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Maize for Silage - Effects of Chop Length on Compaction, Ensiling and Secondary Fermentation

The influence of improved structural value through bigger chop lengths are currently a much-discussed issue. Apart from animal nutrition aspects, the discussion must consider the effects on silage quality for feed preservation. In the following, a 21 mm chop length is compared to 5.5 mm for silage quality and temperature development in the interior and on the silo face of tube silos.

Undesirable rises in silage temperature, i.e. secondary fermentation, lead to energy and nutrient losses and they reduce the palatability of the feed, which in turn is connected with reduced feed intake and reduced performance. The high variability in loss rates is due, among other things, to different populations of microbes, particularly yeasts, at the time of feedout [1].

The relevant literature defines a variety of criteria for undesirable temperature rises: according to [2], silage temperature increases by 5 K or more must be regarded as undesirable. The interior temperature in stabile, cooled down silos is usually between 10 and 15 °C regardless of ambient temperature. Likewise, temperature increases by more than 10 K, close to the silo face, constitute undesirable increases in temperature [3]. Other publications speak of undesirable temperature rises, if silage temperature is 10 K or more above ambient temperature [4]. [5] regard silage as unstable if it reaches a level more than 1 K above local temperature.

Undesirable temperature increases can in many cases be attributed to insufficient compaction of the forage. The officially recommended chop length for silage maize is 4 to 6 mm, which is assumed to be a prerequisite of satisfactory compaction. For reasons of ruminal physiology, however, there is a move towards greater chop lengths as a means of improving the physical structure of silage.

In the year 2003 a combined chop length and variety experiment was set up on the land of the training and research station “Haus Riswick” in cooperation with the Chamber of Agriculture North Rhine-Westphalia and Syngenta Seeds. This experiment included comparisons between surface silos with chop lengths (CL) of 5.5 mm (1.0 mm kernel processing roll clearance) and 21 mm (2.0 mm kernel processing roll clearance) of a quality-oriented maize variety (S220) with a slight “greening effect.” Despite dry matter contents of up to 43 % and an oversize fraction (percentage of particles > 25 mm) of more than 7 % in the 21 mm variant, undesirable temperature increases were noted in neither of the surface silos [6]. However, with a 4 m per week the removal rate in this experiment was very high compared to practical conditions. Therefore, the following will deal with the question whether a practical removal rate of 1.7 m per week produces the same results. For this purpose, silo bags were filled with maize chopped at chop lengths of 5.5 mm and 21 mm respectively and bagged with a uniform compaction pressure inside the bags (model ‘RotoBag’, truck version).

Material and Methods

After the silo bags had been filled, a probe was applied from above to extract forage from the bags, thus producing bore holes

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Keywords

Maize silage, chop length, compactibility, ensiling, undesirable rises in temperature

Literature

Literature references can be called up under LT 05113 via internet http://www.landwirtschaftsverlag.com/landtech/local/literatur.htm.

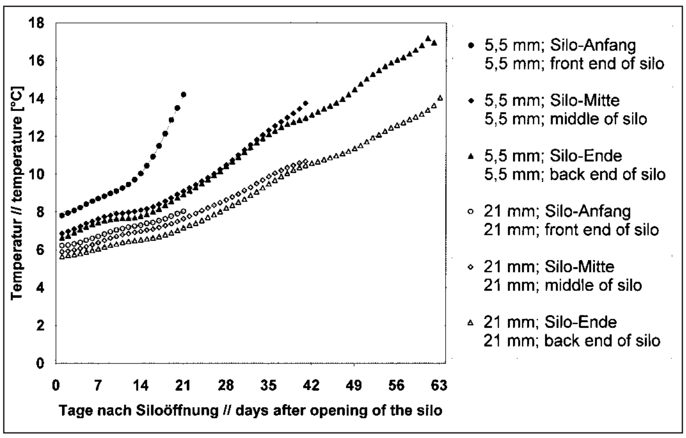

Fig. 1: Development of silo interior temperature in tube silos after the beginning of the feed-out phase

Table 1: Influence of theoretical chop length and mechanical processing on the bulk density of chopped maize in tube silos

Chop length [mm]	**5,5**	**21**
Processing roll clearance [mm]	**1,0**	**2,0**
Dry matter in fresh maize [%]	38,4	42,1
Density in surface silo [kg_{DM}/m^3]	219	188
Density in tube silo [kg_{DM}/m^3]	241	203
Fermentation quality [DLG points]	84	83

reaching the centre of the silo (equivalent to a depth of 1.20 m), into which temperature loggers were inserted. Afterwards the forage was put back into the bore holes, and the incisions in the silo bags were sealed with adhesive tape. By this procedure, three data loggers per hole were inserted at three measuring points 5 m apart (front end, middle, back end of silo) and retrieved along with the silage during the feedout phase. The density of the silos was calculated on the basis of their geometrical properties [7].

The tube silos were opened at the same time (April 2004) and unloaded at a rate of 1.70 m per week (unloading equipment: wheel loader). Thus, three data loggers were retrieved from each of the silos after 21 days. In addition to these measurements in the interior of the silos, silage temperature was measured thrice weekly at three different points (left, middle, right) of the 2.40 m-wide silo face at depths of 50 and 100 cm.

Results

The results show that increased chop length is connected with lower density both in tube silos and in surface silos (*table 1*). With later changes in shape not taken into consideration, the densities in the tube silos could be regarded as low according to [8]. However, fermentation quality was assessed as 'good' in both cases, which can be attributed to the good ensilability of maize.

Figure 1 contrasts the silo temperature development for both chop lengths from ensiling to feedout (daily unloading). There is little variation (approximately 1.7 K) in the initial temperatures measured at the time when the tube silos were first opened at the front end; initial temperatures were 7 °C on average. Silo interior temperature increases in both tube silo variants as the distance between silo face and measuring point grows smaller.

An analysis of the temperature development in the front segment of the tube silo reveals differences between the chop lengths: during the 21 days between the first opening of the tube silo and the retrieval of the first data loggers, silage temperature rose from 7.8 °C to 14.5 °C (6.7 K) in the CL 5.5 mm variant. In the 21 mm variant, silo interior temperature was lower after the first 21 days (8.2 °C), with a smaller total temperature increase (2 K).

For the middle segment of the tube silo (middle of silo) these results are confirmed only partly. There is a distance of 10 m between day 1 and day 42 (retrieval of the second set of data loggers) after the first opening of the tube silos. Despite their distance of 10 m from the front end of the silo, by the time the first loggers were retrieved from the silos (5 m), the loggers in the middle segment had already recorded temperature rises in all variants.

By the time the data loggers are retrieved from the back segment of the silo tube (back end of silo) the temperatures range between 14.0 and 17.0 °C in all variants. Thus, the temperature differences have decreased in comparison to the front end of the silo (Fig. 1).

Figure 2 depicts the temperature measurements made 50 cm into the silage at the silo faces as well as the corresponding ambient temperatures. In the 5.5 mm CL variant, temperatures of up to 28 °C were measured at the top centre of the silo face, which resulted in temperature differences of 5 K and more between measuring points. These results must be regarded as undesirable rises in temperature. By contrast, the temperature at the silo face of the 21 mm CL variant remained constant at a level of 15 °C, except during the last eight days. The temperatures measured 100 cm into the silage basically follow the same trends.

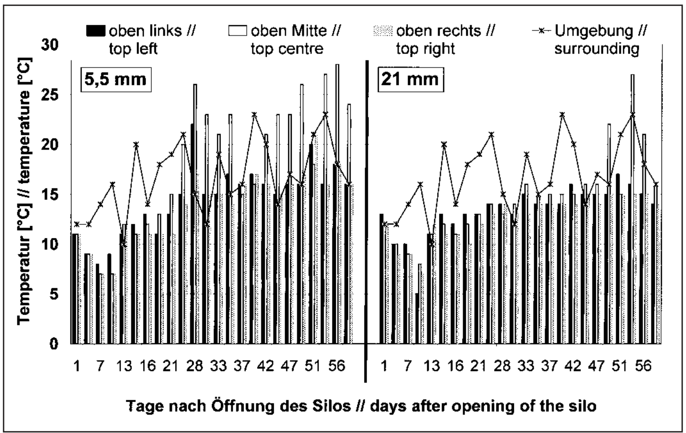

Fig. 2: Temperatures at the top of the silo face (50 cm penetration depth)

Fig. 3: Silopress machine used in the trial

Discussion and Conclusion

In neither of the chop length variants under scrutiny did the development of silo interior temperature reveal undesirable rises, with temperatures at most 3 °C above the assumed average silage temperature of 15 °C. By contrast, the temperatures at the silo face of the 5.5 mm variant must clearly be regarded as undesirable rises in temperature, especially at top centre. Due to the higher degree of compaction possible in the 5.5 mm variant, this is an unexpected result, raising questions about the uniformity of compaction inside the tube silos. On the one hand, this effect may be due to the use in this experiment of a bagging machine in which the chopped forage is transported into the silo bag by an auger (*Fig. 3*). This auger does not cover the whole diameter of the tunnel, which fact might lead to differences in compaction. On the other hand, differences in density within silage bags have been observed even where other bagging machines were used, with densities at the top centre of the silo face only 40% of densities in the middle of the tube silo [9].

Within the context of this chop-length experiment, another set of tube silos was prepared in October 2004. This time a bagging machine was used in which a rotor compresses chopped forage across the whole diameter of the silo bag. Morever, it was technically possible to integrate data loggers in the silage without damaging the silo bag [10]. Results concerning density and temperature development may be expected for one of the next editions of this publication.