UDK 633.2/.3:581.19:621.384:681.3

B. Butkute, doctor

Lithuanian Institute of Agriculture

VARIATIONS IN AND EFFECTS OF HARVESTING YEAR AND ENSILING DATE ON QUALITIES OF GRASS AND MAIZE SILAGES

ABSTRACT

The aim of the present work was to compare nutritive value of grass silage produced during 1998-2006 and maize silage produced during 2004-2006 and to estimate the effects of ensiling time and year on forage quality. Compared with grass silage quality variation, maize silage quality is less variable. According to average values of many quality indicators maize silage quality increased annually: starch, crude fat, metabolisable energy concentrations increased, whereas fibre contents declined. Average grass silage quality of each year varied inappreciably, but the silage fermentation quality improved annually. Grass silage was characterised by the best feeding value when produced until May 20, and later metabolisable energy, crude protein and organic matter digestibility declined until the period of June 21-25. Harvesting date also affected maize silage quality, but not so markedly.

INTRODUCTION

Silage is produced from different plant species at different stages of maturity using different silage making technologies. As a result, this forage type is subject to great variability regarding its quality. For most herbaceous crops, forage quality decrease with maturity, i.e. fibre levels increase, protein and digestibility decrease (Butkute, Paplauskiene, 2004, Rinne, Nykänen, 2000). Maize quality variation regularities are different than those in cool-season grasses. In maize most of the energy is in the grain and immature crops have a lower proportion of grain in the silage (Lauer, 2005). CP concentration declines with increasing maturity, averaging a drop of 2 percentage units from soft dough to no milkline and fibre concentration declines from soft dough to 1/2 milk line (Wiersma *et al*., 1993). Maize grown under the low-yield drought conditions has higher CP, lower fibre concentration than that in more temperate year (Crasta et al., 1997; Wiersma *et al*., 1993). The aim of this research was to summarise the data of silage analyses of several years and to estimate the effect of harvesting time, and year on the quality of grass and maize silage produced on Lithuanian farms.

Materials and methods. In the current study we discuss results of silage analyses that include quality of grass silage produced on individual farms and agricultural partnerships before end of June 1998-2006 and of maize silage produced in 2004-2006. Samples of undried, unground grass silage and dried, ground maize silage were analysed by near infrared spectroscopy (NIRS). Fresh grass silage samples were scanned on a monochromator NIRS 6500 (Perstorp Analytical, USA) equipped with a Transport Module by using high moisture / high fat cell. Silage samples of natural moisture are well mixed, chopped into particles not larger than 3 cm, and wrapped in the cling film 235/0412/03 from Merck. The samples were scanned with three repetitions. The reflectance spectra (log 1/R) from 400 to 2500 nm were recorded at 2-nm intervals. Quality of grass silage was predicted by the equations, developed at the Laboratory of Agricultural Advisory Service (ADAS, England). Here we analyse the data of prediction, recalculated to the indicators of grass silage quality which are used for the ration formulation. Samples of maize silage were dried at (65±5) °C and ground by Cyclotec mill with 1 mm sieve, scanned by the NIRS-6500 using Spinning Module. For the prediction of quality of maize silage we used the equations, developed at the laboratory VDLUFA (Germany). Indicator of maize silage fermentation was calculated according to VDLUFA methodology under the data dry matter (DM) and pH. Values of pH were measured ionometrically for both grass and maize silage, DM – gravimetrically for maize silage, while DM for grass silage was predicted by NIRS.

Results and discussion. Grass silage was noted for especially high variability (Table 1). It varied from high metabolisable energy (ME) – 12.9 MJ kg^{-1} DM to very low – 6.3 MJ kg^{-1} DM. The lowest and the highest ME values differed twice in grass silage, i.e. 6.6 MJ/kg DM, while for maize silage they differed by 2.85 MJ kg^{-1} DM. Similar regularities are specific to the other silage quality indicators: crude protein (CP) and pH values. CP content in individual samples varied from 80 to 266 g kg^{-1} DM (for grass silage) and from 55.6 to 154.8 g kg^{-1} DM (for maize silage). DM especially varied in grass silage (variation coefficient 32.79), in maize silage it varied much less. Maize forage was low in both protein and minerals. High values of neutral detergent fibre (NDF) and CP identified in several maize silage samples are not typical of maize, it is likely that the raw material being ensiled contained a lot of weeds or silage was produced not only from maize.

Table 1. Variation of nutritive quality and pH in grass and maize silages

	Grass silage, n 1312				Maize silage, n 595			
	Mean	Min	Max	CV %	Mean	Min	Max	CV %
DM g kg^{-1}	365	135	837	32,79	335	164	585	16,45
ME MJ kg^{-1}	10	6,3	12,9	8,82	10,7	9	11,8	4,93
CP g kg^{-1}	162	80	266	16,64	90,4	55,6	154,8	12,1
NDF g kg^{-1}	634	463	892	8,06	395	268	677	14,8
Ash g kg^{-1}	84	61	118	9,28	53	32	97	15,39
pH	4,7	3,7	9	12,86	4	3,3	7,3	10,16

The effects of the harvesting year conditions was not very appreciable on averaged data of grass silage quality, but was significant for maize silage quality (Tables 2, 3).

Table 2. Grass silage quality variation in separate experimental years

Grass silage	n	OMD g kg^{-1}	ME MJ kg^{-1}	CP g kg^{-1}	Protein degra-dability % CP	pH	TFA g kg^{-1}	Lactic a. % TFA	Butyric a. g kg^{-1}
1998	17	612	9.79	173	69.90	5.10	83.70	39.90	10.4
1999	89	606	9.69	167	71.10	4.70	77.80	38.90	5.90
2000	80	622	9.90	161	68.90	4.60	66.20	51.00	4.50
2001	166	634	10.11	167	73.10	4.70	74.60	45.10	5.70
2002	177	611	9.74	163	69.60	4.60	59.80	35.60	3.90
2003	208	616	9.84	162	68.47	4.78	65.39	43.82	3.07
2004	193	623	9.96	169	68.71	4.71	64.78	49.87	2.78
2005	204	629	10.05	156	70.80	4.66	70.21	45.46	2.17
2006	186	652	10.45	156	67.22	4.87	47.14	60.55	1.57

According to many quality indicators, only the average quality of grass silage produced in 2006 was notably better: with higher ME, organic matter digestibility (OMD), regardless of the fact that CP concentration was lower. Means of concentrations of total fermentation acids TFA, lactic and butyric acids and other parameters, describing silage fermentation quality and depending on the silage-making technology (Butkute, Masauskiene, 2002), indicated, that fermentation quality tended to improve with a year.

Table 3. Maize silage quality variation in separate experimental years

Year	n	DM g kg^{-1}	ME MJ kg^{-1}	CP g kg^{-1}	Starch g kg^{-1}	CFat g kg^{-1}	CFibre g kg^{-1}	pH	Indicator of fermentation
2004	119	312	10.25	91	202	24.7	231	4.06	25.7
2005	204	333	10.44	89	236	26.6	219	4.05	25.9
2006	272	346	11.00	91	314	32.2	182	3.90	26.9

Quality of maize silage increased annually with rising of starch from 202 g kg^{-1} 2004 to 314 g kg^{-1} 2006, crude fat (CFat) from 24.7 to 32.2 g kg^{-1}, ME from 10.25 to 10.45 MJ kg^{-1}, and declining crude fibre (CFibre) content from 232 to 182 g kg^{-1} DM respectively (Table 3). Silage produced in 2006 accumulated the highest content of ME (11 MJ kg^{-1} DM). This year was characterised by exceptionally warm, even hot weather with droughts. During September the duration of sunshine was by 70-100 hours, and during October 5-30 hours longer than the long-term average. Maize is a plant of sub-tropical origin that requires warm soil temperatures. The weather conditions in 2006 were favourable for plants to perform photosynthesis and accumulate storage materials, especially starch. This observation is consistent with previous works (Crasta et al., 1997; Herrmann, Taube, 2005; Wiersma et al., 1993).

The time of harvesting and ensiling affects the composition of dry matter of both grass and maize silages (Fig. 1, 2). Harvesting time especially influenced grass silage quality. Grass silage of the best feeding value was produced until May 20: average ME concentration in silage samples produced at this time amounted to 10.5 MJ kg^{-1}, CP 181 g kg^{-1}, OMD 655 g kg^{-1}, and NDF 598 g kg^{-1}. Silage quality declined until the period of 21-25 June. It is most likely that in the last five-day period of the month not only herbage of the first cut but also aftermath were ensiled. Protein degradability (PDegr) was the highest in the silages produced from young grass which has high levels of water soluble protein, later the PDegr values tended to decline.

The trend of maize silage quality variation was as follows: with a delay in maize harvesting time from the middle of September to October 25, the ME and starch content increased, the concentration of fibre (CF) declined. These trends were especially obvious after October 5. CP concentration only inappreciably depended on ensiling time. Unlike other forages, as maize nears maturity, quality improves due to greater starch content accumulated in maize grain.

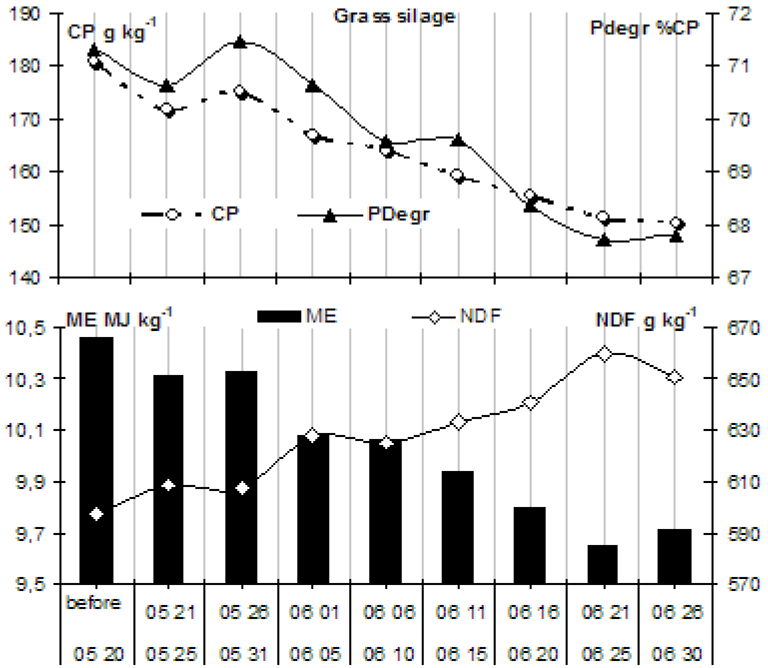

Figure 1. Quality of grass silage of 2003-2006 in relation to ensiling period.

Conclusion.

Quality of maize silage is less variable than that of grass silage. Year conditions were a more important factor for maize silage quality, whereas harvesting time was more important for grass silage.

Acknowledgements. Separate stages of this study were done during the projects supported by the Lithuanian State Science and Studies Foundation.

References

1. Butkute B., Masauskiene A. Quality of grass and grass-legume silage and the effect of silage-making technology on fermentation characteristics. Grassland Science in Europe, 7, 2002, p.112-113.

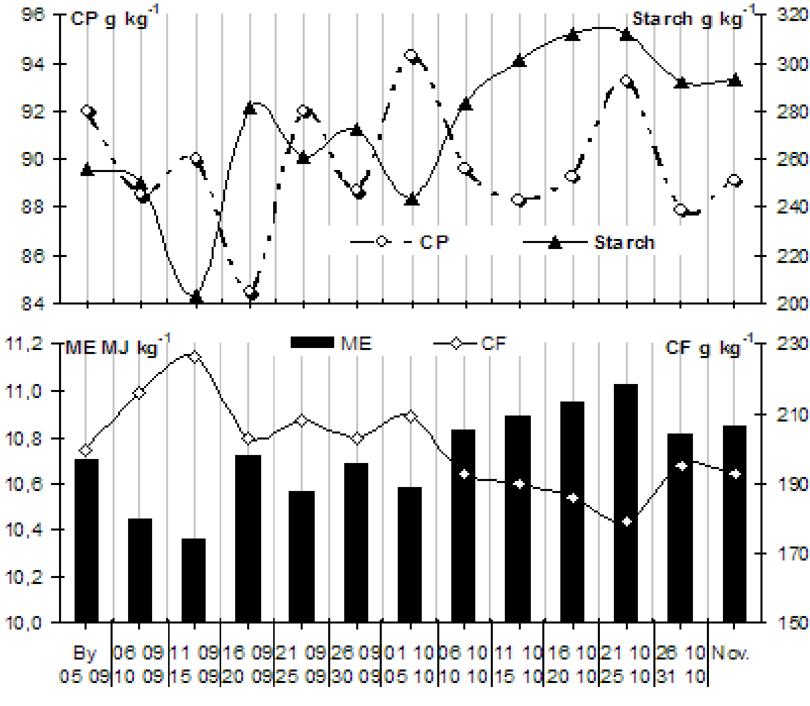

Figure 2. Quality of maize silage of 2004-2006 in relation to ensiling period.

2. Butkute B., Paplauskiene V. Changes in the quality of some Lithuanian grasses as affected by cutting time in spring. Grassland Science in Europe, 2004, 9, 909-911.

3. Crasta, O. R., Cox W. J., Cherney J. H. Factors affecting maize forage quality development in the northeastern USA. Agronomy Journal, 1997, 89, 251-256.

4. Herrmann A., Taube F. Nitrogen concentration at maturity. An indicator of nitrogen status in forage maize. Agronomy Journal, 2005, 97, 201-210.

5. Lauer J. Impacts of the 2004 growing season on silage quality. 2005, 4p. www.soils.wisc.edu/extension/wfapmc/2005/pap/Lauer1.pdf

6. Rinne M., Nykänen A. Timing of primary growth harvest affects the yield and nutritive value of timothy-red clover mixtures. Agricultural and Food Science in Finland, 2000, 9 (2), 121-134.

7. Wiersma D. W., Carter P. R., Albrecht K. A., Coors J. G. Kernel milkline stage and maize forage yield, quality, and dry matter content. Journal of Production Agriculture, 1993, 6, 94-99.