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The Effects of Restaurant Residuals in the Diet on General Performance, Egg Characteristics, Blood Parameters and Intestinal Morphology of Japanese Quails

Research Article

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ABSTRACT

This study was conducted to investigate the effects of different levels of restaurant residuals (RR) on blood parameters, intestinal morphology, eggs characteristics and performance of layers Japanese quails. This experiment included 300 layers Japanese quails (age 10-18 weeks) arranged in 5 treatments, 4 replicates and 15 quails in each in a completely randomized design. The treatments consist of control diet (corn-soybean meal) and supplementation of control diet by 5, 10, 15 and 20% RR, respectively. Feed intake was significantly higher by 5% RR than 20% RR treatment (P<0.05). Egg weight was increased by receiving 20% RR compared with control group (P<0.05). Also, yolk weight of treatments containing 10, 15 and 20% of the RR were significantly higher than control (P<0.05). The serum cholesterol concentration of control group was significantly higher than 5, 10 and 15% RR-fed groups (P<0.05). However, quail egg yolk cholesterol increased significantly by treatments 15 and 20% RR. At the end of the experiment, intestinal contents viscosity was significantly higher by 10 and 15% RR group than control. Based on this study, RR could be replaced by some parts of the quail diet without adverse effects on egg quantity and quality with reducing effect on the diet cost.

KEY WORDS cholesterol, intestinal morphology, Japanese quail, performance, restaurant residuals.

INTRODUCTION

In recent decades, restaurant residuals (RR) have been recognized as alternative for feedstuffs in the Japanese quail diets. The RR may contain rich nutrient and digestible material, which can be made available to producers at low cost as well as reduce feed costs. The competition between human and animal in cereals consumption, increasing environmental pollution and the high cost of production feed for livestock which are important reasons for using the some by-products such as RR (Kim *et al.* 2001). The RR disposal in most countries has created concerns in relation to the environment (Myer *et al.* 1999), however feeding made 60 to 70% of daily cost in livestock raising (Dhakad *et al.* 2002). Therefore, increases the grain cost as poultry feed. The RR quality may be different by several factors such as geographical location, weather, human food consumption, method of collection, recycling and chemical composition (Saki *et al.* 2005; Saki *et al.* 2006). Consequently the RR may have a high nutritional value (protein and energy) thus it is possible could replace by some part of the poultry ration especially in Japanese quail. This by-product is a good candidate for utilization since it could be recycled, reduced pollution, improve the current situation, and provide new dietary sources. Increasing costs and problems associated with waste excretion, it increases the need for re-evaluation and utilization of waste in livestock and poultry feed. Rearing of quails can be priority as a source of commercial meat and eggs production (Mello Rezende *et al*. 2009). Because quail eggs have more protein than hen eggs. Moreover, the quail egg yolk contains 73.45mg of cholesterol, whereas the average hen egg yolk contains 200mg of cholesterol (Leeson and Summers, 2001; Tokuşoğlu, 2006). The quails could be a bridge between consumer demand and the availability of animal protein (Chimote *et al*. 2009). One of the strategies to use RR is the use in the diet of livestock and poultry. Also, overpopulation and development of public welfare have lead to increase of food residual quantitative and qualitative. Therefore, the aim of this study was to consider the effect of RR on performance, nutrient digestibility, blood parameters, intestinal morphology and egg characteristic in Japanese quail.

MATERIALS AND METHODS

A total of 300 layer Japanese quails (age 10-18 weeks) were arranged in a completely randomized design (CRD). The experiment was adjusted with 5 treatments, 4 replicates and 15 quails in each treatment (corn and soybean meal) and 5, 10, 15 and 20% of RR were managed as a treatments 2, 3, 4, 5 respectively. Experiment starting at the 10 to 18 weeks of age, the experimental diets was recommended by Brazilian tables guide line (Rostagno *et al*. 2011). The RR was dried at 45 ˚C, grind, and held at -20 ˚C until experiment was performed. At the end of each week feed intake (FI), percentage of egg production (EP), egg mass (EM) and feed conversion ratio (FCR) were recorded and measured weekly.

The first week of the experiment was devoted to dietary adaptations for the laying quail. Than experimental diet was arranged during 8 weeks of production period. The composition and analysis of experimental diets are respectively presented in Tables 1 and 2. Calculated the average weight gain by comparing weights measured at the start and end of the experiment.

Serum biochemistry

In each group eight quail were randomly selected for blood sampling from veins under their wings. The serum samples were separated and were kept at -20 ˚C temperatures until tested. The serum parameters including glucose, cholesterol, triglyceride, high and low density lipoproteins, were measured by Pars Azmon kits (Gowenlock *et al*. 1988).

Intestinal morphology

In order to evaluate intestinal morphology, 2 birds from each replicate were slaughtered at end of experiment and a 2 cm segment of the midpoint of the ileum was dissected.

After 24 hours that the segments were fixed in 10% buffered formalin, paraffin was used to embed the segments. A 5 µm section of the fixed segments was cut which was then stained with haematoxylin and eosin on a glass slide. Analyses were made by the program image. The variables evaluated were height of the villi, villus width and crypt depth (Ruangpanit *et al*. 2020).

Statistical analysis

The experiment was adjusted with 5 treatments, 4 replicates and 15 quails in each treatment. Data were analyzed using GLM procedure of SAS 9.4 (SAS, 2001) according to a completely randomized design. Means were compared by Duncan's multiple range test at $P \leq 0.05$.

RESULTS AND DISCUSSION

Performance

The results of this study have shown thatwere no significant differences in body weight (BW), feed conversion ratio (FCR), percentage of egg production (EP), egg mass (EM) between treatments at end of the experiment (P>0.05). However, there was, a significant difference in feed intake between the treatment 5% of restaurant residues (RR) and the treatment 20% of RR (P<0.05). Furthermore, the results showed that replacing 20% of diet items with RR will reduce ration prices significantly (Table 3).

Egg characteristics

The results have indicated that the yolk weight (YW) related treatments containing 10 and 20% of the RR was significantly higher than control (P<0.05) (Table 4). Eggs white weight of 20 and 5% RR treatments were significantly increased compared with 10% (P<0.05). Furthermore, egg weight (EW), shell surface area and egg surface area by 20% RR were significantly higher than control and 10% RR (P<0.05). There were maximum feed intake by 5 and 10 % RR in comparison 15 and 20% of treatments (P<0.05). In terms of quail EM, percentage eggs production, FCR, EW and the average BW no significant differences were found between treatments (P>0.05).

Serum parameters and egg cholesterol

There were no significant differences between treatments in serum glucose, triglycerides, high-density lipoprotein (HDL) and low-density lipoprotein (LDL) concentration (P>0.05). In contrast,content of serum cholesterol in groups fed diets containing 5, 10 and 15% RR (Table 6) were lower than control diet (P<0.05). Contents of total cholesterol in egg of quails fed 15 and 20% RR-containing diets generally appeared to be higher (Table 7) compared with control group (P<0.05).

Table 1 The analyzed nutrients of the ingredients (% DM)

Ingredient	Dry matter	Crude protein	Totalash	Crude fat	Gross energy (kcal/kg)	Crude fiber
Restaurant residuals	88.90	15.70	3.40	9.00	4476.50	3.12
Corn	90.34	8.15	1.20	3.70	4546.88	2.60
Soybean meal	91.86	46.82	6.70	1.50	4614.10	4.30
Corn gluten	94.86	56.64	1.80	1.51	3715.69	2.50

Table 2 Ingredient, experimental treatments and chemical analysis of diets (%)

Ingredient	Control	A	B	C	D
Corn	62.13	57.61	53.09	48.51	43.91
Soybean meal	25.38	24.55	23.72	22.90	22.09
Restaurant residuals	0.00	5.00	10.00	15.00	20.00
Corn gluten	3.00	3.00	3.00	3.00	3.00
Oyster shell	6.87	6.53	6.19	5.86	5.52
Dicalcium phosphate	1.04	0.99	0.94	0.89	0.85
Salt	0.30	0.26	0.23	0.22	0.23
Vitamin premix	0.25	0.25	0.25	0.25	0.25
Mineral premix	0.25	0.25	0.25	0.25	0.25
Corn oil	0.67	1.43	2.19	2.97	3.75
Methionine	0.11	0.12	0.13	0.14	0.16
Total	100	100	100	100	100
Calculated nutrients					
Metabolizable energy (kcal/kg)	2800	2800	2800	2800	2800
Crude protein (%)	18.71	18.71	18.71	18.71	18.71
Calcium (%)	2.90	2.90	2.90	2.90	2.90
Available phosphorus (%)	0.30	0.30	0.30	0.30	0.30
Sodium (%)	0.14	0.14	0.14	0.14	0.14
Lysine (%)	0.80	0.81	0.82	0.83	0.84
Methionine (%)	0.38	0.39	0.40	0.41	0.42
Methionine + cysteine (%)	0.65	0.66	0.67	0.68	0.68
Analyzed nutrients					
Dry matter (%)	91.26	91.40	92.32	92.46	91.78
Crude ash (%)	7.20	8.10	8.50	7.90	7.40
Crude protein (%)	18.90	18.90	19.00	19.09	18.85
Crude fiber	2.78	2.62	2.47	2.32	2.16
Crude fat	5.33	6.00	6.33	7.00	9.00

Control: restaurant residuals (RR) 0%; A: RR 10%; B: RR 10%; C: RR 15% and D: RR 20%.

Table 3 Effect of restaurant residual on quail performance at 10 to 18 weeks of age

Treatment	FI (g/hen/day)	EM (g/day)	EP (%)	FCR (g/g)	BWG (g)	RPG (Rial)
0	32.13^{ab}	9.96	86.25	3.24	20.15	35063.8^{a}
5	32.58^{a}	9.87	85.01	3.32	19.47	34820^{ab}
10	31.88^{ab}	10.05	87.64	3.18	23.47	32891.9^{ab}
15	31.56^{ab}	10.16	87.64	3.13	23.32	31787.1^{abc}
20	31.33^{b}	10.07	85.02	3.13	22.46	30197.5^{c}
SEM	0.270	0.218	1.905	0.067	0.430	699.40
P-values						
Treatment	0.0378	0.899	0.717	0.249	0.691	0.0037
Linear	0.007	0.471	0.974	0.069	0.315	0.0003
Quadratic	0.329	0.921	0.418	0.756	0.634	0.8219
Cubic	0.175	0.503	0.298	0.217	0.503	0.2050
Initial weight	-	-	-	-	0.814	-
Week	< 0.0001	< 0.0001	< 0.0001	< 0.0001	-	< 0.0001
Treatment × week	0.0053	0.9995	0.9858	0.4007	-	0.4717

FI: feed intake; EM: egg mass; EP: egg production; FCR: feed conversion ratio; BWG: body weight gain and RPG: ration price per kg of eggs produced.
The means within the same column with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Table 4 The effect of different levels restaurant residual on internal egg characteristics

Treatment groups	Albumen weight (%)	Haugh unit (%)	Yolk index (%)	Albumen index (%)	Yolk weight(g)
0	6.98	88.13	42.62	4.79	3.73[c]
5	7.27	88.20	41.92	4.84	3.83[bc]
10	6.83	89.36	42.79	5.09	4.16[a]
15	7.08	87.53	41.87	4.67	4.05[ab]
20	7.36	87.29	42.77	4.66	4.12[a]
SEM	0.089	0.490	0.552	0.136	0.065
P-values					
Treatment	0.0532	0.1667	0.6083	0.4345	0.0016
Linear	0.0767	0.2729	0.5161	0.4617	0.0007
Quadratic	0.0862	0.1752	0.3872	0.3121	0.0336
Cubic	0.0114	0.6919	0.8227	0.6504	0.6555
Week	0.1157	0.4512	0.0013	0.1189	0.0160
Treatment × week	0.0980	0.2729	0.1503	0.1985	0.1654

The means within the same column with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Table 5 The effect of different levels restaurant residual on the diet external egg characteristics

Treatment groups	Shell thickness (mm)	Weight specific (g/mm^3)	Weight unit to surface (g/cm^2)	Egg surface (cm^2)	Shell ratio (%)	Shape index (%)	Egg weight (g)
0	0.27	1.08	0.4647[b]	25.32[b]	9.02	77.29	11.77[b]
5	0.26	1.07	0.4685[ab]	25.95[ab]	8.73	78.54	12.17[ab]
10	0.27	1.07	0.4674[b]	25.75[b]	8.81	77.72	12.05[b]
15	0.27	1.07	0.4688[ab]	25.98[ab]	8.71	78.33	12.19[ab]
20	0.27	1.07	0.4725[a]	26.61[a]	8.75	78.08	12.58[a]
SEM	0.002	0.005	0.001	0.186	0.083	0.431	0.115
P-values							
Treatment	0.1189	0.5028	0.0051	0.0064	0.1711	0.3944	0.0058
Linear	0.5988	0.3334	0.0008	0.0011	0.1291	0.3398	0.0010
Quadratic	0.8452	0.2733	0.8318	0.8004	0.1147	0.4072	0.8058
Cubic	0.5948	0.6875	0.0567	0.0559	0.4916	0.4039	0.0529
Week	0.0002	0.6146	0.272	0.0348	0.5474	0.0196	0.0325
Treatment × week	0.0006	0.9538	0.4900	0.5275	0.9100	0.9839	0.5486

The means within the same column with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Table 6 The effect of different levels restaurant residual diet on the serum parameters of laying quail (mg/dL)

Treatment groups	Glucose	Cholesterol	Triglyceride	HDL	LDL
0	269.52	169.55[a]	410.15	20.624	66.90
5	273.39	139.07[bc]	388.11	15.884	53.56
10	275.22	142.51[bc]	395.78	17.800	57.56
15	307.42	119.71[c]	388.61	19.488	58.51
20	283.45	148.69[ab]	403.74	21.724	88.22
SEM	0.162	1.000	3.102	0.353	8.011
P-values					
Treatment	0.4890	0.0004	0.0762	0.2483	0.0526
Linear	0.2409	0.0041	0.0070	0.3444	0.0799
Quadratic	0.6788	0.0006	0.9260	0.0700	0.0143
Cubic	0.3026	0.3393	0.7377	0.3205	0.6582

HDL: high-density lipoprotein and LDL: low density lipoprotein.
The means within the same column with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Viscosity and intestinal morphology

At the end of the experiment, intestinal contents viscosity in 10 and 15% residual RR containing groups were signify-cantly higher than control (Table 8).

In contrast control and ileum contents were the lowest in amount of viscosity.

Table 7 The effect of different levels restaurant residual diet on yolk cholesterol in quail egg

Restaurant residual levels (%)	Yolk cholesterol (mg/dL)
0	115.16^{b}
5	124.71^{b}
10	117.44^{b}
15	202.07^{a}
20	178.53^{a}
SEM	7.2756
P-values	
Treatment	< 0.0001
Linear	< 0.0001
Quadratic	0.3594
Cubic	0.0012

The means within the same column with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Table 8 The effect of different levels restaurant residual on the ileum villus morphology and ileum content viscosity laying quail

Treatment groups	Villus height	Villus width	Villus area	Crept depth	Viscosity of ileum contents (centipoises)
0	0.762	0.108^{a}	0.0817^{a}	0.057	1.60^{d}
5	0.713	0.113^{a}	0.0809^{a}	0.053	1.67^{c}
10	0.755	0.075^{b}	0.0571^{b}	0.48	1.84^{a}
15	0.796	0.066^{b}	0.0526^{b}	0.047	1.88^{a}
20	0.720	0.067^{b}	0.0486^{b}	0.05	1.74^{b}
SEM	0.036	0.071	0.003	0.031	0.010
P-values					
Treatment	0.505	< 0.0001	< 0.0001	0.200	< 0.0001
Linear	0.982	< 0.0001	< 0.0001	0.0485	< 0.0001
Quadratic	0.689	0.235	0.3166	0.1854	< 0.0001
Cubic	0.089	0.0033	0.0399	0.6207	< 0.0001

The means within the same column with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

The villus ileum width and surface are also significantly higher by control and 5% RR (P<0.05).

Results of this study are comparable with other studies concerning restaurant residual in broilers and laying hens (Cho *et al.* 2004a; Sadao, 2005; Saki *et al.* 2006). Researchers seem to have reported conflicting results due to differences in geographical location, type of food, method of collection and recycling (Saki *et al.* 2006).

The restaurant residual contains relatively high ether extract (EE) (Fung *et al.* 2019). Myer *et al.* (1999) have reported that EE content in restaurant residual ranged from 17 to 24% (DM). The results obtained in the present study have shown that supplemented of control diet by 5, 10 and 15% RR decreased of yolk and blood cholesterol. Researchers have also reported that polyunsaturated fats in layer hens' diets can reduce egg and blood cholesterol (Holland *et al.* 1980; Mori *et al.* 1999).

However, increased of yolk weight, weight unit to surface, egg surface, egg weight and blood cholesterol, by supplemented of control diet by 20% RR. Also, the increase cholesterol content in the eggs yolk may be described by the report of Vargas and Naber (1984), that correlated yolk cholesterol content with dietary energy and excessive energy intake, beyond requirements, increases cholesterol synthesis in liver. Finally, extreme cholesterol would be transferred to the egg yolk.

Soliman *et al.* (1978), Yoshida and Hoshii (1979) and Lipstein (1985) have reported that no significantly differentness were found in egg shape index between treatments during utilization restaurants residue (RR) as the feed. This was matched with present study result. Sadao (2005) and Farhat *et al.* (2001) have shown no significant response was indicated in Haugh unit by RR and this was corresponding by this study results. Cho *et al.* (2004b) have reported that contents of total cholesterol, free cholesterol, cholesterol ester and LDL-cholesterol in blood of broilers fed RR-containing diets generally appeared to be higher compared with control group without significant differences. Our study have shown that similar tendency to this. Also, in this study there were no significant differences between different treatments on HDL concentration and blood glucose concentration. Griffin (1992) has shown that, lipogenesis decreased cholesterol synthesis in the liver by consumption of unsaturated fat. Since the accumulation and storage of cholesterol in liver, increased by feeding fatty acids, polyunsaturated for content in diet and, this could leads to increased secretion of cholesterol in the egg. Reynolds (2006) has shown that high blood glucose stimulates lipogenesis in adipose tissue increases body fat layer thickness. Clearly, the consistencies and inconsistencies described are a result of the restaurant residual type and the methods of process.

No significant differences was found in terms of viscosity by restaurant residual contain in diet by Saki *et al*. (2006), this results was no corresponded by current study results. This condition may be related to the presence of some cereals in the restaurant residual. This assumption by Leeson and Summers (2001) has been confirmed. The crypt can be considered as a factory build villus and the height or depth of crypts showed rapid replenishment tissue and demand for new tissue. Also, the energy and protein requirement for maintaining intestinal is higher in comparison to other organs (Swatson *et al*. 2002; Choct, 2009). However, in this study villus width and villus area of 15 and 20% RR-fed groups were lower than that of control. But, in other treatments, no significant difference were observed with increasing RR level.

CONCLUSION

The final results of this study have shown that the 20% of RR was the best level that could be replace by some part in laying quail diet without any adverse effect on production as well as in reduction of diet price. In addition blood and egg yolk cholesterol were deceased by 20% RR. Otherwise the similar trend was found on villous status, but increased intestinsl viscosity was shown in this respect.

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