



Effect of feeding low energy diets with non-starch polysaccharides enzymes on growth performance and some physiological indices in broilers

Ahmed Ali Saleh^{1*}, El-Sayed Saleem Torky¹, Eslam Ahmed Ellban¹, Ahmed Salah Mohmoud¹, Ibrahim Fawzi Omer¹, Ahmed Mohamed Abd-Elatty¹, Ismail Shaker El-Alfy¹, Mohammed H. Alzawqari^{1,2}

¹ Department of Poultry Production, Faculty of Agriculture, Kafrelsheikh University, Kafrelsheikh, Egypt

² Department of Animal Production, Faculty of Agriculture and Veterinary Medicine, Ibb University, Ibb, Yemen

*Corresponding author: ahmed.saleh1@agr.kfs.edu.eg

Abstract

Objective: The prime objective of this study was to evaluate the effects of feeding low energy diets and non-starch polysaccharides (NSP) enzymes on some growth- and carcass-related parameters in broilers.

Methods: A total of 240 chicks (1 day of age) were randomly allocated to two groups, each comprising 6 replicates of 20 chicks. The birds were fed two diets, optimum control (23, 21 and 19% CP by 3000, 3040, 3140 kcal/kg of diets without NSP enzymes supplementation) and low ME (23, 21 and 19% CP by lowering 60 kcal/kg from each optimum ME level plus 100g/ton of NSP enzymes supplementation) during starter, grower and finisher periods, respectively.

Results: Compared to the control treatment, no significant difference ($p > 0.05$) in body weight gain, feed intake, and feed conversion ratio was observed with the low ME diet with NSP enzymes supplemented. Also, dietary low ME with NPS enzymes supplementation did not affect carcass, breast, and thigh muscles ($p > 0.05$). Nevertheless, the NSP enzymes supplementation to low ME broilers diets did not decrease the total cholesterol and triglyceride plasma concentration. Furthermore, neither aspartate aminotransferase, alanine aminotransferase glucose, total protein nor albumin were significantly changed.

Conclusion: The supplementation of NSP enzymes is needed to support the performance and physiological activities of the broilers when fed the dietary low energy diets. However, no adverse effect such as lower lipid profile was observed when NSP enzymes supplementation with low ME diets were simultaneously applied in this study.

Keywords: low energy diets, NSP enzymes, growth performance, physiological indices, broilers

1. Introduction

In broiler commercial production, the main goal of broiler producers is to produce high-quality meat at a low cost per unit (Singh, et al., 2017). Poultry nutrition experts are constantly looking for the best approaches to reduce the cost of the feed, which is constantly changing due to the demand to raise production performance (De Keyser, et al., 2016). Corn and soybeans are one of the primary raw materials used to formulate chicken diets that have the ability to cover most of this diet's energy and protein needs. Such ingredients are an important source of energy-like nutrients, which are generally very expensive. The researchers, however, claimed that around 400-450 calories of energy per kilogram of diet will be wasted without digestion when maize and soybeans are the diet's reliable components (Cowieson, 2010; Chalghoumi et al., 2020).

The amount of metabolizable energy (ME) in diets based on corn-soybean meal depends on the digestibility of starch and protein, nonstarch polysaccharides (NSP). Starch is the main source of energy in maize; however, there is no complete digestion of maize starch in the digestive tract, as some components are digestive resistant (Tufarelli et al., 2007). In recent years, the use of NSP enzymes has

increased with more development coming from the consumer segment that uses non-viscous diets (Aftab and Bedford, 2018). Nonetheless, in the presence of certain enzymes, nondigestible soybean meal (SBM) carbohydrates may be available to broilers (Cowan, 1993). Enzyme-based strategies have therefore been used to boost the nutritional benefit of maize and SBM (Maisonier-Grenier et al., 2004). Decreasing ME in broiler diets to 100 and 150 kcal/kg resulted in considerable body weight gain (BWG) and feed conversion rate (FCR) depression (Downs et al., 2006; Golian et al., 2010; O'Neill et al., 2012; Abou El-Wafa et al., 2013 and Selim et al 2015). To compensate for this effect, xylanase enzyme was added to the low ME diets of maize-soybean food broiler (Nian et al., 2011; and Williams et al., 2014; Pirgozliev et al., 2015 and Selim et al., 2015).

Moreover, the cost of energy-rich ingredients is around 65 % of the cost of feed. Thus, scientists are seeking to conduct many experiments to reduce this cost by increasing the percentage of certain energy components while increasing poultry production (Bedford, 2000). Feeding technique for improving productivity by administering nutritional supplements with commercial enzymes as feed additives in

poultry is a well-established technique (Alagawany and Attia, 2015; Alagawany et al., 2017, 2018; Abd El-Hack et al., 2017, 2018b), and increased the growth performance parameters such as feed intake (FI), FCR or BWG (Almirall et al., 1995; Williams et al. 2014). The addition of enzymes to the cereal basal diets such as corn and soybean meal is useful as additives because the amount of NSP in these diets is high and thus it improves the growth efficiency of monogastric animals (Abdel-Latif et al., 2017). FCR is enhanced by the dietary incorporation of exogenous enzymes in the growing process through improved digestibility and reduced digestive viscosity (Choct et al., 1996).

In Egypt, poultry farmers rely on yellow maize and SBM to feed birds, as these are the available ingredients; however, the soybean content of NSP is 29% and maize 9% (Bedford, 2000). Broilers cannot create the enzymes found in the cell walls of the grains for the hydrolysis of these NSPs (Dibner and Richards 2004; Saleh et al., 2017). Exogenous enzymes that can hydrolyze NSPs are amply present in chickens' diets (Cho and Kim 2013). Amerah, et al., (2017) reported that growth performance in the broiler diets was improved by adding protease, alone or in combination with xylanase and amylase. Researchers hypothesized that low protease doses improve the nutrient usage, enhance the solubilization of NSP components, and increase the digestibility of protein and amino acid in chickens (Cozannet et al., 2017). However, the combination of xylanase, amylase, and protease works better than protease supply alone (Olukosi, 2007). This method could reduce the number of raw matter ingredients needed for poultry diets such as yellow maize and soy meal, and reduce production costs (Hussein et al., 2019, 2020).

However, few studies are available concerning the effect of using NSP enzymes supplementation on broilers' low energy diets. Therefore, the study aimed to evaluate the effect of feeding low energy diets with non-starch polysaccharides enzymes on growth performance and some physiological indices in broilers.

2. Materials and methods

This research was carried out under the approval of the Local Experimental Animals Care Committee's Ethics Committee and performed in compliance with guidelines of Kafrelsheikh University (Number 4/2016EC).

2.1. Supplements preparation

The NSP (YEMZIM B100) mixture enzymes were kindly provided by the ORBA BOKIMYA company, Tuzla Istanbul, Turkey. The enzymes were supplemented to the premix mixture, which is one of the basic ingredients in the experimental diets, according to the recommendations of the manufactured company. All experimental diets were prepared and offered to birds in a pelleted form.

2.2. Experimental design, diets, and husbandry

A total of 240 chicks (1 day old) were randomly allocated into two groups, each comprising 6 replicates of 20 chicks. The birds were fed two diets, optimum control (23, 21 and 19% CP by 3000, 3040, 3140 kcal/kg of diets without NSP enzymes supplementation) and low ME (23, 21 and 19% CP by lowering 60 kcal/kg from each optimum ME level plus 100g/ton of NSP enzymes supplementation) during starter, grower and finisher periods, respectively. The basal control diet was formulated to meet the nutrient requirements recommended by Ross 308 broiler nutrition specifications guide (Aviagen, 2019). The

experimental diet composition is presented in Table 1. The birds were reared in an environmentally controlled room and had free access to feed and water. All birds had the same environmental management (temperature, moisture, ventilation, and light).

2.3. Growth performance and carcass organs weights

Feed intake (FI) was recorded by subtracting the weight of the leftover feed of the total feed. The body weight (BW) was recorded at the beginning and end of the experimental period and the body weight gain (BWG) was then calculated. The feed conversion ratio (FCR) was calculated using the following formula; $FCR = \text{total feed taken/whole live body weight gained}$. Throughout the experimental phase, the health status and mortalities were measured daily on a regular basis. At the end of the experiment, five birds from each treatment were randomly chosen and slaughtered. Eviscerated weight, liver, gizzard, heart, carcass and abdominal fat were weighted as carcass traits. On the basis of live body weight, the percentage yield of each part was calculated.

2.4. Biochemical parameters analysis

At slaughtering time, the blood samples (5 ml) were collected and centrifuged at 3000 rpm for 20 minutes. The plasma was frozen at -20°C till the time of chemical analysis. Blood parameters including total cholesterol, triglyceride, aspartate aminotransferase (AST) and alanine aminotransferase (ALT), total protein (TP), albumin, and glucose concentrations were measured colorimetrically using commercial kits (Diamond Diagnostics, Egypt) according to the procedure outlined by the manufacturer and according to Saleh (2014).

2.5. Statistical analysis

The collected data were analyzed by one-way ANOVA in a completely randomized designed using IBM SPSS Statistics version 26 (IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp). The significance of means' differences was tested using the T-test and all differences were considered significant at $p < 0.05$.

3. Results

3.1. Growth performance

The effect of feeding low energy diets with NSP enzymes on growth performance was summarized in Table 2. There were no significant differences ($p < 0.05$) in all growth performance parameters, including BW, BWG, FI, FCR, and mortality between the control diet and low energy diets with NSP enzymes.

3.2. Carcass organs traits

The results of carcass organs traits are listed in Table 3. Low energy diets with supplementation of NSP enzymes decreased the abdominal fat weight significantly, while carcass, breast and thigh muscles, liver, gizzard, heart, and spleen were not affected.

3.3. Plasma parameters

Plasma concentrations of AST, total protein, albumin, globulin, triglyceride, ALT, glucose, and total cholesterol are shown in Table 4. Plasma total cholesterol and triglyceride concentrations decreased ($p < 0.05$), while, plasma glucose, and AST, ALT, total protein, and albumin were not affected by feeding low energy diets with NSP enzymes.

Table 1. The ingredients and chemical compositions of the experimental diets (1-34 d).

Ingredient, g/kg	Starter, 1-10 days		Grower, 11-25 days		Finisher, 26-34 days	
	Control	Low energy	Control	Low energy	Control	Low energy
	Enzymes		Enzymes		Enzymes	
	-	+	-	+	-	+
Yellow corn, 8.5%	532	546	592	606	633	648
Soybean meal, 46%	370	370	317	317	275	270
Corn gluten meal, 62%	25	23	26	24	20	23
Soybean oil	28	16	24	12	34	21
Dicalcium phosphate	18	18	15.5	15.5	14	14
DL- Methionine, 99%	2.7	2.7	2	2	1.9	1.9
L-Lysine HCL, 98%	2.5	2.5	2.3	2.3	2.2	2.2
Threonine, 99%	1.1	1.1	0.7	0.7	0.6	0.6
Limestone	13.6	13.5	13.3	13.2	12	12
NaCl	2.3	2.3	2.6	2.6	2.7	2.6
Premix*	3	3	3	3	3	3
Sodium bicarbonate	1.8	1.8	1.6	1.6	1.6	1.6
YEMZIM B100**	-	0.1	-	0.1	-	0.1
Total	1000	1000	1000	1000	1000	1000
Chemical composition**						
Crude protein, %	23	23	21	21	19	19
TME, Kcal/kg diet	3001	2940	3043	2982	3142	3083
Calcium, %	1.036	1.033	0.955	0.952	0.861	0.860
Total phosphorus, %	0.735	0.738	0.671	0.674	0.625	0.628
Na	0.17	0.17	0.17	0.17	0.17	0.17
Cl	0.18	0.18	0.20	0.20	0.20	0.20
L-Lysine, %	1.47	1.47	1.31	1.31	1.17	1.17
DL- Methionine, %	0.66	0.66	0.57	0.57	0.53	0.54

*Each 3 kg of vitamin-mineral premix contain: 6000000IU vit A, 900000 IU vit D3, 40000mg vit E, 2000mg vit K, 2000mg vit.B1, 40000mg vit B2, 2000mg vit B6, 10mg vit B12, 50000mg Niacin, 10000 mg pantothenic acid, 50mg Biotin, 3000mg Folic acid, 250000 mg choline, 8500mg Mn, 50000mg Fe, 50000mg Cu, 200mg I, 100mg Se and 100mg Co. **YEMZIM B100: 30000 unit/g Beta-glucanase; 450000 unit/g Xylanase ; 125000 unit/g Hemicellulase; 125000 unit/g Cellulase.

Table 2. Effect of feeding low energy diets with NSP enzymes on growth performance in broilers.

Item	Diet treatments		P
	Control	Low Energy with NSP Enzymes	
Initial Body weight, g/b	49.3±0.3	49.4±0.3	NS
Final body weight, g/35 d	1842.6±11.8	1857.3±17.6	NS
Body weight gain, g/b	1793.3±11.6	1807.9±11.7	NS
Feed intake, g/35 d	2747.5±33.2	2776.3±58.4	NS
Feed conversion ratio, g/g	1.491±0.013	1.495±0.028	NS
Mortality, %	2.5±0.26	2.5±0.39	NS

Values are expressed as means ± standard error; NS, non-significant.

Table 3. Effect of feeding low energy diets with NSP enzymes on carcass organs weight in broilers.

Item	Diet treatments		P
	Control	Low Energy with NSP Enzymes	
Carcass weight, g/100g BW	70.92±0.74	70.74±0.79	NS
Breast muscle weight, g/100g BW	23.84±1.05	23.39±0.71	NS
Thigh muscle weight, g/100g BW	15.79±0.48	15.86±0.47	NS
Liver weight, g/100g BW	2.74±0.16	2.77±0.17	NS
Gizzard weight, g/100g BW	1.21±0.04	1.24±0.06	NS
Heart weight, g/100g BW	0.51±0.04	0.58±0.05	NS
Spleen weight, g/100g BW	0.12±0.03	0.16±0.02	NS
Abdominal fat weight, g/100g BW	1.46±0.10 ^a	1.17±0.07 ^b	*

Means values placed at the rows by different superscript letters are significantly different ($p < 0.05$). Values are expressed as means ± standard error; NS, non-significant.

Table 4. Effect of feeding low energy diets with NSP enzymes on plasma parameters in broilers.

Item	Diet treatments		P
	Control	Low Energy with NSP Enzymes	
AST, mg/dL	5.5±0.85	5.52±0.25	NS
ALT, mg/dL	258±21.2	245±7.71	NS
Total cholesterol, mg/dL	125±8.58 ^a	104±4.87 ^b	*
Triglyceride, mg/dL	6.2±0.62 ^a	4.5±0.22 ^b	*
Glucose, mg/dL	162±14.11	155±10.32	NS
Total protein, g/dL	5.54±0.42	5.52±0.34	NS
Albumin, g/dL	1.55±0.06	1.52±0.04	NS
Globulin, g/dL	3.97±0.39	4.01±0.27	NS

Means values at the rows by different superscript letters are significantly different ($p < 0.05$). Values are expressed as means ± standard error; NS, non-significant; AST aspartate aminotransferase; ALT, alanine aminotransferase.

4. Discussion

The present research aimed at testing whether the supplementation of NSP commercial enzymes into a low-energy diet will compensate for the reduced amount of energy claimed by the manufacturer for broilers fed a standard diet based on maize - soybean meal. There were no significant differences ($p < 0.05$) in all growth performance parameters. In consistence, some other researchers have reported no major effects on the introduction of an enzyme for broiler chickens. Günal, et al., (2004) showed that the Avizyme 1300-xylanase or Avizyme 1500- amylase enzymes addition in diets had nonsignificant ($p < 0.05$) effect on the ADG, ADFI, FI, or FCR of chickens. However, Narasimha et al., (2015) reported that supplementation of NSP enzymes to low energy diet significantly reduced ($p < 0.05$) the price feed per kg producing one kg of live body weight and increased growth performance of broilers. Moreover, Zhou et al., (2009) have demonstrated that adding commercial xylanase, α -amylase, and protease multienzyme complex to broiler (38 days of age) diets has enhanced the use of ME, especially in low ME meals. Williams et al., (2014) also examined the probability of dietary supplementation of xylanase in reduced-energy diets (66 and 132 kcal/kg) to increase the feed intake of broiler chicken as opposed to birds fed energy-required diets.

NSP enzymes can elevate the arrival of endogenous and exogenous enzymes in the endosperm cell to protein and starch (Cowieson, 2005) by breaking down the highly branched insoluble arabinoxylans in the cell wall (Chesson, 2001). It may also be a fermentable form of xylo-oligosaccharides (Fernandez et al., 2000), fermented into volatile fatty acids in the ceca. This will have beneficial effects on gut health and improve digestion and absorption through peptide YY production in the small intestine (Singh et al., 2012), resulting in delayed gastric emptying and duodenal transit rates (Park et al., 2013). In addition, the use of xylanase and amylase in a commercial broiler diet acts on various insoluble NSPs and other anti-nutritional factors commonly found in the diet that cause hydrolysis of indigestible bonds in the plant cell wall, allowing proper digestion (Flores et al., 2016). Freitas et al. (2011) reported an improvement in FCR in broilers when supplementing NSP enzymes as well as improving the digestibility of fat and crude proteins were observed. Though the mortality rate occurred during the first week of chicks age, it is considered within a normal range.

The results of the carcass organs were in agreement with the other researchers' results (Liu et al., 2007; Hussein et al., 2019, 2020). Farran et al. (2010) reported that the muscle weights were not affected by the inclusion of enzyme preparations. Garipoglu et al. (2006) found that the dressing percentage reduced, but the abdominal fat weight was not influenced by feeding low energy diets with NSP enzymes supplementation including a mixture of protease, xylanase, and amylase enzymes. Similarly, Kocher et al. (2003) found that the Xyl and amylase supplementation to the corn-soybean meal-based diets did not affect abdominal fat weight. The reduction of the abdominal fat relative weight in this study observed in broilers fed low-energy diets with enzyme supplementation, may be due to the lower of calorie diets which produced less fattening that is often associated with lowering the feed intake.

Feeding low-energy diets supplemented with NSP enzymes may reduce the limitations of bile salt functions and their emulsifying properties in intestinal chyme and may, therefore, be a reason to reduce the concentration of plasma lipids, including total cholesterol and triglycerides (Hajati et al., 2009; Saleh et al., 2018b). The liver

function indices (AST and ALT) were not significantly impacted. Ahmed et al. (2013) reported in accordance with our findings that adding NSP enzymes to low-energy diets is considered healthy for poultry without having any adverse effects on vital organ function. In support, Saleh et al. (2018a) also found that dietary enzyme supplementation did not significantly affect serum concentrations of AST, ALT, glucose, and albumin.

5. Conclusion

This study demonstrated that the supplementation of low energy diet with NSP enzymes could support the growth performance, physiological activities responses of the broiler chickens. Whereas, no negative effect was observed when the low energy diet was supplemented with NSP enzymes simultaneously in the diets in this study. Therefore more further studies are needed to exactly explain NSP enzymes effect on growth performance.

Conflict of interest statement

The authors declare no conflict of interest in the current research work

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Data availability statement

All data sets collected and analyzed during the current study are available from the corresponding author on reasonable request.

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