HAEMATOLOGY AND SERUM BIOCHEMICAL INDICES OF BROILER CHICKENS FED TURMERIC RHIZOME POWDER

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ABSTRACT
This study was aimed to explore the ability of turmeric rhizome powder (TRP) to impact the blood haematological and biochemical composition of broiler chickens. A total of 120 ROSS 308 strains of unsexed broiler chicken were used for the study which lasted for a period of 8 weeks. The study was made up of four treatments including control. The three other groups were treated with 200g, 400g and 600g supplementation of TRP in the broiler diets. Blood samples were collected for the analysis of haematology and serum biochemical indices. The result from this analysis showed that the dietary treatment with TRP had a significant effect ($p<0.05$) on the haematological parameters including RBC, PCV haemoglobin, platelet, MCH, MCHC as well as the ser um biochemical indices including serum lipids (HDL-C, LDL-C, VLDL, and total cholesterol) and the serum proteins (total proteins and globulin). The RBC, PCV and Haemoglobin counts of all the treated groups were significantly different ($p<0.05$) from the control but the highest was recorded in the group fed 200g of TRP (4.37x106/ul, 39.33%, and 13.93g/dL respectively), while the two other treatments were significantly lower than the control (3.95x106/ul, 35.67% and 13.13g/dL). However, the values were within the range for a normal broiler chicken. The reduction of the lipid composition of the serum also confirms the anticholesteremic effect of turmeric rhizome powder. This study therefore supports the supplementation of broiler diets with TRP and recommends 200g as the optimal level for supplementation in 100kg of broiler diets.
KEYWORDS: Turmeric Rhizome powder, curcumin, broiler, haematology, serum

INTRODUCTION

In the past decade, the concern has always been on meeting the global food demand for the achievement of food security and United Nations' zero hunger agenda by 2030 especially following the decline in global food and meat production in 2019/2020 due to the COVID-19 pandemic (OECD/FAO, 2020). In this regard, in the OECD/FAO Outlook projection for 2020 to 2030, it is reported that "Poultry meat will continue to be the primary driver of meat production growth, albeit rising at a slower rate in the projection period relative to the past decade. In the same report, consumption of poultry meat is projected to increase globally to 152 Mt over the projection period, accounting for 52% of the additional meat consumed. Despite this affinity to chicken meat across the globe, chicken production is threatened by cost of production and diseases especially pathogenic diseases (Khan *et al.,*2012). Broiler health specifically, is threatened by a host of pathogens that causes several diseases which affects the immunity, meat yield and general profitability of the poultry industry (Kumari *et al.,*2007). The health status of animal in totality contributes as much as nutrition to their growth and yield (Griggs and Jacob, 2005). With this understanding, researchers in Africa have resorted to seeking alternatives to antibiotics that are both safe and more economical unlike synthetic medications. So many other additives have since then found their way into the animal production industry for their preventive and therapeutic tendencies. Among these alternatives are plants, probiotics, plant extracts, roots, essential oils, turmeric, and its derivatives etc (Giggs and Jacob, 2005). Turmeric (*Curcuma longa* L.) is a popular medicinal herb, which shows a wide range of pharmacological properties, such as antioxidant, antiprotozoal, antivenom, antimicrobial, anti-inflammatory, antiproliferative, antiangiogenic, antitumor and antiaging (Amalraj *et al.,* 2017). Turmeric rhizome powder (TRP) contains bioactive secondary metabolites and curcuminoids that are needed to produce healthy poultry. Besides the good results of bird performance, TRP inclusion into feed induces positive actions on blood biochemical parameters, such as the enhancement of the activities of antioxidant and detoxifying enzymes (Guil-Guerrero *et al.,* 2017). It also improves

antibody titers in the post-vaccination periods, counteracts the harmful effects of aflatoxins provided with diet, and decreases some potentially pathogenic bacteria counts in the ileal content of farmed laying hens (Faghani *et al.,*2014).

Haematology and serum biochemical values of an animal are great indicators of an animal's physiological and immunological status and upon the introduction of a new additive, the values of this markers can be or go below the normal ranges for a healthy animal (Emadi *et al.,*2007). The aim of this study therefore is to find out in addition to already existing knowledge how the dietary supplementation of graded levels of TRP affects the values of the broilers' blood biochemistry and hematology.

MATERIALS AND METHODS

Experimental site and Material

This study was carried out at the poultry unit of the Teaching and Research Farm, Department of Animal science, University of Uyo, Akwa Ibom State. Uyo town falls within the tropical rainforest zone of Nigeria, with two distinct seasons, rainy season (March – Mid November) and dry season (November - March) and has an average rainfall of 2200mm to 3500mm. The temperature of the area ranges from 26ºC to 28ºC (University of Uyo Meteorological Station, 2018). The turmeric rhizomes used for preparing the experimental material (Turmeric rhizome powder) used for this study were procedure from traders in a local market in Uyo, Akwa Ibom State. The rhizomes were washed to eliminate debris, peeled, and chopped into smaller sizes after which the sliced pieces were washed, and sun dried until brittle. The sundried and brittle pieces were ground using mechanical blenders into very fine powder.

Experimental birds and Design

A total of 120 unsexed Ross 308 broiler strains were used for this study. They were divided into four groups of 30 birds each and each group was replicated three times. Each of the groups were randomly assigned to one of the four experimental diets in a completely randomized design (CRD). The four experimental broiler diets were formulated with the supplementation of the turmeric powder such that diet I (control) had no turmeric powder (TRP). Diets II, III and IV had 200g, 400g and 600g respectively in 100kg of the formulated feed. The ingredient composition and the calculated chemical composition of the formulated diets are presented in Table 1.

Table 1: Composition of experimental diets (straight diet) with varying levels of turmeric rhizome powder (TRP).

	Experimental Diet			
Ingredients (%)	***T_1 (0g)***	***T_2 (200g)***	***T_3 (400g)***	***T_4 (600g)***
Maize	52.00	52.00	52.00	52.00
Full fat soya	20.00	20.00	20.00	20.00
Groundnut cake	11.00	11.00	11.00	11.00
Fish meal	3.00	3.00	3.00	3.00
Wheat offals	5.20	5.20	5.20	5.20
Palm kernel meal	5.00	5.00	5.00	5.00
Bone meal	3.00	3.00	3.00	3.00
Common Salt	0.25	0.25	0.25	0.25
Vitamin /mineral premix***	0.25	0.25	0.25	0.25
L-Lysine	0.20	0.20	0.20	0.20
L-Methionine	0.10	0.10	0.10	0.10
Tumeric rhizome powder	0.00	0.02	0.04	0.06
Total	**100.00**	**100.00**	**100.00**	**100.00**
Calculated analysis				
Crude protein (%)	22.13	22.13	22.13	22.13
Crude fat (%)	26.85	26.85	26.85	26.85
Crude fibre (%)	3.76	3.76	3.76	3.76
Calcium (%)	1.10	1.10	1.10	1.10
Phosphorus (%)	0.45	0.45	0.45	0.45
Metabolizable Energy ME (Kcal/kg)	2985.20	2985.22	2985.22	2985.22

****Vitamin/mineral premix = vitamin A, D3, E,K, B_1, B_2,B_6, B_{12}, vitamin A 10,000 i.u., vitamin D_3 12,000 i.u., vitamin E 20 i.u., vitamin K 2.5mg, thiamin 2.0mg, riboflavin 3.0mg, Nacin, Patothemic acid, Folic acid, Biotin, Choline Chloride, Manganese, Zinc, iron, Copper, iodine, selenium, cobalt and Antioxidants.*

Data Collection and analysis

Blood Samples were collected from three chickens per replicate making it a total of nine per treatment. Samples for haematology were collected into an Ethylene Diamine Tetra acetic Acid (EDTA) bottle to avoid coagulation of the blood and was analyzed using an automated haematology analyzer (BC-2300 model, Mindray Medical Co., China). The blood sample for the sera analyses was also collected into a sterile serum tube. The Sera were separated and obtained by centrifugation of the coagulated blood (2500 rpm: 10 min) within 30 min after sampling to measure serum chemical components.

Data Analysis

Data generated from the experiment were subjected to analysis of variance (ANOVA) according to Steel and Torie (1980). ANOVA detected the treatment effects while means were compared using the Duncan New Multiple Range Test as designed by Duncan (1955).

Result and Discussion

Haematology of Broiler Chickens fed Turmeric Rhizome Powder (TRP)

The result for the haematology of broilers chickens fed diets supplemented with TRP as presented in Table 2 below, shows that TRP had a significant effect ($p<0.05$) on several of the measured haematological parameters including the RBC, PCV, Haemoglobin, MCH and MCHC. The counts recorded for RBC, PCV and Haemoglobin reveal that the group treated with 200g of TRP recorded the highest values (4.37, 39.33, and 13.93 respectively). The consistent occurrence of the highest values of RBC, PCV and HB in T2 presents it as having the best effect on the haematology of chicken. This can also be confirmed as the other levels of inclusion also consistently lowered the values of these parameters in comparison to the control. The primary function of the RBC is the transportation of haemoglobin, and its value is used to gain insight into the haemoglobin content of the blood (Etim *et al.,* 2013). Because of the function of haemoglobin in oxygen transport, the Red Blood cells have been reported to account for oxygen made available to different tissues of the body. The raised RBC count recorded for birds on T2 in the present study also has a positive correlation with haemoglobin. The values were, however, decreasing with increasing TRP. Thus, high levels of TRP (>200g) may influence the oxygen availability and very low RBC and Hb could lead to anaemia in birds.

Table 2: Haematology of broilers fed diets with TRP supplementation

	Experimental Diets				
Parameters	**T1 (Control)**	**T2 (200g)**	**T3 (400g)**	**T4 (600g)**	**SEM**
RBC ($x10^6$/uL)	3.95^b	4.37^a	3.72^c	3.35^d	0.1
PCV (%)	35.67^b	39.33^a	32.67^c	30.33^d	1.04
HB (g/dL)	13.13^b	13.93^a	12.63^c	11.83^d	0.23
WBC ($x10^3$)	29.22	26.68	27.77	25.48	0.73
MCV (*fl*)	90.37	90.06	87.75	90.55	0.46
MCH (*pg*)	33.29^b	31.91^c	33.93^b	35.32^a	0.38
MCHC (g/dL)	36.84^b	35.44^c	38.67^a	39.01^a	0.46
White Blood Cell differential counts (%)					
Neutrophils	32.00	33.33	31.33	32.00	0.88
Lymphocytes	64.00	65.33	63.67	62.67	0.99
Monocytes	2.67	2.67	2.67	3.00	0.13
Eosinophils	1.67	2.00	2.33	2.33	0.15
Basophils	0.00	0.00	0.00	0.00	0.00

[ab] Means with different superscripts within a row are significantly different ($P<0.005$), SEM= Standard error of mean. RBC – Red Blood Cell, PCV – Packed Cell Volume, HB – Haemoglobin, WBC – White Blood Cell, MCV - mean corpuscular volume, MCH – mean corpuscular haemoglobin, MCHC – Mean corpuscular haemoglobin concentration,

The Packed cell volume, which is also known as haematocrit is a measure of the percentage of red blood cells in the blood of any animal (Demoranville and Best, 2013). Kopp and Hetesa (2000) and

Chineke et al. (2006) documented that high PCV/haematocrit reading indicated either an increase in the number of circulating RBCs or a reduction in circulating plasma volume. With the value of PCV, the state of anaemia in an animal can be estimated (Etim *et al.,* 2013). The decrease in the values of the PCV when the chickens were fed TRP beyond 200g may be a pointer to the optimal level at which broiler diets should be supplemented. A decrease in haematocrit has also been associated with a variety of common conditions including liver and kidney diseases, malnutrition, vitamin B12 and folic acid deficiencies, iron deficiency, and pregnancy among others (Demoranville and Best, 2013).

The haemoglobin in the bloodstream transports oxygen from the lungs to the body's various tissues. It then releases this oxygen into the tissues, where it is used to metabolize nutrients, and generate energy to support the organism's functions. Simultaneously, haemoglobin gathers the produced carbon dioxide and returns it to the respiratory organ for expulsion from the organisms (Sidell and Kristin, 2006). Although the PCV, RBC and haemoglobin recorded in this study are within the range reported by Talebi *et al.* (2005), feeding high concentration of TRP to broilers may have adverse effects where there are other underlying physiological challenges.

The values recorded for MCH and MCHC also showed significant differences ($p<0.05$) between groups but in this case, the highest values were recorded by the birds fed 600g (35.32 pg and 39.01 g/dL respectively). The MCH values were followed by the birds fed 400g (33.93 pg) and the birds on the control (33.29 pg) while the lowest was observed in the birds that received 200g TRP (31.91pg). All the values recorded for MCH and MCHC were also within the range provided by Talebi et al. (2005) for normal broiler chickens. The MCH and MCHC measure the volume and concentration of haemoglobin in the blood and their outcome is usually employed in the diagnosis of different kinds of anaemia (Washington and Van, 2012). The increasing MCH and MCHC, imply that despite the lower values of red blood cells and haemoglobin in these treatments, the haemoglobin concentration of their red blood cell is higher. As haemoglobin is the oxygen-carrying component of the blood, MCHC also serves as a useful index of the capacity of the bone marrow to produce red blood cells (Etim *et al.,* 2013). In all, the findings from this study agree with some past works that had evaluated the effect of TRP on the Haematology of broilers including Emadi *et al.* (2007), Guil-Guerrero *et al.* (2017), and Hosseini-Vashan *et al.,* (2015). In these studies, it was found that supplementing broiler diets with TRP had several positive effects including improvement of several haematological health indicators and increasing antibody titer against Newcastle disease among other metabolic effects.

Serum biochemistry of broiler chickens fed Turmeric Rhizome Powder

The result from the sera analysis of the broilers fed graded levels of TRP is shown in Table 3 below. The result reveals the significant effect ($P < 0.05$) TRP had on most of the serum biochemical parameters measured including the levels of total cholesterol, High-density lipoprotein cholesterol (HDLC), Triglyceride (TAG), Low-density lipoprotein cholesterol (LDLC), Total protein, and globulin. There was no trend in the values, but a very significant outcome is that the control recorded the highest level of serum lipid ranging from cholesterol (125.76mg/dL), HDL-C (70.86 mg/dL), TAG (90.44 mg/dL), LDL-C (36.81 mg/dL), and VLDL-C (18.09 mg/dL). In other words, TRP had a significant anticholesteremic effect on the broilers especially in the treatment fed 400g and 600g TRP

Table 3: Serum biochemical indices of broilers fed diets with TRP supplementation

	Experimental Diets				
TREATMENT	**T1 (Control)**	**T2 (200g)**	**T3 (400g)**	**T4 (600g)**	**SEM**
Total cholesterol (mg/dL)	125.76^{a}	106.84^{b}	106.52^{b}	109.25^{b}	2.58
HDL-C (mg/dL)	70.86^{a}	70.08^{a}	65.10^{b}	69.75^{a}	0.79
TAG (mg/dL)	90.44^{a}	89.11^{a}	84.05^{ab}	80.24^{b}	1.62
LDL-C (mg/dL)	36.81^{a}	18.94^{b}	24.61^{b}	23.46^{b}	2.12
VLDL-C (mg/dL)	18.09^{a}	17.82^{a}	16.81^{ab}	16.05^{b}	0.32
Total protein (g/dL)	3.07^{b}	3.31^{a}	3.27^{a}	3.08^{b}	0.04
Albumin (g/dL)	1.63	1.75	1.63	1.56	0.03
Globulin (g/dL)	1.45^{b}	1.56^{ab}	1.64^{a}	1.52^{b}	0.03
ALP (u/L)	64.00	68.00	65.33	71.33	1.31
ALT (u/L)	35.33	35.00	37.67	40.00	0.89
Bilirubin (mg/dL)	0.69	0.68	0.73	0.72	0.01

^{ab} = Means with different superscripts within a row are significantly different ($P<0.005$), SEM= Standard error of the mean. SEM – Standard error of means. HDL-C – High-Density Lipoproteins Cholesterol, LDL-C – Low-Density Lipoproteins

cholesterol, VLDL-C – Very Low-Density Lipoproteins Cholesterol, ALP – Alanine amino phosphatase, ALT - Alanine aminotransferase

by reducing the serum cholesterol and other serum lipoprotein cholesterol. It was also found to boost the protein and globulin levels where the control recorded the lowest (3.07g/dL, and 1.45g/dL, respectively). Total protein is related to the ability of the liver to synthesize protein, so it indicates a better humoral immune status (Kumari *et al.,*2007).

Our findings in the present study agree with some of the earlier studies that have been carried out by *Soni et al.* (1992), Emadi *et al.* (2007), Hosseini-Vashan *et al.* (2012). In the study of *Soni et al.* (1992) a decrease in serum lipid peroxides (33%) and a decrease in total serum cholesterol (12%) concentrations were observed upon curcumin administration (500 mg of curcumin per day for 7d). Just like in this study, Hosseini-Vashan *et al.* (2012) also found that dietary supplementation of TRP lowered the total cholesterol and LDL in broiler chickens. Furthermore, Kumari *et al.* (2007) found that TRP induced an increase in total protein content in serum (from 3.15 to 3.49 mg · dL^{-1}). However, an increase in the level of good cholesterol (HDL-C) which was observed by *Soni et al.* (1997), Emadi *et al.* (2007), and Hosseini-Vashan *et al.* (2012) when their diets were supplemented with TRP differs from our finding. This was not the case in our present study where the HDL-C also reduced significantly with the LDL-C and other lipid parameters. Our findings also differ from the findings of Emadi and Kermanshahi (2007) where two liver enzymes (ALT and ALP) were significantly decreased with dietary supplementation of TRP.

The serum has for long been used in the diagnosis of important diseases and sicknesses especially those relating to metabolism. Several hepatic and renal diagnoses to evaluate the health of the liver and the kidneys are conducted using the serum and their values are indicative of the health status of these vital organs (Verma *et al.,*2018). The reduced composition of lipids in the serum of broilers expressed the ability of turmeric rhizome powder to be anticholesteremic.

CONCLUSION

From our findings in this study, it can be concluded that supplementing broiler diets with turmeric rhizome powder (TRP) has beneficial effects for broilers. Firstly, it was able to raise some of the haematological blood parameters measured including the red blood cell, packed cell volume, haemoglobin, mean corpuscular haemoglobin, and mean corpuscular haemoglobin concentration. Secondly, its inclusion also significantly reduced the serum lipid of the broiler chickens. There was a significant reduction in the serum lipid and a significant increase in serum protein of broilers especially the treatment fed 400g and 600g. The range for all the parameters assessed were within the range for a normal healthy broiler chicken.

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