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EFFECT OF CONSERVATION ADDITIVE ON FERMENTATION PROCESS QUALITY OF BREWER GRAINS' SILAGE WITH ADDITION OF MALT SPROUTS AS HUMIDITY ABSORBENT

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Abstract

The aim of the work was to evaluate the effect of chemical conservation additive on fermentation process quality of brewer grains' silage with addition of humidity absorbent (malt sprouts). In a model experiment the fresh brewer grains were used. A dry matter (DM) content of brewer grains was 221.9 g/kg. The brewer grains' were supplied by malt sprouts to reach DM content of conserved matter on level 320 – 350 g/kg. Three Variants with three repetitions were prepared. The Variant A was a control Variant were supplied by humidity absorbent, but without any additive. The Variant B was supplied by chemical additive with its dose 3.5 l per tone. Chemical conservation additive was based on formic acid, propionic acid, benzoic acid and formamide content. The Variant C was supplied by microbiology additive with its dose 2 g per tone. Microbiology additive contains *Lactobacillus paracasei* (DSM 16245), *Lactobacillus lactis* (NCIMB 30160) and *Pediococcus acidilactici* (DSM 16243). Model silages were evaluated after 56 days of conservation at average laboratory temperature 26–28 °C, from each Variant were the final laboratory samples taken and analyzed. In the experiment were monitored following parameters: Dry matter, pH, acid water extract quality, lactic acid content, propionic acids content, acetic acid content, butyric acid content and ammonia and alcohol content. During conservation of Variants A, B and C were no drain recognized. The malts sprouts addition eliminates waste fluid drain. The butyric acid was not detected and propionic acid was detected only Variant C.

Keywords: fermentation quality, brewers' grains, silage



Introduction

Brewer's grains as a remainder after leaching of crushed malt in beer brewing represent an important protein feed the annual production of which amounts to about 380 thousand tons in the Czech Republic. Dried brewer's grains are valuable raw material in the production of fodder mixtures and fresh grains with DM content of 200-220 g/kg are used either for the direct feeding of cattle and pigs, or for ensiling (*Lohnert et al.* 1996; *Nishino et al.* 2003; *Doležal et al.* 2005 and others). Chemical composition and digestibility of brewer's grains were studied by many authors (*Amari and Purnomoadi*, 1996; *Lohnert et al.* 1996; *Daccord et al.* 1997 and others). Brewer's grains feature high nutritive value and different ruminal degradability of proteins (*Costa et al.* 1995; *Costa et al.* 1994). Biological value of proteins depends on the content of aminoacids in malting barley and is further enriched by the activity of yeasts.

Prevailing carbohydrates are maltose, mellitriose (*Nishino et al.* 2003) and glucose, too. Net energy content ranges from 6.1 – 6.7 MJ NEL/kg DM (*Lohnert et al.* 1996; *Spann*, 1993). *Costa et al.* (1994) claim that 1 kg of brewer's grains DM contains 161.9 g/kg fibre, 386.3 g/kg BNLV, 486.0 g/kg NDF and 188.3 g/kg ADF. Brewer's grains have excellent dietary characteristics relating namely to the higher content of group B vitamins (*Spann*, 1993).

A specific property of high-quality brewer's grains is their beneficial influence on the rumen environment in dairy cows, namely on microbial activity in the rumen and on the production of microbial protein. *Daccord et al.* (1997) state that average ruminal degradation of proteins from the grains is 65%.

Brewer's grains are fodder that readily deteriorates, especially in summer months. *Gruber et al.* (1997) and *Doležal et al.* (2006) report that fresh, non-conserved grains keep in feedable condition as a rule 48 hours at the longest. During storage, serious sensory, nutritional and particularly microbial changes occur in the grains. The low content of dry matter in the fresh grains causes extensive release and discharge of effluents. *Wyss* (1997) claims that in the first week after ensilaging, an amount of up to 160 litres is released from each ton of conserved grains. Similar results are reported by *Vyskočil et al.* (2006). In order to prevent the discharge of silage effluents, *Buchgraber and Resch* (1997) recommend that fresh brewer's grains be pressed to a higher DM content of 350-400 g/kg or ensilaged in combination with the addition of various absorbents (*Pereira et al.* 1998; *Tanaka et al.* 2001).

The objective of this model experiment was to establish the effect of the supplementation of various silage additives onto the quality of the fermentation process in brewer's grains with the addition of moisture sorbent.



Material and methods

Material used in the model experiment was fresh brewer's grains at a DM content of 221.9 g/kg. Malt sprouts were used as moisture sorbent. The brewer grains' were supplied by malt sprouts to reach DM content of conserved matter on level 320 – 350 g/kg. Three Variants with three repetitions were prepared. The Variant A was a control Variant were supplied by humidity absorbent, but without any additive. The Variant B was supplied by chemical additive with its dose 3.5 l per tone. Chemical conservation additive was based on formic acid, propionic acid, benzoic acid and formamide content. The Variant C was supplied by microbiology additive with its dose 2 g per tone. Microbiology additive contains *Lactobacillus paracasei* (DSM 16245), *Lactobacillus lactis* (NCIMB 30160) and *Pediococcus acidilactici* (DSM 16243).

Model silages were stored in the laboratory at average laboratory temperature of 26-28 °C for 56 days. Parameters assessed to establish the quality of the fermentation process after the 56 days were as follows: DM content of silage, pH, water extract acidity (KVV), amounts of lactic acid, acetic acid, propionic acid, butyric acid, contents of alcohol and ammonia. The content of dry matter was established by desiccation at a temperature of 103 ± 2 °C to constant weight. Analytical procedures were described in our earlier work (Doležal, 2002). Results were statistically processed by using the analysis of variance and differences between individual groups were analyzed by Scheffe-test in software STATISTICA 8. Data in the text are presented as average \pm standard deviation.

Results and discussion

Dry matter of silages made of brewer's grains sampled after 56 days of storage ranged from 306.5 ± 0.54 g/kg in Variant C to 326.85 ± 4.04 g/kg in Variant B. Thanks to the use of moisture sorbent – malt sprouts, none of the model silages showed discharge of effluents (Table 1).

The assessment of fermentation process quality corroborated the efficacy of silage additive on the pH value of silages. The lowest pH value (3.91 ± 0.07 pH) was found in the control silage and the highest pH value (4.23 ± 0.03 pH) was detected in Variant C. Measured pH value in Variant C was significant higher ($P < 0.01$) comparing with Variant A and Variant B. The KVV value in variants treated with the silage additive correlated with the pH value. Variant C exhibited the highest KVV (1866.33 ± 22.33 mg KOH/100 g). A statistically significant difference ($P < 0.05$) was found between Variant B with the lowest KVV (1574.67 ± 30.31 mg KOH/100 g) and control Variant A (Table 1).



A statistically highly significant difference ($P < 0.01$) was found between Variant B and all the other variants also in the amount of lactic acid, which was established in Variant B at merely 54.03 ± 2.46 g/kg of dry matter, and in the total amount of fermentation acids, which amounted to 69.48 ± 2.78 g/kg of dry matter. Total amounts of fermentation acids in Variant A were 99.56 ± 7.41 g/kg DM and Variant C 106.20 ± 3.13 g/kg DM (Table 1).

The amount of acetic acid was lowest in Variant B, too (15.45 ± 0.42 g/kg DM) and highest in Variant C (28.55 ± 1.26 g/kg DM). Statistically highly significant differences ($P < 0.01$) were found between all studied variants (Table 1).

Table 1. Quality of the fermentation process in brewer's grains silages (g/kg DM)

Variant	Variant A		Variant B		Variant C	
Parameter	Av. \pm stand.dev.	Note	Av. \pm stand.dev.	Note	Av. \pm stand.dev.	Note
Dry matter [g/kg]	321.69 ± 3.88	A,a	326.85 ± 4.04	A,b	306.5 ± 0.54	B,c
pH	3.91 ± 0.07	A	3.99 ± 0.05	A	4.23 ± 0.03	B
KVV [mg KOH/100g]	1847.33 ± 175.75	b	1574.67 ± 30.31	a	1866.33 ± 22.33	a,b
Lactic acid	78.69 ± 6.37	A	54.03 ± 2.46	B	75.86 ± 2.1	A
Acetic acid	20.87 ± 1.2	A	15.45 ± 0.42	B	28.55 ± 1.26	C
Propionic acid	0 ± 0	A	0 ± 0	A	1.79 ± 0.18	B
Sum of acids	99.56 ± 7.41	A	69.48 ± 2.78	B	106.2 ± 3.13	A
KM:KTM	3.77 ± 0.16	A,a	3.5 ± 0.11	A,b	2.5 ± 0.08	B,c
Ethanol	10.82 ± 0.5	A	15.75 ± 0.84	B	7.45 ± 0.24	C
Ammonia	2.64 ± 0.3	a,b	2.5 ± 0.25	a	3.1 ± 0.18	b

KVV: water extract acidity, KM: lactic acid, TKM: volatile fatty acids

The differences are statistically significant when labeled by different letters. Capitals are connected with higher significance ($P < 0.01$), and normal letters with lower significance ($P < 0.05$)

In Variant C, the propionic acid was detected at an amount of 1.79 ± 0.18 g/kg DM. Nishino et al. (2003) observed that metabolization of lactic acid into acetic acid and propionic acid occurs with the storage time. In the assessment of the fermentation process quality with respect to the ratio of the amount of lactic acid to volatile fatty acids, statistically highly significant differences ($P < 0.01$) were found between all studied variants. The lowest and the highest ratio was found in Variant C (2.50 ± 0.08) and in Variant A (3.77 ± 0.16), resp (Table 1).

Highly significant differences ($P < 0.01$) between all studied variants were found also in the amount of ethanol, which ranged from 7.45 ± 0.24 g/kg of dry matter in Variant C to 15.75 ± 0.84 g/kg of dry matter in Variant B.



Although the amount of ammonia in the respective silages was relatively equable (*Table 1*), the amount established in Variant C was significantly ($P < 0.05$) higher than in Variant B.

Conclusion

The objective of the model experiment was to establish the effect of the supplementation of various silage additives onto fermentation process quality in brewer's grains with the addition of malt sprouts as moisture sorbent. The results indicate that the dose of silage additive in Variant B was high because the fermentation process was suppressed, which is further corresponded to – in spite of low pH – by a demonstrably ($P < 0.01$) low content of fermentation acids. Variant C showed a demonstrably higher ($P < 0.01$) pH value at which higher amounts of acetic acid, propionic acid and ammonia were generated.

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