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Sugar Beet Losses during Short-term Storage in Headland Heaps

Structural change in the sugar industry has increasingly led to short-term storage of beets at the edge of the field. As a result, suitable process engineering must ensure low storage losses and a timely transport to provide a continuous supply of uniform and high quality beets to the sugar mill.

Sugar beet production represents an important source of income for agriculture in Germany. In the campaign 2002/03 country widely altogether 27 956 490 t sugar beets grew on 457 146 hectares [7].

Storage at the edge of field of sugar beets

The kind and the range of the storage at the edge of field of sugar beets is very different in Germany and in the neighbouring European countries. In Germany between 70 % (Rhineland) and 100 % (remaining regions) of sugar beets are stored at the field edge. The storage in the factory is only for bridge the gap for the days without sugar beet delivery and was replaced by "just-in-time"-delivery. Usually , the sugar beets are not stored not longer than four days at the edge of field up to the 3. quarter of November. Afterwards the storage can last, depending upon region, up to six weeks. The European-wide collection disclosed for Germany that 3% to 24% of the sugar beets stored in the heaps at the edge of field are covered. As cover material a so-called polypropylene fleece (110 g/m^2) [4] dominates.

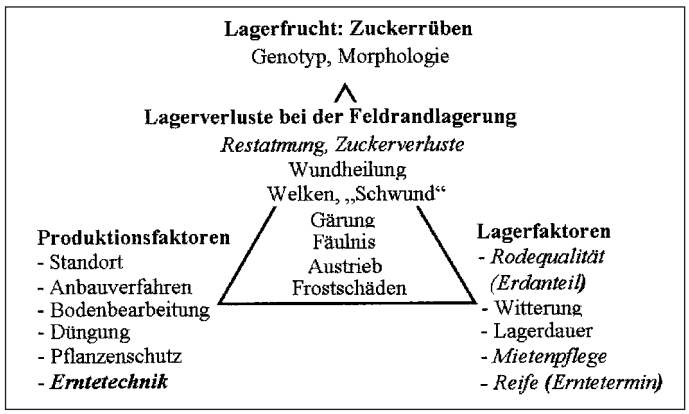

Fig. 1: Factors of influence on storage losses of sugar beets

In the other European countries 75% to 100 % of the sugar beets are stored intermediately. Thereby it is remarkable that the storage on made-up heap underground in the Netherlands, Denmark and Ireland ranges from 30 % to 75 % of the harvest [4].

Problem definition

The storage of sugar beets in heaps at the edge of field results in losses in mass, sugar content and beet quality.

Objective

In successive steps, therefore, storage losses and storage factors had to be systematised, the influence of a four-day storage of beets on sugar content had to be investigated in relation to different harvest dates (and thus to different degrees of physiological ripeness and different harvest dates in the Rhineland). These aims required simultaneous laboratory and field tests, by which it was also possible to determine the influence of harvest date, of harvest procedure, and of heap maintenance on the internal and external quality of sugar beets.

Storage losses and storage factors

The influence factors at the storage losses are represented in *Figure 1*.

Sugar losses during long-term storage vary from 33 g/(t•d) for healthy sugar beets up to 300 g/(t•d) for beets that are diseased, severely damaged, badly topped or that have been excessively fertilised with nitrogen [4, 6, 7]. Storage temperatures of 15 °C may raise sugar losses up to 800 g/(t•d) [6]. Under average Central European harvesting and storage conditions, sugar losses may be assumed to be 200 g/(t•d). *Figure 2* presents losses resulting from long-term storage for different regions of Germany [2, 5, 9].

Material and methods

In order to produce expressive results that are suitable for practical application, simultaneous field and lab tests were performed under controlled storage conditions. For the field tests, sugar beets were assembled according to "good technical practice" in heaps such as are commonly used. The factor "heap maintenance" was varied by storing the beets in heaps with and without cover (polypropylene fleece 110 g/m^2) respectively. In addition, the influence of these variants on soil tare after storage was determined.

In the lab tests, the influence of three variations of the factor "harvest procedure" ("mechanically harvested", "manually harvested and topped and intact") on residual respiration and losses in quality, mass, and

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Keywords

Sugar beets, sugar losses, short-term storage, heaps at field edge

Literature

Literature references can be called up under LT 04201 via internet http://www.landwirtschaftsverlag.com/landtech/local/literatur.htm.

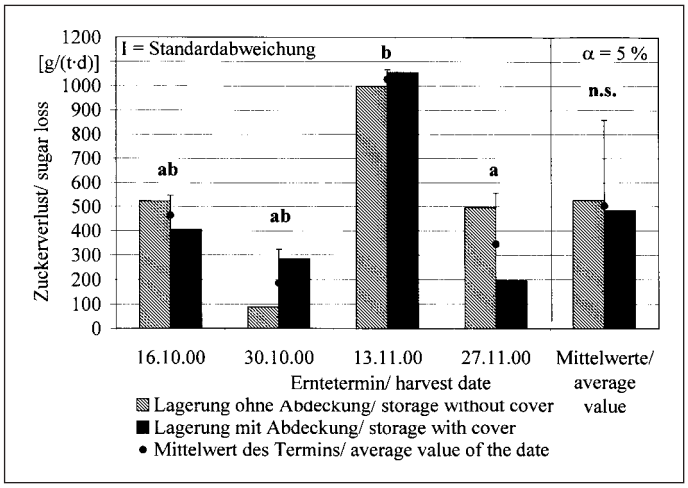

Fig. 2: Sugar loss depending on harvest date, storage variant in the field tests, duration of storage four days

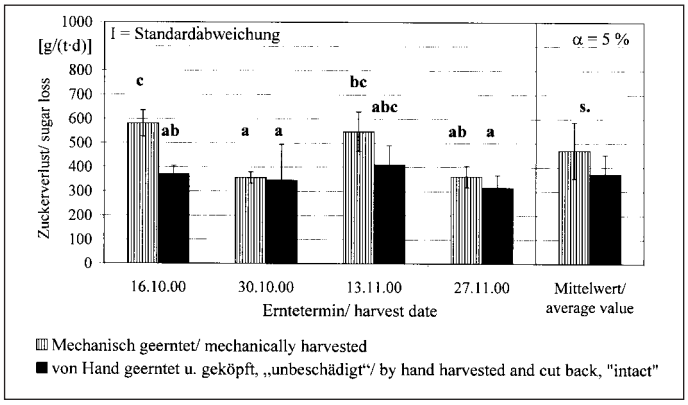

Fig. 3: Calculated sugar loss depending on harvest variant and harvest date in the laboratory tests, duration of storage four days

sugar content was examined under the conditions of the climate, typical for the Rhineland. A comparison of the results from the parallel field and lab tests showed to what degree the work-intensive field tests can be replaced by lab exact tests.

Results of field tests

Influence of the harvest date

The sugar content at the time of storage was 17.41 % on 16 October 2000, rising throughout the consecutive harvest dates, it reached 19.02 % on 27 November 2000. The sugar content before storage was insignificant different from the sugar content after four-day storage.

The average sugar losses for each test period are represented in Figure 1. Depending on the harvest date, average sugar losses varied between 88 and 1055 g/(t•d), and their variation remained relatively insignificant.

Influence of heap maintenance

In the 2000 harvest, the average sugar losses for all harvest dates (*Fig. 2*) amounted to 526 g/(t•d) in storage without cover and to 484 g/(t•d) in storage with cover. Covered storage resulted in a slight but insignificant reduction in sugar losses during four-day storage.

The soil tare during storing at harvest differed significantly from the soil tare after storage, both with and without cover, and subsequent cleaning and loading. Covering the four-day storage pile did not result in any significant reduction of soil tare. Neither did soil tare differ significantly between storage with and without pile maintenance.

Region	Cover-material	Time of storage	Ø Sugar losses [g/(t•d)]		Change of losses through covering
			without cover	with	
		[d]			[%]
South-Germany	Plastics *	30	371	209	- 44
	Fleece	93	415	145	- 65
Nordrhein	Fleece	15-28	230	210	- 9
North-Germany	Fleece	43	102	113	+ 10
	Chopped straw	43	102	136	+ 25

* PVC-Foils, PE-Cover and PP-Fleece
Source: Südzucker, Rheinischer Rübenbauerverband, Nordzucker

Table 1: Sugar losses of long time sugar beet storage in Germany

Test results of the lab tests

The storage temperature chosen for the lab tests was the long-term average daytime temperature of the Rhineland region. Only at the last harvest date did the current daytime temperature differ significantly from the long-term average. The sugar losses were determined both by means of a sugar content analysis (in analogy to the field tests) and via CO_2-production according to the equation: .

1 ml CO_2 $\hat{=}$ 2mg CO_2 $\hat{=}$ 1.4 mg sugar [1]

Influence of the harvest procedure

On the harvest dates, the sugar losses as determined by sugar content analysis ranged between 251 and 1709 g/(t•d) for the commonly used variant "mechanically harvested", amounting to an average of 967 g/(t•d).

The results of the computations of the sugar losses are presented in *Figure 3*. The sugar loss in the "mechanically harvested" variant amounted to 470 g/(t•d), that of the "manually harvested and topped, intact" variant to 371 g/(t•d). Superficial lesions have a significant influence on sugar losses, if beats are subsequently stored for four days.

Summary

In a comparison of mean values for the common harvest variety "mechanically harvested" the sugar losses in the field tests amounted to 526 g/(t•d) in the case of storage without cover and to 484 g/(t•d) in the case of storage with cover, whereas the sugar loss in the lab tests amounted to 967 g/(t•d) according to the calculation on the basis of sugar content and to 470 g/(t•d) according to the calculation on the basis of CO_2-production. The difference between the mean sugar losses as established in the field tests and the sugar losses as determined on the basis of CO_2-production was 35 g/(t•d).

The sample of 12 beets was too small for a determination of the sugar content by means of sugar analysis. The test results prove that the determination of sugar losses in lab tests which analyse the gas metabolism of 12 beets are sufficiently exact to replace field tests of sugar losses.

In the case of four-day temporary storage, the sugar losses of the mechanically harvested beets range from 470 to 526 g/(t•d), which is above the sugar losses assumed for long-term storage in Central Europe.