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Hot Red Pepper (Capsicum annum L.) Meal Enhanced the Immunity, Performance and Economy of Broilers Fed in Phases

Kolawole Daniel, Afolabi[1*] Eugenes Kelechi, Ndelekwute[1] Olufemi Mobolaji, Alabi[2] Rotimi, Olajide[3]
1.Department of Animal Science, University of Uyo, Uyo, Akwa Ibom State, 520003, Nigeria
2.Department of Animal Science & Fisheries Management, Bowen University, Iwo, Osun State, Nigeria
3.Department of Animal Production, Joseph Ayo Babalola University, Ikeji-Arakeji, Osun State, Nigeria

Abstract
Feeding of poultry in phases had been advocated to prevent wastage of nutrients, resources, and environmental pollution; and for optimal performance at every stage of production. The possibility of using organic materials like spices such as hot red pepper meal as feed additive to enhance performance is hereby tested. The effect of dietary Dried Hot Red Pepper-DHRP (*Capsicum annum*) meal on the performance, haematology, and carcass traits of broilers fed in three phases were evaluated. In a CRD, 240 day-old broiler chicks were allotted to four experimental diets or treatments at the pre-starter (0 - 3rd weeks), starter (4 – 6th weeks) and finisher (7th week) phases for 7 weeks on deep litter poultry house at 20 chicks per replicate of three. Four experimental diets were formulated for each of the growth phases with 0.1, 0.2 and 0.3 % DHRP meal in diets 2, 3 and 4 respectively; while diet 1 without DHRP meal served as the control. The performance at the end of 7th week showed that feed intake and daily Body Weight Gain (BWG) for birds fed diets with DHRP meal were significantly ($p < 0.05$) higher than what obtained for those on control diet. The least Feed conversion Ratio-FCR (2.06) and least cost of feed intake per kg BWG (₦273.6) were obtained for birds fed diets with 0.2% DHRP meal. DHRP meal in broilers diet significantly increased the BWG and decreased the FCR and cost of feed intake. The leucocytes of broilers fed diets with DHRP meal beyond 0.1% level were elevated significantly. Relative broilers' carcass cut and internal organs weights were not adversely affected by DHRP meal-based diets. Inclusion of up to 0.2% hot red pepper meal in broilers diet improved their performance at a lower cost; had no adverse effect on their carcass traits and haematology but elevated the leucocytes cell count as a potential immunity booster.
Keywords: Hot red pepper (*Capsicum annum*), Performance, Broiler, Haematology, Carcass

1. Introduction

The quest for alternative health, growth and performance enhancer that is organic in nature had sprouted research efforts to consider the possibility of using probiotics, prebiotics, herbs, spices, enzymes, organic acids, essential oils among others as feed additive. Spices and herbs have been reported (Dorman and Deans, 2000; Hui, 1996) to have antioxidant, antimicrobial and digestion enhancing activity and benefits in broilers besides acting as stimulant to endogenous enzymes. Pepper is one of the most important herbs or spices which are widely and frequently used by human worldwide (Kobata *et al*., 1998). It is either consumed by man or used to treat his sick animals or as insecticide to preserve grains. Pepper is a common ingredient normally included in local dishes (stew and soups) consumed in Africa. It originated from central and South America and belonged to Solanaceae family, genus *Capsicum.* It is a common believe in southwestern Nigeria that pepper in diets guarantees good health and long life as meat delicacy with pepper is often recommended as a complement to medication for quick recuperation from ailments. Pepper (*Capsicum annum*) in either fresh or dried form had been used in African traditional medicine and given to sick domestic animals like chicken, goats and sheep with the aim of increasing their resistance to diseases and parasites (worms).

Capsicum annuum cultivar pepper is rich in vitamin C and E (Lee *et al*., 2010; Abdo, *et al*., 2003 and Azouz, 2001), and capsaicin (Shahverdi *et al*., 2013; Al-Kassie *et al*., 2011; Chevallier, 1996). Hot red peppers, also known as chili (or chile) peppers, owe their "heat" or pungency to a chemical substance called capsaicin (Shahverdi *et al*., 2013; Al-Kassie *et al*., 2011; Chevallier, 1996). This chemical is concentrated in the cross walls of the fruit and around the developing seeds. Chili peppers can be mild to fiery hot, depending on the amount of capsaicin present. The active material capsaicin, causing the hotness, is an odorless white alkaloid, soluble in hot water, ethyl and methyl alcohols and acetone (An *et al.*, 2007). This study investigated the effects of dietary dried red hot pepper meal on broiler chicken's growth performance, some haematological parameters and carcass characteristics.

2. Materials and Methods

2.1. Experimental Materials and Animals

The study was carried out at the Poultry Unit of the Teaching and Research Farm of University of Uyo, Uyo, Nigeria. Dried Red hot pepper (prepared by parboiling and sun drying) was purchased from Itam market in Uyo metropolis, Nigeria. The dried pepper was further dried under the sun for 3 days before milling it into powdery form or meal herein referred to as Dried Hot Red Pepper (DHRP) meal. Two hundred and forty (240) day-old broiler chicks were allotted to four experimental diets which is referred to as treatments at the pre-starter (0 - 3rd weeks), starter (4 – 6th weeks) and finisher (7th week) phases (NRC, 1994) covering the period of 7 weeks on deep litter poultry house at the Teaching and Research farm of the University of Uyo, Uyo, Nigeria. Prior to the chicks' arrival, the house had been fumigated, cleaned and disinfected 4 weeks earlier. Wood shaving was used as the litter or floor bedding.

2.2. Experimental Design and Diets

Four experimental diets were formulated for three growth phases (NRC, 1994) of pre-starter (0 - 3rd weeks), starter (4 – 6th weeks) and finisher (7th week) phases. Four experimental diets with 0.1, 0.2 and 0.3 % Dried Hot Red Pepper (DHRP) meal in diets 2, 3 and 4 respectively were formulated and compounded. Diet 1 without DRHP (*Capsicum annum*) meal serves as the control. The DHRP used contained 8.5% moisture. 7.5% crude protein, 3.5% ether extract, 4.3% ash, 3.7% crude fibre, 9.3mg/100g Iron, and 1,435µg/100g β-carotene (AOAC, 2010). Each treatment was replicated three times with 20 chicks per replicate. Experimental diets contained 3,105 – 3,117 kcal Metabolizable energy per kg of the feed; and 23, 20 and 17.64% protein at the pre-starter, starter and finisher phases respectively (Tables 1 and 2). Feed and water were offered *ad libitum*. Standard health (medication/vaccination) and management practices were observed.

Table1. Percentage composition of experimental diets at pre-starter (0 – 3rd wk) and starter (4th – 6th wk) phases phases

Growth phase	**Pre-Starter (0-3rd week)**				**Starter (4rd-6th week)**			
Treatments	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Levels of DHRP meal (%)	**0**	**0.1**	**0.2**	**0.3**	**0**	**0.1**	**0.2**	**0.3**
Maize	54.8	54.7	54.6	54.5	60.18	60.08	59.98	59.88
Soyabean meal	29.8	29.8	29.8	29.8	28.6	28.6	28.6	28.6
Fish meal	7.90	7.90	7.90	7.90	3.17	3.17	3.17	3.17
Bone meal	3.00	3.00	3.00	3.00	3.70	3.70	3.70	3.70
Palm oil	3.70	3.70	3.70	3.70	3.50	3.50	3.50	3.50
*Premix	0.20	0.20	0.20	0.20	0.25	0.25	0.25	0.25
Table salt	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
L-Lysine	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
DL-Methionine	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
DHRP meal	-	0.10	0.20	0.30	-	0.10	0.20	0.30
Total Composition	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Calculated analysis:								
ME (Kcal/kg)	3111	3109	3107	3105	3116	3114	3112	3110
Crude protein (%)	23.08	23.08	23.08	23.08	20.19	20.19	20.19	20.18
Ether extract (%)	3.11	3.10	3.10	3.10	3.06	3.06	3.06	3.06
Crude fibre (%)	2.42	2.42	2.42	2.43	2.46	2.46	2.46	2.46
Calcium (%)	1.32	1.34	1.36	1.37	1.28	1.30	1.31	1.33
Phosphorus (%)	0.91	0.91	0.91	0.91	0.93	0.93	0.93	0.93
Lysine (%)	1.58	1.58	1.58	1.58	1.25	1.25	1.25	1.25
Methionine (%)	0.46	0.46	0.46	0.46	0.37	0.37	0.37	0.37

DHRP = Dried hot red pepper (*Capsicum annum*); ME = Metabolizable energy (kcal/kg).

***Supplied per kg diet: Vit. A, 12 x 10^6 I.U., Vit. D_3, 3 x10^6 I.U., Vit. E, 3 x 10^4mg; Vit. K_3, 2500mg; Vit. B_1, 2000mg; Vit. B_2, 5000mg; Vit. B_{12}, 20mg; Vit. B_6, 3500mg; Folic acid, 1000mg; Niacin, 40000mg; Ca Pantothenate, 10000mg; Biotin, 80mg; Cobalt, 250mg; Selenium, 250mg; Iodine, 1200mg; Iron, 40000mg; Manganese, 70000mg; Copper, 8000mg; Zinc, 80000mg; Choline, 20000mg; Antioxidant, 12500mg.*

Table 2. Percentage composition of experimental diets at finisher phase (7th week)

Treatments	**1**	**2**	**3**	**4**
Levels of DRHP meal (%)	**0**	**0.1**	**0.2**	**0.3**
Maize	66.0	65.9	65.8	65.7
Soyabean Meal	26.0	26.0	26.0	26.0
Bone meal	4.20	4.20	4.20	4.40
Palm oil	2.95	2.95	2.95	2.95
*Premix	0.25	0.25	0.25	0.25
Table salt	0.20	0.20	0.20	0.20
L-Lysine	0.20	0.20	0.20	0.20
DL-Methionine	0.20	0.20	0.20	0.20
DHRP meal	-	0.10	0.20	0.30
Total Composition	**100**	**100**	**100**	**100**
Calculated analysis:				
Metabolizable Energy (kcal/kg)	3117	3115	3114	3112
Crude protein (%)	17.64	17.64	17.64	17.64
Ether extract (%)	3.10	3.10	3.10	3.10
Crude fibre (%)	2.45	2.45	2.46	2.46
Calcium (%)	1.26	1.27	1.29	1.30
Phosphorus (%)	0.93	0.93	0.93	0.93
Lysine (%)	0.98	0.98	0.98	0.98
Methionine (%)	0.32	0.32	0.32	0.32

DHRP = Dried hot red pepper (*Capsicum annum*).
**Supplied per kg diet: Vit. A, 12 x 10^6 I.U., Vit. D_3, 3 x10^6 I.U., Vit. E, 3 x 10^4mg; Vit. K_3, 2500mg; Vit. B_1, 2000mg; Vit. B_2, 5000mg; Vit. B_{12}, 20mg; Vit. B_6, 3500mg; Folic acid, 1000mg; Niacin, 40000mg; Ca Pantothenate, 10000mg; Biotin, 80mg; Cobalt, 250mg; Selenium, 250mg; Iodine, 1200mg; Iron, 40000mg; Manganese, 70000mg; Copper, 8000mg; Zinc, 80000mg; Choline, 20000mg; Antioxidant, 12500mg.*

2.3. Haematological Studies
At the end of the seventh week blood was collected aseptically using a sterile syringes and needles from the wing veins of three birds per replicate into a bottle with ethylene diamine tetraacetic acid (EDTA) to prevent clotting. All blood samples collected were subjected to haematological analysis of Packed Cell Volume (PCV), haemoglobin, leucocytes (White Blood Cell-WBC) and platelets, in the laboratory according to the procedure of MAFF (1984). The percentage Mean Corpuscular Haemoglobin Concentration (MCHC) was calculated from the respective values obtained for haemoglobin and the haematocrit (PCV) of each blood samples.

2.4. Carcass analysis
At the end of the study the birds were starved or fasted overnight but with access to only water to clear the gut of the digesta. In the following morning four birds per replicate (12 birds per diet) were selected for carcass analysis. The live weight of the birds were taken and then slaughtered and stunned by severing at the junction between the head and the neck, hung and allowed to bleed. The birds were dipped in warm water bath of 65^0C for 3 minutes after which they were de-feathered, eviscerated and the carcasses were cut into pieces as breast, back, thigh, drumstick, shank, wing, neck and head as described by Hann and Spindler (2002). The internal organs (liver, heart, gizzard, intestine and the proventiculus), the gizzard and abdominal fat and the dressed carcass cuts were weighed and expressed as percentage of the live weight.

2.5. Data Collection and Analysis
Data were collected on growth performance characteristics (initial body weight, feed intake, cost of feed/kg and final body weights from which weight gain, feed:gain or feed conversion ratio, feed efficiency, cost of feed intake per kg Body Weight Gain-BWG were calculated), haematological parameters (haemoglobin, platelets, pack cell volume-PCV, leucocytes or white blood cells, MCHC) and carcass traits (carcass cuts and internal organs weights) of the birds. Data obtained were subjected to descriptive statistics and ANOVA of GENSTAT (2005) and their respective means were separated by Duncan multiple range test of the software.

3. Results and discussion
3.1. Performance Characteristics
The performance characteristic of broilers fed diets with dried red hot pepper meal is as shown in Table 2. The initial body weights (43.34 – 43.37g/chick) of day old broiler chicks were similar ($p > 0.05$). Daily feed intake varied significantly ($p < 0.05$) from 77.82g/bird/day in treatment 4(0.3% DRHP meal) to 81.87g/bird/day in

those fed diets with 0.1% DHRP meal (T2). Daily BWG obtained for birds fed diets with DRHP meal (36.21 – 38.56g/bird/day) were significantly ($p < 0.05$) higher than those on control diet (32.49g/bird/day). DHRP had significantly ($p < 0.05$) increased the daily BWG. The same trend was reported by Shahverdi *et al.* (2013) who reported 33.8 – 38.83g/bird/day when red hot pepper and black pepper were included in the diets of broilers for 42 days.

Feed Conversion Ratio (FCR) obtained for birds on control diet and diet with 0.1% DHRP meal were similar ($p > 0.05$) but significantly ($p < 0.05$) higher and poorer than the feed:gain ratio obtained for those on diets with 0.2 and 0.3% DHRP meal (2.06 – 2.08). Birds on diets with 0.2 and 0.3% DRHP meal had the least and better FCR compared to those on diets 1 and 2 despite their significantly ($p < 0.05$) lower feed intake (77.82 – 79.79g/bird/day) and the higher cost of their feed per kg (N132.80 – 138.75) compared to those of diets 1 and 2. Feed efficiency followed the opposite trend with diets 3 and 4 being more efficiently utilized than diets 1 and 2 by broilers. The hot red pepper could have stimulated digestion of feed and absorption of nutrients in the digestive tract. The capscacinoids and capsaicin from pepper had been reported (Ohnuki et al., 2001) to increase body temperature, oxygen consumption and promote energy metabolism in human. The capsaicin in hot red pepper had been implicated to possess a stimulant, antiseptic and digestive effect (Chevallier, 1996) which increases carbohydrate metabolism by activating the sympathetic nervous system (Yoshioka *et al*., 1995; 1999; Kawada *et al*., 1988). The increase in energy or carbohydrate metabolism will enhance manufacturing of more tissues and weight gain or growth. The result obtained from this study corroborates with the reports of Shahverdi *et al.* (2013) and Al-Kassie *et al*., (2012) that inclusion of red pepper in broilers diet improved body weight gain, feed intake and conversion ratio. Al-Kassie *et al*., (2011) also concluded that the inclusion of hot red pepper at levels of 0.50%, 0.75% and 1% in the diets improved body weight gain and conversion ratio.

Cost of feed (₦)/kg (₦121.00 – 138.75) increased with the levels of dried pepper meal in the diet and the cost of feed intake (₦469.00 – 530.40/bird/7weeks) increased significantly ($p < 0.05$) with increasing levels of DHRP meal in the diet. The cost of feed intake per kg BWG also increased significantly ($p < 0.05$). The highest cost of feed intake per kg BWG (₦292.80) was obtained for birds fed control diet while the least cost of feed intake per kg BWG (₦273.6) was obtained for those fed diets with 0.2% DHRP meal. Lower cost of feed intake/kg BWG was obtained for birds of diets with DHRP meal (T2 – T4) compared to those on control diet despite the least cost of feed per kg (₦121.00) recorded for the control diet.

Table 3. Performance characteristics of broilers (day old - 7wks) fed diets with varying levels of dried hot red pepper (*Capsicum annum*) meal

Treatments	**1**	**2**	**3**	**4**	**SEM**
Levels of DHRP meal	**0**	**0.1**	**0.2**	**0.3**	
Parameters					
Initial body weight (g)	43.36	43.35	43.34	43.37	1.09
Daily feed intake (g/bird/day)	78.89^{b}	81.87^{a}	79.79^{b}	77.82^{c}	0.29
Daily weight gain (g/bird/day)	32.49^{c}	36.21^{b}	38.56^{a}	37.31^{ab}	0.41
Final body weight (g)	1636^{b}	1818^{ab}	1933^{a}	1871^{a}	65.10
FCR	2.42^{a}	2.26^{a}	2.06^{b}	2.08^{b}	0.01
Feed Efficiency	0.41^{b}	0.44^{b}	0.48^{a}	0.47^{a}	0.01
Total cost of FI (₦/bird/7wks)	469^{d}	510.80^{c}	521.1^{b}	530.4^{a}	0.64
Cost (₦) of FI/kg BWG	292.80^{a}	286.80^{c}	273.60^{d}	288.60^{b}	0.06
Cost of feed (₦)/kg	121.00	126.90	132.80	138.75	-

$^{a-d}$Means on the same row with different superscript(s) are significantly ($p < 0.05$) different.
DHRP = Dried hot red pepper (*Capsicum annum*); FCR = Feed conversion ratio (Feed:gain);
FI = Feed intake; BWG = Body weight gain; SEM = Standard error of mean.

3.2. Haematological Studies

Some haematological parameters of broilers fed diets with varying levels of hot red pepper meal is as shown in Table 7 below. The PCV (57.57 – 62.28 ml%), Haemoglobin (9.03 -10.43 g/dl) and MCHC (15.09 - 18.24%) were similar across treatments. The PCV values obtained in the present study were higher than the values reported for normal chicken (23.0 – 55.0 ml%) by Mitruka and Rawnsley (1977) which is an indication that the birds were not anemic. The haemoglobin values obtained for the birds were within the range of values (7.00 – 18.6 g/dl) reported (Mitruka and Rawnsley, 1977) for normal chicken. Similar values (7.45 – 8.6 %) were obtained (Al-Kassie *et al*., 2011) when 0.25 – 1,00% DHRP-based diets were fed to broilers for six weeks. Al-Kassie *et al*., (2012) obtained 7.4 – 7.9 g/dl haemoglobin, 23.9 – 27.9 % PCV when broilers were fed diets with 0.25 – 1.0 % hot red pepper and black pepper for six weeks. However, the MCHC which is the proportion of haemoglobin contained in the average red cell of the blood sample were lower than the range of values reported (Mitruka and Rawnsley, 1977) for chicken. The platelets obtained for birds fed control diet and those on 0.1 – 0.2% DHRP meal (27.00 – 51.67 x 10^3/mm^3) were similar and fall within the range of values reported for health chicken. The platelets volume obtained for birds fed diet with 0.3% DRHP was significantly higher those of other diets and higher than the maximum value (70.00 x $10^3/mm^3$) documented (Mitruka and Rawnsley, 1977) for normal chicken. The DHRP meal may have caused the platelet to be elevated which implies the increase in the blood clotting ability of the birds when injured.

The leucocyte or white blood cells (WBC) of broilers fed control diets and diets with 0.1% DHRP meal (4.7 – 5.6 x $10^3/mm^3$)were similar and significantly lower than what obtained (11.27 – 13.73 x $10^3/mm^3$) for those fed diets with 0.2 and 0.3% DHRP meal. The leukocyte of broilers fed diets with DHRP meal beyond 0.1% was elevated significantly. Al-Kassie *et al*. (2012) had reported 12.7 – 13.8 x $10^3/mm^3$ WBC for broilers fed 0.25 1.0 % mixtures of red and black pepper for 42 days on deep litter house. The capsaicin in DHRP meal which is pungent or pepperish could have challenged the body which in turn stimulated the production of more leucocytes or antibodies that can fight foreign bodies and diseases when the need arise. This will increase the ability of the bird to fight diseases and hence their anti-pathogenic or antibacterial properties (El-Deek *et al.,* 2012; Choi *et al*., 2006). El-Deek *et al*. (2012) had used hot red pepper in place of antibiotics in broilers. Pepper (*Capsicum annum*) in either fresh or dried form had been used in African traditional medicine and given to sick domestic animals like chicken, goats and sheep with the aim of increasing their resistance to diseases and parasites (especially to deworm the animals). Recent studies involved in poultry performance showed that blends of active compounds from hot red pepper causes chemo-preventive and chemotherapeutic effects (Puvaca *et al.,* 2015; Puvaca *et al.,* 2014).

Table 4. Haematological parameters of broilers fed diets with varying levels of hot red pepper (*Capsicum annum*) meal

Treatments	**1**	**2**	**3**	**4**	**SEM**
Levels of DHRP meal	**0**	**0.1**	**0.2**	**0.3**	
Packed cell volume (ml%)	62.28	58.16	59.88	57.57	4.37
Platelets (x $10^3/mm^3$)	51.67^{ab}	27.00^{b}	39.33^{b}	73.33^{a}	8.62
Haemoglobin (g/dl)	10.43	10.40	9.03	9.90	1.69
Leucocytes (x $10^3/mm^3$)	4.7^{b}	5.63^{b}	11.27^{a}	13.73^{a}	0.87
MCHC (%)	16.78	18.24	15.09	16.87	2.69

$^{a-b}$Means with different superscript across rows are significantly ($p<0.05$) different
DHRP = Dried hot red pepper (*Capsicum annum*); SEM = Standard error of mean; MCHC = Mean corpuscular haemoglobin concentration.

3.3. Carcass analysis

The carcass characteristics and internal organs (expressed as percentage of live weight) of broilers fed diets with varying levels of red hot pepper (*Capsicum annum*) meal is as shown in Table 8 below. The percentage carcass or dressing percentage (60.24 – 65.65) were similar across board and were within the range of values (54.97 – 67.80%) reported (Bot *et al*., 2013) for broiler fed 0 – 50.53% African locust bean-based diets for eight weeks. The values were however lower than those (70.11– 74.30%) reported by other scientist (Shahverdi *et al*., 2013; Al-Kassie *et al*., 2011) who fed broilers with diets supplemented with 0.02 – 1.00% hot red pepper and black pepper for six weeks. The thigh (10.82 – 11.36%), drumstick (9.50 – 9.84), shank (3.98 – 4.18%), wings (7.23 – 7.90), breast cut (18.74 – 21.84%), back cut (13.67 – 15.36%), neck (4.40 – 4.85%), and the head (2.61 – 2.72%) were similar ($p > 0.05$) for all birds across treatments. The values were within the range of values obtained (Bot *et al*., 2013) for broilers fed diets with or without varying levels of African locust bean, but lower than the values reported by Shahverdi *et al*. (2013) for six weeks broiler fed hot red pepper-based diets.

The proportion of the weights of internal organs like liver (1.79 – 2.03%), heart (0.45 – 0.51), intestine (4.24 – 4.99%), gizzard (1.49 – 1.58%) and the proventriculus (0.44 – 0.68%) to live weights were also not significant across diets or treatments. This implies that DHRP meal had no adverse effects on birds' internal organs when compared with the control. The percentage kidney of broilers fed control diet (0.10%) and diets with 0.1 and 0.25% DHRP meal (0.14%) were similar ($p > 0.05$). The least value for kidney (0.06%) was obtained for birds fed diet with 0.3% DHRP meal, and is not significantly different ($p > 0.05$) from the kidney of birds on diet without DHRP meal (control). The effect of DHRP meal on abdominal and gizzard fat weight was not significant ($p > 0.05$).

Table 5. Carcass characteristics and internal organs of broilers fed diets with varying levels of red hot pepper (*Capsicum annum*) meal

Treatments	1	2	3	4	SEM
Levels of DHRP meal	0	0.1	0.2	0.3	
Live weight (g))	1887[a]	1907[a]	1740[ab]	1667[b]	58.9
Carcass cuts (as % of live weight)					
Carcass	60.24	65.19	65.65	63.93	1.64
Thigh	11.01	11.36	10.82	11.28	0.68
Drumstick	9.50	9.71	9.76	9.84	0.36
Shank	3.98	4.06	3.88	4.18	0.16
Wings	7.23	7.90	7.86	8.32	0.46
Breast cut	18.74	21.16	21.84	20.42	1.15
Back cut	13.67	15.00	15.36	14.14	0.70
Neck	4.78	4.85	4.48	4.40	0.31
Head	2.72	2.44	2.61	2.71	0.11
Internal Organs and fat (%)					
Liver	1.79	2.03	1.99	1.93	0.11
Heart	0.49	0.46	0.45	0.51	0.06
Intestine	4.24	4.36	4.70	4.99	0.30
Gizzard	1.58	1.54	1.49	1.58	0.09
Proventriculus	0.46	0.48	0.68	0.44	0.08
Abdominal & gizzard fat	1.45	2.02	1.65	1.69	0.18
Kidney	0.10[ab]	0.14[a]	0.14[a]	0.06[b]	0.02

[a-b]Means with different superscript across rows are significantly ($p < 0.05$) different
DHRP = Dried hot red pepper (*Capsicum annum*); SEM = Standard error of mean.

4. Conclusions

Dried hot red pepper meal in broiler chickens diet significantly enhanced their body weight gain, final body weight and efficiency of feed utilization. It also decreased the cost of production or cost of feed intake per kg body weight gain.

Inclusion of up to 0.2% hot red pepper meal in broilers diet improved their performance at a lower cost; had no adverse effect on their carcass traits, organ weights and haematology but elevated the leucocytes cells as a potential immunity booster that improved the ability to defend and fight against foreign bodies or pathogens.

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