# 13. BOKU-SYMPOSIUM TIERERNÄHRUNG

TAGUNGSBAND

Wertvolle Pflanzenstoffe
für die Tierernährung:
Perspektiven und Entwicklungen

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## Wertvolle Pflanzenstoffe für die Tierernährung: Perspektiven und Entwicklungen

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**Institut für Tierernährung, Tierische Lebensmittel und Ernährungsphysiologie**

**Interuniversitäres Department für Agrarbiotechnologie**

**BOKU – University of Natural Resources and Life Sciences, Vienna**

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# Influence of *Ustilago maydis* on the nutritive and hygienic value and fermentation characteristics of maize silage

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## Introduction

**Maize smut** (*Ustilago maydis*) can create from June until the harvest time greyish bulging galls with sticky and badly smelling, later strongly dusting mass of *teliospores* which can infect the stands, seeds and soil. The occurrence of maize smut has not been for a long time described as a disease of the stand edges only as its occurrence has significantly increased in the last five years. Bochowiak a Skorupska (2006) state that the distinctive temperature changes in June 2006 were the main reason behind the incidence of maize smut in Poland. Epidemiological study has shown that 20 – 50% of the maize stand was infected during this period. Spores are capable to infect only the following year if ploughed into the soil they can safely survive for one year and they survive for at least three years on the soil surface and in the plants remnants. The infection presents itself especially in the places of mechanical damage or injury (ŘÍHA, 2006) but the factor of mechanically damaged maize tissue due to the unfavourable climate (drought, dampness) resp. the lack of moisture followed by rainfall also plays an important part. The reduction of smut incidence is achieved in places where there is a consistent pest control as well as limited movement of mechanization in the fully grown stand and thus the plant damage is limited. As a consequence, the infection is limited (ŘÍHA 2006). Several authors studied the influence of smut in maize regarding the quality of silage and nutritional value. Many studies have shown that silages made from the infected maize had low content of mycotoxins 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 content of DM, lower content of nutrients and *in sacco* degradability of DM and OM did not differ from healthy plants. However, sheep ate 28% less of DM from sick plants than from healthy plants.

## Materials and methods

In the model experiment there was used ensilaged maize from healthy stand with DM of original weight 358.95 $gkg^{-1}$ (A) and maize plants naturally infected with smut(*Ustilago maydis*) from the same land with the weight of DM below 300 g. $kg^{-1}$ (B). Established were two experimental variants in three repetitions: Variant A – control silage, Variant B – experimental treated – by natural contamination with *Ustilago maydis*. Model silages were stored in the laboratory at average laboratory temperature of 25-27 °C for 180 days. Parameters assessed to establish the quality of the fermentation process after the 185 days were as follows: DM content of silage, pH, water extract acidity (TA), amounts of lactic acid, acetic acid, sume of acids in DM and contents of ethanol. Analytical procedures were described in our earlier work (Doležal, 2002). Silages also underwent microbial analysis and the total amount of microorganisms (CPM), moulds and yeast-fungi were established. 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. This manifested itself especially in different pH values, KVV and fermentation acids. 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 KVV (1744.3 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.There was found a statistically different ($P<0.01$) lower average alcohol content (0.87 %) in comparison with the control silage (2.385 %).

In the experimental silage even considering the statistically lower ($P<0.01$) DM content (249.63 $g.kg^{-1}$) there was found lower average content of lactic acid and higher ($P<0.05$) average content of acetic acid (0.838 %) in comparison with control silage (2.388 %, resp. 0.692 %), which had a higher DM content (328.70 $g.kg^{-1}$). Richter et al. (1994) also states lower DM content in infected silage as opposed to the silage from healthy maize plants. The experimental infected silage in correlation with lower DM content discharged silage liquids in ratio of 36.93 $l.t^{-1}$ of silage matter while the control silage due to the higher DM content did not discharge any liguids. 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. It was confirmed that the silage prepared from the infected stand was diagnosed with lower mould content than in the control silage which corresponds with the results of Richter et al. (1994). The silage from infected plants also contained higher amount of lactic fermentation bacteria ($63.6*10^6$) in comparison with control silage ($57.1*10^6$). The silage from infected plants had significantly lower yeast fungi content (24.4% share) from the content in control silage. The silage from infected plants had significantly higher total amount of microorganisms (TAM) than the amount diagnosed in control silage. From the above stated it is apparent that the infection of maize plants with smut (*Ustilago maydis*) 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.

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

| Maize silage | DM (g/kg) | pH | TA mg KOH | LA % | AA % | Σ acids in D M % | LA/AA | Ethanol % | Ammonia % |
|---|---|---|---|---|---|---|---|---|---|
| Healthy plants | 328.70 ±19.738$^A$ | 3.865 ±0.04$^a$ | 1498.3 ±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$^b$ | 1744.3 ±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 |

TA... water extract acidity; LA ... lactic acid; AA .... acetic acid; *Variants in capitals differ* ($P<0.01$); *variants in lower case differ* ($P<0.05$).

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

| Maize silage | TAM | LAB | Micromycetes | | | |
|---|---|---|---|---|---|---|
| | | | Total | Yeast fungi | Moulds | |
| | | | | | in total | Geotrichum |
| A- Controle | 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 ..... bacteria of lactic fermentation

# Conclusion

The results of the experiment indicated that the used sick plants of maize of *Ustilago maydis* has different effect on the contents of lactic acid bacteria and the quality of fermentation process. There were found significant differences in the important fermentation characteristics of the observed model silages. The silage from sick plants of maize had non significantly lower LA content, lower pH value, worse ratio of LA:AA but overall higher ($P< 0.01$) content of acids in the dry matter of silage. Ethanol fermentation was significantly ($P<0.01$) reduced in silage from sick plants in comparison with control silage. There was found a significantly lower content of moulds and yeast fungi but on the other hand significantly higher total amount of microorganisms. There was higher fermentation loss (4.30 %) in the experimental silage from sick plants of maize in comparison with control silage (3.17 %).

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