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The effect of *Saccharomyces cerevisiae* on the *in vitro* degradability of maize grain, cellulose and wheat straw dry matter

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ABSTRACT

The aim of the study was to determine the effect of two live yeast cultures (LY1 and LY2) and yeast metabolites (YM) on dry matter degradability. Dry matter degradability of maize grain, cellulose and wheat straw was determined *in vitro* using a Daisy[II] incubator (ANKOM Technology). A statistically significant increase ($P<0.05$) was observed in dry matter degradation of maize grain after the application of yeast, although no such effect was seen on the degradation of wheat straw. After incubation of cellulose for 12 and 14 h , the highest increase in degradability was observed after application of LY2. Yeast metabolites (YM) significantly improved ($P<0.05$) the degradability of cellulose after 6 h incubation.

KEY WORDS: yeasts*, Saccharomyces cerevisiae*, *in vitro*, cellulose, straw

INTRODUCTION

The yeast, *Saccharomyces cerevisiae,* has been used as a feed additive in the feeding of dairy cows for many years (Eckles and Williams, 1925). In studies conducted to date, it was shown that the addition of *Saccharomyces cerevisae* increased the degradation of dry matter and NDF (Carro et al., 1992), improved ruminal degradability of crude fibre and increased milk production in cows (Williams et al., 1991). Various preparations containing different live cultures of *Saccharomyces cerevisiae* as well as their metabolites have been marketed. Dry matter degradation *in vitro* may be used to estimate the nutritive value of feeds for

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ruminants (Mabjeesh et al., 2000). The aim of the study was to determine the effect of various forms of *Saccharomyces cerevisiae* on the *in vitro* degradation of feeds differing in carbohydrate composition (cellulose, wheat straw and maize grain).

MATERIAL AND METHODS

The experiment was conducted using two cultures of live yeast *Saccharomyces cerevisiae* (LY1-Yea-Sacc^{1026}, LY2-Biosaf Sc 47) and their metabolites (YM-Diamond V XP). The addition of yeast in the amount of: 2 g LY1, 2 g LY2 and 15 g YM, was performed through a cannula directly to the rumen of sheep. The degradation of dry matter of α-cellulose (Sigma; No 232-674-9), maize grain and wheat straw was determined *in vitro* using a Daisy^{II} incubator (ANKOM Technology). Ruminal fluid was collected from three sheep after a 14-day preliminary period. Sheep were fed meadow hay *ad libitum*. Bags (four replicates) were incubated in a mixture of ruminal fluid with buffers for 6, 12 and 24 h. The results of the experiment were analysed statistically, using one-way analysis of variance and calculating LSD at α=0.05 with the use of the Stat.Graph. 5.0 software package.

Table 1. Chemical composition of hay and incubated feeds, %

Feed	Dry matter	Crude ash	Crude protein	Crude fibre	ADF	NDF
Hay	92. 06	8.95	13.47	26.88	34.08	57.65
Maize	89.19	1.25	9.23	2.93	3.88	14.82
Cellulose	-	-	-	-	89.09	95.49
Straw	93.88	2.88	3.00	48.34	53.62	80.50

Table 2. The effect of yeast on dry matter degradation, %

Feed	Incubation time (h)	Control	YM	LY1	LY2
Maize	6	50.50^{a}	56.47^{b}	52.79^{a}	60.61^{c}
	12	61.17^{a}	67.94^{b}	66.56^{b}	72.68^{c}
	24	76.63^{a}	83.51^{b}	81.52^{b}	82.52^{b}
Cellulose	6	19.39^{a}	25.85^{b}	20.86^{ab}	23.81^{ab}
	12	23.31^{ab}	26.27^{bc}	22.34^{a}	29.31^{c}
	24	25.11^{a}	28.12^{a}	35.40^{b}	40.95^{c}
Straw	6	14.73	14.93	14.92	15.23
	12	14.29	16.41	15.45	16.45
	24	16.51	16.38	15.91	17.86

different superscripts (a, b) indicate significant differences between treatments ($P<0.05$)

RESULTS

The chemical composition of feeds is presented in Table 1. All of the studies yeast preparations increased the *in vitro* degradation of maize grain dry matter (Table 2). However, the highest increase in comparison to control was found after the introduction of the live yeast cultures in preparation LY2. This statistically significant

increase ($P<0.05$) over the control after 6 and 12 h incubation equaled 10.1 and 11.5%, respectively. Also the same LY2 active yeast gave the highest improvement in the degradability of cellulose after 12 and 24 h incubation $P<0.05$. Yeast metabolites (YM) significantly improved ($P<0.05$) the degradability of cellulose after 6 h incubation by 6.46% compared with the control. None of the yeast preparations had a statistically significant effect ($P<0.05$) on the degradation of wheat straw dry matter.

DISCUSSION

We found significant improvement of cellulose and maize dry matter rumen degradability mainly by supplementation of live yeast (Biosaf Sc 47). It may be assumed that by decreasing the oxygen concentration in ruminal fluid the active yeast improved conditions for growth of anaerobic amylo- and cellulolytic bacteria. Similarly to our results, Williams et al. (1991) found an increase of hay degradation after 12 h incubation as an effect of supplementing live cultures of *Saccharomyces cerevisiae* (Yea Sacc^{1026}). Differing effects were obtained by Arcos-Garcia et al. (1999) who observed changes in dry matter degradation affected by the addition of live yeast cultures only after 48 h incubation (Levucell). The addition of yeast may increase the counts of cellulolytic bacteria (Harrison et al., 1988), and, as a consequence, improve fibre digestibility (Carro et al., 1992). *In vitro* experiments reported that yeast metabolites (Diamond V XP) favourably altered rumen fermentation and stimulated lactate uptake and cellulose digestion by providing growth factors such as malate to bacteria utilizing lactate, and by elevating rumen pH (Callaway and Martin, 1997). Harrison et al. (1988) concluded that stabilization of the ruminal environment with less variation in ruminal ammonia and microbial count, increases the total anaerobic bacteria seen when yeast cultures are added to diets. Sullivan and Martin (1999) suggested that yeast cultures stimulate the initial rate of cellulose digestion by two predominat cellulolytic bacteria *Fibrobacter succinogenes* and *Ruminococcus flavefaciens* without influencing the extent of degradation. Results from experiments on additives containing yeasts are not conclusive. No effect of added live yeast culture (PMX70SBK; Saf Agri) and yeast metabolites (Diamond V XP) was found by Lynch and Martin (2002), who investigated *in vitro* degradation of dry matter of lucerne hay.

CONCLUSIONS

All of the investigated yeast preparations improved *in vitro* degradation of maize grain dry matter, although they had no effect on dry matter degradation of straw. The live yeast cultures found in preparation LY2 increased the degradation

of cellulose. These results may point to the stimulating effect of live yeast on the activity of some specific anaerobic cellulolytic bacteria. The obtained results need to be confirmed in *in vivo* studies.

REFERENCES

Arcos-Garcia J.L., Castrejon F.A., Mendoza G.D., Perez-Gavilan E.P., 1999. Effect of two commercial yeast cultures with *Saccharomyces cerevisiae* on ruminal fermentation and digestion in sheep fed sugar cane tops. Livest. Prod. Sci. 63, 153-157

Carro M.D., Lebzien P., Rohr K., 1992. Effects of yeast culture on rumen fermentation, digestibility and duodenal flow in dairy cows fed a silage based diet. Livest. Prod. Sci. 32, 219-229

Callaway E.S., Martin S.A., 1997. Effects of *Saccharomyces cerevisiae* culture on ruminal bacteria that utilize lactate and digest cellulose. J. Dairy Sci. 80, 2035-2044

Eckles C.H., Williams V.M., 1925. Yeast as a supplementary feed for lactating cows. J. Dairy Sci. 8, 89

Harrison G.A., Hemken R.W., Dawson K.A., Harmon R.J., Barker K.B., 1988. Influence of addition of yeast culture supplement to diets of lactating cows on ruminal fermentation and microbial populations. J. Dairy Sci. 71, 2967-2975

Lynch H.A., Martin S.A., 2002. Effects of *Saccharomyces cerevisiae* culture and *Saccharomyces cerevisiae* live cells on *in vitro* mixed ruminal microorganism fermentation. J. Dairy Sci. 85, 2603-2608

Mobjeesh S.J., Cohen M., Arieli A., 2000. *In vitro* methods for measuring the dry matter digestibility of ruminant feedstuffs: comparison of methods and inoculum source. J. Dairy Sci. 83, 2289-2294

Sullivan H.M, Martin S.A., 1999. Effects of *Saccharomyces cerevisiae* culture on *in vitro* mixed ruminal microorganism fermentation. J. Dairy Sci 82, 2011-2016

Williams P.E.V., Tait C.A.G., Innes G.M., Newbold C.J., 1991. Effects of the inclusion of yeast culture (*Saccharomyces cerevisiae* plus growth medium*)* in the diet of cows on milk yield and forage degradation and fermentation patterns in the rumen of sheep and steers. J. Anim. Sci. 69, 3016-3026

STRESZCZENIE

Wpływ dodatku drożdży *Saccharomyces cerevisiae* na rozkład ziarna kukurydzy, celulozy i słomy pszennej *in vitro*

Celem badań było określenie wpływu dwóch dodatków zawierających żywe kultury drożdży (LY1 i LY2) oraz metabolitów *Saccharomyces cerevisiae* (YM) na rozkład suchej masy ziarna kukurydzy, celulozy i słomy pszennej *in vitro*. Dodatek wszystkich rodzajów badanych drożdży zwiększył rozkład suchej masy ziarna kukurydzy, natomiast nie miał istotnego wpływu na rozkład słomy pszennej. Żywe kultury drożdży (LY2) zwiększyły istotnie ($P<0,05$) rozkład celulozy po 12 i 24 godzinach inkubacji, a metabolity (YM) rozkład celulozy po 6 godzinach inkubacji.