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Poultry Byproduct Meal: Influence on Performance and Egg Quality Traits of Layers

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ABSTRACT

This research was conducted to determine the effects of poultry diets containing 0, 2.5, 5 and 7.5% levels of poultry byproducts on layer performance and egg quality. One hundred and twenty eight Hy-Line (W-36) laying hens were randomly assigned to four treatments and four replicates eight layers per replicate. Experiment was 56 day long from 66-74 weeks of age spread over 4 periods; each period was of two weeks. Feed intake (FI), egg production (EP), egg mass (EM), egg weight (EW), feed conversion ratio (FCR), egg shape index (ESI), egg shell thickness (EST), egg shell weight (ESW), Haugh unit (HU) and yolk color score (YCS) were measured. The results indicated that YCS was significantly affected ($P< 0.01$) by dietary treatments. YCS in control group was lesser than the other groups. FI, EP, EM, EW, FCR, ESI, EST, ESW and HU had no significant differences among the dietary treatments. Results suggested that poultry byproduct meal could be used up to 7.5% in layer diets without detrimental effects on performance and egg quality.

Key Words: Poultry by-product meal; Performance; Egg quality; Layer

INTRODUCTION

About 80% of the total animal production cost is feed cost (El Boushy & Van Der Poel, 2000). Providing protein sources as a feedstuff to animals is costly; therefore, reducing feed cost and using feed sources that are not competition with human food source are important to poultry industry. One of the replacements is poultry byproduct meal (PBPM). The feeding value of this product for poultry was established during early 1950s (Senkoylu *et al.,* 2005; Samli *et al.,* 2006). PBPM is one of the byproducts resulting from poultry slaughterhouses and producing by processing of the inedible parts of poultry carcasses including heads, feet and viscera, exception of feathers (Pesti, 1986; Jahanian Najafabadi *et al.,* 2007). A high quality PBPM contains 58 to 63% crude protein, 12 to 20% ether extract and 18 to 23% ash (Senkoylu *et al.,* 2005; Samli *et al.,* 2006). A study by Wang and Parsons (1998) indicated that cystine, tryptophan, threonine and lysine were the first four limiting amino acids in PBPM, while methionine may be slightly limiting in PBPM protein. However, Main and Doghir (1981 & 1982) reported that methionine and lysine were the first and second limiting amino acids in PBPM, respectively.

Some researchers suggested that, PBPM could be included in broiler and layer diets up to 10% level (Bhargava & O'Neil, 1975; Samli *et al.,* 2006). Ertürk and Celik (2004b) found that using different levels of PBPM replaced with soybean meal in the Japanese quail breeders (*Coturnix coturnix japonica*) diets had no significant difference on egg production, egg mass and feed conversion ratio between groups. Raja *et al.* (2001) replaced fish meal by PBPM at 0, 25, 50, 75 and 100% in isonitrogenous and isocaloric layer diets and observed that hen-day egg production, feed intake and feed efficiency were significantly affected by 100% PBPM than the other feeds. They further recommended that PBPM can be safely used up to 75% by replacing with the fishmeal. Ali (2003) used 6.4% of PBPM in layer rations without causing any detrimental effect on performance and egg quality.

Based on the estimates, the amounts of world production of PBPM will be double until 2050 year (El Boushy & Van Der Poel, 2000). Therefore, with the development of poultry industry and high-level productions of PBPM, especially in developing countries, it is likely to be use as a replacement part with other expensive feed ingredients. Therefore, recycling of wastes from poultry slaughterhouses is an economically, biologically and environmentally importance aspect (Cai *et al.,* 1994; Steffens, 1994).

There are few reports on effects of PBPM on layer performance and egg quality. The objective of this study

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was to determine the effects of PBPM on layer performance, egg quality and determination the proper level of PBPM in the diets.

MATERIALS AND METHODS

In this study, 128 commercial layer (Hy-Line W-36) used to examine the effects of inclusion PBPM on performance and egg quality. At the start of experiments, all layers were 66-weeks-old. This trial was performed in completely randomized design and laying hens were randomly assigned to each of four dietary treatments with four replications (eight layers per replicate), four periods and each period was of two weeks. Laying hens were randomly located in commercial wire cages (50 × 50 × 40 cm), with four hens per cage (2 cages as a replicate).

Experimental diets were: (1) Control group (no PBPM), (2) 2.5% PBPM, (3) 5% PBPM and (4) 7.5% PBPM and formulated according the requirements of the Hy-line (W-36) to obtain isoenergetic and isonitrogenous diets (Table I). Water and feed were provided *ad libitum* and laying hens received 16 h light and 8 h dark daily.

The PBPM supplied from a local rendering unit of industrial poultry slaughterhouse. Dry matter (DM), crude protein (CP), ether extract (EE), calcium (Ca), phosphorous (P), salt and total volatile nitrogen (TVN) of the PBPM samples were determined according the AOAC (1984) procedures (Table II).

A per-experimental period (15 d) was used to evaluate the flock's response and reducing experimental error. Feed intake (FI), egg production (EP), egg mass (EM), egg weight (EW), feed conversion ratio (FCR), egg shape index (ESI), egg shell thickness (EST), egg shell weight (ESW), Haugh unit (HU) and yolk color score (YCS) were measured. Layers consumed feed and water *ad libitum* daily. The residues of feed were weighed at the end of each period to determine feed consumption. FCR was calculated as grams of feed consumption to egg mass. Eggs were collected daily, then hen-day egg production and mean of EW determined every period.

At the end of each period, two eggs were selected randomly from each replicate to determine egg quality characteristics. Short and long diameters of the eggs measured using a vernier caliper (± 0.05 mm) to determine the shape index. Selected eggs were broken, shells cleaned under slow flowing of water to remove albumen residues, air-dried and weighed. Shell thickness was measured (mean of 3 different sides of eggs) using an eggshell thickness meter (Ogawa Seiki Co. Ltd Osk 13469). In addition, the HU was calculated based on the height of albumen determined by a micrometer and egg weight (Nesheim *et al.,* 1979). Finally yolk color was determined by using a Roche Fan.

Experimental data analyzed by mixed model analysis using the mixed procedure of SAS (Little *et al.,* 1998). Significant differences between means were determined using the Tukey's W-procedure. All differences were based on significant at $p<0.05$. Since the yolk color trait is an ordinal variable, the Logistic procedure of SAS (2003) used.

RESULTS AND DISCUSSION

Results showed that using different levels of PBPM had not any significant effects on performance parameters (Table III). Senkoylu *et al.* (2005) showed that separate incorporation of PBPM and feather meal in the diet of laying hen had no significant effect on egg production, feed intake, egg mass and feed conversion ratio between experimental diets in compare with control group. Ali (2003) indicated that using 6.4% PBPM, as a replacement for soybean meal in layer diets, had no significant effects on egg production, feed intake, egg weight and feed conversion and resulted decrease in feed cost per kilogram egg. In agreement with our results, Damron *et al.* (2001) reported that the inclusion of rendered layer mortality (RLM) up to a level of 10% had no great effect on laying hen performance.

Table I: Composition of experimental diets

Ingredient and composition	Diets (%)			
	0.0% PBPM	2.5% PBPM	5.0% PBPM	7.5% PBPM
Corn	59.83	60.63	58.32	56.63
Soybean meal (44% CP)	21.29	16.97	14.86	11.42
Wheat bran	2.86	0.96	3.00	5.71
PBPM[1]	0.00	2.50	5.00	7.50
Sunflower oil	2.00	0.00	0.00	0.00
Alfalfa meal	2.00	2.00	2.00	2.00
Wheat	0.00	5.00	5.00	5.00
Oyster shell	9.55	9.5	9.47	9.43
Bone meal	1.56	1.55	1.50	1.46
Vitamin premix[2]	0.33	0.33	0.33	0.33
Mineral premix[3]	0.33	0.33	0.33	0.33
Salt	0.10	0.10	0.10	0.10
DL-methionine	0.11	0.11	0.10	0.09
L-lysine	0.05	0.02	0.00	0.00
Calculated analysis				
ME (kcal/kg)	2700	2700	2700	2700
Crude protein	15.25	15.25	15.99	16.32
Calcium	4.20	4.20	4.20	4.20
Available phosphorus	0.32	0.32	0.32	0.32
Methionine	0.36	0.36	0.36	0.36
Lysine	0.80	0.74	0.75	0.75
Methionine + cysteine	0.62	0.62	0.63	0.64
Threonine	0.56	0.50	0.46	0.41
Tryptophan	0.20	0.18	0.18	0.17
Arginine	0.93	0.89	0.92	0.92
Crude fiber	3.60	3.25	3.28	3.30
Ether extract	2.57	3.26	3.84	4.46
Sodium	0.07	0.07	0.07	0.07
Linoleic acid	1.45	1.42	1.40	1.39

[1]PBPM = Poultry by product meal
[2]Vitamin premix provided per kilogram of diet: vitamin A, 10000 IU; vitamin D3, 2500 IU; vitamin E, 10 IU; vitamin B_1, 2.2 mg; vitamin B_2, 4 mg; pantothenic acid, 8 mg; vitamin B_6, 2 mg; niacin, 30 mg; vitamin B_{12}, 0.015 mg; folic acid, 0.5 mg; biotin, 0.15 mg; cholin chloride, 200 mg.
[3]Mineral premix provided per kilogram of diet: manganese, 80 mg; copper, 10 mg; iodine, 0.8 mg; cobalt, 0.25 mg; selenium, 0.3 mg; zinc, 80 mg; iron, 80 mg

Table II: Chemical composition of poultry by-product meal (PBPM)

Chemical composition	Values
Dry matter (%)	95.5
Crude protein (%)	62.12
Crude fat (%)	25.28
Calcium (%)	1.3
Phosphorous (%)	0.42
Salt (%)	0.5
Total volatile nitrogen (TVN) (g/kg)	0.56
Metabolizable energy[1] (Kcal/kg)	3920

[1]Energy estimated using high-fat prediction equation: $ME_n = 31.02 \times CP + 78.87$ether extract (NRC, 1994)

Table III: Performance of layers fed different levels of PBPM

Diets	FI (g)	EP (%)	EM (g/hen/day)	EW (g)	FCR
0.0%PBPM	102.62	74.60	48.41	64.91	2.12
2.5%PBPM	104.27	76.68	48.61	63.45	2.15
5.0%PBPM	104.83	73.37	47.22	64.42	2.23
7.5%PBPM	106.17	72.07	46.43	64.43	2.29
SEM	0.770	0.903	0.564	0.188	0.023
Pvalue	0.737^{NS}	0.730^{NS}	0.783^{NS}	0.557^{NS}	0.257^{NS}

FI= Feed intake, EP= Egg production, EM= Egg mass, EW= Egg weight, FCR= Feed conversion ratio
SEM: Standard error of the mean, *Pvalue*: Probability value

Table IV: Egg quality of layers fed different levels of PBPM

Diets	SI	EST (mm)	ESW (g)	HU
0.0%PBPM	76.24	0.414	6.06	61.63
2.5%PBPM	75.13	0.431	5.90	63.77
5.0%PBPM	75.07	0.432	6.24	60.32
7.5%PBPM	76.71	0.426	6.12	60.34
SEM	0.226	0.003	0.049	0.976
Pvalue	0.100^{NS}	0.161^{NS}	0.179^{NS}	0.771^{NS}

SI= Shape index, EST= Eggshell thickness, ESW= Eggshell weight, HU= Haugh unit
SEM: Standard error of the mean, *Pvalue*: Probability value

Table V: Yolk color score of egg samples from different experimental diets

Diets	YCS[1]			
	5	6	7	8
0.0%PBPM	9	19	4	0
2.5%PBPM	0	23	9	0
5.0%PBPM	0	6	21	5
7.5%PBPM	0	5	10	17
Total	9	53	44	22

YCS[1] =Yolk color score (Roche yolk color scorer: 1= light yellow; 15= orange)

The effect of PBPM inclusion in layer diets on egg quality characteristics indicated that using different levels of PBPM had not any significant effect on egg shape index, shell thickness, shell weight and Haugh unit (Table IV), which is in agreement with the results of Ertürk and Celik (2004a) for Japanese quail breeders (*Coturnix coturnix japonica*) diets. Ali (2003) reported a similar observation on shell thickness and Haugh unit when PBPM fed to laying hens up to 6.4% of diet. Moreover, Senkoylu *et al.* (2005) and Samli *et al.* (2006) using PBPM in the layer diets did not observed any significant differences in eggshell weight and eggshell thickness between experimental diets as compared with control diet.

Different levels of PBPM in diet caused significant differences between the numbers of eggs with different yolk color ($P < 0.01$). Consequently, using diets without PBPM in compared to diets containing PBPM resulted in a lower egg yolk color when evaluated with Roche scale (Table V). Therefore, increased PBPM levels in diets resulted in a higher egg yolk color. In this study, the fat content of PBPM probably is a reason for increased egg yolk color, because it improves the pigment absorption from diet (Wiseman, 1984).

CONCLUSION

Inclusion of PBPM in layer diets as a high protein content and lower cost ingredient compared with the other protein sources has importance for nutritional and economical aspects. Thus PBPM can be used up to 7.5% in layer's diet at old age, without causing any detrimental effects on performance and egg quality.

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