β-GLUCANASE REDUCES BUT DOES NOT ELIMINATE VARIATION IN AME OF BARLEY VARIETIES

A. KOCHER*, R.J. HUGHES* and A.R. BARR**

Summary

The effect of a commercial β-glucanase on the variability of apparent metabolisable energy (AME) of barley was studied in two experiments. In Experiment 1, supplementation with enzyme significantly improved the mean AME value of 11 varieties of barley from 11.35 ± 1.24 to 13.80 ± 0.56 MJ/kg dry matter (DM), i.e., the variability between the different barley varieties measured as the standard deviation was reduced by 55% with enzyme supplementation. In Experiment 2, the mean AME value of 22 varieties with enzyme was 14.18 ± 0.77 MJ/kg DM. The overall mean value for AME of all barley varieties with enzyme supplementation was 14.06 ± 0.73 MJ/kg DM. The lower limit in the 95% confidence interval was 12.91 MJ/kg DM. Hence, the use of a commercial β-glucanase resulted in a highly predictable “attainable” AME value for barley for feed formulation purposes. However, from a plant breeding viewpoint, a range of 1.5-2.0 MJ/kg indicates that AME could become a selection priority.

I. INTRODUCTION

The apparent metabolisable energy (AME) of barley as a feedstuff for poultry is strongly affected by its β-glucan content. The total β-glucan content of barley cultivars varies between 26 and 79 g/kg DM with 23 - 69 g/kg DM soluble β-glucan (Jeroch and Dänicke, 1995). β-glucan is not depolymerised by endogenous digestive enzymes. Diets containing a high level of barley β-glucan give an increased digesta viscosity and reduced performance accompanied by sticky droppings (Choct and Annison, 1991).

Nutritionists are often not able to test raw ingredients and establish a true feeding value prior to use. Variation in raw ingredients accounts for 30% of the variation in the finished product and creates multiplicative effects together with weighing errors (Fawcett and Webster, 1996). Subsequently, the diet may not reach the required specification which can result in sub-optimal performance and economic loss. Several methods of treatment of barley have improved nutritive value mainly by reducing β-glucan content (Jeroch and Dänicke, 1995). For example, addition of β-glucanase to a diet containing a high inclusion rate of barley (80%) improved AME and reduced the variability of barley varieties by nearly 50% (Bedford, 1996).

This paper reports the AME of a wide range of genetically different barley varieties. The barley varieties were chosen from a diverse set of breeding lines ranging widely in starch, lysine, β-glucan and hull content. The crops were grown at three different locations in South Australia. In the first experiment 11 varieties were tested with and without a commercial β-glucanase. In the second experiment, the “attainable” AME of 22 varieties was determined by supplementation with a commercial enzyme, as shown by Hughes et al. (1996) for wheat.

* SARDI, Pig and Poultry Production Institute, Nutrition Research Laboratory, University of Adelaide, Roseworthy, SA 5371.
**Department of Plant Science, University of Adelaide, Glen Osmond, SA 5064.
II. MATERIALS AND METHODS

(a) Bird management and AME trial

Day-old mixed sexed broiler chickens (Ingham IM98) were raised in floor pens on a commercial starter crumble. The birds were transferred at 20 days of age, two per cage, to individual metabolism cages and given a commercial starter diet with no added commercial β-glucanase. Birds were given two days to adapt to the new environment. At 22 days of age, one bird was removed from the each cage. The remaining chickens were weighed individually. A three day period enabled the birds to adapt to the experimental feed. Feed intake was measured during this period. During the following four days all excreta were collected and feed intake was measured. Moisture content of excreta voided during the first day of the collection period was measured. At the end of the 7 d experimental period, all birds were weighed individually.

(b) Diet formulation, experimental design and determination of gross energy

The first experiment included 11 barley varieties grown at Brentwood. Each variety was tested with and without enzyme present in the feed. The second experiment included 22 barley varieties grown at the Roseworthy Campus, University of Adelaide and the Charlick Experiment Station at Strathalbyn. Samples were a composite of equal weight from each site. Enzyme was added to all diets. Schooner barley grown at each site was pooled and incorporated in an enzyme-supplemented control diet used in both experiments together with a sorghum control diet without enzyme. The basal composition was barley, (500 g/kg), sorghum (320 g/kg), casein (134 g/kg) and minor ingredients (vitamin + minerals) (66 g/kg). A commercial β-glucanase (Avizyme 1100, inclusion rate 1 kg/t) was added directly to the minor ingredients prior to mixing. Each diet was cold pelleted and replicated four times in a randomised block design.

Gross energy of excreta and milled feed was measured using a Parr isoperibol bomb calorimeter. Dry matter content of each sample of barley and pelleted and milled feeds was determined by drying at 105°C.

III. RESULTS

In Experiment 1, the addition of β-glucanase significantly improved the AME of barley. The mean value of unsupplemented samples was 11.35 ± 1.24 MJ/kg DM and 13.80 ± 0.56 for supplemented samples (Figure 1). The addition of enzyme significantly improved feed conversion ratio (FCR) from 2.03 ± 0.22 to 1.77 ± 0.15 and significantly reduced excreta moisture from 76.36 ± 2.61 to 67.58 ± 3.64.

In Experiment 2, the mean value for AME calculated over all 22 samples was 14.18 ± 0.77 MJ/kg DM (Figure 2). The FCR was 1.73 ± 0.21 and excreta moisture was 67.17 ± 5.24%. These results were similar to those from Experiment 1 for enzyme-supplemented diets.

IV DISCUSSION

The inclusion of a commercial β-glucanase in barley-based diets reduced the variability in AME by more than 50%. These results agree with the findings of Bedford (1996). The AME results from our first experiment were confirmed in a second
Figure 1. Increased metabolisable energy in barley and reduced variability with enzyme supplementation (vertical bars indicate one standard deviation calculated over all varieties).

Figure 2. Variability between varieties of barley with enzyme supplementation (vertical bars indicate one standard deviation calculated over all varieties).
experiment with a wider range of barley varieties. Addition of enzyme did not improve the AME of some varieties according to pair-wise t-tests. The lower limit of the 95% confidence limits for the mean value of AME for barleys with enzyme was 12.91 MJ/kg DM, i.e. only one in 20 barley varieties supplemented with β-glucanase will be expected to be lower than 12.91 MJ/kg DM (e.g., variety B1508 which has impaired starch synthesis). The results for the barley control diet (14.43 ± 0.24 MJ/kg DM for Experiment 1 and 14.69 ± 0.07 MJ/kg DM for Experiment 2) indicate that the two studies were comparable. The mean value of “attainable” AME calculated over all 32 barley varieties with enzyme was 14.06 ± 0.73 MJ/kg DM.

Improvements in AME and FCR together with a reduction in excreta moisture are likely to be the result of reduced intestinal viscosity brought about by depolymerisation of β-glucan with subsequent improvement in starch digestibility and avoidance of ileal fermentation as shown by Choct et al. (1996) in birds given diets enriched with non-starch polysaccharides.

Overall, the addition of β-glucanase improved AME but did not eliminate the variability in AME of a diverse range of barley varieties. The relatively large differences in AME remaining after addition of feed enzyme indicates wide scope for improvement by plant breeding.

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REFERENCES