STABILITY OF HIGH MOISTURE MAIZE GRAIN ENSILED WITH AND WITHOUT CHEMICAL ADDITIVES

Loučka R.

Institute of Animal Science, Prague-Uhřiněves, Czech Republic

Abstract

The goal of the work was to determine the influence of chemical preservation on fermentation indicators, nutritional value and aerobic stability of silage of maize grain with about 66.5% of the dry matter. The coarsely ground maize grain was ensiled in glass laboratory vessels. After the end of fermentation the vessels were opened, a part of the mass was subject to chemical analyses and a part was stored in special boxes isolated from surrounding environment by a 10 cm layer of polystyrene. After 24, 48, 72 and 96 hours the silages were passed to chemical analyses. The temperatures were measured continuous also after 168 hours, i.e. the seventh day after the start of ensilaging. The control silage of wet maize grain without preservative was stable for about 48 hours, than it started decaying quickly (the temperature rose from 19°C to 30.5°C, pH from 5.0 to 5.9, acidity of water extract dropped from 774 to 471 g/kg). The silages preserved by chemical preparations in doses of 3 and 6 litres per ton of wet grain were stable in air for the whole 7 days of observation. The fodder is suitable also for nutrition of pigs.

Key words: maize, grain, silage, additives

In our geographic conditions, maize was not commonly used plant in pig nutrition. Changes occurred only with the use of new technologies of ensilaging of high moisture grain corn, often called HMGC. Maize grain of grain hybrids is harvested directly by harvester tresher in full grain maturity, while in classical harvest by cutter for the purpose of ensilage from whole plants, the vegetation is harvested in the stage characteristic by milk line in two thirds of the grain (Di Marco et al., 200ě). The difference against classical grain harvest consists in not leaving the grain to dry completely. It is stored in wet condition with the help of chemical preservatives or ensilaged. As compared to classical drying and additional crushing of the dried grain, the costs for pork production can be reduced by up to 15% when using the technology of ensilaging of high moisture grain corn (www.agroprogres-servis.cz). For example Wilkerson et al. (1997) found that holstein dairy cows produced 2 kg milk a day more when they were fed dry grain, i.e. the net energy of lactation was demonstrably higher for diet with high moisture grain than for diet with dry grain (1,78 vs 1,64 Mcal/kg dry substance).

The critical content of dry substance for preservation of storage life of 80 days was set at 81% by Sone (1999, 2000). As soon as the grain has more moisture, it cannot be stored without preservatives over a long period. Optimum dry substance of the grain for preservation has stabilized at 65 % in practice. After grinding to particle size under 2 mm for use in pigs and over 2 mm for use in ruminants, biological agents can be added to the grain for better progress of the fermentation process, but better experience has been gained with chemical agents; the silages have higher stability at long-term storage of fodder, particularly in warm spring and summer weather.

Mixtures of formic acid and propionic acid and their salts are most frequently used for preservation of ground high moisture grain corn (http://test.romill.cz/cz). The influence of biological and chemical agents on chemical composition and aerobic stability of high moisture grain corn silage is described e.g. by Bíro et al. (2006), Gálik et al. (2007), Pyš et al. (2010).

The goal of our experiments was to verify for preservation chemical preservatives of other type, i.e. agents based on sodium benzoate and sodium propionate (Mais Kofasil Liquid), or sodium benzoate, potassium sorbate and sodium nitrite (Safesil).

Material and Methods

The coarsely ground (1,3 to 2 mm) maize grain was ensiled in glass laboratory vessels with a volume of 5 litres. The control silage was without preservatives, the experimental silage with chemical preservatives in variants: Safesil 3 l/t, Safesil 6 l/t, Kofasil 3 l/t, Kofasil 6 l/t. Additive Safesil (AB Hanson & Möhring, Sweden, www.agro.salinity.com) contains sodium benzoate, potassium sorbate and sodium nitrite. Additive Mais Kofasil Liquid (ADDCON AGRAR GmbH, Germany, www.addcon.net) contains sodium benzoate and sodium propionate. Each variant was created in six repetitions. After the end of fermentation (after six weeks) the vessels were opened, a part of the mass was subject to chemical analyses and a part was stored in special boxes with a volume of 1 litre, isolated from surrounding environment by a 10 cm layer of polystyrene. After 24, 48, 72 and 96 hours the silages were passed to chemical analyses (ash, fibre, starch, fermentation). The temperatures of silages exposed to air were continuously measured 168 hours. Stability was evaluated by Honig (1990) methodology.

Results and Discussion

The dry substance of the ensilaged ground grain was 66,5 % and the grinding 1,65 mm on average, which corresponds completely to the type of dry mass and grinding the preservation of this material is made in practice, as well as to the type of dry mass and grinding (63,2 % and 1,86 mm) at which the grain corn was preserved e.g. in the experiments of Oba and Allen (2003).

The contents of nutrients of the ensilaged material, stated in Table 1 in absolute dry substance, correspond to commonly determined values. The contents of nutrients of the silages just after opening the laboratory silos are stated in Table 2. The differences in the contents of nutrients and in the fermentation indicators between individual variants without and with preservatives were not statistically significant (Table 3). But losses of organic mass in control silage were significantly higher as compared to the experimental silage. Significant influence of the preservative used and of its application dose could be seen also in testing of aerobic stability. The differences between the control silage and silage with application dose of 3 l/t and silage with application dose of 6 l/t were significant.

The control silage of wet maize grain without preservative was stable for 41 hours, then it started decaying quickly (pH rose from 5,0 to 5,9, acidity of water extract dropped from 774 to 471 g/kg, lactic acid dropped from 1,12 to 0,63% and acetic acid from 0,66 to 0,32%). The changes in the pH values were the most meaningful; they can be seen in Chart 1. Significant changes were found in temperatures as well. The temperature of control silage, as can be seen in Chart 2, rose from the original 19^{o}C to 30,5^{o}C on the fourth day after opening the silo already. The temperature above 28° C lasted for the whole period of the seven days of measurement.

The other silage preserved with chemical additives did not show statistically significantly different changes in the course of seven days of measurement (P>0,05) as compared to the values soon after opening the silo, which indicates good stability of chemically treated silage. The increased doses of the agent from 3 to 6 litres per ton had only insignificant influence on stability (Table 3). For lower application dose, the temperature increased after 45 hours (Kofasil 3 l/t) and 72 hours (Safesil 3 l/t), but only temporarily (Chart 2). The higher dose of the agent is an issue of ensuring of longer stability or of worsened environment conditions (humidity, heat), which could be seen on stability evaluation according to Honig (1990). Our results are in compliance with the results of Fassio et al. (2009) and Pyš et al. (2010).

Table 1. The contents of nutrients of the ensilaged material (fresh DM 66.5 %, n = 6)

Index	Protein % DM	Ash % DM	Fiber % DM	NDF % DM	Starch % DM
AVG	8.90	1.57	1.94	13.61	57.28
SD	0.01	0.21	0.12	0.66	1.38

Table 2. The contents of nutrients of the silages

Index	Units	Without additives	Safesil 3 l/t	Safesil 6 l/t	Kofasil 3 l/t	Kofasil 6 l/t
Dry matter	%	66.48	66.39	66.20	66.33	65.76
Ash	% DM	2.06	1.80	1.62	1.68	1.70
Fiber	% DM	2.93	3.52	3.23	3.47	4.18
Starch	% DM	66.29	65.90	67.69	67.67	65.51
OM losses	%	23.76	12.63	2.64	6.31	6.61
Stability	days	41	72	168	62	168

Table 3. The differences in the contents of the fermentation indicators

Index	Units	Without additives	Safesil 3 l/t	Safesil 6 l/t	Kofasil 3 l/t	Kofasil 6 l/t
pH		4.88	4.88	5.01	5.11	5.06
Acidity of water extract	g	668	840	756	651	713
Lactic acid	%	1.12	0.90	0.77	1.05	0.92
Acetic acid	%	0.66	0.61	0.58	0.71	0.60

Figure 1. pH of silages after opening of silos (0 - 168 hours)

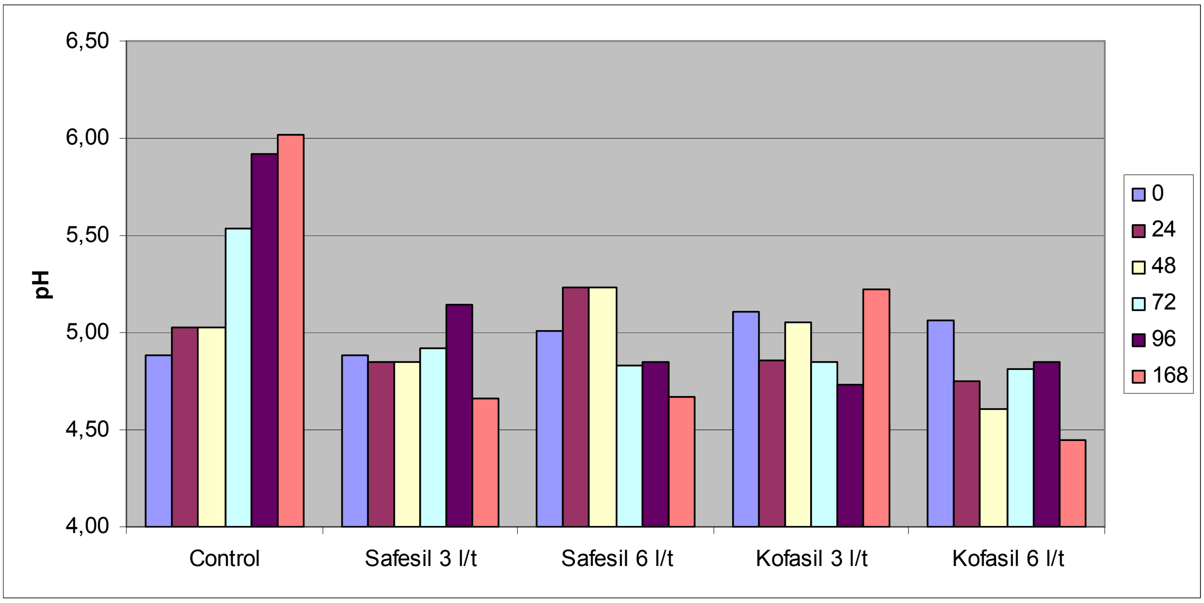
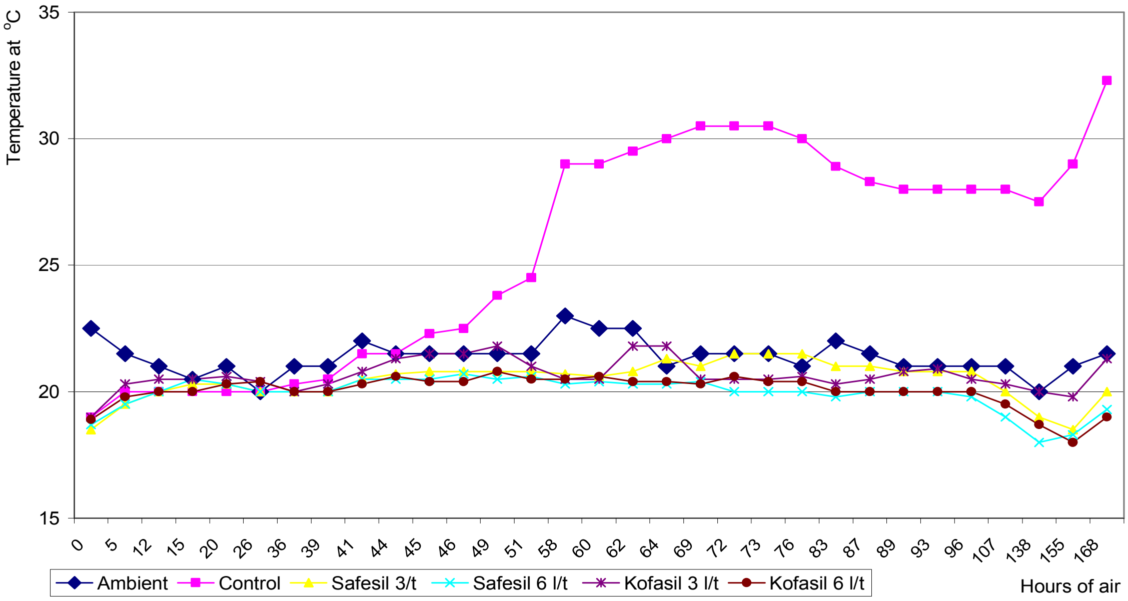


Figure 2. The temperature of silages after opening of silos (0 - 168 hours)



Conclusion

The silage of high moisture grain corn was stable for 41 hours; then it started decaying quickly. The silage preserved by Safesil and Maise Kofasil were stable in air for the whole seven days of observation. The increased doses of the agent from 3 to 6 litres per ton had only insignificant influence on the stability of the fermentation process. For lower application dose, the temperature increased, but only temporarily. The higher dose of the agent is an issue of ensuring of longer stability or of worsened environment conditions (humidity, heat). Significant differences were found in losses of organic mass.

In order to avoid high risk of oxidizing and contamination by disintegrative processes, there must be complex solution and approach with clear goal of the animal breeder and bond to maize producer. High moisture grain must be ground and ensilaged, i.e. isolated in anaerobic manner as soon as possible, otherwise it starts oxidizing, the yellow colour changes to greyish and the grain starts going mouldy.

The ensilaging of high moisture grain corn must be understood as a system that must include complete technologies for harvesting, storage, selection, transport and feeding. If one of these components is not handled well, the expected effect will not be met. All pig categories can be fed ensilaged maize grain.

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