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Haematology and Serum Biochemistry of Broiler Chicken Fed Diets Containing Composite Blends of Herbs and Spices as Natural Growth Promoters

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Abstract :	The ban on antibiotic growth promoters in poultry production has increased interest in natural feed additives that can serve as growth promoters in broiler chicken production. This study evaluated the effects of dietary blends of herbs and spices, as natural growth promoters, on the haematological and serum biochemical parameters of broiler chicken. One hundred and sixty (160) day-old chicks were acclimatized for one week in deep litter floor pens; and then fed diets containing oxytetracycline (control), 0 %, 1.25 %, and 2.5 % inclusion levels of composite blends of garlic, ginger, Ethiopian pepper, red hot pepper and cloves for eight weeks. After the growth trial, blood samples were collected for both haematological and serum biochemical analyses. Haematological indices showed no significant differences (P > 0.05) among the treatments, except for mild variations in mean corpuscular haemoglobin, and in lymphocyte and eosinophil counts, which remained within physiological ranges. Serum enzymes and metabolites were also within safe limits, with significant differences observed only in the concentration of sodium, potassium, chloride, urea, and creatinine levels. The inclusion of herbal blends did not impair liver or kidney function and indicated potential immune-modulatory effects and improved protein metabolism. These findings suggest that composite blends of herbs and spices can serve as effective natural alternatives to antibiotic growth promoters in broiler production without adverse effects on blood health or organ function.
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Abstract

The ban on antibiotic growth promoters in poultry production has increased interest in natural feed additives that can serve as growth promoters in broiler chicken production. This study evaluated the effects of dietary blends of herbs and spices, as natural growth promoters, on the haematological and serum biochemical parameters of broiler chicken. One hundred and sixty (160) day-old chicks were acclimatized for one week in deep litter floor pens; and then fed diets containing oxytetracycline (control), 0 %, 1.25 %, and 2.5 % inclusion levels of composite blends of garlic, ginger, Ethiopian pepper, red hot pepper and cloves for eight weeks. After the growth trial, blood samples were collected for both haematological and serum biochemical analyses. Haematological indices showed no significant differences ($P > 0.05$) among the treatments, except for mild variations in mean corpuscular haemoglobin, and in lymphocyte and eosinophil counts, which remained within physiological ranges. Serum enzymes and metabolites were also within safe limits, with significant differences observed only in the concentration of sodium, potassium, chloride, urea, and creatinine levels. The inclusion of herbal blends did not impair liver or kidney function and indicated potential immune-modulatory effects and improved protein metabolism. These findings suggest that composite blends of herbs and spices can serve as effective natural alternatives to antibiotic growth promoters in broiler production without adverse effects on blood health or organ function.

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Introduction

Poultry meat is a good source of animal protein that has contributed immensely to the consumption of animal proteins in Nigeria [1]. According to [2], consumers' demand for white meat is gradually increasing compared to red meat in order to keep a healthy life. [3] also reported that protein derived from poultry meat and egg has more standard quality compared to other sources of protein. Growth promoters are substances added to the feed or injected into farm animals to improve the growth of animals and feed efficiency. While antibiotic growth promoters (AGP) are antibiotics added to animal feed to enhance growth rate, feed efficiency, and health. Antibiotics used for growth promotion in livestock and poultry have a dual benefit: they enhance animal health and productivity through improved weight gain and feed conversion efficiency, while also preventing and controlling animal diseases [4].

Over the past decades, antibiotics have played a significant role in enhancing growth rates in animal production, particularly in the United States, Australia, and selected European countries, where they were first introduced in the 1950s [4]. Numerous studies have demonstrated that supplementing animal feed with low concentrations (typically 2.5-50 mg/kg) of antibiotics enhances growth rates and improves feed conversion efficiency in agricultural animals, including cattle, pigs, sheep, and poultry. However, antibiotics commonly used as growth enhancers in poultry in the past have a potential side effect on public health [5]. Thus, the international ban on the use of antibiotics in animal feeds has increased the effort of researchers to study the natural products from plants (phytobiotics), especially locally available herbs and spices like turmeric (*Curcuma longa*), black pepper (*Piper guineense*), clove bud (*Syzygium aromaticum*), Selim pepper (*Xylopia aethiopica*) and several other beneficial plant materials that can serve as safer and cheaper substitutes for synthetic antibiotics.

Herbs are leafy green or flowering part of a plant cultivated for their aromatic, pungent, or otherwise desirable contents. Spices are usually dried and produced from other part of the plant including seeds, bark, roots and fruits. The necessity of utilizing natural plant products in poultry production has emerged as a viable alternative to mitigate the adverse effects associated with antibiotic growth promoters. Various herbs, spices, and plant-derived compounds have demonstrated potentials as effective substitutes, offering growth promotion, antimicrobial properties, and additional health benefits [6, 7, 8, 9]. For this reason, the use of antibiotics as feed additives has reduced considerably [10].

Materials and Methods

(i) Experimental Site

The experiment was carried out at the Teaching and Research Farm of the Department of Animal Production, Federal University of Technology, Minna, Niger State, Nigeria. Minna is located between latitude 9^0 28′ North to 9^0 37′ North and longitude 6^0 23′ East to 6^0 33′ East with annual rainfall of 1000 mm – 1500 mm and average temperature of 32 ^{0}C. Minna is located in the Southern Guinea Savannah vegetational zone [11].

(ii) Source and Preparation of Test Ingredients

Clove, Ethiopian pepper, garlic, ginger, red hot pepper and other feed ingredients were purchased at the Kure Ultra-modern Market, Minna. The ingredients were cleaned, sorted for any foreign particles and oven dried at 80 ^{0}C for 12 hours, to ensure complete drying, to give a totally dehydrated and crunchy or crispy product. After drying, the samples were blended into powder and stored in plastic containers with lid, until needed for further use.

(iii) Experimental Design and Management

Composite blends of herbs and spices consisting of Cayenne pepper (red hot pepper), clove, Ethiopian pepper, garlic and ginger were used for the experiment as shown on Table 1. The composite blend was used at different inclusion levels (0 %, 1.25 % and 2.50 %). The feeding trial involved the use of one hundred and sixty (160) day-old chicks, which were acclimatized in the deep litter pens for one week. After acclimatization, the birds were weighed and randomly allocated to four treatments, replicated four times, with 10 birds per replicate, using the completely randomized design model, such that Treatment 1 served as the positive control without the blend (but a conventional antibiotic, oxytetracycline at 100 mg/kg of the feed; while treatments 2, 3, and 4 consisted of diets with the composite blends at different levels. Treatment 2 contained 0 % composite blend, Treatment 3 contained 1.25 % composite blend and Treatment 4 contained 2.5 % composite blend. A single-phase feeding regime was used during the feeding trial. Broiler chicken were fed the experimental diets (Table 2) *ad libitum* for seven weeks. Thereafter, blood samples were collected for haematological and serum biochemical analyses.

Table 1: Composition of composite blends of herbs and spices

Ingredients	Quantity (kg)
Garlic	1.00
Ginger	0.50
Ethiopian pepper	0.05
Red hot pepper	0.50
Cloves	0.05
Maize offal (Dusa)	0.40
TOTAL	2.50

(iv) Blood samples collection

At the end of the feeding trial, one bird was randomly selected from each replicate, making a total of four birds from each treatment, for blood sample collection at the point of slaughter. 2 ml each of the blood sample was collected in a sterile sample bottle containing anti-coagulant (Ethylene diamine tetra acetic acid, EDTA) for haematological analysis while 3 ml was collected in a plain bottle with no anti-coagulant (non-EDTA) for serum analysis. The samples were immediately taken to the Laboratory for haematological and serum biochemical analyses. Data collected for haematological parameters included packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular haemoglobin concentration (MCHC), mean corpuscular haemoglobin (MCH), white blood cell count (WBC), red blood cell (RBC), haemoglobin concentration (HB), lymphocyte, monocyte, neutrophil, and eosinophil concentrations, while alkaline phosphate (ALP), alanine Aminotransferase (ALT), aspartate aminotransferase (AST) total protein (TP), sodium (Na), potassium (K), chloride (Cl), creatinine and urea were obtained for serum biochemistry.

(v) Data Analysis

All data collected were subjected to analysis of variance (ANOVA) using SAS software (2000), and Duncan's Multiple Range Test (contained in the Software) was used to separate the means when significant.

Table 2: Ingredient composition of the experimental diets

Ingredients	T1 (%)	T2 (%)	T3 (%)	T4 (%)
Maize	50.00	50.00	50.00	50.00
Wheat offal	1.00	1.00	1.00	1.00
Soya cake	6.00	6.00	6.00	6.00
Full fat soya	35.00	35.00	35.00	35.00
Fish meal	1.50	1.50	1.50	1.50
Lime stone	2.00	2.00	2.00	2.00
Bone meal	3.00	3.00	3.00	3.00
Salt	0.25	0.25	0.25	0.25
*Premix	0.25	0.25	0.25	0.25
Lysine	0.50	0.50	0.50	0.50
Methionine	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00
Calculated analysis				
Crude protein (%)	22.80	22.80	22.80	22.80
Energy (kcal/kg)	3006.60	3006.60	3006.60	3006.60

Treatment 1 contained conventional antibiotics (oxytetracycline at 100 mg/kg of feed). Treatment 2 contained 0 % composite blend. Treatment 3 contained 1.25 % composite blend. Treatment 4 contained 2.5 % composite blend.

Results and Discussion

The haematological parameters showed no significant ($P<0.05$) differences across the treatment groups except in MCH, L and E (Table 3). Hb ranged between 8.65–9.55 g/dl, and PCV ranged from 26.0–28.5 %. Both parameters were within recommended safe values (RSV), with no significant ($P>0.05$) differences across treatments. This suggests that herbs and spices maintained normal erythropoiesis comparable to antibiotic inclusion. Adequate Hb and PCV reflect good oxygen transport and metabolic activity [2]. Similarly, the values of WBC ($12.04–14.14 \times 10^9$/L) were within RSV and not significantly different across the treatments. Thus, since WBCs indicate immune competence, this implies that herbs and spices did not compromise immunity, corroborating reports that phytogenic feed additives support immune response [13]. MCV values

(80.5–83.5 fl) obtained were slightly lower than RSV (100–129 fl), which may indicate microcytic tendencies although still within functional limits. MCH however showed significant ($P<0.05$) differences, with the values for Treatment 1 (29.0 g/dl) higher than that of Treatment 3 (27.5 g/dl). This suggests a mild influence of the composite blend on Hb content per RBC. However, all values were within RSV. RBC ranged from $3.1–3.45 \times 10^{12}$/L, showing no detrimental effect on erythropoiesis as recommended by [14]. The differential count for lymphocyte showed a significant difference with Treatment 2 (55.0 %) having the highest value and Treatment 4 lowest (50.5 %); but with Treatment 3 not being significantly ($P>0.05$) different from Treatment 1 (Control). Lymphocyte elevation is often associated with enhanced immune activity, suggesting possible immune modulation by herbs and spices [15]. Similarly, eosinophil indicated a significant variation. Treatments with herbs showed moderated values compared to control, possibly indicating anti-parasitic or anti-inflammatory activity of the phytogenics.

Table 4 showed the results of serum biochemical parameters. The results revealed no significant ($P>0.05$) differences among treatments in all liver enzymes (ALP, ALT and AST). However, values fell within RSV, indicating that both antibiotics and herbal blends did not impair hepatic function. This aligns with previous findings that phytogenic feed additives exert hepatoprotective properties [16]. Slight increases were observed in treatments with composite blends (5.8 g/dl in T3; 5.75 g/dl in T4), approaching the RSV range in total protein. This suggests enhanced protein metabolism and possibly improved nutrient utilization due to phytogenic inclusion [17]. A significant ($P<0.01$) difference was observed with values increasing from 89 mmol/L (T1) to 118 mmol/L (T4) in Na, although all values were below RSV (148–163 mmol/L). However, the upward trend suggests that the herbal blends improved electrolyte balance. Similarly, K showed a significant difference, with T3 having the highest value (2.70 mmol/L) and T4 lowest (2.25 mmol/L). Though below RSV

Table 3: Effect of composite blends of herbs and spices on the haematological profile of broiler chicken

	Treatment						
Parameters	**1**	**2**	**3**	**4**	**SEM**	**P-value**	**RSV**
Hb (g/dl)	8.95	8.65	9.30	9.55	0.28	0.46	7.40-13.10
PCV (%)	26.00	26.50	27.00	28.50	0.89	0.45	24.90-45.20
WBC ($x10^9$)	14.14	12.04	12.35	12.14	0.51	0.29	9.20-31.00
MCV	83.50	81.50	80.50	82.50	0.53	0.36	100.00-129.00
MCH	29.00^{a}	28.00^{ab}	27.50^{b}	28.00^{ab}	0.23	0.04	25.40-40.70
MCHC	28.50	29.50	29.50	30.00	0.26	0.08	25.30-33.90
RBC	3.10	3.30	3.35	3.45	0.11	0.38	1.58-4.10
N (%)	45.00	39.50	39.50	43.00	1.16	0.53	15.60-43.90
L (%)	51.50^{ab}	55.00^{a}	54.50^{ab}	50.50^{b}	0.83	0.05	43.90-81.20
M (%)	1.50	2.50	2.00	5.50	0.77	0.12	0.06-0.94
E (%)	4.50^{a}	3.00^{b}	4.00^{ab}	3.50^{ab}	0.25	0.05	6.25-9.66

^{ab} Means with different superscripts on the same row differs significantly ($P<0.05$). SEM= Standard error of mean; P-value = probability value; RSV = Recommended save value, Hb – Haemoglobin concentration, PCV – packed cell volume, WBC – White blood cell count, MCV – Mean corpuscular volume, MCH – Mean corpuscular haemoglobin, MCHC - Mean corpuscular haemoglobin concentration, RBC – Red blood cell count, N – Neutrophil, L – Lymphocyte, M – Monocyte, E – Eosinophil

Treatment 1 contained conventional antibiotics (oxytetracycline at 100 mg/kg of feed). Treatment 2 contained 0 % composite blend. Treatment 3 contained 1.25 % composite blend. Treatment 4 contained 2.5 % composite blend.

Table 4: Effect of composite blends of herbs and spices on the serum biochemical profile of broiler chicken

	Treatment						
Parameters	**1**	**2**	**3**	**4**	**SEM**	**P-value**	**RSV**
ALP (I/U)	44.25	50.67	41.00	40.88	2.08	0.38	38.50-55.00
AST (I/U)	11.95	10.44	11.41	11.96	0.35	0.76	9.80-15.30
ALT (I/U)	11.15	10.70	13.40	15.45	1.67	0.43	10.30-18.10
TP (g/dl)	4.25	5.15	5.80	5.75	0.32	0.11	5.20-6.90
Na (mmol/L)	89.00^{d}	93.00^{c}	102.00^{b}	118.00^{a}	4.22	0.00	148-163
K (mmol/L)	2.60^{ab}	2.55^{ab}	2.70^{a}	2.25^{b}	0.08	0.05	4.60-6.50
Cl (mmol/L)	85.00^{ab}	81.00^{b}	82.00^{ab}	85.50^{a}	0.82	0.05	116-140
Urea (mmol/L)	2.15^{d}	2.70^{b}	2.80^{a}	2.40^{c}	0.10	0.01	1.50-6.30
Cret (mmol/l)	0.70^{b}	0.90^{a}	1.01^{a}	1.09^{a}	0.06	0.01	0.90-1.85

^{abcd} Means with different superscripts on the same row differs significantly ($P<0.05$). SEM = Standard error of mean; P-value = probability value; RSV = Recommended save value; ALP = Alkaline phosphate; ALT = Alanine Aminotransferase; AST = Aspartate Aminotransferase; TP = Total protein; Na = Sodium; K = Potassium; Cl = Chloride; Cret = Creatinine.

Treatment 1 contained conventional antibiotics (oxytetracycline at 100 mg/kg of feed). Treatment 2 contained 0 % composite blend. Treatment 3 contained 1.25 % composite blend. Treatment 4 contained 2.5 % composite blend.

(4.60–6.50), however, values are consistent with broiler physiology and suggest no electrolyte imbalance. More so, significant values within 81–85.5 mmol/L, but below RSV (116–140) was observe in Cl, reflecting a typical lower serum chloride value in poultry compared to mammals [18]. Renal function urea and creatinine showed a significant difference with all values within the RSV, suggesting a normal protein catabolism. However, elevated creatinine observed in herbal treatments suggests improved muscle metabolism and protein turnover, but still within safe physiological ranges.

Conclusion

The study shows that composite blends of herbs and spices positively influenced the haematological and biochemical parameters of broiler chicken, maintaining values within safe physiological ranges and sometimes improving them compared to conventional antibiotic supplementation. The immune-modulatory effects (lymphocyte and eosinophil changes) and improved protein metabolism highlight the potential of phytogenics as natural alternatives to antibiotics in poultry production.

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Conflict of interest

The authors declare that there is no conflict of interest.

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