PERFORMANCE AND NUTRIENT UTILIZATION OF LAYING HENS FED DIFFERENT APPARENT METABOLIZABLE ENERGY AND MICROBIAL PHYTASE LEVELS.

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SUMMARY

A 3 × 3 factorial Treatment design with three dietary energy levels (2600, 2700 and 2800 kcal ME/kg) and three additional microbial phytase levels (0, 400 and 800 FTU/kg) was conducted to determine the effect of dietary energy, microbial phytase and their interactions on productive performance, egg shell quality and nutrients digestibility of Bovans White laying hens strain. This experiment lasted 20 weeks under similar management conditions. Bovans White hens (n = 540) in Phase I (21 weeks of age) were randomly assigned into 9 treatments (4 replicates of 15 birds per treatment). With increasing dietary energy, hens adjusted feed intake to achieve a constant energy intake. Dietary energy had a significant effect on egg weight, feed conversion ratio and nutrients digestibility. However, no significant effect on egg was found. Dietary microbial phytase at level of 800 FTU/kg had significant effects on egg production, egg weight, feed conversion ratio, egg shell thickness and nutrients digestibility compared to both 0 and 400 FTU of microbial phytase addition/kg., Feed intake was not affected by microbial phytase levels. A significant interaction between energy and microbial phytase levels, in, group received dietary energy level of 2800 kcal ME/kg and 800 FTU supplemental phytase/kg, increased hen productive performance and nutrients digestibility. Also, adding microbial phytase can spare part of metabolizable energy in laying hen diets without adverse effects on laying hen performance, egg shell quality nutrients digestibility.

***Keywords**: dietary energy, microbial phytase, laying hens, performance, shell quality, digestibility.*

INTRODUCTION

Phytate exists widely in feed ingredients and is poorly degradable in the gastrointestinal tract of poultry because of the lack of endogenous phytase. Phytase is a much studied enzyme, with the first modern series of studies conducted in the 1960's early research on the application of phytase to poultry diets showed promise to improve availability of phosphorus to poultry, particularly on young birds. However, it is not until the 1990's that phytase become economically feasible for use in animal and poultry feed (Remus, 2005). Its presence in poultry feed ingredients restricts the effective use of organic phosphorus (P) and other nutrients, including calcium (Ca), energy, and amino acids (AA), in the alimentary tract (Ravindran *et al.*, 1995). This is due to the chelation of Ca (Cheryan, 1980), amino acids (De Rham and Jost, 1979), and starch (Ravindran *et al.*, 1999) by phytate. This anti-nutritional effect was demonstrated in broilers, in which the digestibility of energy and amino acids declined with an increase in dietary phytate (Ravindran *et al.*, 2006).

Corn-soybean meal diets typically contain 0.80-0.90% phytic acid (or 0.22 to 0.25% phytate-phosphorus) (Chen, 2000). By releasing these phytate bound nutrients and improving their utilization, dietary supplementation with microbial phytase would be expected to have protein/amino acid and energy effects in monogastric animals. A number of studies ~~that~~ have demonstrated generally positive effects of supplemental phytase on apparent metabolizable energy (Ravindran *et al.*, 2000, 2001; Camden *et al.*, 2001) of poultry

diets. Phytase has been shown to increase energy and AA availability in diets for nonruminants (Lan *et al.*, 2002; Selle *et al.*, 2003; Shirley and Edwards, 2003), but there is much less data on amino acid and energy effects than on the Ca and P effects. Cowieson and Ravindran (2008) and Agbede *et al.* (2009) concluded that supplemental phytase increased apparent metabolizable energy (AME) values.

Based on a corn/soy diet with 400g/kg starch and 80 g/kg fat the undigested starch and fat fractions are approximately 35 g/kg and 12 g/kg respectively. So, in a conventional corn/soy-based diet there is between 400-450 kcal/kg of undigested energy that is potentially open to capture via the use of feed additives such as exogenous enzymes (Zanella *et al.*, 1999). This energy is partitioned approximately 18%, 45% and 37% from undigested fat, protein and starch, respectively. The reason that this energy escapes digestion may be due to physical encapsulation of starch, protein and oil in cells, or more generally associated with a fibre matrix, through a lack of suitability of endogenous enzyme compliments, via reduced digestion associated with viscosity of luminal contents, or via secretion and absorption dynamics. Based on the literature, Meng and Slominski (2005) and Cowieson and Bedford (2009) suggested that the use of xylanase and phytase will deliver a maximum improvment in ileal digestible energy of around 120 kcal/kg.

Importantly, the effect of enzymes (and other feed additives) is substantially lower in diets with a higher digestibility and the return follows a distinct law of diminishing return (Cowieson and Bedford, 2009). The implication here is that it is relatively 'easy' to improve digestibility from 80 to 90% but extremely difficult to improve digestibility from 90-100%. This principle must be applied when considering the likely impact of enzymes, enzyme combinations and other feed additives on digestibility and how these effects are captured via least cost formulation. Further research is warranted to explore the less tangible effects of the ingestion of enzymes such as physiological changes, secretory and absorptive function differences and ultimately the effect of enzymes on nutrient requirement and the net value of energy and other nutrients (Cowieson, 2010). The objective of this experiment was to determine the effect of different levels of metabolizable energy on laying hen performance. Seemingly, it aimed to determine the effect of adding microbial phytase, under such conditions, to laying hen diets on their performance, egg shell quality and nutrients digestibility.

MATERIALS AND METHODS

The experimental procedure was carried out at the Poultry Nutrition Research Unit, Faculty of Agriculture, Cairo University. The analytical part of this study was performed at the Laboratories of Animal Production Department, Faculty of Agriculture, Cairo University.

A total number of 540 Bovans White laying hens, 21 weeks of age were used to study the effect of different levels of metabolizable energy and microbial phytase on laying hens performance, egg quality and nutrients digestibility. Birds were randomly distributed into 9 treatments, each containing 60 hens in 4 replicate of 15 hens each. Three levels of metabolizable energy (ME) and microbial phytase (MP) were used in a 3 x 3 factorial arrangement design. The tested ME levels were the optimum level, 2800 Kcal/kg (ME1), 2700 Kcal/kg (ME2) and 2600 Kcal/kg (ME3). Each ME level was supplemented with three microbial phytase levels, 0 FTU/kg (MP1), 400 FTU/kg (MP2) and 800 FTU/kg (MP3). Natuphos was used as a source of microbial phytase, each gram of Natuphos contains 2500 phytase units (FTU). Therefore, Natuphos was supplemented to basal diets at levels of 0, 160, 320 mg/kg to obtain 0, 400 and 800 FTU of microbial phytase. The first diet containing 2800 kcal ME/kg, 18% CP and without microbial phytase supplementation represents the control group. Composition of the experimental diets and their calculated analysis are presented in Table (1). In all experimental diets, metabolizable energy, crude protein, vitamins and minerals were adjusted according to the strain recommended catalog. Hens were allocated in cleaned and fumigated cages of wire floored batteries in an open system house under similar conditions of management. Water and feed in mash form were offered *ad-libtium* allover the experimental period (20 week, 5 periods of 4 weeks each) from 21 to 40 weeks of age, under a total of 16 hours light/day regimen.

During the experimental period, daily egg production, feed intake, and egg weight averages were calculated per hen every 4 weeks intervals. Records of egg production, feed intake, and egg weight were used to calculate the values of feed conversion ratio (g feed consumed / g egg mass). Every 4 weeks, a total number of 40 eggs were taken from each treatment (10 eggs / replicate) for testing egg quality as measured by shell thickness, using a digital dial pipe gauge. At the end of feeding trial, 4 hens of each treatment (one /

replicate) were randomly chosen and individually housed in metabolic cages to determine the digestion coefficient of nutrients. The analyses of feed and dried excreta were done according to the official methods (A.O.A.C., 1990). Nitrogen-free extract (NFE) was calculated according to Abou-Raya and Galal (1971). Fecal nitrogen was determined according to Jacobson *et al.* (1960). The data obtained were statistically examined ~~by~~ using SAS (2000) procedure. Differences among treatment means were separated by Duncan's new multiple-range test (Duncan, 1955).

Table (1). Ingredients and nutrient composition (%) of basal diets

Ingredients	Basal diets		
	Diet 1	Diet 2	Diet 3
Yellow corn	56.55	51.25	46.15
Soybean meal (44%)	27.60	26.90	26.00
Wheat bran	1.00	8.00	15.00
soybean oil	3.00	2.00	1.00
Bone meal	3.00	3.00	3.00
Limestone	8.00	8.00	8.00
Salt (NaCl)	0.40	0.40	0.40
Vit. & min. mixture *	0.30	0.30	0.30
DL-methionine	0.15	0.15	0.15
Total	100	100	100
Calculated nutrient composition**			
Metabolizable energy (Kcal/kg)	2800	2701	2605
Crude protein (%)	17.47	17.74	17.94
Calcium (%)	4.02	4.02	4.03
Available phosphorus (%)	0.52	0.60	0.68
Lysine (%)	0.95	0.96	0.96
Methionine (%)	0.42	0.41	0.41
Linoleic acid (%)	2.88	2.38	1.88

* *Vitamin and mineral mixture at 0.3% of the diet supplies the following per Kg of the diet: Vitamin A 10000 I.U. Vitamin D_3 3000 I.U. Vitamin E 20mg, Vitamin K_3 3mg, Vitamin B_1 2mg, Vitamin B_2 6mg, Vitamin B_6 5mg, Vitamin B_{12} 20mcg. Pantothenic acid 10mg, Folic acid 1mg, Biotin 5mg, Choline chloride 500mg, niacin 66mg, Manganese 100mg, Iron 100mg, Zinc 75mg, Copper 8mg, Iodine 45mcg, Selenium 10mcg and Cobalt 10mcg.*

** *According to NRC (1994)*

RESULTS AND DISCUSSION

Hen-day egg production (Table 2) was not significantly affected by dietary ME level. Enzyme supplementation significantly increased egg production for hens fed 400 and 800 FTU/kg. The highest ($P \leq 0.05$) egg production was determined in laying hens fed 800 FTU of microbial phytase/kg (90.67%), followed by those with 400 FTU of microbial phytase/kg (89.88%) and then by the control group (89.29%) without enzyme supplementation. These observations are in line with those of Harms *et al.* (2000), Wu *et al.*, (2005), Wu (2006) and Junqueira *et al.* (2006) who reported that egg production was not affected by dietary energy level. However, Ciftic *et al.* (2005), Lim *et al.* (2003) and Nezhad *et al.* (2007) concluded that supplementation of microbial phytase to laying hen diets improved egg production. Simon and Versteegh (1993) noted an increase in egg production when phytase was added to layer diets. Data showed that laying hens fed diet containing optimum level of energy and phytase (T3) recorded the highest value of egg production (90.86%). While, the lowest value (88.87%) was observed when laying hens were fed control diet (T1). No significant differences in egg production values among T3, T6 and T9 which recorded 90.86, 90.83 and 90.33%, respectively, this indicated that the addition of 800 FTU microbial phytase/kg to either ME 2 (2700 Kcal/Kg) or ME 3 (2600 Kcal/Kg) improved production performance compared to the ME 13 (2800 Kcal/Kg).

Egg weight (Table 2) was significantly affected by dietary ME levels. Hens fed diets containing 2800 Kcal ME/kg significantly ($P \leq 0.05$) improved egg weight compared to those fed diets containing 2700 or 2600 Kcal ME/kg diet. Supplementation of microbial phytase had significant effect on egg weight. This result was in agreement with that of Harms *et al.* (2000), Bohnsack *et al.* (2002) and Sohail *et al.* (2003) who observed that increasing dietary energy levels from 2719 to 2877 kcal ME/kg had positive effects on early egg weight. When dietary energy increased, hens adjusted feed intake to achieve a constant intake of energy and other nutrients such as protein, TSAA, and lysine so that the same amount of dietary energy was used to produce 1 g of egg and supports the hypothesis that there probably is an ideal energy/protein (lysine) ratio for optimal performance (Wu, 2006). It is worthy to note that there are conflicting results on effect of linoleic acid on egg weight. NRC (1994) recommended that linoleic acid requirement for laying hens was 1.0%. In this trial, as dietary energy increased from 2600 to 2800 kcal ME/kg by the addition of graded amounts of soybean oil, linoleic acid increased from 1.88 to 2.88%. The increase of egg weight might be attributed to linoleic acid or soybean oil independent of linoleic acid content (Wu, 2006). On other hand, hens received 800 FTU microbial phytase/Kg recorded heavier eggs (62.74 g) than 0 and 400 FTU microbial phytase/kg (61.61 and 62.08 g, respectively). higher egg weight was observed in this study with microbial phytase supplementation which is in agreement with those reported by Keshavarz (2003 a,b), Ciftc *et al.* (2005), Jalal *et al.* (2006) and Nezhad *et al.* (2007). Data showed that laying hens fed diet containing 2800 Kcal ME/Kg with 800 FTU/Kg supplemental microbial phytase (T3) recorded the highest value of egg weight (63.76 g). While, the lowest value (61.11 g) was observed when laying hens were fed diet containing low levels of ME without supplemental microbial phytase (T7). No significant differences were observed in egg weight values between control group (T1) and those fed diets containing 2700 Kcal ME/Kg with 0 and 400 FTU microbial phytase (T4 and T5), being 62.0, 61.74 and 62.20 g, respectively.

Dietary energy had a significant effect on feed intake (Table 2). With increasing dietary energy levels, feed intake linearly decreased from 126.94 to 113.80 g/hen/day, resulting in a net decrease of 13.14 g/hen/day of feed intake. This may be explained on the basis that hens tend to consume more feed to cover the requirement of nutrients such as energy, protein, amino acids, vitamins and minerals which have a favorable effect on laying hen performance. Similar results were reported by and Wu *et al.* (2005) and Wu (2006) who found that energy level significantly affected feed intake. Additionally, feed intake was not significantly influenced by phytase supplementation according to Liebert *et al.* (2005) and Liu et al (2007). The interaction of ME and microbial phytase showed that laying hens fed diet containing lower level of ME (2600 kcal/kg) with no supplemental microbial phytase (T7) consumed the highest value (128.16 g/hen/day). While, the lowest feed intake (113.07 g/hen/day) was observed when laying hens were fed diet containing 2800 Kcal ME/kg and supplemented with 800 FTU microbial phytase/kg (T3). There were highly significant differences in feed intake values between control group and all other groups containing different levels of ME with microbial phytase.

There were significant effects ($P \leq 0.05$) of either ME or microbial phytase on average feed conversion ratio (FCR) (Table 2). The higher energy level significantly improved FCR (2.02) compared to the other energy levels (2.15 and 2.30, respectively). Also, feed conversion was significantly ($P \leq 0.05$) better for birds fed 800 FTU microbial phytase/kg diets than for those fed 0 and 400 FTU/kg diets. Such improvement perhaps is due to increasing both egg production and egg weight of laying hens received level of ME and supplemental microbial phytase diets. Similar results were obtained by Colvara *et al.* (2002), Wu *et al.* (2005) and Wu (2006) who indicated that increasing the dietary energy levels up to 3000 kcal ME/kg improved FCR, due to the decrease in feed intake. Moreover, Jalal and Scheideler (2001), Lim *et al.* (2003), Ciftic *et al.*, (2005), Liebert *et al.* (2005) and Nezhad *et al.* (2007) reported that dietary supplementation of microbial phytase to layer diets significantly improved FCR. A significant difference was shown in FCR due to ME with Microbial phytase levels. The best FCR value (1.96) was recorded by T3. While, the worst value of FCR (2.34) was obtained by T7. Data showed significant differences in FCR values between the control diet (T1) and ~~the~~ all dietary treatments except T2.

Both ME and microbial phytase levels had a significant effect on egg shell thickness (Table 2). It is clear that egg shell thickness decreased gradually by increasing levels of ME from 2600 to 2800 Kcal ME/kg while increased by increasing microbial phytase from 0 to 800 FTU/kg. Also, Atteh and Leeson (1985) indicated that the reasons of improved egg shell thickness with diets containing 2600 kcal ME/kg was due to lower calcium losses on the low ME diet than on the high ME diet. This could be explained by the formation of indigestible Ca-soaps between Ca and fats/oils in high energy-high fat diet. Many researchers have

demonstrated that phytase supplementation (from 100 to 2000 FTU phytase/kg of feed) has positive effects on eggshell quality by improving phosphorus utilization (Boling et al., 2000 a, b; Roland et al., 2003 and Keshavarz, 2003a). The egg shell thickness showed a significant increase ($P \leq 0.05$) as the level of phytase increased. This may be due to liberation of inorganic phosphorus and calcium from the phytase molecular by supplemental enzyme. Phytase supplementation improved Ca and P digestibility to varying degrees. Supplementation of phytase in normal, corn-soybean meal diets improved feed intake, feed conversion, and egg mass and elicited a response in shell quality and egg components (Jalal and Scheideler, 2001). Moreover, the significant effects in egg shell thickness due to ME with microbial phytase interaction were observed. The hens received T9 gave the highest value (36.15 μm), while hens fed control diet (T1) recorded the lowest value (34.16 μm).

Table (2). Laying performance and egg shell thickness of hens fed different energy levels supplemented with microbial phytase.

Treatments	Egg production (%)	Egg weight (g)	Feed intake (g/hen/day)	Feed conversion ratio	Shell thickness (μm)
Energy main effect:					
ME1 (2800 kcal/kg)	89.93	62.74 ^{a}	115.80 ^{c}	2.02 ^{c}	34.56 ^{c}
ME2 (2700 kcal/kg)	90.09	62.26 ^{ab}	120.60 ^{b}	2.15 ^{b}	35.11 ^{b}
ME3 (2600 kcal/kg)	89.82	61.82 ^{b}	126.94 ^{a}	2.30 ^{a}	35.62 ^{a}
Phytase main effect:					
MP1 (0 FTU/kg)	89.29 ^{c}	61.61 ^{c}	121.47	2.21 ^{a}	34.62 ^{b}
MP2 (400 FTU/kg)	89.88 ^{b}	62.08 ^{b}	120.12	2.15 ^{b}	35.01 ^{b}
MP3 (800 FTU/kg)	90.67 ^{a}	63.12 ^{a}	119.74	2.09 ^{c}	35.66 ^{a}
Interaction (Energy x Phytase):					
T1 (ME1 x MP1)	88.87 ^{d}	62.00 ^{ed}	114.54 ^{f}	2.08 ^{f}	34.16 ^{e}
T2 (ME1 x MP2)	90.06 ^{abc}	62.55 ^{bc}	113.76 ^{g}	2.03 ^{gf}	34.38 ^{ed}
T3 (ME1 x MP3)	90.86 ^{a}	63.67 ^{a}	113.07 ^{h}	1.96 ^{g}	35.13 ^{c}
T4 (ME2 x MP1)	89.46 ^{cd}	61.74 ^{ef}	121.72 ^{d}	2.20 ^{d}	34.51 ^{d}
T5 (ME2 x MP2)	89.98 ^{bc}	62.20 ^{cd}	120.12 ^{e}	2.15 ^{e}	35.14 ^{c}
T6 (ME2 x MP3)	90.83 ^{a}	62.86 ^{b}	119.96 ^{e}	2.10 ^{e}	35.70 ^{b}
T7 (ME3 x MP1)	89.55 ^{bcd}	61.11 ^{g}	128.16 ^{a}	2.34 ^{a}	35.20 ^{c}
T8 (ME3 x MP2)	89.60 ^{bcd}	61.56 ^{fg}	126.48 ^{b}	2.29 ^{b}	35.51 ^{b}
T9 (ME3 x MP3)	90.33 ^{ab}	62.84 ^{b}	126.48 ^{c}	2.23 ^{c}	36.15 ^{a}

a, b, c...etc. means in same column, within each factor with different superscripts are significantly ($P \leq 0.05$) different.

The results of digestibility (Table, 3) showed that using the higher level of ME (2800 kcal/kg) and nutrients supplemental microbial phytase (800 FTU/kg) in laying hen diets significantly ($P \leq 0.05$) improved nutrients digestibility of organic matter (OM), crude protein (CP), ether extract (EE), crude fiber (CF) and nitrogen free extract (NFE).

The improvement in nutrients digestibility in (T3) fed higher level of ME along with higher microbial phytase level (T3) may be due to the associative effect of dietary nutrients. While, the improvement in group fed microbial phytase is perhaps due to the improvement in nutrients absorption especially crude protein which complicate with phytate and its inhibitory effects on proteolytic enzymes such as pepsin and trypsin. In this regard, Ravindran (1999); Zhang et al. (1999) and Attia at al. (2001) indicated that phytase addition improved protein and amino acids utilization of poultry diets by 4-6% depending on feedstuffs used. Theoretically, the impact of phytate on the digestion of N in birds mainly results from the phytate-protein

complexes existing in feedstuffs or being formed de novo in the gastrointestinal tract under acidic conditions, consequently restricting the contact of phytase to its substrate and the digestion of refractory complexes by pepsin (Selle *et al.*, 2000). The addition of phytase in the poultry diet partially prevents the formation of phytate-protein complexes by the prior hydrolysis of phytate, and thus increases the digestibility of protein. An improvement in energy by applying phytase also was reported in broilers by Ravindran *et al.* (2006) and Cowieson *et al.* (2006). Such improvement in the energy value is a reflection of the increase in digestibility of organic nutrients, including protein, fat, and starch.

Table (3). Nutrients digestibility of hens fed different energy levels supplemented with microbial phytase.

Treatments	OM	CP	EE	CF	NFE
Energy main effect					
ME1 (2800 kcal/kg)	82.22 ^{a}	93.17 ^{a}	79.28 ^{a}	28.05 ^{a}	85.26 ^{a}
ME2 (2700 kcal/kg)	81.80 ^{b}	92.64 ^{b}	78.65 ^{b}	27.60 ^{b}	84.99 ^{a}
ME3 (2600 kcal/kg)	80.82 ^{c}	91.68 ^{c}	77.16 ^{c}	26.73 ^{c}	84.13 ^{b}
Phytase main effect					
MP1 (0 FTU/kg)	81.31 ^{b}	92.03 ^{b}	77.80 ^{b}	27.07 ^{b}	84.41 ^{b}
MP2 (400 FTU/kg)	81.57 ^{ab}	92.35 ^{b}	78.34 ^{ab}	27.37 ^{ab}	84.74 ^{ab}
MP3 (800 FTU/kg)	81.96 ^{a}	93.11 ^{a}	78.96 ^{a}	27.93 ^{a}	85.23 ^{a}
Interaction (Energy x Phytase)					
T1 (ME1 x MP1)	81.92 ^{c}	92.60 ^{d}	92.00 ^{c}	27.63 ^{d}	84.93 ^{bc}
T2 (ME1 x MP2)	82.13 ^{b}	92.93 ^{c}	79.29 ^{b}	27.91 ^{c}	85.11 ^{b}
T3 (ME1 x MP3)	82.61 ^{a}	94.00 ^{a}	79.71 ^{a}	28.62 ^{a}	85.73 ^{a}
T4 (ME2 x MP1)	81.51 ^{d}	92.20 ^{ef}	77.98 ^{e}	27.16 ^{e}	84.65 ^{cd}
T5 (ME2 x MP2)	81.71 ^{d}	92.34 ^{ed}	78.41 ^{d}	27.36 ^{e}	84.90 ^{bc}
T6 (ME2 x MP3)	82.17 ^{b}	93.38 ^{b}	79.55 ^{ab}	28.24 ^{b}	85.45 ^{a}
T7 (ME3 x MP1)	80.50 ^{g}	91.30 ^{h}	76.54 ^{h}	26.42 ^{g}	83.64 ^{f}
T8 (ME3 x MP2)	80.87 ^{f}	91.77 ^{g}	77.31 ^{g}	26.83 ^{f}	84.24 ^{e}
T9 (ME3 x MP3)	81.10 ^{e}	92.00 ^{gf}	77.62 ^{f}	26.94 ^{f}	84.51 ^{de}

a. b. c...etc. means in same column, within each factor with different superscripts are significantly (P ≤0.05) different.

In conclusion, the levels of 2800 kcal ME/Kg with 800 FTU supplemental microbial phytase/kg were sufficient for laying hens starting the first production cycle without decreasing their performance or egg shell quality. Moreover, laying hens can be fed diets containing lower levels of ME with supplemental 800 FTU microbial phytase/kg of the diet without adverse effects on laying hen performance and egg shell thickness.

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الأداء الانتاجى والاستفادة من المركبات الغذائية للدجاج البياض المغذى على المستويات المختلفة من الطاقة الممثلة الظاهرية وانزيم الفيتيز الميكروبى.

عبدالله على علي غزاله و ممدوح عمر عبد السميع و محمد أحمد فؤاد المنيلاوى و اسلام ابراهيم عماره

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تم اجراء هذه التجربة لدراسة تأثير المستويات المختلفة من الطاقة الممثلة وانزيم الفيتيز الميكروبى وتداخلهم على الأداء الانتاجى ، وجودة قشرة البيضة و معاملات هضم المركبات الغذائية لسلالة الدجاج البياض من النوع البوفانز الأبيض. تم تصميم التجربة بنظام تام العشوائية 3 x 3 (ثلاث مستويات من الطاقة 2600 ، 2700 و 2800 كيلو كالورى طاقة ممثلة / كجم عليقة وثلاث مستويات من انزيم الفيتيز الميكروبي صفر ، 400 و 800 وحدة دولية / كجم عليقة). استمرت هذه التجربة لمدة 20 إسبوع تحت نفس ظروف التربية والرعاية. استخدمت فى هذه التجربة 540 دجاجة بياضة عمر 21 اسبوع وتم توزيع الطيور عشوائيا الى 9 معاملات (بحيث تحتوى كل معاملة على 4 مكررات كل مكرر يحتوى على 15 طائر). أظهرت النتائج انه بزيادة مستوى الطاقة، أدى ذلك الى تعديل الطيور لكمية الغذاء المأكول. كان هناك تأثير معنوى لمستويات الطاقة على كلا من وزن البيضة ، معامل التحويل الغذائى ومعاملات هضم المركبات الغذائية ومع ذلك، لم يوجد هناك تأثير معنوى لمستوى الطاقة على النسبة المئوية لإنتاج البيض. كان هناك تأثير معنوى لمستوى إنزيم الفيتيز (800 وحدة دولية/كجم) على كلا من النسبة المئوية لإنتاج البيض، وزن البيضة، معامل التحويل الغذائي، سمك قشرة البيضة و معاملات هضم المركبات الغذائية بالمقارنة بالمستويات صفر و 400 وحدة دولية/كجم. لم يتأثر الغذاء المأكول معنويا بالمستويات المختلفة لانزيم الفيتيز الميكروبى. وجد تداخل معنوى بين مستويات الطاقة وانزيم الفيتيز الميكروبى حيث سجلت المجموعة المحتوية على 2800 كيلو كالورى طاقة ممثلة/كجم عليقة و 800 وحدة دولية إنزيم الفيتيز ميكروبي/كجم عليقة زيادة فى الأداء الانتاجى ومعاملات هضم المركبات الغذائية. يتضح من النتائج أن اضافة انزيم الفيتيز يمكن أن تؤدى الى توفير جزء من الطاقة الممثلة فى علائق الدجاج البياض بدون أى تأثير عكسى على الأداء الانتاجى ، جودة قشرة البيضة ومعاملات هضم المركبات الغذائية.