EFFECT OF USING "AVIZYM ^{1500} " ENZYME ON PERFORMANCE OF JAPANESE QUAIL FED OPTIMAL AND SUB-OPTIMAL ENERGY LEVELS

M.A.A. Abdel-Mageed and E.M. EL-Kamash

Animal Prod. Res. Inst., Agric. Res. Center, Ministry of Agric, Doki, Giza, Egypt.

ABSTRACT

An on-farm experiment was conducted using 240 one-day old Japanese quail chicks which, individually wing-banded, weighed and randomly distributed into four experimental groups of similar mean body weight of three replicates each and aimed to study the possibility of improving the ME of SBM-based diets fed to Japanese quail (Coturnix coturnix japonica) by dietary addition of a commercial enzyme preparation "Avizym^{1500}" at a level of 0.1% (1 kg/ton) diet and its effect on growth performance, some carcass traits, intestinal viscosity and incidence of pasting vents, volatile fatty acid concentration in cecum, and laying performance. Two experimental starter-grower corn-soybean meal diets (C-SBM) were formulated to be iso-nitrogenous (24% CP) and containing two ME levels (2900 and 2750 kcal ME/kg diet). Also, two experimental C-SBM layer basal diets were formulated to be iso-nitrogenous (20% CP) and containing two ME levels (2900 and 2750 kcal ME/kg diet). Four dietary treatments in both starting-growing and laying periods were compared; two treatments consisted of the two basal diets without "Avizym^{1500}" supplementation and two treatments consisted of the two basal diets supplemented with "Avizym^{1500}" at a level of 0.1% (1 kg/ton). Live growth performance, carcass characteristics, intestinal viscosity and incidence of pasting vents, volatile fatty acid concentration in cecum and laying performance were determined. Generally, supplementing Avizym^{1500} to RE-diet gave equal performance to the corresponding Avizym^{1500} –free diet (Control). But, supplementing Avizym^{1500} to LE-diet significantly improved performance index (PI) and growth rat (GR), egg production (EP%), egg number (EN), egg weight (EW), egg mass (EM), feed conversion ratio (FCR), carcass parameters %, liver, heart and edible giblets %. However, it significantly decreased mortality rate (MR%), abdominal fat %, the viscosity in different parts of intestine, pasting vents % and Feed intake (FI). Nutritionally, it could be concluded that supplementing "Avizym^{1500}" in both starter-grower and layer diets at a level of 0.1% (1 kg/ton) helped in improving quail performance, carcass traits and egg production traits.

Key words: Performance, growth, slaughter, carcass, intestinal viscosity, pasting vents, volatile fatty acid, egg production and Japanese quail.

INTRODUCTION

Corn and soybean meal (SBM) are commonly used in poultry diets for their high available energy and protein, respectively. However, corn and SBM contain 9.7 and 21.7% non-starch polysaccharides (NSP), respectively **(Knudsen, 2001)**. **Honig and Rakis (1979)** noted that the carbohydrate fraction of SBM is made up almost equally of various oligo- and poly-saccharides. Galactosyl oligosaccharides include α-galactosides (raffinose, stachyose and verbascose) and β-galactomannan are present in SBM in relatively high amount. **Kennedy *et al.* (1985)** reported that SBM contains 4.00-7.67% sucrose, 0.67-0.94% raffinose, 2.96-4.14% stachyose and trace amounts of verbascose.

Studies on metabolizable energy indicated that SBM and dehulled SBM contain about 5-6% more gross energy than corn; however, they contain 54 and 42%; respectively, less metabolizable energy than corn **(Hill *et al.*, 1960; Hill and Renner, 1960; Potter and Matterson, 1960; Sibbald and Slinger, 1962)**, indicated that some components of SBM are poorly digested and metabolized. The **NRC (1982)** suggested energy value for dehulled SBM of 2455 and 3155 ME kcal/kg for chicks and pigs, respectively (a difference of approximately 30%). This difference between species may be due to innate galactosidase in pigs indicating the potential value of improving carbohydrate fraction utilization for chicks.

The action of NSP in poultry digestive system is essentially a physical one in which plant cell wall either acts as barrier to nutrients release from cell or increase digesta viscosity restricting their absorption **(Knudsen, 2001)**. It also contributes to dropping stickiness, which can cause footpad disorders **(Abbott *et al.*, 1969; Jensen *et al.*, 1970)**. Galactosyl oligosaccharides, known as flatulence-producing factors, are responsible for digestive disorders that influence animal performance **(Knudsen, 1997)**.

Oligo- and poly-saccharides are indigestible to monogastric animals **(Iji and Tivey, 1998; Zhang *et al.*, 2001; Park *et al.*, 2003; Selle *et al.*, 2003; Shim *et al.*, 2004)**. Poultry lack endogenous enzymes targeting α-galactosyl bonds (α-1, 6 galactosidase and β-1, 4 mannanase that target α-1, 6- and β-1, 4-galactosyl bonds, respectively) to digest them **(Pluske and Lindemann, 1998)**. Poor digestibility of oligosaccharide fraction leads to loss of potential energy. Alpha-galactosides have been implicated in reducing energy utilization, fiber digestion and feed retention in SBM-fed chicks **(Coon *et al.*, 1990)**, producing osmotic catharsis **(Wagner *et al.*, 1976)** and flatus in animals **(Leske and Coon, 1999)**. Various extraction methods and autolysis have been employed in the removal of the α-galactosides **(Angel *et al*., 1988;**

.Leske *et al.*, 1993). However, these techniques are usually expensive and time consuming. Moreover, scientists have been successful in eliminating the principle growth inhibitors in soybeans through physical and chemical processing. This is due to these compounds are heat stable and cannot be eliminated during processing. Applying an exogenous enzyme preparation, mainly composed of α-1, 6-galactosidase is an alternative to alleviate the detrimental effects of the saccharides **(Sugimoto and Van Buren, 1970; Pan *et al.*, 2002)**.

Therefore, this study was conducted to study the possibility of improving energy and nutrients bioavailability of SBM-based diets fed to Japanese quail (*Coturnix coturnix japonica*) by dietary addition of "Avizym^{1500}", an enzymatic preparation containing Amylase, Xylanase, Protease and to test its effect on growth performance, some carcass traits and egg production traits

MATERIALS AND METHODS

Experimental birds and housing

Two hundred and forty unsexed one-day old Japanese quail chicks with an average body weight of 7.25 ± 0.07 g were used in a 42-day growing trial. Chicks were individually wing-banded, weighed, randomly distributed into four equal experimental groups of similar mean weight of 60 chicks each, which consists of three replicates of 20 chicks each. At 42 days of age, birds were transferred to layer quail cages for a 90-day laying trial.

Experimental diets, design and treatments

Two starter-grower corn-soybean meal (C-SBM) basal diets were formulated to be iso-nitrogenous (24% CP) and containing 2900 (recommended energy, RE-diet) and 2750 (low energy, LE-diet) kcal ME/kg diet. Also, two C-SBM layer basal diets were formulated to be iso-nitrogenous (20% CP) and containing 2900 (recommended energy, RE-diet) and 2750 (low energy, LE-diet) kcal ME/kg diet.

A commercial enzyme cocktail preparation, "Avizym^{1500}", was added at two levels of 0 and 1 kg/ton diet. Dietary treatments were designed in a 2 x 2 factorial arrangement of two ME levels (2900 and 2750 kcal/kg diet) and two enzyme levels (0 and 1 kg/ton of feed). Thus, this supplementation resulted in four dietary treatments in both starting-growing and laying periods. The composition and chemical analysis of the experimental diets are shown in Table (1).

Tested materials

The commercial enzyme cocktail preparation, "Avizym^{1500}", used in this study was a dried enzyme cocktail preparation that mainly composed of standardized activities of Amylase, Xylanase, Protease enzymes.

Management

During the experimental period, birds were exposed to similar care and management in all treatment groups. Ambient temperature was maintained at 34-36 ^{o}C during the 1st week and was weekly decreased by 4 ^{o}C for the next three weeks. During the 5th and 6th week temperature was maintained at 22-24 ^{o}C. Birds were daily received continuous artificial lighting during growing trial and 17 h afterwards. Chicks were fed the starter-grower diets from one day to six week and the layer diets from seven to 19 week of age. Mash feed and clean fresh tap water were provided *ad liblitum*.

Measurements and data collection

Growth performance:

Individual body weight (BW, g) and feed intake (FI, g/bird) were weekly recorded to determine body weight gain (BWG, g) [gain = final weight (g) – initial weight (g)]. Feed conversion ratio (FCR, g feed/g gain) and caloric conversion ratio (CCR) were also calculated for the starting-growing period.

Performance index (PI) for the starting-growing period, was calculated according the equation reported by **North (1981)**, PI = [(BW, kg/FC) x 100]. Growth rate (GR) for the starting-growing period was also calculated, GR = [(final BW- initial BW) / 0.5 (initial BW + final BW)] × 100. Mortality rate % (MR) was also calculated.

Carcass parameters:

At the end of the starting-growing period (42 days), 24 birds (3 ♂ + 3 ♀/ treatment) with BW similar to the mean were slaughtered to determine carcass characteristics. Obtained criteria were dressing breast and thighs weights. Abdominal fat was removed from the gizzard and abdominal region and individually weighed for each carcass. Edible giblets (liver, heart, gizzard and total edible giblets) were individually separated, weighed and calculated for each organ as % of live BW.

Intestinal fluid viscosity:

At 14 d of age, two birds per replicate were killed and individual digesta samples were collected from each segment of the intestine (duodenum, jejunum and ileum), weighed and kept on ice before centrifugation at 12,000 × *g* for 10 min. The supernatant obtained from each sample were separately stored at −20 °C until use. The supernatants were thawed and the viscosity of the supernatant (0.5 mL), expressed as centipoises (cP), was immediately measured with a digital viscometer.

Volatile fatty acid concentration in the cecum:

At 21 d of age, two birds per replicate were killed and cecal content was collected to determine the concentration of acetic, propionic, and butyric acids. Cecal content was diluted with an equal weight of distilled water **(Sudo and Duke, 1980)** and centrifuged at 25,500 × *g* for 20 min. A solution of 5% orthophosphoric acid (vol/vol) plus 1% mercury chloride (wt/vol) was added (0.1 mL/mL) to the supernatant **(Garcı´a *et al.*, 2000)**, the mixture was then frozen and stored at −20 °C until volatile fatty acids determination.

Egg production traits:

Daily egg number (EN) and egg weight (EW, g) as well as weekly feed intake (FI, g/bird) was recorded. Egg production (EP, %), egg mass (EM, g) and feed conversion ratio (FCR, g feed/g egg) were calculated per each replicate and treatment from seven to 19 weeks of age.

Chemical analysis:

Experimental diets were analyzed following procedures detailed by the Association of Official Analytical Chemists **(AOAC, 1990)** for crude protein (CP), crude fiber (CF) and ether extract (EE). Metabolizable energy (ME) of experimental diets was calculated considering the ME values of different feed ingredients according to the **Feed Composition Tables for Animal and Poultry Feedstuffs Used in Egypt (2001)**.

Statistical analysis:

Obtained data were expressed as means ± standard error and statistically analyzed by analysis of variance as a factorial arrangement of 2 × 2 according to **Steel and Torrie (1980)**. Also, the General Linear Method (GLM) procedure of **SPSS (1993)** computer statistical program for MS Windows release 6.0 was used. The significant means were ranked using Duncan's Range Test **(Duncan, 1955)** as outlined by **Obi (1990)**. Statistical significance level was tested at probability of $P \leq 0.05$.

RESULTS AND DISCUSSION

Growth performance:

The results for live growth performance in terms of final body weight (BW), body weight gain (BWG), feed intake (FI), feed conversion ratio (FCR) and caloric conversion ratio (CCR) during the whole experimental period are shown in Table (2).

With regard to ME levels, it was noticed that feeding RE-diets significantly improved final BW, BWG, FI, FCR and CCR in comparison to LE-diets. Regarding enzymatic preparation, feeding "Avizym^{1500}" -supplemented diets gave significant improvement in BW, BWG, FI, FCR and CCR in comparison to "Avizym^{1500}" -free diets. With respect to the interaction between ME level and enzymatic preparation, using "Avizym^{1500}" with RE-diet did not exert any significant effect in BW, BWG, FI, FCR and CCR as compared to the corresponding "Avizym^{1500}" -free diet. On the other hand, supplementing "Avizym^{1500}" to LE-diet gave equal performance to the corresponding "Avizym^{1500}" -free diet.

The present study indicated that the improved values of BW in case of supplementing "Avizym^{1500}" to LE-diet were greater than that of supplementing "Avizym^{1500}" to RE-diet. This agreed with that reported by **Kocher *et al.* (2003)**. Moreover, **Cowan *et al.* (1996)** mentioned that enzyme supplementation to low nutrient level diets had greater beneficial effect than supplementation to high nutrient level diets. This will be practicable for producers to reduce the apparent metabolizable energy of diets by 3 to 4% in feed formulas and therefore has a cost benefit. The improvement in BWG and FCR in this study is in agreement with those of reported by **Jackson *et al.* (2004)** and **Abdel-Mageed *et al.* (2013)** who found that the addition of β-mannanase significantly improved the BWG and FCR of male broilers during starter and grower phases, indicating that the improvement in FCR can mainly be attributed to energy utilization and perhaps changes in intestinal viscosity.

However, these results are in disagreement with the findings of **Waldroup *et al.* (2006)** who found a lack of improvement in growth performance of broiler chickens fed α-galactosidase-supplemented diets and those of **Irish *et al.* (1995)** who demonstrated that the addition of α-galactosidases did not significantly improve FCR in broilers. In other studies, the inclusion of commercial enzyme complexes containing multicarbohydrase activities did not produce an improvement in growth performance of birds fed SBM-based diets **(Marsman *et al.,* 1997)**.

Performance index, growth rate and mortality rate:

The mean values of PI, GR values as well as MR % are given in Table (3). Regarding ME levels, it was observed that feeding RE-diets resulted in significant increase in PI and GR and significant decrease in MR % as compared to LE-diets. Concerning enzymatic preparation, feeding "Avizym^{1500}" -supplemented diets gave significant improvement in PI and GR and significant decrease in MR % in comparison to "Avizym^{1500}" -free diets. With respect to the interaction between ME level and enzymatic preparation, using "Avizym^{1500}" with RE-diet had no significant effect on PI and GR, whereas it significantly decreased MR % as compared to the corresponding "Avizym^{1500}" -free diet. While, supplementing "Avizym^{1500}" to LE-diet significantly improved PI and GR, whereas it significantly decreased MR % as compared to the corresponding "Avizym^{1500}" -free diet.

The improvement in GR in this study is in disagreement with those results reported by **Irish *et al.* (1995)** who demonstrated that the addition of α-galactosidases did not significantly improve GR in broilers.

Carcass parameters

The percentage of dressing, breast, thighs and abdominal fat are summarized in Table (4).

With regard to ME levels, it was noticed that feeding RE-diets caused significant increase in carcass parameters, the only exception was for abdominal fat that did not significantly differ as compared to LE-diets. Regarding enzymatic preparation, feeding "Avizym^{1500}" -supplemented diets gave significant increase in dressing, breast and thighs % as well as significant decrease in abdominal fat % in comparison to "Avizym^{1500}" -free diets. With respect to the interaction between ME level and enzymatic preparation, using "Avizym^{1500}" with NE-diet did not exert any significant effect in carcass parameters % except for abdominal fat % that was significantly decreased as compared to the corresponding "Avizym^{1500}" -free diet. However, supplementing "Avizym^{1500}" to LE-diet had significantly increased carcass parameters %, but it significantly decreased abdominal fat % as compared to the corresponding "Avizym^{1500}" -free diet.

The present result of improving breast yield agreed well with the findings that reported by **Lamptey *et al.* (2001)** and **Abdel-Mageed *et al.*, (2013)** but it was in disagreement with these found by **Kidd *et al.* (2001)** who demonstrated that diets containing α-galactosidase have no effect on breast meat yield. This discrepancy may be due to the different α-galactosidase characterization and rearing environment. The improvement of breast yield may be interpreted by the utilization of nutrients liberated from the non-digestible compounds of corn and soybean meal diet with α -galactosidase.

Edible giblets:

Percentages of edible giblets in terms of liver**,** heart, gizzard and total edible giblets at 6 wk of age are given in Table (5).

Regarding ME levels, it was noticed that feeding RE-diets caused significantly increased each of liver, heart and total edible giblets % in comparison to LE-diets. Concerning enzymatic preparation, feeding "Avizym1500" -supplemented diets gave significant increase in liver, heart and total edible giblets % in comparison to LE-diets. There was no significant response obtained for ME levels, enzyme supplementation or their interaction on gizzard %. With respect to the interaction between ME level and enzymatic preparation, using "Avizym1500" with RE-diet diet did not cause significant change in liver**,** heart and edible giblets % as compared to the corresponding "Avizym1500" -free diet. However, supplementing "Avizym1500" to LE-diet had significantly increased liver**,** heart and edible giblets % as compared to the corresponding "Avizym1500" -free diet. This agreed with that reported by **Abdel-Mageed *et al.* (2013)**.

The aforementioned reduction of the relative weights of liver and heart are in disagreement with the results of **Tahir *et al.* (2005)** who showed that enzyme treatments did not affect the relative weight of liver. **Gracia *et al.* (2003)** reported that enzyme has no effect on the relative weights of digestive organs.

The lack of response in relative weight of gizzard is in disagreement with the results of **Brenes *et al.* (1993**) who found that the relative weight of gizzard was reduced by enzyme treatment.

Intestinal fluid viscosity:

The mean values of viscosity in different parts of intestine and incidence of pasting vents at seven and 14 days of age are presented in Table (6).

With regard to ME levels, it was noticed that feeding both levels did not exert any significant effect in the viscosity in different parts of intestine; however it significantly increased the pasting vents % for RE-diets as compared with LE-diets.

With respect to enzymatic preparation, feeding "Avizym1500" -supplemented diets significantly decreased the viscosity in different parts of intestine and pasting vents % compared with "Avizym1500" -free diets. Regarding the interaction between ME level and enzymatic preparation, using "Avizym1500" with either RE- or LE-diet significantly decreased the viscosity in different parts of intestine and pasting vents % compared with the corresponding "Avizym1500" -free diet.

Increasing viscosity of intestinal fluid inhibits the absorption of nutrients by decreasing the gastrointestinal passage rate. In other words, Enzymes supplementation act to decrease the viscosity of intestinal fluid, which results in improving the digestion and absorption process by increasing the gastrointestinal passage rate and increasing the diffusion of digestive enzymes and the secretion of endogenous enzymes **(Van der Klis *et al.*, 1993** and **Abdel-Mageed *et al.*, (2013)**.

Volatile fatty acid concentration in cecum

Percentages of volatile fatty acid (VFA) in terms of acetic acid, propionic acid, butyric acid as well as the total VFA concentration in cecum at quail at 6 wk of age are shown in Table (7).

Regarding ME levels, it was noticed that feeding RE-diets did not exert any significant effect in the percentages of acetic acid, butyric acid as well as the total VFA concentration compared with LE-diets. No significant responses was obtained for each of ME levels, enzyme supplementation or the interaction between ME level and enzymatic preparation in propionic acid %. With respect to enzymatic preparation, feeding "Avizym^{1500}" -supplemented diets significantly increased the percentages of acetic acid, butyric acid as well as the total VFA concentration compared with "Avizym^{1500}" -free diets. Regarding the interaction between ME level and enzymatic preparation, using "Avizym^{1500}" with either RE- or LE-diet significantly increased percentages of acetic acid, butyric acid as well as the total VFA concentration compared with the corresponding "Avizym^{1500}" -free diet.

Laying performance:

Results concerning laying performance in terms of feed intake (FI), egg production (EP) %, egg number (EN), egg weight (EW), egg mass (EM) and feed conversion ratio (FCR) values are shown in Table (8).

With regard to ME levels, it was noticed that feeding RE-diets caused significant increase in EP %, EN, EW, EM and better FCR, but it significantly decreased FI compared with LE-diets. With respect to enzymatic preparation, feeding "Avizym^{1500}" -supplemented diets significantly improved EP %, EN, EW, EM and FCR, but it significantly decreased FI compared with "Avizym^{1500}" -free diets. Regarding the interaction between ME level and enzymatic preparation, using "Avizym^{1500}" with RE-diet did not exert any significant effect in FI, EP %, EN, EW, EM and FCR compared with the corresponding "Avizym^{1500}" -free diet. However, supplementing "Avizym^{1500}" to LE-diet had significantly improved EP %, EN, EW, EM and FCR, but it significantly decreased FI as compared to the corresponding "Avizym^{1500}"-free diet. This agreed with that reported by **Abdel-Mageed *et al.* (2013)**.

In conclusion, this study provides some evidence that exogenous Amylase, Xylanase, Protease may improve energy extraction from SBM by Japanese quail (*Coturnix coturnix japonica*). From the nutritional point of view, it could be concluded that supplementing "Avizym^{1500}" in both starter-grower and layer diets at a level of 0.1% helped in improving quail performance, carcass traits and egg production traits.

Table (1): Composition and calculated analysis of the experimental starter-grower and layer basal diets.

Ingredients	Percentage (%)			
	Starter-grower basal diets*		Layer basal diets*	
	RE-diet	LE-diet	RE-diet	LE-diet
Yellow Corn, ground	54.27	50.64	58.45	53.70
Soybean meal (44% CP)	35.00	38.23	25.80	27.34
Corn gluten meal (62% CP)	7.14	4.37	6.70	4.90
Wheat bran	0.00	3.80	0.00	5.30
Vegetable oil	0.50	0.00	1.30	1.10
Dicalcium phosphate	0.75	0.70	1.10	1.05
Limestone	1.35	1.35	5.70	5.70
Common salt (NaCl)	0.34	0.34	0.34	0.34
Premix**	0.30	0.30	0.30	0.30
DL-Methionine	0.04	0.07	0.05	0.07
L-Lysine	0.11	0.00	0.06	0.00
Choline chloride	0.20	0.20	0.20	0.20
Total	100.00	100.00	100.00	100.00
Determined values (%)				
CP %	24.01	24.00	20.01	20.00
CF %	3.95	4.46	3.36	3.91
EE %	2.74	2.61	2.76	2.58
Calculated values***				
ME (kcal/kg)	2903	2759	2890	2750
Ca %	0.80	0.80	2.50	2.50
Av. Phosphorus %	0.30	0.30	0.35	0.35
L-Lysine %	1.30	1.30	1.00	1.01
DL-Methionine %	0.50	0.50	0.45	0.45
Methionine + Cyst %	1.00	1.00	0.80	0.84

*****Starter-grower and layer basal diets were assigned to 2 levels of "Avizym1500" enzyme preparation (0 & 1kg/ton diet).

******Vitamins and minerals premix provides per kg of diet: 10000 IU vit. A, 11.0 IU vit. E, 1.1 mg vit. K , 1100 ICU vit. D_3, 5 mg riboflavin, 12 mg Ca pantothenate, 12.1 µg vit. B_{12}, 2.2 mg vit. B_6, 2.2 mg thiamin, 44 mg nicotinic acid, 250 mg choline chloride, 1.55 mg folic acid, 0.11 mg d-biotin, 60 mg Mn, 50 mg Zn, 0.3 mg I , 0.1 mg Co, 30 mg Fe, 5 mg Cu and 1 mg Se.

*******According to Feed Composition Tables for animal and poultry feedstuffs used in Egypt (2001).

Table (2): Effect of dietary treatments on performance of growing Japanese quail during the period from 0 – 6 weeks of age.

Items Treatments (24% CP)	Initial BW (g/bird)	Final BW (g/bird)	BWG (g/bird/35 d)	FI (g/bird/35 d)	FCR (Feed: gain)	CCR (Calorie: gain)
Energy effects						
2900 (kcal/kg diet)	7.24±0.07	197.42±1.34[a]	190.18±1.10[a]	446.08±3.05[b]	2.35±0.08[b]	6.46±0.04[b]
2750 (kcal/kg diet)	7.25±0.11	184.04±1.42[b]	176.79±1.09[b]	469.02±2.90[a]	2.65±0.05[a]	7.28±0.05[a]
Enzyme effects						
Avizym[1500] (0.0kg/kg diet)	7.23±0.09	184.29±1.25[b]	177.06±1.15[b]	466.57±2.23[a]	2.64±0.06[a]	7.45±0.09[a]
Avizym[1500] (0.1kg/kg diet)	7.27±0.06	197.17±1.41[a]	189.90±1.22[a]	448.54±2.11[b]	2.36±0.11[b]	6.66±0.11[b]
Interaction						
2900 x 0.0	7.22±0.05	195.36±1.14[a]	188.14±1.13[a]	450.10±2.21[b]	2.39±0.11[b]	6.93±0.09[b]
2900 x 0.1	7.28±0.08	199.48±1.10[a]	192.20±1.05[a]	442.06±2.17[b]	2.30±0.06[b]	6.67±0.04[b]
2750 x 0.0	7.24±0.06	173.21±1.12[b]	165.97±1.14[b]	483.03±3.04[a]	2.91±0.10[a]	8.00±0.07[a]
2750 x 0.1	7.26±0.04	194.86±1.11[a]	187.60±1.07[a]	455.01±2.18[b]	2.43±0.12[b]	6.68±0.04[b]

Means in the same column within the same effect having different letters are significantly different at $P \leq 0.05$.

BW = Body weight BWG = Body weight gain FI = Feed intake FCR = Feed conversion ratio
CCR = caloric conversion ratio

Table (3): Effect of dietary treatments on performance index, growth rate and mortality rate of Japanese quail at 0 – 6 weeks of age.

Items Treatments (24% CP)	PI	GR	MR (%)
Energy effects			
2900 (kcal/kg diet)	7.67±0.11[a]	186.65±0.13[a]	6.05±0.03[b]
2750 (kcal/kg diet)	6.73±0.12[b]	185.56±0.21[b]	8.56±0.05[a]
Enzyme effects			
Avizym[1500] (0.0kg/kg diet)	6.78±0.08[b]	185.61±0.12[b]	10.22±0.06[a]
Avizym[1500] (0.1kg/kg diet)	7.61±0.05[a]	186.59±0.10[a]	4.39±0.05[b]
Interaction			
2900 x 0.0	7.83±0.06[a]	186.55±0.15[a]	8.55±0.05[b]
2900 x 0.1	7.50±0.11[a]	186.74±0.13[a]	3.55±0.06[d]
2750 x 0.0	5.73±0.12[b]	184.67±0.07[b]	11.89±0.04[a]
2750 x 0.1	7.72±0.11[a]	186.44±0.23[a]	5.22±0.03[c]

Means in the same column within the same effect having different letters are significantly different at $P \leq 0.05$.

PI = Performance index GR = Growth rat MR = mortality rate

Table (4): Effect of dietary treatments on carcass characteristics of Japanese quail at 6 weeks of age.

Items Treatments(24%CP)	(% of BW)			
	Dressing*	**Breast**	**Thighs**	**Abdominal fat**
Energy effects				
2900 (kcal/kg diet)	77.99±0.40[a]	38.77±0.33[a]	24.94±0.12[a]	1.35±0.02
2750 (kcal/kg diet)	76.50±0.28[b]	36.90±0.21[b]	23.21±0.11[b]	1.36±0.01
Enzyme effects				
Avizym1500 (0.0kg/kg diet)	76.16±0.32[b]	36.60±0.42[b]	23.01±0.11[b]	1.42±0.02[a]
Avizym1500 (0.1kg/kg diet)	78.33±0.11[a]	39.07±0.11[a]	25.14±0.13[a]	1.30±0.01[b]
Interaction				
2900 x 0.0	77.45±0.23[a]	38.33±0.34[a]	24.81±0.11[a]	1.42±0.02[a]
2900 x 0.1	78.52±0.36[a]	39.20±0.28[a]	25.06±0.13[a]	1.28±0.01[b]
2750 x 0.0	74.87±0.15[b]	34.86±0.45[b]	21.20±0.10[b]	1.41±0.01[a]
2750 x 0.1	78.13±0.33[a]	38.94±0.14[a]	25.22±0.13[a]	1.31±0.02[b]

* Dressing % = [(Carcass weight + Giblets weight) / (Pre-slaughter weight)] x 100.
Means in the same column within the same effect having different letters are significantly different at P ≤ 0.05.

Table (5): Effect of dietary treatments on edible giblets % of Japanese quail at 6 weeks of age.

Items Treatments (24% CP)	Edible giblets (%)			Total edible giblets (%)
	Liver (%)	**Heart (%)**	**Gizzard (%)**	
Energy effects				
2900 (kcal/kg diet)	2.72±0.13[a]	1.66±0.08[a]	2.24±0.12	6.62±0.13[a]
2750 (kcal/kg diet)	2.37±0.11[b]	1.44±0.06[b]	2.29±0.11	6.10±0.11[b]
Enzyme effects				
Avizym1500 (0.0kg/kg diet)	2.38±0.06[b]	1.45±0.11[b]	2.25±0.11	6.08±0.12[b]
Avizym1500 (0.1kg/kg diet)	2.70±0.10[a]	1.65±0.08[a]	2.29±0.08	6.64±0.10[a]
Interaction				
2900 x 0.0	2.65±0.10[a]	1.68±0.05[a]	2.22±0.12	6.55±0.13[a]
2900 x 0.1	2.78±0.06[a]	1.63±0.07[a]	2.26±0.10	6.67±0.11[a]
2750 x 0.0	2.11±0.09[b]	1.22±0.11[b]	2.27±0.11	5.60±0.12[b]
2750 x 0.1	2.62±0.13[a]	1.66±0.05[a]	2.31±0.06	6.59±0.11[a]

Means in the same column within the same effect having different letters are Significantly different at P ≤ 0.05.

Table (6): Effect of dietary treatments on intestinal viscosity and incidence of pasting vents of Japanese quail at 14 days of age.

Items / Treatments (24% CP)	Intestinal viscosity (cP) Day 14			Pasting vents (%)
	Duodenum	Jejunum	Ileum	
Energy effects				
2900 (kcal/kg diet)	2.24±0.08	4.94±0.16	4.10±0.11	16.89±0.21[a]
2750 (kcal/kg diet)	2.18±0.07	4.68±0.11	4.12±0.08	11.34±0.30[b]
Enzyme effects				
Avizym[1500] (0.0kg/kg diet)	2.73±0.10[a]	5.55±0.13[a]	4.61±0.13[a]	19.67±0.23[a]
Avizym[1500] (0.1kg/kg diet)	1.72±0.05[b]	4.07±0.18[b]	3.61±0.11[b]	8.56±0.26[b]
Interaction				
2900 x 0.0	2.82±0.04[a]	5.63±0.12[a]	4.67±0.13[a]	22.44±0.12[a]
2900 x 0.1	1.66±0.02[b]	4.24±0.10[b]	3.53±0.10[b]	11.33±0.30[c]
2750 x 0.0	2.63±0.04[a]	5.46±0.15[a]	4.55±0.11[a]	16.89±0.20[b]
2750 x 0.1	1.72±0.05[b]	3.90±0.11[b]	3.69±0.14[b]	5.78±0.33[d]

Means in the same column within the same effect having different letters are significantly different at $P \leq 0.05$

Table (7): Effect of dietary treatments on volatile fatty acid (VFA) concentration in cecum of growing Japanese quail at 21 d of age.

Items / Treatments (24% CP)	Acetic acid (%)	Propionic acid (%)	Butyric acid (%)	Total VFA (μ mol/g)
Energy effects				
2900 (kcal/kg diet)	69.71±0.21	3.60±0.06	11.73±0.12	16.69±0.22
2750 (kcal/kg diet)	70.97±0.17	3.61±0.11	12.02±0.11	16.82±0.20
Enzyme effects				
Avizym[1500] (0.0kg/kg diet)	68.52±0.11[b]	3.69±0.07	10.64±0.12[b]	15.37±0.22[b]
Avizym[1500] (0.1kg/kg diet)	72.16±0.15[a]	3.52±0.05	13.11±0.10[a]	18.14±0.21[a]
Interaction				
2900 x 0.0	68.34±0.13[b]	3.74±0.08	10.52±0.13[b]	15.32±0.21[b]
2900 x 0.1	71.08±0.18[a]	3.45±0.07	12.93±0.11[a]	18.06±0.22[a]
2750 x 0.0	68.70±0.12[b]	3.63±0.05	10.76±0.12[b]	15.41±0.20[b]
2750 x 0.1	73.24±0.15[a]	3.58±0.07	13.28±0.12[a]	18.22±0.23[a]

Means in the same column within the same effect having different letters are significantly different at $P \leq 0.05$

Table (8): Effect of dietary treatments on performance of laying Japanese quail from 7 to 19 weeks of age.

Items / Treatments (20% CP)	FI (g/hen/day)	EP (%)	EN (No./hen/day)	EW (g)	EM (g/hen/day)	FCR (g feed/g egg)
Energy effects						
2900 (kcal/kg diet)	23.96 ± 0.05^{b}	82.88 ± 0.38^{a}	0.95 ± 0.02^{a}	11.38 ± 0.01^{a}	9.31 ± 0.02^{a}	2.83 ± 0.02^{b}
2750 (kcal/kg diet)	26.18 ± 0.10^{a}	80.21 ± 0.71^{b}	0.92 ± 0.01^{b}	10.76 ± 0.02^{b}	8.55 ± 0.01^{b}	3.37 ± 0.01^{a}
Enzyme effects						
Avizym1500 (0.0kg/kg diet)	26.22 ± 0.10^{a}	80.44 ± 0.33^{b}	0.93 ± 0.01^{b}	10.74 ± 0.01^{b}	8.65 ± 0.02^{b}	3.34 ± 0.02^{a}
Avizym1500 (0.1kg/kg diet)	23.93 ± 0.07^{b}	82.65 ± 0.53^{a}	0.95 ± 0.03^{a}	11.39 ± 0.02^{a}	9.22 ± 0.01^{a}	2.86 ± 0.01^{b}
Interaction						
2900 x 0.0	24.45 ± 0.09^{b}	82.75 ± 1.34^{a}	0.95 ± 0.01^{a}	11.32 ± 0.02^{a}	9.32 ± 0.02^{a}	2.88 ± 0.01^{b}
2900 x 0.1	23.47 ± 0.05^{b}	83.01 ± 1.42^{a}	0.95 ± 0.02^{a}	11.43 ± 0.01^{a}	9.30 ± 0.01^{a}	2.78 ± 0.02^{b}
2750 x 0.0	27.98 ± 0.11^{a}	78.13 ± 1.21^{b}	0.90 ± 0.01^{b}	10.16 ± 0.02^{b}	7.97 ± 0.02^{b}	3.80 ± 0.01^{a}
2750 x 0.1	24.38 ± 0.08^{b}	$82.29\pm1.24^{`a}$	0.94 ± 0.03^{a}	11.35 ± 0.01^{a}	9.13 ± 0.01^{a}	2.93 ± 0.02^{b}

Means in the same column within the same effect having different letters are significantly different at $P \leq 0.05$.

FI = Feed intake   EP = Egg production   EN = Egg number
EW = Egg weight   EM = Egg mass   FCR = Feed conversion ratio

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تأثير استخدام انزيم الافيزايم ١٥٠٠ على أداء كتاكيت السمان اليابانى المغذى على مستويات مثلى وتحت المثلى من الطاقة.

محمد أحمد على عبد المجيد - عزت موسى عبد التواب القماش

معهد بحوث الإنتاج الحيواني - الدقي - جيزة - مصر.

أجريت هذه الدراسة باستخدام ٢٤٠ كتكوت سمان يابانى عمر يوم تم وزنها وترقيمها فى الجناح فردياً ثم وزعت عشوائياً إلى ٤ مجاميع تجريبية متساوية العدد والوزن لدراسة إمكانية إضافة المستحضر الإنزيمى " **الافيزايم** ١٥٠٠ " الهاضم للكربوهيدرات وتأثير ذلك على أداء النمو وبعض صفات الذبيحة ولزوجة الأمعاء وتصمغ فتحة المجمع وتركيز الأحماض الدهنية الطيارة فى الأعورين وصفات إنتاج البيض. تم تكوين عليقتين بادئ - نامى وعليقتين بياض (عليقتين كنترول). كما تم تكوين عليقتين بادئ - نامى وعليقتين بياض بإضافة المستحضر الإنزيمى " **الافيزايم** ١٥٠٠" بنسبة ١ كجم/طن علف لعليقتى الكنترول. تم تقدير صفات أداء النمو وصفات الذبيحة ولزوجة محتويات الأمعاء وتصمغ فتحة المجمع وتركيز الأحماض الدهنية الطيارة فى الأعورين وقياس صفات إنتاج البيض. أوضحت نتائج هذه الدراسة من وجهة النظر الغذائية وتحت ظروف التجربة الحالية أن إضافة المستحضر الإنزيمى " **الافيزايم** ١٥٠٠ " المحتوى على الأنزيمات الهاضمة للكربوهيدرات بنسبة ١ كجم/طن علف فى علائق البادئ - النامى والبياض لكتاكيت السمان اليابانى أدى إلى تحسن معنوى فى مظاهر النمو وصفات الذبيحة وصفات إنتاج البيض.

الكلمات الدالة: (صفات – النمو - الذبح – الذبيحة – لزوجة الأمعاء – تصمغ فتحة المجمع - الأحماض الدهنية الطيارة – إنتاج البيض - سمان يابانى).