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Effects of Substitution of Soybean Meal with Poultry By-Product Meal on Broiler Chickens Performance

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Abstract: An experiment was conducted to evaluate the effects of Poultry By-Product Meal (PBPM) as the replacement of soybean meal (SBM) in the diets of broiler chickens on growth performance. Total 360 male Arbor Acers day old broiler chicks with 45 g initial body weight were selected and divided to six dietary treatments. Each treatment involved 5 replicates of 12 chickens. Experimental diets were formulated to be isocaloric and isonitrogenous. The diets involved the levels of 0, 3, 6, 9, 12 and 15% of poultry by-product meal. Chickens were fed the experimental diets from 21-49 days of age. Experimental design was a completely randomized design. Measured traits, in this study, included live body weight, daily weight gain, feed consumption, feed efficiency, percentage of Tibia ash, weight of different body organs and their ratio to live body weight and feed cost per 1 kg weight gain up to 42 and 49 days of age. Results of the present study showed that the use of poultry by-product meal up to 6% had a positive effect on weight gain and feed to gain ratio in 42 and 49 days of age. No significant effect was observed for Tibia ash percentage ($p>0.05$). Differences for live body weight, feed intake, feed to gain ratio and feed cost per 1 kg of live body weight were significant ($p<0.05$). Birds fed 6% poultry by-product meal had maximum weight gain, yield and better feed to gain ratio among the treatments in whole experimental period.

Key words: Poultry by-product meal, soybean meal, broiler chicken, performance

INTRODUCTION

Oluyemi and Roberts (2000) asserted that about 60-70% of the cost of poultry production is attributed to feeds. Further, a critical cost appraisal of poultry feed formulae shows protein, especially protein of animal origin, to be the most expensive per unit cost.

Poultry By-Product Meal (PBPM) is a readily available feedstuff for poultry diets. It is usually composed of the wastage of poultry slaughterhouses. This product is normally made from viscera, heads and feet by conventional dry-rendering methods. While PBPM typically higher in protein content and lower in mineral levels, it also suffers the same variability found in meat and bone meal. This is largely due to the inclusion of other poultry tissues, such as feathers and differences in rendering procedures (Elkin, 2002). Inclusion of poultry bones obtained from separation of the poultry meat for minced meat processing might have offset this change. Therefore, PBPM of good quality is considered to contain 58-63% crude protein, 12-20% ether extract and 18-23% 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 with that of meat meal (Jackson and Fulton, 1971; Bhargava and O'Neal, 1975). The feeding values of PBPM for poultry reported at the beginning of the 1950s.

Dramatic improvements in poultry slaughter technologies have made it possible to produce a variety of poultry offal such as poultry by-product meal (PBPM), feather meal and blood meal through the separate processing lines. However, in a latter study, it was stated that methionine might 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).

Although, an appreciable amount of data is available on the processing of PBPM and its incorporation into broiler diets, but its variability is high. Therefore, the aim of this study was to evaluate the effects of inclusion of PBPM, on broiler chicken performance.

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MATERIALS AND METHODS

Three hundred sixty male broiler chickens from Arbor Acres plus (AA+) strain were allotted to 6 dietary treatments in a completely randomized design. Each treatment was replicated 5 times with 12 chicks per replicate. Commercial brooding and management procedures were followed and all chicks were fed a typical commercial broiler starter diet for the first 21 days. On 21 day, after an overnight fast, the chicks were weighed, wing-banded and allotted to the treatments. They were then fed the experimental diets (Table 1) through to 49 day. Chicks were housed in environmentally controlled floor pens (1.5×1.5 m). Chicks, feed and water were checked twice daily. Feed and water were provided on an *ad libitum* basis throughout the experiment. Body weight and feed consumption were recorded on a pen basis at weekly intervals. Experimental diets were formulated to be isoenergetic and isonitrogenous and the diets met or exceeded all nutrient requirements (NRC, 1994). Chemical composition of PBPM was determined according to AOAC (1980). It contained 91% dry matter; 55% crude protein; 2.5% crude fiber; 14% ether extract; 3% Calcium; and 1.3% total phosphorus.

The dietary treatments for 21-49 day involved the levels of 0, 3, 6, 9, 12 and 15% of poultry by-product meal to make up 6 dietary treatments. At 28 day, one bird close to the pen body weight mean was selected from each pen, killed and the left Tibia was carefully removed and was frozen until analyzed. The bones were extracted for 48 h with ethyl alcohol followed by a 48-h extraction in ethyl ether. They were then dried for 24 h at 100°C and the dry fat-free bones ashed in a muffle furnace overnight at 600°C. Ash weight was calculated as a percentage of dry fat free bone weight. At 42 and 49 day one bird close to pen body weight mean was killed and the edible carcass and body organ weights were determined. Mortality rate was recorded daily through the experiment.

Statistical analysis: Data were analyzed as completely randomized design using the GLM procedure of SAS (SAS Inst. Inc., Cary, NC, 1999). The pen of chicks served as the experimental unit. Means were compared using Duncan's new multiple range test (Steel and Torrie, 1980). The level of significance was reported at p<0.05.

RESULTS AND DISCUSSION

The effects of substitution of soybean meal with poultry by-product meal on growth performance of the broiler chickens are summarized in Table 2 and 3.

Table 1: Ingredients and nutrient composition of experimental diets

21-49 day							
Dietary treatments (% of PBPM)							
15%	12%	9%	6%	3%	0% (Control)	0-21 day	Ingredients (%)
69	67	46.04	61.9	59.1	56.2	52	Corn
12.4	17	21.8	26.2	31	36	41	Soybean meal
15	12	9	6	3	-	-	PBM
1	1.3	2	2.6	3.5	4.2	1.6	Soybean oil
0.3	0.3	0.3	0.3	0.3	0.3	0.5	Bone meal
0.8	0.9	1.2	1.3	1.4	1.6	1.7	Dicalcium phosphate
0.5	0.6	0.7	0.8	0.9	1.1	1.3	Oyster shell
0.07	0.07	0.08	0.08	0.08	0.08	0.12	DL-Methionine
0.15	0.1	0.05	-	-	-	0.05	L- Lysine hydrocloride
0.25	0.25	0.25	0.25	0.25	0.25	0.25	Common salt
0.01	0.03	0.03	0.03	0.03	0.05	0.05	Sodium bicarbonate
0.25	0.25	0.25	0.25	0.25	0.25	0.25	Vitamins premix[2]
0.25	0.25	0.25	0.25	0.25	0.25	0.25	Mineral premix[1]
							Calculated composition (%)
3180	3136	3157	3153	3117	3130	2900	ME (kcal kg^{-1})
19	19	19	19	19	19	21	CP
0.47	0.47	0.46	0.47	0.45	0.46	0.5	nPP
0.93	0.93	0.91	0.92	0.9	0.9	1	Ca
1.03	1.06	1.06	1.1	1.1	1.1	1.3	Lysine
0.45	0.45	0.45	0.45	0.45	0.45	0.5	Methionine
0.83	0.83	0.84	0.84	0.84	0.84	0.94	Met + Cys
1.38	1.44	1.50	1.56	1.60	1.65	1.89	Arginine
0.22	0.23	0.25	0.27	0.28	0.29	0.33	Tryptophan
1820	1860	1930	2010	2080	2160	2400	Cost (RLS)

[1]Mineral mix supplied the following per kg of diet: Cu, 20 mg; Fe, 100 mg; Mn, 100 mg; Se, 0.4 mg; Zn, 169.4 mg, [2]Vitamins mix supplied the following per kg of diet: Vitamin A, 18,000 IU; vitamin D3, 4,000 IU; vitamin E, 36mg; vitamin K_3, 4 mg; vitamin B_{12}, 0.03 mg; thiamine, 1.8 mg; riboflavin, 13.2 mg; pyridoxine, 6 mg; niacin, 60 mg; calcium pantothenate, 20 mg; folic acid, 2 mg; biotin, 0.2 mg; choline chloride, 500 mg

Table 2: Effects of substitution of soybean meal with poultry by-product meal on performance characteristics of broiler chickens in different ages (day)

DWG (g/b/d)						DFI (g/b/d)						Treat
21-49	42-21	49-42	42-35	35-28	28-21	49-42	21-49	42-21	35-42	35-28	28-21	(PBPM %)
100^{a}	76^{ab}	73^{ab}	87^{ab}	78^{a}	61^{ab}	172^{b}	145^{ab}	138^{a}	148^{ab}	149^{bc}	110^{a}	0
102^{a}	77^{a}	74^{ab}	99^{a}	69^{b}	63^{a}	176^{ab}	148^{a}	139^{a}	153^{ab}	152^{ab}	111^{a}	3
100^{a}	72^{bc}	84^{a}	81^{b}	76^{ab}	57^{bc}	183^{ab}	150^{a}	140^{a}	155^{ab}	154^{a}	109^{ab}	6
92^{b}	68^{c}	74^{ab}	78^{b}	70^{ab}	54^{cd}	180^{ab}	151^{a}	141^{a}	159^{a}	154^{a}	109^{ab}	9
85^{c}	62^{d}	67^{c}	64^{c}	73^{ab}	49de	185^{ab}	148^{a}	135^{b}	154^{ab}	146^{c}	106^{b}	12
74^{d}	55^{e}	58^{c}	59^{c}	57^{c}	46^{e}	193^{a}	141^{b}	124^{c}	147^{b}	126^{d}	99^{c}	15
0.1	0.5	0.8	0.4	0.5	0.3	1.4	1.3	1.4	2.1	1.2	1.1	SE

FCR (g g^{-1})						BW (g)					DWG (g/b/d)	Treat
21-49	21-42	42-49	35-42	28-35	21-28	49	42	35	28	21	21-49	(PBPM %)
1.90^{d}	1.80^{d}	2.40^{bc}	1.72^{bc}	1.90^{b}	1.79^{c}	2682^{a}	2187^{a}	1556^{a}	1007^{ab}	577^{a}	100^{a}	0
1.94^{d}	^{d}1.79	2.42^{bc}	1.54^{c}	2.21^{a}	1.75^{c}	2726^{a}	^{a}2236	1506^{a}	1022^{a}	579^{a}	102^{a}	3
2.01^{d}	1.95^{c}	2.16^{c}	1.94^{b}	2.04^{ab}	1.91^{bc}	2680^{a}	2116^{ab}	1515^{a}	980^{bc}	580^{a}	99^{a}	6
2.17^{c}	^{bc}2.08	2.41^{bc}	2.06^{b}	2.22^{a}	2.04^{ab}	2524^{b}	^{b}2038	1450^{a}	957^{cd}	578^{a}	92^{b}	9
2.33^{b}	^{ab}2.18	2.78^{b}	2.46^{a}	1.99^{ab}	2.13^{a}	2356^{c}	1891^{c}	1435^{b}	922de	573^{a}	85$^{c?}$	12
2.55^{a}	^{a}2.29	3.35^{a}	2.51^{a}	2.19^{a}	2.15^{a}	2128^{d}	1731^{d}	1304^{c}	899^{e}	575^{a}	74^{d}	15
0.04	0.05	0.03	0.06	0.08	0.07	22.4	16.2	12.5	9.1	6.4	0.4	SE

$^{a-d}$ Means within each column with no common superscript differ significantly (p<0.05), ^{SE} Standard Error

Table 3: Effects of substitution of soybean meal with poultry by-product meal on carcass and body organs to live body weight (%) and feed cost per kg of weight gain

Treat	Carcass		Breast		Tights		AFP		
(PBPM %)	42 day	49 day	42 day	49 day	42 day	49 day	42 day	49 day	Tibia ash
0	71.4^{a}	72.3^{a}	24.0^{a}	23.2^{a}	20.6^{a}	20.3^{a}	1.69^{b}	1.76^{d}	57.5^{a}
3	73.5^{a}	72.5^{a}	25.3^{a}	22.8^{a}	20.3^{a}	20.3^{a}	1.66^{b}	1.91^{cd}	55.7^{a}
6	71.9^{a}	72.9^{a}	22.4^{b}	22.0^{ab}	20.5^{a}	20.2^{a}	1.57^{b}	1.95^{cd}	55.7^{a}
9	73.3^{a}	72.0^{a}	22.9^{b}	22.04^{ab}	20.7^{a}	20.3^{a}	1.66^{b}	2.21^{bc}	57.4^{a}
12	72.1^{a}	72.1^{a}	19.5^{c}	20.7^{b}	20.2^{a}	20.3^{a}	2.12^{a}	2.35^{ab}	57.6^{a}
15	71.0^{a}	71.6^{a}	19.1^{c}	19.8^{c}	20.1^{a}	20.2^{a}	2.14^{a}	2.66^{a}	55.8^{a}
SE	0.3	0.5	0.3	0.4	0.3	0.5	0.3	0.3	4.2

Treat	Gizzard and Proventriculus		Liver		Heart		Empty intestine		Feed cost (RLS) kg^{-1}
(PBPM %)	49 day	42 day	49 day	42 day	49 day	42 day	49 day	42 day	WG 49 day
0	2.8^{b}	4.5^{a}	2.8^{b}	2.3^{a}	2.0^{c}	0.58^{a}	4.8^{a}	4.6^{a}	4730^{b}
3	2.7^{b}	4.2^{a}	2.7^{b}	2.1^{b}	1.9^{c}	0.55^{a}	4.1^{a}	4.2^{a}	4520^{c}
6	2.9^{b}	3.8^{a}	2.9^{b}	1.9^{b}	1.9^{c}	0.48^{a}	4.7^{a}	3.8^{a}	4410^{c}
9	2.7^{b}	4.2^{a}	2.7^{b}	2.2^{ab}	2.1^{bc}	0.54^{a}	4.1^{a}	4.2^{a}	4750^{b}
12	3.0^{ab}	4.2^{a}	3.0^{ab}	2.2^{ab}	2.3^{a}	0.57^{a}	4.2^{a}	4.2^{a}	4770^{b}
15	3.3^{a}	4.1^{a}	3.4^{a}	1.9^{b}	2.3^{ab}	0.53^{a}	4.6^{a}	4.1^{a}	5090^{a}
SE	0.12	0.15	0.01	0.01	0.02	0.1	0.01	0.01	25

$^{a-c}$ Means within each column with no common superscript differ significantly (p<0.05), ^{SE} Standard Error

Average daily weight gain and body weight: As shown in Table 2, substitution of SBM with different levels of PBPM, significantly (p<0.05) affected body weigh and body weight gain. Body weigh of 3% PBPM fed birds up to 42 and 49 day was significantly (p<0.05) more than other groups and body weigh of 15% PBPM fed birds was significantly (p<0.05) lesser than other groups. There were no significant differences (p>0.05) between body weights of 3 and 6% PBPM fed birds, although body weight of 3% PBPM fed birds was numerically more than control group. These data indicated that substitution of up to 6% PBPM had no adverse effect on body weight, but higher levels of this source of protein decreased body weight gain of broiler chickens.

As shown in Table 2, higher levels of PBPM more than 6%, significantly decreased weight gain. Decrease in body weight of the chicks with inclusion of higher levels of PBPM is probably due to better amino acid profile of SBM in compare to PBPM. Otherwise, protein biological value, tryptophan and arginine content, digestibility and bioavailability of SBM are higher than PBPM (Beilorai *et al*., 1983; Burgos *et al*., 1974; Herreara and Gorica, 1983; Wang and Parsons, 1998). The results of the present study are in accord with findings of Escalona and Pesti (1987). These investigators were included two levels of 5 and 10% PBPM in broiler chicken diets and found that level of 5% has no adverse effect on body weight but level of 10% significantly decreased weight gain of the broiler chicks. Similar findings were observed by Pesti (1987). Mendoca and Jensen (1989) in their study on PBPM, found possibility of this protein source using in broiler diets up to 10%. The results of the present experiment indicated that PBPM might be replaced about 6% of practical diets for broiler chickens without significant impairment on performance characteristics. Observed differences between results of our experiment with study of Mendoca Junior and Jensen (1989) might be due to poorer quality of PBPM used in the present study or differences in heat processing in the tow samples (Escalona and Pesti, 1986, 1987; Mendoca and Jensen, 1989). Heat processing of protein sources may change L amino acids to form of Damino acids which may decrease its digestibility and amino acid availability (Ford and Shorrock, 1971; Mohammad *et al*., 1991; Rao *et al*., 1984).

Average daily feed intake: The results of the present study indicated that substitution of SBM with different levels of PBPM significantly ($p<0.05$) affected feed intake. As shown in Table 2, 15% level of PBPM significantly decreased feed intake in compare to other treatments. There were no significant differences among 3, 6, 9 and 12% PBPM substitution. Jackson *et al.* (1982) reported that essential amino acid imbalances in diet decreases biological value of the diet and hence decreases feed intake. Poorer quality and lower palatability of PBPM in compare to SBM might be other reasons of lower feed intake by the broiler chickens. However, other workers reported that addition of PBPM up to 10% to boiler chickens diets did not decrease feed intake in compare to control birds. At the present study there were no significant differences ($p>0.05$) among up to 9% PBPM and the control group. This finding is in agreement with results of Akkilic (1977) and Hamid (1986).

Feed conversion ratio: The results of the present study showed that substitution of SBM with different levels of PBPM significantly ($p<0.05$) affected feed conversion ratio (FCR). As shown in Table 2, FCR increased as the level of PBPM in the experimental diets increased. The birds fed 15% level of PBPM diet showed poorer FCR and control group had better FCR among the treatments. Results of the present study showed that higher levels of PBPM more than 6% significantly ($p<0.05$) increased FCR up to 49 days of age. Decrease of body weight of the chicks with inclusion of higher levels of PBPM due to better amino acid profile of SBM in compare to PBPM might be the cause of poorer feed efficiency. This effect of PBPM on FCR is in agreement with findings of Akkilic (1977) and Pesti (1987) who reported that 5% PBPM level in broiler diets has no adverse effect on FCR and other investigators that reported 10% PBPM level, results poorer feed efficiency (Akkilic, 1977; Escalona and Pesti, 1987; Mendoca Junior and Jensen, 1989).

Tibia ash: The levels of PBPM in experimental diets had no significant effect ($p>0.05$) on Tibia ash percentage (Table 3). This result regarding to Tibia ash was expectable, because all experimental diets contained same calcium, available phosphorus and other minerals concentrations.

Carcass and body organs: Eviscerated carcass (Carcass without head, neck, feet and gut), intestines, gizzard and proventriculus and tights ratio to live body weight of the chicks was not significantly different ($p>0.05$) among the treatments in 42 and 49 days of age (Table 3). These data was in accord with findings of Escalona and Pesti (1987) and Akkilic (1977). Abdominal fat pad percentage of the birds in 42 and 49 day was increased as the level of PBPM was increased in the diet. This effect might be due to probable amino acids imbalances in diets containing high levels of PBPM. Jackson *et al.* (1982) reported that amino acids imbalances increases deamination of amino acids to make up fats. Breast yeil was decrease by high levels of PBPM that might be due to decrease of lysine content of this source of protein. As seen in Table 1, diets containing higher levels of PBPM had lesser lysine concentration. Lysine is most affective factor to produce breast muscles (Han and Parsons, 1990).

Yield cost: Yield cost was calculated as feed cost to Iranian Rial (RLS) per Kg of weight gain. It was observed that 3 and 6% PBPM decreased feed cost per Kg of weight gain ($p<0.05$) in 42 and 49 days of age (Table 3). There was not significant difference between chicks fed with 3 or 6% PBPM. Lowest yield cost was obtained by chicks fed 6% PBPM and highest yield cost was obtained by chicks fed 15% PBPM diet.

CONCLUSION

Overall results of the present study showed that the use of poultry by-product meal up to 6% had a positive effect on weight gain and feed to gain ratio in 42 and 49 days of age. No significant effect was observed for Tibia ash percentage ($p>0.05$) among treatments. Differences for live body weight, feed to gain ratio and feed cost per kg of live body weight were significant ($p<0.05$). Birds fed 6% poultry by-product meal had maximum weight gain and better feed to gain ratio among the treatments in whole experimental period.

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