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308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

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Effects of Poultry by Product Meal on Laying Performance Egg Quality and Storage Stability

H. Ersin Samli, Nizamettin Senkoylu, M. Levent Ozduven, Hasan Akyurek and Aylin Agma
Department of Animal Sciences, Trakya University, 59030 Tekirdag, Turkey

Abstract: To examine the effects of poultry by-product meal (PBPM) with the diet on laying hen performance and egg quality, 30 Bovans White strain laying hens of 40 wk of age, housed in individual cages, were randomly assigned to three dietary treatments. The diets were formulated with the inclusions of PBPM at 0, 5 and 10% levels. For the effect of PBPM on storage stability a 3x2x2 factorial arrangement was implemented. Thus, 3 PBPM levels (0, 5 and 10%), 2 storage temperatures (5 or 21°C) and 2 storage periods (5 or 10 days) were used to carry out this part of the experiment. Results of the present study indicated that, egg production, feed intake and egg mass were significantly ($P > 0.05$) affected by the dietary treatments, whereas feed conversion rate (FCR) was not significantly ($P < 0.05$) affected. Egg production (%), feed intake (g/hen/day) and egg mass (g/hen/day) ranged between 91.3-95.4, 100.6-107.3 and 56.0-60.6, respectively. Egg mass in groups fed the diets with the inclusions of 5% and 10% PBPM were significantly ($P < 0.05$) lower than that of the hens fed with the control diet. The diets with the inclusions of 5% PBPM significantly ($P < 0.05$) affected the internal egg quality parameters in terms of albumen % and the air cell size. However, none of the inclusion levels of PPM significantly ($P > 0.05$) affected the shell thickness, yolk percentage, shell weight and albumen pH. The results of the present study suggested that layer diets could be incorporated with PBPM up to 10% without causing any detrimental effects on laying performance and farmer profit. Overall these effects demonstrated that different levels of PBPM did adversely affected storage stability, except shell weight and air cell size.

Key words: Poultry byproduct meal, laying performance, egg quality

Introduction

The feeding value of poultry by-product meal (PBPM) for poultry was first-ever established at the beginning of the 1950s. This product is normally made from viscera, heads and feet by conventional dry-rendering methods. The PBPM of good quality is considered to contain 58 to 63% crude protein, 12 to 20% ether extract, and 18 to 23% ash (Ravindran and Blair, 1993). Although methionine and lysine are the limiting amino acids in the PBPM, its protein quality is reported to be comparable to that of meat meal (Jackson and Fulton, 1971; Bhargava and O'Neal, 1975). However, in a latter study, it was stated that methionine may be slightly limiting in PBPM (Wang and Parsons, 1998). PBPM is remarkably rich in choline content, and up to 5% can be included in poultry diets (Gohl, 1981).

The availability of metabolisable energy was reported to be high with a 20% inclusion rate of PBPM compared with a 40% inclusion rate according to the study of Pesti *et al.* (1986).

As expressed in above, although an appreciable amount of data have been found on the processing of PBPM and its inclusion into broiler diets, almost none or very few reports were found on effects of this product on laying performance and particularly on egg quality. Therefore, the aim of this study was to examine the effects of inclusion of PBPM on laying hen performance and egg quality during the post peak period.

Materials and Methods

This experiment was carried out to examine the effects of inclusion of PBPM on laying hen performance and egg quality. Thirty of 40-week-old Bovans White strains laying hens were randomly transferred to single-type wire cages providing one hen per cage. Individual cages were equipped with nipple drinkers and trough feeders. The experiment was set up in a completely randomized design where 10 hens were randomly assigned to each of three treatments. Each hen represented one replicate. Laying hens were maintained in a house with windows and received additional artificial light to provide 16.5 h light and 7.5h dark daily.

Three diets were prepared with the inclusions of PBPM, at 0, 5, and 10%, respectively. The main dietary ingredients, corn, wheat, soybean meal and full-fat soybean, were ground in a hammer mill to pass a 3-mm sieve and mixed through a horizontal mixer. The proximate composition and the calculated metabolisable energy of the PBPM were presented in Table 1 (Senkoylu *et al.*, 2005). Experimental diets were formulated to contain 18% crude protein and 2850 kcal/kg metabolisable energy, and all were isocaloric and isonitrogenous (Table 2). All the diets were fed in mash form and in *ad libitum* manner to the laying hens from 40 to 48 wk of age during which the performance of laying hens was monitored. The birds were weighted at

Table 1: Proximate composition of poultry by-product meal (as fed) [7]

Ingredient	Poultry by-product meal
Dry matter (g/kg)	955.0
Metabolizable energy (kcal/kg)	2,885
Crude protein (g/kg)	630.0
Ether extract (g/kg)	118.0
Ash (g/kg)	207.0

Table 2: Composition of experimental diets

	Experimental diets		
	Control	PBPM	PBPM
Ingredient, %	5%	10%	
Corn	25.0	27.0	30.0
Wheat	32.0	34.0	35.9
Soybean meal-48	14.0	13.4	10.9
Full fat soybeans	13.8	6.4	-
Poultry-by-product meal	-	5.0	10.0
Limestone	9.7	9.5	9.3
Sunflower oil	3.0	3.0	2.6
Monocalcium phosphate	1.3	0.9	0.6
Salt	0.4	0.3	0.3
Premix[A]	0.3	0.3	0.3
DL-methionine	0.2	0.2	0.2
L-lysine Hcl	0.5	-	-
	100.0	100.0	100.0
Calculated nutrients[B]			
ME, kcal/kg	2850	2850	2850
Crude protein, %	18.00	18.00	18.00
Ether extract, %	7.14	6.52	5.66
Crude fiber, %	2.62	2.38	2.15
Calcium, %	4.00	4.02	4.00
Available phosphorus, %	0.40	0.40	0.40
Methionine, %	0.43	0.44	0.45
Lysine, %	1.32	0.87	0.80

[A]Provided the following per kg of diet: Apo Carotenoid Acid Ester,0.5 mg; vitamin A as retinyl acetate, 12,000 IU; vitamin D_3 as cholecalciferol, 2,000 IU; vitamin E as dl-α-tocopherol acetate, 35 mg; vitamin K_3, 5 mg; vitamin B_1, 3 mg; vitamin B_2, 6 mg; vitamin B_6, 5 mg; vitamin B_{12}, 15μg; vitamin C, 50 mg; niacin, 20 mg; iron, 60 mg; folic acid, 0.75 mg; D-calcium pantothenate, 6 mg; d-biotin, 0.045 mg; choline chloride, 125 mg; copper, 5 mg; manganase, 80 mg; zinc, 60 mg; selenium, 0.15 mg; canthxanthin, 1.5 mg. [B]Based on NRC values for feed in ingredients.

the start (40 wk of age) and end (48 wk of age) of the trial. The initial and final weights of hens were 1420±137 and 1489±145 g, respectively. Feeds intake was recorded weekly. Egg production was determined daily. Egg weight was determined weekly by weighing all the collected eggs from the experimental groups. Egg quality parameters were determined on the one egg from each replicate at the end of each week (10 eggs per treatment per week). The FCR was calculated as gram feed consumption per day per hen divided by gram egg mass per day per hen. For the effect of PBPM on storage stability a 3x2x2 factorial arrangement was implemented. Thus, 3 PBPM levels (0, 5 and 10%), 2 storage temperatures (5 or 21°C) and 2 storage periods (5 or 10 days) were used to carry out this part of the experiment. Each of 10 sampled egg was stored in chambers for 5 or 10 days in a refrigerator (5°C), or at room temperature (21°C).

All the collected data were recorded on a weekly basis and statistically subjected to the test of ANOVA using GLM (General Linear Model) procedure in a Windows-based statistical package program (SAS, 1996). The differences between the means of groups were separated by Duncan's Multiple Range Test. The significant level used for the group comparisons was set at $P > 0.05$.

Results and Discussion

The results of Table 3 showed that the egg production, feed intake and egg mass were significantly affected by the dietary treatments, whereas FCR was not significantly affected. Egg production (%), feed intake (g/hen/day) and egg mass (g/hen/day) ranged from 91.3 to 95.4, 100.6 to 107.3 and 56.0 to 60.6, respectively. The egg mass was significantly lowered by the diet of 5% PBPM and 10% PBPM compared with the control group. FCR was not significantly improved by the diets. The variations in ingredient quality are assumed to yield in possible variability in the performance of laying hens even though the amino acid levels were appropriately balanced for all the diets (Pike, 1979; Potter *et al.*, 1980). The results of the present study suggested that layer diets could be incorporated with PBPM up to 10% without causing any detrimental effects on laying performance. No significant effect of increased levels of PBPM on FCR suggests that this protein source can be incorporated at higher levels compared to the level suggested in a previous study (Senkoylu *et al.*, 2005). In this study, PBPM was suggested to be used up to 5% with a minimal adverse effect on laying performance and egg quality.

From the results of present study on egg quality parameters, it can be seen that groups fed the diets with the inclusion of PBPM significantly affected internal egg quality in terms of albumen percentages (Table 4). The results suggested that the albumen percentages are significantly differed between control groups (53.83) and groups fed with PBPM (57.3). Air cell sizes of eggs were 3.1, 2.9, and 2.3 mm, respectively. Differences between the groups fed with control diet or with 10% PBPM have been found to be significant. This result might cause diets ingredients lack of the animal protein sources.

The results of the present study indicated that different inclusion levels of PBPM did not significantly affected egg weight loss, shell thickness, albumen pH, Haugh Unit, albumen and yolk %, whereas shell weight and air cell size were significantly affected. Storage period, however, significantly affected egg weight loss, shell weight, shell thickness, air cell size, albumen pH and

Table 3: Effects of PBPM supplementation on laying performance

	Egg Production %	Feed Intake g	Egg Mass g	FCR[1] g feed/g egg
Control	95.4^{a}	107.3^{a}	60.6^{a}	1.770
PBPM 5%	93.6^{a}	100.7^{b}	56.7^{b}	1.776
PBPM 10%	91.3^{b}	100.6^{b}	56.0^{b}	1.798
SEM	0.784	1.102	0.700	0.016
P level	0.103	0.017	0.009	0.605

$^{a-b}$Means in the same column followed by different letters differ significantly (p<0.05). Means represent 10 individualy housed birds.

[1]FCR, feed conversion rate.

Table 4: Effects of PBPM supplementation on egg quality parameters

	Albumen %	Yolk %	Shell weight g	Shell thickness µ	Air cell size mm	pH
Control	53.8^{b}	27.1	6,9	288^{ab}	3.1^{a}	8.1
PBPM 5%	57.3^{a}	26.4	6,5	270^{b}	2.9^{ab}	7.7
PBPM 10%	55.4^{ab}	27.3	6,9	304^{a}	2.3^{b}	7.8
SEM	0.534	0.290	0.096	0.379	0.136	0.045
P level	0.033	0.484	0.411	0.013	0.081	0.262

$^{a-b}$ Means in the same column followed by different letters differ significantly (p<0.05). Means represent 10 individually housed birds.

Table 5: Effects of PBPM supplementation on egg storage performance

Diets	Storage period d	Temp °C	n	Egg weight loss g	Shell Weight g	Shell Thickness µ	Air cell size mm	Albumen pH	Albumen (%)	Yolk (%)	Haugh Unit
	5	5	10	0.5^{b}	7.8^{a}	310.0^{a}	5.8^{b}	8.0^{b}	56.4	28.0	72.4^{a}
Control		21	10	0.6^{b}	7.0^{abc}	292.0^{ab}	5.3^{b}	9.0^{a}	56.6	29.6	55.7^{b}
	10	5	10	0.6^{b}	7.1^{abc}	302.2^{ab}	6.5^{bc}	8.5^{b}	57.6	28.9	76.6^{a}
		21	10	1.4^{a}	6.8^{bc}	302.5^{ab}	7.0^{ac}	9.1^{a}	56.0	30.3	37.4^{b}
PBPM 5%	5	5	10	0.6^{b}	7.0^{abc}	291.1^{ab}	6.1^{b}	8.1^{b}	59.0	28.3	77.3^{a}
		21	10	0.7^{b}	6.4^{c}	276.3^{b}	5.0^{b}	9.0^{a}	57.4	29.9	55.8^{b}
	10	5	10	0.6^{b}	6.8^{bc}	305.0^{a}	6.6^{ac}	8.5^{b}	59.8	28.1	78.7^{a}
		21	10	1.5^{a}	6.6^{bc}	300.0^{ab}	7.0^{ac}	9.1^{a}	56.1	30.1	33.8^{b}
PBPM 10%	5	5	10	0.6^{b}	7.7^{a}	303.3^{ab}	6.3^{bc}	8.1^{b}	56.6	30.5	77.6^{a}
		21	10	0.6^{b}	6.5^{bc}	292.5^{ab}	5.4^{b}	9.1^{a}	56.8	29.6	60.7^{b}
	10	5	10	0.6^{b}	6.9^{bc}	306.3^{a}	6.4^{bc}	8.5^{b}	57.6	28.5	77.0^{a}
		21	10	1.5a	6.6^{bc}	318.0^{a}	7.4^{a}	9.0^{a}	57.3	30.0	37.0^{b}
SEM				0.043	0.066	2.3490	0.099	0.043	0.313	0.225	1.861
Source of Variation				**P**							
Diets				0.696	0.031	0.147	0.031	0.534	0.229	0.690	0.498
Storage period				<0.001	0.042	0.022	<0.001	<0.001	0.713	0.971	<.001
Storage Temp				<0.001	<0.001	0.217	0.543	<0.001	0.124	0.023	<0.001
Diets x Period				0.805	0.428	0.274	0.860	0.319	0.851	0.468	0.462
Diets x Temp				0.794	0.711	0.672	0.513	0.942	0.323	0.496	0.386
Period x Temp				<0.001	0.056	0.089	<0.001	<0.001	0.315	0.388	<0.001
Diets x Period x Temp				0.460	0.787	0.875	0.580	0.731	0.915	0.560	0.994

Haugh Unit, except albumen and yolk %. On the other hand, egg weight loss, shell weight, albumen pH, yolk% and Haugh Unit were affected significantly by storage temperature whereas shell thickness, air cell size and albumen % were not.

Overall these effects demonstrated that different levels of PBPM did adversely affected storage stability, except shell weight and air cell size. The relation between PBPM and shell weight could not be explained. Moreover, no data in the scientific literature could be found with respect to this effect. In the case of the effect on air cell size further studies are needed.

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