Asian Journal of

Poultry Science

ISSN 1819-3609

Academic Journals Inc.

www.academicjournals.com

Asian Journal of Poultry Science 6 (1): 1-9, 2012
ISSN 1819-3609 / DOI: 10.3923/ajpsaj.2012.1.9

Replacement Value of Boiled Pigeon Pea (*Cajanus cajan*) on Growth Performance, Carcass and Haematological Responses of Broiler Chickens

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ABSTRACT

The use of boiled pigeon seeds as a replacement for groundnut cake in the diets of broiler chickens was evaluated in growth performance, carcass and haematological studies. Five each of broiler starter and finisher diets were formulated to contain, 0, 20, 40, 60, 80 and 0, 25, 50, 75, 100% of pigeon pea meal protein as replacement for soybean meal protein, respectively. One hundred and twenty (120), 1 week old broilers were divided into five groups of 24 birds each and were randomly assigned to the five dietary treatments in a Completely Randomised Design (CRD). Each group had 3 replicates of chicks each. Water and feeds were offered *Ad libitum*. The results obtained indicated that pigeon pea meal protein replacement for soybean meal protein up to 50% level in the finisher diet supported growth or total weight gain without any significant ($p<0.05$) depression. Total weight gain deceased significantly ($p<0.05$) with higher levels of pigeon pea meal protein replacement for soybean meal. Feed utilization viz., feed intake, feed efficiency and protein efficiency ratios were not significantly ($p>0.05$) affected by dietary treatments. Carcass and organ weights decreased significantly ($p<0.05$) with increasing levels of pigeon pea meal in the diets. Haematological values were also significantly ($p<0.05$) affected. Haemoglobin, white blood cells, packed cell volume, leutrophils and the differential white blood cell counts were observed higher among chickens fed control diets and generally decreased with increasing levels of pigeon pea meal in the diets. Total serum protein, albumin and globulin value recorded among the chickens fed control diets can be considered low when compared with values obtained for the test diets. It is important to add that the negative effects of decrease or increase in some blood parameters had no observed serious negative impact on chickens fed diets 2 and 3 containing up to 50% pigeon pea meal protein replacement for soybean meal protein since they were not inferior to chickens fed the control diet with regard to growth performance.

Key words: Pigeon pea, soybean meal, broiler chicken, growth performance

INTRODUCTION

The search for alternative protein sources for livestock feeding in developing countries because of high cost and scarcity of the conventional protein sources such as soybean meal and groundnut cake is a continuous one. Olorede and Longe (1999) had earlier opined that, the feed and nutritional crisis besetting livestock production in Nigeria strongly indicate the need to expand the raw materials base for livestock feed formulations to accommodate unconventional feed resources. One of such unconventional feed sources that could be used to reduce the problem of high cost of conventional protein sources in livestock diets with particular reference to poultry is the pigeon pea. The pigeon pea seeds have low human food preference and unlike soybean and groundnut cake, its value in livestock feeding has not been fully investigated.

Pigeon pea (*Cajanus cajan*) is one of the legumes grown in Nigeria. It is an important pulse crop in the middle belt of Nigeria and is a moderately yielding legume (300-3000 kg ha^{-1} of dry seeds) in native farms where it serves as valuable soil improver and yields 5000-7000 kg ha^{-1} under improved cultivation for over 2-3 years period (Phillips *et al*., 1981; Ngoka, 1997). In spite of its yield potential, its consumption in Nigeria is quite low possibly because of the availability of other beans which are easier to cook.

A wide variation exists in the chemical composition of pigeon pea seeds due to genotype, growth condition and duration of storage (D'Mello, 1982; Amaefule and Onwudike, 2000). Raw pigeon pea seeds contain 14.0-28.9% crude protein, 1.0-9.0% ether extracts, 5.0-9.4% crude fibre, 3.5% ash and 36.0-65.0% NFE (Oyenuga, 1968; Kay, 1979).

Pigeon pea like many other grain legumes contain various secondary metabolites which when consumed by animals and man may result in the reduction of nutritional value. Such compounds among others include protease inhibitors (Liener, 1989) and lectins (Aletor, 1984). Igene *et al*. (1999) listed trypsin, chemotrypsin, phenol compounds and amylase inhibitors as potential anti-nutritional factors in legumes. These anti-nutritional factors inhibit the activities of the digestive enzymes thereby causing digestive losses.

Several methods including boiling, auto-claving and roasting (Igene *et al*., 1999) have been reported to significantly detoxify and improve the attractive value of legume meals. In this present studies, the use of boiled pigeon pea seeds as a replacement for soybean meal in the diets of broiler chickens was evaluated in the chickens growth performance, carcass and haematological studies.

MATERIALS AND METHODS

The test ingredient, pigeon pea was bought in the open market at Ekpoma, Edo State, Nigeria while all other ingredients were purchased in and around Ekpoma and Benin City.

The pigeon pea seeds were divided into batches of 10 kg each. Each batch was boiled in an aluminium pot using dried firewood for 1 h. At the end of the cooking period water was drained off while the seeds were sun-dried for 5 days at ambient temperature of about 29°C. The pigeon pea seeds were thereafter ground in a hammer mill to the desired particle size.

Five experimental diets were formulated using boiled pigeon pea meal as the test ingredient to replace soybean meal protein at 0, 20, 40, 60 and 80% in broiler starter diets 1, 2, 3, 4 and 5, respectively. In the formulation of the finisher diets, the boiled pigeon pea meal replaced soybean meal protein at levels of 0, 25, 50, 75 and 100%, respectively in diets 1, 2, 3, 4 and 5.

The determined composition of both boiled pigeon pea meal and soybean meal are given in Table 1 while Table 2 and 3 show those of the starter and finisher diets, respectively.

The diets were compounded manually by weighing the components separately using a sensitive scale at pre-determined percentages (kg/100 kg). The diets were mixed thoroughly to avoid selective feeding by birds on some of the components at the expense of the others. The ingredients used include, maize, soybean meal, boiled pigeon pea meal, fishmeal, wheat offal, bone meal, premix, methionine and lysine and salt.

The starter diets were fed for 3 weeks, while the finisher diets were fed for another 4 weeks.

Table 1: Proximate chemical composition of boiled pigeon pea meal and soybean meal (g 100 g^{-1} DM)

Parameters	BPPM*	SBM*
Dry matter (DM)	93.00	93.50
Ether extract	3.70	3.44
Crude fibre	7.60	6.20
Ash	4.62	5.14
Crude protein	21.00	45.00
NFE	63.08	40.22
Metabolizable energy (kcal kg^{-1})	2.66	2.92
Calcium	0.13	0.20
Phosphorus (%)	0.28	0.60

*BPPM: Boiled pigeon pea meal **SBM: Soybean meal

Table 2: Composition of the experimental starter diets

	Replacement levels of soybean meal protein with pigeon pea meal protein				
Ingredients	0%	20%	40%	60%	80%
Maize	48.00	43.00	34.30	24.10	14.70
Soybean meal	30.00	24.00	18.00	12.00	6.00
Pigeon pea meal	0.00	14.00	28.00	43.20	57.60
Wheat Offal	14.30	10.00	10.00	10.00	0.00
Fish meal	4.00	5.00	6.00	07.00	8.00
Bone meal	3.00	3.00	3.00	03.00	3.00
Premix (Vit. and mineral mix.)	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10
Total	0.00	100.00	100.00	100.00	100.00
Calculated analysis					
Crude protein (%)	22.81	22.84	22.81	22.62	22.62
Metabolisable energy (kcal kg^{-1})	2804.31	2811.02	2807.04	2817.44	2815.16

Table 3: Composition of the experimental finisher diets

	Replacement levels of soybean meal protein with pigeon pea meal protein				
Ingredients	0%	25%	50%	75%	100%
Maize	50.00	45.00	36.60	32.00	25.00
Soybean meal	25.00	16.70	12.50	08.33	0.00
Pigeon pea meal	00.00	15.00	30.00	40.00	60.00
Wheat offal	18.30	15.60	12.70	10.47	5.30
Fish meal	3.00	4.00	4.50	05.50	6.00
Bone meal	3.00	3.00	3.00	03.00	3.00
Premix (Vit. and mineral mix.)	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis					
Crude protein (%)	19.98	19.91	19.80	19.88	19.64
Metabolisable energy (kcal kg^{-1})	2996.40	3092.16	3009.52	2999.25	2999.21

Experimental design and experimental animals: A total of 150-day old Anaak 200 strain of broiler chicks were brooded together for one week during which they were given a commercial boiler starter diet. At the end of week one, 120 of the chicks were divided into 15 groups of 8 chicks per group which were again divided into 5 units in a random order. The units corresponded to the treatment levels and each unit had 3 replicates. The test diets, starter and finisher were, respectively fed *ad libitum* from the 2nd to 4th week and from the 5th to the 8th week in a deep litter house. On the day of collection of the birds, they were given vitalyte soluble powder against stress condition. On the second day, they were vaccinated using Newcastle disease vaccine (1/0). On the 7th and 14th days, they were orally immunised against Newcastle disease (Lasota) and infections Bursal disease (Gumboro), respectively, by dissolving 200 doses of each vaccine in 2 litres of chlorine-free water. Half (1/2) litre of this water was given to the chicks, while the remaining 1/2 was appropriately discarded. The birds were also prophylactically treated against bacterial infection at the second week using terramycine (chick formular) soluble powder (50 g in 60 L) and against coccidiosis using embazin fort at 30 g per 50 L of water at the 21st day.

Data collection

Performance indices: Data were collected weekly on the parameters listed below as follows:

- **Feed intake:** The weights of the feeds served and what were left unconsumed (collected daily) were weighed weekly. Weekly feed intake was obtained by difference. To obtain the consumption per day, weekly feed intake was divided by 7 and the value further divided by the number of birds in each replicate to get consumption per day per bird
- **Body weight and weight gain:** Weights of the birds in different replicates were taken weekly and weights gained for the week were obtained by difference. The values were divided by the number of chicks to get gain per chick per week and from this gain per day was calculated
- **Feed/gain ratio:** This was calculated as the ratio of the feed consumed to the weight gained
- **Protein efficiency ratio:** This was calculated as the ratio of weight gained to protein consumed

Organs and carcass quality studies: On the last day of the trial, 2 chickens per replicate were randomly selected, weighed, slaughtered, dressed, eviscerated and dissected into thigh, chest, back, drumstick, shank, belly-fat and head. All the organs were weighed after they have been dissected out. The relative organ weights of the liver, kidney, heart, gizzard, bursa, spleen and pancreas were calculated.

Haematological studies: On the 56th day, 3 birds per treatment were used for blood collection. Blood samples were collected by cardiac puncture into EDTA-anticoagulant treated bottles. Another set of blood were collected in bottles that did not contain EDTA. These blood samples were analysed as follows; Packed Cell Volume (PCV), Red Blood Cells (RBC), White Blood Cells (WBC) and haemoglobin were determined using Wintrobe's microhaematocrit, improved Neubauer haemacytometer and cyanomethaemoglobin methods, respectively. Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Haemoglobin Concentration (MCHC) were compared according to Jain (1986). The blood samples that did not contain anti-coagulant were allowed to clot by putting them into a refrigerator at 4°C for 3 h. They were then centrifuged for 10 min and the serum was separated and stored frozen at-10°C until they were analysed.

Data analysis: All data collected were subjected to one-way analysis of variance and Duncan's multiple range test was applied for the separation of the means, where significant differences were noted among the means.

RESULTS AND DISCUSSION

Growth performance, carcass and haematological responses data of the broiler chickens are showed in the tables below.

Growth performance of experimental chickens: Data on growth performance of boiler chickens fed Pigeon Pea Meal (PPM) at varying levels of dietary inclusion are presented in Table 4 and 5. There were significant differences ($p<0.05$) in total weight gain at both starter and finisher phases. Weight gain performance of chickens fed diets (2 and 3) containing lower levels of pigeon pea meal inclusion 15 and 30%, respectively, representing 25 and 50% PPM respective replacement for soybean were not significantly different ($p>0.05$) from the control diet. This result agrees with that of Ani and Okeke (2003) that there was no significant ($p>0.05$) depression in weight gain among birds fed diets containing 5.5 to 27% roasted pigeon pea seed meal. Higher

Table 4: Performance characteristics of broiler chickens fed experimental starter diets

	Replacement levels of soybean meal protein with pigeon pea meal protein diets (%)				
Parameters	0	20	40	60	80
Avg. initial wt. (g/bird) at 1 week	80.00	80.0	80.81	80.12	80.16
Avg. final wt. (g/bird) at 4 weeks	802.40^{a}	752.84^{a}	741.05^{a}	726.71^{b}	679.40^{b}
Avg. total wt. gain (g/bird/21 days)	722.40^{a}	672.84^{a}	660.24^{ab}	646.59^{b}	599.34^{b}
Avg. daily wt. gain (g/bird/day)	34.40	32.04	31.44	30.79	28.54
Total feed consumed (g/bird/21 days)	1294.69	1252.69	1105.65	1044.54	1028.58
Avg. daily feed intake (g/bird/day)	061.65	59.65	52.65	49.74	48.98
Feed efficiency ratio	1.79	1.81	1.72	1.65	1.65
Avg. daily protein intake	13.92^{a}	13.39^{a}	12.0^{a}	11.19^{b}	10.86^{b}
Protein efficiency ratio	2.54	2.36	2.58	2.52	2.48

Means with different superscripts are significantly ($p<0.05$) different

Table 5: Performance characteristics of broiler chickens fed experimental finisher diets

	Replacement levels of soybean meal protein with pigeon pea meal protein diets (%)				
Parameters	0	25	50	75	100
Avg. initial wt. (g/bird) at 4 weeks	802.40	752.84	741.05	726.71	679.40
Avg. final wt. (g/bird) at 8 weeks	2305.72^{a}	2246.92^{a}	2245.49^{a}	2153.87^{b}	2116.64^{b}
Avg. total wt. gain (g/bird/28 days)	1503.32^{a}	1494.08^{a}	1504.44^{a}	1427.16^{b}	1437.24^{b}
Avg. daily wt. gain (g/bird/day)	53.69	53.36	53.73	50.97	51.33
Total feed consumed (g/bird/28 days)	2736.44	2642.64	2471.28	2410.52	2278.64
Avg. daily feed intake (g/bird/day)	97.73	94.38	88.26	86.09	81.38
Feed efficiency ratio	1.82^{a}	1.79^{a}	1.63^{b}	1.66^{b}	1.60^{b}
Avg. daily protein intake	20.49^{a}	18.78^{ab}	17.45^{bc}	17.22^{bcd}	15.57^{e}
Protein efficiency ratio	2.63	2.80	2.47	2.66	2.30

Means with different superscript are significantly ($p<0.05$)

levels of pigeon pea meal inclusion above 30% progressively decreased weight gain performance of chickens. The result obtained in this study seems to suggest that both starter and finisher broilers can be fed diets containing up to 40% level of soybean meal protein replacement with pigeon pea meal protein without any observed weight depression.

There were no significant differences (p>0.05) among treatments in feed intake at both starter and finisher phases. This result shows an improvement over the observation of Ani and Okeke (2003) that broilers fed up to 27% roasted pigeon seed meal significantly reduced feed intake. The high feed consumption by the chickens on pigeon pea meal diets suggests that boiling as a processing method was able to eliminate or considerably reduce the anti-nutritional factors in the pigeon pea which inhibits feed intake in most legumes (Igene *et al*., 1999). There were significant differences (p<0.05) among treatments in feed efficiency only at the finisher phase. This might have been responsible for the differences in total weights recorded among the chickens fed varying dietary levels of pigeon pea meal.

Protein intake was significantly (p<0.05) affected by dietary treatments at both starter and finisher phases. At the starter phase, protein consumption for diets 2 and 3 were similar to the control diet. Higher levels of pigeon pea meal inclusion significantly (p<0.05) reduced protein intake among the starter and finisher broilers. Protein efficiency was not in any way significantly (p>0.05) affected by dietary treatments at various stages of growth. This implies that complete substitution of soybean meal with pigeon pea meal in the diets of broiler chickens had no adverse effect on

Table 6: Carcass characteristics of broiler chickens fed experimental finisher diets

	Replacement levels of soybean meal protein with pigeon pea meal protein diet (Finisher %)				
Parameters	0	25	50	75	100
Live weight (kg)	1.70^{a}	1.60^{b}	1.60^{b}	1.55^{c}	1.40^{d}
Dressed weight as % of live weight	91.15^{a}	86.86^{b}	83.33^{c}	83.97^{c}	87.50^{b}
Eviscerated weight as % of live weight	65.60^{a}	66.42^{a}	60.60^{a}	51.35^{b}	52.32^{b}
Cut-parts					
Head (g kg^{-1} b.wt.)	46.50^{a}	46.20^{a}	41.00^{b}	40.20^{b}	39.40^{c}
Neck (g kg^{-1} b.wt.)	87.53^{a}	73.33^{b}	068.20^{c}	64.16^{d}	50.33^{e}
Breast (g kg^{-1} b.wt.)	268.00^{a}	201.53^{b}	149.77^{c}	126.73^{d}	125.20^{e}
Back (g kg^{-1} b.wt.)	206.33^{a}	201.33^{b}	150.13^{c}	126.37^{d}	125.83^{d}
Drumstick (g kg^{-1} b.wt.)	174.97^{a}	162.70^{b}	136.37^{c}	119.50^{d}	101.50^{e}
Thigh (g kg^{-1} b.wt.)	153.30^{a}	127.93^{b}	126.53^{b}	114.80^{c}	97.10^{d}
Shank g kg^{-1} b.wt.)	81.27^{a}	73.03^{b}	68.83^{c}	63.07^{d}	57.70^{e}
Wings (g kg^{-1} b.wt.)	141.10^{a}	123.57^{b}	119.27^{c}	117.30^{d}	89.67^{e}
Organ weight					
Heart (g kg^{-1} b.wt.)	7.06^{a}	6.50^{b}	6.30^{b}	5.40^{c}	3.60^{d}
Kidney (g kg^{-1} b.wt.)	10.03^{a}	6.37_{b}	6.47^{b}	5.53^{c}	5.20^{c}
Lung (g kg^{-1} b.wt.)	8.40^{a}	7.13^{b}	6.27^{c}	6.27^{c}	5.42^{d}
Liver (g kg^{-1} b.wt.)	34.67^{a}	31.00^{b}	31.03^{b}	27.37^{c}	25.80^{d}
Gizzard (g kg^{-1} b.wt.)	47.60^{a}	38.03^{b}	35.80^{c}	27.07^{d}	25.02^{e}
Abdominal fat (g kg^{-1} b.wt.)	28.33^{a}	21.47^{b}	14.59^{c}	13.30^{d}	12.19^{d}
Spleen (g kg^{-1} b.wt.)	1.70^{a}	1.60^{a}	1.37^{b}	1.27^{b}	0.77^{c}
Proventriculus (g kg^{-1} b.wt.)	8.90^{a}	9.57^{a}	7.23^{b}	5.60^{c}	5.00^{c}

Means with different superscripts in the same horizontal rows are significantly different (p<0.05)

Table 7: Haematological parameters of chickens fed experimental broilers finisher diets

	Replacement levels of soya bean meal protein with pigeon pea meal protein diets (%)				
Parameters	0	25	50	75	100
PCV (%)	29.00^a	28.00^b	28.00^b	28.00^b	25.00^c
Haemoglobin (%)	9.47^a	9.47^a	9.40^{ab}	9.33^b	8.30^c
WBC (mm^3)	6,000.00^d	9,000.00^c	11,933.33^b	9833.33^c	13,066.67^a
Neutrophils (%)	59.67^a	60.00^a	58.14^b	42.00^c	43.88^c
Leucocytes (%)	60.00^a	60.00^a	58.00^b	42.00^c	38.00^d
MCV (fl)	94.67^a	94.00^b	93.67^b	94.00^a	86.67^c
MCH (pg)	28.01^b	27.67^b	27.67^b	30.33^a	27.67^b
MCHC (g/c)	276.00^a	265.68^b	265.67^b	260.33^c	207.67^d
Total protein (g/100 mL)	3.47^c	3.00^d	3.70^b	3.87^a	3.40^c
Albumin (g/100 mL)	2.40^b	1.87^d	2.10^c	2.50^a	2.03^c
Globulin (g/100 mL)	1.10^c	1.10^c	1.60^a	1.53^a	1.37^b

Means with different superscripts in the same horizontal row are significantly different ($p<0.05$)

protein utilization even though it did not translate to equal growth among the chickens considering the fact that higher inclusion levels of pigeon pea meal resulted to a decrease in growth.

Carcass characteristics of broiler chickens: Table 6 shows data on the carcass quality of broiler chickens as influenced by the test diets. The results show that all carcass parameters were significantly affected ($p<0.05$) by dietary treatments. Dressed weight percentage was least (83.33%) in diet 3 containing 50% soybean meal protein replacement with pigeon pea meal protein and highest among chickens fed the control diet. Eviscerated weight percentages among chickens fed diets 1, 2 and 3 were not significantly ($p>0.05$) different from each other and the observed values were 65.60, 66.42 and 60.60%, respectively. Similarly the lower values observed for diets 3 and 4 (83.33 and 83.97%, respectively) were not significantly different ($p>0.05$) from each other.

The weights of cut parts namely; head, neck, breast, back, drumstick, thigh, shank and wings were significantly highest ($p<0.05$) among birds fed the control diet. Weight of all cut parts in chickens fed test diets generally decreased with increasing levels of pigeon pea meal. This agrees with earlier reports that higher rates of inclusion of pigeon pea reduced feed efficiency (Arora, 1995; Bamgbose *et al*., 2004). Tissue deposition of birds on pigeon pea meal diets was seriously impaired.

The control diet with no inclusion of pigeon pea meal was superior to all the test diets with regards to organ weight values. Organ weights namely; heart, kidney, lung, liver, gizzard, abdnominal fat, spleen and proventriculus were 7.06, 10.03, 8.40, 34.67, 7.60, 28.33, 1.70 and 8.90 g kg^{-1} b.wt.), respectively in chickens fed the control diet. The weights of all the organs also decreased in the chickens with higher inclusion levels of pigeon pea meal in the test diets.

Haematological parameters of experimental chickens: Results obtained from the blood packed cell volume content of the broiler chickens showed significance differences ($p<0.05$) on the different experimental diets. The highest value was obtained from chickens fed the control diet with a value of 29.0%. Diet 5 with 100% replacement of soybean meal protein with pigeon pea meal protein had the least value (25.0%). PCV decreased with increasing levels of pigeon pea meal in the diets. PCV value obtained among all the chickens were however, slightly below the values (30-40%) reported by Igene *et al*. (2001). It should be understood however, that, PCV measures the percentage composition of the blood cells in relation to other contents such as plasma, food nutrients etc. It is therefore useful in assessing the normal blood level in the body. With regards to the PCV results, the control diet can be said to be superior to all the test diets.

Haemoglobin values among the chickens ranged from 8.36% in diet 5 to 9.46% in the control diet. Significant differences ($p<0.05$) were found among the values. Values observed for diets 1, 2 and 3 were however, not influenced by dietary treatments since significant differences ($p>0.05$) did not exist among them. It is also important to remark that increasing levels of pigeon pea meal in the diets (diets 4 and 5) resulted to a decrease in haemoglobin. According to Frandson (1986), a decrease in the quantity of haemoglobin much below normal, might be as a result of poor nutrition including dietary deficiency of iron, copper, vitamins or amino acids.

White Blood Cells (WBC) and Neutrophils were also significantly affected ($p<0.05$) by dietary treatments. WBC ranged from 6,000.0 mm^3 in the control diet to 13,066.67 mm^3 in diet 5. The reverse was the case for neutrophils which was highest in the control diet (59.67%) and diet 2 (60.0%) and then decreased with increasing levels of pigeon pea in other test diets.

An increase in WBC could be due to the presence of an infection (Okon, 1975). Therefore the significantly higher values recorded from feeding the boiler chickens pigeon pea meal diets could be indicative of the presence of mild infection possibly introduced with the pigeon pea. This problem could also be the effect of numerous anti-nutritional factors normally present in pigeon pea. High levels of WBC in blood indicate increased anti-body level with increase lymphocytes count (Frandson, 1986).

Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Haemoglobin Concentration (MCHC) were all significantly affected ($p<0.05$) by dietary treatments as shown in Table 7. MCV and MCHC were highest in the control diet, 94.67 fl and 276.0 g^{-1}, respectively and decreased steadily in chickens fed diets containing pigeon pea meals. MCH on the other hand was highest among birds fed 75% soya bean meal protein replacement with pigeon pea meal protein with a value of 30.33 pg. Values recorded for other diets including the control were not significantly different ($p>0.05$) from each other.

MCV, MCH and MCHC contents are derived from red blood cells, haemoglobin and packed cell volume contents and concentration and they are readily used in the assessments of the nutritional status of an animal as a result of the feeds ingested. Increase in MCV, MCH and MCHC have been reported to cause anaemia (Seivered, 1972). However, the values for MCV, MCH and MCHC observed in this study are within the normal range reported by Igene *et al.* (2001).

Total serum proteins, albumin and globulin were significantly affected ($p<0.05$) among the experimental chicken. Values were generally higher in diet 4 compared with others. Total serum protein in chickens fed diet 4 was 3.87 g 100 mL^{-1} while diet 1,2,3 and 5 had 3.47, 3.0, 3.70 and 3.40 g 100 mL^{-1}. Igene *et al.* (2001) in their studies with broiler chickens reported that a linear correlation existed between protein quality and serum protein. Relating this observation to the current work, it can be stated that diet 4 was superior to other diets including the control in terms of protein quality.

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