

The effect of drying temperature and exogenous enzymes supplementation on the nutritional value of maize for broiler chickens

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A total of 480 male Ross 308 chickens were used in a 6 treatment and 10 replicate growth study. The chickens received a maize/soy-based mash diet *ad libitum* and all treatments were formulated to be isonitrogenous and isocaloric according to the following design: Starter – from day 1 to 14; Grower – from day 15 to 35. The experimental groups comprised maize grain: 80°C - in groups one and two, 120°C - in groups three and four and 140°C - in groups five and six. In addition diet in group II, IV and VI were supplemented with enzyme (Avizyme 1502, Danisco Animal Nutrition, UK). While birds in groups I, III and V were given diet without enzyme.

The objective of the experiment was to estimate whether different drying temperature (80°C, 120°C, 140°C) of maize and exogenous enzymes inclusion influence the performance of broiler chickens.

During the entire period, the worst production results were recorded in the groups V and VI. The effect of the applied enzyme was observed most strongly in the diets that contained maize dried at higher temperatures. The observed results in group four were better ($P \leq 0.05$) in comparison with the results from group III. The lowest pH levels were observed in the *ileum* and *caeca* content in groups III and IV.

Key words: broiler; chickens; enzymes; maize quality; drying

Introduction

There is well known that maize have a relatively high and constant nutritional value for broiler chickens but recent data indicate that the energy value of maize and nutrients available can be very diverse and in the case of energy level may be greater than +/- 162 kcal/kg (Song et al. 2004) There are many suggested causes for this variation: chemical composition, starch content, amylase to amylopectin proportion, starch structure, starch encapsulation within large particles; or the embedding of starch with a matrix of lipid, protein, or carbohydrate and the presence of amylase inhibitors and phytate concentration. (Cowieson, 2005).

Recent research focusing on the bird's endogenous enzymes (Krogdahl and Sell, 1989) also suggested that the young bird might be limited in the types and level of enzymes necessary to digest a high carbohydrate diet at early age. Choct et al. (1996) show that the ileal starch digestibility was 90% in broilers received sorghum-based diets.

Other area in the case of the maize grains nutritional value, is the effect of post harvesting processes climatic conditions during growth and storage (D'Alfonso 2002; Iji et al. 2003). When maize is harvested with a high moisture content then is dried aggressively will have lower nutritional value. Diets containing overheating maize tending to negatively affect AME, body weight gain and feed conversion ratio (FCR). There are many explanation for this phenomena: denaturation of heat labile vitamins, damage to protein via an interaction with reducing sugars - during Maillard reaction and

retrograde starch formation after heat processing (Cowieson 2005; Iji et al. 2003; Panigrahi et al. 1996).

Presented above data suggested some possibilities for improvement nutritional value of maize-base diets used in chickens nutrition. Effect of supplementation poultry maize/soy diets on enzyme preparation was presented by few investigators (Zanella et al. 1999; Kocher et al. 2003; Iji et al. 2003) and they reported that enzyme preparation may improved broiler chickens production results. Present data show that use of enzyme preparation can improved FCR from 0.78 to 10,5% over control and BWG from 0,5% to 10,9% over control (Cowieson 2005).

Materials and Methods

Semident type grains in this experiment was used. The material was received at a moisture content of 23.2 %. All batches were drying in draught-ovens at 80, 120 and 140°C. The batches were dried respectively for 6 hours and 50 minutes, 5 hours and 40 minutes and 5 hours and 10 minutes. After draying dry mater content was on the level 87.6, 87.4 and 87.2% respectively. The analysis of the maize samples, was conducted In accordance with the methods of AOAC.

Four hundred and eighty, one day-old male broiler chickens (Ross 308) were used in this experiment. All chickens were used in a 6 treatment and 10 replicate growth study. The chickens received a maize/soy-based mash diet *ad libitum* and all treatments were formulated to be isonitrogenous and isocaloric (*Tabele 1*) according to the following design: Starter – from day 1 to 14; Grower – from day 15 to 35.

Table 1. Composition of diets and nutritional value for day 1 to day 14 (starter) and for day15 to day 35 (grower).

Ingredient	Day 1 to 14 (g·kg-1)	Day 15 to 35 (g·kg-1)
Maize	488*	602.5*
Soybean meal 42%	400	310
Soybean oil	60	48
Calcium phosphate	14.5	14.5
Limestone	4	3
NaHCO ₃	1	1
L-lysine 20%	7	2
DL-methionine 20%	12	6
NaCl	3.5	3
Premix	10**	10***
Calculated nutritional value (g·kg-1)		
Metabolizable energy (MJ· kg-1)	12.53	12.76
Crude protein (N x 6.25)	211	180
Lysine	13	9.9
Methionine	5.4	3.9
Calcium	10.6	10
Available phosphorus	4.3	4.2

* In groups II, IV, VI 0.1% of enzyme Avizyme 1502, Danisco Animal Nutrition, UK was used.

** Premix starter A 360 mg; D₃ 6 mg; E 150mg; K₃ 3mg; B₁ 3mg; B₂ 8mg; B₆ 5 mg; B₁₂ 0,025mg; niacin 50mg; D-pantothenic acid 10 mg; folic acid 2mg; biotin 0,15mg; C 150mg; choline 400 mg. Salinomycin 60 ppm.

***Premix grower A 300 mg; D₃ 6 mg; E 3000mg; K 200mg; B₁ 200mg; B₂ 500 mg; B₆ 500mg; B₁₂ 3mg; niacin 2400mg; D-pantothenic acid 1740mg; folic acid 80mg; biotin 8mg; C 100mg; choline 20000mg; Salinomycin 60 ppm

The experimental groups comprised maize grain: 80⁰C - in groups one and two, 120⁰C - in groups three and four and 140⁰C - in groups five and six. In edition diet in group II, IV and VI were supplemented with enzyme at 1 g·kg⁻¹ diet (Avizyme 1502, Danisco Animal Nutrition, UK) containing amylase 800, xylanase 1200, protease 8000 U/g. While birds in groups I, III and V were given diet without enzyme. Body weight and feed intake were measured at the end of each week body weight gain (BWG) and feed conversion ratio (FCR) were calculated. At the end of the feeding period,

10 chickens, were randomly selected, and killed by cervical dislocation. The ileum was defined as the small intestinal segment caudal to the Meckel's diverticulum. The contents of the crop, gizzard, ileum and caeca were quantitatively collected before further analyses. The pH in the contents of selected gastrointestinal segments was measured with a combined glass/reference electrode (CP-40 Elmetron, Poland).

Statistical analysis of results was performed using the General Linear Models procedure (GLM) of the SAS® (SAS Institute, 1988) according to the following general model:

$$Y_{ij} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ij}$$

where Y_{ij} was the observed dependent variable; μ -overall mean; α_i - the effect of drying temperature; β_j - the effect of enzyme preparation; $(\alpha\beta)_{ij}$ - the interaction between drying temperature and enzyme preparation; ε_{ij} the random error.

Results and Discussion

During the entire period, the worst production results (FCR, BWG) were recorded in the groups V and VI (Table 2). The effect of the applied enzyme was observed most strongly in the diets that contained maize dried at higher temperatures (140°C). Also results observed in group four were better ($P < 0.05$) in comparison with the results from group III. Throughout the entire feeding period a significant effect of grain drying temperature on the production results, the body weight gain and feed conversion ratio were observed.

Table 2. The effect of drying temperature and enzyme addition on the performance of broiler chickens and pH value fed on a maize/soy-based diet.

	Groups						SEM	Source of variation		
	I-80°C	II-80°C+E	III-120°C	IV-120°C+E	V-140°C	VI-140°C+E		M	E	M*E
	Body weight gain (g)									
Days 1-14	361 ^a	360.7 ^a	354 ^a	354.7 ^a	337.5 ^b	350.25 ^{ab}	2.16	*	NS	NS
Days 15-35	1516.6 ^{ab}	1543.9 ^a	1484 ^b	1530.6 ^{ab}	1185.9 ^d	1308.3 ^c	18.79	*	*	*
Days 1-35	1877.6 ^{ab}	1904.7 ^a	1838 ^b	1885.3 ^{ab}	1523.4 ^d	1658.5 ^c	19.71	*	*	*
	Feed conversion ratio (kg feed/kg BWG)									
Days 1-14	1.22	1.22	1.29	1.28	1.28	1.26	0.0095	*	NS	NS
Days 15-35	1.58 ^b	1.58 ^b	1.62 ^b	1.53 ^c	1.78 ^a	1.78 ^a	0.0160	*	NS	NS
Days 1-35	1.51 ^{bc}	1.51 ^{bc}	1.56 ^b	1.48 ^c	1.67 ^a	1.67 ^a	0.0124	*	NS	NS
	pH value									
Crop	5.24 ^a	4.94 ^{ab}	5.04 ^{ab}	4.98 ^{ab}	4.80 ^b	4.76 ^b	0.056	*	NS	NS
Gizzard	4.05 ^a	4.06 ^a	4.22 ^a	4.02 ^a	3.64 ^b	3.87 ^b	0.053	*	NS	NS
Ileum	6.09 ^a	6.05 ^a	5.96 ^b	5.85 ^b	6.03 ^a	6.02 ^{ab}	0.024	*	NS	NS
Caeca	6.71 ^{ab}	6.81 ^a	6.63 ^{ab}	6.46 ^b	6.68 ^{ab}	6.68 ^{ab}	0.044	*	NS	NS

Means in the rows with different letters are significantly different at $P \leq 0.05$ SEM is the standard error of difference between the means. NS – not significant, * - significance at $P \leq 0.05$, M – Maize, E – enzyme, M*E – interaction maize*enzyme

However in the grower period and considering whole experimental period a significant interaction between temperature of drying and enzyme supplementation was registered with respect to BWG. Enzyme addition had no significant effect on production results during entire experimental period ($P \leq 0.05$). The feed conversion efficiency tended to be better in birds fed with the maize dried at lower temperatures compared to that in birds fed the maize dried at highest temperatures. During the entire experimental period no mortality occurred.

These data demonstrate that it is possible to adversely affect the nutritional value of maize by drying at high temperatures FCR (1.51 vs. 1.67). Based on previous work (Iji et al., 2003) it seems that in order to detect these effects the maize must also be harvested with a high moisture content as further drying of maize that already has a high dry matter content does not give the same inimical responses. It is possible that, when harvested with a high moisture content and stored prior to drying, starches and other carbohydrates are

partially degraded increasing the reducing sugar concentration in the grain. The drying process may then cause Maillard reaction products to form or reduce the solubility of starch and protein through other mechanisms. The response to exogenous enzyme was more apparent in maize that had been dried at higher temperatures BWG (1523 vs. 1658) . It is not clear whether these data are due to the expected lower AME of those diets allowing more ‘room’ for the enzyme to elicit a response or due to an increase in substrate for the enzyme through the drying process such as damaged proteins and resistant starches. It can be concluded that drying temperature has a profound effect on the nutritional value of maize for broilers and that exogenous enzymes are effective in partially ameliorating this discrepancy in caloric value for poultry.

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