Quality of maize silage fermentation process infected with *Ustilago maydis*

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Introduction Maize smut (*Ustilago maydis*) can create greyish bulging galls with sticky and badly smelling, later strongly dusting mass of teliospores which can infect the stands, seeds and soil. Bochowiak and Skorupska (2006) state that the distinctive temperature changes were the main reason behind the incidence of maize smut in Poland. Many studies have shown that silages made from the infected maize by smut *Ustilago maydis* had low mycotoxins content (Potkanski et al., 2010) and silages did not have a harmful effect on the production and health of cattle. On the other hand, Richter et al. (1994) state that plants infected with maize smut had lower DM content, lower nutrients content and *in sacco* DM degradability and OM did not differ from healthy plants. However, sheep ate 28% less DM from sick plants than from healthy plants.

Materials and Methods In the model experiment there was used ensiled maize from healthy stand with 358.95 $g.kg^{-1}$ DM of original mass (A) and maize plants naturally infected with smut (*Ustilago maydis*) from the same land (B). Established were two experimental variants (A, B) in three repetitions. Model silages were stored at average laboratory temperature of 25–27^{o}C for 185 days. Parameters assessed to establish the quality of the fermentation process were as follows: Dry matter (DM) content of silage, pH, water extract acidity (AWE), amounts of lactic acid (LA), acetic acid (AA), sum of acids in DM and ethanol contents. Analytical procedures were described in our earlier work (Dolezal, 2002). Results were statistically processed by using the analysis of variance and differences between individual groups were analyzed by Scheffe–test in program Statistica 8. Data in the text are presented as average ± standard deviation.

Results and Discussion From the outcome of the model experiment in which the influence of smut (*Ustilago maydis*) infection of maize on the quality of fermentation (Table 1) was studied, it is apparent that the course of fermentation was different due to the differing DM content of silage biomass. The silage infected with maize smut had, in comparison with control silage, higher ($P<0.01$) concentration of fermentation acids in 1kg of DM (12,15 %) as compared to 9.37 % and that was reflected in the higher value of AWE (1,744.3 mg KOH) as compared to 1498.3 mg KOH in 100 g of silage. The higher value of titrate acidity corresponded statistically lower ($P<0.05$) with the lower average pH value of silage. In the experimental silage even considering the statistically lower ($P<0.01$) DM content (249.63 $g.kg^{-1}$) it was found lower average content of lactic acid and higher ($P<0.05$) average content of acetic acid (0.838 %) in comparison to control silage (2.388 %, resp. 0.692 %), which had a higher DM content (328.70 $g.kg^{-1}$). Richter et al. (1994) also stated lower DM content in infected silage as opposed to the silage from healthy maize plants. This confirmed that the infection of maize stand with smut (*Ustilago maydis*) results in lower DM content ($P<0.01$) of infected plants. It is obvious from the results as shown in Table 2 that the smut (*Ustilago maydis*) infection of maize plants also influenced the change in microbial composition of silages. The silage from infected plants also contained higher counts of lactic fermentation bacteria (63.6×10^6 cfu/g) in comparison with control silage (57.1×10^6

cfu/g). From the Table 2 is apparent that the infection of maize plants with smut leads to the overall increase in the amount of microorganisms but at the same time it does not lead to the increase in the amount of micromycetes. This hypothesis can be also supported by the lower DM content in infected plants which is more convenient for bacterial microflora.

Conclusion The results of the experiment indicated that the used sick plants with *Ustilago maydis* have different effect on the contents of lactic acid bacteria and the quality of fermentation process. Ethanol fermentation was significantly ($P<0.01$) reduced in silage from sick plants in comparison to control. There was found a significantly lower content of moulds and yeast fungi, but on the other hand significantly higher total amount of microorganisms and higher fermentation loss (4.30 %) in the experimental silage from sick plants in comparison to control.

References

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Table 1. Average characteristics of maize silage from healthy and sick plants of *Ustilago maydis*

Maize silage	DM (g/kg)	pH	AWE mg KOH	LA %	AA %	∑ acids in DM %	LA/AA	Ethanol %	Ammonia %
Healthy plants	328.70 ±19.738^{A}	3.865 ±0.04^{a}	1,498.3 ±37.333	2.388 ±0.00	0.692 ±0.261^{b}	9.370 ±0.755^{B}	3.605 ±0.936	2.385 ±0.203^{A}	0.040 ±0.00
Sick plants	249.63 ±5.797^{B}	3.692 ±0.124^{b}	1,744.3 ±253.8	2.195 ±0.219	0.838 ±0.084^{a}	12.250 ±1.39^{A}	2.628 ±0.237	0.87 ±0.511^{B}	0.035 ±0.005

AWE - water extract acidity; LA - lactic acid; AA - acetic acid; *Variants in capitals differ* ($P<0.01$); *variants in lowercase differ* ($P<0.05$).

Table 2. Average content of micromycetes in maize silages (in 1 g)

Maize silage	TAM	LAB	Micromycetes			
			Total	Yeast fungi	Moulds	
					in Total	Geotrichum
A- Control	34,063,636	57,100,000	46,182	45,955	227	0
B - Sick plants	54,500,000	63,600,000	11,272	11.227	45	0

TAM - total amount of microorganisms; LAB - lactic acid bacteria

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