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Compaction of Silage Crops in Case of Bagging Technology

The conservation of feed crops in silage bags has been developed as an alternative operating technology to clamp silos. With the development of the technology to higher throughput it can be employed in harvesting systems with higher performance. Similar to other silage technologies the crop compaction has important effect on silage quality. To evaluate the crop compaction for the bagging technology, measurements at silages of sugar beet pulp, maize and maize ear silage were made.

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Keywords

Density, compaction of ensiling material, silage bag, secondary fermentation

Silage crop compaction contributes significantly to the process of ensilage, stability and therefore quality of silage. The entirely sealed bag allows for almost perfect air tight conditions during storage, as long as the bag foil is not mechanically damaged. However, compactness of the packing has a great effect on the air exchange rate after opening the silage bag. According to [1] silage crop should be compressed to an extent that the air exchange rate does not exceed 20 l/hm^2. This leads to different recommendations for compaction, depending on the kind of crop. However, probe sampling in real-life silos shows that only about 20% of the analyzed silos have a compactness of packing as recommended. In order to assess the technology of silage bags and to compare it with other technologies, samples were taken from several farms and analyzed with regard to compactness of packing. On the one hand, the effect of dry matter content on compaction in silage bags was determined, while on the other hand the evenness of compactness across the bag's cross-section was measured.

Material and methods

An electrically driven drill was used for sample-taking, which was earlier developed at our institute. The cutting crown (inner diameter 102 mm) allows for taking samples of 50cm length, which are stored inside a tube and can be removed easily and in one peace from the silage. A second set of samples was taken using a block cutter and analyzed with regard to compactness of packing. The results were consistent to a satisfyingly high extent. The rather large diameter and the internally stepped cutting crown serve to avoid lateral expulsion of silage crop and blocking of the drilling stick. Disadvantages may be found in the large driving force due to the drill's size and the uncomfortable handling.

The samples from silage bags were taken in April 2007 and 2008, from ten different positions altogether, which are located across the bag's cutting surface as shown in *Figure 1*. In total ten samples were taken from both maize silages and beet pulp silages and seven samples from maize ear silages.

The original density was measured by weighing immediately after taking the sample, while both the dry matter content and dry matter density were determined after drying part of the samples at a temperature of 105 °C. An electronic thermometer was used to measure the silage's temperature across the cutting surface.

Results

On average, the compactness of packing for maize in silage bags was measured to be on the same level as found earlier in clamp silos. Set into relation to the original density, a compactness of between 520 and 680 kg/m^3 could be measured: Assuming a dry matter content between 32 % and 38 % this results in a density of between 180 and 230 kg/m^3 dry matter. A significant increase in dry matter density corresponding to increasing dry matter density, as it was postulated earlier,

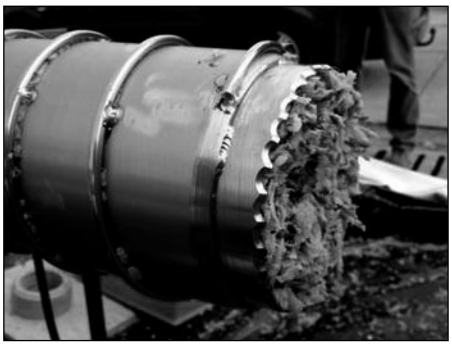
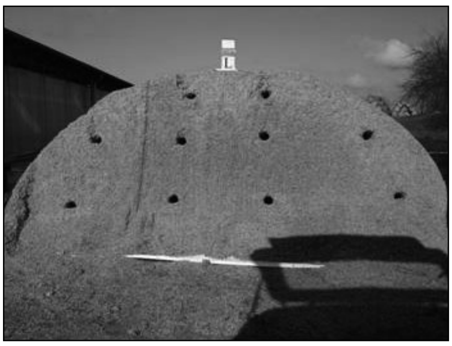



Fig 1: Filled drill (left) and positions of the cores at the transverse section of the bag (right)

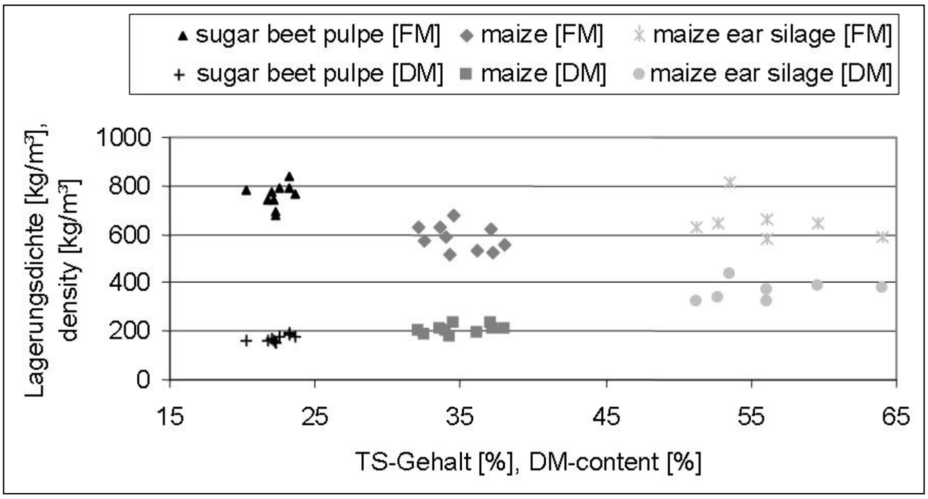


Fig 2: Density of dry matter and fresh matter, depending on the dry matter content of the silage crop (arithmetic average of ten samples)

could be found neither in clamp silos nor in silage bags. For sugar beet pulp stored in bags and a dry matter content of about 22%, density values of up to 800 kg/m? in respect to original substance were determined.

The difference in compactness of packing in core, border and upper part of the bag amounts to circa 30% between core and upper bag middle for sugar beet pulp and is therefore slightly higher as for maize or maize ear silage. For those a difference in density of circa 20 % could be found, while the average compactness was between 580 and 750 kg/m^3 in respect to original substance for maize ear silage. The higher difference between core and border in sugar beet pulp can be explained by the higher weight of silage material due to the rather high water content. Therefore the silage crop in the core is compressed more than the crop with a higher dry matter content and lower density.

A significant rise in temperature only occurred when the foil was damaged close to the cutting surface and aerial oxygen could enter the silo for a rather long time period. The highest effect is due to damage in the upper part of the bag since in this sector air can flow more easily through silage crop and small cavities.

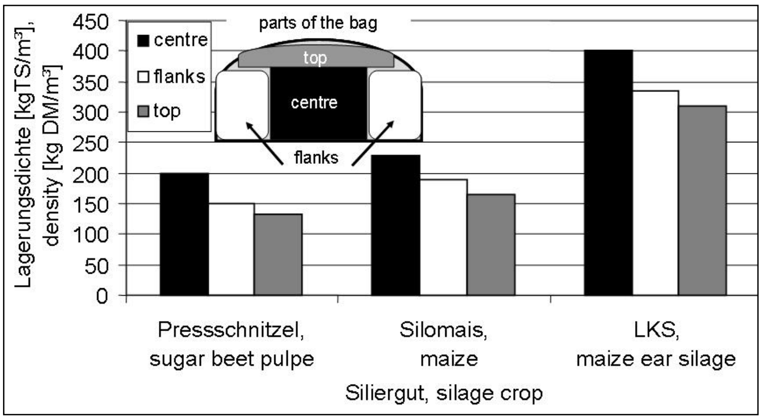
The bag foil is expanded while filling the bag and tightens again when silage is removed; therefore the foil lies closely to the silage and reduces the air flow significantly. However, an unbalanced distribution of mass can lead to cavities under the foil and therefore can increase air flow through the cutting surface.

In future we want to work on monitoring the filling process, using sensors and control the pressure automatically in order to optimize filling the bag, avoiding cavities and relieving the operator.

Conclusion

The average storage density is about the same for silage bags and clamp silos. Compared to the core, the compactness is between 20 % and 30 % smaller in the edges, depending on what kind of crop is used. The main reason for secondary fermentation, i.e. increasing temperature, can be found in damaged foil which has to be avoided by covering the bag with grids or nets. The relative small cutting surface in silo bags allows a satisfying feed rate, and therefore avoiding a rise of temperature at the cutting surface.

Fig 3: Density of sugar beet pulpe (n = 10), maize (n = 10) and maize ear silage (n = 7) at the transverse section of the bag



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