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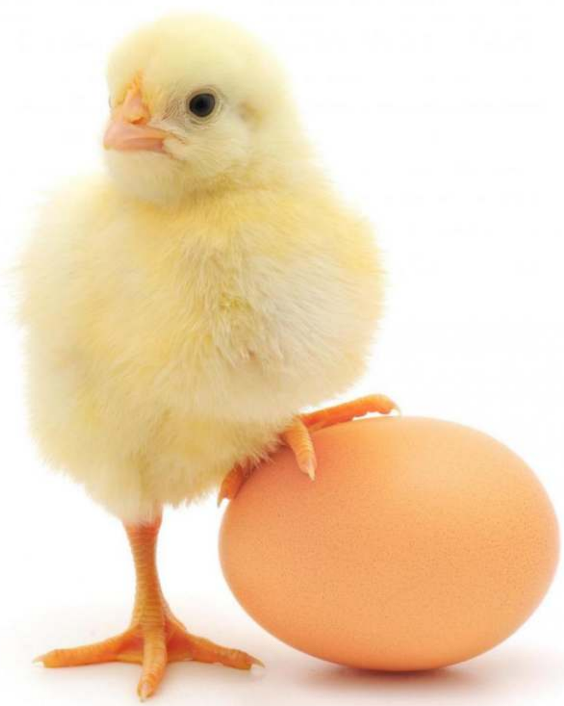

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Effect of Xylanase Supplementation and Particle-Size on Performance of Guinea Fowl Broilers Fed Wheat-Based Diets

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Abstract: The effect of xylanase enzyme supplementation and particle-size in wheat (*Triticum durum*)-based diets was studied in guinea broilers from 29 to 91 days of age. Weekly body weight, gain, feed consumption and Feed Conversion Ratio (FCR) were determined. Was formed 4 groups, each fed: diet A (ground wheat with enzyme); diet B (ground wheat without enzyme); diet C (ground wheat passed through 3 mm sieve, pelleted and after crumbled with enzyme): diet D (crumbled wheat without enzyme). The highest body weights values were recorded by guinea fowls fed diet C. Birds fed diet B have shown low mean values of body weight. Subjects fed diet C were obtained values of mean body weight different ($p<0.05$) respect to subjects fed both unsupplemented diets. Between two diets containing xylanase, even if prepared with different method, weren't recorded differences ($p<0.05$), even if subjects fed crumbled diets show an increase of body weight in comparison to subjects that received ground diets. Body weight gain of guinea broilers fed diet A and diet B were recorded high values, with differences ($p<0.05$) in birds fed supplemented diets. These differences weren't observed between birds fed diets B and D. Feed consumption showed that birds fed diets A and B consume an higher amount of feed ($p>0.05$) compared to the diets C and D, regardless the supplementation of xylanase. Within every typology of diet (ground versus crumbled) aren't recorded differences ($p<0.05$) for the presence or not of enzyme, even if between crumbled diets, supplementation however has reduced feed consumptions. FCR of every diets shown't differences ($p<0.05$) among them, with values in guinea broilers fed supplemented diets similar to data recorded in birds fed unsupplemented diets. The supplementation of xylanase in a crumbled wheat-based diet improved the growth performance of guinea fowl broilers.

Key words: Xylanase, particle-size, wheat, guinea fowl, growth performance

Introduction

The feed and poultry production industry is faced with a number of challenges, not the least of which are the pressures to produce high quality products to satisfy customer needs in a cost effective manner. Of cereal grains, wheat has been preferred as main dietary ingredient in poultry diets by European and Canadian feed manufacturers, in contrast to their counterparts in USA. This is most likely to due to the high production of wheat grain in Europe and Canada and it is one of the major energy contributors to the diets of poultry (Steenfeldt *et al*., 1998). An important problem in the use of wheat in commercial poultry diets has been caused by their low and variable energy values. The Apparent Metabolizable Energy (AME) of wheat can be lower and more variable than expected among different cultivars because of the amount of Non-Starch Polysaccharides (NSP) contained in the kernel. The AME and soluble NSP are negatively correlated in wheat (Choct and Annison, 1990; Choct *et al*., 1999a).

Smulikowska and Mieczkowska (2000) reported that 62% of the increase of the AME values was due to better fat digestibility when broilers are fed wheat-based diet supplemented with enzymes containing xylanase activities.

The water-soluble Non-Starch Polysaccharides (NSP) of the endosperm cell walls of wheat, barley, rye and oats have anti-nutritive properties in poultry. It has been clearly demonstrated that the presence of soluble arabinoxylans in wheat (Choct and Annison, 1992) is the major cause of growth depression and poor feed conversion in poultry. The addition of exogenous enzymes to wheat-diets can overcome the anti-nutritive effect of water soluble NSP and numerous studies have reported the beneficial impact of exogenous enzymes on chick performance and nutrient digestibility (Cowan *et al*., 1996; Odetallah *et al*., 2002; Silva and Smithard, 2002). Dietary enzyme supplementation has been shown to improve the feeding value of wheat by disrupting the water holding capacity of the NSP, improving nutrient digestion and reducing microflora fermentation in the small intestine (Choct *et al*., 1999b). Supplementing wheat-based diets with an enzyme preparation that is capable of hydrolyzing the long complex of xylan into smaller units has been shown to increase performance and nutrient digestibility (Annison and Choct, 1991; Steenfeldt *et al*., 1998; Preston *et al*., 2001).

Appropriate enzyme supplementation to wheat-based diets not only improves growth performance and AME, but it also reduces disease and management problems associated with poor and wet litter conditions (Santos Jr *et al*., 2004). Moreover, Odetallah *et al*. (2002) reported that supplemental xylanase to turkeys decreased mortality rate.

The effects of enzyme supplementation are dependant upon the source and type of wheat. Veldman and Vahl (1994) studied the effect of four wheat varieties supplemented with xylanase on the growth performance of broilers. Santos Jr. *et al*. (2004) reported that supplementation of a commercial enzyme blend that contain high level of xylanase reduced the adverse effect of high NSP content of frost damaged wheat when fed to turkeys.

Feed particles are what a bird actually sees and touches in its diet. Broilers and layers eat using their own sensory perception of the food, ignoring in the short term all of the work done by the nutritionist (Picard *et al*., 2002). Grinding of ingredients is a routine part of feed manufacture. Traditionally hammer mills have been used for finer diets while roller milling has been applied mainly to produce courser feeds. Roller mils can however produce fine grinds of similar uniformity to those produced by hammer mill. In either case a range of particle sizes is produced depending on a number of factors including the type of grain used, the speed of grinding and the screen size used (McCracken, 2002). Nir *et al*. (1995) stated that the effect of grinding was additive to that of pelleting: the diets produced with roller mill ground grain other than that of hammer mill caused improved performance when broilers were fed with a mash diet or crumbles to 4 weeks of age, then pellets to 7 weeks of age. Therefore, particle size (Nir *et al*., 1994ab) and grinding method, hammer mill versus roller mill (Nir *et al*., 1995), greatly influence the performance parameters. Bennett *et al*. (1995); Rose *et al*. (1995) reported that broiler chickens fed whole-wheat diets had the same market weight and feed conversion as bird fed pelleted wheat diets. Guinea fowl production has already proven to be a profitable enterprise in Canada and also in European markets such as France and Italy (Embury, 1998). Scientific literature on enzyme supplementation associated to the grain presentation of diets for guinea fowl broilers is very limited. The aim of the present study was to determine the effect of xylanase supplementation and diet form (ground or crumbled) in a wheat-based diet on growth performance, feed consumption and feed conversion ratio of guinea fowl broilers.

Materials and Methods

Three hundred, one-day old pearl gray guinea fowl (*Numida meleagris*) keets were kept in cages placed in a room where temperature and humidity were together automatically controlled during the trial. The one-day old keets were fed *ad libitum* with a commercial starter diet up to 14 days of age. The trial was started at 14 days of age and terminated at 91 day of age. The trial was designed to have a totally of 4 experimental groups by 75 birds. All keets at 14 days of age were weighed and separated into 100 individual cages with similar body weight. Totally was formed 4 experimental groups, each composed by 25 cages with 3 birds, up to 91 days of age. During the trial, there was a constant lighting in the room. The birds of all experimental groups were fed with a grower experimental diet from 14 to 28 days of age and with a finisher experimental diet from 29 to 91 days of age. Diets were formulated according to the nutritional requirements (INRA, 1988) and were calculated using a specific software (Plurimix, Pocket Italy). The diets were formulated to be isonitrogenous and isocaloric. The exogenous enzyme used in this trial was the commercial preparation Ronozyme® (Roche Vitamins, Switzerland) containing endo-1,3 (4) beta-xylanase activities of 1,000 FXU/g of product and contains a source of xylanase produced by *Aspergillus oryzae* by a xylanase gene from *Thermomyces lanuginosus*.

Particularly, were formulated 4 experimental grower diets and 4 experimental finisher diets: diet A (ground wheat passed through 8 mm sieve with enzyme); diet B (ground wheat without enzyme); diet C (ground wheat passed through 3 mm sieve, then pelleted and after crumbled with enzyme): diet D (crumbled wheat without enzyme).

The nutrient composition of every diets is given in Table 1. The nutritional characteristics of wheat (*Triticum durum*) used for experimental diets are given in Table 2. Five samples of complete diets after the homogenous mixing were taken for the measurement of particle size distributions. This was determined by passing the known weights of each sample through a series of laboratory sieves and weighting the amount of samples collected on each screen and on the pan under the 0.5 mm screen. The chemical analysis of feed ingredients were performed according to the methods of the Association of Official Analytical Chemists (AOAC, 1990). The body weights of birds in every groups were weekly recorded and the Feed Conversion Ratio (FCR) was calculated by dividing the amount of feed consumed during a period of 7 day with the weight gained starting 29 days of age. The feed consumptions of birds in all experimental groups were daily recorded. The remaining feed was discarded from the feeders to which new feed was supplied every day. Data obtained were analyzed using the general linear models of SAS (1998). Data were subjected to analysis of variance according to the method of complete randomized. The means were separated using least significant difference. Differences were considered significant when $p<0.05$.

Results

Analysis of the ingredients utilized in every experimental diets has permitted to obtain complete diets with the preferred chemical and nutritional characteristics (Table 1-2).

Table 1: Composition and calculated nutrient content of the experimental diets fed to guinea fowls from 14 to 91 days of age

	Grower diets				Finisher diets			
Ingredients, %	A	B	C	D	A	B	C	D
Wheat	68.98	68.88	68.98	68.88	71.50	71.40	71.50	71.40
Wheat bran	---	---	---	---	20.00	20.00	20.00	20.00
Soybean meal (48% CP)	20.00	20.00	20.00	20.00	---	---	---	---
Soybean	7.00	7.00	7.00	7.00	5.00	5.00	5.00	5.00
Dicalcium phosphate	1.80	1.80	1.80	1.80	1.30	1.30	1.30	1.30
Calcium carbonate	0.70	0.70	0.70	0.70	1.00	1.00	1.00	1.00
Vitamin Mineral premix*	0.50	0.50	0.50	0.50	0.05	0.05	0.05	0.05
L-Lysine	0.32	0.32	0.32	0.32	0.50	0.50	0.50	0.50
Sodiun chloride	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Sodium carbonate	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
D,L-Methionine	0.10	0.10	0.10	0.10	0.05	0.05	0.05	0.05
Enzyme**	---	0.10	---	0.10	---	0.10	---	0.10
Coccidiostats	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Calculated analysis								
ME, kcal/kg	2,860.00				2,900.00			
Crude protein, %	20.20	20.39	20.36	20.29	14.80	14.72	14.69	14.87
Crude fiber, %	3.56	3.42	3.49	3.77	3.47	3.38	3.56	3.41
Ether extract, %	3.43	3.58	3.63	3.72	2.36	2.22	2.42	2.41
Ash, %	5.80	5.80	6.21	6.16	5.06	5.21	5.11	5.26
N.D.F., %	11.92	11.88	12.06	11.83	17.61	17.83	17.57	17.93
A.D.F., %	4.62	4.54	4.81	4.69	4.52	4.32	4.52	4.52
A.D.L., %	1.25	1.13	1.12	1.19	1.22	1.41	1.37	1.29
Methionine+cysteine, %	0.83	0.83	0.83	0.83	0.62	0.62	0.62	0.62
Lysine, %	1.20	1.20	1.20	1.20	0.54	0.54	0.54	0.54
Calcium, %	0.84	0.84	0.84	0.84	0.81	0.81	0.81	0.81
Phosphorus, average %	0.71	0.71	0.71	0.71	0.57	0.57	0.57	0.57
Threonine, %	0.70	0.70	0.70	0.70	0.44	0.44	0.44	0.44

*Provided per kilogram of diet: 12,500 IU Vit A; 1,500 IU Vit D_3; 30.00 mg Vit E; 2.50 mg Vit K; 1.50 mg Vit B_1; 5,00 mg Vit B_2; 2.00 mg Vit B_6; 15.00 mg Vit B_{12}; 20.00 mg Nicotinamide; 10.00 mg D-Pantothenate; 0.75 mg Folic acid; 0.10 mg D-Biotin; 300.00 mg Choline chloride; 4.00 mg Antioxidant; 150.00 mg Mn; 50.00 mg Fe; 75.00 mg Zn; 5.00 mg Cu; 1.50 mg I; 0.20 mg Co and 0.10 mg 2 Se, **Ronozyme (Roche Vitamins, Switzerland), containing endo-1,3(4) beta-xylanase activities of 1,000 FXU/g

Table 2: Percentage nutritional characteristics of wheat (*Triticum durum*) utilized in experimental diets fed to guinea fowls (mean±SD)

Moisture	10.38	±	0.35
Crude protein	13.28	±	0.26
Crude fiber	2073	±	0.21
Ether extract	2023	±	0.14
Ash	1.64	±	0.07
N.D.F.	16.81	±	0.92
A.D.F.	3.44	±	0.14
A.D.L.	1.21	±	0.08
A.I.A.	0.19	±	0.26
N.D.S.	83.19	±	0.91
Hemicellulose	13.37	±	0.42
Cellulose	2.04	±	0.24
Solubles sugar, g/kg DM			
Arabinose	0.22	±	0.18
Xylose	0.29	±	0.33
Soluble arabinoxylans	0.51	±	0.21
Soluble beta-glucans	0.22	±	0.11

DM: dry matter

Particle-size analysis of the diets (grower and finisher) used during experimentation has shown a similar distribution of ingredient particles in the different experimental groups in comparison. The health state of the raised guinea fowls was satisfactory during all experimental period. The state of sensory and organic functions of the birds have shown regular course, without underlining variations between the birds the different experimental theses.

Table 3: Body weight (g) of guinea fowls fed experimental wheat-based diets from 28 to 91 days of age

	Diets			
Age (days)	A	B	C	D
28	503.33	502.22	501.11	505.56
35	718.89[ab]	711.11[b]	738.89[a]	726.67[ab]
42	923.33[bc]	906.67[c]	956.67[a]	943.33[ab]
49	1,144.44	1,123.33	1,185.56	1,164.44
56	1,320.00	1,270.00	1,352.22	1,311.11
63	1,498.89	1,427.76	1,511.11	1,455.56
70	1,610.00	1,552.22	1,621.11	1,583.33
77	1,717.78	1,673.33	1,721.11	1,692.22
84	1,814.44[a]	1,768.89[b]	1,813.33[a]	1,786.67[ab]
91	1,883.33	1,832.22	1,866.67	1,844.44
mean (28-91)	1,313.44[ab]	1,276.78[c]	1,326.78[a]	1,301.33[b]

a,b,c: p<0,05;

Body weights, determined at 28, 35, 42, 49, 56, 63, 70, 77, 84 and 91 days of age, are summarized in Table 3. The experimental diets have permitted an increase of body weights in line with INRA (1988), this result is

Table 4: Daily body weight gain (g) of guinea fowls fed experimental wheat-based diets from 28 to 91 days of age

	Diets			
Age (days)	A	B	C	D
28-34	30.79	29.84	33.97	31.59
35-41	29.21	27.94	31.11	30.95
42-48	31.59	30.95	32.70	31.59
49-55	25.08	20.95	23.81	20.95
56-62	25.56[a]	22.54[ab]	22.70[ab]	20.63[b]
63-69	15.78	17.78	15.71	18.25
70-76	15.40	17.30	14.29	15.56
77-84	13.81	13.65	13.17	13.49
85-91	9.84[a]	9.05[ab]	7.62[b]	8.25[ab]
mean (28-91)	21.90[a]	21.11[b]	21.68[ab]	21.25[b]

a,b: p<0,05;

Table 5: Feed consumption (g) of guinea fowls fed experimental wheat-based diets from 28 to 91 days of age

	Diets			
Age (days)	A	B	C	D
28-34	47.33	47.39	47.24	46.67
35-41	57.17	56.78	56.72	56.50
42-48	72.22[a]	67.28[b]	64.00[b]	67.00[b]
49-55	77.78	66.56	62.56	58.67
56-62	85.11	75.44	69.89	71.00
63-69	61.11	76.89	63.22	70.67
70-76	64.78	71.67	55.56	66.67
77-84	67.11	70.67	65.44	61.56
85-91	64.78	66.67	54.44	54.44
mean (28-91)	66.40[a]	66.59[a]	59.90[b]	61.46[b]

a,b: p<0,05;

Table 6: Feed conversion ratio (feed:gain) of guinea fowls fed experimental wheat-based diets from 28 to 91 days of age

	Diets			
Age (days)	A	B	C	D
28-34	1.55	1.62	1.42	1.49
35-41	1.97	2.06	2.10	1.95
42-48	2.33	2.34	2.28	2.29
49-55	3.16	3.37	3.27	3.15
56-62	3.46	3.47	3.53	3.51
63-69	4.31	4.36	4.11	4.33
70-76	4.50	4.37	4.52	4.46
77-84	5.13[a]	5.48	5.11	5.20
85-91	7.62	7.70	7.71	7.31
mean (28-91)	3.79	3.86	3.78	3.74

a,b: p<0,05;

demonstration of a suitable coverage of nutritional requirements.

Comparing the mean body weights of the birds of the different experimental diets, the highest values have been recorded in the guinea fowls fed with diet C. Contrarily, the birds fed with ground wheat without enzyme (diet B) have shown low mean values of body weight in comparison to other diets. Particularly, the subjects fed with crumbled wheat with enzyme (diet C) have been recorded values of mean body weight significantly different (p<0.05) with the subjects fed with both diets without supplementation of xylanase. Between the two diets containing xylanase, even if prepared with different method (ground versus crumbled), have not been recorded significant differences (p<0.05) even if the subjects fed with crumbled diets show a tendential increase of mean body weight in comparison to the subjects that received the ground diet (1,326.78 versus 1,313.44 g). In fact, comparing the daily body weight gain (Table 4) of guinea fowl broilers fed diet A with birds fed diet C have been observed high values, with significantly differences (p<0.05), for birds fed diets supplemented with xylanase. These differences were not observed between the birds fed diets B and D.

The effect of xylanase supplementation and particle-size of wheat-based diets on feed consumption at different controls are summarized in Table 5. Data of feed consumption clearly showed that birds fed diets A and B consume an higher amount of feed statistically significant (p>0.05) if compared with the diets C and D, regardless the supplementation of xylanase. Within every typology of diet (ground versus crumbled) are not recorded statistically significant differences (p<0.05) for the presence or no of enzyme, even if between the crumbled diets, the supplementation of enzyme however has reduced feed consumptions (59.9 versus 61.46 g/day). Feed conversion ratio, expression of relationship between feed consumption and increase in weight (feed:gain) of raised birds, are given in Table 6.

Data obtained show that means feed conversion ratio of all four diets in comparison not show statistically differences (p<0.05) among them, with values in guinea fowl broilers fed diets with enzyme (3.79 versus 3.78) similar to data recorded in the birds fed diets without enzyme (3.86 versus 3.74).

Discussion

Supplementation of wheat-based diets with xylanase enzyme has been shown to influence the performance of poultry (McKnight, 1997; Mathlouthi *et al.*, 1999; McCracken and Quintin, 2000) by degrading xylan-rich polysaccharides and improving the digestion and absorption of nutrients. However, much of this research is based on chicken, turkeys and not guinea fowls. Another important aspect is value the effects of particle-size and the method of preparation of diets for guinea fowl broilers, data today insufficient in scientific literature. The pearl gray guinea fowl exhibits a growth performance characterized by an accelerated growth from 0 to 11 weeks of age (Sales and Du Preez, 1997; Nahashon *et al.*, 2004); and the pearl gray guinea fowl exhibits a slower, but considerable, growth from 11 to 16 weeks of age (Sales and Du Preez, 1997; Nahashon *et al.*, 2004). Comparing our results, the higher performance has been obtained by guinea fowl broilers fed wheat-diets with or without enzyme supplementation, according to precedent trials on turkeys (Bennett *et al*., 1995; Odetallah *et al*., 2002). Investigating on the protein and energy requirement of the pearl gray guinea fowl, Sales and Du Preez (1997) reported a steady increase in energy requirement proportionate to age of birds. They reported the highest requirement for energy in these birds to be at 9 and 10 weeks of age in males and females, respectively. Precedent studies (Plavnik *et al*., 1997; Nahashon *et al*., 2006) have suggested that as dietary energy increases, birds satisfy their energy needs by decreasing feed consumption. In the present trial, guinea broilers fed crumble diets containing 2900 kcal of ME/kg with 15% crude protein show lower average feed consumption, even if birds was exhibited greater ($p<0.05$) average body weight and body weight gain. Utilized the French variety of the guinea fowl, Nahashon *et al*. (2006) reported a 3 to 4% increase in feed consumption in birds fed 25% crude protein diets when compared with those fed 21 and 23% CP diets. Moreover they reported, guinea broilers on 25% crude protein diets consumed about 3 to 4% more feed and 3 to 6% more feed than those on diets containing 23 and 21% crude protein, respectively. Observing average body weight gains of birds fed experimental diets, starting to first control, is clear that the positive effect of xylanase supplementation in diet is influenced by particle-size of ingredients. In fact, these differences hasn't been shown in birds fed crumbled wheat-based diets to demonstration that, the utilization of ground wheat has been reduced the effects of xylanase supplementation on body weight gains of guinea broilers.

The method of preparation of diets (ground or crumbled) end the supplementation with enzyme has been improved on utilization of nutritive principles and ME in experimental diets. The positive response observed in the present study is in agreement with results found by other authors when enzyme preparations are included in wheat-based broiler diets (Annison, 1992). Nahashon *et al*. (2006) reported that, pearl gray guinea fowl pullets fed corn-based diets containing 2,900 kcal of ME/kg of diet consumed about 7% more feed than those fed diets comprising 3,000 and 3,100 kcal of ME/kg of feed at 2 to 5 and 8 weeks of age. However, at 6 and 7 weeks of age, average feed consumption of birds on 2,900 kcal of ME/kg of diet was not different ($p>0.05$) from those of birds on diets containing 3,000 kcal of ME/kg of diet. In conclusion, the supplementation of xylanase to a wheat-based associated to crumbled form of diet improved the growth performance of pearl gray guinea fowl broilers. Moreover, wheat-based diets may be an alternative to corn-based diets, today used in guinea fowls feeding. The high productions of wheat in Europe and other country should reduced production costs. Further trials are needed to determine the positive effects of enzyme supplementation in wheat-based diets in association to particle-size on performance in guinea fowl broilers.

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