THE CHOPPING QUALITY OF SILO MAIZE

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ABSTRACT

For obtaining high quality silages through a positive development of the biological processes, for stimulating the gastric microfauna and for reducing the losses caused by putrefaction, the silo maize must be chopped. The chopping quality is usually estimated by the theoretical length „l_t" established in conformity with the kinetic parameters. In reality the medium chopping length „l_m" is longer than the theoretical chopping length „l_t" as the real length is also influenced by other factors, unquantified according to the calculation formula for the theoretical chopping length.

Key words: chopping quality, silo maize.

QUALITY INDICES

Today, the lack of silo maize in the rational feeding of beef and milk cattle is almost inconcivably. This silo maize is considered a valuable fodder both from its nutritive value and the production point of view.

The importance of the silo maize in the food of the animals is pointed out by the continuous expansion of the areas under these crops in the most of European countries.

The silo maize chopping degree must be established according to many other factors, both those which determine the gastric microfauna stimulation diminishing the losses through putrefaction and those which favourize a high quality silage.

By reducing the chopping length at the fodder plants, for silage, a better mixing between stems, leaves and grains is provided as well as a better compaction and so the air from the spaces betweem the fractions is eliminated for a positive development of the microbiological process.

Yet, a too short chopping length causes an abundant juice separation and has as a result a great energy consumption.

A chopping length between 6 and 20 mm is recommemded.

For establishing the quality of the chopping material the following parameters are presently used:

- the chopping degree, „G_1";
- the theoretical chopping length (adjusted), „l_t";
- the effective average chopping length, „l_m";
- the coefficient of variation for the length of the chopped material, „C".

The chopping degree is calculated with the formula:

$$Gt = \frac{M_{tz}}{M_t} \cdot 100$$

where:

M_{tz} = the mass of the chopped stems at a conventional length taken from the sample, in g;

M_t = the total mass of the sample, in g.

The measurements for determining the chopping degree must be repeated three times at least. The minimum chopping degree must be between 75 and 80 %. The chopping quality is estimated by the chopping length parameters pointed out previously and it is good if more than 80 % from the chopped material has the length up to 20 mm.

It is known nowadays that a series of performant chopping apparatuses have been released which present facilities in adjusting the theoretical chopping length.

The chopping quality is estimated usually through the theoretical chopping length „l_t".

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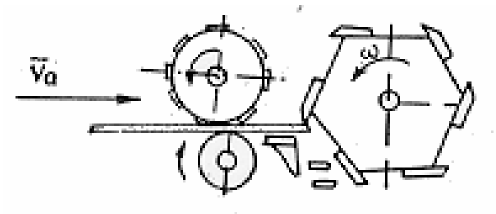

Figure 1. The design for determining the theoretical chopping length

According to figure 1, the theoretical chopping length is calculated with the formula:

$$l_t = \frac{v_a \cdot 60}{n \cdot z}$$

where:

v_a = the feeding speed, in m/s;

n = the number of rotations of the cutterhead, in rot./min.;

z = the number of knives.

THE ANALYSIS OF THE SILO MAIZE QUALITY

In reality, the average chopping length „l_m” is longer than the theoretical chopping length „l_t”, as the real chopping length is also influenced by other factors which have a significant influence upon the quality of the chopped material.

Among these factors, the most important are:

- the feeding capacity;
- the diameter of the maize stems;
- the moisture content of the material subjected to chopping;
- the thickness of the material layer;
- the material orientation towards the cutterhead;
- shearbar clearance distance;
- knife dullness.

In the case of the silo maize, the chopped material represents a mixture of stems, leaves and grains. For determining the average chopping length and the division in dimensional classes, the chopped mass passes through a separator with sieves whose holes are smaller and smaller on the vertical plan and, also, the direct measurement method is used.

The used dimensional classes are:

- 0 ... 10 mm;
- 11 ... 20 mm;
- 21 ... 30 mm;
- 31 ... 40 mm;
- 41 ... 50 mm;
- over 50 mm.

For a comparative study of procedures for analysing the quality of the silo maize chopping, samples from the chopped material were taken, the moisture content for the silo maize stems at harvest being between 72 and 74% and the results that were obtained can be seen in table 1.

Having as a base the division of the chopping material samples in dimensional classes, obtained at a rotation number of the cylindrical cutterhead of n = 1000 rot./min. and a feeding speed with vegetal material of v_a = 0.87 m/s, the qualitative parameters of the silo maize chopping can be calculated:

- the theoretical chopping length:

$$l_t = \frac{2 \cdot p \cdot v_a}{? \cdot z} = 8.7\ \text{mm};$$

- the average chopping length:

$$l_m = \frac{\sum_{i=1}^{n} l_i \cdot m_i}{\sum_{i=1}^{n} m_i} = 12.6\ \text{mm}$$

- the variation coefficient of the chopping material length:

$$C = \frac{s_m}{l_m} \cdot 100 = 87\%,$$

where:

m_i = the mass of the fractions from the dimensional class „i”;

l_i = the average length of the fractions from the dimensional class „i” (the centre of the experiment;

σ_m = mean square deviation.

In analysing procedure of the chopping quality of the material, through the division in dimensional classes, the length of the fractions from the marginal classes can have a great influence in the calculation of the average (arithmetical) chopping length.

The distribution of the frequencies has the form of a curve making a surface together with the abscissae-axis (Figure 2).

The indicator that divides the collectivity effective (the mass of the chopped silo maize), arranged by the characteristic size criterion, in two equal parts is the position average M_e (the median):

$$M_e = x_0 + d \cdot \frac{(\sum f + 1)/2 \cdot \sum f_a}{f_m} = 9.5\,\text{mm}$$

Calculating the median, with the two quartiles, the inferior quartile Q_i and the superior quartile Q_s, the values of the marginal elements that can have a great influence upon the calculation of the average chopping length are excluded.

Σf_a = the sum of the frequencies previous to the median interval;

f_m = the frequency of the median interval;

Δ_1 = the difference between the frequency of the dominant interval and the frequency of the preceding interval;

Δ_2 = the difference between the dominant interval frequency and the next interval frequency.

Table 1. The analysis of the silo maize chopping quality

0...5 mm	6...10 mm	11...15 mm	16...20 mm	21...25 mm	26...30 mm	31...35 mm	36...40 mm	41...45 mm	46...50 mm	51...55 mm	> 55 mm
21%	32%	19%	14%	3.6%	2.6%	2.2%	1.4%	1.2%	1%	0.9%	1.1%

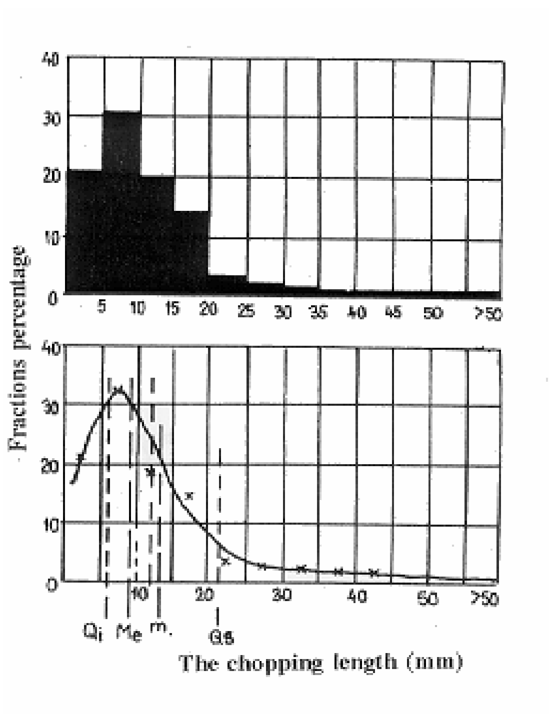

Figure 2. The distribution of the chopped silo maize mass in dimensional classes

The calculation formula of the two quartiles, inferior Q_i, superior Q_s, and of the dominant Δ_0 are:

$$Q_i = x_0 + d \cdot \frac{(\sum f)/4 - \sum f_a}{f_{Q_i}} = 6\,\text{mm}$$

$$Q_s = x_0 + d \cdot \frac{(3 \cdot \sum f)/4 - \sum f_a}{f_{Q_s}} = 16\,\text{mm}$$

$$\Delta_0 = x_0 + d \cdot \frac{\Delta_1}{\Delta_1 + \Delta_2} = 7.2\,\text{mm}$$

where:

x_0 = the inferior limit of the interval;

d - the size of the interval;

The calculation of the median with the two quartiles, inferior and superior, is made in a very simple way and gives the advantage of a more rapid evaluation concerning the quality of the chopped silo maize mass.

Having in view the calculated values for the two quartiles the result is that 75% from the chopped material mass has a length shorter than 16 mm, 25% from these having a length shorter than 6 mm.

So, it can be concluded that the total mass of the chopped material is made of three partial masses like:

$$m = \sum_{0}^{l_1} m_i + \sum_{l_1}^{l_2} m_i + \sum_{l_2}^{l_{max}} m_i$$

The first term of the sum represents the subdimensional chopped mass, the second represents the chopped mass at the imposed size and the third term represents the oversize chopped mass.

The asserted problems are that of determining the value of the parameters for the chopping process for reducing the subdimensional chopped mass which consumes a suplimentary energy and that of reducing the mass of the oversize chopped material which do not meet the quality requirements.

With all the objectivity of each previously enumerated methods as regarding the analysis of the chopping quality, these methods can lead to different results, thus the option for one or another method includes both technical, technological and economical aspects.

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