16 silos were moved from 6°C to 18°C after 45 days to see which effect that would have on silage pH compared to silages that had been stored at 18°C from the beginning. To study the pH course during silage fermentation, 2 silos from each storage temperature were opened and sampled at 5 or 7 occasions during a storage period of approx. 60 days. Aerobic stability was determined only in the first year (according to Honig, 1990).

Results and Discussion The composition of the fresh corn material is shown in Table 1. Cobs were more mature during the second than the first year and the epiphytic LAB counts were very high compared to grass-based forages. In the first year silages were well fermented with the exception of high ethanol levels (Table 2). Aerobic stability was high (>7 days) in all these silages irrespective of storage temperature. From the course of the pH decrease in silages (Figure 1) it became evident that even at temperatures as low as 2.6° an acid formation and pH-decrease occurred. However, pH values of these silages leveled out at a much higher level as compared to silages stored at higher temperatures. When silages were moved after 45 days from 6° to 18°C ambient temperature, pH values dropped to approximately the same level as in silages stored at 18°C from the beginning. The initial pH <u>in</u>crease in silages stored at 2.6° and 6°C might be explained by a longer aerobic phase because plant respiration was restricted by low temperatures. First after oxygen is depleted, lactic acid producing bacteria may be able to grow readily and decrease silage pH.

Conclusions This experiment indicates that a fermentation process (pH decrease) occurs even at temperatures as low as 2°C. The pH-decrease was, however, much slower and final pH values leveled out at considerably higher values than in silages stored at common temperatures.

Considering the limited data on fermentation quality and aerobic stability, the minimum temperature lays probably between 2° - 6°C.

References

Honig H. 1990. Evaluation of aerobic stability. In: Proceedings of the EUROBAC Conference (Aug. 1986), SLU, Uppsala. Grass and Forage Reports 3, 76-82.

Weissbach F. 1996. New developments in crop conservation. In: Proceedings of the 11th International Silage Conference (eds.: Jones, Jones, Dewhurst, Merry & Haigh). IGER, Aberystwyth, Wales, UK. p.11-25.

Table 1. Composition of the fresh corn material. Values in g/kg DM if not stated otherwise.

Year	Lot	DM	Ash	WSC	Starch	NDF	CP	pH	BC[a]	FC[b]	LAB[c]
2008	1	213	52	61	156	511	100	5.00	2.50	41	1.3x10^{7}
2009	2	293	39	75	199	475	86	4.54	1.93	60	2.2x10^{7}

[a]BC = buffering capacity (g lactic acid to reduce pH in 100 g DM from 6.0 to 4.0); [c]FC = fermentability coefficient = DM/10 + (0.8 x WSC/BC) (Weissbach 1996); [c]LAB = lactic acid bacteria in the fresh crop (cfu/g FM).

Table 2. Composition of silages from the first year after 61 days. Silos which were moved from 6° to 18°C after 45 days (6°➞18°C) were analyzed after 106 days (= 45+61).

Storage temp.	DM	N-NH3[a] % of N	Lactic	Acetic	Butyric	Propionic	2,3-Butanediol	Ethanol
			g/kg DM					
6°C	219	6.1[a]	34[d]	16[d]	<0.6	0.3[c]	3.2[b]	19.7[b]
12°C	224	6.7[b]	50[c]	2.0[c]	<0.6	0.3[c]	3.2[b]	13.7[c]
18°C	218	7.0[c]	59[b]	29[b]	<0.6	1.3[b]	2.9[b]	10.4[d]
6°➞18°C	215	7.5[c]	61[a]	34[a]	<0.6	2.3[a]	4.6[a]	22.6[a]
Mean	219	6.8	51	25	<0.6	1.1	3.5	16.6
Prob.[c]	NS	**	***	***	NS	***	**	***
MSD[b]	183	0.81	1.8	1.8	-	0.6	0.7	2.8

[a] N-NH3 = ammonia-N in % of total N; [b]MSD = minimum significant difference between two means (p = 0.05); [c]Prob. = Probability that all treatment means are equal; NS = not significant.

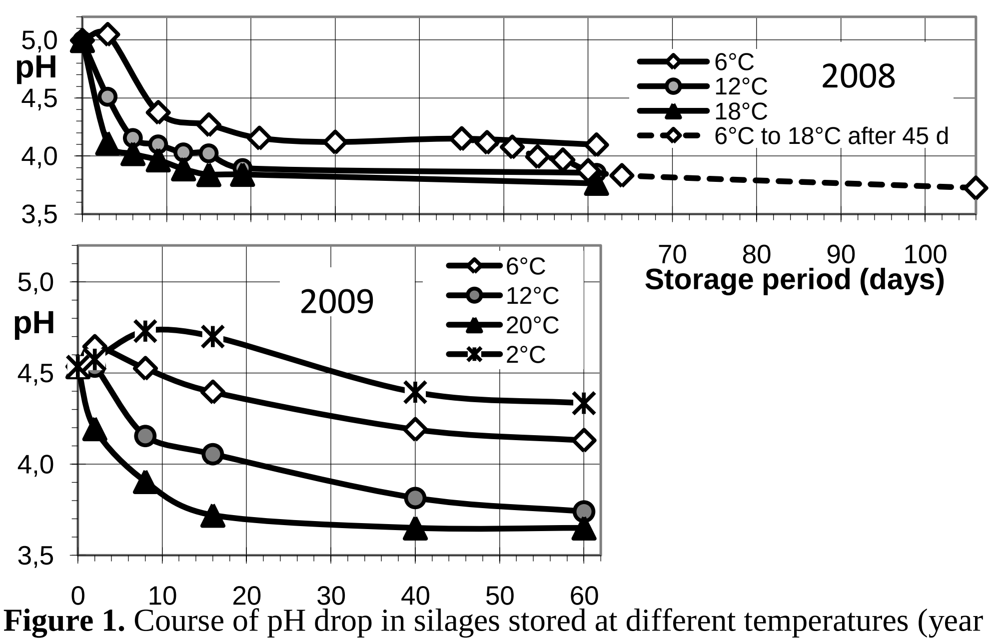

Figure 1. Course of pH drop in silages stored at different temperatures (year 2008 + 2009).