THE METABOLISABLE ENERGY VALUE OF SORGHUM AND BARLEY FOR BROILERS AND LAYERS

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Summary

A series of experiments was conducted to determine the apparent metabolisable energy (AME) values of 11 sorghum and 11 barley samples using broilers and layers. In addition the AME values of three selected samples were compared using laying hens and adult cockerels. The mean AME value (MJ/kg DM) of sorghum was 15.0 (range: 14.9-15.2) in broilers and 15.1 (range: 14.8-15.5) in layers, and the mean AME of barley was 12.5 (range: 11.6 to 13.8) in broilers and 13.0 (range: 12.5-13.5) in layers. Digesta viscosities (mPa.s) in birds fed sorghum diets averaged 2.7 and 2.6 in broilers and layers, respectively, with little variation between samples. Digesta viscosities in birds fed barley diets differed widely ($P<0.01$) between samples with the mean value in broilers being 25.5 (range: 8.4-70.7) and in layers 11.8 (range: 3.4-20.5) mPa.s. Dietary ME values obtained using broilers and layers were highly correlated ($R^2=0.947$). In addition, in two of the three samples examined AME values determined with adult cockerels and hens were similar.

I. INTRODUCTION

Despite the persistent debate on energy systems for evaluation of dietary energy for poultry (Farrell *et al.*, 1991), perhaps the question about the suitability of using AME data generated in broilers, layers at various egg laying stages, and adult cockerels interchangeably is more pressing (Härtel, 1986; Bourdillon *et al.*, 1990). This is due to the age effect on the ME of grains, especially that of viscous grains. For instance, Rogel *et al.* (1987) reported that the ME value of low-ME wheats was significantly higher when the assay was done with 6-week old rather than 3-week old broilers. It has been suggested that the age-related difference in the ME of feedstuffs for poultry is related to carbohydrate and lipid digestion (Carré *et al.*, 1995). The current study examined the AME values of sorghum and barley samples for both broilers and layers. Gut viscosities were also measured.

II. MATERIALS AND METHODS

Eleven samples of both sorghum and barley were assayed for AME using broilers (Pig and Poultry Production Institute, SARDI) and layers (the Queensland Poultry Research and Development Centre; QPRDC). Measurements of AME were also made with groups of adult cockerels using three of the diets in pelleted form so that comparisons could be made with the results obtained with laying hens (QPRDC). Data were analysed using ANOVA and regression analysis (Statgraphics, Manugistics, Inc., Maryland, USA).

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(a) Broiler bioassay

Ross broiler chicks were reared to 24 d and were then transferred in mixed-sex groups of four replicates of six birds (three male and three female) per diet to metabolism cages located in controlled-temperature rooms kept at 20-25°C. A classic ME trial was conducted over a 7-d period using the Australian ME Standard diet described by Mollah *et al.* (1983). At the end of the experimental period, two chickens per cage were sacrificed to collect ileal digesta (pooled) for gut viscosity determination.

(b) Layer bioassay

Four replicates of six ISA Brown hens which had been in lay for 35-40 weeks were placed in individual wire-mesh, sloping floor cages (23 cm wide x 45 cm long x 48 cm high) with individual feeders and drinking cups. Plastic trays were placed beneath the cages for excreta collection. Experimental diets (g/kg): test cereal, 940.05; dicalcium phosphate, 30.00; sodium chloride, 2.75; minerals, 0.70; vitamins, 0.50; lysine, 5.00, choline chloride, 1.00, and celite (as a source of acid insoluble ash marker) 20.00 were offered 4 d prior to excreta collection. Starting from d 5 excreta were collected daily for 7 d. Coarse shell grit was offered in a separate container to prevent egg shell deterioration and reduced egg production. At the end of the trial the birds were killed by cervical dislocation and the contents of the upper part of the small intestine were squeezed into plastic tubes, centrifuged and the viscosity of the supernatant measured.

(c) Adult cockerel bioassay

White Leghorn adult cockerels were placed in individual, specially constructed cages (36cm wide x 45 cm long x 48 cm high) with feeders that minimised spillage. Galvanised metal trays were placed beneath the cages. Weighed plastic sheets were placed in the trays for excreta collection. The birds were trained to consume their daily pelleted feed allowance in one hour. When this was achieved, the six birds per diet were starved for approximately 32 h before receiving their feed allowance of 100 g. Excreta were collected for the next 42 h and dried at 70°C in a forced draft oven for 48 h.

III. RESULTS

(a) Apparent metabolisable energy and digesta viscosity

The mean AME value (MJ/kg DM) of the 11 sorghum samples was 15.0 (range: 14.9-15.2) and 15.1 (range: 14.8-15.5) in broilers and layers, respectively, whereas corresponding values for the 11 barley samples were 12.5 (range: 11.6 to 13.8) and 13.0 (range: 12.5-13.5). The digesta viscosity value (mPa.s) for the sorghum diets averaged 2.7 and 2.6 in broilers and layers, respectively, with little variation between samples, whereas the corresponding values in birds fed the barley diets were 25.5 (range: 8.4-70.7) and 11.8 (range: 3.4-20.5), respectively (Table 1).

(b) Correlations

Dietary AME values for broilers and layers were significantly ($P<0.01$) correlated ($R^2=0.947$). There were significant ($P<0.01$) negative correlations between ileal viscosity and dietary AME with broilers (R^2=0.494) and layers (R^2=0.652). Ileal viscosity values obtained with broilers and layers were also significantly ($P<0.01$) correlated (R^2=0.508).

Table 1. Apparent metabolisable energy (AME) (MJ/kg DM) and digesta viscosity values (mPa.s) of 11 sorghum and 11 barley samples fed to broilers and layers.

Parameter	Sorghum		Barley	
	Broiler	Layer	Broiler	Layer
Mean AME	15.0 (0.03)[1]	15.1 (0.07)	12.5 (0.14)	13.0 (0.10)
AME range	14.9-15.2	14.8-15.5	11.6-13.8	12.5-13.5
Mean viscosity	2.7 (0.07)	2.6 (0.10)	25.5 (5.69)	11.8 (2.03)
Viscosity range	2.3-3.0	1.9-3.0	8.4-70.7	3.4-20.5

[1] Values in parenthesis are standard errors.

(c) Comparison between laying hens and cockerels

In two out of three samples examined there were no differences between AME values determined with adult cockerels and laying hens (Table 2).

Table 2. Comparison of apparent metabolisable energy (AMEn) values determined with laying hens and adult cockerels.

		AMEn (MJ/kg DM)		
Grain	N	Cockerels	Layers	SEM
Sorghum, composite control	6	14.47	14.84	0.182
Barley, Grimmett PBI Narrabri	6	13.60	13.64	0.092
Sorghum, Thunder Biloela	6	14.40	15.50[1]	0.090

[1] Significantly different to cockerels ($P<0.05$).

IV. DISCUSSION

There was no significant difference between the AME of sorghum measured using laying hens and broiler chickens but the AME of barley was on average 0.5 MJ/kg higher in layers. Carré *et al.* (1995) demonstrated that laying hens could obtain 0.8 MJ/kg more ME through effective use of lipids and carbohydrates compared to young broilers. The inference of adaptation of the gut microflora of the chicken to high non-starch polysaccharide (NSP) diets is suggested by the viscosity data in the current study where the mean gut viscosity in birds fed barley diets was 25.5 mPa.s in broilers and 11.8 mPa.s in layers. The ranges of viscosity values were extremely wide (8.4-70.7mPa.s for broilers and 3.4-20.5 mPa.s for layers). Choct and Kocher (2000) reported that the caecal microflora of the chicken can produce xylanase and β-glucanase. It is possible that the enzyme levels produced by the gut microflora vary from bird to bird or perhaps the extreme variation in viscosity value reflects different times of caecal emptying and/or refluxing of caecal contents into the small intestine. If the latter is true, the enzymes produced by the caecal microflora could be refluxed into the small intestine at different rates and times, thus alleviating the anti-nutritive effect of the soluble NSP to a variable extent. Since older birds utilise NSP better, the higher the NSP level in the grain then the larger the difference in the AME between broilers and layers.

The negative effect of NSP in poultry diets is related to the viscous nature of the polymers and their ability to increase gut viscosity (Antioniou *et al.*, 1981). Consequently, attempts have been made to use gut viscosity as a predictor of the AME value of some grains for broilers with mixed success (Bedford and Classen, 1992, 1993; Choct and Kocher, 2000). In the current study gut viscosity was negatively ($P<0.01$) correlated with AME with R^2 values of 0.494 in broilers and 0.652 in layers.

It has been argued that the use of ME values obtained in adult birds may not be applicable to young chickens (Härtel, 1986; Bourdillon *et al.,* 1990). This appears to be true for viscous grains such as barley but not for sorghum. The AME values obtained using broilers and layers were closely correlated (R^2=0.947). However, it is not known whether variations in broiler and layer AME values for a particular grain remain the same under different conditions. Traditionally, adult cockerels are used for the measurement of dietary ME of feedstuffs for layers because the availability of laying hens at appropriate ages, the high dietary mineral concentration and stress to the hens during excreta collection make ME determination in laying hens difficult. In this study the AME values were similar in two of the three diets selected for comparison of adult cockerels and laying hens. More systematic studies are required for such a comparison.

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