Indian Journal of Animal Sciences **82** (3): 312–317, March 2012

Effect of feeding rendered poultry slaughter byproduct meal on growth and immunocompetance of growing turkey poults

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Received: 23 March 2011; Accepted: 13 December 2011

ABSTRACT

The present study was conducted to assess the feeding value of poultry slaughter byproduct meal (PSBM) and its effect on immune response in growing turkey poults. Day-old turkey poults (150) were distributed into 5 dietary treatments, T_1 (0%), T_2 (2.5%), T_3 (5%), T_4 (7.5%) and T_5 (10% PSBM), having 3 replicates of 10 birds/replicate. Each dietary treatment was fed *ad lib.* in 2 phases i.e. starter (0–4 wk, 28% CP and 2800 Kcal ME/kg) and developer (4–8 wk, 26% CP and 2900 Kcal ME/kg). The poults fed 7.5% or 10% PSBM had significant less body weight, feed intake and poorer feed conversion compared to those on 0% PSBM (T_1) diet at 8 wk of age, but these parameters did not differ among the diets containing 0% to 5% PSBM. There was no significant difference in the relative weight of immune organs and immune response among different treatment groups. These observations suggested that inclusion of poultry slaughter byproduct meal up to 5% in diet replacing soybean meal had no adverse effect on body weight, feed intake and feed utilization efficiency but at higher levels (7.5 or 10%) of inclusion of PSBM as a source of protein decreased the body weight gain of growing turkey poults. Therefore, poultry slaughter byproduct meal can safely and effectively be incorporated up to 5% level without adverse effect on immuno-competence.

Key words: Growth performance, Immune response, Poultry slaughter byproduct meal

In India, nearly 24.5 lakh chickens were slaughtered during 2007 for production of 2749.5 metric tons meat with yield of 916.5 metric tons of poultry slaughter waste (Watt Executive Guide 2009–10). The modern way of disposal of slaughter processing wastes is converting it to granular, free flowing powdered meal in highly efficient rendering plants. The meals so obtained are hygienic, nutritious and most convenient for use. cost and scarcity of soybean meal, a major used conventional protein source of choice for compounding poultry rations, necessitates looking for affordable and available alternative source of animal protein. Poultry offal and feather meals are alternative feed sources, rich in fat, protein and vitamins and may, therefore, be very useful as a nutritive substrate for animals (Raja *et al.* 2001, Zier *et al.* 2004, Aimiuwu and Lilburn 2006, Khosravinia 2006, Isika *et al.* 2006, Hassanabadi *et al.* 2008). Feeding feather meal to chickens is well documented, but few studies have explored feeding feather meal to turkeys. Scanty research has been done so far to determine the maximum inclusion rate of rendered poultry byproduct meal in diets of growing poults. So, the present study was carried out to evaluate the feeding value of rendered poultry slaughter byproduct meal in the diets of growing turkey poults under intensive system.

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MATERIALS AND METHOD

The rendered poultry slaughter byproduct meal (PSBM) was prepared after processing of slaughter house byproducts/ wastes including head, feet, digestive tract without contents and feathers of slaughtered birds (broilers, layers, and spent hen) as well as whole birds found dead on arrival at the processing plants. The wastes were stored in a cold storage tank before processing. The feathers of the dead birds were fluffed before processing for smooth functioning of the rendering machine. The wastes were then digested in batches in the dry rendering plant at temperature of 140°C and pressure of 3.5–4 kg/cm^2 for 45–60 minutes under vaccum, which followed by 4 h of vacuumization. Thereafter, the vapour line of the digestion chamber was opened for drying the rendered meal. The meal was then finely powdered, treated with antioxidant, butylaled hydroxy anisole (0.01%), packed in polyethylene pouches and stored at room temperature for use.

In feeding trial, 150 day-old Belts Vilie White turkey poults (small white) from the flock maintained at CARI, were selected for the study. The poults were randomly distributed into 5 experimental groups with 3 replicate in each group having 10 poults in each replicate i.e. 30 poults/treatment. The experimental birds were housed group-wise in randomly allotted cabins or tiers of the electrically heated battery brooders with the provision of wire-mesh floor, feeder and waterer, located in the well ventilated room, 24 h light and uniform management. Five dietary treatments were formulated separately for starter (0–4 wk) and developer (4–8 wk) phases for growing turkey poults. The treatments were T_1 control diet (28% CP with 2800 Kcal ME/kg during 0–4 wk and 26% CP with 2900 Kcal ME/kg during 4–8 weeks), T_2 (2.5% PSBM), T_3 (5% PSBM), T_4 (7.5% PSBM) and T_5 (10% PSBM replacing soybean meal). The formulae and chemical composition of different experimental diets for starter and developer phases are presented in Table 1. Weighed amount of each test diet during starting period (0–4 weeks) and developer period (4–8 weeks) was offered daily to ensure *ad lib.* feeding at all the time. The fresh and wholesome water was always made available. The data on growth performance, immune response, mortality were recorded. Body weight changes were recorded periodically during the experimental period to ascertain the biweekly and overall body weight gain. A weighed quantity of respective diet was offered *ad lib.* daily to triplicate groups of each dietary regimen in the morning and the residue was weighed at biweekly interval to arrive at biweekly and overall feed intake. Based on the data pertaining to the feed intake and body weight gain, the biweekly and period-wise cumulative feed conversion ratio (FCR) was calculated. Daily monitoring and recording on individually basis had been carried out to study the livability/mortality of the experimental birds used in the present investigation.

The humoral immune response was studied on 7 chicks per treatment at 46^{th} day post-hatch using 1 ml of 1% (v/v) suspension of SRBC. About 3 ml of blood on 5^{th} and 10^{th} day post immunization (dpi) were collected from the jugular vein. The blood was allowed to clot in an incubator at 37°C for 1 h. Centrifugation of blood was carried out at 2000 rpm for 5–10 min to facilitate rapid collection of the serum. Required quantity of immune serum was harvested and stored at –20°C until analyzed for the antibody titres to SRBC. The antibody titre was determined by haemagglutination (HA) test methods (Siegal and Gross 1980 and Vander Zijpp *et al.*1983). Micro titre plates (U bottom) were used. The cell mediated immune response was assessed by cutaneous basophilic hypersensitivity test *in vivo* as per Corrier and Deloach (1990). At 56^{th} day post- hatch, seven birds from each treatment were selected and the toe thickness of both left and right foot at 3^{rd} and 4^{th} inter-digital spaces were measured by micrometer. Immediately after measurements 100 µg of PHA-P suspended in 0.1 ml of phosphate buffer saline (PBS) an 0.1 ml of PBS was injected into right and

Table1. Ingredients and nutrient composition of experimental starting (0–4) and developing (4–8 wk) rations

Feed ingredients	Starter (0 to 4 weeks)					Developer (4 to 8 weeks)				
	T_1	T_2	T_3	T_4	T_5	T_1	T_2	T_3	T_4	T_5
Gross composition (kg/100 kg)										
Maize, yellow	47.31	45.72	42.7	39.5	36.6	52.42	53.77	50.8	47.77	44.6
Soybean meal, solv.ext	48.4	45	41.7	38.3	35	43.3	40.1	36.8	33.4	30
PSBM*	0	2.5	5	7.5	10	0	2.5	5	7.5	10
Vegetable oil	0.3	0	0	0	0	0.9	0	0	0	0
Dicalcium phosphate	2.2	1.95	1.7	1.5	1.25	1.65	1.4	1.18	0.92	0.7
Limestone	1	1.05	1.15	1.15	1.25	1	1	1.1	1.2	1.2
Constant**	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
Choline chloride (60%)	0.05	0.05	0.05	0.05	0.05	0.08	0.08	0.08	0.08	0.08
Lysine hydrochloride	1.6	1.6	1.59	1.59	1.6	0.152	0.163	0.163	0.165	0.17
DL-Methionine	0.55	0.55	0.55	0.55	0.55	0.074	0.067	0.06	0.052	0.047
Chemical composition (%)										
Crude protein	28	28	28	28	28	26	26	26	26	26
ME (kcal/kg)	2800	2800	2800	2800	2800	2900	2900	2900	2900	2900
Lysine	1.6	1.6	1.59	1.59	1.6	1.5	1.5	1.49	1.49	1.5
Methionine	0.55	0.55	0.55	0.55	0.55	0.45	0.45	0.45	0.45	0.45
Calcium	1.2	1.19	1.2	1.19	1.2	1.02	1.01	1.01	1.026	1.01
Available P	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.49	0.5
Cost (₹)	8.65	8.4	8.17	7.93	7.71	8.53	8.26	8.04	7.8	7.56

PSBM:* Poultry slaughter by-product meal ** Constant includes common salt 0.3%, trace mineral premix 0.1%, vitamin premixes 0.12%. [1]Trace mineral mixture contained (mg/kg diet): KIO_3 2; $MnSO_4.H_2O$ 124; $CuSO_4.5H_2O$; $FeSO_4.7H_2O$ and $ZnSO4.7H_2O$ 174. [2] Vitamin premix supplied/kg diet vit A 8250 IU ; vit D_3 1200 ICU, vit K 1 mg, vit E 40 IU, vit B_1 2 mg, vit B_2 5 mg, vit B_{12} 10 mcg, choline 500 mg, niacin 60 mg, and pantothenic acid 10 mg.

left foot (acted as control), respectively. The web swelling of both the foot was measured 24 hours after injection by micrometer. The *in vivo* response to PHA-P was expressed as web index. Weight of lymphoid organs (bursa of fabricius, thymus and spleen) was taken at the end of experiment and was expressed as % live weight. The data pertaining to various parameters were analyzed statistically by the methods of Snedecor and Cochran (1989). The significant mean differences were tested as per Duncan's multiple range test (DMRT) described by Duncan (1955).

RESULT AND DISCUSSION

Data on biweekly body weight (0 day–8 wk), feed intake and feed conversion ratio are presented in Table 2. The birds fed T_5 (10% PSBM) had significant less ($P<0.001$) body weight compared to those on control T_1 (0%) diet at 8 wk of age. However, there was no significant difference in body weight among T_1 (0% PSBM), T_2 (2.5% PSBM) and T_3 (5% PSBM) fed birds. These observations suggested that inclusion of poultry slaughter byproduct meal (PSBM) up to 5% in the diet replacing soybean meal had no adverse effect on body weight, but at higher levels (7.5 or 10%) decreased the body weight gain of growing turkey poults. Data indicated that biweekly body weight gain of T_1 (0% PBPM) fed birds at 8 wk was more ($P<0.001$) than those fed either 7.5% or 10% PSBM in diet. But there was no difference in body weight gains amongst T_1, T_2 and T_3 fed birds at 8 weeks of age. The results indicated that higher levels of PSBM beyond 5% reduced the body weight gain significantly, which might be attributed to destruction of certain amino acids (tryptophan and arginine) variation in available amino acid profile in PSBM. Generally, the apparent or true digestibility of protein and availability of amino acids of meat-cum-bone meal, undergoes heat treatment, is lesser than soybean meal. In the present study the PSBM used was exposed to 140°C that might have reduced the protein digestibility and thus amino acid availability. Browning of lysine and can also not be ruled out. Earlier reports indicated that the biological value, tryptophan and arginine contents, digestibility and bioavailability of soybean meal was higher than PSBM (Beilorai *et al.*1982, Wang and parson 1998). Our results

Table 2.Effect of feeding of poultry slaughter byproduct meal at various levels on growth performance of growing (0 to 8 wk) turkey poults

Treatments	T_1	T_2	T_3	T_4	T_5	Mean±SE
			Biweekly body weight (g)			
0 wk	50±0.27	51±0.41	51±0.38	51±0.32	50±0.23	50±0.15
2 wk**	239^{c}±0.96	239^{c}±0.92	240^{c}±O.81	230^{b}±0.90	224^{a}±0.67	235±0.64
4 wk**	633^{d}±2.02	631^{cd}±1.88	628^{c}±1.58	619^{b}±1.25	592^{a}±1.79	620±1.44
6 wk**	1072^{d}±5.13	1062^{d}±8.17	1045^{c}±5.22	1012^{b}±4.57	981^{a}±3.99	1034±3.70
8 wk**	1703^{c}±5.33	1697^{c}±7.75	1694^{c}±7.75	1659^{b}±8.57	1609^{a}±6.19	1673±4.24
			Body weight gain (g)			
0 to 2**	189.5^{c}±0.89	188.6^{c}±0.93	189.4^{c}±0.85	179.1^{b}±0.97	174.5^{a}±0.73	184.24±0.64
2 to 4**	393.6^{d}±1.72	391.3^{cd}±1.55	387.6^{c}±1.74	378.9^{b}±1.43	367.5^{a}±1.57	383.8±1.05
4 to 6**	439.3^{b}±4.33	431.3^{b}±7.79	425.3^{b}±4.86	396.5^{a}±7.60	389^{a}±3.02	416.28±3.04
6 to 8**	1070.3^{c}±4.57	1066.9^{c}±7.59	1066.6^{c}±7.25	1034.9^{b}±8.10	997.1^{a}±6.81	1047.16±3.84
0 to 4**	583^{d}±2.61	580^{cd}±2.48	577^{c}±2.59	558^{b}±2.4	542^{a}±2.3	569±1.69
4 to 8**	1072^{b}±7.39	1067^{bc}±14.2	1075^{bc}±12.42	1038^{bc}±14.41	987^{a}±8.59	1047±6.08
0 to 8**	1655^{b}±10	1647^{bc}±16.68	1652^{bc}±15.01	1593^{bc}±16.92	1529^{a}±10.89	1614±7.77
			Feed intake (g)			
0 to 2**	298.7^{b}±0.77	298.6^{b}±0.31	298.3^{b}±0.54	297.7^{b}±0.68	268.7^{a}±0.83	292.54±1.02
2 to 4**	619.7^{b}±0.829	619.3^{b}±0.74	618.3^{b}±0.53	617.3^{b}±0.88	578.7^{a}±1.29	610.41±1.38
4 to 6**	822.7^{b}±0.23	821.3^{b}±0.68	822^{b}±0.40	821.2^{b}±0.40	778.66^{a}±0.88	813.13±1.43
6 to 8**	1918.6^{b}±0.53	1916.3^{b}±1.37	1917.3^{b}±0.48	1915.7^{b}±0.63	1810.7^{a}±0.60	1895.54±3.49
0 to 4**	918^{b}±1.59	918^{b}±1.05	916^{b}±1.07	915^{b}±1.56	847^{a}±2.12	903±2.4
4 to 8 **	2741^{b}±0.73	2738^{b}±1.98	2739^{b}±0.8	2737^{b}±1.1	2589^{a}±1.48	2709±4.83
0 to 8**	3660^{b}±2.32	3655^{b}±3.03	3656^{b}±1.87	3652^{b}±2.56	3437^{a}±3.6	3612±7.23
			FCR			
0 to 4**	1.57^{a}±0.01	1.58^{a}±0.01	1.58^{ab}±0.05	1.60^{c}±0.01	1.62^{c}±0.01	1.59±0.002
4 to 8**	2.53^{a}±0.10	2.54^{ab}±0.02	2.55^{ab}±0.02	2.59^{c}±0.010	2.61^{c}±0.02	2.56±0.007
0 to 8**	2.19^{a}±0.01	2.23^{a}±0.005	2.21^{a}±0.01	2.25^{b}±0.01	2.31^{c}±0.01	2.23±0.01

** Values differ significantly ($P<0.01$); ^{abcd} values bearing different superscripts differ significantly ($P<0.05$).

Table 3. Effect of feeding of poultry slaughter byproduct meal at various levels on immunocompetance and weight of immune organ of growing turkey poults at 8 weeks

Treatments	T_1	T_2	T_3	T_4	T_5	Mean±SE
Wt of immune organ						
Bursa	246±3.8	250±3.7	249±2.5	241±4.8	239±5.3	245±2.3
Thymus	225±3.7	227±3.4	227±3.2	219±4.4	218±4.9	223±2.1
Spleen	219±3.8	218±3.2	218±2.2	211±4.2	203±4.7	214±2.0
Humoral immune response (response to SRBC)						
5^{th} DPI	9.14±0.59	9.14±0.40	9.42±0.29	9.14±0.40	9.28±0.47	9.02±0.20
10^{th} DPI	4.28±0.60	3.85±0.34	4.42±0.52	4.14±0.26	3.85±0.45	4.11±0.19
Cell mediated immunity						
Foot-web-index (mm)	0.31±0.05	0.31±0.03	0.31±0.04	0.30±0.08	0.30±0.07	0.31±0.02

DPI, Day post immunization.

were in line with the findings of Escalona and Pesti (1987). They included 5 and 10% of poultry byproduct meal (PBPM) in broiler chicken diets and found no adverse effect on body weigh at 5% level but at 10% level body weight gain of broiler chicks decreased significantly. Similar findings were also observed by Pesti *et al.* (1986). However, Mendoca and Jenson (1989) found the possibility of using this protein source up to 10% in broiler diets. These differences in observation might be attributed to the differences in processing methods (Robbins and Firman 2006), raw material used (Johnson and Parsons 1997), storage time of raw materials prior to rendering (Tamim and Doer 2003), processing pressure and temperature (McNaughton *et al.* 1997, Escalona and Pesti 1987, Mendoca and Jensen 1989), and ash content of the finished material (Johnson and Parsons 1997). Heat processing of protein sources may change L-amino acids which may decrease its digestibility and availability (Ford and Shorrock 1971, Mohammad *et al*. 1991).

Substitution of soybean meal with different levels of rendered PSBM led to significant ($P<0.001$) reduction in feed intake. Inclusion of 10% PSBM in diet (T_5) significantly decreased feed intake compared to other treatments. However, there were no significant differences among 0%, 2.5%, 5% and 7.5% PSBM fed groups in feed intake. Jackson *et al.* (1982) justified that essential amino acid imbalances and decrease in the biological value of poultry byproduct meal were the reasons for reduced feed intake. In the present study, there was no significant difference in feed intake up to 7.5% PSBM level, the findings were in agreement with results of Akkilic (1977).

Replacement of soybean meal with different levels of PSBM significantly ($P< 0.001$) affected FCR. As the level of PSBM in the experimental diets increased FCR also increased (Table 2) and turkey poults fed diet with 10% PSBM showed poorest FCR followed by 7.5% PSBM. However, there was no significant difference in FCR in diets containing 0 – 5% PSBM. Decrease of body weight of chicks with higher inclusion levels of PSBM due to poorer amino acid availability in PSBM in comparison to soybean meal might be the cause of poorer FCR. This effect of PSBM on FCR was in agreement with the findings of Akklic (1977) and Pesti *et al.* (1986) who also reported that 5% PSBM levels in broiler diets has no adverse effect on FCR. Similarly, other investigators also reported that 10% PSBM level in diet resulted in poorer feed efficiency (Akkllic 1977, Escalona and Pesti 1987, Mendoca and Jensen 1989).

No mortality was observed in any of the treatment group throughout the experiment. Therefore, it indicated that the PSBM had no toxicity in near term. Although previous study of Richard *et al.* (1992) indicated that poultry by-product meal or poultry fat that may impose an additional burden on metabolism, may be sufficient to increase tissue oxygen demand and blood-flow to levels resulting in an increased incidence of pulmonary hypertension with right ventricular failure and ascites in commercial broiler chickens. No such incidence occured in growing turkey poult throughout experimental period.

The relative weight of immune organs (bursa, thymus and spleen) of the 5 treatment groups are presented in Table 3. Statistical analysis of data revealed that though there was no significant difference in the mass of bursa, thymus and spleen among the treatment groups, but the weights of bursa and thymus were numerically more in 5% PSBM replacement group (T_5) and spleen weight was higher in control group. The humoral immune response (response to SRBC HA titre) in the treatment groups was determined by injecting 5% SRBC and collecting blood after 5^{th} day and 10^{th} day (Table 3). Statistical analysis of the data revealed that there was no significant difference in the HA titre among the different treatment groups irrespective of collection of blood at days of post immunization. However the HA titre of all treatment groups were significantly higher ($P<0.001$) at 5 days of post immunization. Li *et al*. (2000) also found that the antibody titre was on the increasing trend with 5% SRBC at 5 days post immunization and was highest at 7 days as compared to 10 days post immunization. Effect of PSBM feeding on cell mediated immune response was studied by injecting PHA-P

Table 4. Pearson correlation (r) of bursa, thymus and spleen weight (mg/100g BW) with HA titre (Log 2) and foot-web-index (mm)

	V	Level of significance
HA ×Bursa	0.1426	0.421
PHAP×Bursa	–0.317	0.859
Spleen×Bursa	0.1143	0.52
Thymus×Bursa	0.3667*	0.034
PHAP×HA	–0.2207*	0.04
Spleen×HA	–0.2255	0.24
Spleen×PHAP	–0.391	0.826
Thymus×HA	0.0247	0.89
Thymus×PHAP	0.0685	0.7
Thymus×Spleen	0.1038	0.559

*Correlation is significant at P<0.05.

and determining the foot-web-index (Table 3). No significant difference was found in the response to PHA-P in any of the treatment groups. However foot-web-index was numerically higher in the control group (0% PSBM). Results of humoral and immune response revealed that there was no adverse effect of feeding of PSBM on the immune-competence of growing turkey poults.

An attempt was made to find out any correlation among weight of bursa, thymus, spleen, HA titre and foot-web-index (Table 4). Positive correlation was found between thymus and bursa (P<0.034), whereas negative correlation was found between HA titre and response to PHA-P (P<0.05).

It was concluded that inclusion of poultry slaughter byproduct meal (PSBM) up to 5% in diet replacing soybean meal had no adverse effect on body weight and feed conversion ratio, but at higher levels (7.5 or 10% PSBM) there was decrease in the body weight gain and poorer feed conversion of the growing turkey poults. PSBM did not cause any adverse effect on survivability and immune-competence of growing turkey poults. Therefore, it was concluded that the PSBM could safely and effectively be used up to 5% level in diet of growing turkey poults up to 8 weeks of age.

ACKNOWLEDGEMENTS

Authors are grateful to Director, Central Avian Research Institute (CARI) and Head, Poultry Housing & Management and other Scientist of Avian Nutrition and Feed Technology section of CARI for providing laboratory facilities to carry out present work.

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