Effect of Rice Bran on Productivity, Hatchability and Yolk and Blood Lipid Profile of Laying Japanese Quail

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ABSTRACT: A total number of 216 female and 108 male Japanese quail at 14 wks of age were used in a 7-week-trial to investigate the effect of rice bran on the quality and quantity of egg production as well as blood lipid profile. There were three dietary treatment groups: a control group fed on a corn-soybean based diet, 12.5 and 25.0 % rice bran diets. Results showed that egg laying rate, egg weight, egg mass and feed conversion ratio were insignificantly affected by treatments. Egg quality insignificantly affected by different treatments. The results showed significant decrease in egg yolk total lipids and cholesterol due to inclusion of rice bran in the diets in comparison with the control group. Hatchability and fertility was not influenced by different treatments. Blood serum total lipids, triglycerides, low density lipoprotein were significantly decreased, however, high density lipoprotein increased with increasing level of rice bran in the diet. Rice bran treatments showed significant ($P \leq 0.01$) increase in concentration of TAC than control group reached to 32.6 and 66.3 % for birds fed 12.5 and 25 % rice bran containing diets, respectively. Numerical increase in glutathione peroxidase in the group given 12.5 and 25 % rice bran containing diet as compared to the control group. In conclusion, egg laying rate and egg quality insignificantly affected by rice bran, however, the results showed significant improvements in blood and egg lipid profile, beside the antioxidative status as a result of inclusion fresh rice bran in the diet.

Key words: Quail, rice bran, laying performance, egg quality, lipid profile

INTRODUCTION

Chicken eggs are recognized as a perfect source of protein, lipids, vitamins and other valuable nutrients, but eggs also contain a high level of cholesterol, which is strongly associated with cardiovascular diseases. The current recommended level for daily intake of cholesterol is less than 300 mg and people often limit their egg consumption to avoid increases in the blood cholesterol levels (AHA, 1996; Carrillo-Domínguez *et al.,* 2005). Therefore, approach to reduce the cholesterol content in eggs not only helps to improve public health efforts, but it can also be beneficial for the egg industry. Recently, dietary supplementations of probiotic strains (Abdelqader *et al.,* 2013; Lei *et al.,* 2013; Zeweil *et al.,* 2016), vegetable oils (Zeweil *et al.,* 2013) and fiber feed ingredients (Olgun and Yıldız (2015) have already been used to regulate the egg yolk cholesterol concentration.

Rice bran, a major by-product from the rice milling process, has been used as an ingredient in livestock feed. It is probably the most widely used cereal by-product available. The feeding value of rice bran used as an ingredient in poultry feed has been reviewed by Farrell (1994). Because of its high oil content (20%), rice bran is poorly metabolized by young birds (Warren and Farrell, 1990). Rice bran oil contains a high concentration of unsaturated fatty acids (80-85%) which easily become rancid, especially under warm and humid climatic conditions. Hussein and Kratzer (1982) found that the free fatty acid content of rice bran fat was increased from 13.7% before storage to 42.8%

during 3-month storage period. Srinivasan *et al.* (2007) demonstrated that dietary rice bran is an excellent source of phytochemicals with antioxidative properties, such as β-sitosterol and a wide variety of phenolics and carotenoids. Ferulic acid, a well-studied phenolic compound, has been shown to be an effective scavenger of superoxide anion radicals and inhibitor of lipid peroxidation. Calabrese *et al.* (2008) demonstrated that ferulic acid protected against hydrogen peroxide–induced cellular damage through increased cellular levels of heme oxygenase-1 and heat shock protein-70. A limited number of studies have been conducted to evaluate the feeding value of rice bran for Japanese quail. Studies with other poultry species have shown that layer chickens and ducks can tolerate as high as 40% dietary rice bran while broilers can tolerate a maximum of 20% (Farrell, 1994). These differences may be attributed to the extent to which respective species/type of poultry can tolerate the anti-nutrients such as phytate, fibre, anti-proteolytic substances and lipase present in rice bran. Therefore, this study aimed to investigate the effect of rice bran,(not stored more than 14 day) on the quality and quantity of egg production as well as blood lipid profile in Japanese quail laying hens.

MATERIALS AND METHODS

This study was carried out at the Poultry Research Laboratory belonging to Animal and Fish Production Department, Faculty of Agriculture (Saba Basha), Alexandria University.

Three hundred and twenty-four (216 females and 108 males) Japanese quail of 14 weeks-old which had been in production for ٧weeks were weighed and randomly allocated in a completely randomized design considering three treatments groups, 108 birds each (72 females and 36 males), and each in three replicate per treatment. The birds were selected on the basis of more than 70 % egg production rate after a two-week observation period. All birds were reared under similar hygienic and managerial conditions. Rice bran was included at levels of 0, 12.5 and 25.0 % and fed to 21weeks of age. The samples of rice bran were obtained from the milling of rice (*Oryza sativa L.*) namely Sakha 104 a popular short grain Japonica cultivar for the consumption in Egypt. Rice bran obtained from the milling of rice 4 times and each not stored more than 14 days. The composition and calculated analysis of the experimental diets are shown in Table (1). Fresh feed was mixed weekly and not stored for more than one week. The hens were reared in wire batteries under similar environmental conditions. All birds had full access to feed and fresh water. The photoperiod was 16 hours of light per day throughout the experimental period, which lasted for 7 weeks from January to February. Records were kept for egg number, egg laying rate, feed consumption, egg weight and average body weight change. Measurements of egg quality were taken on average of 21 eggs from each treatment and were performed through two consecutive days per month. Yolk cholesterol was extracted and measured by the method of Folch *et al.* (1956) as modified by Washburn and Nix (1974) from three eggs of each replicate.

Table (1). Composition and calculated analysis of the experimental diets.

Ingredients	Rice bran %		
	0	12.5	25
Yellow corn	59.40	50.00	40.05
Soybean meal (44 %)	22.8	20.30	17.50
Concentrate (50 %) **	10.00	10.00	10.00
Di-calcium phosphate	0.30	0.20	0.20
Limestone	5.50	5.25	5.28
Sunflower oil	1.00	0.75	1.00
Vit. and min. mix.*	0.50	0.50	0.50
Salt (NaCl)	0.50	0.50	0.50
Rice bran [1]	0.00	12.50	25.00
Total	100	100	100
Calculated analyses[2]:			
Crude protein, %	20.08	19.93	19.60
ME (Kcal/ Kg diet)	2905	2879	2874
Ether extract, %	2.59	4.30	5.52
Crude fiber, %	3.05	4.07	5.07
Methionine, %	0.41	0.73	0.66
Methionine + cystine, %	0.56	0.57	0.58
Lysine, %	1.03	1.01	1.00
Calcium, %	2.96	2.85	2.85
Av. Phosphorus, %	0.38	0.38	0.39

*Each kg of vitamin and minerals mixture contained: Vit. A, 4,000,000 IU; Vit. D3, 500,000 IU; Vit, E, 16.7 g., Vit. K, 0.67 g., Vit. B1, 0.67 g., Vit. B2, 2 g., Vit. B6, 0.67 g., Vit. Bi2, 0.004 g., Nicotinic acid, 16.7 g., Pantothenic acid, 6.67 g., Biotin, 0.07 g., Folic acid, 1.67 g., Choline chloride, 400 g., Zn, 23.3 g., Mn, 10 g., Fe, 25 g., Cu,1.67 g., I, 0.25 g.,Se, 0.033 g.,Mg, 133.4 g.

** Concentrate: ME (K cal/kg) 2870, Crude protein 50%, Crude fiber 1.19%, Crude fat 6.16%, Calcium 7.3%, Phosphorus 3.2%, NaCl 1.44%, Methionine 1.65%, Methionine & Cystine 1.98%, Lysine 2.58%.

[1] Rice bran contain 14% crude protein; 3980 ME/kg; 0.59% lysine; 0.26% methionine; 0.35% methionine + cystine; 0.07% calcium; 0.22% available phosphorus; 11.4% crude fiber; 13.0% crude fat.

[2] According to NRC (1994).

Eggs were collected during the 21week of age for 7-day period and were stored in an egg room at 15.5° C dry bulb and 70 % relative humidity. They were incubated at 37.6 ℃ and relative humidity was 55-60% and hatched at 37.3 ℃ and relative humidity was 65-70% in automatic incubators. The removed eggs and eggs not hatched on day 18 were broken to differentiate infertile eggs from those containing dead embryos. Fertility was calculated as number of fertile eggs as relative to total number of eggs set; meanwhile hatchability was calculated as number of healthy hatched chicks as relative to total fertile number of eggs set; embryonic mortality percentage expressed as percentage of fertile eggs set was recorded on day 18 to differentiate the first and second embryonic death. Blood samples from the brachial vein of 4 hens in each treatment were drawn and serum were obtained by centrifugation of blood at 3500 r.p.m. for 15 min. and kept at – 18º C until analyzing. Serum total protein, albumin, total lipids, cholesterol, low density lipoprotein , high density lipoprotein, total antioxidant capacity and glutathione peroxidase were, calorimetrically, determined using commercial kits (from Biomerieux, Poains,

France). The proximate analysis of feed was carried out according to A O A C (2000). Data was statistically analyzed according to SAS program (SAS Institute, Inc., 1994) using general linear model (GLM) and the significant differences among treatments were determined using Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSIONS

Results presented in Table 2 showed that different levels of rice bran inclusion in the diet had no significant effects on egg laying rate, egg weight, egg mass and feed conversion ratio as compared with the control. However, body weight change was significantly decreased in the groups given 12.5 and 25 % rice bran containing diets in comparison with the control group, even they consumed more feed comparing to the control. These results were in agreement with those of Amoah and Martin (2010) who reported that performance of laying type quail fed 20% full fat rice bran was comparable with those fed control diet. On the other hand, Abeyrathna *et al.* (2014) reported that the total egg production of quail fed diet containing 40% rice bran was significantly lower than that of birds fed 20 and 30% of rice bran.

The results in Table 3 showed that egg weight, specific gravity, percentage of albumin weight, egg shape index, yolk weight, yolk weight percentage and yolk color were not significantly affected by rice bran inclusion in the diet. On the other hand, absolute albumen weight was significantly ($P \leq 0.05$) increased with 12.5 % rice bran containing diet than the group fed control diet, also, the group given 25 % rice bran increased absolute albumin weight, but the increase was not significant. Significant ($P \leq 0.01$) decrease in albumin height in the group received 25 % rice bran was recorded as compared to the group had 12.5 % rice bran, , however, the groups had 12.5 and 25 % rice bran in their diets was not significantly differ in comparison with the control group. Significant ($P \leq 0.05$) increase in yolk index was observed in the group received 25 % rice bran in their diet in comparison with control group, while the group given 12.5 % rice bran diet did not different significantly than the control group. Egg shell weight was significantly ($P \leq 0.05$) deteriorated by increasing the level of rice bran in the diet and this deterioration reached significant with 25 % rice bran diet in comparison with the control group. The results showed also numerical deterioration in egg shell percentage and egg shell thickness due to increasing level of rice bran in the diet. The results obtained by Nobakht (2007) stated that egg quality did not significantly affected by inclusion different levels of rice bran in laying hen diets. The results obtained by Hagnazar and Rezaei (2004) indicated also that there were insignificant difference in egg quality with inclusion rice bran in laying hen diets up to 25 %. The same results were obtained by Filardi *et al.* (2007) reported that the inclusion of rice bran up to 15% in the diet had no negative effect on egg quality of commercial laying hens. On the other hand, Ademola *et al.* (2012) reported that laying hens fed diet containing 20 % rice bran had the best Haugh units, shell thickness, yolk and shell weights as compared to laying hens fed 40 % rice bran containing diet. Also, Samli *et al.* (2006) showed that Haugh units significantly improved by using up to 15 % rice bran in laying hen diets.

Table (2). Performance of laying Japanese quail hens fed on the experimental diets.

Parameters	Rice bran %			P value
	0	12.5	25	
Body weight change, g	8.04±2.68	-6.36±3.82[b]	-6.51±2.84[b]	0.001
Egg production, % hen-da y	76.91±2.11	76.22±2.50	74.18±2.44	0.692
Egg number, hen/day	0.77±0.02	0.76±0.02	0.74±0.02	0.629
Mean egg weight, g	13.23±0.16	13.45±0.14	13.33±0.12	0.429
Egg mass/hen/day, g	10.16±0.25	10.27±0.41	9.87±0.26	0.653
Feed consumed /hen /day, g	32.31±0.50[b]	34.08±0.31	33.43±0.45[ab]	0.026
Feed conversion ratio	3.18±0.08	3.34±0.14	3.39±0.08	0.392

[ab..] Means having the different small letters in each row are differ significantly (P≤0.05)

Table (3). Egg quality and egg yolk lipid profile of laying Japanese quail hens fed on the experimental diets.

Parameters	Rice bran %			P value
	0	12.5	25	
Egg weight, g	13.38±0.19	13.67±0.21	13.14±0.19	0.1737
Egg specific gravity	1.074±0.001	1.074±0.001	1.074±0.001	0.8449
Albumen height, mm	2.62±0.08[ab]	2.91±0.13	2.43±0.12[b]	0.0063
Albumen weight, g	5.85±0.18[b]	6.36±0.15	5.89±0.15[ab]	0.0543
Albumen ,%	43.68±1.13	46.74±1.13	44.85±1.04	0.1550
Yolk weight, g	4.28±0.07	4.30±0.08	4.25±0.08	0.931
Yolk, %	32.12±0.63	31.55±0.55	32.49±0.61	0.541
Yolk color	3.69±0.09	3.51±0.13	3.51±0.11	0.4396
Yolk index	420.92±1.05[b]	449.59±1.02[ab]	472.90±0.66	0.006
Egg shell weight, g	1.151±0.022	1.117±0.019[ab]	1.084±0.017[b]	0.0550
Egg Shell ,%	8.625±0.153	8.219±0.162	8.277±0.133	0.1194
Egg shell thickness, mm	0.246±0.004	0.243±0.004	0.244±0.004	0.8157
Egg yolk lipid profile:				
Total lipids, g/100g yolk	307.05±7.37	270.03±4.40[b]	227.37±1.721[c]	0.0001
Total cholesterol, g/100g yolk	12.57±0.17	11.81±0.21[b]	11.76±0.18[b]	0.005

[ab..] Means having the different small letters in each row are differ significantly (P≤0.05)

The obtained results showed significant decrease (P ≤ 0.01) in egg yolk total lipids and cholesterol due to rice bran inclusion in the diets in comparison with the control group. Our results were in agreement with the results presented by Dung *et al.* (2012) reported that levels of 2.5 and 3% of rice bran oil had beneficial effect on lowering egg yolk cholesterol. But the results of Safamehr and Attarhoseini (2011) and Abeyrathna *et al.* (2014) showed that inclusion of the rice bran in laying hens diets did not significantly influence cholesterol in egg yolk as compared with the control group.

In the present study, hatchability and fertility was not influenced by different treatments (Table 4). Also, the results of Awad *et al.* (2011) showed no significant differences were found among groups fed diets contained rice bran at levels of 16 and 24 % as compared to those of the control for egg fertility, hatchability, early and late embryonic mortality percentages and chick weights.

Table (4). Fertility and hatchability traits of Japanese quail hens fed on the experimental diets.

Parameters	Rice bran %			P value
	0	12	25	
Fertility, %	90.19±0.99	90.83±0.62	90.78±1.12	0.896
Hatchability, %	82.43±1.17	85.43±1.70	83.72±1.15	0.350
Early embryonic death, %	1.87±0.54	2.03±0.58	2.27±0.61	0.901
Late embryonic death, %	3.48±0.79	2.86±0.74	2.83±0.77	0.793
Hatch chick weight,g %	8.97±0.10	9.09±0.19	9.09±0.14	0.880

Blood serum total lipids, triglycerides, low density lipoprotein were significantly decreased, however, high density lipoprotein increased with increasing level of rice bran in the diet (Table 5). The increase in high density lipoprotein concentration reached to 30.5 and 34.4 % for birds fed 12.5 and 25 % rice bran containing diets, respectively. On the other hand, the obtained results showed that different levels of rice bran had insignificant effect on total cholesterol concentrations as compared with the control group. Dung *et al.* (2012) indicated that crude rice bran oil is a rich source of phytoceuticals such as, oryzanol, tocopherols, tocotrinols and linoleic acid. Gamma oryzanol is one of a component having antioxidant property. The role of gamma oryzanol in decreasing plasma or serum cholesterol was showed by Kahlon (1992a, b), lowering cholesterol absorption, decreasing platelet aggregation and lowering LDL-cholesterol were well documented (Patel and Naik, 2004).

Table (5). blood Serum lipid profile, total antioxidant capacity and glutathione peroxidase of laying Japanese quail hens fed on the experimental diets.

Parameters	Rice bran %			P value
	0	12.5	25	
Total lipids (mg/dl)	716.00±29.98	599.88±30.00^{b}	639.44±28.37^{b}	0.007
Triglycerides (mg/dl)	335.22±24.17	208.33±20.40^{c}	258.00±25.28^{b}	0.0001
Cholesterol (mg/dl)	179.44±3.02	173.50±2.78	178.20±4.26	0.232
Low density lipoprotein (mg/dl)	49.66±1.13	49.22±1.52	42.22±1.09^{b}	0.0001
High density lipoprotein(mg/dl)	62.66±3.51^{b}	81.77±5.02	84.22±6.43	0.0051
Totalantioxidantcapacity(mm/L)	0.89±0.04^{c}	1.18±0.14^{b}	1.48±0.09	0.001
Glutathioneperoxidase(nmol/ml)	45.44±5.71	49.56±7.41	54.33±8.06	0.593

$^{ab.}$ Means having the different small letters in each row are differ significantly ($P \leq 0.05$)

The results presented by Abd El-Hady (2013) reported that, full fat rice bran is more effective in cholesterol lowering than either rice bran oil or defatted rice bran, certainly due to the presence of comparatively high levels of tocopherol, tocotrienol and oryzanol as well as unsaponifiables. These results are supported by those of Minhajuddin *et al.* (2005), Wilson *et al.* (2007) and Zigoneanu *et al.* (2008). Also, Abd El-Hady (2013) observed that, full fat rice bran showed slight improvement in serum HDL-cholesterol of rats followed by rice bran oil and defatted rice bran in comparison with the control group.

The results illustrated in Table 5 showed significant (P ≤ 0.01) decrease in serum total antioxidant capacity (TAC) in the control group, however, inclusion of rice bran showed significant (P ≤ 0.01) increase in concentration of total antioxidant capacity surpassed the control one by 32.6 and 66.3 % for birds fed 12.5 and 25 % rice bran containing diets, respectively. The results of Liang *et al.* (2014) reported that lipid oxidation can be prevented by rice bran oil in poultry muscle, due to having different compounds such as: gamma-oryzanol, tocotrienols, tocopherols and squalene. Seifi *et al.* (2015) showed that the decrease of TBARS values in chicken muscle which has been injected by rice bran oil may be due to the increase of the ratio of other components like tocopherol, tocotrienol, and oryzanol in the products that come from rice bran oil. Kim *et al.* (2000) and Chae *et al.* (2002) demonstrated that rancid rice bran reduced TBARS value in chicken meat.

Glutathione peroxidase was insignificantly affected by rice bran levels, however, it was observed numerical increase in glutathione peroxidase in the group given 12.5 and 25 % rice bran containing diet. This increase surpassed the control one by 9.1 and 19.6 %, respectively. Seifi *et al.* (2015) found that the level of glutathione was higher either in muscle or heart in that group which has been injected by rice bran oil into the yolk as compared to control group. These results also confirmed the antioxidant capacity power of rice bran oil (Öztürk-Ürek *et al.,* 2001).

In conclusion, egg laying rate and egg quality insignificantly affected by rice bran, however, the results showed significant improvements in blood and egg yolk lipid profile and diminished oxidative status as a result of inclusion fresh rice bran in the diet. A number of human (Lai *et al.,* 2012; Mäkynen *et al.,* 2012) and animal (Mobarak *et al.,* 2010) studies have shown that rice bran and rice bran oil have hypocholesterolemic effects, results of this experiment suggested that such an effect does exist in laying Japanese quail.

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الملخص العربي

تأثير رجيع الكون على الانتاج ، الفقس، مستوى الدهون فى الصفار والدم فى السمان اليابانى البياض

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أستخدم عدد ٢١٦ انثى ، ١٠٨ ذكر سمان يابانى عمر ١٤ أسبوع فى تجربة أستمرت لمدة ٧ أسابيع لدراسة تأثير أضافة رجيع الكون فى العليقة على جودة ومعدل انتاج البيض بالاضافة الى تأثيره على دهون الدم وصفار البيض. أستخدمت ثلاث معاملات غذائية ، مجموعة كونترول ضابطة تناولت عليقة من الذرة الصفراء وكسب الصويا، مجموعة تناولت عليقة تحتوى ١٢.٥ % رجيع الكون الطازج (لم يخزن أكثر من ١٤ يوم) ، مجموعة تناولت عليقة تحتوى ٢٥ % رجيع الكون الطازج. أوضحت النتائج أن معدل انتاج البيض ، وزن البيض، كتلة البيض، والكفاءة

التحويلية لم تتأثر بالمعاملات المختلفة. لوحظ انخفاض في الدهون الكلية وكولسترول صفار البيضة نتيجة أضافة رجيع الكون فى العليقة مقارنة مع المجموعة الضابطة. لم يتأثر كل من نسبة الخصوبة والفقس بالمعاملات المختلفة. أنخفض كل من الدهون الكلية ، الجلسريدات الثلاثية ، الكولسترول منخفض الكثافة بينما أرتفع الكولسترول مرتفع الكثافة نتيجة لاحتواء العليقة على رجيع الكون الطازج. معاملات رجيع الكون أدت الى زيادة تركيز الصفات الضد تاكسدية مقارنة مع المجموعة الضابطة وصلت الى ٣٢.٦ ، ٦٦.٣ % للطيور التى تناولت ١٢.٥ ، ٢٥ % رجيع الكون على التوالى. تلاحظ زيادة رقمية فى تركيز الجلوتاثيون بيروكسيديز نتيجة لاضافة رجيع الكون فى العليقة مقارنة مع المجموعة الضابطة. وخلاصة الدراسة أن معدل انتاج البيض وصفات جودة البيض لم تتأثر برجيع الكون ولكن تلاحظ تحسن معنوى فى محتوى الدم وصفار البيض من الدهون بجانب الصفات الضد تأكسدية نتيجة لاضافة رجيع الكون الطازج .