ISSN 1682-8356
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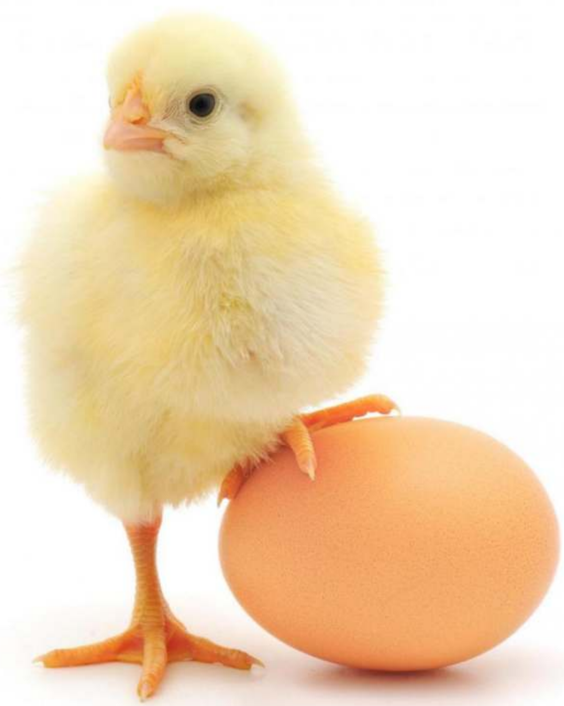

INTERNATIONAL JOURNAL OF
POULTRY SCIENCE

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International Journal of Poultry Science 6 (12): 860-865, 2007
ISSN 1682-8356

Effect of Different Levels of Blood Meal on Broiler Performance During Two Phases of Growth

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Abstract: The study was conducted to investigate the effect of blood meal in broiler diets during starter (0-4 weeks) and finisher (5-6th week) phases of growth. Fresh blood was boiled at 100°C for 45 min and then dried in an hot air oven at 55°C for 6 days and ground into meal. The chemical composition of the dried blood meal was 92% dry matter, 80% crude protein, 8.5% total ash, 1.2% ether extract, 1.3% crude fibre, 9% nitrogen free extract, 0.28% calcium, 0.25% phosphorus, 1.98% sodium chloride and 2850 Kcal kg^{-1} metabolizable energy. Amino acid profile revealed that sufficient quantity of almost all essential amino acids was present in blood meal. Chemical score of the blood meal was 13. Isoleucine was the Ist limiting amino acid and methionine was the 2nd limiting amino acid. Three hundred, day-old broiler chicks were reared in deep litter house system using completely randomized design. Five different isonitrogenous and isocaloric experimental mash diets were prepared with five levels 0, 3, 4, 5 and 6% of blood meal, designated as A, B, C, D and E, respectively, for starter phase. Five corresponding finisher diets were used during the finisher phase. The chickens were randomly allocated to five dietary treatment groups having three replicates of 20 birds in each group. Weight gain was higher ($p<0.01$) in chickens fed diets containing 3% blood meal during two stages of growth. Feed intake during 0-42 weeks of age was reduced ($p<0.01$) in chickens fed diets with 3% level of blood meal. Similarly, feed utilization efficiency was better ($p<0.01$) in chickens fed diet containing 3% blood meal compared to all other treatment groups. Also 3% blood meal in diet improved ($p<0.05$) apparent faecal digestibilities of dry matter, organic matter, crude protein and ether extract. Dressing percentage and relative weight of liver of chickens among all treated groups were similar ($p>0.05$). The results indicated that inclusion of blood meal (3%) in broiler diets reduced the relative cost per unit weight gain. It may be suggested that blood meal upto 3% can be incorporated in broiler diets without any adverse effect on production parameters during starting and finishing stages of growth.

Key words: Blood meal, amino acid profile, apparent digestibility, broiler performance, economics

Introduction

One of the major problems of poultry production in Pakistan is the high cost of feeds. Its cost usually ranged between 65-75 percent of the total production cost (Haq and Akhtar, 2004). This problem has tended to reduce the rate of expansion of the poultry industry and has added to the low level of animal protein nutrition of its people. A possible way of increasing the supply of poultry products at cheaper prices is by reducing the cost of production through the use of cheaper, locally available sources of protein such as blood meal in place of costly fish meal and imported soyabeen meal.

Blood meal is a dark chocolate-coloured powder with characteristic smell. It contains about 650-850 g kg^{-1} of protein this variation is due to difference in methods of preparation (McDonald *et al*., 1992). It is one of the richest sources of lysine, a rich source of arginine, methionine, cystine, leucine but is very poor in isoleucine and contain less glycine than either fish meal or bone meal (NRC, 1994). When we compare blood meal with vegetable protein supplements for poultry it is quite high in biological value. Generally vegetable protein supplements are deficient in two of the essential amino acids which are lysine and methionine, whereas blood meal is rich in both of these amino acids (McDonald *et al*., 1992). There is some evidence showing that the 1 to 4% blood meal can be incorporated in the poultry diet with better growth performance (Petkov *et al*., 1980; Nuarautelli *et al*., 1987; Ikram *et al*., 1989). This is in contrast to the reports of others who have shown that the higher level of blood meal significantly improved the growth of chickens (Toor and Fahimullah, 1972; Hassan *et al*., 1974; Onwudike, 1981). Today, mostly blood meal is being used as by-pass protein ingredient in ruminant diet (Kamalak *et al*., 2005; Taylor, 2005). Little information is available of blood meal use in broiler diet. The present project is designed to investigate effects of different levels of blood meal on the performance of broiler chickens during starter and finisher phases of growth.

Materials and Methods

Preparation of blood meal: Fresh blood was collected from the Sehala Slaughtering House, Islamabad

Table 1: Ingredients composition (%) of broiler starter diets with different levels of blood meal

	Diets*				
Ingredients	A	B	C	D	E
Rice broken	43.10	44.10	44.60	45.44	46.10
Rice Bran	10.00	10.00	10.00	10.00	10.00
Rice polish	8.00	8.00	8.00	8.00	8.00
Canola meal	10.00	10.00	10.00	10.00	10.00
Sunflower meal	4.00	5.00	5.00	4.50	5.00
Guar meal	5.00	5.00	5.00	5.00	3.00
Soybean meal	5.00	1.00	-	-	-
Animal protein conc.	3.00	3.00	3.00	3.00	3.00
Fish Meal	11.00	10.00	9.50	8.16	8.00
Blood Meal	-	3.00	4.00	5.00	6.00
Limestone	0.10	0.10	0.10	0.10	0.10
Premix	0.80	0.80	0.80	0.80	0.800

*A: 0% BM; B: 3% BM; C: 4% BM; D: 5% BM; E: 6% BM

Table 2: Ingredients composition (%) of broiler finisher diets with different levels of blood meal

	Diets*				
Ingredients	A	B	C	D	E
Rice broken	48.54	51.8	52.10	47.94	46.20
Rice Bran	10.00	10.00	10.00	10.00	10.00
Rice polish	7.00	8.00	8.00	5.00	6.00
Canola meal	10.00	10.00	10.00	10.00	10.00
Sunflower meal	-	1.60	3.30	5.00	5.70
Guar meal	5.00	3.00	-	5.00	5.00
Soybean meal	5.50	1.00	-	-	-
Animal protein conc.	3.00	2.00	3.00	3.00	3.00
Fish Meal	10.16	8.40	8.40	8.00	6.70
Blood Meal	-	3.00	4.00	5.00	6.00
Limestone	-	0.40	0.40	0.26	0.60
Premix	0.80	0.80	0.80	0.80	0.800

*A: 0% BM; B: 3% BM; C: 4% BM; D: 5% BM; E: 6% BM

immediately after cattle were slaughtered. After collection, the blood was boiled immediately in a cask to 100°C for 45 min in order to let water evaporate and destroy pathogenic organisms. After boiling it was then dried in an oven at low temperature 55°C for 6 days and then ground into flour.

Chemical analysis of blood meal: Dried blood meal sample was analyzed in laboratory chemically for proximate constituents, including minerals (AOAC, 2000) gross energy (Herris, 1970) and amino acid profile (Moore and Stein, 1954). Chemical score of blood meal was also calculated (FAO, 1957). After determining the gross energy contents of blood meal, Metabolizable Energy (ME) was calculated by following the prediction equation (NRC, 1994).

Experimental birds: A total of 300 day-old broiler chickens (Hubbard), having 47.5 g average body weight, were randomly divided into 15 separate floor pens (each 10×15 feet) each comprising 20 chicks and three pens (replicates) per treatment group following completely randomized design. The experimental house was thoroughly cleaned and disinfected before the arrival of chicks. Experimental chickens were maintained under standard managemental conditions for 42 days on deep litter system. The brooder temperature was maintained at about 95°F upto 7 days of age and gradually decreased to 75°F by 21st day of age, after which the chickens were kept at room temperature.

The experimental chicks were fed broiler starter from day-old to four weeks and broiler finisher rations in the fifth to sixth week *ad-libitum*. The birds had free access to feed and clean drinking water. All the chicks were vaccinated against new castle disease, hydro-pericardium syndrome and infectious bursal disease.

Experimental diets: Five isonitrogenous and isocaloric broiler starter and finisher diets in the form of mash were prepared (NRC, 1994). Blood meal and all other ingredients were purchased from the local market after analyzing each consignment randomly at feed testing laboratory Poultry Research Institute, Rawalpindi. The different levels of blood meal such as 0, 3, 4, 5 and 6% were used in both the broiler starter and finisher diets (Table 1 and 2) fed to experimental groups A, B, C, D and E, respectively. Each diet was analyzed as described methods in AOAC (2000) for proximate composition, minerals and aflatoxin at feed testing laboratory, Poultry Research Institute, Rawalpindi (Table 3). All analyses and determinations were done in triplicate. Experiment lasted for 42 days in December and January, 2005-2006.

Table 3: Percent nutrient composition and aflatoxin (ppb) of broiler diets with different levels of blood meal

	Diets*				
Ingredients	A	B	C	D	E
Broiler starter					
Dry matter	90.35	90.45	89.85	90.15	90.00
Crude protein	22.25	22.26	22.26	22.12	22.12
Metabolizable Energy (Kcal/kg)	2856.6	2848.6	2850.2	2850.9	2852.2
Crude fat	4.36	4.22	4.16	3.99	3.91
Crude fibre	5.50	5.50	5.50	4.00	4.50
Ash	7.93	7.56	7.40	7.17	7.26
Salt (inorganic)	0.30	0.28	0.27	0.25	0.26
Calcium	1.08	1.03	1.01	1.00	1.09
Phosphorus	0.56	0.52	0.50	0.45	0.45
Aflatoxin B_1 (ppb)	14.00	14.00	14.00	14.00	14.00
Broiler finisher					
Dry matter	88.60	88.75	87.15	87.60	87.40
Crude protein	19.96	19.66	19.79	20.82	21.00
Metabolizable Energy (Kcal/kg)	3049.6	3050.2	3049.7	3051.6	3027.3
Crude fat	4.06	3.90	3.84	2.89	2.74
Crude fiber	5.00	5.00	5.00	4.50	5.00
Ash	7.35	7.00	7.02	6.43	6.35
Salt (inorganic)	0.30	0.25	0.26	0.25	0.24
Calcium	1.00	1.00	1.00	0.93	0.96
Phosphorus	0.52	0.45	0.45	0.44	0.40
Aflatoxin (B_1), ppb	20.00	20.00	20.00	20.00	20.00

*A: 0% BM; B: 3% BM; C: 4% BM; D: 5% BM; E: 6% BM

Digestibility of nutrients: Apparent faecal digestibilities of Dry Matter (DM), Organic Matter (OM), Crude Protein (CP) and Ether Extract (EE) of the diets were also measured at 35 days of age by the total collection method (European reference method; Bourdillon *et al.*, 1990). Three birds from each replicate were housed in the metabolic cages, after a three days adaptation period, excreta samples were collected daily from each cage for 4 consecutive days, frozen and store in plastic bags (-20°C) until analysis. Prior to analysis, excreta samples were thawed over night, homogenized, dried (72 h; 60°C) and ground (1 mm screen).

Parameter measured: Body weight gain and feed intake per pen were recorded at weekly intervals. The efficiency of feed utilization was calculated as feed intake per unit body weight gain. Daily mortality and etiology of the dead birds, if any, was recorded after conducting the post-mortem examination. At the termination of the experiment, five birds from each replicate were randomly selected, slaughtered and eviscerated to record carcass and liver weights. Liver weights were expressed in terms of relative weight (liver weight/kg pre-slaughter weight). Carcass weight was recorded after removing skin, head, feathers, lungs, feet and gastro-intestinal tract. Economic analysis of live weight gain of broiler chicks was calculated by deducting net expenditure cost of chick from the gross income of the live weight gain.

Statistical analysis: The data obtained through this experiment were analyzed by using analysis of variance technique M STAT-C and Least Significant Difference test in M STAT-C was applied for multiple mean comparisons.

Results and Discussion

Blood meal can be used as a supplemental source of protein and used to increase the crude protein content of cereal grains and plant by-products. The chemical composition of the dried blood meal in the current study was 92% dry matter, 80% crude protein, 8.5% total ash, 1.2% ether extract, 1.3% crude fibre, 9% nitrogen free extract, 0.28% calcium, 0.25% phosphorus, 1.98% sodium chloride and 2850 Kcal kg^{-1} metabolizable energy. These results are supported by the findings of Oyenuga (1968) and McDonald *et al.* (1992). Amino acid profile (Table 4) revealed that sufficient quantity of almost all essential amino acids were present in blood meal. Similar results were obtained by Devuyst (1964) and Onwudike (1981) reported that the lysine level in the blood meal is relatively high (7-8%), which makes it an excellent supplemental protein source to use with plant derived feed ingredients that are low in lysine. Chemical score of the blood meal (Table 5) was 13. Isoleucine was the Ist limiting amino acid and methionine was the 2nd limiting amino acid. Schingoethe (1991) also reported that in blood meal isoleucine and methionine were 1st and 2nd limiting amino acids, respectively relative to milk (Protein Score).

Table 4: Amino acid Profile of blood meal

Amino acids	(g/100g)
Arginine	2.35
Glycine	4.6
Histidine	5.7
Isoleucine	0.8
Leucine	10.3
Lysine	8.0
Methionine	1.5
Phenylalanine	5.1
Threonine	4.5
Tryptophan	1.3
Tyrosine	3.2
Valine	5.1

Table 5: Chemical Score of blood meal

Amino acids	Amino acid pattern* (mg/g)	Blood meal (mg/g)	Available Amino acid (%)
Phenylalanine	28	51	182
Leucine	48	103	214
Valine	42	51	121
Lysine	42	80	130
Methionine	42	15	35
Isoleucine	42	08	13

*FAO (1957)

During the starting and finishing periods of growth, the chickens fed diet containing 3% blood meal gained ($p<0.01$) maximum weight compared to other diets (Table 6). These results are supported by the findings of Petkov *et al.* (1980), Nuarautelli *et al.* (1987) and Ikram *et al.* (1989), who reported that blood meal can be effectively used upto 3% without any adverse effect on growth of broiler chickens however, weight gain in broiler chickens was reduced with higher concentrations of blood meal due to very low levels of the sulphur containing amino acids and isoleucine are responsible for the poor utilization of blood meal (Onwudike, 1981). In the present study, 3% blood meal diet also contained 8-10% fish meal and 1% soyabean meal which made an excellent combination of amino acid profile of diet compared to other diets. Similarly, Hassan *et al.* (1974) reported 6% blood meal with 15% meat meal can be used in broiler diet without adverse effect on growth rate because meat meal is a good sources of B-complex vitamins and various unidentified beneficial factors have been claimed to be present in meat meals, among them the enteric growth factor from the intestine tract of chicken, the Ackerman factor and a growth factor located in the ash (McDonald *et al.*, 1992). In an experiment, when blood meal was used to partially replace fish meal at 66% dietary inclusion for juvenile tilapia, fish fed blood meal had poor productivity values in weight gain and protein efficiency due to amino acid imbalance (Fasakin *et al.*, 2005).

During the 0-42 days of growth, the broiler chickens of group B consumed less ($p<0.01$) diet but showed better ($p<0.01$) feed conversion ratio than the chickens of other groups (Table 6). The feed conversion ratio occurred in chickens fed the diet in which 3% blood meal, 8-10% fish meal and 1% soyabean meal appears also to be related to the amino acid pattern of the diet. Blood meal is rich in lysine, fish meal rich in methionine, lysine and tryptophan whereas soyabean meal is the richest sources of essential amino acids than the other vegetable meal sources (McDonald *et al.*, 1992). The studies indicated that a higher amount of essential amino acids improve the efficiency of utilization of feeds in the broiler and fish (Friedhelm *et al.*, 2002; Subhadra *et al.*, 2006). From this study it appears that a combination of blood meal, fish meal and soyabean meal in group B diet produces a complementary effect which raised the quality of the diet.

Apparent digestibilities of DM, OM, CP and EE were increased ($p<0.05$) with 3% blood meal (Table 7). Carsten (2004) reported that the measured apparent crude protein digestibility in blood meal was 70%. In another study, the values apparent crude protein digestibility of blood meal was reported 64% (Edney *et al.*, 2005). This variation in digestibility values may cause due to certain factors like sources and processing conditions etc. (Han and Parsons, 1991). Many of the studies showed that overheating result from reduced protein quality and decreased digestibility. The decrease in amino acids digestibility due to over heating was reported in lysine and histidine (Zhang and Parsons, 1994). This decrease in lysine digestibility may be due to formation of maillard reaction products created during heat process (Hurrell, 1990). Keeping in view amino acid profile in the present study, blood meal was prepared excellent from raw blood under control heat process. Apparent protein digestibility was better in 3% blood meal group due to better amino acids availability from fish meal and soyabeen meal as compared to other groups.

Dressing percentage and relative weights of liver in chickens of 5 groups are presented in Table 8. Apparently better dressing percentage and relative weight of liver was found in chickens fed diet supplemented with 3% blood meal compared to those fed diets contained 4, 5 and 6% blood meal, however, the difference was non-significant ($p>0.05$). These findings are supported by those of Nuarautelli *et al.* (1987), who reported that dressing %age (67.28) was better at 3% level of blood meal in a broiler diet due to its high digestibility value.

Total chicken mortality during starter phase was 1, 6, 5, 4 and 3%, while during finisher phase it was 0, 3, 1, 2 and 1% for diets A, B, C, D and E, respectively. Comparatively higher mortality was observed in chicken fed diet with 3% blood meal compared to other diets. This was consistent with the observations of Ikram *et al.* (1989) with 3% level of blood meal. Mortalities were recorded due to ascites because of rapid growth, high

Table 6: Performance of broiler fed diets containing different levels of blood meal

	Weight gain (g)		Feed intake (g)		FCR	
Diets*	0-28 d	29-42 d	0-28 d	29-42 d	0-28 d	29-42 d
A	656.02[c]	978.63[e]	1583.38[bc]	2449.8[b]	2.43[ab]	2.52[a]
B	733.37[a]	1133.18[a]	1571.04[c]	2389.4[c]	2.15[c]	2.11[c]
C	699.51[b]	1108.53[c]	1605.40[a]	2521.85[a]	2.30[bc]	2.27[bc]
D	671.20[bc]	1120.87[b]	1596.48[ab]	2550.70[a]	2.38[ab]	2.28[b]
E	661.35[c]	1094.12[d]	1610.52[a]	2539.23[a]	2.45[a]	2.33[b]

*A: 0% BM; B: 3% BM; C: 4% BM; D: 5% BM; E: 6% BM, Means with different letters differ significantly ($p \leq 0.01$)

Table 7: Apparent digestibility (%) of dry matter, organic matter, crude protein and ether extract of the experimental diets

	Diets*				
Parameters	A	B	C	D	E
Dry Matter	68.2±0.42[b]	76.8±0.32[a]	73.5±0.50[a]	68.4±0.44[b]	63.7±0.61[c]
Organic Matter	76.0±0.80[b]	81.6±0.55[a]	80.3±0.60[a]	76.2±0.32[b]	72.1 ±0.34[c]
Crude Protein	78.4±0.32[b]	86.50±1.83[a]	85.4±1.75[a]	78.7±0.32[b]	71.6±1.60[c]
Ether Extract	60.0±0.25[b]	68.3±0.60[a]	67.1±0.62[a]	60.2±0.32[b]	53.8±0.45[c]

*A: 0% CB; B: 3% BM; C: 4% BM; D: 5% BM; E: 6% BM, Means with different letters differ significantly ($p \leq 0.05$)

Table 8: Percent dressed carcass weights and relative weights of liver of broiler chickens fed blood meals

	Diets*				
Parameters	A	B	C	D	E
Dressing percentage	56.23	63.41	61.43	60.38	57.74
Relative weights of liver	18.60	18.86	21.05	21.85	22.15

*A: 0% CB; B: 3% BM; C: 4% BM; D: 5% BM; E: 6% BM

Table 9: Economic analysis of broiler fed on experimental diets (0-6 weeks)

	Diets*				
Parameters	A	B	C	D	E
Cost per kg of starter ration (Rs.)	10.00	10.21	10.28	10.35	10.43
Per kg cost of finisher ration (Rs.)	9.60	9.81	9.88	9.95	10.03
Chick cost (Rs.)	20.00	20.00	20.00	20.00	20.00
Feed intake (g/bird)	4032	3960	4126	4146	4149
Cost of feed consumed (Rs./bird)	39.38	39.47	41.39	41.88	42.25
Others (vaccine, medicine, elec.etc.)	7.00	7.00	7.00	7.00	7.00
Total cost (Rs.)	66.38	66.47	68.39	68.88	69.25
Average live weight after 42 days (g)	1682	1913	1850	1839	1803
Return on sale @ Rs.44 per Kg (Rs.)	74.00	84.17	81.61	80.91	79.33
Per bird net profit (Rs.)	7.62	17.70	13.20	12.03	10.08

*A: 0%BM, B: 3%BM, C: 4% BM, D: 5%BM and E: 6%BM; 1 US$ = 60 rupees

feed efficiency and large pectoral muscle mass, all require high oxygen level. Modern chicken has a small lung volume: body weight ratio causing an inability of the respiratory system to respond to the broilers elevated oxygen needs, which can lead to hypoxia and respiratory acidosis (Kiiskinen, 1985). Acidosis affects cellular membrane integrity and reduces free radical elimination, transude leakage of blood vessels that leads to accumulation in the abdominal cavity; hence the ascites develops (Proudfoot and Hulan, 1987).

Finally, the economics of 3% blood meal diet was more encouraging, as it generated more profit than those of control and high level of blood meal diets. The results revealed that per bird total return on sale was Rs. 74.00, 84.17, 81.61, 80.91 and 79.33 at total expenditure of Rs. 66.38, 66.47, 68.39, 68.88 and 69.25 for groups A, B, C, D and E, respectively (Table 9). The net per bird income was Rs. 7.62, 17.70, 13.20, 12.03 and 10.08 for groups A, B, C, D and E, respectively. Economic data clearly indicated that 3% level of blood meal was more feasible and economical to obtain maximum profitability from broiler production. Petkov *et al.* (1980) reported that chicks fed 3% diet containing blood meal showed most economic weight gain than high level of blood meal groups. Onwudike (1981) reported that economic benefit from the blood meal based diets when compared to the diet in which groundnut cake was the major source of protein and that which contained the groundnut cake and fish meal mixture was related to the price differential between groundnut cake and blood meal (830 US$ and 260 US$ per tone, respectively). Low prices of blood meal and better feed efficiency with 3% blood meal are two major factors which resulted in decreased cost of production.

The findings of this experiment suggested that blood meal upto 3% can be incorporated in broiler starter and finisher diets without any adverse effect on production parameters. For optimizing the profits from feeding of blood meal, it may be used to the diets of commercial broiler chicks.

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