EFFECT OF MULTICARBOHYDRASE ENZYMES ON PERFORMANCE OF JAPANESE QUAIL FED OPTIMAL AND SUB-OPTIMAL ENERGY LEVELS

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ABSTRACT

An on-farm experiment was conducted using 360 one-day old Japanese quail chicks which, individually wing-banded, weighed and randomly distributed into 4 experimental groups of similar mean body weight of 3 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 "Xylam^{500}" at a level of 0.5 kg/ton and its effect on growth performance, some carcass traits, intestinal viscosity and incidence of pasting vents 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 & 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 & 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 "Xylam^{500}" supplementation and two treatments consisted of the two basal diets supplemented with "Xylam^{500}" at a level of 0.5 kg/ton. Live growth performance, carcass characteristics, intestinal viscosity and incidence of pasting vents and laying performance were determined. Generally, supplementing Xylam^{500} to RE-diet gave equal performance to the corresponding Xylam^{500}-free diet. But, supplementing Xylam^{500} to LE-diet significantly improved PI and GR, EP %, EN, EW, EM, FCR, carcass parameters %, liver**,** heart and edible giblets %. However, it significantly decreased MR %, abdominal fat %, the viscosity in different parts of intestine, pasting vents % and FI. Nutritionally, it could be concluded that supplementing "Xylam^{500}" in both starter-grower and layer diets at a level of 0.5 kg/ton helped in improving quail performance, carcass traits and egg production traits.

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

INTRODUCTION

The cost of poultry feeds is largely derived from the exorbitant feed ingredients prices, increasing competitive demand for them by man and animals and conventional ingredients scarcity **(Apata and Ojo, 2000)**. Therefore, to reduce feed cost, which accounts for 65 to 70% of total production cost **(Nworgu *et al.*, 1999; Singh, 1990; Banerjee, 1992)**, research efforts are being geared towards supplementing SBM-based diets with multicarbohydrase enzymes.

Corn and soybean meal (SBM) are the backbone in poultry diets for their high available energy and protein, respectively. They contain 9.7 and 21.7%

non-starch polysaccharides (NSP), respectively **(Knudsen, 2001)**. 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, 1997)**. It also contributes to dropping stickiness, which can cause footpad disorders **(Abbott *et al.*, 1969; Jensen *et al.*, 1970)**. Studies on metabolizable energy indicaeted 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)**, indicating that some components of SBM are poorly digested and metabolized.

This highlights the opportunity for using feed enzymes in SBM-based diets. Many attempts has been made to cut feeding cost down to the minimum levels by supplementing SBM-based diets with multicarbohydrase enzymes and their effect on growth performance, some carcass traits, some blood parameters, and economical efficiency. Among the important attempts made to minimize the feeding cost is the present study which was designed 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 Xylam^{500}, an enzymatic preparation containing β-xylanase (1260 U) and α-amylase (8000 U), and to test its effect on growth performance, some carcass traits and egg production traits.

MATERIALS AND METHODS

This study was carried out at the poultry farm, Faculty of Agriculture, Fayoum University, during the period from November (2011) to March (2012).

Experimental birds and housing

Three hundred and sixty unsexed one-day old Japanese quail chicks with an average body weight of 7.21 ± 0.05 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 90 chicks each, which consists of three replicates of 30 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, Xylam^{500}, was added at two levels of 0 and 0.5 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 0.5 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).

Management

During the experimental period, birds were exposed to similar care and management in all treatment groups. Ambient temperature was maintained at 33-34 ^{o}C during the 1st week and was decreased by 2 ^{o}C weekly for the next 3 weeks. During the 5th and 6th week temperature was maintained at 22-24 ^{o}C. Birds were received continuous artificial lighting daily during growing trial and 17 h afterwards. Chicks were fed the starter-grower diets from one day to 6 week and the layer diets from 7 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.

Intestinal fluid viscosity:

At 14 days 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 minute. The supernatant obtained from each sample were stored separately 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.

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.

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 7 to 19 weeks of age.

Chemical analysis:

Experimental diets were analyzed according to the 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 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)**.

RESULTS AND DISCUSSION

Growth performance:

The results for live growth performance in terms of initial BW, final BW, BWG, FI, FCR and 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, FCR and CCR but significantly decreased FI in comparison to LE-diets. Regarding enzymatic preparation, feeding $Xylam^{500}$-supplemented diets gave significant improvement in BW, BWG, FCR and CCR but significantly decreased FI in comparison to $Xylam^{500}$-free diets. With respect to the interaction between ME level and enzymatic preparation, using $Xylam^{500}$ with RE-diet did not exert any significant effect in BW, BWG, FI, FCR and CCR as compared to the corresponding $Xylam^{500}$-free diet. On the other hand, supplementing $Xylam^{500}$ to LE-diet gave equal performance to the corresponding $Xylam^{500}$-free diet.

The present study indicated that the improved values of BW in case of supplementing $Xylam^{500}$ to LE-diet were greater than that of the corresponding $Xylam^{500-}$free 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 **Jackson et al. (2004)** and **Abdel-Mageed (2012)**. However, these results are in disagreement with those of **Waldroup *et al.* (2006)** and **Marsman *et al.* (1997)** who found that the inclusion of commercial enzyme complexes containing multicarbohydrase activities did not produce an improvement in growth performance of birds fed SBM-based diets**.** The improvement in FCR can mainly be attributed to better energy utilization than the un-supplemented $Xylam^{500}$ diet and perhaps changes in intestinal viscosity.

Performance index, growth rate and mortality rate:

The mean values of PI, GR values as well as MR % are given in Table (3).

With regard to ME levels, it was observed that feeding RE-diets resulted in significant improvement in PI and GR and significant decrease in MR % as compared to LE-diets. Regarding enzymatic preparation, feeding $Xylam^{500}$-supplemented diets gave significant improvement in PI and GR and significant decrease in MR % in comparison to $Xylam^{500}$-free diets. With respect to the interaction between ME level and enzymatic preparation, using $Xylam^{500}$ with RE-diet had no significant effect on PI and GR, whereas it significantly decreased MR % as compared to the corresponding $Xylam^{500-}$free diet. While, supplementing $Xylam^{500}$ to LE-diet significantly improved PI and GR, whereas it significantly decreased MR % as compared to the corresponding $Xylam^{500}$-free diet.

Carcass parameters

The percentages 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 Xylam^{500}-supplemented diets gave significant increase in dressing, breast and thighs % as well as significant decrease in abdominal fat % in comparison to Xylam^{500}-free diets. With respect to the interaction between ME level and enzymatic preparation, using Xylam^{500} with RE-diet did not exert any significant effect in carcass parameters % except for abdominal fat % that was significantly decreased as compared to the corresponding Xylam^{500}-free diet. However, supplementing Xylam^{500} to LE-diet had significantly increased carcass parameters %, but it significantly decreased abdominal fat % as compared to the corresponding Xylam^{500}-free diet.

The present result of improving breast % agreed with that reported by **Lamptey *et al.* (2001)** and **Abdel-Mageed (2012)** but it was disagreement with that of **Kidd *et al.* (2001)** who demonstrated that enzyme supplementation to diets has no effect on breast meat yield. 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 due to Xylam^{500} supplementation.

Edible giblets:

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

There was no significant response obtained for ME levels, enzyme supplementation or their interaction in gizzard %. Regarding ME levels, it was noticed that feeding RE-diets caused significant increase in liver, heart and total edible giblets % in comparison to LE-diets. Concerning enzymatic preparation, feeding Xylam^{500}-supplemented diets gave significant increase in liver, heart and total edible giblets % in comparison to LE-diets. With respect to the interaction between ME level and enzymatic preparation, using Xylam^{500} with RE-diet did not cause significant change in liver**,** heart and edible giblets % as compared to the corresponding Xylam^{500}-free diet. However, supplementing Xylam^{500} to LE-diet had significantly increased liver**,** heart and edible giblets % as compared to the corresponding Xylam^{500} -free diet. This agreed with that reported by **Abdel-Mageed (2012)**.

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 disagreed 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 7 and 14 days of age are summarized in Table (6).

With regard to ME levels, it was observed that feeding RE-diets did not exert any significant effect in the viscosity in different parts of intestine; however it significantly increased the pasting vents % compared with LE-diets. With respect to enzymatic preparation, feeding Xylam^{500} -supplemented diets significantly decreased the viscosity in different parts of intestine and pasting vents % compared with Xylam^{500}-free diets. Regarding the interaction between ME level and enzymatic preparation, using Xylam^{500} with either RE- or LE-diet significantly decreased the viscosity in different parts of intestine and pasting vents % compared with the corresponding Xylam^{500}-free diet.

Increasing viscosity of intestinal fluid inhibits the absorption of nutrients by decreasing the gastrointestinal passage rate. 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., 2012)**.

Laying performance:

Results concerning laying performance in terms of FI, EP %, EN, EW, EM and FCR values are shown in Table (7).

With regard to ME levels, it was noticed that feeding RE-diets caused significant improvement in EP %, EN, EW, EM and FCR, but it significantly decreased FI compared with LE-diets. With respect to enzymatic preparation, feeding Xylam^{500}-supplemented diets significantly improved EP %, EN, EW, EM and FCR, but it significantly decreased FI compared with Xylam^{500}-free diets. Regarding the interaction between ME level and enzymatic preparation, using Xylam^{500} with RE-diet did not exert any significant effect in FI, EP %, EN, EW, EM and FCR compared with the corresponding Xylam^{500} -free diet. However, supplementing Xylam^{500} to LE-diet had significantly improved EP %, EN, EW, EM and FCR, but it significantly decreased FI as compared to the corresponding Xylam^{500} -free diet. This agreed with that reported by **Abdel-Mageed (2012)**.

Nutritionally, it could be concluded that supplementing "Xylam^{500}" in both starter-grower and layer diets at a level of 0.5 kg/ton 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 "Xylam[500]" enzyme preparation (0 & 0. 5 kg/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 & poultry feedstuffs used in Egypt (2001).

Table (2): Effect of dietary treatments on performance of growing Japanese quail at 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)	7.21±0.07	192.31±1.34^{A}	185.10±1.11^{A}	453.18±3.06^{B}	2.59±0.09^{B}	7.10±0.04^{B}
2750(kcal/kg diet)	7.21±0.10	178.93±1.41^{B}	171.72±1.09^{B}	476.12±2.91^{A}	2.79±0.05^{A}	7.66±0.06^{A}
Enzyme effects						
Xylam^{500}(0.0kg/kg diet)	7.19±0.09	179.18±1.26^{B}	171.99±1.15^{B}	473.67±2.23^{A}	2.78±0.07^{A}	7.81±0.10^{A}
Xylam^{500}(0.5kg/kg diet)	7.23±0.06	192.06±1.40^{A}	184.83±1.23^{A}	455.64±2.12^{B}	2.60±0.10^{B}	6.96±0.11^{B}
Interaction						
2900 x 0.0	7.18±0.04	190.25±1.14^{a}	183.07±1.13^{a}	457.20±2.21^{b}	2.50±0.12^{b}	7.24±0.08^{b}
2900 x 0.5	7.24±0.08	194.37±1.10^{a}	187.13±1.04^{a}	449.16±2.18^{b}	2.67±0.07^{b}	6.96±0.04^{b}
2750 x 0.0	7.20±0.06	168.10±1.13^{b}	160.90±1.14^{b}	490.13±3.04^{a}	3.05±0.10^{a}	8.37±0.06^{a}
2750 x 0.5	7.22±0.03	189.75±1.12^{a}	182.53±1.07^{a}	462.11±2.19^{b}	2.53±0.13^{b}	6.95±0.05^{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)	7.45±0.11^{A}	185.55±0.14^{A}	5.83±0.04^{B}
2750 (kcal/kg diet)	6.51±0.13^{B}	184.46±0.20^{B}	8.34±0.05^{A}
Enzyme effects			
Xylam^{500}(0.0kg/kg diet)	6.56±0.09^{B}	184.51±0.11^{B}	10.00±0.07^{A}
Xylam^{500}(0.5kg/kg diet)	7.39±0.05^{A}	185.49±0.10^{A}	4.17±0.05^{B}
Interaction			
2900 x 0.0	7.61±0.07^{a}	185.45±0.16^{a}	8.33±0.04^{b}
2900 x 0.5	7.28±0.10^{a}	185.64±0.13^{a}	3.33±0.06^{d}
2750 x 0.0	5.51±0.12^{b}	183.57±0.08^{b}	11.67±0.05^{a}
2750 x 0.5	7.50±0.10^{a}	185.34±0.23^{a}	5.00±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 rate 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)	76.89±0.41^{A}	37.67±0.34^{A}	23.84±0.13^{A}	1.13±0.03
2750 (kcal/kg diet)	75.40±0.29^{B}	35.80±0.20^{B}	22.11±0.10^{B}	1.14±0.01
Enzyme effects				
Xylam^{500}(0.0kg/kg diet)	75.06±0.33^{B}	35.50±0.42^{B}	21.91±0.11^{B}	1.20±0.02^{A}
Xylam^{500}(0.5kg/kg diet)	77.23±0.10^{A}	37.97±0.10^{A}	24.04±0.14^{A}	1.08±0.01^{B}
Interaction				
2900 x 0.0	76.35±0.24^{a}	37.23±0.34^{a}	23.71±0.12^{a}	1.20±0.02^{a}
2900 x 0.5	77.42±0.35^{a}	38.10±0.27^{a}	23.96±0.13^{a}	1.06±0.01^{b}
2750 x 0.0	73.77±0.16^{b}	33.76±0.45^{b}	20.10±0.10^{b}	1.19±0.01^{a}
2750 x 0.5	77.03±0.32^{a}	37.84±0.13^{a}	24.12±0.14^{a}	1.09±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)	2.50±0.14^{A}	1.44±0.09^{A}	2.02±0.13	5.95±0.12^{A}
2750 (kcal/kg diet)	2.15±0.10^{B}	1.22±0.05^{B}	2.07±0.10	5.44±0.10^{B}
Enzyme effects				
Xylam^{500}(0.0kg/kg diet)	2.16±0.06^{B}	1.23±0.10^{B}	2.03±0.11	5.42±0.13^{B}
Xylam^{500}(0.5kg/kg diet)	2.48±0.11^{A}	1.43±0.08^{A}	2.07±0.09	5.97±0.11^{A}
Interaction				
2900 x 0.0	2.43±0.10^{a}	1.46±0.05^{a}	2.00±0.11	5.89±0.14^{a}
2900 x 0.5	2.56±0.07^{a}	1.41±0.08^{a}	2.04±0.10	6.01±0.11^{a}
2750 x 0.0	1.89±0.09^{b}	1.00±0.10^{b}	2.05±0.12	4.94±0.13^{b}
2750 x 0.5	2.40±0.12^{a}	1.44±0.06^{a}	2.09±0.07	5.93±0.10^{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)	2.02±0.09	4.72±0.17	3.88±0.11	16.67±0.22^{A}
2750 (kcal/kg diet)	1.96±0.07	4.46±0.10	3.90±0.09	11.12±0.30^{B}
Enzyme effects				
Xylam^{500}(0.0kg/kg diet)	2.51±0.10^{A}	5.33±0.13^{A}	4.39±0.13^{A}	19.45±0.24^{A}
Xylam^{500}(0.5kg/kg diet)	1.50±0.04^{B}	3.85±0.19^{B}	3.39±0.10^{B}	8.34±0.27^{B}
Interaction				
2900 x 0.0	2.60±0.05^{a}	5.41±0.11^{a}	4.45±0.14^{a}	22.22±0.12^{a}
2900 x 0.5	1.44±0.02^{b}	4.02±0.10^{b}	3.31±0.11^{b}	11.11±0.31^{c}
2750 x 0.0	2.41±0.04^{a}	5.24±0.16^{a}	4.33±0.10^{a}	16.67±0.20^{b}
2750 x 0.5	1.50±0.06^{b}	3.68±0.12^{b}	3.47±0.14^{b}	5.56±0.34^{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 performance of laying Japanese quail from 7 to 19 weeks of age.

Items / Treatments (20% CP)	EP (%)	FI (g/hen/day)	EW (g)	EN (No./hen/ day)	FCR (g feed/g egg)	EM (g/hen/day)
Energy effects						
2900 (kcal/kg diet)	23.74±0.05^{B}	82.66±0.39^{A}	0.83±0.01^{A}	11.16±0.02^{A}	9.09±0.01^{A}	2.61±0.01^{B}
2750 (kcal/kg diet)	25.96±0.11^{A}	79.99±0.71^{B}	0.80±0.01^{B}	10.54±0.01^{B}	8.33±0.02^{B}	3.15±0.02^{A}
Enzyme effects						
Xylam^{500}(0.0kg/kg diet)	26.00±0.10^{A}	80.22±0.33^{B}	0.81±0.01^{B}	10.52±0.01^{B}	8.43±0.02^{B}	3.12±0.02^{A}
Xylam^{500}(0.5kg/kg diet)	23.71±0.08^{B}	82.43±0.52^{A}	0.83±0.02^{A}	11.17±0.01^{A}	9.00±0.02^{A}	2.64±0.02^{B}
Interaction						
2900 x 0.0	24.23±0.09^{b}	82.53±1.34^{a}	0.83±0.01^{a}	11.10±0.02^{a}	9.10±0.02^{a}	2.66±0.01^{b}
2900 x 0.5	23.25±0.05^{b}	82.79±1.41^{a}	0.83±0.01^{a}	11.21±0.02^{a}	9.08±0.01^{a}	2.56±0.01^{b}
2750 x 0.0	27.76±0.10^{a}	77.91±1.21^{b}	0.78±0.02^{b}	9.94±0.02^{b}	7.75±0.03^{b}	3.58±0.01^{a}
2750 x 0.5	24.16±0.07^{b}	82.07±1.23^{a}	0.82±0.03^{a}	11.13±0.01^{a}	8.91±0.01^{a}	2.71±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 الأنزيمات الهاضمة للكربوهيدرات على أداء كتاكيت السمان اليابانى المغذى على مستويات مثلى وتحت المثلى من الطاقة.

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أجريت هذه الدراسة باستخدام ٣٦٠ 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 "زيلام٥٠٠" الهاضم للكربوهيدرات وتأثير ذلك على أداء النمو وبعض صفات الذبيحة ولزوجة الأمعاء وتصمغ فتحة المجمع وصفات إنتاج البيض. تم تكوين عليقتين بادئ - نامى وعليقتين بياض (عليقتين كنترول). كما تم تكوين عليقتين بادئ - نامى وعليقتين بياض بإضافة المستحضر الإنزيمى "زيلام٥٠٠" بمعدل ٠.٥ كجم/طن علف لعليقتى الكنترول وكانت علائق النمو والبياض تحتوى على ٢٤% و ٢٠% بروتين خام على الترتيب بينما كانت الطاقة الممثلة ٢٩٠٠ و ٢٧٥٠ كيلو كالورى لكل من العليقتين. تم تقدير صفات أداء النمو وصفات الذبيحة ولزوجة محتويات الأمعاء وتصمغ فتحة المجمع وقياس صفات إنتاج البيض. أوضحت نتائج هذه الدراسة من وجهة النظر الغذائية أن إضافة المستحضر الإنزيمى "زيلام٥٠٠" المحتوى على الأنزيمات الهاضمة للكربوهيدرات عدل ٠.٥ 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 محتويات الأمعاء – وتصمغ فتحة المجمع - إنتاج البيض - سمان يابانى).