Effect of an exogenous fibrolytic enzyme on growth rate, feed intake and feed conversion ratio in growing lambs

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Abstract

Thirty-two Döhne Merino lambs with an initial mean (± s.d.) body weight of 30.3 ± 2.5 kg were used in a randomised block experiment to determine the effect of an exogenous fibrolytic enzyme preparation (Abo 374) on body weight gain, dry matter intake and feed conversion ratio. Wheat straw was pre-treated with different levels of the enzyme supernatant and mixed with lucerne hay and a concentrate mix just before feeding. Treatments were 10 (High), 5 (Med), 1 (Low) or 0 (Control) mL supernatant/kg wheat straw. For each treatment, the Abo 374 supernatant was appropriately diluted with water to allow an application rate of 300 mL of the solution/kg straw. In the Control treatment, the solution consisted of water alone. Following enzyme application, the wheat straw was stored uncovered in plastic containers at room temperature for a pre-feeding incubation time of 18 hours. Enzyme treatment significantly improved body weight gain and feed conversion ratio from 0-6 weeks. Cumulative weight gains (kg) and feed conversion ratios (kg gain/kg dry matter intake) were 6.8 and 0.15, 7.1 and 0.16, 5.5 and 0.13, and 5.4 and 0.12. Treatment had no effect on dry matter intake. It was concluded that fibrolytic enzymes produced by Abo 374 are able to increase cell wall degradation and have potential to be used in the animal feed industry.

Key words: Feed enzymes, nutrition, wheat straw
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Introduction

Ruminants are well adapted to utilize plant cell walls, and the degradation thereof by the animal is of major economic importance. However, even under ideal feeding conditions, cell wall digestibility in the total digestive tract is still less than 65% (Van Soest, 1994). With plant cell walls typically contributing towards 40 to 70% of forage dry matter (Van Soest, 1994), attempts to improve ruminal fibre degradability has been a research focus area for many years. Recent positive responses in feeding trials with regard to the use of fibrolytic enzymes as feed additives for ruminants resulted in the topic receiving much research interest in the past few years (Yang et al., 1999; Kung et al., 2000). Diet composition (Beauchemin et al., 1995) and the diet component to which the enzyme is added (McAllister et al., 1999) appear to influence its effectiveness. Pinos-Rodrigues et al. (2002) found that the effect of an exogenous fibrolytic enzyme appears to be substrate related. Possible pre-feeding effects resulting from incubation of enzyme to the feed prior to feeding also need to be further examined (Wallace et al., 2001). Although enzyme additives have in the past resulted in positive animal responses, the mode of action of exogenous enzymes in the ruminant is not fully understood (Colombatto et al., 2003). The possibility exists that added enzymes may stimulate fibre digestion in the rumen (Wallace et al., 2001) as well as increase total tract digestibility in ruminants (Yang et al., 1999). Improvements in body weight gain and increased digestibility of high forage ruminant diets have been reported where enzyme additives had been used (Beauchemin et al., 1995).

South Africa is faced with a shortage of high quality forages. Large quantities of grain crop by-products, such as wheat straw, are available after the harvesting season. In an attempt to improve the nutritive value of these low quality forages, a number of enzymes were cultivated on wheat straw at the Stellenbosch University. In the current study, one of the best enzyme candidates was chosen to determine the effect of enzyme pre-treatment of wheat straw on lamb growth, feed intake and feed conversion ratio.

Materials and Methods

Thirty-two Döhne Merino ram lambs, with an initial mean (± s.d.) body weight of 30.3 ± 2.5 kg, were used in a six weeks growth trial. They were housed individually in 1.8 x 1.2 m pens on wooden slatted floors in a semi-open metabolism building. Lambs were stratified according to initial weight and randomly allocated to four treatment blocks with eight repetitions.

All the lambs received a basal diet consisting of 392 g/kg enzyme treated wheat straw, 276 g/kg lucerne hay, 197 g/kg maize meal, 65 g/kg cottonseed oil cake, 57 g/kg molasses, 11 g/kg urea and 2 g/kg of
a trace mineral and vitamin premix. The diet was formulated (based on previous analyses from our laboratory) to contain 130 g/kg crude protein, 443 g/kg NDF, 4.6 g/kg Ca and 1.8 g/kg P and 9.0 MJ ME/kg.

Treatments consisted of different application rates of the locally produced enzyme product, Abo 374 (patent pending), to the wheat straw component of the diet to provide either 10 mL (High), 5 mL (Med) or 1 mL (Low) supernatant/kg straw and a control. Method of treatment and application rates were based on a series of in vitro analyses performed in our laboratory. The appropriate quantity of enzyme supernatant was diluted with water to provide a solution that was applied at a rate of 300 mL/kg straw. In the control treatment, water alone was applied at the same rate. Enzyme supernatant was produced fresh each day (and on Fridays for the week-end) by the Department of Microbiology and the straw and enzyme solution (or water in the control treatment) was mixed daily at 14h00 with the aid of an electric concrete mixer for 10 minutes. The treated straw was then stored uncovered in plastic crates until the next morning to allow a pre-feeding enzyme-substrate interaction time of 18 hours. The straw was then added each morning at 08h00 to the rest of the mixed diet and offered to the lambs ad libitum plus 5%. Orts were weighed back and dried daily to determine DM intake. Lambs were weighed weekly on two consecutive days and the average weight was used to determine weekly gains.

Data were subjected to an ANOVA and treatment means were separated with a Bonferroni test to determine significant differences with the aid of Statistica 6.1 (2003). Significance was declared at P < 0.05.

Results and Discussion
The effect of enzyme treatment of wheat straw on body weight gain, feed intake and efficiency of feed conversion (EFC) is presented in Table 1.

Table 1 Body weight gain, dry matter intake (DMI) and feed conversion ratio (FCR) of Döhne Merino lambs receiving diets containing wheat straw treated with different levels of an enzyme supernatant (Abo 374) and control for a period of six weeks

<table>
<thead>
<tr>
<th>Item</th>
<th>Treatment (^a)</th>
<th>Control</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body weight gain (kg)</td>
<td>6.75(^b)</td>
<td>7.13(^d)</td>
<td>5.50(^c)</td>
</tr>
<tr>
<td>Total DMI (kg)</td>
<td>44.5</td>
<td>45.3</td>
<td>43.5</td>
</tr>
<tr>
<td>FCR (kg gain/kg DMI)</td>
<td>0.15(^a)</td>
<td>0.16(^c)</td>
<td>0.13(^b)</td>
</tr>
</tbody>
</table>

\(^a\)Abo 374 supernatant application to wheat straw: High = 10 mL/kg; Med = 5 mL/kg; Low = 1 mL/kg
\(^a, b\)Means with different superscripts differed significantly (P < 0.05)

The high and medium levels of enzyme treatment resulted in significantly higher weight gains by lambs, while the low level had no effect. Considering the relative small number of animals (eight per treatment) and the variation usually observed in lamb growth rates, the effect is noteworthy. Increased weight gains of steers and growing heifers receiving enzyme treated forages have been reported by Beauchemin et al. (1995) and McAllister et al. (1999).

Treatment did not affect feed intake, but feed conversion ratios were improved for the High and Med treatment groups, suggesting a possible improvement in the digestibility of the wheat straw component of the diet with certain levels of enzyme application. McAllister et al. (1999) observed an improvement in average daily gain, feed intake and efficiency of feed conversion in feedlot cattle receiving enzyme-treated silage. Yang et al. (2000) found an increase in total tract digestibility in lactating cows when high concentrate diets were supplemented with fibrolytic enzymes, but observed no response in sheep. In the current study, lambs received low concentrate diets and results suggested a possible positive effect of Abo 374 on digestibility.

Weekly and cumulative weight gains are presented in Figure 1. The effect of the High and Med enzyme application levels are clearly observable at four and six weeks. It appears as if the effect started at an earlier stage, possibly already after two weeks, but that it did not become significant before four weeks. It appears as if 5 mL supernatant/kg wheat straw was as effective as 10 mL/kg. The level of application would obviously have an effect on the economical implications of the use of fibrolytic enzymes in the feed industry.

Conclusion
Pre-feeding treatment of wheat straw with Abo 374 supernatant at levels equivalent to 10 and 5 mL supernatant/kg straw resulted in improved weight gains and EFC ratios compared to a low level treatment (1
mL/kg) or no enzyme treatment. These results would suggest that fibrolytic enzymes produced by Abo 374 are able to increase cell wall degradation and have potential to be used in the animal feed industry. More research is required to determine the optimal application level of Abo 374 and also its effect on in vivo digestibility, DMI over prolonged periods and other animal production parameters.

**Figure 1** Weekly and cumulative weight gains of Döhne Merino lambs receiving diets containing wheat straw treated with different levels of an enzyme supernatant (Abo 374) and control. High, Med and Low refer to 10, 5 and 1 mL supernatant/kg wheat straw DM.

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**References**


Statistica 6.1, 2003. StatSoft, Inc. 2300 East 14th Street, Tulsa, OK 74104, USA.


