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Secondary Fermentation of Forage Maize Silage

Effect of Chop Length

That quality losses through secondary fermentation are closely correlated to insufficient compaction of the harvested material was proven in a survey in practice. One aspect of this survey was testing the chop length distribution through size analysis, in order to determine the relation between secondary fermentation, compaction and chop length. Decisive in the discussion on longer chop length, from an animal physiology perspective, is determining the digestibility of the small particle portion, while from an ensiling perspective, the compactibility decreases with a higher percentage of oversize material.

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Keywords

Forage maize silage,secondary fermentation, chop length, particle size distribution

Literature

Literature references can be called up under LT 04202 via internet http://www.landwirtschaftsverlag.com/landtech/local/literatur.htm.

Quality requirements for silage are usually defined with reference to minimise energy losses, which depends on the composition of the microflora in the silage. Depending on ensiling conditions, there are increases in desirable microbes (lactic acid bacteria) or in undesirable ones (clostridia, mould, yeasts).

Secondary Fermentation

Temperature increases in the silage at the silo face before feed-out (secondary fermentation) result in the following changes in quality:

- energy losses due to aerobic metabolic processes in the feed,
- depressed feed consumption due to changes in palatability,
- increases in mycotoxins in the feed resulting from fungus growth.

Temperature increases of 10 °C cause energy losses of 0.1 MJ NEL per kg dry mass and day [1].

The ensiling process is influenced, first, by the nature and composition of the fresh forage, e.g. by contamination and dry matter content [2]. Second, measures for the maintenance of anaerobic conditions in the silo, e.g. adequate chopping, compaction and feed rate, are of particular importance.

Compaction, being the prerequisite not only for the onset of fermentation but also for the minimisation of oxygen infiltration through the silo face at feed-out, is the decisive criterion for avoiding secondary fermentation. Increased chop lengths raise chopping performance, but they also necessitate more effective compacting [3].

As regards quality-assuring measures, agricultural consultants base their recommendations on standard values [1]. These, however, do not differentiate between the specific quality requirements of individual farms, although the importance of the individual influencing factors depends on the required storage time. Long-term stable silage, as round the year in-door keeping of livestock depends on, requires deeper consideration of quality-securing measures than does short-term stable silage (winter in-door keeping).

Chop Length

The compactibility of silage is captured as dry mass content and chop length, with theoretical chop length (setting on the chopper) to be differentiated from effective chop length (actual length of chopped material).

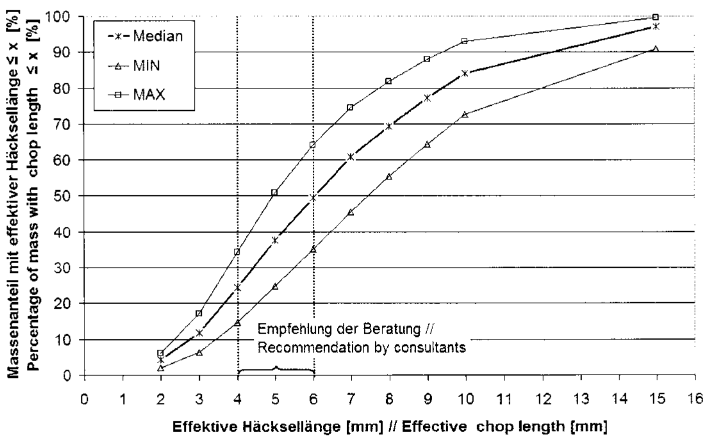
According to agricultural consultants' current recommendations for maize, choppers should be set at 4-6 mm theoretical chop length (in the sense of the desired particle size) in order to ensure optimum ensilability. Although short chop lengths are advantageous in the ensiling process, the possibility of size reduction is limited by the requirements of structural value in ruminant feed [4]. For reasons of animal physiology, therefore, and for the sake of increases in structural value and feed intake, considerably longer chop lengths (theoretical chop length of 15-20 mm) are being considered at present [5]. Detailed scrutinies must determine the degree to which chop lengths can be increased without unacceptable consequences for the ensilability of fresh forage or for the long-term stability of silage.

Field Survey

In a field survey of „Secondary Fermentation in Maize Silage,“ undertaken by the Chamber of Agriculture Rhineland and by the Chamber of Agriculture Westfalen-Lippe in order to call attention to possible shortcomings and unused potential in feed conservation, sampling and temperature measurements were performed at 63 farms in North Rhine-Westphalia [1].

One aspect of this survey was the characterisation of chopped forage by sieve analysis. This served the purpose of investigating the influence of chop length on secondary fermentation, of comparing theoretical chop length and effective chop length, and of characterising the oversize fraction.

The chop length distribution was analysed by means of a sieve stack, consisting of flat sieves with circular holes between 1 and 15 mm in diameter. The system delivers eleven



mm	< 2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-15	>15
Mass %	4,3	7,5	12,2	13,3	12,4	11,0	8,9	7,9	6,6	12,7	3,7

Fig. 1: Distribution and cumulative frequency. Results of chop length analysis of whole plant maize (n of farms = 63)

fractions; the sifting takes 3 minutes. Small gradations in hole diameter were used in order to facilitate the comparison with other studies.

Prior to sifting, the samples were dried at 100 °C for 12 hours. After sifting, the fractions were weighed and the mass percentages were calculated.

The results of the sieve analysis (*Fig. 1*) show that an average of 37 % had effective chop lengths exactly between 4-6 mm, which is the chop length currently recommended by agricultural consultants as the desired chop length for good ensiling properties. An average of 50 % was longer than the theoretical chop length of 6 mm, with the results for individual farms varying by up to 25 %. The fine fraction (< 4mm), which is used to evaluate structure, made up an average of 24 %. The fine fraction is classified on the basis of scientific recommendations. Based on these, mass percentages below 50 % are to be judged as 'okay,' whereas those between 50 % and 70 % are deemed 'acceptable' and those between 70 % and 90 % are 'undesirably high.'

These results are difficult to compare with those of similar investigations (*Table 1*) because of the variety of sifting methods used. By comparing the results achieved with the theoretical chop length set at 4 mm, however, an approximate assessment of the results of this study in the context of those of other studies is possible. For the fine fraction (< 5 mm), the latter determined mass percentages of 71 % [6] and 68.0-80.0 % [7]. By contrast, in the field survey under discussion (assuming a theoretical chop length of 4 to 6 mm) the mass percentage of the fine fraction was much lower 37.3 % (Fig. 1). Raising theoretical chop length from 4 mm to 7 mm reduces the mass percentage of the fraction < 5 mm from 71 to 52 % [6] (Table 1).

Characterising the Oversize Fraction

According to the sieve analysis, the average mass percentage of the oversize fraction (particle size = 15 mm) was 3.7 %. According to scientific recommendations, oversize fractions with a mass percentage of 1 % can be classified as 'very good' and those with a mass percentage above 7 % as 'too high'. Thus, the 3.7 % determined in the present study could be classified as 'satisfactory'.

By visual classification, the fraction = 15 mm was subdivided into the components leaf, stem, cob, and 'unidentifiable material'. This classification was undertaken to enable conclusions on problems during chopping or compaction. On examination, it became clear that, on average, the greatest part of this fraction can be identified as cob fragments. However, a substantial part of the oversize fraction consisted of particles which, though clearly shorter than 15 mm, formed greater units by agglutination. Thus, there is an error inherent in the rapid determination of particle size distribution by sieve analysis, which has also been noted in similar studies of separation [10]. Agglutination of the material can be put down to the high drying temperature of 100 °C. Experiments showed that it is possible to reduce agglutination almost to zero by pre-drying the samples at 60 °C for four hours before they are dried at 100 °C for twelve hours.

The evaluation of the field survey carried out in North Rhine-Westphalia was unable to find a direct correlation between chop length, compaction and secondary fermentation. Although the large number of farms made it possible to draw conclusions about practical problems, it was impossible to establish a clear relation between the diversity of harvesting and ensiling techniques and their effects. An analysis of the influence of chop length on compactibility and, implicitly, on secondary fermentation requires research based on one standardised degree of compaction.

Autor, Jahr // Author, Year	Theoretische Häcksellänge [mm] Theoretical chop length [mm]	Effektive Häcksellänge [mm]// Effective chop lenth [mm] Fraktion [mm] Category [mm]	Massenanteil [%] Mass [%]
Honig & Rohr,	4,0 *	< 5,0 ; > 20,0	71,0 ; 10,0
1982 [6]	7,0 *	< 5,0 ; > 5,0	52,0 ; 7,0
De Boever et al.,	4,0	< 4,8 ; > 9,5	68,0-80,0; 2,2-14,2
1993 [7]			
Kononoff, 2002 [8]	17,0	< 8,0 ; > 19,0	11,6 ; 14,3
Johnson et al.,	11,1 *	< 8,0 ; > 19,0	9,8 ; 11,5
2003 [9]	27,8 *	< 8,0 ; > 19,0	14,1 ; 41,2
	39,7 *	< 8,0 ; > 19,0	14,0 ; 58,1

* mit Aufbereiter // with mechanical processing

Tab. 1: Results of chop length analysis of whole plant maize silage

Conclusions

The survey has shown that there are shortcomings in the ensiling methods currently applied. Experiments under standardised conditions are needed to determine whether increased chop lengths should be recommended in the future and to find out what effect chop length has on compactibility. It is subject to discussion whether the advantages arising from greater structure value are outweighed by the disadvantages resulting from ensiling losses. Research on secondary fermentation as depending on chop length and feed rate is a further important step towards quality management in large silos.

Before new recommendations are published, there must be a particularly thorough investigation of this problem because ensiling losses, in addition to causing economic losses, lead to the contamination of livestock and livestock products with mycotoxins, which implies considerable consequences for consumers.

Consequent to the introduction of QS for beef, certification is intended to integrate dairy farms into the Quality Assurance System of dairy factories [11]. With the introduction of a Quality Assurance System for milk, the quality of basic rations is becoming more and more important.