A simple method for the correction of fermentation losses measured in laboratory silos

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Introduction Dry matter (DM) losses caused by formation of gaseous fermentation products can be measured by different methods. The most common method (A) is measuring the difference between the DM input and output of a silo. Other methods are based on the measurement of the fermentation gases which spontaneously leave the silo, either directly by collecting them (B) in a special absorbent like KOH or, much more easily, by weighing the filled silo at the beginning and the end of the fermentation process (C). The figures obtained by B and C are substantially smaller than those by A. This difference represents a certain amount of CO_2 which is retained within the silage. The objective of this paper is to deduce a procedure for estimating the amount of this retained CO_2 so that the results obtained by method C (or B) can be corrected.

Materials and methods Berg (1971) carried out extensive and well documented investigations on the formation of gaseous fermentation products in silages from different kinds of crops at different DM contents. By means of special techniques he measured several gas fractions: the CO_2 that spontaneously left the silo (I), the CO_2 escaped from the silo under evacuation (II), the CO_2 released during drying the silage samples (III) and finally a small amount of other gases (IV) which spontaneously left the silo but were not absorbed in KOH. The total of fractions I to IV is the fermentation loss. The sum of I and IV is the weight loss of the silo during fermentation. The sum of II and III represents the CO_2 retained in the silage. Table 1 shows the mean results from 70 of such experimental balances. These data were used to estimate the retained CO_2.

Table 1 Fractions of gas produced in the silo*

Fraction	Amount as % DM ensiled	
	Mean	Range
CO_2 (I)	7.7	1.6 ...16.0
CO_2 (II)	1.3	0.8 ... 2.1
CO_2 (III)	1.2	0.4 ... 2.2
NO, H_2 etc. (IV)	0.4	0.2 ... 1.1
Total	10.6	4.4 ...19.8

Table 2 Retention of CO_2 in silage*

Crop	DM %	n	retained CO_2	
			g/kg H_2O	g/kg DM
Beet tops	11.8	4	4	26
Green rye	11.8	5	3	20
Cabbage	13.0	3	6	41
Red clover	14.1	5	6	36
Potatoes	15.0	5	3	15
Grass	15.6	5	6	31
Maize	16.7	4	5	23
Sugar beets	18.7	5	4	19
Lucerne	19.2	4	7	28
Potatoes	20.8	4	4	14
Grass	20.9	3	6	24
Sugar beets	22.5	3	5	16
Grass	34.9	3	15	29
Lucerne	39.8	5	15	23
Grass	50.5	12	27	27
		Mean	**7.7**	**24.8**
		Standard deviation	6.5	7.6
		Coefficient of variance	84%	31%

*Source of data: Berg, 1971

Results Mean figures for the CO_2 retention (fraction **II** plus **III**) in the silage from the individual experiments are given in Table 2. The figures are listed in the order of DM content. The retained CO_2 was calculated per kg water or, alternatively, per kg DM ensiled. The CO_2 retention in the silo was not related to the quantity of water but to the quantity of DM. An approximately constant amount of CO_2 was retained per kg DM, obviously adsorbed by the surface structures of the solid phase in the silage. The variation in this amount may be explained by differences in the composition and microstructure of individual herbage materials. If only gramineae and legumes are included, the coefficient of variance decreased from 31 to 18%.

Conclusions The results of the present study show that the adsorbed CO_2 on average amounted to 2.5% of the ensiled DM. Consequently, in laboratory silos without air entrance and effluent outflow the fermentation losses (*FL*) can be calculated from the weight difference between the beginning and end of fermentation (*WD*) by the following equation:

$$FL[\%] = 100 \frac{WD[g]}{DMensiled[g]} + 2.5$$

Reference

Berg, K. (1971). Die Trockensubstanzbestimmung von Silagen und die Erfassung flüchtiger, den Futterwert beeinflussender Verbindungen sowie Modellversuche zur Ermittlung der Gärverluste. Dissertation, Deutsche Akademie der Landwirtschaftswissenschaften, Berlin, 97-145.