NUTRITIVE VALUE OF WINTER WHEAT FOR BROILER CHICKENS

R.J. HUGHES[1], L. ACONE[2], P. ZVIEDRANS[1] and M. CHOCT[3]

Summary

The nutritive value of Australian winter wheat varieties for broiler chickens was assessed in a series of conventional energy balance studies each of 7-days duration. Across all samples, the mean and standard deviation for apparent metabolisable energy (AME, MJ/kg dry matter) were 14.29±0.36 (n=25) and ranged from 13.68 to 15.02. For individual varieties, means and standard deviations were 14.80±0.03 for Declic (n=2), 14.31±0.33 for Lawson (n=16), 13.97±0.34 for More (n=4) and 14.20±0.09 for Paterson (n=3). In conclusion, winter wheats were consistently high in AME but, nevertheless, were responsive to endo-1,4-xylanase added to the diet. Uplift in AME of wheat due to enzyme supplementation averaged 0.7 MJ/kg (4.9%) and ranged from 0.22 MJ/kg (1.5%) to 1.13 MJ/kg (8.2%).

I. INTRODUCTION

In 1995, CSIRO Plant Industries and the Australian Wheat Board introduced Lawson, a leaf and stripe rust resistant winter wheat, which provided an opportunity for livestock producers in cooler, high rainfall areas to diversify into wheat production. There are now ten winter wheat varieties with varying degrees of rust resistance, five of which can be grazed during winter and then recover to provide a high yielding wheat crop in summer. Currently, the most popular varieties are More, Declic and Paterson. Tennant, which is due for release, is stem, stripe and leaf rust resistant. Winter wheats now comprise about 4% of the Australian feed wheat market, the remainder being spring wheat deemed unsuitable for milling.

The apparent metabolisable energy (AME) of Australian wheats is highly variable (10.35 - 15.9 MJ/kg DM) according to studies by Mollah *et al.* (1983) and Rogel *et al.* (1987) with broiler chickens. Recent studies also with broilers (Choct, 1995; Hughes *et al.*, 1996; Hughes and Choct, 1997) have confirmed earlier reports of wide variability. AME of wheat is related to the non-starch polysaccharide (NSP) level, which in turn is affected by climatic conditions such as high temperature or low rainfall during the growth period (Choct *et al.*, 1999). Feed manufacturers routinely add NSP-degrading enzymes to wheat based broiler feeds to enhance the AME of low nutritive value wheat and to minimise variability in AME between wheats. Since winter wheats are grown under mild conditions it is likely that these wheats will be of high nutritive value with low variability compared with spring wheats.

This paper summarises for broiler chickens (1) the nutritive value of four winter wheat varieties determined in ten studies between 1993 and 1999, (2) the nutritive value of two winter wheats from each of two regions with differing environmental conditions, and (3) the effects of dietary addition of a commercial enzyme product with endo-1,4-xylanase activity.

II. MATERIALS AND METHODS

The AME values of wheats were determined in conventional energy balance experiments involving measurements of feed intake and excreta output as described by Mollah *et al.* (1983) with

---

[1] SARDI, Pig and Poultry Production Institute, University of Adelaide, Roseworthy SA 5371.

[2] Agrifood Technology (Division of AWB Limited), Werribee Vic 3030.

3 University of New England, Division of Animal Science, Armidale NSW 2351.

minor modifications, and subsequent measurement of gross energy values of feed and excreta by bomb calorimetry. Day-old mixed sexed broiler chickens were raised in floor pens on a commercial broiler diet to 3-4 weeks of age then transferred in groups of five to metabolism cages in controlled temperature rooms. Semi-purified basal diets used prior to 1999 contained (per kg) 820 g sorghum, 134 g casein, 26 g dicalcium phosphate, 11 g limestone, 5 g mineral and vitamin premix, 3.6 g salt and 0.4 g choline chloride (50%). In 1999, semi-purified basal diets contained (per kg) 800 g sorghum, 152 g casein, 20 g dicalcium phosphate, 11 g limestone, 7 g DL-methionine, 5 g mineral and vitamin premix, 3 g salt and 2 g choline chloride (60%). Wheat replaced sorghum in the basal diets as required. In each study, dietary treatments were replicated at least four times. Cold-pressed diets were fed for seven days. The first three days enabled the chickens to adapt to the cages and feeds. During the following four days, all excreta were collected and dried. Moisture content of excreta voided over a 24 h period was measured. Feed intake was measured during the adaptation and collection phases of the study. Birds were weighed at the start and end of the seven day period. Dry matter (DM) contents of samples of pelleted and milled feeds were measured. Gross energy values of dried excreta and milled feeds were measured with a Parr isoperibol bomb calorimeter. AME of the grain was calculated by subtracting from the total energy intake the energy contribution of casein, which was assumed to be 20.1 MJ/kg dry matter (Annison *et al.*, 1994).

III. RESULTS AND DISCUSSION

Summarised results from 10 AME studies conducted between 1993 and 1999 are shown in Table 1. There were no indications of any sample of wheat of any variety falling in the "low-AME" category, that is, less than 13MJ/kg dry matter.

Table 1. Effects of variety of winter wheat on AME (MJ/kg dry matter) and feed conversion ratio (FCR, g feed/g gain) measured over a seven-day period commencing when chickens were 3-4 weeks of age. Each dietary treatment was replicated at least four times.

Variety	Number of samples	Mean	Standard deviation	Minimum	Maximum
				AME	
Declic	2	14.80	0.14	14.71	14.90
Lawson	16	14.31	0.33	13.83	15.02
More	4	13.97	0.34	13.68	14.51
Paterson	3	14.20	0.09	14.10	14.27
Overall	25	14.29	0.36	13.68	15.02
				FCR	
Declic	2	1.94	0.03	1.92	1.95
Lawson	16	2.00	0.14	1.82	2.41
More	4	2.01	0.03	1.98	2.05
Paterson	3	1.93	0.05	1.88	1.97
Overall	25	1.99	0.12	1.82	2.41

The results of an experiment to study the effects of variety, growth site and enzyme addition are summarised in Table 2. There were no significant effects of variety or growth site on feed conversion, AME, dry matter digestibility or excreta moisture content. In contrast, enzyme addition significantly improved weight gain (373 vs 355 g/bird), feed conversion (1.89 vs 1.98), AME (14.8 vs 14.0 MJ/kg dry matter), and dry matter digestibility (0.74 vs 0.71 g retained/g eaten), and reduced excreta moisture content (670 vs 697 g/kg). The only effects of variety of wheat were on feed intake and weight gain. Chickens given the diet based on Paterson ate significantly less (98 vs 104 g/bird/day) and grew at a slower rate (355 vs 374 g/bird) than those on More.

Table 2. Effects of variety, growth site and enzyme addition (200 g/tonne) on feed intake (FI, g/bird 22-29 days), growth rate (GR, g/bird), feed conversion ratio (FCR, g feed/g gain), AME (MJ/kg dry matter) of wheat, dry matter digestibility (DMD, g retained/g eaten), and excreta moisture (EM, g/kg). Means (n=6 replicates, each comprising five birds) having a common postscript letter are not significantly different (P<0.05).

Variety	Site	Enzyme	FI	GR	FCR	AME	DMD	EM
Paterson	Ballarat	-	97 bc	345 c	1.97 abc	14.10 cd	0.715 bc	682 abc
Paterson	Ballarat	+	99 bc	368 ab	1.89 de	14.70 ab	0.740 ab	672 abc
Paterson	Hamilton	-	96 c	344 c	1.94 bcd	14.24 bcd	0.719 bc	690 abc
Paterson	Hamilton	+	99 bc	361 bc	1.93 bcd	14.46 abc	0.730 abc	664 c
More	Ballarat	-	105 a	370 ab	1.99 ab	13.88 cd	0.705 c	710 a
More	Ballarat	+	103 ab	379 ab	1.91 cde	14.88 a	0.751 a	671 bc
More	Hamilton	-	105 a	362 abc	2.02 a	13.84 d	0.706 c	705 ab
More	Hamilton	+	101 ab	384 a	1.85 e	14.97 a	0.753 a	674 abc
	Pooled SEM		2	8	0.02	0.20	0.007	13

The results of a further experiment to examine effects of growth site and enzyme addition are summarised in Table 3. There were no significant differences between growth sites but the beneficial effects of enzyme approached significance for AME (15.2 vs 14.8 MJ/kg dry matter, P=0.09) and for dry matter digestibility (0.763 vs 0.741, P=0.06).

Table 3. Effect of enzyme addition (200 g/tonne) to variety Declic grown on separate sites in the Ballarat region on feed intake (FI, g/bird 22-29 days), growth rate (GR, g/bird), feed conversion ratio (FCR, g feed/g gain), AME (MJ/kg dry matter) of wheat, and dry matter digestibility (DMD, g retained/g eaten). Means (n=4 replicates, each comprising five birds) having a common postscript letter are not significantly different (P<0.05).

Site	Enzyme	FI	GR	FCR	AME	DMD
Bungaree	-	97 a	349 a	1.95 a	14.90 a	0.746 a
Bungaree	+	98 a	356 a	1.93 a	15.41 a	0.771 a
Bradvale	-	104 a	381 a	1.92 a	14.71 a	0.737 a
Bradvale	+	100 a	369 a	1.90 a	15.08 a	0.754 a
Pooled SEM		4	14	0.03	0.24	0.010

The results of another experiment to examine further any effects of variety and enzyme are shown in Table 4. There were significant differences between the varieties Paterson and More in live weight gain and feed conversion. Chickens given the diet based on More gained less weight (328 vs 363 g/bird) and were less efficient (1.94 vs 1.85) than chickens given Paterson. The beneficial effects of enzyme were clearly evident (P<0.05) for live weight gain (362 vs 329 g/bird), feed conversion (1.86 vs 1.93), AME (15.2 vs 14.3 MJ/kg dry matter), and dry matter digestibility (0.77 vs 0.73 g retained/g eaten). Feed intake and excreta moisture were unaffected by either variety or enzyme addition in this experiment.

Table 4. Effects of variety and enzyme addition (200 g/tonne) on feed intake (FI, g/bird 22-29 days), growth rate (GR, g/bird), feed conversion ratio (FCR, g feed/g gain), AME (MJ/kg dry matter) of wheat, and dry matter digestibility (DMD, g retained/g eaten). Means (n=6 replicates, each comprising five birds) having a common postscript letter are not significantly different ($P<0.05$).

Variety	Enzyme	FI	GR	FCR	AME	DMD
Paterson	-	95 a	354 a	1.88 b	14.27 b	0.726 a
Paterson	+	97 a	371 a	1.83 b	15.06 a	0.764 b
More	-	94 a	304 b	1.99 a	14.37 b	0.735 a
More	+	95 a	352 a	1.90 a	15.37 a	0.779 b
Pooled SEM		4	14	0.03	0.20	0.009

IV. CONCLUSIONS

Winter wheats were consistently high in AME but, nevertheless, responded to enzyme supplementation. Further studies are warranted to confirm or refute the notion that winter wheats are consistently high in AME because they are relatively low in soluble NSP content in comparison with spring wheats, as a result of being grown in areas with mild weather conditions. However, there were small but important differences between winter wheat varieties, hence it would be useful to examine other features of grain, such as starch granule size, composition and structure, which can affect nutrient utilisation by monogastric animals.

V. ACKNOWLEDGMENTS

Enzyme product (Bio-Feed Wheat CT) was provided *gratis* by Novo Nordisk. We gratefully acknowledge the dedicated efforts of the poultry research staff at the Pig and Poultry Production Institute and at the University of New England.

REFERENCES

Annison, G., Choct, M. and Hughes, R.J. (1994). *Proceedings Australian Poultry Science Symposium* (Ed. R.J. Johnson), **6**: 92-96.

Choct, M. (1995). Final Report to CMRDC on Project CSN 2CM.

Choct, M., Hughes, R.J. and Annison, G. (1999). *Australian Journal of Agricultural Research,* **50**: 447-451.

Hughes, R.J., and Choct, M. (1997). *Proceedings of the Australian Poultry Science Symposium* (Ed. D. Balnave), **9**: 138-141.

Hughes, R.J., Kocher, A., Acone, L., Langston, P. and Bird, J.N. (1996*). Proceedings of the Tenth Australian Poultry and Feed Convention,* Melbourne, Australia, pp. 232-235.

Mollah, Y., Bryden, W.L., Wallis, I.R., Balnave, D. and Annison, E.F. (1983). *British Poultry Science,* **24**: 81-89.

Rogel, A.M., Annison, E.F., Bryden, W.L. and Balnave, D. (1987). *Australian Journal of Agricultural Research,* **38**: 639-649.