

THE EFFECT OF CEREAL TYPE AND NON-STARCH POLYSACCHARIDE (NSP) DEGRADING ENZYMES ON BROILER PERFORMANCE AND NUTRIENT UTILIZATION

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SUMMARY

The aim of this work is to study the effects of cereal type (corn or wheat-based diets), and multi-carbohydrase enzyme supplementation to broiler diets containing recommended, intermediate (-100) or low (-150) Kcal/kg ME energy levels and their interactions on broiler performance, protein and energy efficiency ratios, nutrient digestibility, carcass traits and some blood measurements.

A total of 480, seven day-old unsexed Cobb500 broiler chicks of 160 g average body weight were randomly divided into eight experimental treatments and three replicates per treatment group. The experiment consisted of 3 growing phases {starter (7-14 d), grower (15 – 28 d) and finisher (29 – 42 d)}. Diets were formulated to contain 21, 19 and 18 % protein levels and 2988, 3083 and 3176 kcal/kg ME during the starter, grower and finisher phases, respectively. During each growing phase, each group was fed on one of the following experimental diets: corn–soybean based diet without supplementation(C), wheat–soybean based diet without supplementation (W), corn–soybean based diet supplemented with enzymes cocktail at level of 50 g/ 100 kg diet (C+), wheat–soybean based diet supplemented with enzymes cocktail at level of 50 g/ 100 kg diet (W+), low energy (100 kcal) corn–soybean based diet supplemented with enzymes cocktail at level of 50 g /100 kg diet (LC100+), low energy (-100 kcal) wheat–soybean based diet supplemented with enzymes cocktail at level of 50 g /100 kg diet (LW100+), low energy (150 kcal) corn – soybean based diet supplemented with enzymes cocktail at level of 50 g /100 kg diet (LC150+) or low energy (-150 kcal) wheat–soybean based diet supplemented with enzymes cocktail at level of 50 g /100 kg diet (LW150+). The carbohydrase enzymes cocktail supplement supplied per 1 g, 3000 U α – galactosidase, 5000 U β - mannanase 2500 U xylanase, 1500 U β - glucanase and 1000U cellulose.

The obtained results could be summarized as follows: birds fed the corn-based diets had overall superior weight gain, feed consumption, feed conversion ratio, nutrient digestibility and protein and energy conversion ratio compared with those fed the wheat-based diets. Enzyme cocktail supplementation to corn or wheat based diets improved all tested parameter cited above. No significant differences were found between the low ME enzymes supplemented diets (L100+ and L150+) and their respective control groups for body weight gain during the overall period. Enzymes supplementation to low energy diets compensate for lowering energy level by increasing feed consumption.

Birds fed corn based diets or enzyme supplemented diets, irrespective of cereal type, had significantly high blood plasma glucose level. On the other hand, neither cereal type nor enzyme supplementation had a significant effect on blood plasma total proteins and total lipids. Chicks fed corn based diet improved EPEI (European production efficiency index) by 18.21 % compared to those fed wheat based diet and enzyme supplementation to corn or wheat based diets improved significantly EPEI and the improvement was more pronounced for wheat based diet compared to corn based diet (13.03 vs. 5.03). No significant differences in EPEI were detected when enzyme cocktail was added to low AME diets based on corn or wheat.

Keywords: *Broiler, cereal based diets, enzyme supplementation, performance and nutrient utilization.*

INTRODUCTION

The long-term sustainability of commercial broiler production is dependant on both economic and environmental constraints. Since the feed is one of the major costs associated with broiler production and the initial source of pollutants, there are considerable pressures to reduce feed costs and minimize the polluting effects of the feed.

Consistent increase in the price of feed ingredients has been major constraint in most of the developing countries. As a consequence cheaper and nonconventional feed ingredients have to be used which contain higher percentage of non-starch polysaccharides (NSP's) along with starch. For example, Despite, maize being the most commonly used cereal grain in poultry diet formulation world-wide

because of its high available energy content and low soluble non-starch polysaccharides, which are an anti-nutrient factor (Iji *et al.*, 2003), wheat is an important energy feedstuff that is widely used throughout the European Union due to inland cultivation and low price, and is also the cereal grain of choice for whole grain feeding.

However, wheat contains arabinoxylans at concentrations of 50 to 80 g/kg DM that act as NSP and effectively depress AME (Annison *et al.*, 1987). The average total content of NSP's was analyzed to be 104.8 g/kg DM, whereas the evaluation of wheat AME values ranging from 9.2 to 14.9 MJ/kg DM, and AME was negatively correlated with all fractions of NSP's (Choct *et al.*, 1999).

The term NSP's refers to indigestible polysaccharides of different physiochemical properties that have various negative effects on bird digestion and ultimately, production. The NSP's are not well digested by poultry (Annison, 1993), and a part of these NSP's is water-soluble which is notorious for forming a gel like viscous consistency in the intestinal tract (Ward, 1995) thus reducing gut performance. Also, predominantly water soluble and viscous arabinoxylans are assumed to increase the water intake by the birds, which lead to unmanageable litter problems caused by wet and sticky droppings. This deteriorates the hygienic conditions and carcass quality (Dunn, 1996). Non-starch polysaccharides (NSP) in cereals and in vegetable proteins, may also play a role as an energy storage material.

With advances in biotechnology and fermentation processes, cost of production of feed enzymes has dramatically reduced, and the use of feed enzymes in poultry diets has become popular. Research work has suggested that the negative effects of NSP's can be overcome by dietary modifications including supplementation of diets with suitable exogenous enzyme preparations (Creswell, 1994).

Therefore, use of commercially available exogenous enzymes preparations in poultry nutrition to target specific substrates in the feeds and ameliorate their antinutritive effect and to reduced pollution problems arising from an excessive output of excreta containing large amounts of organic matter, as well as to increase the choice and content of ingredients which are acceptable for inclusion in diets has received increased attention in the last decade (Acamovic, 2001). However, the selection of a correct type and amount of an enzyme and its method of mixing with diet would be essential to achieve the objectives of a successful broiler production system (Anjum and Chaudhry, 2010).

Benefits of using feed enzymes to poultry diets include ; reduction in digesta viscosity, enhanced digestion and absorption of nutrient, improved apparent metabolizable energy (AME) value of the diet, increased feed intake, weight gain and feed – gain ratio, reduced beak impaction and vent plugging, decreased size of gastrointestinal tract, altered population of microorganisms in gastrointestinal tract, reduced water content of excreta (Annison, 1993; Bedford and Schulze, 1998; Simon, 1998; Dudley-Cash, 2001; Sheppy, 2001).

One of the main reasons for supplementing wheat and barley – based poultry diets with enzymes is to increase the available energy content of the diet. Increased availability of carbohydrates for energy utilization is associated with increased energy digestibility (Van der Kils *et al.*, 1995). The improvement in wheat AME resulting from enzyme supplementation are variable because of the variability in the NSP content and structure of wheat (Pirgozliev *et al.*, 2003 and Smeets *et al.*, 2014). Classen *et al.*, (1995), Schutte *et al.* (1995) and Van der kils *et al.* (1995) reported improvements of 5 – 16, 3.1–4.5, and 4.5 – 12.4 % respectively.

Also, adding adequate activity levels of α -Amylase, β –glucanase and xylanase to broiler starter and grower corn – soybean diets with a 3 % reduction in dietary ME allowed full restoration of growth performance of broilers comparable to those fed the adequate energy (Yu and Chang, 2004).

Exact biochemical function of enzyme mixtures within the lumen remains unclear. However, one thing is certain; exogenous enzyme supplementation does not improve growth through the complete hydrolysis of polysaccharide and subsequent monosaccharide absorption. Instead, de-polymerization of the polysaccharide into smaller polymers aids in digestibility by decreasing overall digesta viscosity (Choct, 2001).

Therefore, the aim of this work is to study the effects of cereal type (corn or wheat –based), and multi-carbohydrase enzyme supplementation, to broiler diets had recommended – intermediate (100 Kcal/ kg lower) – and low (150 Kcal/kg lower) ME energy levels and their interactions on broiler performance, protein and energy efficiency ratios, nutrient digestibility, carcass traits and some blood measurements.

MATERIAL AND METHODS

A total of 480 seven day-old unsexed Cobb500 broiler chicks of 160 gm average body weight were randomly divided into eight experimental treatments and three replicates per treatment group. Birds were

vaccinated against avian influenza, Newcastle and gumboro diseases. All the recommended practices for broiler rearing were followed throughout the experimental period. Mash diets and fresh water was offered *ab libitum*. Experimental periods lasted for 42 days at poultry experimental station, faculty of agriculture, Al-Azhar University, Cairo, Egypt.

Experimental design and diets:

The experiment consisted of 3 growing phases (7-14d, starter; 15–28 d, grower and 29–42d, finisher). Antibiotic and Coccidiostate-free diets were formulated to contain 21, 19 and 18 % protein levels and 2988, 3083 and 3176 kcal/kg ME during the starter, grower and finisher phases, respectively. During each growing phase, each group was fed on one of the following experimental diets:

1. Corn – soybean based diet without supplementation (C).
2. Wheat – soybean based diet without supplementation (W).
3. Corn–soybean based diet supplemented with enzymes cocktail at level of 50 gm / 100 kg diet (C+).
4. Wheat–soybean diet supplemented with enzymes cocktail at level of 50 gm/100 kg diet (W+).
5. Low energy (100 kcal) corn – soybean based diet supplemented with enzymes cocktail at level of 50 gm /100 kg diet (LC100+).
6. Low energy (100 kcal) wheat – soybean based diet supplemented with enzymes cocktail at level of 50 gm /100 kg diet (LW100+).
7. Low energy (150 kcal) corn – soybean based diet supplemented with enzymes cocktail at level of 50 gm /100 kg diet (LC150+).
8. Low energy (150 kcal) wheat – soybean based diet supplemented with enzymes cocktail at level of 50 gm /100 kg diet (LW150+).

The carbohydrase enzymes cocktail supplement supplied per 1 gm, 3000 U α – galactosidase, 5000 U β - mannanase 2500 U xylanase, 1500 U β - glucanase and 1000U cellulase.

Productive performance traits:

Weekly records on live body weights of chicks and feed intake were maintained on replicate group basis. Thus, body weight gain and feed conversion were calculated weekly. Mortality was monitored and recorded daily.

Protein and energy efficiency ratios:

Protein conversion ratio (PCR) and energy conversion ratio (ECR) were calculated for each growing phase and for whole period as following formula:

$$\text{PCR (g protein/g gain)} = \text{protein intake (g)} / \text{body weight gain (g)}$$

$$\text{ECR (Kcal/g gain)} = \text{gross energy intake (Kcal)} / \text{body weight gain (g)}$$

Digestibility trials:

During the 6th week of age, digestibility trials were conducted for evaluating nutrient digestibility of the experimental diets. The proximal analysis of the experimental diets and dried excreta were determined according to the official of analysis (AOAC, 1990). In order to estimate protein digestibility fractions of fecal and urinary nitrogen in the excreta were chemically separated according to the method of Jacobsen *et al.* (1960). Digestibility coefficients percentage were calculated for organic matter (OM) , crude protein (CP), ether extract (EX) crude fiber (CF) and nitrogen free extract (NFE).

Determination of metabolizable energy (AME):

Gross energy determination was done on the experimental diets and excreta in the digestibility trial by using an IKA – Calorimeter C4000 adiabatic bomb calorimeter.

The apparent metabolizable energy values (AME) were calculated as follows:

$$\text{AME (K Cal/ gm)} = \text{EI} - \text{ExE} / \text{FI}$$

Corrected apparent metabolizable energy values to zero nitrogen balance (AMEn) were calculated by using the formula of sibbald *et al.*, (1960).

$$\text{AMEn} = \text{EI} - [\text{ExE} + (\text{NR} * 8.22)] / \text{FI}$$

Where: EI = Energy Intake.

ExE = Excreta energy.

FI = Feed intake.

NR= Nitrogen retained = NI – ExN

NI = Nitrogen intake

ExN= Nitrogen excreted

8.22: The energy in Kcal / g nitrogen retained by the bird (Hill and Anderson, 1958).

Carcass traits:

At the end of the experiment (42 days of age) six birds were selected from each treatment (group) on the basis of average body weight and slaughtered by slitting the jugular vein. The birds were then immediately scalded, feather plucked and eviscerated. Records on individual weights of eviscerated carcass and edible organs (heart, liver, and skinned empty gizzard). Total edible parts were calculated as eviscerated carcass plus giblets. All measurements were expressed in terms of percentage of live weight at slaughter.

Blood parameters:

During the slaughter process blood samples were collected from the jugular vein in heparinized tubes. Blood samples were centrifuged at 3000 r.p.m for 10 minutes and plasma was stored at (- 20 °CD). Individual plasma samples were analyzed using commercial kits for Total protein, albumin, aspartate amino transferases, alanine amino transferases, total lipids and total cholesterol according to methods of Doumas *et al.* (1981), Doumas and Bigg (1972), Reitman and Rankel (1957), Chabrol and Charonnat (1937) and Flegg (1973), respectively.

Production efficiency:

Evaluating production efficiency was carried out using the European production efficiency index (EPEI) according to Hubbard broiler management guide (1999).

The equation that was used is as follows:

$$EPEI = ((BW(kg)*LA) / (PP * FCR)) * 100$$

Where: BW = Body weight (kg), LA = Livability (100 - % mortality), PP = production period (days), FCR = Feed conversion (kg Feed / kg gain in live body weight).

Statistical analysis:

Data were analyzed by using one way ANOVA of the GLM procedure of SAS (SAS Institute, 1990). Duncan's multiple range tests were used to determine differences among means when treatment effects were significant (Duncan (1955)).

RESULTS AND DISCUSSION

The effects of cereal type and enzyme supplementation on the performance of broilers are presented in table (4). Chicks fed corn based diet consumed slightly insignificant more feed than the wheat based fed chicks (370 vs. 364g) in the starter phase. In the growing, finishing and over the entire trail, birds consumed significantly more corn based diet than wheat based diets (1621 vs 1603, 1995 vs. 1967 and 3986 vs. 3934 g , respectively). During all trail periods enzyme supplementation resulted in an increase in feed consumption regardless of cereal type (corn or wheat), except for wheat based diet during starter period where the differences were insignificant. However, the effect was more pronounced for birds fed wheat based diet compared to corn based diets. The improvement in feed intake was 1.12, 1.42, and 1.32 % during grower, finisher and over the entire trail, respectively.

Body weight gain (BWG) was increased significantly ($P < 0.05$) when the corn- based diet was fed during the entire experiment compared with the bird fed wheat- based diets. The percentage improvements were 7.57, 3.36, 21.8 and 11.48 for starter, grower, finisher and total period, respectively. Body weight gain was significantly ($P < 0.05$) increased by enzyme supplementation. The total improvement in body weight gain was 3.21 % and 7.73 % for corn and wheat-base diets compared to the un-supplemented control diets, respectively.

Feed per gain ratio (FCR) was affected by cereal type (corn vs wheat), feeding corn-based diet had significant and positive effect on feed per gain compared to its counterpart with wheat-based diet. The corresponding improvement with corn feeding were estimated to be 6.12, 16.6, and 8.91 % during starter, finisher and overall period, respectively relative to results reported for wheat based diet. Enzyme supplementation ameliorate feed conversion ratio by 2.72 % and 5.94 % for chicks fed corn-based and wheat based diets, respectively during the total experimentation.

Results in table (5) show the effect of enzyme supplementation to low energy diets on broiler performance. There were no significant differences between the low AME enzyme supplemented diets (L100+ and L150+) and their respective control group (Corn and wheat) for body weight gain during grower, finisher and over all period. It's obvious that both feed intake and feed conversion ratio were significantly ($P < 0.05$) affected by treatments for each growth interval. Feed intake, increased by decreasing AME content of broiler diets supplemented by enzyme cocktail regardless of cereal type. On

the other hand, decreasing AME content of broiler ration supplemented by enzymes tend to increase slightly feed per gain ratio. The effect was more pronounced for group (LC150+).

The results indicating that, Birds fed low AME diets compensate for the lack of energy by increasing feed intake as might be expected and in fact had a significantly higher Feed Intake compared to birds fed the adequate energy diets.

Results in tables (6,7) revealed that cereal type (corn or wheat) had insignificant effect on digestibility coefficient of crude protein (CP), Ether extract (EE) and crude fibre CF and also on feeding value in terms of apparent metabolizable energy (AME). However, inclusion of corn instead of wheat in broiler diets increased slightly the values of digestibility coefficient of CP, EE and CF and also AME.

On the other hand enzyme supplementation to broiler diets improved significantly the digestibility coefficient of (EE) and the effect was more pronounced when wheat is used as main source of energy in broiler diets compared to corn. In addition, enzyme supplementation increased numerically but insignificant the digestibility coefficient of (CP) and (CF) and the nutrition value in term of (AME).

The increase in improvement for digestion coefficient values of all tested parameters when wheat is used may be due to that corn is not regarded as viscous feedstuffs even though it do contain appreciable amount of NSP's (Bach Kundsén, 1996). The increase in (EE) digestibility irrespective of cereal type by enzyme supplementation may be due to that the absorption of large molecules is affected to greater extent by increased viscosity than smaller molecules (Choct and Annison, 1992 and Classén, 1996). In this regard the response in lipid digestion with enzyme supplementation is greater compared to protein digestion (Choct Annison, 1992).

Results in table (8, 9) show the effect of cereal type and enzyme supplementation on protein and energy conversion ratios. Results indicated that formulation of broiler diets based on corn improved significantly protein and energy conversion ratio by 8.3 % and 7.3 % respectively, compared to wheat. Also, enzyme supplementation tends to improve protein and energy conversion ratio irrespective of cereal type (corn or wheat). However, the improvement was more pronounced in case of wheat based diet (5.4 and 6.19 % for protein and energy, respectively) compared to corn based diet (2.8 and 2.0 %) for protein and energy, respectively.

Regarding the effect of enzyme supplementation to low energy diets on protein and energy conversion ratio, data in tables (10,11) revealed that enzyme supplementation to low energy corn or wheat based diets (LC100+ and LC150+ or LW100+ and LW150+) had no significant effect on energy conversion ratio within each cereal type . The same trend was observed for protein conversion ratio. The results indicated that enzyme supplementation compensate for the decrease in energy level by 100 or 150 kcal/kg diet regardless of cereal type.

The data on carcass traits at 6 week old broiler chicks as affected by cereal type and enzyme supplementation are shown in tables (12, 13). Cereal type had no significant effect all carcass traits studied. However, enzyme supplementation, significantly, have positive effect ($P < 0.05$) on relative weight of gizzard regardless of cereal type. In general, enzyme supplementation increases numerically but insignificant relative weights of different segments of gastro intestinal tract (liver, heart and abdominal fat).

Results in tables (14, 15) summarize the effects of cereal type and enzyme supplementation on blood serum glucose, total proteins and total lipids levels at 42 day of age. Data revealed that birds fed corn based diet had significantly higher blood glucose level compared to those fed wheat based diet (289 vs 210 mg/dl). Enzyme supplementation ameliorates blood glucose level by 9.4 % and 19.2 % for chicks fed corn-based and wheat based diets, respectively during the total experimentation. On the other hand, cereal neither type nor enzyme supplementation had a significant effect on blood plasma total proteins and total lipids.

The effects of cereal type and enzyme supplementation on the European Production Efficiency Index (EPEI) of broilers are presented in table (16, 17). Chicks fed corn based diet improved EPEI by 18.21 % compared to those fed wheat based diet. Enzyme supplementation to corn or wheat based diets improved significantly EPEI and the improvement was more pronounced for wheat based diet compared to corn based diet (13.03 vs 5.03 %). On the other hand, no significant differences in EPEI were detected when enzyme cocktail was added to low AME diets based on corn or wheat, However, the improvement was more pronounced for birds fed enzyme supplemented low AME corn based diets (Table 17).

The results of the current study showed that birds fed the corn-based diets had overall superior WG, FI and FCR, nutrient digestibility and protein and energy efficiency ratio compared with those fed the wheat-based diets. In general, wheat has lower nutritional value than corn because it contains high amounts of water-soluble and viscous NSP's (Leeson & Summers, 2005). It is generally assumed that NSP's exhibit anti-nutritional effects through different ways. Firstly by increasing digesta viscosity through the release of soluble NSP's leached from cell walls (Chesson, 2001) which may result in reduced rates of diffusion of nutrients and/or reduced feed passage time (and thus ingestion)(Classén,

1996). Secondly it is thought that soluble NSP's increases the size and solidity of the unstirred layer at the mucosal surface of the digestive tract, resulting in limited contact between the digestive enzymes and the substrates (Chesson, 2001). Thirdly, by encapsulating the starch, fat and protein in the feed (Cowan *et al.*, 1996) forming a physical barrier between the digestive enzymes and the substrates to be digested. Fourthly, by altering the microbial profile of the digestive tract (Choct *et al.*, 1999) and promoting bacterial proliferation to the detriment of digestive efficiency and bird health (Choct *et al.*, 1996). Lastly, by altering intestinal morphology. Mathlouthi *et al.* (2002) found that the addition of xylanase and-glucanase to rye based diets increased ($P<0.05$) villi size and the villus height to crypt depth ratio, as well as the concentration of conjugated bile acids ($P<0.05$) in the small intestinal contents leading to increased nutrient absorption. The anti-nutritional effect of NSP's is often confounded by the fact that the above mentioned factors rarely can be separated. It is more likely that a combination of these factors will result in the overall anti-nutritional effect associated with NSP's.

The results also showed that enzyme supplementation to corn or wheat based diets improved all tested parameter cited above. Various reports suggest that, significant improvement can be made with the use of NSP's degraded enzyme combinations (Zanella *et al.* (1999), Cowieson and Adeola 2005, Meng and slominski, 2005).

The results of the current study evident also that feed intake was increased when low NSP cereal (corn) was substitute for high NSP cereal (wheat) and also due to supplementation of NSPase's enzymes in the broiler diets regardless of cereal type. This may due to that, with increasing intestinal viscosity the bird perceives a reduction in nutrient density and compensates by eating slightly more until a threshold is reached, which is likely in the region of 20 mPas, at which point the digest is too viscous for further compensatory increments in passage rate. The consequence is that when viscosity increases from 1 to 20 mPas, the principal problem is a deterioration in FCR with little loss in gain as intake is able to compensate, whereas above 20 mPas both gain and intake fall with further viscosity increments and FCR is doubly compromised. Thus, diets which generate viscosities in excess of 20 mPas will have far more detrimental effects on performance than those that are below 10 mPas (Bedford, 2014).

In the case of high viscosity diets, the effects of NSP'ases on both performance and health are therefore much more self-evident than in the case of low viscosity diets. In that regard, maize based diets rarely result in viscosities in excess of 10 mPas, and thus it is likely that viscosity plays only a minor role in the response to NSP'ases in such diets (Bedford, 2014). The results agree with Hesslman *et al.*, (1981 and 1982) reported an increase in feed intake due supplementation of enzyme in the broiler diets.

In this study, fat availability was more affected than effects on other nutrients by the enzyme supplementation. This is consistent with other studies (Yu *et al.*, 2002), and may be due to that, bile salts are required for fat emulsification to form micelles (Erlinger, 1987). The viscosity caused by SDF in wheat depressed the fat emulsification and the enterohepatic circulation of bile salts (Cameron-Smith *et al.*, 1994; Pasquier *et al.*, 1996). Therefore; the effects of substituted wheat for corn and enzyme supplementation on fat availability were greater than effects on other nutrients.

The results of the current study demonstrated also that enzyme supplementation to low energy diets (by up to less 150 kcal/kg diet compared to the control) compensate for lowering energy level by increasing feed intake. This may partially due to the effect of physical constraint of viscosity on digesta flow rate that increased digesta residence time and thereby decreased feed intake and / or the effect of dietary energy level on feed intake. Leeson *et al.* (1996) showed that broiler feed intake increases linearly with decreasing dietary energy level. Albuquerque *et al.* (2003) also described reduction in feed intake due to higher dietary energy density. In addition, Leeson *et al.* (1996) found that broilers fed free-choice on diets with either 2700 or 3300 kcal metabolizable energy/kg presented the same growth rate and constant energy consumption. Also Juan-Louis (2007) reported that--In the reformulated diet, the energy level was reduced by 75 Kcal ME. This may be the reason for increased feed intake. In this connection also Yu and Chung (2004) reported that adding adequate activity levels of α - amylase, β - glucanase and Xylanase to broiler starter and grower corn-soya diets with 3 % reduction in dietary ME allowed full restoration of growth performance comparable to those fed the adequate energy positive control. Cowieson and Masey (2013) found improvement in body weight gain of 6.3 % associate with addition of Xylanase to the control diet. The birds that received the reduce energy diet supplemented with Xylanase had performance equivalent to the control group.

CONCLUSION

In conclusion, results of the current study demonstrated that the multi-carbohydrase enzyme preparation used in the current study was effective in viscosity reduction, which resulted in increased

digestibility of fat, and AME in broiler chickens fed wheat-based diets. Also, the improvements in feed intake are at least of equal importance as the viscosity-reducing aspects.

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Table (1). Composition and chemical analyses of the experimental diets used during 7-14 days of age (starter period).

Ingredients	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆
yellow corn	59.5	60.3	58.35	14.55	12.65	00.00
Soybean meal 44%	25.2	28.0	28.8	15.6	18.95	19.0
Corn gluten meal 60%	7.6	5.6	4.9	8.0	5.55	4.00
Wheat	---	---	---	50.0	50.7	63.72
Wheat bran	1.95	1.9	3.65	2.95	4.05	5.06
Di Calcium Phosphate	1.95	1.9	1.92	2.07	2.00	1.82
Limestone	1.2	1.15	1.22	1.25	1.2	1.00
Premix*	0.3	0.3	0.3	0.3	0.3	0.3
NaCl	0.55	0.5	0.53	0.5	0.5	0.45
L- Lysine HCL	0.3	0.2	0.18	0.52	0.41	0.39
DL- Methionine	0.1	0.15	0.15	0.16	0.19	0.26
Soya oil	1.35	---	---	4.1	3.5	4.0
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Analysis **						
C.P %	21.0	21.0	21.0	21.0	21.0	21.0
ME(Kcal/Kg)	2988	2888	2837	2987	2888	2843
Calcium %	0.95	0.93	0.97	1.0	0.97	0.9
Av. Phosphorus%	0.50	0.50	0.50	0.52	0.52	0.49
Lysine %	1.2	1.19	1.2	1.18	1.17	1.17
Methionine %	0.51	0.54	0.54	0.53	0.54	0.54
Meth+Cys %	0.84	0.83	0.84	0.86	0.86	0.88
Determined Analysis						
C.P %	22.14	22.14	22.20	22.04	22.07	22.18
C.F	4.62	4.77	4.94	3.92	4.14	4.12
E.E	4.89	3.54	3.49	5.86	5.17	5.16
GE(Kcal/Kg)	4047	3979	3970	4017	3977	4064

*Vitamin & Mineral mixture supplied per Kg of diet: Vit A, 12000 I.U; Vit D₃, 3100 I.U; Vit E, 30 mg; Vit K₃, 1.65 mg; Vit B₁, 4.4mg; Vit B₂, 5.5mg; Vit B₆, 3.3mg; Vit B₁₂, 15µg; Niacin, 53 mg; Pantothenic acid, 11 mg; Folic acid, 1 mg; Biotin, 200µg; Choline, 715mg; Copper, 9 mg; Iodine, 1.1mg; Iron, 88 mg; Manganese, 66 mg; Zinc, 40 mg, Cobalt, 0.2mg and Selenium, 0.3 mg.

Table (2). Composition and chemical analyses of the experimental diets used during grower period (15 – 28 days of age).

Ingredients	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆
Yellow corn	61.1	63.55	60.5	24.5	25.5	14.5
Soybean meal, 44%	24.0	23.9	23.6	8.25	10.9	5.9
Corn gluten meal 60%	4.9	4.7	4.55	9.2	7.5	8.8
Wheat	---	---	---	48	48.17	60.12
Wheat bran	2.6	2.5	5.7	1.9	1.38	4.0
Di Calcium Phosphate	1.85	1.88	1.8	2.0	2.0	1.9
Limestone	1.15	1.13	1.20	1.11	1.11	1.2
premix*	0.3	0.3	0.3	0.3	0.3	0.3
NaCl	0.45	0.45	0.45	0.43	0.42	0.43
DL- Methionine	0.16	0.15	0.15	0.16	0.17	0.18
L- Lysine- HCL	0.24	0.24	0.25	0.65	0.55	0.67
Soya oil	3.25	1.2	1.5	3.5	2.0	2.0
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Analysis **						
C.P %	19.00	19.00	19.00	19.00	19.00	19.00
ME (Kcal/Kg)	3083	2983	2935	3083	2982	2935
Calcium %	0.91	0.91	0.92	0.95	0.94	0.96
Av. Phosphorus%	0.48	0.49	0.48	0.49	0.49	0.49
Lysine %	1.1	1.1	1.1	1.1	1.1	1.1
Methionine %	0.52	0.51	0.51	0.51	0.51	0.51
Meth+Cys %	0.84	0.83	0.84	0.86	0.86	0.88
Determined Analysis						
C.P %	20.15	20.16	20.28	20.01	20.03	20.04
C.F	4.62	4.70	4.94	3.71	3.82	3.80
E.E	6.78	4.84	5.09	5.65	4.16	3.80
GE(Kcal/Kg)	4103	4010	4023	3993	3915	3987

*Vitamin & Mineral mixture supplied per Kg of diet: Vit A, 12000 I.U; Vit D₃, 3100 I.U; Vit E, 30 mg; Vit K₃, 1.65 mg; Vit B₁, 4.4mg; Vit B₂, 5.5mg; Vit B₆, 3.3mg; Vit B₁₂, 15µg; Niacin, 53 mg; Pantothenic acid, 11 mg; Folic acid, 1 mg; Biotin, 200µg; Choline, 715mg; Copper, 9 mg; Iodine, 1.1mg; Iron, 88 mg; Manganese, 66 mg; Zinc, 40 mg, Cobalt, 0.2mg and Selenium, 0.3 mg.

Table (3). Composition and chemical analyses of the experimental diets used during finisher period (29-42 days of age).

Ingredients	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆
Yellow corn	65	63.30	60.3	25.8	25.45	15.5
Soybean meal, 44%	23.05	23.1	23.6	4.05	6.5	5.00
Corn gluten meal 60%	4.2	3.55	3.0	10.15	8.2	7.9
Wheat	---	---	---	51.65	50.0	60.1
Wheat bran	---	3.05	5.85	---	2.15	3.55
Di Calcium Phosphate	1.74	1.71	1.7	1.87	1.87	1.9
Limestone	1.1	1.10	1.12	1.08	1.07	1.07
premix*	0.3	0.3	0.3	0.3	0.3	0.3
NaCl	0.45	0.45	0.45	0.42	0.43	0.43
DL- Methionine	0.18	0.18	0.18	0.16	0.2	0.23
L- Lysine- HCL	0.23	0.21	0.2	0.72	0.63	0.67
Soya oil	3.75	3.05	3.3	3.8	3.2	3.35
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Analysis **						
C.P %	18.00	18.00	18.00	18.00	18.00	18.00
ME (Kcal/Kg)	3175	3075	3023	3176	3075	3023
Calcium %	0.87	0.86	0.87	0.86	0.87	0.91
Av. Phosphorus%	0.45	0.45	0.46	0.46	0.47	0.48
Lysine %	1.06	1.05	1.06	1.04	1.02	1.02
Methionine %	0.53	0.53	0.52	0.51	0.53	0.55
Meth+Cys %	0.82	0.82	0.82	0.83	0.87	0.88
Determined analysis						
C.P %	19.13	19.15	19.30	19.05	19.00	19.09
C.F	4.40	4.67	4.90	3.42	3.71	3.70
E.E	7.36	6.65	6.83	5.97	5.37	5.15
GE(Kcal/Kg)	4116	4082	4090	4000	3962	3936

* Vitamin & Mineral mixture supplied per Kg of diet: Vit A, 12000 I.U; Vit D₃, 3100 I.U; Vit E, 30 mg; Vit K₃, 1.65 mg; Vit B₁, 4.4mg; Vit B₂, 5.5mg; Vit B₆, 3.3mg; Vit B₁₂, 15µg; Niacin, 53 mg; Pantothenic acid, 11 mg; Folic acid, 1 mg; Biotin, 200µg; Choline, 715mg; Copper, 9 mg; Iodine, 1.1mg; Iron, 88 mg; Manganese, 66 mg; Zinc, 40 mg, Cobalt, 0.2mg and Selenium, 0.3 mg.

Table (4). Effect of cereal type and enzyme supplementation on performance of broiler chicks.

Items Treatments	Feed Consumption				Body Weight Gain				Feed Conversion Ratio			
	Starter	Grower	Finisher	Total	Starter	Grower	Finisher	Total	Starter	Grower	Finisher	Total
Corn												
C+	374a	1643a	2014a	4031a	284 a	959 a	1002	2246 a	1.33	1.72b	2.04	1.79b
	+ 0.43	+ 3.02	+ 2.17	+ 5.61	+4.26	+10.43	+17.05	+13.68	+0.02	+0.01	+0.04	+0.01
C	370b	1621b	1995b	3986b	272b	922b	983	2176b	1.38	1.78a	2.11	1.84a
	+ 0.28	+ 1.90	+ 1.91	+ 3.53	+4.43	+14.06	+24.1	+18.5	+0.02	+0.03	+0.05	+0.01
SIG	*	*	*	*	*	*	N.S	*	N.S	*	N.S	*
Wheat												
W+	367	1633a	1989a	3990a	269 a	937a	896a	2102a	1.37b	1.74b	2.27b	1.90b
	+ 1.35	+ 6.75	+ 1.03	+ 6.49	+2.59	+5.64	+10.44	+8.95	+0.03	+0.01	+0.03	+0.01
W	364	1603b	1967b	3934b	251 b	894b	806b	1951b	1.47a	1.80a	2.53a	2.02a
	+ 1.02	+ 7.74	+ 3.33	+ 3.98	+4.24	+10.44	+20.71	+16.73	+0.03	+0.02	+0.06	+0.02
SIG	N.S	*	*	*	*	*	*	*	*	*	*	*
Cereal sources												
C	370	1621a	1995a	3986a	272 a	922 a	983 a	2175 a	1.38b	1.78	2.11b	1.84b
	+ 0.28	+ 1.90	+ 1.91	+ 3.53	+4.43	+14.06	+24.11	+ 18.5	+0.02	+0.03	+0.05	+0.01
W	364	1603b	1967b	3934b	251 b	894 b	807 b	1951 b	1.47a	1.80	2.53a	2.02a
	+ 1.02	+ 7.74	+ 3.33	+ 3.98	+4.23	+10.44	+ 20.7	+ 16.7	+0.03	+0.02	+0.06	+0.02
SIG	N.S	*	*	*	*	*	*	*	*	N.S	*	*

Table (5). Effect of low energy diets supplemented by enzymes cocktail on performance of broiler chicks.

Items Treatments	Feed Intake				Body Weight Gain				Feed Conversion Ratio			
	Starter	Grower	Finisher	Total	Starter	Grower	Finisher	Total	Starter	Grower	Finisher	Total
C	370b	1621b	1995d	3986c	272 a	922ab	983a	2176 a	1.38b	1.78b	2.11b	1.84c
	+0.28	+1.90	+1.91	+3.53	+4.43	+14.06	+24.11	+18.52	+0.02	+0.02	+0.05	+0.01
LC100+	372b	1618b	2031c	4021b	274 a	926 ab	979a	2179a	1.38b	1.76b	2.14b	1.85c
	+3.45	+5.35	+3.59	+9.41	+4.93	+11.97	+21.50	+18.11	+0.03	+0.02	+0.05	+0.02
Lc150+	367bc	1652a	2055b	4075a	254b	950a	974a	2177 a	1.47a	1.76b	2.19b	1.89b
	+0.16	+4.40	+0.95	+5.38	+4.12	+13.42	+21.12	+22.31	+0.03	+0.02	+0.05	+0.02
W	364c	1603c	1967e	3934d	251b	894 b	807 b	1951b	1.47a	1.80a	2.53a	2.02a
	+1.02	+7.74	+3.33	+3.98	+4.23	+10.44	+20.71	+16.73	+0.03	+0.02	+0.06	+0.01
LW100+	370b	1623b	2080a	4074a	254b	911ab	832b	1998b	1.48a	1.80a	2.54a	2.03a
	+0.53	+1.55	+10.52	+12.23	+4.74	+14.71	+19.27	+16.36	+0.02	+0.02	+0.06	+0.02
LW150+	384a	1617b	1987d	3989c	262b	890b	811b	1964b	1.50a	1.88a	2.48a	2.04a
	+1.07	+3.02	+2.74	+6.67	+5.27	+10.54	+19.45	+16.14	+0.03	+0.02	+0.06	+0.01
SIG	*	*	*	*	*	*	*	*	*	*	*	*

Table (6). Effect cereal type and enzyme supplementation on nutrients digestibility and apparent metabolizable energy values.

Items Treatments	CF	EE	CP	NFE	OM	AME	AMEn
C+	27.4 + 1.86	82.9a + 0.85	96.5 + 0.28	83.7 + 1.10	84.3 + 0.86	3494 + 33.1	3349 + 027.7
C	23.8 + 2.15	80.6b + 1.05	95.9 + 0.39	81.1 + 1.18	82.2 + 0.99	3438 + 43.0	3308 + 34.4
SIG	N.S	*	N.S	N.S	N.S	N.S	N.S
W+	29.1a + 1.13	82.0a + 1.01	96.1 + 0.27	85.8a + 0.73	85.6a + 0.57	3544a + 26.0	3403a + 20.4
W	23.1b + 2.28	77.2b + 1.26	95.6 + 0.29	82.4b +0.84	82.5b +0.72	3419b + 32.8	3298b + 25.2
SIG	*	*	N.S	*	*	*	*
C	23.8 + 2.15	80.6 + 1.05	95.9 + 0.39	81.1 + 1.18	82.2 + 0.99	3438 + 43.0	3308 + 34.4
W	23.1 + 2.28	77.2 + 1.26	95.6 + 0.29	82.4 + 0.84	82.5 + 0.72	3419 + 32.8	3298 +25 .2
SIG	N.S	N.S	N.S	N.S	N.S	N.S	N.S

Table (7). Effect of low energy diets supplemented by enzymes cocktail on nutrients digestibility and apparent metabolizable energy values.

Items Treatments	CF	EE	D.CP	NFE	OM	AME	AMEn
C	23.8 + 2.15	80.6a + 1.04	95.9ab + 0.39	81.1b + 1.18	82.2b + 0.99	3438 + 43.0	3308 + 34.4
LC100+	24.7 + 1.71	80.1a + 0.57	96.7a + 0.22	86.1a + 0.41	85.6a + 0.36	3480 + 23.2	3321 + 19.6
LC150+	26.3 + 1.55	79.4a + 0.71	96.3ab + 0.26	83.3b + 0.49	83.5ab + 0.42	3420 + 16.9	3272 + 13.8
W	23.1 + 2.28	77.2b + 1.26	95.6b + 3.02	82.4b + 0.84	82.5b + 0.72	3419 + 32.8	3298 + 25.2
LW+	26.3 + 2.40	73.9c + 1.60	96.3ab + 0.23	82.7b + 1.05	82.8b + 0.92	3418 + 32.6	3289 + 28.5
LW150+	26.8 + 1.21	73.4c + 1.61	95.7b + 0.23	83.8b + 0.99	83.7ab + 0.83	3438 + 29.9	3299 + 25.6
SIG	N.S	*	*	*	*	N.S	Ns

Table (8). Effect of cereal type and enzyme supplementation on gross energy efficiency.

Items Treatments	Gross Energy conversion ratio											
	GIS	GIG	GIF	GIT	GS	GG	GF	GT	GCS	GCG	GCF	GCT
Corn												
C+	1514	6739	8287	16542	284a	959	1002	2246a	5.32b	7.03	8.26	7.36b
	+9.44	+67.50	+48.80	+124.8	+1.85	+13.5	+7.09	+12.00	+0.05	+0.12	+0.06	+0.02
C	1497	6649	8211	16358	272b	921	982	2175b	5.50a	7.21	8.35	7.51a
	+6.18	+42.50	+42.8	+78.60	+3.17	+6.96	+3.17	+1.20	+0.04	+0.03	+0.06	+0.03
Sig	NS	NS	NS	NS	*	NS	NS	*	*	NS	NS	*
Wheat												
W+	1489	6522	7956	15966	266	937a	896a	2102a	5.53	6.96	8.88b	7.59b
	+25.50	+146.40	+22.2	+127.6	+5.17	+3.21	+9.90	+9.84	+0.09	+0.16	+0.11	+0.03
W	1461	6402	7869	15732	251	894b	807b	1951b	5.83	7.16	9.75a	8.06a
	+22.28	+167.9	+72.4	+86.2	+3.48	+10.17	+2.00	+8.45	+0.16	+0.15	+0.08	+0.06
Sig	NS	NS	NS	NS	NS	*	*	*	NS	NS	*	*
Cereal sources												
C	1497	6649	8211a	16358a	272a	921	982a	2175a	5.50	7.21	8.35b	7.51b
	+6.18	+42.50	+42.8	+78.60	+3.17	+6.96	+3.17	+1.20	+0.04	+0.03	+0.06	+0.03
W	1461	6402	7869b	15732b	251b	894	807b	1951b	5.83	7.16	9.75a	8.06a
	+22.28	+167.9	+72.4	+86.2	+3.48	+10.17	+2.00	+8.45	+0.16	+0.15	+0.08	+0.06
Sig	NS	N.S	*	*	*	N.S	*	*	N.S	N.S	*	*

GIS = Gross Energy Intake Starter, GIG = Gross Energy Intake Grower, GIF = Gross Energy Intake Finisher, GIT = Gross Energy Intake Total

GCS = Gross Energy Conversion Starter, GCG = Gross Energy Conversion Grower, GCF = Gross Energy Conversion Finisher, GCT= Gross Energy Conversion Total

Table (9). Effect of low energy diets supplemented by enzymes cocktail on gross energy conversion ratio.

Items Treatments	Gross Energy conversion ratio											
	GIS	GIG	GIF	GIT	GS	GG	GF	GT	GCS	GCG	GCF	GCT
C	1497	6649	8211a	16358ab	272a	921a	982a	2175a	5.50bc	7.21	8.35b	7.51b
	+6.18	+42.50	+42.8	+78.60	+3.17	+6.96	+3.17	+1.20	+0.04	+0.03	+0.06	+0.03
LC100+	1480b	6489.5	8289a	16258abc	274a	926ab	979a	2179a	5.40c	7.01	8.47b	7.46b
	+6.90	+116.5	+79.7	+195.3	+4.00	+1.76	+19.4	+16.7	+0.06	+0.12	+0.23	+0.14
LC150+	1458b	6647	8404a	16510a	254b	950ab	973a	2177a	5.74ab	7.00	8.64b	7.58b
	+3.50	+96.20	+20.10	+116.3	+4.36	+10.3	+5.78	+7.00	+0.08	+0.09	+0.06	+0.05
W	1461b	6402	7869b	15732c	251b	894b	807b	1951c	5.83ab	7.16	9.75a	8.06a
	+22.28	+167.9	+72.4	+86.2	+3.48	+10.17	+2.00	+8.45	+0.16	+0.15	+0.08	+0.06
LW100+	1471b	6355	8242a	16069abc	254b	911ab	832b	1997b	5.80ab	6.98	9.91a	8.05a
	+11.40	+32.9	+126.5	+262.8	+7.21	+21.4	+2.64	+24.6	+0.16	+0.13	+0.28	+0.11
LW150+	1560a	6448	7822b	15831c	262ab	889b	812b	1964b	5.95a	7.24	9.63a	8.06a
	+23.8	+65.3	+58.6	+144.1	+3.28	+12.6	+3.7	+7.44	+0.15	+0.04	+0.10	+0.05
Sig	N.S	N.S	*	*	*	*	*	*	*	N.S	*	*

GIS = Gross Energy Intake Starter, GIG = Gross Energy Intake Grower, GIF = Gross Energy Intake Finisher, GIT = Gross Energy Intake Total

GCS = Gross Energy Conversion Starter, GCG = Gross Energy Conversion Grower, GCF = Gross Energy Conversion Finisher, GCT= Gross Energy Conversion Total

Table (10). Effect of cereal type and enzyme supplementation on protein conversion ratio.

Items Treatments	Protein conversion ratio											
	PIS	PIG	PIF	PIT	GS	GG	GF	GT	PCS	PCG	PCF	PCT
Corn	82.8	331	385	799	284a	959	1002	2246a	0.28 b	0.34	0.38	0.35 ^b
C+	+0.51	+3.33	+2.33	+6.02	+1.85	+13.5	+7.09	+12.00	+0.01	+0.00	+0.00	±0.00
C	81.9	326	381	790	272b	921	982	2175b	0.30a	0.35	0.38	0.36 ^a
Sig	+0.34	+2.00	+2.08	+3.92	+3.17	+6.96	+3.17	+1.20	+0.01	+0.00	+0.00	±0.00
Wheat	N.S	N.S	N.S	N.S	*	N.S	N.S	*	N.S	N.S	N.S	*
W+	81.7	326	378	786	266	937a	896a	2102a	0.30	0.34	0.42b	0.37 b
W	+1.40	+7.33	+1.20	+6.43	+5.17	+3.21	+9.90	+9.84	+0.00	+0.01	+0.01	+0.00
W	80.1	321	374	775	251	894b	807b	1951b	0.31	0.35	0.46a	0.39a
Sig	+1.22	+8.41	+3.38	+4.33	+3.48	+10.17	+2.00	+8.45	+0.01	+0.00	+0.00	+0.00
Cereal sources	N.S	N.S	N.S	N.S	N.S	N.S	N.S	*	N.S	N.S	*	*
C	81.9	326	381	790	272a	921	982a	2175a	0.30a	0.35	0.38b	0.36 ^b
W	+0.34	+2.00	+2.08	+3.92	+3.17	+6.96	+3.17	+1.20	+0.01	+0.00	+0.00	±0.00
W	80.1	321	374	775	251b	894b	807b	1951b	0.31	0.35	0.46a	0.39 ^a
Sig	+1.22	+8.41	+3.38	+4.33	+3.48	+10.17	+2.00	+8.45	+0.01	+0.00	+0.00	±0.00
	N.S	N.S	N.S	N.S	*	N.S	*	*	N.S	N.S	*	*

PIS = Protein Intake Starter, PIG = Protein Intake Grower, PIF = Protein Intake Finisher, PIT = Protein Intake Total

PCS = Protein Conversion Starter, PCG = Protein Conversion Grower, PCF = Protein Conversion Finisher, PCT = Protein Conversion Total

Table (11). Effect of low energy diets supplemented by enzymes cocktail on protein conversion ratio.

Items Treatments	Protein conversion ratio											
	PIS	PIG	PIF	PIT	GS	GG	GF	GT	PCS	PCG	PCF	PCT
C	81.9ab	326	381ab	790ab	272a	921ab	982a	2175a	0.30	0.35	0.38b	0.36b
	+0.34	+2.00	+2.08	+3.92	+3.17	+6.96	+3.17	+1.20	+0.01	+0.00	+0.00	+0.00
LC100+	82.3ab	326	388ab	797ab	274a	926ab	979a	2179a	0.30	0.35	0.39b	0.36b
	+2.05	+5.60	+3.71	+9.84	+4.00	+1.76	+19.4	+16.7	+0.00	+0.00	+0.01	+0.01
LC150+	81.5ab	335	396a	812a	254b	950a	973a	2177a	0.31	0.35	0.39b	0.37b
	+0.19	+4.9	+0.88	+5.92	+4.36	+10.3	+5.78	+7.00	+0.01	+0.00	+0.00	+0.00
W	80.1b	321	374b	775b	251b	894b	807b	1951c	0.31	0.35	0.46a	0.39a
	+1.22	+8.41	+3.38	+4.33	+3.48	+10.17	+2.00	+8.45	+0.01	+0.00	+0.00	+0.00
LW100+	81.6ab	325	395a	801ab	254b	911ab	832b	1997b	0.32	0.35	0.47a	0.40a
	+0.64	+1.76	+10.8	+12.7	+7.21	+21.4	+2.64	+24.6	+0.01	+0.00	+0.01	+0.00
LW150+	85.1a	324	379ab	788ab	262b	889b	812b	1964b	0.32	0.36	0.46a	0.39a
	+1.30	+3.21	+2.84	+7.42	+3.28	+12.6	+3.7	+7.44	+0.01	+0.00	+0.00	+0.00
Sig	*	N.S	*	*	*	*	*	*	N.S	N.S	*	*

*PIS = Protein Intake Starter, PIG = Protein Intake Grower, PIF = Protein Intake Finisher, PIT = Protein Intake Total
 CPS = Protein Conversion Starter, CPG = Protein Conversion Grower, CPF = Protein Conversion Finisher
 CPT = Protein Conversion Total.*

Table (12). Effect of cereal type and enzyme supplementation on carcass traits of boiler chicks.

Pram. Treat.	Hot carcass	liver	Heart	Gizzard	Abdominal Fat	Giblet	Total Edible part	Dressing %
Corn								
C+	71.60 +0.79	2.30 +0.14	0.44 +0.03	1.66a +0.05	2.37 + 0.14	4.39 +0.18	76.00 +0.89	90.99 +0.27
C	71.38 +0.53	2.20 +0.08	0.41 +0.01	1.42b +0.04	2.17 + 0.19	4.04 +0.11	75.42 +0.58	91.36 +0.35
SIG	N.S	N.S	N.S	*	N.S	N.S	N.S	N.S
Wheat								
W+	73.45a +0.6	2.35 +0.10	0.46 +0.03	1.76a +0.09	2.57 + 0.08	4.58 +0.17	78.03a +0.57	91.06 +0.11
W	71.43b +0.44	2.27 +0.07	0.45 + 0.01	1.54b +0.04	2.67 + 0.17	4.26 +0.07	75.70b +0.44	91.31 +0.39
SIG	*	N.S	N.S	*	N.S	N.S	*	N.S
Cereal Sources								
C	71.38 + 0.53	2.20 +0.08	0.41b +0.01	1.42 + 0.04	2.17 + 0.19	4.04 +0.11	75.42 + 0.58	91.36 +0.35
W	71.43b +0.44	2.27 +0.07	0.45a +0.01	1.54+ 0.04	2.67+ 0.17	4.26+0.07	75.70 + 0.44	91.31 +0.39
SIG	N.S	N.S	*	N.S	N.S	N.S	N.S	N.S

Table (13). Effect of low energy diets supplemented by enzymes cocktail on carcass characteristics of boiler chicks.

Pram. Treat.	Hot carcass	liver	Heart	Gizzard	Abdominal Fat	Giblet	Total Edible part	Dressing %
C	71.38c +0.53	2.21bc +0.08	0.41bc +0.01	1.42b +0.04	2.17 + 0.19	4.03c +0.11	75.42bc +0.58	91.36 +0.35
LC100+	72.70b +1.03	2.41ab +0.06	0.39c +0.02	1.48ab +0.04	2.24 + 0.08	4.28ab + 0.1	76.98ab +0.97	92.52 + 0.56
LC150+	73.53a +0.81	2.06c + 0.06	0.41ab +.01	1.52ab +0.06	1.96 + 0.09	3.99 c + 0.08	77.52a + 0.75	92.43 + 0.90
W	71.43c +0.43	2.27ab +0.07	0.45a + .02	1.54ab +0.04	2.67 + 0.18	4.26ab +0.07	75.70ab +0.44	91.31 + 0.39
LW100+	72.08b +0.35	2.44a + 0.06	0.42ab +.01	1.62a + 0.06	2.52 + 0.24	4.48a + 0.06	76.56ab +0.32	90.97 + 0.35
LW150+	70.13c +0.39	2.26ab +0.07	0.44ab +.01	1.63a + 0.04	2.59 + 0.19	4.34a + 0.09	74.46c + 0.36	90.88 + 0.68
SIG	*	*	*	*	N.S	*	*	N.S

Table (14). Effect of cereal type and enzyme supplementation on some blood parameters (mg/dl).

Items Treatments	Glucose	Total lipid	Total protein	Albumin	Globulin
Corn					
C+	319a+9.25	374+34.5	3.95+0.17	2.66+ .24	1.29+0.14
C	289b+8.03	386+35.8	4.21+0.09	2.66+ .24	1.55+0.21
SIG	*	N.S	N.S	N.S	N.S
Wheat					
W+	260a+18.7	386+35.8	4.20+0.22	2.83+0.22	1.37 0.20
W	210b+3.02	374+22.2	3.86+0.11	2.48+ .24	1.37+0.15
SIG	**	N.S	N.S	N.S	N.S
Cereal Sources					
C	289a+ .03	386+35.8	4.21a+0.09	2.66+0.24	1.55+ .21
W	210b+3.08	374+22.3	3.86b+0.11	2.48+0.24	1.37+ .15
SIG	*	N.S	N.S	N.S	N.S

Table (15). Effect of low energy diets supplemented by enzymes cocktail on some blood parameters (mg/dl).

Pram Treatm.	Glucose	Total lipid	Total protein	Albumin	Globulin
C	289ab+8.03	386+35.8	4.21+0.09	2.65+ 0.24	1.55+ 0.21
LC100+	316 a+3.30	326+31.0	4.03+0.11	2.83+ 0.17	1.19+ 0.15
LC150+	279ab+17.9	362+26.4	3.89+0.10	2.66+ 0.31	1.24+ 0.25
W	210 c+3.03	374+22.2	3.86+0.10	2.48+ 0.24	1.37+ 0.15
LW100+	271ab+21.9	362+37.4	3.85+0.24	2.65+ 0.20	1.19+ 0.14
LW150+	247bc+23.6	386+35.8	3.98+0.24	2.66+0.20	1.32+ 0.09
SIG	**	N.S	N.S	N.S	N.S

Table (16). Effect of main factors on European Production Efficiency Index (EPEI).

Items Treatments	EPEI
C+	318a ± 1.20
C	302b ± 1.45
SIG	*
W+	284a ± 0.88
W	247b ± 0.88
SIG	**
C	302a ± 1.45
W	247b ± 0.88
SIG	*

Table (17). Effect of low energy diets supplemented by enzymes Cocktail on European Production Efficiency Index.

Items Treatments	EPEI
C	302.3 a ± 1.45
LC100+	300 a ± 7.55
LC150+	290 a ± 4.40
W	247 b ± 0.88
LW100+	253 b ± 5.69
LW150+	247 bc ± 0.88
SIG	*

تأثير نوع الحبوب وإضافة الأنزيمات المحللة للمواد الكربوهيدراتية الغير نشوية على أداء دجاج اللحم وكفاءة الاستفادة من عناصر الغذاء

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** قسم تغذية الدواجن-معهد بحوث الانتاج الحيوانى-مركز البحوث الزراعية - جمهورية مصر العربية.

يهدف هذا البحث لدراسة تأثير كل من نوع الحبوب (أذره - قمح) وإضافة الأنزيمات المحللة للكربوهيدرات الى علائق منخفضة الطاقة بمقدار 100 أو 150 كيلو كالورى طاقة ممثلة / كجم على أداء دجاج اللحم ، كفاءة تحويل الطاقه والبروتين ، القيمه الهضميه لعناصر الغذاء المختلفه ، قيم الطاقه الممثله ، مواصفات الذبائح ، بعض مقاييس الدم ومعامل الانتاج الأوروبى. استخدم فى الدراسه عدد 480 ككوت من نوع كوب غير مجنس عمر 7 ايام بمتوسط وزن 160 جرام قسمت الى 8 معاملات وتحتوى كل معامله على 3 مكررات.

اشتملت التجريه على 3 مراحل للنمو (البادىء خلال الفتره من 7 - 14 يوم ، النامى خلال الفتره من 15 - 28 يوم ، الناهى خلال الفتره من 29 - 42 يوم) باستخدام علائق تحتوى على 21 ، 19 ، 18 % بروتين مع مستويات من الطاقه الممثله 2988 ، 3083 ، 3175 كيلو كالورى / كجم من العلائق خلال مراحل البادىء ، النامى والناهى على التوالى. فى كل مرحله من مراحل النمو تم تغذية كل مجموعه على واحده من المعاملات التاليه :

- 1- عليقة ذرة وصويا بدون اضافات
 - 2- عليقة قمح وصويا بدون اضافات
 - 3- عليقة ذرة وصويا مع خليط الأنزيمات بمعدل 50 ج لكل 100 كجم علف.
 - 4- عليقة قمح وصويا مع خليط الأنزيمات بمعدل 50 ج لكل 100 كجم علف.
 - 5- عليقة ذرة وصويا مع خليط الأنزيمات بمعدل 50 ج لكل 100 كجم علف مع خفض مستوي الطاقه بمعدل 100 ك ك لكل كجم علف.
 - 6- عليقة قمح وصويا مع خليط الأنزيمات بمعدل 50 ج لكل 100 كجم علف مع خفض مستوي الطاقه بمعدل 100 ك ك لكل كجم علف.
 - 7- عليقة ذرة وصويا مع خليط الأنزيمات بمعدل 50 ج لكل 100 كجم علف مع خفض مستوي الطاقه بمعدل 150 ك ك لكل كجم علف.
 - 8- عليقة قمح وصويا مع خليط الأنزيمات بمعدل 50 ج لكل 100 كجم علف مع خفض مستوي الطاقه بمعدل 150 ك ك لكل كجم علف.
- و يحتوى كل 1 جم من خليط الأنزيمات المستخدم على 3000 وحدة الفاجلاكتوسيديز و500 وحدة من البيتا منانيز و2500 وحدة من الزيلانيز و1500 وحدة بيتا جلوكانيز و1000 وحدة سيلليوز . ويمكن تلخيص النتائج المتحصل عليها كالتالى.

- تفوقت الطيور المغذاه على علائق تحتوى على الذرة والصويا فى كل من معدل زيادة وزن الجسم وكمية الغذاء المستهلك ومعامل التحويل الغذائى ومعاملات هضم العناصر الغذائية وقيم الطاقه الممثله وكفاءة تحويل والبروتين والطاقة بالمقارنة بالطيور التي تغذت على علائق القمح والصويا.
- اضافة خليط الأنزيمات الى كل من علائق الذرة والصويا وعلائق القمح والصويا حسن قيم كل المقاييس المختبره المذكوره سابقا.
- الطيور التي غذيت على العلائق المنخفضة الطاقه حتى 150 كيلو كالورى والمضاف اليها خليط الأنزيمات عوضت جزئيا إنخفاض مستوى الطاقه بزيادة إستهلاك الغذاء.
- لم يكن لنوع الحبوب (ذره - قمح) اى تأثير على محتوى بلازما الدم من البروتين الكلى والدهن الكلى فى حين ارتفع مستوى جلوكوز بلازما الدم معنوياً فى الطيور التي غذيت على علائق الذره مقارنة بعلائق القمح. .
- لم يكن لإضافة خليط الأنزيمات اى تأثير على مقاييس الدم المختبره فيما عدا مستوى جلوكوز بلازما الدم الذى زاد معنوياً .
- استخدام الأذره و الصويا فى علائق دجاج التسمين زاد من قيم معامل الكفاءة الأوروبى بمعدل 18.21% بالمقارنة بالعلائق التي تحتوى على القمح والصويا .
- اضافة خليط الأنزيمات الي علائق الذرة والصويا وعلائق القمح والصويا كان له تاثير معنوي على كفاءة الانتاج الأوربي وكان التحسن اكثر وضوحا مع علائق القمح والصويا بالمقارنة بعلائق الذرة والصويا وكان بمعدل (13.03 % مقابل 5.03 %) على الترتيب
- لا توجد فروق معنوية بين قيم معامل الكفاءة الأوربي عند اضافة خليط الأنزيمات لعلائق الذرة والقمح المنخفضة الطاقه .