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Effect of Triticale Level and Exogenous Enzyme in the Grower Diet on Performance, Gastrointestinal Tract Relative Weight, Jejunal Morphology and Blood Lipids of Japanese Quail (*Coturnix coturnix* Japonica)

E. Ebrahimi[1], S. Sobhani Rad[1], and H. Zarghi[2*]

ABSTRACT

The present study was conducted to investigate the effect of corn substitution with triticale in grower diets (zero, 50 and 100%) with/without exogenous enzyme supplementation on growth performance, digestive organs relative weight, jejunal morphology and blood lipids of quail chicks. Two hundred and forty one-day-old unsexed Japanese quail chicks were randomly assigned to a completely randomized design experiment with six treatments, four replicates/treatment and 10 chicks/replicate. Substituted triticale for corn in quail grower diets didn't have significant effect on finaly weight and daily body weight gain. In the quail chicks that fed triticale based diet, feed intake and feed conversion ratio significantly reduced compared those fed corn based diet. Inclusion triticale in the quail grower diets at different levels significantly decreased the crop relative weight, blood serum concentration of triglyceride and very low density lipoprotein and significantly increased large intestine relative weight. The villus height, crypt depth, villus surface area and villus height to crypt deep rate in the quail chicks that fed triticale-soy meal diet were significantly more than those fed corn-soy meal diet. Supplemented exogenous enzyme to the experimental diets didn't have significant effect on whole studied traits, except significantly reduced duodenum relative weight. In conclusion, triticale is a good alternative for corn in quail grower diet, it can completely substitute for corn and have a decreasing effect for blood triglyceride and very low density lipoprotein.

Keywords: Exogenous Enzyme, Growth performance, Histomophometry, Quail chicks, Triticale.

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INTRODUCTION

Cereals are grasses that produce edible starchy grains, many of which can be used in poultry diets as an energy source. Corn and wheat are the grains most routinely used in commercial poultry diets because they have a good energy content. For consumption of these cereal there are a competition between humans and monogastric animals (King *et al*., 1997). Corn price is increasing because of the limited world yield in covering the demands for both humans and livestock and using part of corn yield in production of bio-ethanol. Due to limitation corn crop in Iran, approximately 50% of the corn required for poultry nutrition is supplied through imports (Chizari and Hajiheidary, 2010). Since triticale is more resistant to various diseases, dry weather and in similar culture and weather conditions can

[1] Department of Animal Science, Mashhad Branch, Islamic Azad University, Mashhad, Islamic Republic of Iran.
[2] Department of Animal Science, Faculty of Agriculture, Ferdowsi University of Mashhad, Mashad, Islamic Republic of Iran.
[*] Corrosponding author; e-mail: h.zarghi@um.ac.ir

product higher yield than wheat, triticale considered as a crop suitable for cultivation in the inefficient land and its culture in the world has increased (AAFRD, 2005).

In the cell wall of some feed ingredient with plant source used in poultry nutrition such as wheat, barley, rye and triticale there are high amounts of soluble non starch polysaccharides (Choct and Annison, 1990; Engberg *et al*., 2004). High levels of these compounds in diet can increase viscosity of gastrointestinal tract contents and decrease physical mixing of chyme, release of enzymes and nutrients, movement of materials in the gastrointestinal tract and thereby reduce digestion and absorption of nutrients and diminishing poultry production performance (Jozefiak *et al*., 2007).

In the recent years quail production is common in Iran because of its inexpensive rearing requirment, rapid maturation and adaptability to a wide range of enviromental conditions, also quail has a small size so it is an appropriate bird in many of scientific investigation such as behavioural (Mills and Faure, 1991), developmental (Le Douarin *et al*., 1997), physiological (Balthazart *et al*., 2003), genetic (Jones *et al*., 1991) and inbreeding (Mizutani, 2002).

Triticale is a relatively new feed grains that is not used to great degree in poultry diets. The purpose of this study was to evaluate the effects of different replacement levels of corn by triticale in grower diets with and without exogenous enzyme supplementation on growth performance, relative weight of digestive organs, jejunal morphology and blood metabolites of Japanese quail chicks.

MATERIALS AND METHODS

Birds, Housing and Care

Experimental procedures were approved by the Animal Care Committee of the Ferdowsi University of Mashhad. The study was done with use of 240 one-day-old ashatch (unsexed) Japanese quail chicks. The chicks were obtained from a local hatchery and were randomly allocated to 6 dietary treatments with 4 replicates/treatment of 10 birds/replicate (pen). The chicks' mean weight at the start of testing were 9.5 ± 1.5 g. Each pen had 0.3 square meter area, surrounded by net barrier to a height of 0.5 meter, equipped with a manual drinker and a manual feeder and it's floor was covered with wood shaving. During the testing period (1-35 days of age.), the house temperature at the start of rearing was 35-37ºC and after 72 hours reduced 0.5°C per day to reach a constant temperature of 20-22°C. The relative humidity and the light-darkness program were kept in the range of 50-60% and 23 hours light and 1 hour darkness, respectively in the whole experimental period.

Feed Stuffs Composition

Triticale grain that used in this experiment (Juanillo-92 variety) was obtained from Khorasan Razavi Agricultural and Natural Resource Research Centre (Northeast of Iran). The chemical compositions of triticale, corn and soy meal were determined by NIR through Evonik-Degussa agent in Tehran, Iran and data were used to formulate the experimental diets (Table 1).

Experimental Design and Diets

A Completely Randomized Design (CRD) with factorial arrangement (3×2) of three triticale replacement levels for corn (zero, 50 and 100% corresponding to zero, 268.5 and 587.8 g triticale kg^{-1} of diet) and two exogenous enzyme supplementation levels (zero and 0.5 g of Enzyme Cocktail (EC) kg^{-1} (Safizym, Lesaffer Animal Care, France) of diet "the level recommended by the manufacturer") in the quail grower diets was used. The EC was a blend of 3,500 U g^{-1} β-

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Table 1. Ingredients and composition of experimental diets with/without enzyme cocktail fed to quail chicks in the 1 to 35 d.[a]

Item	Triticale levels replacement for corn (%)		
	0.00	50	100
Ingredients, %			
Corn (3350 kcal ME kg^{-1} and 8.5% CP)	49.40	26.85	0.00
Triticale (3160 kcal ME kg^{-1} and 14% CP)	0.00	26.85	58.78
Soybean meal (2230 kcal ME kg^{-1} and 44% CP)	44.91	40.51	35.27
Soybean oil (8850 kcal ME kg^{-1})	2.65	2.66	2.70
DL-Methionine	0.15	0.14	0.14
Lysine HCl	0.00	0.10	0.20
Dicalcium phosphate	0.73	0.77	0.78
Limestone	1.31	1.30	1.30
Salt	0.35	0.32	0.33
Vitamin mix[b]	0.25	0.25	0.25
Mineral mix[c]	0.25	0.25	0.25
Total	100	100	100
Calculated composition, % except for ME (as fed basis)			
Metabolizable energy (kcal kg^{-1})	2900	2900	2900
Crude protein	24.00	24.00	24.00
Calcium	0.80	0.80	0.80
Available phosphorus	0.30	0.30	0.30
Sodium	0.15	0.15	0.15
Total Lysine	1.34	1.34	1.34
Total Methionine	0.51	0.51	0.51
Total Methionine+Cysteine	0.90	0.90	0.90
Analyzed nutrient contents, % (as fed basis)			
Dray mater	93.53	93.28	92.93
Crude protein	24.65	24.47	24.24
Crude fat	3.42	3.40	3.38
Crude fiber	4.70	4.70	4.72

[a] Each diets was divided into two equal portion and enzyme cocktail "containing xylanases min 1600 U g^{-1}, β-glucanases 3500 U g^{-1} and cellolases 25 U g^{-1}" was added to each part at rate of zero and 0.5 g/kg to provide the six experimental diets. [b] Vitamin permix Supplied the following per kilogram of diet: Vitamin A, 11000 IU; Vitamin D3, 1800 IU; Vitamin E, 36 mg; Vitamin K3, 5 mg; Vitamin B12, 1.6 mg; Thiamine, 1.53 mg; Riboflavin, 7.5 mg; Niacin, 30 mg; Pyridoxine, 1.53 mg; Biotin, 0.03 mg; Folic acid, 1 mg; Panthothenic acid, 12.24 mg; Choline chloride, 1100 mg, Etoxycoin, 0.125 mg.[c] Mineral permix Supplied the following per kilogram of diet: Zn-sulfate, 84 mg; Mn-sulfate, 160 mg; Cu-sulfate, 20 mg; Se, 0.2 mg; I, 1.6 mg, Fe, 250 mg.

glucanase, 1,600 U g^{-1} xylanase and 25 U g^{-1} cellulase activity. The dietary treatments were: (1) Corn-soy meal diet (control); (2) Corn-soy meal diet plus EC; (3) Corn-triticale-soy meal diet (corn/triticale was 50/50); (4) Corn-triticale-soy meal diet plus EC; (5): Triticale–soy meal diet, and (6) Triticale–soy meal diet plus EC. The experimental diets were formulated by using the least-cost linear programming to meet or exceed nutrient requirements for Japanese quail (NRC, 1994). The experimental diets were adjusted equal for energy, protein and other nutrients and were prepared in mash form. During the experimental period (1 to 35 days of age) birds were offered water and feed ad-libitum. In the Table 1 is presented the ingredient and nutrient contents of experimental diets.

Diet Chemical Analysis

Chemical composition of the experimental diets (dry matter, crude protein, crude fat and crude fiber) were determined in the laboratory analysis after the samples were ground through 20 μm mesh screen and were dried at 70°C for 48 hours. for chemical analysis. The proximate feed analysis were performed according to (AOAC, 2002).

Growth Performance Traits

All birds were weighed after their arrival from the hatchery to the experimental farm (initial weight) and at 21 and 35 days of age. Before birds weighting in order to ensure the relative uniformity of the intestinal content, the birds were imposed fasting for 4 hours. Everyday the dead chicks were recorded, weighed and data was used to correct the growth performance traits. Feed consumption was recorded in the course of the 1-21, 22-35 and 1-35 days of age. The growth performance as mean body weight, daily Weight Gain (WG) and daily Feed Intake (FI) were calculated during each experimental period. The Feed Conversion Ratio (FCR) was calculated as the amount of feed consumed divided by pen weight gain including the weight gain of the dead chicks.

Slaughter and Tissue Sampling

At 21 days of age, one bird from each pen, close to the average pen weight selected, weighed, and euthanized by cervical dislocation. The bird's abdomen immediately opened and the digestive tract from the proventriculus to the end of the large intestine excised. The crop, proventriculus, gizzard, small intestine, and large intestine emptied and weighed. The small intestine divided into three segments: (1) Duodenum; from gizzard to the pancreatic and bile ducts; (2) Jejunum; from pancreatic and bile ducts to Mackle diverticulum, and (3) Ileum; from Meckel diverticulum to the ileocecal valve (Samanya and Yamauchi, 2002). The relative weight of digestive organs were calculated as the amount of organ weight divided by live body weight multiplied to 100 (Bjerrum *et al*., 2005). For histological traits, about 0.5 cm in length of the jejunum midpoint taken and rinsed with phosphate buffer solution (0.1M, pH 7.4) to remove the residual contents. The tissue samples fixed in 10% neutral buffered formalin (Merck, Darmstadt, Germany) solution, after 24 hours fixative solution container switched and then stored in room condition.

Intestinal Slide Preparation

The tissue samples treated in tissue processor apparatus and embedded in paraffin wax. Transverse sections were cut (5μm thickness) by using a rotary microtome (RM 2145, Leica Microsystems Wetzlar, Germany) placed on glass slides and stained with Hematoxylin and Eosin (H and E) to prepare intestinal slide (Bancroft and Gamble, 2002). All chemical material purchased from sigma chemical company.

Jejunal Morphology

Morphological measurements of intestinal slide performed by using an Olympus light Microscope (Model U- TV0.5 XC-2, Olympus corporation, BX41, Olympus, Tokyo, Japan) and image Pro-Plus V 4.5 software package on 9 villus chosen from each slide and only vertically oriented villus were selected for measuring (Saki *et al*., 2012). The morphological traits were: (1) Villus height (distance from the tip of the villi to the crypt junction); (2) Villus width (average of villus width at one-third and two-thirds of villus length); (3) Crypt depth (distance from the base of the villi to the submucosa), and (4) Muscular thickness (Ganjali *et al*., 2015). The villus surface area calculated according Formula (1) (Solis de los Santos *et al*., 2007).

$$VSA = \frac{1}{2} \times VW \times VH \times 2\pi \qquad (2)$$

Where: *VSA*= Villus Surface Area; *VW*= Villus Width; *VH*= Villus Height, and π= 3.14

Blood Serum Lipids

At 35d of age, one bird from each pen was randomly selected and blood samples was collected from the wing vein by a syringe. Blood samples were transferred in labeled sterile test tubes and immediately centrifuged at 3,000 rpm for 10 minutes. After centrifugation, serum was collected in 1.5ml microtube and stored at –20°C in the deep freezer until the time of chemical determinations. The biochemical characteristics of blood serum such as Triglyceride (TG), Cholesterol (Chol), High Density Lipoproteins (HDL) and Low Density Lipoproteins (LDL) were determined enzymatically by using an auto-analyzer (Vitalab Selectra E, Vital Scientific, Argentina).

Statistical Analysis

Statistical analysis of all data were performed by using the General Liner Models (GLM) procedure of the SAS software (SAS, 2003). All partially data were converted by using the Formula 2 and then were analyzed. Data were tested for main effects of triticale levels and enzyme cocktail addition and interaction between those. Means were compared for significant differences by using the Duncan's multiple range test (P< 0.05). Statistical plan model is shown in Formula (3).

$$X = Degrees\ (arcSin\sqrt{\frac{x}{100}}) \qquad (2)$$

Where: *X*= Transformed data, *x*= Basic data.

$$Yijk = \mu + \alpha i + \beta j + (\alpha\beta)ij + \varepsilon ijk \qquad (3)$$

Where: *Yijk*= Value that view; μ= Mean population; α_i= Effect of triticale levels; β_j= Effect of enzyme cocktail addition; $(\alpha\beta)_{ij}$= Interaction between triticale level×Enzyme cocktail addition, and ε_{ijk}= Effect of experimental error.

RESULTS AND DISCUSSION

Growth Performance

Table 2 shows data of Body Weight Gain (BWG), Feed Intake (FI) and Feed Conversion Ratio (FCR) during the 1-21, 22-35 and 1-35 day of age periods. Replacement different levels of corn by triticale in quail grower diets, Enzyme Cocktail (EC) addition and interaction between those on BWG were not significant (P> 0.05). Inclusion of triticale in the quail grower diets caused a significant (P< 0.05) reduction in *FI* (g bird^{-1} day^{-1}) and *FCR* during the 22-35 day and whole (1-35 day) periods. In the birds that fed triticale-soy meal basic diet the *FI* and *FCR* was significantly lower than those fed corn-soy meal based diet. The effect of EC addition and interaction between triticale levels with EC addition on *FI* and *FCR* were not significant (P> 0.05).

The results obtained in this study showed triticale substituted for corn had no negative effect on BWG and final body weight of quail chicks. However, there are the contradictory findings reported in the scientific literature, according with our obtained reported: Triticale can be use efficiently for broiler chickens to replace other grains (Braggy and Sharby, 1970). Growth of broiler chickens was similar whether triticale or wheat have been the cereal source in diets that contained 50% cereal and were equalized for nutrient content (Johnson and Eason, 1988). The graded inclusion of triticale up to 40%

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Table 2. Effect of Triticale Levels (TL) and Enzyme Cocktail (EC) addition to grower diet on performance of quail chicks (1-35 days of age).[a]

Effects	Body weight gain ($g\ b^{-1}\ d^{-1}$)			Feed intake ($g\ b^{-1}\ d^{-1}$)			Feed conversion ratio		
	…………………………. Age periods (Day)								
	1-21	22-35	1-35	1-21	22-35	1-35	1-21	22-35	1-35
Triticale levels replacement for corn (%)									
0	8.89	7.45	8.37	17.11	35.44[a]	23.78[a]	1.91	4.78[a]	2.85[a]
50	8.82	7.32	8.22	16.32	33.19[ab]	22.60[ab]	1.86	4.60[ab]	2.76[ab]
100	9.17	7.35	8.45	15.82	32.51[b]	21.80[b]	1.73	4.50[b]	2.58[b]
SEM	0.16	0.33	0.14	0.36	0.98	0.57	0.05	0.09	0.07
Enzyme cocktail ($g\ kg^{-1}$)									
0.0	8.92	7.52	8.36	16.45	33.79	22.63	1.85	4.58	2.71
0.5	9.07	7.23	8.33	16.38	33.63	22.82	1.81	4.67	2.74
SEM	0.13	0.27	0.12	0.30	0.80	0.45	0.04	0.07	0.06
P-Value									
TL	0.32	0.66	0.55	0.12	0.22	0.05	0.12	0.73	0.05
EC	0.42	0.46	0.88	0.89	0.79	0.77	0.57	0.74	0.74
TL × EC	0.19	0.62	0.17	0.63	0.88	0.84	0.63	0.64	0.60

[a] Mean within the same column with no common superscript differ significantly (P< 0.05).

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substituted for corn had no negative effect on weight gain or final weight of broiler chickens (Vieira *et al*., 1995). Other studies with broilers and egg production show no differences in productivity, even when diets consist of 100% cereal portion with triticale (McNab and Shannon, 1975; Yaqoob and Netke, 1975; Karunajeewa and Tham, 1984; Leeson and Summers, 1987; Maurice *et al*., 1989; Boros, 1999). Disagreed with our finding and above literature negative effects were observed by applying triticale in poutry grower diet (Gerry, 1975; Ruiz *et al*., 1987; Smith *et al*., 1989; Al- Athari and Al-Bustany, 1997; Korver *et al*., 2004).

During the 22-35 and 1-35 day periods, *FCR* and *FI* values for quail chicks fed triticale–soy meal diet were significantly lower compared with the groups fed corn-soy meal based diet. According with our result, in some reports, triticale feeding has resulted in similar or improved feed efficiency relative to other grains (Vohra *et al*., 1991). Ruiz *et al.* (1987) determined that feed efficiency was significantly better for chicks fed triticale than for those fed corn. Vohra *et al.* (1991) found no statistically significant differences in *FCR* among quail fed triticale or corn based diets to 21 days of age. However, other researchers have observed poorer *FCR* with triticale based diets in broiler chickens (Gerry, 1975; Proudfoot and Hulan, 1988; Vieira *et al*., 1995). Smith *et al.* (1989) reported 4 to 5% reduction in average *FCR* for broilers fed triticale compared with a cornsoy meal (control) diet from zero to 2 week and from 2 to 3 week of ages. The inclusion of triticale 50% of dietary cereal portion didn't have significant effect on *FI* when compared to the corn-soy meal diets. This may give an indication that inclusion of triticale in the quail diet up to 50% of cereal portion didn't have a negative effect on diet palatability.

Relative Weight of Digestive Organs

The relative weight of digestive organs of birds fed diets containing different levels of triticale with and without EC have been reported in Table 3. Evaluation the results shown with increasing levels of triticale in the quail grower diet the relative weight of

Table 3. Effect of Triticale Levels (TL) and Enzyme Cocktail (EC) addition to grower diet on digestive organs relative weight (g 100 g^{-1} of live body weight) of quail chicks slaughtered at 21 d.[a]

Effects	Crop	Proventriculus	Gizzard	Small intestine	Duodenum	Large intestine
Triticale levels replacement for corn (%)						
0	0.37[a]	0.46[ab]	2.34	3.62	0.86	0.79[b]
50	0.29[b]	0.49[a]	2.33	3.91	0.89	1.16[a]
100	0.31[b]	0.41[b]	2.25	3.84	0.92	0.93[ab]
SEM	0.10	0.08	0.18	0.29	0.15	0.27
Enzyme cocktail (g kg^{-1})						
0.0	0.33	0.46	2.38	3.76	0.96[a]	0.96
0.5	0.32	0.45	2.23	3.28	0.82[b]	0.94
SEM	0.09	0.07	0.15	0.24	0.12	0.22
P-Value						
TL	0.05	0.03	0.79	0.55	0.74	0.03
EC	0.76	0.59	0.20	0.75	0.01	0.96
TL×EC	0.11	0.56	0.48	0.49	0.76	0.47

[a] Mean within the same column with no common superscript differ significantly (P< 0.05).

crop and proventriculus of birds that slaughtered at 21 days of age were significantly decreased (P< 0.05). This decrease can be associated with reduced feed intake as increasing triticale levels in diet (Table 2). The relative weight of the small intestine and large intestine increased with increasing levels of triticale in diet. In the birds fed triticale-soy meal based diet the large intestine relative weight was significantly higher than the birds fed corn-soy meal based diet (P< 0.05). Intestine relative weight increase in the birds fed triticale-soy meal based diet may be influenced by the increasing in the activity of this organ that made in response to higher levels of dietary non starch polysaccharides.With addition EC to the diets the relative weight of digestive organs numerically decreased so that the duodenal relative weight of birds fed diets containing EC was significantly lower than the birds fed diets without EC (P< 0.05). According with our results, reported diet supplemented with exogenous enzyme can decline relative weight of pancreas and small intestine (Almirall *et al*., 1995; Gracia *et al*., 2003), the gastrointestinal tract and pancreatic relative weight has been decreased by diet supplemented with exogenous enzymes especially in the grower stage of broiler production (Wang *et al*., 2005).

Jejunal Morphology

Morphological measurements of quail chicks' jejunum at 21 days are shown in Table 4. With increasing triticale levels in quail grower diet the Villus Height (VH), Crypt Depth (CD), Villus Surface Area (VSA) and VH/CD significantly increased (P< 0.01). The effect of EC addition to diet on all of jejunal morphological measurements were not significant (P> 0.05). The effect of interaction between triticale levels with EC addition to diet on the VSA was significant (P< 0.02), but on other morphological traits were not significant (P> 0.05). In the birds that fed triticale-soy based diet compared to birds fed corn-soy meal or corn-triticale–soy meal diet the jejunal VSA significantly increased, whereas in the dietary treatment without EC the jejunal VSA increasing was vigorous (Figure 1).

Higher size of the villus and the deeper crypts observed in the gut mucosa of quail chicks fed triticale-soy meal diet as compared to those fed corn- soy meal diet

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Table 4. Effect of Triticale Levels (TL) and Enzyme Cocktail (EC) addition to grower diet on morphological observations of jejunum in quail chicks slaughtered at 21 days of age.[a]

Effects	VH	VW	CD	MT	VH/CD	VSA
Triticale levels replacement for corn (%)	………………	10 µ	………………			1000 µ^2
0	53.45[b]	10.88	9.31[b]	7.76[a]	4.98[c]	183[b]
50	56.44[b]	10.16	10.38[b]	5.45[b]	6.06[b]	178[b]
100	78.15[a]	11.00	10.16[a]	7.88[a]	7.62[a]	276[a]
SEM	4.20	0.45	0.33	0.37	0.32	13
Enzyme cocktail (g kg^{-1})						
0.0	62.16	10.19[a]	10.28	7.33	6.01	204
0.5	63.19	11.42[b]	9.92	6.80	6.42	221
SEM	3.43	0.37	0.37	0.3	0.26	10
P-Value						
TL	0.01	0.19	0.01	0.02	0.01	0.01
EC	0.83	0.03	0.36	0.22	0.27	0.27
TL×EC	0.84	0.07	0.33	0.68	0.97	0.02

[a] Mean within the same column with no common superscript differ significantly (P.< 0.05). VH (Villus Hight); VW (Villus Width); CD (Crypt Depth); MT (Muscular Thickness), VSA (Villus Surface Area).

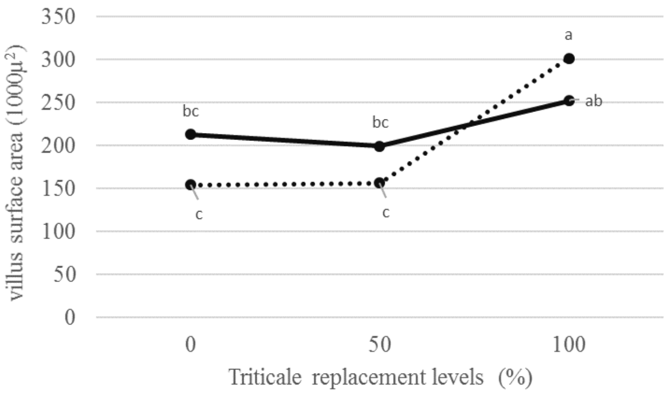

Figure 1. Effect of interaction between Triticale Levels (TL) and Enzyme Cocktail (EC) addition to grower diet on villus surface area of jejunum in quail chicks slaughtered at 21 days of age.

seems to be eventuate from increasing anaerobic bacterial capacity proliferation and colonization in caecum. The stimulatory effects of some cereal grain on intestinal mucosa may be attributed with the production of hort chain fatty acids outcome dietary non-starch polysaccharide fermentation in the hind gut which undigested at upper part of digestive tract. It was suggested that some hort chain fatty acids induce cell proliferation in the intestinal mucosa (Lan, 2004). The increasing crypt depth coupled with longer villus is indicative for the increasing epithelial turnover. Such effects were introduced by production of short chain fatty acids, reduction intestinal pH and diminishing development of pathogenic bacteria (Bedford and Partrige, 2010).

Blood Metabolites

The lipid metabolites cocentration such as cholesterol, Triglyceride (TG), High Density Lipoprotein (HDL), Low Density

Table 5. Effect of Triticale Levels (TL) and Enzyme Cocktail (EC) addition to grower diet on serum lipid metabolites (mg dl^{-1}) in quail chicks at 35 d.[a]

Main effects	TG	Cho	HDL	LDL	VLDL
Triticale levels replacement for corn (%)			mg dl^{-1}		
0	476[a]	279	30	32	33[a]
50	240[b]	236	31	38	26[b]
100	304[b]	273	36	30	27[ab]
SEM	26	29	5	5	2
Enzyme cocktail (g kg^{-1})					
0.0	336	265	32	34	28
0.5	345	261	32	33	29
SEM	21	24	4	4	2
P-Value					
TL	0.01	0.55	0.78	0.65	0.05
EC	0.77	0.91	0.95	0.87	0.62
TL × EC	0.07	0.12	0.88	0.68	0.26

[a] Mean within the same column with no common superscript differ significantly (P< 0.05). TG (Triglycerides); Cho (Cholesterol); HDL (High Density Lipoprotein); LDL (Low Density Lipoprotein), VLDL (Very Low Density Llipoprotein).

Lipoprotein (LDL) and Very Low Density Lipoprotein (VLDL) in the blood serum of birds fed dietary treatments shown in Table 5. Different levels of triticale replacement in the quail grower diet shown significant effect on serum concentration of TG and VLDL (P< 0.05). Effect of addition EC to diet and interaction between EC and triticale levels on blood metabolits were not significant (P> 0.05).

With increasing levels of triticale in the quail grower diet the blood serum concentration of TG and VLDL significantly decreased. These effects are associated with other researcher that reported, triticale seems to have lowering properties for serum TG and LDL in chickens (Pettersson and Aman, 1993; Zarghi and Golian, 2009; Zarghi *et al*., 2010), also in the rats that fed with whole wheat and triticale flour diets plasma cholesterol was lower than control groups (Adam *et al*., 2001). Several modes of actions propose for lipid metabolites lowering effect of dietary fiber whether working alone or in combination with together. First, dietary fiber resists digestion in the small intestine, thereby allowing it to enter the large intestine where it fermented to produce short chain fatty acids. Short chain fatty acid production, specifically propionate, has been shown to inhibit cholesterol synthesis (Lattimer and Haub, 2010). Second, since dietary fiber increases intestinal contain viscosity, there is interference with lipid and bile acid absorption (Jackson *et al*., 1994). Soluble fibers have been shown to increase the rate of bile excretion therefore reducing serum total and LDL cholesterol (Story *et al*., 1997). Third, either through glycemic control or reduced energy intake, dietary fiber has been shown to alterations in plasma concentration or tissue sensitivity to insulin or other hormones (Zarghi and Golian, 2009). fourth, dietary fiber has been shown to up regulation of the hepatic LDL receptor (Anderson *et al*., 1990).

CONCLUSIONS

In conclusion, the experiment results demonestrated that; Triticale can be completely substituted for corn in quail grower diets without any adverse effect on performance. Triticale cause a significant

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decrease on blood serum TG and VLDL in quail chicks. The addition exogenous enzyme to triticale based quail grower diet does not have an improved effect on growth performance.

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اثر سطح تریتیکاله و مکمل آنزیمی در جیره رشد بر عملکرد، وزن نسبی مجرای گوارشی، ریخت شناسی ژژنوم و چربی خون بلدرچین ژاپنی

ا. ابراهیمی، س. سبحانی راد، و ح. زرقی

چکیده

این مطالعه به منظور بررسی اثر جایگزینی سطوح مختلف ذرت با تریتیکاله (صفر، ۵۰ و ۱۰۰ درصد) در جیره با و بدون افزودن آنزیم بر عملکرد رشد، وزن نسبی اندام‌های گوارشی، ریخت شناسی ژژنوم و متابولیت‌های خونی بلدرچین انجام شد. آزمایش با استفاده از ۲۴۰ قطعه جوجه بلدرچین یک روزه (مخلوط دو جنس) در قالب طرح کاملاً تصادفی ۶ تیمار با ۴ تکرار و ۱۰ قطعه پرنده در هر واحد آزمایشی انجام شد. جایگزینی ذرت با تریتیکاله در جیره رشد بلدرچین بر وزن پایان دوره و افزایش وزن روزانه اثر معنی دار نداشت. خوراک مصرفی و ضریب تبدیل غذایی در بلدرچین‌های تغذیه شده با جیره بر پایه تریتیکاله در مقایسه با پرندگان تغذیه شده با جیره بر پایه ذرت به طور معنی دار کمتر بود. افزایش سطح تریتیکاله در جیره رشد بلدرچین‌ها باعث کاهش معنی‌دار وزن نسبی چینه دان، غلظت تری گلیسرید و لیپوپروتئین‌ها با دانسیته خیلی پایین و افزایش معنی‌دار وزن نسبی روده بزرگ شد. ارتفاع و مساحت ویلی‌ها، عمق کریپت‌ها، نسبت ارتفاع ویلی به عمق کریپت در پرندگان تغذیه شده با جیره بر پایه تریتیکاله در مقایسه با پرندگان تغذیه شده با جیره بر پایه ذرت بیشتر بود. اثر افزودن مکمل آنزیمی به جیره مصرفی باعث کاهش معنی دار وزن نسبی دئودنوم شد ولی بر روی سایر شاخص‌های مورد مطالعه اثر معنی دار نداشت. نتایج حاصل از این آزمایش نشان داد می‌توان از تریتیکاله در جیره رشد بلدرچین تا سطح جایگزینی کامل استفاده کرد همچنین تریتیکاله باعث کاهش تری گلیسرید و لیپوپروتئین‌ها با دانسیته پایین سرم خون می‌شود.

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