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The Effect of Different Levels of Lentil by Product on Growth Performance, Carcass Traits and Egg Yield in Quail (Coturnix Coturnix Japonica)

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ABSTRACT

The subject of this study was to evaluate the effects of lentil byproduct (LP) on growth performance, carcass traits and egg yield of quail (*Coturnix coturnix Japonica*). To achieve this goal, a total of 600 0-day-old quail chicks were used. The birds were divided into 5 groups with 3 replicates. The 1st, 2nd, 3rd, 4th and 5th groups received 0, 5, 10, 15 and 20% lentil byproduct, respectively. All the diets were prepared as isonitrogenous and isocaloric. As a result of this study, the highest live body weights of quails as Laudadio mixed gender were observed in the 3rd (195.5 g) and 5th (195.3 g) groups at the end of the study, however the differences between the control and treatment groups were not significant ($p>0.05$). Similar results were observed in the carcass traits, as well. The best feed conversion ratio (FCR) was noted in both the 2nd and 3rd groups as 3.04 and it was significantly ($p<0.05$) different than in the control and other treatment groups. The least feed intake (FI) was observed in the 2nd group. The highest and the lowest egg yield percentages were in the 3rd (90.78 %) and 5th (66.57 %) groups, and differences were significant ($p<0.01$). Linear increments were observed in the yolk color when LP increased in the diet. As a result, it could be concluded that lentil by product could be added into quail diets up to 15% with no negative effect on live body weight (BW) and carcass traits and to get better yolk color.

INTRODUCTION

It is a fact that feed is the single greatest cost of poultry production. In non-ruminant diets, soybean meal and corn have been used widely as protein and energy sources. However, the price of soybean meal as a main source of protein has doubled over the last 7 years (Woyengo & Zijlstra, 2014). Soybean meal, which is traditionally the stable vegetable protein source for poultry feed in Turkey as in other countries, is mainly imported and it is predicted that soybean will be insufficient and expensive (Leeson & Summer, 1997; Laudadio & Tufarelli, 2011). Therefore the need of alternative feedstuffs to reduce the cost of diets and to replace animal meal concentrate during the period of soybean shortage exists (Leeson & Summer, 1997; Robinson & Singh, 2001; Defang *et al.*, 2008; Laudadio *et al.*, 2012).

Lentil (*Lens culinaris L.*) is one of legume grains and an important source of protein; it has been used in ruminants and non-ruminant diets including poultry (Mavromichalis, 2013; Çabuk *et al.,* 2014; Woyengo *et al.,* 2014) and it is relatively tolerant to drought and grown all over the world. Canada, India and Turkey produce nearly 60% of lentil in the world (Bathy, 1995; Wang & Daun, 2005). Depending on the cultivar type, lentil seeds vary in color, and typically red lentils are grown by farmers as human nutrition in Turkey. Lentil seeds have to be processed before using human diet to remove inedible parts. Various byproducts are generated during the processing time such as lentil, pea byproduct, etc. Recently lentils are separated by a special machine according to color. If the lentils are suffered from quality problems (such as discolored, frost damage or seed damage), and are considered as byproducts after the processing, (Ogretmen et al., 1993; Çabuk et al., 2014), they become occasionally available to the animal feed industry. These byproducts do not pose any problems when such lentils are fed to nonruminant animals like poultry and pigs of all ages in appropriate amounts (Mavromichalis, 2013).

The nutritive value of lentil depends on the processing methods and the amount of present antinutritional factors (Xu & Chang, 2010). Lentil seeds have a relatively high protein (27%) and energy content (3570 kcal/kg ME) and low digestive inhibitors (Gorgulu, 2010). However, the major antinutritional factors in lentils are protease inhibitor, excessive content of polyphenols, especially tannins, but these are not present in sufficient quantities to depress animal performance (Mavromichalis, 2013).

There is little information and research available on the use of lentil byproducts in quail diets. Significantly decrease in egg weight were observed in quails with 20% lentil byproduct in diets (Çabuk *et al.,* 2014). Similarly, researches (Kanat 1992; Kanat & Camcı 1993) indicated that more than 20% of lentil byproducts in quail diets had negative effects on quail performance. Up to 30% of row lentils have been used with success in pig diets (Mavromichalis, 2013). On the other hand, more than 5% of lentil byproducts had adverse effects on layer egg's production (Kılıçalp & Benli, 1994). Besides this, 15% of lentil byproducts in the diets of layers decreased body weight, egg yield, FCR, but it did not affect egg quality (Yalcın *et al.,* 1991).

There is little information available about lentil byproducts on quails so far. Therefore, the subject of this study was to figure out the effect of different levels of lentil byproducts on quail growth performance, carcass traits, egg yield and egg quality.

MATERIAL AND METHOD

Two experiments were conducted in this study. The first one was to figure out the effect of lentil byproduct (LP) on growth performance and carcass traits, and the second one was on egg yield and egg quality evaluation. All the chicks in this experiment were obtained from a commercial hatchery in Van, in Turkey. A total of 600, 0-day-old quail chicks (*Coturnix coturnix Japonica*) were leg (first 2 wk)-wing (3-6 wk) banded and weighed, then divided into 5 groups (1 control and 4 treatments) with three replicates, 40 chicks in each cage (replicate), randomly. The first group (control) did not have lentil byproduct (LP), the 2nd, 3rd, 4th and 5th groups received 5, 10, 15 and 20% of LP both in the diet of growing and laying period. The content of the diet for grower and layer are given in Tables 2 and 3.

Chicks were reared in multiple floor cages (45x90x20cm) with heat and light control. All the birds (males+females together) were reared under similar environmental conditions. The temperatures of the experimental unit was maintained at 35±1°C during the first week and gradually decreased to 21°C till 3 weeks of age. A 23L:1D lighting regiment was applied through 42 days of the experiment, however, it was 16L:8D through the laying period (43 to 143 d). The birds were fed *ad libitum* and fresh water was provided through the experiment.

All diets were balanced with energy and protein and formulated to contain adequate nutrient levels as defined by the National Research Council, NRC (1994). The diet was based on corn and soybean meal, and it was calculated based on nutrient level of feed stuffs. To calculate protein and energy level, estimated nutrient content of feed was (NRC, 1994) used except for lentil byproduct. Nutrition content of lentil byproduct is given in Table 1. In the first experiment, all the birds were fed by the feed containing either 24% crude protein and 2900 kcal kg^{-1} ME from 1-42 days of age and the feed containing 20% crude protein and 2900 kcal kg^{-1} ME was given during the laying period.

Birds and feed were weighed weekly and individually to determine live body weight (BW), feed intake (FI) and feed conversion ratio (FCR).

At the end of the first experiment (at 42 days), 10 male and 10 female birds were bled, defeathered and eviscerated by hand. Carcasses were pre-chilled then aged in ice water for 5 h and then separated for the parts as carcass yield, breast, legs (thighs and drumsticks) liver and heart. After 42 days of the first experiment, 75 females in each experiment group (totally 5 x 75=375 birds) were kept in 3 laying cages (25 in each cage) to calculate the number of eggs laid during the laying period in experiment 2. If all the birds laid 10 % of eggs, we started to collect eggs. The 2nd experiment lasted 3 months. Eggs were collected daily. Every month 30 eggs in each group were weighted then they were broken to figure out egg quality traits [egg yield (%), egg weight (g), yolk index, haugh unit (HU), internal quality unit (IQU) and yolk color]. The egg yolk color was measured visually by using La Roche scale (today also named as DSM Yolk Color Fan).

Haugh Unit (HU) and Internal Quality Unit (IQU) were calculated with the following equation (Kaya & Aktan, 2011);

$$HU = 100 \log [H + 7.57 - 1.7 x W^{0.37}]$$

$$IQU = 100 \log [H + 4.18 - 0.8989 \times W^{0.6674}]$$

Where; H= thick Albumen height (mm); W= egg weight (g)

Data were analyzed by using the GLM procedure of a Statistic Packed Program (SAS, 1998). The BW, FI, FCR and carcass characteristics were studied by analysis of variance including the effect of rearing conditions. When the F-test was significant, the least mean square was compared by using pdiff of SAS. The level ($p<0.05$) at which differences were considered significant.

Table 1 – Nutrient content of lentil byproduct.

Ca, %	0.05
P , %	0.35
Dry Matter, %	90.1
Crude ash, %	5.8
Ether extract, %	1.4
Crude cellulose, %	8.8
Crude protein, %	18.72
Metabolisable energy, Kcal/kg	2100

Table 2 – Nutrient content (%) of diet with 24 % crude protein and 2900 kcal/kg ME at 0-6 weeks of age

	Diet included lentil byproduct, %				
Ingredients	0	5	10	15	20
Corn	49.85	46.10	44.00	41.50	39.60
Lentil Byproduct	-	5.00	10.00	15.00	20.00
Soybean meal 44 CP %	5.00	4.00	4.10	4.30	5.80
Sunflower seed meal 33CP %	23.00	18.50	15.00	10.80	5.30
Whole soybean	10.00	13.50	14.50	16.00	16.90
Fish powder	6.00	6.00	6.00	6.00	6.00
Meat-bone powder	5.00	5.00	5.00	5.00	5.00
Limestone	0.15	0.40	0.40	0.40	0.40
DCP	-	0.50	-	-	-
Vitamin - Mineral*	0.50	0.50	0.50	0.50	0.50
Methionine	0.15	0.15	0.15	0.15	0.20
Lysine	0.35	0.35	0.35	0.35	0.30
Nutrient content %					
Crude Protein	24.08	24.08	24.10	24.08	24.03
ME	2903.9	2903.4	2908.3	2907.6	2909.7
Ca	1.05	1.25	1.12	1.11	1.10
P	0.93	0.99	0.89	0.87	0.84
Methionin+Sistin	1.00	0.97	0.95	0.93	0.95
Lysine	1.49	1.50	1.50	1.50	1.47

*:Added per kg: vit. A - 11.00 IU; vit. D - 32,000 IU; vit. B1 - 2.5 mg; vit. B6 - 1.25 mg; vit. B12 - 0.01 mg ; α-tocopheryl acetate - 50 mg; biotin - 0.06 mg; vit. K - 2.5 mg; niacin - 15 mg; folic acid - 0.30 mg; pantothenic acid - 10 mg; choline - 600 mg; Mn - 60 mg; Fe - 50 mg; Zn - 15 mg; I - 0.5 mg; Co - 0.5 mg

RESULTS

The studies about the effect of lentil byproduct (LP) on egg yield and growth performance of quails are still not clear so far. This is the experiment conducted to evaluate the impact of LP on fattening performance, carcass traits (CT), feed intake (FI), FCR, egg yield and egg quality traits of Japanese quails (*Coturnix coturnix Japonica*).

The effect of dietary LP on Live Body Weight (BW) at different age, CT, FI, FCR and some internal egg quality traits are given Table 3, 4, and 5, respectively,

Live Body weight (BW), Feed intake (FI) and Feed conversion ratio (FCR)

The mortality rate through the experiment was very low (1%) and was not related with the experiment. The results of fattening performance and feed intake, expressed as live body weight, intake of LP and FCR are summarized in Table 3. At the beginning of the experiment (day 7), there were no significant differences between treatment and control, and among the mean BW of all treatment groups. The weight of the birds in the groups (1^{st}, 2^{nd}, 3rd, 4th and 5th) ranked between 65.9 and 66.1g. At the end of the 6th week of experiment, among the males, the highest BW with 185.9 g was observed in the 4th group, which received 15% LP and followed by the 5th (184. 7g), 3rd (180.5 g) 2nd 176.1 g) and 1st (172.5 g), which received 20, 10, 5 and 0 % LP, respectively. The differences between the treatment and the control group, and among the treatments were not significant (*p*>0.05). Among the females, however, the highest BW value was observed in the 3rd group with 211.1g, it was followed by the 5th (205.9 g), 2nd (204.1 g), 4th (201.9 g) and 1st (201.1 g). Same as in male, no significant differences were observed (*p*>0.05) among the females in all groups.

Table 3 – The least square means of body weight (g) and standard error (±) of quails

	Treatment groups					
	1	2	3	4	5	Sig. level
M	172.5±4.8	174.1±5.5	179.5±6.9	185.9±6.3	184.7±5.4	0.0790
F	201.1±7.3	204.3±6.4	211.1±5.4	201.9±5.8	205.9±5.9	0.4634
M+F	187.2±4.2	189.7±4.3	195.5±4.3	192.6±4.3	195.3±4.1	0.7354
FI	623.37±1.02a	580.48±1.02b	596.83±1.02c	618.654±1.02d	630.0±1.02e	0.001**
FCR	3.41±0.03a	3.04±0.03b	3.04±0.03b	3.19±0.03c	3.22±0.03c	0.001**

*a, b, c: Differences between means of the same line with different letters are significant. M: Male, F: Female. FI: Feed intake, FCR:Feed conversion ratio; **: *p*<0.01.

Carcass Traits (CT)

After sacrificing the birds (ten males and ten females/group) at the end of the 6th week of the experiment, carcass traits of the birds were summarized in Table 4. Dressing percentage of the quails were affected by the treatment with 15 and 20% LP inclusion (*p*<0.05), even though lower dressing percentage was observed in 5 and 10% of LP groups than in the control, the differences were not significant in males (*p*>0.05) as in females. The best dressing percentage was observed in the control group. The average breast weight, which is the most important part of the quail carcass, was not affected by inclusion of LP with any doses in both genders. Similar results were observed in terms of liver weight.

Egg Traits (ET)

The egg yields were linearly increased (*p*>0.05) by including 5% (89.9) and 10% (90.8) of LP, however it was decreased (*p*>0.05) tremendously by including 15% (78) and 20% (66.6) of LP in comparison to the controls. No significant differences (*p*>0.05) were noticed in terms of egg weights and yolk indexes between treatment and control groups. Haugh Unit (HU) and Internal Quality Unit (IQU) was observed pretty high due to measurement taken one day after laying, however, the best one was noticed in control groups (Table 5). In general, LP treatment decreased (*p*>0.05) HU and IQU even though no significant differences were observed between the control and 15% LP group. Including of LP linearly increased the yolk color. The color of the yolk was increased linearly by LP treatment (*p*<0.05). The lowest value (3.46) was noticed in the control and the highest (4.80) one was in the 15% LP group.

Table 4 – Some carcass traits of quails in different treatment groups

		Treatment Groups					
Traits		control	5%	10%	15%	20%	Sig. level
	M	70.37±1.94a	69.31±2.17a	68.94±1.94a	60.00±2.17b	61.06±2.17b	0.01
Dressing %.	F	63.78±5.6	64.18±5.12	61.69±5.6	57.19±5.6	62.96±5.12	0.89
	M+F	66.58±3.01a	62.13±3.03ab	64.82±3.02ab	58.17±3.18b	62.11±3.03ab	0,05
Breast (g)	M	41.7±2.3a	40.48±2.6a	43.56±2.3a	44.02±2.6a	39.14±2.2a	0,64
	F	44.78±2.1a	44.22±1.9a	46.54±2.1a	45.37±1.9a	43.38±1.4a	0,85
	M+F	43.29±1.52a	42.42±1.52a	45.05±1.52a	44.52±1.52a	41.37±1.52a	0,43
Liver (g)	M	2.93±0.3a	2.75±0.3a	2.98±0.3a	3.88±0.3a	3.42±0.3a	0,23
	F	5.19±0.4a	4.18±0.4a	5.06±0.4a	4.09±0.4a	4.86±0.4a	0,24
	M+F	4.06±0.2a	3.45±0.2a	4.02±0.2a	3.86±0.2a	4.13±0.2a	0,50

Mean±standart deviation a, b: Differences between means of the same line with different letters are significant. M: Male, F: Female.

DISCUSSION

We want to point out that this study is most probably the first one about lentil byproduct on quail production. That's why it couldn't be much discussed

Table 5 – Egg production and some egg quality traits in different treatment groups

	Treatment groups					
Traits	control	5%	10%	15%	20%	Sig. level
Egg yield, %	88,23±0,79a*	89,90±0,77ab	90,78±0,78b	78,04±0,78c	66,57,22±0,8d	0,01
Egg weight, gr	11.17±0.29	11.38±0.30	11.24±0.29	11.36±0.29	10.46±0.29	0,170
Yolk index	44.32±1.25	43.56±1.34	40.68±1.25	44.13±1.29	43.35±1.25	0,260
Haugh Unit	91.30±0.74a	87.57±0.77c	87.21±0.71c	89.85±0.74ab	88.44±0.77bc	0,001
IQU	57.92±2.00c	48.76±2.08b	47.94±1.92a	54.06±2.00bc	52.98±2.08b	0,004
Color	3.46±0.30a	3.64±0.31ab	3.73±0.30ab	4.80±0.30c	4.33±0.30bc	0,015

*a, b, c: Differences between means of the same line with different letters are significant. IQU; Internal quality unit

with quail studies. We tried to compare our results to other poultry breeds and leguminous seeds.

The inclusion of LP in excess of 5, 10, 15 and 20 % didn't alter BW much (p>0.05), however, BW tended to increase in all treatment groups in comparison to the control. In the sight of these results, up to 15 and 20% of LP could be included in the diet of female and male quails with no negative effects. Similar results were reported by Yalcın *et al.,* (1991) for broiler. The result of this study is in contrast to results of researchers (Kanat, 1992; Kanat & Camcı; 1993; Çabuk *et al.,* 2014) who noted that using more than 15% of LP in quail diets had negative effects on the birds'egg and BW performance. Besides, using boiled cowpea (14 %) and black common bean (14 %) to replace fish meal and meat meal, members of leguminous family like lentil, in broiler diet acquired lighter weight gains (p<0.05) compared to the control group (Defang *et al.,* 2008). The heavier BW in the present study disagrees with the findings of Defang *et al.,* (2008). Similar results were also reported by Amaefule & Osuagwu (2005) that including row Bambara groundnut up to 20% into chicken starter and finisher diet to replace maize reduced BW gain. In a research, Bambara groundnut didn't have positive effect on BW gain but made diet cheaper (Onwuke & Equakun, 1994).

Defang *et al.,* (2008) reported that observing some increment in the liver and gizzard size may be related to the boiling which did not reduce toxic anti-nutritive compounds in the diets. The performance of data of broiler chicks fed the diets containing different level of plant concentrate which including faba bean, cowpea, pigeon pea and alfalfa meal showed that 5% plant concentrate had higher dressing carcass percentage (69.76%) than the control (67.63 %), however, 15% plant concentrate had the lowest (63.79 %; p>0.05) dressing percentage (Atti *et al.,* 2011). Carcass weight and dressing percentage were not affected (p> 0.05) by up to 15 % cowpea in diet (Abdelgani *et al.,* 2013; Kur *et al.,* 2013). This similarity to the present study could be related to similar feed intake and diets of groups that were all isocaloric and isonitrogenous.

Observing significantly lower (p<0.01) feed intakes of the quails in all treatment groups except 20% of the control group indicating that adding LP into the quail diets did not have negative effects but also had positive effects in terms of FI. Similar results were also observed in the FCR. This indicates that the value of the FCR decreased when quail diets are included with the LP under investigation. These results are consistent with observation of Çabuk *et al.,* (2014) who demonstrated that there were no differences (p>0.05) between the treatments through 11 weeks of experiment period in quail's diet containing up to 20 % LP. In some researches, the effects of some legume seed on broiler performance were significantly lower FI (p<0.05) by the inclusion of faba bean, cowpea, pigeon pea and alfalfa meal (Atti *et al.* 2011), lower FI and FCR (p<0.05) by adding 5% raw bambarra groundnut (Osuagvu & Amaefule, 2005), no significant change (p>0.05) on FCR by inclusion of boiled cow pea and black common bean were (Atti *et al.* 2011; Abdelgani *et al.* 2013; Kur *et al.* 2013) noted. The results of the present study disagree with results of Abdelgani *et al.* (2013) and Kur *et al*. (2013).

If Table 4 is evaluated overall, it could be seen that the inclusion of LP up to 15 or 20 % into the diet didn't alter dressing percentage of female of quail much but it did in males. That means that inclusion of 15 and 20% LP decreased dressing percentage of male quails due to the negative effect of LP. These results indicate that using LP up to 10% is not recommended in terms of dressing percentage in quail diets. Unlike the dressing percentage, the breast, the best carcass part of quails to eat and liver, were not significantly affected (p>0.05) by the inclusion of LP in the diet. These results show us breast weight or percentage should be used instead of dressing percentage in terms of CT. So, up to 15 % inclusion of LP could be used in quail diets because breast weights of 15% treatment group was higher than the control one. Even though the control group had higher breast weight than 20% LP group, the differences were not significant.

It may be concluded with these results that the inclusion of LP up to 15 % in quail diets may not have adverse effect on carcass features. In contrast to the results of the present study was by Defang *et al.* (2008) indicated that the significantly higher (p<0.05) carcass yield was observed in the groups with boiled cowpea diet in comparison to the other treatment groups. The authors also recommended that boiling cowpea and black common bean under uncontrolled temperature and pressure for 30 min could not be used to formulate broiler's diet. Besides, the proportion of the heart, liver and gizzard were higher for birds fed with the treatment diets (Defang *et al.* 2008). Previously Teguia *et al.* (2003) noted similar results to Defang et al. (2008) that when birds of the same strain were fed raw cowpea and Bambara groundnut, the low carcass yield was attributed to the presence of untinutritional factors (ANFs) in the diet.

The observation of higher egg yield in 5 and 10% LP groups and lower egg yield in 15 and 20% groups in comparison to the control group indicating that the inclusion of LP in quail diets shouldn't be used more than 10%. However, it is useful and has positive effect on egg yield when up to 10% LP is added to the quail diets. Çabuk *et al.* (2014) who demonstrated that the inclusion of 10 and 20 % LP in the diet increased (p<0.01) hen-day egg production above that of the control group, in our study, inclusion of 10 % LP increased egg production but 20% LP significantly decreased it. In contrast to our results, inclusion of 10% LP decreased hen-day egg production (Kılıçalp & Benli, 1994). In this study, egg weights just tended to increase in treatment groups (except 20%) in comparison to the controls but differences were not significant. However, Çabuk *et al.* (2014) who reported that while the inclusion of 10% LP did not alter the egg weight significantly, inclusion of 20% LP reduced the egg weight (p<0.01) compared to the control diet. In contrast to our results, Kılıçalp & Benli (1994) indicated that the inclusion of dietary LP in excess of 10% significantly decreased egg weight.

As an internal quality of the egg, yolk index did not change significantly with the inclusion of LP but HU and IQU were significantly altered by the inclusion. Yolk color is one of the very important factors on our perception of food and is the key demand of the food quality (Bovskova *et al.* 2014). Egg yolk color varies from pale yellow to dark orange (Beardsworth *et al.* 2004). In laying hens, yolk color is generally determined by the content and profile of carotenoids present in the diet and can easily be affected by their feed ingredients (Hernandez *et al.* 2005: Laudadio at al. 2015). The yolk color in the treatment groups linearly increased when the inclusion of LP increased compared with the control diet in this study. This result is in agreement with results of Çabuk *et al.* (2014) who noted that the yellowness was increased by the inclusion of 20% LP, but not by 10%. This result indicated that increased deposition of yellow pigment in the yolk was due to the inclusion of LP in the diet of quails.

CONCLUSION

Lentil byproduct could be easily found in many countries such as Canada, India and Turkey, which they lead in production of lentil in the world. This byproduct is mostly used in ruminant diets, not in poultry in such countries mentioned above. Since the use of up to 15% of lentil by product in the diet didn't have adverse effect on BW carcass features and FCR, it could be used in the diet of quails to reduce cost of feed. Considering that yolk color is one of the important factors for consumer demands, Lentil byproduct could be used to increase yolk color. More research is needed to assess the effects of different lentil byproduct on the performance of quail and other poultry species. As in other leguminous, tannins are present in lentil and they have not been eliminated. These tannins could affect animal physiology, and it may decrease utilization of nutrients by enzyme inhibitor (Arora, 1983; South and Miller 1998; Kaya *et al.* 1999). For that reason, the effect of lentil byproduct on poultry should be investigated after heat treatments.

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