Performance, Immuno-stimulatory and blood biochemical Indices of broiler chickens fed hot red pepper *(Capsicum annuum L.)* supplemented diets

Abstract

A study was conducted to evaluate the effects of hot red pepper (HRP) powder as a natural feed additive on performance, immunity and blood biochemical parameters in broiler chickens. A Completely Randomized Design (CRD) was adopted by using 180 two weeks old Anak broiler chicks, allocated to four treatments with nine replicates of five birds each. Commercial broiler diets used containing HRP at the levels of 0%, 1.0%, 1.25% and 1.5%.

Results showed that HRP supplementation did not significantly increase ($p>0.05$) the Average Feed Intake (AFI). Also not significant ($p>0.05$) but birds fed with the control diet had the numerically lowest Average Body Weight Gain (ABWG) (38.11g) and worst Feed Conversion Ratio (FCR) (1.96). Better cost/kg weight gain was also found in the birds fed with the HRP supplemented diets. Mortality was however, significantly ($p>0.05$) higher in control diets compared to other diets. Packed cell volume (PCV), haemoglobin (HG), and white blood cell (WBC) levels were not significantly ($p>0.05$) different among the experimental groups. At the same time, HRP dietary supplementation did not have a significant effect on serum biochemical parameters (Aspartate aminotransferase (AST), Alanine aminotransferase (ALT), Lactate dehydrogenase (LDH), Low-density lipoprotein (LDL), High-density lipoprotein (HDL), triglycerides, cholesterol and glucose. Conclusively, hot red pepper (*Capsicum annuum L*.) inclusion up to 1.5% has the potential to improve feed conversion ratio and cost/kg weight gain, without affecting the blood biochemical indices of broiler chickens.

Key words: Feed additives, performance, immune-stimulatory effects.

INTRODUCTION

The food insecurity is a significant challenge that developing countries must overcome (Adedoyin, 2014). The production of these countries should be increased to more than 100 billion tons of meat in 2020 in order to satisfy population needs according to Dougnon *et al*. (2014)."

In many countries, as well as in Nigeria, consumer preferences have eliminated the use of antibiotics as growth promoters in the poultry industry. Apart from the significant role of antibiotics for the improvement of health and well-being of animals (therapeutic use), these agents were extensively used in the past in order to improve growth rate and feed conversion ratio (FCR) (prophylactic use). However, due to the developed resistance of microbes to antibiotics use, alternative growth promoters are assessed in animal production. The limitation of antibiotics" use as growth promoters has led to reduced growth performance and feed efficiency as well as increased incidence of enteric disorders such as necrotic enteritis in poultry (Dibner and Richards, 2005). Meanwhile, chillies production in West Africa is considered to be one of the most commercial peppers. Although, they originated in the West Indies, Peru and Mexico, nowadays are spread all over the tropics and sub-tropics. Pepper grows best on well-drained soils that have good water- holding characteristics and P^H of 5.8-6.6 (Are *et al*., 2010). Pepper was reported to improve feed digestibility in broiler chickens (Moorthy *et al*, 2009). It also proved to be rich in glutathione peroxidase and glucose-6-phosphate dehydrogenase, and carcass quality of broiler chicks fed pepper has shown that piperine can dramatically increase absorption of selenium, vitamin B complex, β carotene and curcumin as well as other nutrients (Tazi *et al.*, 2014). Feeding broilers hot red pepper can increase their feed intake by between 8 to 10%. Piperine enhances the thermogenesis of lipids and accelerates energy metabolism in the bird and also increases the serotonin and β–endorphin production in the brain (Al-Kassie *et al*., 2011). Pepper in broilers diet has been reported to have antioxidant properties (Galib *et al.*, 2011) and anticarcinogenic effect, especially when combined with chili (Nalini *et al*., 2006). Among its chemical and biological activities, piperine is characterized by anti-microbial (Reddy *et al*., 2004) and anti-inflammatory (Pradeep and Kuttan, 2004) properties. Pepper supplementation in broiler feeding resulted in modulation benzopyrene metabolism through cytochrome P450 enzyme (CYP), which is important for the metabolism and transport of xenobiotics and metabolites (Abou – Elehair *et al*., 2014). Hot red pepper plays an important role in decreasing the deposition of cholesterol and fat in the body, contributes to decreasing the levels of triglycerides and supports the vascular system in the body. The efficient compounds found in hot red pepper are capsaicin, capsisin, and capsantine, some of which allay rheumatic aches. Recent studies on poultry performance have shown that blends of active compounds for hot red pepper have chemo-preventive and chemotherapeutic effects (Al-Kassie *et al*., 2012). Hot red peppers (*Capsicum annuum L*.) are the most important spices that are widely used in human nutrition. They are rich in Vitamin C, a fact that causes a considerable impact in improving poultry production by minimizing heat stress. Several studies on broilers (Al – Kassie *et al*. 2011; Puvaca *et al*. 2015; and Zomrawi *et al*. 2012) have already examined the satisfactory effect of red chilli pepper (*Capsicum annuum L*.) and ginger root powder *(Zingiber officinale*) (up to 1.0% and 1.5% respectively). With the intention to ensure food security of rural and urban populations in Africa, new programs of livestock development promote the use of biological products, including enzymes, probiotics, prebiotics, symbiotic, organic acids and plant extracts (phytobiotics) as alternatives to antibiotic feed additives in diets for monogastric animals. This study, therefore, investigated the effects of hot red pepper (HRP) (*Capsicum annuum L*.) on productive performance, immune-status and blood biochemical indices of broiler chickens.

MATERIALS AND METHODS

Experimental Diets

The sun-dried hot red pepper used in this experiment was obtained in large quantity from Maya market in Ibarapa Area and was then ground into powder. Diet 1 served as a control (without HRP) and diets 2, 3, and 4 were supplemented with 1.0%, 1.25% and 1.50% of hot red pepper, respectively. The analysis of commercial broiler hybrid diets is shown in Table 1.

Experimental birds and management

A total of one hundred and eighty, two – weeks old Anak broiler chicks were used in the present study. Birds were allocated into 4 treatments, each with nine replicates using a Completely Randomized Designed (CRD). Birds were generally vaccinated against Newcastle disease and Infection bursal disease in the 1st, 10th and 21st day. Also, birds fed with control diet were provided with antibiotics, anti-cocci and vitalyte as outlined by Olomu (2003). In contrast, birds fed with the diets 2, 3, and 4 were provided only with the vitalyte. Birds were raised on deep litter.

Feed and water were provided *ad libitum*. Feed intake, weight gain and feed conversion ratio (FCR) were weekly recorded and were used as indicators of birds' performance. The duration of the experiment was 42 days. Feed conversion ratio (FCR) was calculated as follows:

$$\text{FCR}=\frac{\text{feed intake}}{\text{body weight gain}}$$

Blood Sample Collection and Analysis

At the end of the 8th week, nine birds were randomly chosen from each treatment and blood samples were collected via wing vein. 5ml were used for biochemical analysis, while the remaining quantity was stored in a bottle containing measured quantities of EDTA (anticoagulant for haematological analysis). Immune-status parameters were determined: Hematocrit (HT), Haemoglobin (HG), white blood cell (WBC), Lymphocyte, granulocyte, monocyte, Eosinophil and Neutrophils were according to Jain (1986). The serum samples were used for Aspartate aminotransferase (AST), Alanine aminotransferase (ALT), lactate dehydrogenase (LDH), Low-density lipoprotein (LDL), High-density lipoprotein (HDL), Triglycerides, cholesterol and glucose determination as described by Kaneko (1989).

Statistical Analysis

Data obtained were subjected to Analysis of Variance (ANOVA) with SAS software (SAS/STAT, 2012). Duncan multiple range tests (1955) was also carried out to separate subclass means.

Table 1: Nutrients Composition of Commercial Broiler Hybrid Diets (g/100g)

Nutrients	Starter	Finisher
Dry matter	89.4	89.3
Moisture	10.8	10.5
Crude Protein	22.5	20.01
Ether Extract	5.1	3.8
Crude Fibre	4.3	3.6
Ash	5.0	6.0
Metabolisable Energy Kcal/kg	3000.8	3100.1
Phosphorus	0.45	0.44
Calcium	1.2	1.2
Methionine	0.56	0.52
Lysine	1.2	1.2

Table 2: Performance parameters of broiler chickens.

Diets+Additive	Parameters							
	Av.feed intake g/b/d	Av.body weight Gain g/b/d	FCR	Cost/g Additive (₦)	Cost/kg feed (₦)	Cost/feed consumed (₦)	Cost/kg Weight Gain	Mortality (%)
1(control)	74.16	38.11	1.96^{a}	21	141.5	440.73	1156.50	4.4^{a}
2(1% supplemt.)	77.81	41.81	1.86^{ab}	1.0	131.00	428.11	1023.95	2.7^{b}
3(1.25% supplemt)	77.09	40.98	1.88^{ab}	1.028	131.28	425.06	1037.23	0.0^{c}
4(1.5% supplemt.)	76.01	40.16	1.89^{ab}	1.050	131.50	419.80	1045.31	0.0^{c}
SEM±	3.03	4.03	0.10					2.1

abc… Means within coloum with different superscripts are significant (p>0.05)
SEM±: Standard Error of the means
FCR: Feed Conversion Ratio; g/b/d: grams/bird/Day.

Table 3: Haematological Indices of broiler chickens

Diets/Concentration of Additive	PCV (%)	HG (g/dl)	WBC ($x10^3/\mu l$)	Lymphocyte (WBC %)	Monocyte (WBC %)	Eosinophil (WBC %)	Neutrophils' (WBC %)
1(control)	28.57	9.86	16483^{bc}	56.35	4.81	0.39	0.49
2(1% inclusion)	28.68	9.71	16852^{a}	56.55	4.99	0.44	0.49
3(1.25% inclusion)	28.89	9.97	16778^{ab}	56.84	4.89	0.54	0.51
4(1.5% inclusion	28.77	9.88	16847^{ab}	56.83	4.63	0.49	0.48
SEM±	0.36	0.19	311.1	0.510	0.38	0.10	0.11

abcd … means within column with different superscripts are significant (P>0.05)
SEM±: Standard error of means.
PCV: Packed cell volume; HG: Haemoglobin; White blood cell.

Table 4: Serum metabolites parameters of broiler chickens

Diets/Concentration of Additive	AST (iu/l)	ALT (iu/l)	LDH (iu/l)	LDL (mg/dl)	HDL (mg/dl)	Triglycerides (mg/dl)	Cholesterol (mg/dl)	Glucose (mg/dl)
1(control)	188.1	12.98	3858.5	22.61	86.87	87.01	91.84	139.92
2(1% inclusion)	189.2	10.64	3977.9	21.88	88.21	76.99	88.66	133.44
3(1.25% inclusion)	191.3	10.83	3888.6	21.61	81.01	73.83	81.98	129.92
4(1.5% inclusion	188.8	11.60	3781.1	22.08	89.93	78.04	89.16	130.09

SEM±	3.1	0.99	201.0	1.11	7.09	8.03	10.01	9.38

abc … means within each column with different superscripts are significant (P>0.05)
AST: Aspartate aminotransferase; ALT: alanine aminotransferase; LDH: Lactate dehydrogenase; LDL: Low-density lipoprotein; HDL: High-density lipoprotein

RESULTS AND DISCUSSION

The nutrients composition of the test diet indicated an optimum crude protein value of 22.5%and 20.01% for both starter phase and finisher phase, respectively as already shown by previous researchers (Olomu, 2011). Average feed intake (AFI) ranged from 74.16 to 77.81g., and average body weight gain (ABWG) from 38.11 to 41.81g, without significant differences among the treatments. Feed Conversion Ratio (FCR) and cost/kg weight gain are shown in Table 2. Birds fed with the hot red pepper (HRP) supplemented diets had numerically higher AFI and ABWG compared to the controls. It has been reported that some spices stimulate pancreatic digestive enzymes – lipase, amylase and proteases, which might play a crucial role in digestion (Platel and Srinivasan, 2004). Spices were also found to enhance the activities of terminal digestive enzymes of the small intestinal mucosa. At the same time, the stimulation of either bile secretion or activity of digestive enzymes by the spices leads to an accelerated digestion and to a reduction in feed transit time in the alimentary tract (Plate1 and Srinivasan, 2001). The FCR (1.86) were similar across the dietary treatment while cost/kg weight gain (₦ 1023.95) were, however, significantly ($p<0.05$) improved in birds fed the 1% HRP supplemented diet compared to the controls. Lower feed conversion ratio in experimental treatments shows that addition of hot red pepper (HRP) is promising for feed utilization and efficiency. Also, it might be reasoned that the stimulative, carminative, digestive and anti-bacterial properties of HRP in this study, responsible for observed better absorption of the nutrients present in the gut and finally leading to improvement in feed conversion ratio.

The highest mortality rate (4.4%) was recorded in the control diet compared with 2.7%, 0.0% and 0.0% of diets 2 (1% inclusion HRP), 3 (1.25% inclusion HRP) and 4 (1.5% inclusion HRP), respectively. It can be assumed that the birds fed HRP based diets had better phagocytosis within the cells (Frankic *et al*., 2009) leading to a lower stress level of chickens. White blood cell (WBC) count has been reported to be a marker that provides useful information regarding the stimulation of immune system against disease (Robert *et al.*, 2003, Greathead, 2008, Idodo-Umeh, 2011). Generally, no significant effects of HRP supplementation on WBC were found in the present study.

Table 3 shows the examined haematological indices. Packed Cell Volume (PCV), haemoglobin, white blood cell (WBC) count, Lymphocyte and Monocyte numbers were not significantly ($P>0.05$) different among the experimental groups, Eosinophil counts were higher ($p>0.05$) in broilers fed with the HRP supplemented diets. The values for haemoglobin and PCV were within normal range of 24 – 39 for broilers and 24 – 45 for poultry as reported by Oladele *et al.,* (2006) and Ross *et al.,* (1978), respectively. This implies that the birds fed either the control diet (1) (0% inclusion HRP) or the diets 2, 3, and 4 (1%, 1.25% and 1.5% HRP) were not anaemic and no depressive effect of HRP supplementation on the internal physiology of broiler birds was observed. Nevertheless, the slight increase which was not significant in WBC parameters in broilers fed with HRP shows that HRP can be an efficient feed additive. These results are in accordance with the findings of Pradeep and Kuttan, (2004), Kalaiyarasu *et al.* (2013) and Zhou *et al.* (2014), who worked on cytokines as immune-modulating agents. They reported that alkaloids as natural immune- modulators in broilers diet can offer alternatives to conventional chemical-based therapeutics through the activation and regulation of the cells of the immune system. It has been established in their separate studies that alkaloids can function on chicken myelomonocytic growth factor (cMGF) with a resultant effect on the propagation of macrophages and granulocytes from avian bone marrow progenitor cells. Again, the macrophage activity of (cMGF) is reported to be a potential factor in controlling viral diseases, and exploration of its role as an immune – modulation agent is of particular interest (Kaneko, 1989; and Kalaiyarasu *et al.*, 2013).

Effect of HRP supplementation on some serum metabolites is shown in Table 4. Enzymes activities of Alanine aminotransferase (ALT) in the serum of broiler chicken fed the HRP supplemented diets were not significantly decreased compared to the controls (10.64, 10.83 and 11.60 *versus* 12.98iu/l, respectively). Moreover, results obtained for aspartate aminotransferase (AST) and lactate dehydrogenase (LDH) were similar among the dietary treatments and ranged within the normal values reported by Mitruka and Rawnsley (1977), which implied no impairment on heart and liver in broilers fed with either antibiotics or HRP supplemented diets. Fernandez *et al.*, (1994), Emadi and Kermanshahi, (2007); Akbarian *et al.*,(2012); and Gilani *et al.*, (2013) observed liver damage and an increase in serum ALT, AST and LDH activity in layers and broilers after aflatoxin infection.

Glucose levels of broilers fed HRP based diets (2) 133.4mg/dl, (3) 129:9mg/dl, (4) 130.1mg/dl were not significantly different (P>0.05) compared to the control diet (1) 139.9mg/dl. Similarly, the LDL, HDL, triglycerides and cholesterol levels were reduced in the birds fed HRP supplemented diets. According to this result, it appears that HRP supplementation enhances the thermogenesis of lipids and also accelerates the energy metabolism in those birds fed with the test diets. At the same time, a possible cholesterol-lowering effect is observed that could be mediated by the stimulation of hepatic cholesterol-7-hydroxylase which converts cholesterol to bile acids, and the facilitating of biliary cholesterol excretion as suggested by Suresh and Srinivasan (2006).

CONCLUSION

The hot red pepper *(Capsicum annuum L.*) inclusion up to 1.5% had positive effects on performance of broilers. Immuno-stimulatory and serum biochemical indices were generally not affected by the addition of hot red pepper in broiler diets. Consequently, broilers can tolerate up to 1.5% hot red pepper without adverse effects on broiler production parameters.

Ethical Disclaimer

As per international standard or university standard ethical approval has been collected and preserved by the author(s).

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