

The metabolizability of wheat and inedible pasta as affected by xylanase supplementation

R. JAHANIAN NAJAFABADI^{1*}, J. POURREZA¹, A. H. SAMIE¹, and M. A. EDRISS¹

Department of Animal Science, Faculty of Agriculture, Isfahan University of Technology, Isfahan, P.O. Box: 84156, Iran.

*Corresponding author: r.jahanian@gmail.com

An adult rooster study was conducted to compare energy metabolizability of three energy feeds in response to enzyme addition. The corn, wheat and inedible pasta (wastes) samples, each from two sources, were force fed to 58-wk-old adult cockerels according to McNab and Blair procedure. To evaluate the effect of enzyme on improvement of metabolizable energy values, 1000 units/kg xylanase from crude preparation was added to these various energy sources. The apparent DM digestibilities of these three feedstuffs were highly significantly ($P < 0.01$) different, with the highest values for inedible pasta. Enzyme addition of 1000 units/kg had no significant effect on DM digestibility. The apparent fat digestibility and nitrogen retention values were also different among these feedstuffs. The average AME values of corn, wheat and inedible pasta were determined to be 3060, 3069 and 3419 kcal/kg, respectively. The respective values for AME_n were 3464, 3304 and 3671 kcal/kg. The enzyme addition affected ($P < 0.05$) the metabolizability coefficients when ME values of corn samples were ignored, but when corn data were participated in calculations, the effect of xylanase was not apparent. The results show that the inedible pasta can be used in poultry diets as a good alternative energy source and enzyme supplementation additionally improves its feeding value.

Keywords: metabolizable energy; corn; wheat; inedible pasta; xylanase supplementation

Introduction

Sibbald (1982) estimated that energy in feed represents 40% of the cost in producing poultry meat and eggs, underlining the importance of accurate energy determination of feed ingredients for the formulating poultry rations. Wheat is one of the best alternative feed ingredients for corn in poultry diets; however, compared with other cereal grains, the nutrient composition and nutritive quality of wheat vary widely (Hew et al., 1998). Although the exact identity of the factors responsible for this variability remains to be elucidated, available evidence suggests that the water-soluble pentosan content, accounting for 50-80% of the wheat non-starch polysaccharides (NSP's) and consisting mainly of arabinoxylans, is the major contributing factor (Annison and Choct, 1991). The arabinoxylans have been reported to give rise to highly viscous conditions in the small intestine of wheat-fed chickens and, depress nutrient utilization and performance. These adverse effects can be overcome by supplementation with exogenous xylanases which have been shown to lower the viscosity of intestinal contents and to improve broiler performance (Annison and Choct, 1991; Bedford, 1995).

One of the potential approaches to lower the costs of poultry production is dietary utilization of wastes from food processing industries. One of these by-products requiring disposal is pasta that cannot be sold for human consumption. The wastes of pasta are approximately 8-12% (with average of 10%) in Iranian factories. In the most Iranian factories, the pasta is mainly produced from common wheat (not *triticum durum*), and this may be responsible for considerable amounts of produced wastes. This includes product spills, line changes, off-specification materials, etc. There are few published data on the feeding value and metabolizable energy content of inedible pasta for use in poultry diets.

Across the limited literature, Williams et al. (1998) reported that the TME for inedible pasta was 18.1 kJ (4.3 kcal)/g, which was slightly greater than for corn (3.8 kcal/g).

Since no or little data is available regarding to chemical composition and nutritive value of pasta wastes, and because there is conflicting data concerning the adult cockerels' response to feed enzyme, so this study was performed to determine the chemical composition and feeding value of three energy feeds in response to enzyme addition by using a modified rooster bioassay.

Materials and methods

The pasta samples were collected during one week sampling period from two pasta producing factories. Prior to conducting the adult rooster assay, the chemical composition of these feed ingredients was determined according to the standard procedures of AOAC (2002). A total of 50 adult (58 wk-old) Single Comb White Leghorn cockerels, of 2275±95 g average body weight, were used in bioassay trial. When not under experiment, the birds had access freely to a low residue maintenance diet containing 16.5% crude protein and 3100 kcal/kg ME. The cockerels were divided to 10 groups of 5 roosters. Each five individually-housed cockerels were received the same feedstuffs according to McNab and Blair (1988) procedure. The five cockerels received no feed as the control group to estimate endogenous energy loss (EEL), while remaining nine groups were force fed with 30 g feed after a 48-h feed withdrawal. Dietary treatments consisted of corn, wheat and pasta wastes, each from two sources (Six cockerels groups). Because of the insufficient number of cockerels, the xylanase (1000 units/kg) was added only to one composed sample of each feedstuff (totally, nine fed-groups of cockerels). After freeze-drying, all excreta samples were allowed to equilibrate to the atmospheric moisture content, then weighed and ground. The samples were analyzed for gross energy, fat and nitrogen contents. All data were subjected to analysis of variance using the General Linear Models procedures of SAS (SAS Institute, 1999) as a 3 × 2 factorial arrangement with feed type and enzyme supplementation as main effects.

Results and discussion

The nutrient composition of feedstuffs is shown in *Table 1*. As noted, the composition of two composed samples of pasta wastes is very similar and there is not significant difference in their metabolizable energy values. From the CP data, it is appears that the pasta waste can be used as a good protein source because of its relatively high and constant protein content; however the bioavailability of its amino acids needs to be determined.

Table 1 The chemical composition (%), and gross and metabolizable energy contents (kcal/kg) of two various sources of corn, wheat and inedible pasta (As fed basis)

Feedstuffs	DM	CP	EE	Ash	CF	NFE	GE	AME	AME _n
Corn Sample 1	86.81	7.13	3.69	1.30	4.89	69.80	4315	3023	3443
Corn Sample 2	89.68	8.01	4.74	2.47	2.51	71.95	4356	3096	3484
Wheat Cultivar 1	92.74	12.99	2.00	5.98	3.66	68.11	4248	3101	3330
Wheat Cultivar 2	90.08	12.34	2.05	5.52	3.82	66.35	4220	3037	3277
Pasta Sample 1*	94.02	10.94	0.96	0.80	0.21	81.11	4397	3435	3684
Pasta Sample 2*	93.28	10.45	0.70	0.58	0.26	81.29	4380	3403	3658

DM: dry matter; CP: crude protein; EE: ether extract; CF: crude fiber; NFE: nitrogen free extract; GE: gross energy; AME: apparent metabolizable energy; AME_n: apparent metabolizable energy corrected for zero-nitrogen retention

*The pasta samples 1 and 2 were obtained from Golshahr and Milan Macaron Co., respectively.

Interestingly, the chemical composition, and gross and metabolizable energy contents of two composed samples of wheat resemble each other. This similarity may be due to the same origin and

cultivation conditions. Unlike to our results, the apparent metabolizable energy (AME) values of Australian wheat have been reported to range from 10.5 to 15.5 MJ/kg DM (Mollah et al., 1983; Rogel et al., 1987). The so-called 'low-metabolizable energy wheat' are defined as wheats having AME values under 13 MJ/kg DM for poultry (Mollah et al., 1983), therefore the wheat samples studied here not fall into this category.

The apparent DM and fat digestibility coefficients, and nitrogen retention values are presented in *Table 2*. The apparent DM digestibility were highly significantly ($P < 0.01$) affected by feed type, with the highest values assigned to pasta samples followed by wheat samples. The greater DM digestibility of inedible pasta and wheat than of corn samples may be due to the greater DM contents of these feedstuffs. Of course, as noted in *Table 2*, the nitrogen retention value of cockerels fed with corn was also lower than those fed with pasta and wheat samples. This observation indicate that the corn-fed groups had greater endogenous nitrogen loss, thus lower DM retention may be related to higher excretion of endogenous-derived materials. Xylanase addition had no effect on apparent DM retention. This observation was in good agreement with Classen et al. (1985), who reported that dietary enzyme supplementation had no marked effect on feed efficiency in adult birds.

Table 2 Effect of enzyme supplementation on metabolizable energy content, dry matter and fat digestibility, and nitrogen retention value of three energy feeds

Feed type	Enzyme	AME (kcal/kg)	AME _n (kcal/kg)	TME (kcal/kg)	TME _n (kcal/kg)	Apparent fat dig. (%)	Apparent DM dig.(%)	Excreted N to Consumed N
Corn	0	3023 ^b	3443 ^b	3784 ^c	3719 ^c	93.07 ^{ab}	61.07 ^c	5.31 ^a
	1000	3047 ^b	3476 ^b	3808 ^c	3752 ^{bc}	93.10 ^{ab}	60.36 ^c	5.31 ^a
Wheat	0	3101 ^b	3330 ^b	3861 ^c	3607 ^c	91.90 ^b	68.66 ^b	2.10 ^b
	1000	3202 ^b	3454 ^b	3963 ^{bc}	3730 ^{bc}	94.04 ^a	70.02 ^b	1.88 ^b
Inedible pasta	0	3435 ^a	3684 ^a	4118 ^{ab}	3915 ^{ab}	92.88 ^{ab}	76.50 ^a	2.46 ^b
	1000	3542 ^a	3800 ^a	4242 ^a	4031 ^a	94.56 ^a	78.39 ^a	2.20 ^b
Probability								
Feed type		***	***	***	***	NS	***	***
Enzyme		NS	NS	NS	0.08	*	NS	NS
Feed×Enz		NS	NS	NS	NS	NS	NS	NS
SE		71.59	66.30	63.26	61.83	0.66	1.84	0.31

^{abc}Means with common superscripts do not differ significantly ($P < 0.05$); * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$

The apparent fat digestibility was not affected by feed type; however, enzyme supplementation caused to significant ($P < 0.05$) improve in fat digestibility coefficients. Enzyme improved the fat digestibilities of wheat and inedible pasta but not corn samples, whereby the feed type by enzyme interaction come near to significant level. The effect of enzyme on improvement of fat digestibility was more pronounced when the corn data were omitted from calculations. These observations may probably due to unsuitability of corn for enzyme action. The reason why cockerels responded to enzyme addition may be due to the transient and immediate change in their ration.

All birds used in our study were in negative nitrogen balance, and this was the reason why all AME_n values were greater than counterpart values (AME). The nitrogen retention values were highly significantly affected ($P < 0.01$) by feed type, with the least values for corn-tube fed cockerels. Enzyme had not significant effect on this parameter even when the corn data were omitted from the calculations. In their study with ducks, Adeola et al. (1997) observed that the nitrogen retention value of corn-fed adult ducks was lower as compared with ducks fed on wheat and sorghum. These authors attributed this observation to higher nitrogen intake from wheat and sorghum in comparison with corn.

The response of feed' metabolizable energy to enzyme supplementation is shown in *Table 2*. In this table, the metabolizable energy value of one composed sample of each feedstuff is seen. The average AME_n values for corn, wheat and inedible pasta samples were 3443, 3330, and 3684 kcal/kg, respectively. In overall, Enzyme supplementation had no significant effect on ME values, but when corn data were ignored (data not shown), the enzyme effect on improving the AME_n and TME values became apparent. The correction of TME data for nitrogen retention resulted in 2-7% decline in TME_n values. The similar decline (2-5%) has been previously reported by Adeola et al. (1997). Furthermore,

the TME contents of all studied feedstuffs were greater than AMEn values which are in agreement with reports that shown the TME contents of many feedstuffs are about 9-18% higher than respective AMEn values (Baidoo et al., 1991; Sibbald and Price, 1977). The greater ME content of pasta may be due to its very lower ash and CF contents compared with corn and wheat (Sharara et al., 1992). Of course, this observation may be in part due to the beneficial effect of heat processing.

From the present results, it can be concluded the pasta waste is a good alternative energy source for use in poultry rations, however, since this data were obtained using the adult cockerels, the further studies with broilers are needed to confirm its nutritive value for all ages.

References

- Adeola, O., Ragland, D. and King, D. (1997) Feeding and excreta collection techniques in metabolizable energy assays for ducks. *Poult. Sci.* 76: 728-732.
- Annisson, G. and Choct, M. (1991) Anti-nutritive activities of cereal non-starch polysaccharides in broiler diets and strategies minimizing their effects. *World's Poult. Sci. J.* 47: 232-242.
- Association of Official Analytical Chemists (2002) *Official Methods of Analysis*. 16th ed., AOAC. Washington, DC., USA.
- Baidoo, S.K., Shires, A. and Robblee, A.R. (1991) Effect of kernel density on the apparent and true metabolizable energy value of corn for chickens. *Poult. Sci.* 70: 2102-2107.
- Bedford, M.R. (1995) Mechanism of action and potential environmental benefits from the use of feed enzymes. *Anim. Feed Sci. Technol.* 53: 145-155.
- Classen, H.L., Campbell, G.L., Rossnagel, B.G., Bhatti, R. and Reickert, R.D. (1985) Studies on the use of hullless barley in chick diets: deleterious effects and methods of alleviation. *Can. J. Anim. Sci.* 65: 725-733.
- Hew, L.I., Ravindran, V., Mollah, Y. and Bryden, W.L. (1998) Influence of exogenous xylanase supplementation on apparent metabolisable energy and amino acid digestibility in wheat for broiler chickens. *Anim. Feed Sci. Technol.* 75: 83-92.
- March, B.E. and Biely, J. (1971) Factors affecting the response of chicks to diets of different protein value, breed and age. *Poult. Sci.* 50: 1036-1040.
- McNab, J.M. and Blair, J.C. (1988) Modified assay for true and apparent metabolizable energy based on tube feeding. *Br. Poult. Sci.* 29: 697-707.
- Mollah, Y., Bryden, W.L., Wallis, I.R., Balnave, D. and Annisson, E.F. (1983) Studies of low metabolizable energy wheats for poultry using conventional and rapid assay procedures and the effects of feed processing. *Br. Poult. Sci.* 24: 81-89.
- Rogel, A.M., Annisson, E.F., Bryden, W.L. and Balnave, D. (1987) The digestion of wheat starch in broiler chickens. *Aus. J. Agric. Res.* 38: 639-649.
- SAS Institute (1999) *SAS Statistics User's Guide*. Statistical Analysis System. 5th rev. edition. Cary, NC., SAS Institute Inc.
- Sharara, H.H., El-Hammady, H.Y. and Abd El-Fattah H. (1992) Nutritive value of some non-conventional by-products as poultry feed ingredients. I. Chemical evaluation. *Assiut J. Agric. Sci.* 23: 333-346.
- Sibbald, I.R. and Price, K. (1977) True and apparent metabolizable energy values for poultry of Canadian wheats and oats measured by bioassay and predicted from physical and chemical data. *Can. J. Anim. Sci.* 57: 365-374.
- Sibbald, I.R. (1982) Measurement of bioavailable energy in poultry feeding stuffs: a review. *Can. J. Anim. Sci.* 62: 983-1048.
- Slinger, S.J., Sibbald, I.R. and Pepper, W.F. (1964) The relative abilities of two breeds of chickens and two varieties of turkeys to metabolize dietary energy and dietary nitrogen. *Poult. Sci.* 43: 329-333.
- Williams, J.E., Belyea, R.L., Hsieh, F.H. and Firman, J.D. (1998) Responses of growing turkeys to the dietary inclusion of inedible pasta and unextruded and extruded biosolids from milk processing. *Anim. Feed Sci. Technol.* 70: 123-136.
- Wiseman, J., Nicol, N.T. and Norton, G. (1994) Development in the nutritional value of wheat for non-ruminants. in: *Recent Advances in Animal Nutrition*, Garnsworthy, P.C. and Cole, D.J.A. (Eds.). pp. 117-132. Nottingham, UK.