ROLE OF ENZYMES IN REDUCING VARIABILITY IN NUTRITIVE VALUE OF MAIZE USING THE ILEAL DIGESTIBILITY METHOD

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Summary

The energy content of maize and sorghum is considered to be relatively constant. However, there is little data to support such an assumption, and in fact that which is published indicates there may be considerably more variation than is currently accepted. Thus, a study was conducted to evaluate the variability in ileal energy values in 28 day old broilers between eight different commercial maize samples and to evaluate the impact of enzyme addition on this variation. In the absence of enzyme the standard deviation of ileal digestible energy values between maize samples was quite high (± 0.34 MJ/kg; 2.8%). Addition of a specific enzyme product had two significant effects: (1) average ileal energy content was increased by 0.41 MJ/kg (3.3%), and (2) a clear reduction in variation between samples of 50% (± 0.17 MJ/kg). Ileal starch and fat digestibility values were improved by more than 1% with enzyme supplementation. Addition of enzymes resulted in a greater benefit with poorer quality maize compared with better quality maize. These results would indicate a more consistent nutritional quality of maize and bird performance in diets containing an appropriate enzyme supplementation.

I. INTRODUCTION

Maize has traditionally been the preferred cereal for domestic animals, with its dietary energy value being one of the highest of the feed grains. The energy content of this cereal is assumed by many to be relatively constant. The degree to which each cereal grain differs from batch to batch is dependent not only on the variety of the grain and the conditions under which it is grown, but also the conditions to which it is subjected during the feed manufacturing process. Attempts to determine the variation in feeding value of each cereal has been addressed recently for barley (Scott and Boldaji, 1997; Kocher et al., 1997), wheat (Classen et al., 1995; Hughes et al., 1996) and maize (Leeson et al., 1993). It is evident that each study detected considerable variation from sample to sample regardless of cereal type. It is also interesting to note that the variability and range (i.e. difference between best and worst sample) is actually not dissimilar between the three grains. Thus, it is important to understand that cereal source can be a major contributor to variation in performance of diets of identical formulation but different raw material origin.

It is now well established that in wheat and barley (likewise in triticale and rye), the viscous non-starch polysaccharides account for as much as 70-80% of the variation in feeding value (Barrier-Guillot et al., 1997; Bedford, 1997; Chotet et al., 1996; Smits and Annison, 1996). In maize and sorghum, however, this is clearly not the case; instead it appears to be starch structure that plays a large role in the digestibility of these grains in the chick. Starch structure has a strong bearing on its rate of digestion, and may therefore be of great importance in determining its feeding value. The rate of digestion of maize starch is not intrinsically as rapid as that for wheat and barley and is controlled by several factors including starch crystallinity, drying and processing, and the subsequent formation of retrograde starch (Brown, 1996). However, most nutritionists do not consider maize or sorghum digestion as being poor, in fact most would argue that starch is better than 98% digested. In the case of

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faecal digestibility, this is certainly the case. However, recent evidence presented by Noy and Sklan (1995) suggests that at the ileal level, starch digestibility rarely exceeds 85% between 4 and 21 days of age, despite ever increasing amounts of amylase output with increasing age. Likewise, Choct et al. (1996) reported an ileal digestibility of only 90% for the starch in a sorghum diet for broilers. Such a phenomenon will result in more starch escaping small intestinal digestion, which provides a fermentation source for large intestinal resident microbes. Overall, it appears that maize starch (and fat/protein) digestion may not be as complete in the chick as previously thought. Recent advances in enzyme technology have allowed for the development of specifically designed enzyme products, which targets cereal starch and the vegetable proteins. Thus, a study was conducted to evaluate the variability in ileal energy values between eight different commercial maize samples and the impact of enzyme addition in 28 day-old broilers.

II. METHODS

Eight different samples of commercially-grown maize were collected from various countries (France, USA, South Africa, Thailand), and then tested under uniform conditions at the Roslin Institute, Scotland. Each maize sample was used at 530 g/kg in an otherwise unchanged diet containing 380 g soybean meal, 36 g animal fat/kg and amino acid and mineral supplements. The ileal digestibility values were measured in broilers at day 28 with each of the eight experimental diets being tested with and without enzymes (Avizyme 1500) added at 1kg/tonne. This enzyme contains xylanase, amylase and protease.

Four cages of four male Cobb broilers per treatment received the diets over a period of 14 days prior to sampling of ileal digesta. Diets contained titanium oxide as an indigestible marker and were fed as mash ad libitum. Feed and digesta samples were analysed for their energy, starch, fat and protein content to determine ileal digestibility coefficients for each parameter. Data were analysed using ANOVA according to the GLM procedures of SAS.

III. RESULTS AND DISCUSSION

The ileal digestibility assay was shown to be a very accurate and sensitive method to assess differences between maize samples and the subsequent impact of supplemental enzymes. The average dietary energy value across all maize fed without enzymes was 12.24 MJ/kg with a range from 11.71 to 12.56 MJ/kg (Figure 1). Supplementing enzymes significantly (P= 0.006) increased ileal digestible energy values across all diets by 3.2% with an average value of 12.63 MJ/kg. The main effect of enzyme supplementation was to significantly increase ileal starch and fat digestibility values by 1.0% (95.4 vs 96.3%) and 3.5% (74.3 vs 77.1%), respectively. The increase in starch and fat digestion in the small intestine will increase energy availability to the bird by reducing the loss of nutrients to microbes in the caeca. Ileal protein digestibility was increased by 1.3% (79 vs 80%) with enzyme supplementation (P= 0.1), which could be the result of lower endogenous nitrogen losses.

Enzyme addition had two effects: the average energy content was enhanced by 0.405 MJ/kg (3.3%, P<0.001), and at the same time there was a clear reduction in the variability to only ± 0.167 MJ/kg. A larger enzyme effect on the poorer quality maizes and a smaller effect on already good quality batches of maize brought about the latter effect. The correlation between initial maize quality and response to enzyme was significant and is shown in Figure 2. For the two poorest batches of maize tested in this study, which were from Thailand and
Avizyme effect +3.2% (P=0.006)

Figure 1. Effects of enzymes on ileal energy digestibility of maize-based diets in broiler chicks at 28 days of age across 8 different maize batches. (Roslin Institute, Edinburgh, unpublished.)

South Africa, the energy response to enzyme supplementation was 0.85 MJ and 0.76 MJ/kg, respectively (Figure 1). This increase in energy corresponds to more than 1.26 MJ if entirely allocated to the maize fraction of the diet. The findings reported so far may indicate that feeding specific enzymes in the diet may reduce variability in the nutritional value of individual batches of maize. In conclusion, more consistent nutritional quality and bird performance may be expected in diets containing an appropriate enzyme supplement.

Figure 2. Effect of the energy content of the enzyme-unsupplemented diet on the energy response to enzyme addition. (Roslin Institute, Edinburgh, unpublished.)
IV. CONCLUSIONS

Results of growth and digestibility studies show an important potential for improvement in energy availability in maize-based diets. The current results demonstrate that the use of the appropriate enzymes can have a direct effect on ileal energy availability from different maize-based broiler diets. Enzyme addition resulted in a larger benefit with poorer compared with better quality maize. As a result, a more consistent nutritional quality and bird performance may be expected in maize diets containing an appropriate enzyme supplementation.

REFERENCES


