Original Research Article

Performance, haematology and serum biochemical status of two strains of broiler chicken fed *Ficus thonningii* leaf powder and vitamin C supplemented diets

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ABSTRACT

Aims: To evaluate the effect of *Ficus thonningii* leaf powder (FTLP) and vitamin C supplemented diets on performance and haemato-biochemical status of two strains of broiler chickens.

Methodology: Four hundred and eighty-one-day-old of Arbor acre (AB) and Cobb 500 (CO) broiler chicks were randomized to eight dietary treatments; diet 1 and 2 (Control), diets 3 and 4 (200mg/kg vitamin C inclusion), diets 5 and 6 (1% inclusion of FTLP) and (diets 7 and 8 (200mg/kg + 1% FTLP inclusions) for AB and CO strains respectively.

Results: Result shows that feed intake, body weight gain and FCR were significant ($P<0.05$) at the starter phase. Interaction between strains and vitamin C were also significant ($P<0.05$) for body weight gain, FCR and feed intake. Vitamin C and FTLP supplementation significantly ($P<0.05$) improved the erythrocytes count while the MCV, MCH, WBC and lymphocytes of birds fed diets 2 and 6 were significantly ($P<0.05$) higher than the other diets. The dietary supplementation of vitamin C and FTLP shows that strain AB had a significantly ($P<0.05$) higher erythrocytes count than CO strain while the CO showed significant ($P<0.05$) improvement for the MCV and MCH. Vitamin C supplementation showed significant difference ($P<0.05$) for the RBC and the interaction of vitamin C and FTLP significantly ($P<0.05$) improved PCV, HB, MCV, MCH, WBC and lymphocytes. The interactive effect of vitamin C and FTLP significantly ($P<0.05$) improved the total protein and albumin. Cholesterol and creatinine levels were significantly ($P<0.05$) loweredby the inclusion of vitamin C and FTLP

Conclusion: As observed in this study, the inclusion of FTLP and vitamin C as a supplement in the diets of broiler chickens improved the performance, haematological indices and serum biochemical status of the tested birds.

Keywords: *Ficus thonningii, supplementation, performance, haematological, serum biochemical*

1. INTRODUCTION

The impact of heat stress on poultry birds is a trending challenge and a cause for economic loss in the poultry industry because of its detrimental influence on physiological responses like immunity, oxidative stress, and intestinal and muscular functions [1].Poultry birds raised under good management and a thermoneutral zone of $18^{O}C$ -$24^{O}C$ [2], requires little energy for thermoregulation and production goal, otherwise poultry will be under stress [3]. Bueno et al. [4] stated that the actual temperature for broiler production varies from 32°C to 35°C (1st week), 23°C–32°C (2nd and 5th week), and 20°C (6th week) and relative humidity ranging from 60%–70%, which are difficult conditions to keep in the tropics. Heat stress is one of the most pernicious factors in tropical and subtropical corridors of the world, which causes considerable economic losses in poultry production [5]. Thermal-stressed birds have elevated heterophil/lymphocyte ratios and liver enzymes which results in higher mortality levels [6]. The exposure of poultry to a range of stressors in the tropics account for depressed productive, reproductive performance and compromised health status of birds [7,8]. This in turn necessitates the requirement for complementary reinforcement for the antioxidant system in the poultry industry [9]. Studies have shown that dietary supplementation of animal feed with natural bioactive compounds ameliorate the impact of heat stress in chicken due to their significant biological activities [1]. According to Jang et al. [10], oxidative stress induced by heat stress is mutually connected with the initiation of cell-mediated immunity via antioxidant defense system, thus, antioxidant enrichment to mitigate impact of oxidative stress will influence humoral responses. Phytochemicals with antioxidant activity such as polyphenols, which are vital secondary metabolite present in plants have potentials to ameliorate heat stress and complementing poultry diet with capable phytochemical-containing feed could definitely ameliorate the shock of heat stress in poultry production [11]. Herbs possess bioactive constituent which confers optimal antioxidant defense to mitigate adverse effects of heat stress [12]. *Ficus thonningii* leaf powder was found to possess a substantial number of minerals and phytochemicals with strong antioxidant activity [13]. These compounds are naturally produced by the tree as protection against biotic and abiotic stresses [14]. The antihaemolytic and haematinic potential of *F. thonningii* is possibly due to its antagonistic action against the depletion of glutathione and hence prevention of the generation of free radicals which result in oxidative stress [15]. The inclusion of vitamin C in the diets of poultry birds has been reported to be a means of ameliorating the impact of heat stress due to its antioxidant properties, scavenging of free radicals [16], reduction of its biosynthesis during heat stress as well as poultry birds' ability to overcome infectious conditions [17]. Thus, two strains of broiler chickens were examined in this study for their performance, haematological and serum chemistry status by being fed diets supplemented with vitamin C and *Ficus thonningii* leaf powder.

2. MATERIAL AND METHODS

2.1 Ethical approval; collection, processing, and analysis of phytogens

The Research and Ethics Committee of the Department of Animal Production and Health, The Federal University of Technology, Akure, Nigeria, accepted the experiment's requirements and criteria for animal and animal protocol. [13]described the procedure for gathering and preparing *Ficus thonningii* leaf powder (FTLP) as well as investigated the proximate, phytochemical, antioxidant and mineral components of FTLP.

2.2Experimental diets, experimental design and the birds' living environment

To meet the nutritional needs of the birds, a broiler chicken's basal diet was compounded for the starter phase (0 to 21 days) and finisher phase (21-42 days) using the requirement of [18]. For each phase, the basal diet was divided into eight equal portions and named diets 1 to 8. Diet 1 and 2 were not supplemented (negative control), while diets 3 and 4 had vitamin C (200mg/Kg of basal diet) supplementation. Then diets 5 and 6, received 1g FTLP/Kg of basal diet supplementation each while diets 7 and 8 had 1g FTLP/kg of basal diet + 200mg of vitamin C. The feeding trial was undertaken at the Federal University of Technology's Teaching and Research Farm in Akure, Nigeria.
In a completely randomized design, 240 one-day-old chicks each of Cobb 500 and Arbor Acre strains of broiler chicks weighing 37.40±0.45g were randomly assigned to all the eight experimental diets. The diets were replicated six times with ten birds (10 birds/replicate) and a total of 60 birds per treatment. Wood shavings were used as bedding for the floor of the experimental pen (2m x 1m) to a depth of 3cm. The temperature of the experimental house was kept at 31±2 degrees Celsius for the first week and then reduced by 2 degrees Celsius

each week after that until the temperature reached 26±2 degrees Celsius. The lighting was turned on for 24 hours on the first day and 23 hours on consecutive days.

2.3Performance characteristics

The body weight (BW) and feed intake (FI) of the tested birds were measured and recorded weekly. The average body weight gain (BWG) was calculated as the difference between the initial and final weights of the birds. The feed conversion ratio (FCR) was calculated by dividing the feed consumed by the weight gained.

2.4Collection and analysis of Blood samples

On the last day of the feeding trial, 18 birds per replicate were randomly selected for blood collection. Syringe and needle were used to draw blood from the wing vein. For the determination of the serum biochemicals indices (i. e. total protein, aspartate aminotransferase, creatinine, and cholesterol), 4ml of the blood sample was drawn into a plain bottle vial. The sample bottles were spun and the serum decanted into another plain bottle before freezing at -20^0C. The remainder (2ml) was dispensed into Ethylenediaminetetraacetic acid bottle for haematological indices determination [15]. The serum biochemical concentrations were measured using a Reflectron ®Plus 8C79 (Roche Diagnostic, GombH Mannheim, Germany) and kits.

2.5Statistical data evaluation

The model: $Txy = \mu + bx + \beta xy$, was used in this experiment, where Txy any of the factors of response; x = the overall average; bx = the xth treatment's effect (*T*= diets 1, 2, 3, 4, 5, 6, 7 and 8); and βxy = random error due to the investigation. Using SPSS version 20, all of the data were subjected to one-way ANOVA. Duncan multiple range test of SPSS was used to detect the differences between the treatment means ($P<0.05$).

3. RESULT

Table 2 shows the growth performance of different breeds of broiler chickens fed *Ficus thonningii* leaf powder (FTLP) and vitamin C supplemented diets. The body weight gain (BWG) at the starter phase (1 – 3 weeks) were not significantly different (P>0.05) for birds across all the diets except diet 6 and the feed intake (FI) for birds fed diets 1, 2, 3 and 4 were significantly (P<0.05) higher than the other diets. The FCR for birds fed diets 6 was significantly higher than the other tested diets. The breed and FTLP supplementation were significant (P<0.05) for BWG, FI and FCR at the starter phase. The interaction between BRD x VC were significant (P<0.05) for BWG and FCR; BRD x FTLP was significant (P<0.05) for FCR while VC x FTLP showed significance (P<0.05) for BWG and FI. The interactive effect of BRD x VC x FTLP were significant (P<0.05) for BWG and FCR at the starter phase. At the finisher phase (4-6 weeks), the BWG were significantly higher (P<0.01) in diets 2 and 4 though not significantly different (P>0.05) from diet 1; FI was not significantly different (P>0.05) except for diet 3 while the FCR was significantly higher (P<0.05) for diet 5 though not significantly different (P>0.05) from diet 6. The breed CO was significantly (P<0.05) higher than the AB for the BWG while FTLP inclusion showed significance (P<0.05) for BWG and FCR. The interaction between breed and vitamin C were significant (P<0.05) for the FI and FCR; VC x FTLP showed significance (P<0.05) for BWG while the interactive effect of strain, vitamin C and FCLP were significant (P<0.05) for BWG and FI at the finisher phase.
At the overall phase (1-6 weeks), the BWG was significantly (P<0.05) higher for diets 2 and 4, though not significantly different from diet 1 while the FCR was significantly (P<0.05)

higher for diets 5 and 6 but not significantly different (P>0.05) from diets 4, 7 and 8. The inclusion of FTLP at 1% showed significance (P<0.01) for BWG and FCR. The interaction between breed and vitamin C was significant (P<0.05) for FI; VC x FTLP was significant (P<0.05) for FCR and the interaction between strain, vitamin C and FCLP was significant (P<0.01) for FI.

Data on haematological indices of breeds of broiler chickens fed FTLP and vitamin C supplemented diets is presented in Table 3. The RBC of birds fed diet 7 was significantly (P<0.05) higher, though not significantly different (P>0.05) from birds fed diets 3 and 8. The MCV and MCH values of birds fed diets 2 and 6 were significantly (P<0.05) higher than the other diets while the WBC of birds fed diet 2 was significantly (P<0.05) higher, though not significantly (P>0.05) higher than birds fed diet 7. The lymphocytes of birds fed diets 1, 3, 4, 5 and 6 were lower significantly (P>0.05) than those fed diets 2 and 7. The AB strain showed higher significance (P<0.05) than the CO breed in the value of RBC while the MCV and MCH were significantly (P<0.05) higher in the CO breed. The inclusion of 200mg/kg of vitamin C showed significance (P<0.05) for the RBC while the inclusion was significantly (P>0.05) lower for the MCV and MCH. The interaction between BRD x VC were significant (P<0.05) for the PCV, HB, MCV, MCH, WBC and LYM. BRD x FTLP were significantly (P<0.05) higher for WBC and lymphocytes while there was no significant (P>0.05) interactive effect between BRD x VC x FTLP.

The result of serum chemistry indices of the two strain of broiler chickens fed diets supplemented with FTLP and Vitamin C is presented in Table 4. The different dietary inclusion had a positive significant (P<0.05) influence on the Aspartate aminotransferase (AST), Creatine (CREA), Cholesterol (CHOL), Globulin (GLO) and Total Protein (TP). The AST performance of diets 1 and 2 for the strain AB and CO were significantly (P<0.05) higher than those in diets 3 and 4 though, not significantly (P>0.05) different from diets 5 and 6. The serum creatinine level of the control diets (diets 1 and 2) for the strains AB and CO were significantly (P<0.05) different from diets 3, 4, 5, 6, 7 and 8. The serum cholesterol level of diets 1, 2 were significantly (P<0.05) higher than those of the other tested diets. The TP of diets 7 and 8 were significantly (P<0.05) higher than those of diets 1 and 2 but not significantly (P>0.05) different from diets 3, 4, 5 and 6. The GLB performance of diets 5 and 6 (FTLP) and diets 7 and 8 (vitamin C + FTLP) were not significantly (P>0.05) different but they were significantly (P<0.05) higher than those of diets 1, 2, 3 and 4, Vitamin C inclusion also had significance (P<0.05) on the AST, CREA, CHOL, TP and ALB. The inclusion of FTLP has significant effect (P<0.06) on the serum creatinine, serum cholesterol, total protein and serum globulin. The interactive effect of vitamin C and FTLP on AST, CHOL and CREA levels of the birds were significant (P<0.05).

Table 1: Composition of the experimental diets

Ingredients (g/kg)	**Starter feed (%)**	**Finisher diet (%)**
Maize	52.35	59.35
Rice bran	7	0
Maize bran	0	6
Soybean meal	30	24
Soy oil	3	3
Fish meal	3	3
Limestone	0.5	0.5
Bone meal	3	3
Salt	0.3	0.3
Premix	0.3	0.3
Methionine	0.3	0.3
Lysine	0.25	0.25
Nutrient composition (g/kg)	100	100
*Crude protein	22.18	20.03
Metabolizable energy (Kcal/kg)	3018	3108.1

Table 2 The growth performance response of different strains of broiler chickens to *Ficus thonningii*, leaf powder and vitamin C dietary supplementations

Diet	STRN	VC mg/kg	FTLP %	IW g/b	BWG 1-3 wks	FI 1-3 wks	FCR 1-3 wks	BWG 4-6 wks	FI 4-6 wks	FCR 4-6 wks	BWG 1-6 wks	FI 1-6 wks	FCR 1-6 wks
1	AB	0	0	37.66	845.47^{a}	1022.48^{a}	1.21^{bc}	1777.11^{ab}	3262.23^{bc}	1.8^{bc}	2622.58^{ab}	4284.71	1.62^{ab}
2	CO	0	0	37.57	792.45^{a}	982.48^{a}	1.24^{b}	1883.76^{a}	2752.24^{bc}	1.4^{c}	2676.21^{a}	3734.71	1.40^{b}
3	AB	200	0	37.34	812.71^{a}	986.61^{a}	1.21^{bc}	1600.96^{bc}	2564.39^{c}	1.6^{bc}	2413.67^{bc}	3551.00	1.47^{b}
4	CO	200	0	37.56	807.12^{a}	1002.41^{a}	1.24^{b}	1911.59^{a}	3529.52^{a}	1.8^{bc}	2718.71^{a}	4531.93	1.67^{ab}
5	AB	0	1	37.61	820.06^{a}	856.95^{c}	1.04^{e}	1328.55^{d}	3193.86^{abc}	2.4^{a}	2148.61^{d}	4050.81	1.90^{a}
6	CO	0	1	37.52	648.59^{b}	876.55^{bc}	1.35^{a}	1543.93^{bcd}	3138.92^{abc}	2.0^{ab}	2192.52^{cd}	4015.47	1.84^{a}
7	AB	200	1	37.65	787.91^{a}	899.22^{bc}	1.14^{cd}	1624.30^{bc}	3071.24^{abc}	1.8^{bc}	2412.21^{bc}	3970.47	1.64^{ab}
8	CO	200	1	37.42	808.01^{a}	904.24^{b}	1.11^{de}	1533.00^{cd}	2921.14^{abc}	1.9^{bc}	2341.01^{cd}	3825.38	1.63^{ab}
SEM				0.04	13.67	13.07	0.01	44.04	81.28	0.07	47.79	83.93	0.04
P-value				0.60	0.01	0.01	0.01	0.01	0.05	0.01	0.01	0.06	0.02
	AB			37.56	816.54^{a}	941.32	1.15^{b}	1582.73^{b}	3022.93	1.93	2399.27	3964.25	1.66
	CO			37.52	764.04^{b}	941.42	1.23^{a}	1718.07^{a}	3085.45	1.82	2482.11	4026.87	1.63
	SEM			0.06	12.06	6.79	0.01	36.73	94.43	0.07	38.75	98.92	0.04
	P-value			0.60	0.01	0.99	0.01	0.01	0.64	0.25	0.15	0.66	0.69
		0		37.63	720.52	929.51	1.12	1552.83	3228.04	1.76	2385.60	4167.66	1.62
		200		37.49	807.56	953.32	1.17	1612.63	2817.81	1.87	2412.94	3760.73	1.65
		SEM		0.08	17.06	9.61	0.01	51.94	133.54	0.09	54.81	139.89	0.06
		P value		0.28	0.12	0.17	0.07	0.52	0.63	0.17	0.27	0.71	0.19
			0	37.50	829.09^{a}	1004.54^{a}	1.21^{a}	1689.03^{a}	2913.31	1.71^{b}	2518.13^{a}	3917.85	1.55^{b}
			1	37.63	803.99^{b}	878.09^{b}	1.09^{b}	1476.42^{b}	3132.55	2.16^{a}	2280.41^{b}	4010.64	1.77^{a}
			SEM	0.08	17.06	9.61	0.01	51.94	133.54	0.09	54.81	139.89	0.06
			P value	0.82	0.01	0.01	0.01	0.01	0.69	0.01	0.01	0.67	0.01
	Interactions *P-value*												
	STRN x VC			0.63	0.01	0.29	0.01	0.62	0.02	0.02	0.54	0.02	0.08
	STRN x FTLP			0.24	0.19	0.22	0.01	0.17	0.23	0.53	0.09	0.29	0.86
	VC x FTLP			0.44	0.04	0.04	0.06	0.05	0.44	0.48	0.01	0.55	0.03
	STRN x VC x FTLP			0.21	0.05	0.08	0.01	0.02	0.01	0.62	0.11	0.01	0.16

Means with a different superscript in the same column are significantly (P<0.05) different; STRN: Strains; AB: Arbor acre; CO: Cobb 500; VC: Vitamin C; FTLP: *Ficus Thonningii*; IW: Initial weight; BWG: Body weight gain; FI: Feed intake; FCR: Feed conversion ratio; SEM: Standard error of the means.

Table 3 The haematological indices response of different strains of broiler chickens to *Ficus thonningii* leaf powder and vitamin C dietary supplementations

Diet	STRN	VC mg/kg	FTLP %	PCV %	RBC x10^{6}/l	HB g/dl	MCHC g/dl	MCV Fl	MCH Pg/cell	WBC x10^{9}/l	GRA x10^{9}/l	LYM x10^{9}/l	MON x10^{9}/l
1	AB	0	0	30.50	2.26^{c}	10.16	33.56	135.90^{b}	45.30^{b}	2.86^{bc}	0.80	1.96^{bc}	0.06
2	CO	0	0	32.00	1.87^{c}	10.66	33.30	173.26^{a}	57.76^{a}	4.06^{a}	1.00	3.00^{a}	0.07
3	AB	200	0	31.5	3.26^{ab}	10.50	33.31	97.46^{c}	32.46^{c}	2.86^{bc}	0.80	2.10^{bc}	0.00
4	CO	200	0	30.00	2.86^{b}	10.00	33.30	105.33^{c}	35.10^{c}	2.66^{bc}	0.90	1.70^{bc}	0.06
5	AB	0	1	30.66	2.17^{c}	10.23	33.00	142.50^{b}	47.50^{b}	3.10^{abc}	1.00	2.10^{bc}	0.00
6	CO	0	1	30.67	2.07^{c}	11.23	33.13	164.50^{a}	54.83^{a}	2.90^{bc}	0.90	1.93^{bc}	0.06
7	AB	200	1	34.00	3.73^{a}	11.32	33.33	92.63^{c}	30.86^{c}	3.53^{ab}	0.90	2.56^{ab}	0.07
8	CO	200	1	29.33	3.20^{ab}	9.77	33.06	91.80^{c}	30.60^{c}	2.23^{c}	0.80	1.43^{c}	0.00
SEM				0.51	0.14	0.17	0.06	6.78	2.62	0.14	0.04	0.12	0.01
P-value				0.196	0.01	0.17	0.43	0.01	0.01	0.03	0.92	0.02	0.17
	AB			31.67	2.85^{a}	10.55	33.30	117.13^{b}	39.03^{b}	3.09	0.87	2.18	0.33
	CO			31.25	2.50^{b}	10.41	33.20	133.72^{a}	44.57^{a}	2.96	0.90	2.01	0.05
	SEM			0.65	0.09	0.22	0.08	3.65	1.22	0.16	0.07	0.14	0.01
	P-value			0.66	0.02	0.64	0.43	0.01	0.01	0.59	0.81	0.40	0.38
		0		31.71	2.09^{b}	10.57	33.25	154.04^{a}	51.35^{a}	3.23	0.92	2.25	0.05
		200		31.21	3.26^{a}	10.40	33.25	96.81^{b}	32.25^{b}	2.82	0.85	1.95	0.03
		SEM		0.65	0.09	0.22	0.08	3.65	1.22	0.16	0.07	0.14	0.01
		P value		0.59	0.01	1.00	1.00	0.01	0.01	0.09	0.46	0.14	0.38
			0	31.00	2.56	10.33	33.36	127.99	42.65	3.12	0.87	2.19	0.05
			1	31.91	2.79	10.64	33.13	122.85	40.95	2.94	0.90	2.01	0.03
			SEM	0.65	0.09	0.22	0.08	3.65	1.22	0.16	0.07	0.13	0.01
			P value	0.33	0.11	0.32	0.07	0.33	0.34	0.45	0.81	0.36	0.38
	Interactions *P-value*												
	STRN x VC			0.01	0.43	0.01	0.79	0.02	0.02	0.01	0.81	0.01	0.38
	STRN x FTLP			0.66	0.76	0.64	0.79	0.26	0.26	0.02	0.23	0.02	0.38
	VC x FTLP			1.00	0.21	0.97	0.29	0.45	0.44	0.22	0.81	0.16	0.38
	STRN x VC x FTLP			0.22	0.43	0.21	0.19	0.75	0.75	0.74	0.80	0.55	0.06

Means with a different superscript in the same column are significantly (P<0.05) different; STRN.: Strains; AB: Abore acre; CO: Cobb 500; VC: Vitamin C; FTLP: *Ficus Thonningii* leaf powder; PCV: Packed cell volume; RBC: Red blood cells; HB: Haemoglobin conc.; MCHC: Mean cell haemoglobin concentration; MCV: Mean cell volume; MCH: Mean cell haemoglobin; WBC: White blood cells; GRA: Granulocytes; LYM: Lymphocytes; MON: Monocytes; SEM: Standard error of the means.

Table 4: Serum biochemical profiles of different strains of broiler chicken fed *Ficus thonningii* leaf powder and vitamin c supplemented diets

Diet	STRN	VC mg/kg	FTLP %	AST (IU/L)	ALT (IU/L)	CREA (µmol/L)	CHOL (mmol/L)	TP (g/L)	ALB (g/L)	GLB (g/L)	ALB/ GLO
1	AB	0	0	168.06^{a}	18.37	79.73^{a}	157.95^{a}	52.66^{b}	23.97	28.68^{b}	0.83^{b}
2	CO	0	0	171.28^{a}	17.54	81.20^{a}	155.53^{a}	53.65^{b}	23.88	29.77^{b}	0.80^{b}
3	AB	200	0	132.98^{bc}	16.55	65.18^{b}	134.96^{b}	63.47^{ab}	32.51	30.95^{b}	1.05^{ab}
4	CO	200	0	128.61^{c}	17.63	65.31^{b}	139.11^{b}	64.41^{ab}	35.17	29.24^{b}	1.19^{a}
5	AB	0	1	152.41^{ab}	16.28	67.75^{b}	129.78^{b}	61.93^{ab}	27.00	34.93^{a}	0.78^{b}
6	CO	0	1	152.39^{ab}	17.24	67.81^{b}	117.43^{c}	58.52^{ab}	25.30	33.22^{a}	0.75^{b}
7	AB	200	1	135.07^{bc}	16.91	63.93^{b}	119.09^{c}	66.79^{a}	32.35	34.44^{a}	0.94^{ab}
8	CO	200	1	132.22^{bc}	17.19	63.84^{b}	114.50^{c}	68.84^{a}	35.57	33.36^{a}	1.06^{ab}
SEM				3.77	0.57	1.62	3.42	1.56	1.39	0.52	0.04
P-value				0.01	0.99	0.01	0.01	0.05	0.10	0.01	0.05
	AB			147.13	17.02	69.15	135.44	61.21	28.96	32.25	0.90
	CO			146.12	17.40	69.54	131.64	61.35	29.95	31.40	0.95
	SEM			3.16	0.95	1.46	1.77	1.80	1.70	0.37	0.05
	P-value			0.82	0.78	0.85	0.14	0.95	0.68	0.13	0.46
		0		161.03	17.36	74.12^{a}	140.17^{a}	56.69^{b}	25.03^{b}	31.65	0.79^{b}
		200		132.22	17.07	64.57^{b}	126.91^{b}	65.87^{a}	33.88^{a}	31,99	1.06^{a}
		SEM		3.16	0.95	1.46	1.77	1.80	1.70	0.37	0.05
		P value		0.01	0.83	0.01	0.01	0.01	0.01	0.52	0.01
			0	150.23	17.52	72.86^{a}	146.89^{a}	58.55^{b}	28.88	29.66^{b}	0.97
			1	143.02	16.90	65.83^{b}	120.20^{b}	64.02^{a}	30.03	33.99^{a}	0.88
			SEM	3.16	0.95	1.46	1.77	1.80	1.70	0.37	0.05
			P value	0.12	0.65	0.01	0.01	0.04	0.64	0.01	0.24
	Interactions *P-value*										
	STRN x VC			0.56	0.82	0.85	0.17	0.60	0.44	0.32	0.25
	STRN x FTLP			0.92	0.85	0.84	0.08	0.75	0.90	0.33	0.94
	VC x FTLP			0.03	0.67	0.01	0.02	0.54	0.66	0.34	0.62
	STRN x VC x FTLP			0.79	0.63	0.88	0.90	0.59	0.83	0.13	0.94

Means with a different superscript in the same column are significantly ($P<0.05$) different; STRN: Strains; AB: Arbor acre; CO: Cobb 500; VC: Vitamin C; FTLP: *Ficus thonningii leaf powder*; AST: Aspartate aminotransferase; ALT: Alanine aminotransferase; CREA: Creatine; CHOL: Cholesterol; TP: Total Protein; ALB: Albumin; GLB: Globulin; SEM: Standard error of the means.

4. Discussion

The trend of results shows that the birds fed Control and vitamin C supplemented diets have enhanced feed intake, and body weight gain with the Cobb 500 strain having a better feed conversion ratio at the starter phase. The interaction of strain and vitamin C also influenced the body weight gain and feed conversion ratio. The same trend was also reported at the finisher and overall phase though FTLP inclusion does not negatively impacted the FCR. The value of 1.77 recorded is within the range of 1.4 to 1.9 for broiler chicken 9[1]. High ambient temperature in the tropics constitutes thermal stress that is a major cause of systemic oxidative stress; and consequently, poor growth performance [20][21]. Consequently, the improved FCR seen in birds fed vitamin C supplemented diets in this study could be a result of the bioactive components in vitamin C's actions in lowering the effects of oxidative stress in broiler chickens. The lower feed intake and body weight gain in the experimental birds due to FTLP supplementation in this study suggests a possible compromise of nutritive quality and impairment of feed acceptability by the birds, because some phytochemicals may interfere with nutrient bioavailability for the birds, especially when present in excessive amounts in their diets and feed physical properties [22]. [23] reported that the usage of feed supplements can affect an animal's willingness to eat a given feed. The reduction in the FI recorded in the FTLP treated groups (5, 6, 7 and 8) in this study suggests the negative effects of the FTLP on the feed acceptability and consumption by the birds during the early state of their life (the starter phase). The reduced FI in the affected treatment groups could be due to the phyto-constituents of the FTLP. For instance, tannin, when present in high levels in diets reduces the voluntary feed intake and nutrient digestibility [24].

Haematological markers are good indicators of an animal's physiological status, and changes in them are useful in determining how the animal responds to various physiological settings [25]. The values of PCV recorded in this study were within the range reported by [26], of 28 – 35% for broiler chicken aged 5 to 7 weeks.The PCV aids in determining whether supplemented diets have a negative impact on the health status of the broiler chickens. A high PCV value indicates the presence of toxic factors that may have an adverse effect on blood formation [27]. The value recorded in this study indicates that the supplementation does not have deleterious effect on the tested birds. The supplementation of birds' diets with FTLP and vitamin C improved erythrocytic indices of heat stressed broilers. The contribution of FTLP to the mineral profile of the dietary supplementation of the broiler chicken [13], as well as the possible complementary role of supplemental vitamin C in assisting the breakdown of amino acids and aiding in the absorption of minerals, particularly iron, by keeping them in a reduced ferrous state, could be responsible for the improved red blood cells count consequent on the supplementations [28]. The higher RBC counts in the AB breed compared to the CO breed suggest that genetic variables may influence erythrocyte count. Previous research has shown that genetic variables influence haematological parameters such as PCV, RBC, HBC, mean cell haemoglobin, and mean cell haemoglobin concentration, among others [29][30]. The PCV, RBC, and HB values in this study are all within normal ranges (PCV: 22-35 %, RBC: 2.5-3.5 x 106/L, and HB: 7-13 g/dL) reported by [31].The increased MCV and MCH levels in CO breeds could indicate macrocytic anaemia, which is defined by excessively large red blood cells which is a precursor to fewer red blood cells and transport of less haemoglobin in the circulatory system [32]. However, the levels observed in this study consequent on the inclusion of FTLP for MCV are within the range (MCV: 143.08 – 160.97 fl) reported by [33]; therefore, the increased MCV values induced by breeds or reduced MCV values produced by Vitamin C supplementation may not be of health concern [31]. White blood cell assists in protecting the body from pathogen by building up immunity ([34]. The FTLP supplementation increased the WBC of the birds in this current study. [35] had reported an increase in WBC count in chicken fed vitamin A supplemented diet. It is evident that the supplementation of FTLP in the diets of the tested birds boosted their immune response.

The liver is the coordinating point for different metabolic, productive and digestive functions and it is prone to different levels of biological and chemical damages depending on the amount of specific serum enzymes which has their originating sources from it. These enzymes, depending on their levels may compromise many body functions, thereby resulting in poor immunity status and weak production performance [36]. The reduction in AST due to inclusion of Vitamin C and FTLP can be deduced as an indication of better liver function due to the activities of the antioxidants'properties and protective role of ascorbic acid as well as the synergistic effect of the interaction of vitamin C and FTLP which reduces oxidative stress induced by hepatotoxicity [37].Creatinine as a nitrogenous organic acid assist in the supply of energy to the cells, it is a by-product of muscle metabolism and it is excreted entirely by the kidney. Increased level of creatinine is an indication of decreased kidney function [38] and of a chronic kidney disease [39]. Inclusion of vitamin C and FTLP in this study showed reduced level of creatinine less than the value reported by [27], who reported 79.00 and 81.00% for AB and CO breeds respectively. Cholesterol, produced in the liver is a product of fat metabolism. Increase in the level of cholesterol is associated with hormonal and metabolic diseases, liver disease as well as kidney malfunctioning [38]. The significantly lower values of cholesterol with the inclusion of FTLP in comparison to the control diets affirmed the believe that chickens fed with herbs have low levels of cholesterol as a result of decreased activity of lipogenic enzymes in the liver [40]. Serum proteins are essentially synthesized in the liver and they perform the function of maintaining blood volume through colloidal osmotic effect, regulate blood pH, transport hormones and drugs, participate in cell coagulation, catalyze chemical reactions, regulate the metabolism and participate in the body defense against foreign objects [41]. Total Protein is made up of Albumin and Globulin. Globulin is calculated as the difference between Total Protein and Albumin. Albumin is responsible for transporting insoluble substance in the blood and aids to maintain oncontic pressure [42]. The result of Albumin recorded in this study, though elevated by vitamin C supplementation is within the range (21 – 34.5 g/L) reported by [43] for chickens. The observed increase in the serum total protein, due to FTLP and Vitamin C supplementation may not be pathological because, the serum total protein levels (52.66 - 66.79 g/L) recorded in this study is within the normal range for total protein (52-69 g/L) reported by [44][43]. Vitamin C supplementation has been shown to raise blood protein levels [45][37]. Globulins are a diverse collection of large serum proteins that do not include albumin [46]. In addition to the aforementioned variables that cause an increase in total protein, an increase in alpha, beta, or gamma globulin can cause an increase in serum globulin. By implication, the increased globulin concentration observed in this study because of FTLP inclusion in the diets is an indication that phytochemicals present in the leaf stimulated the increased globulin production in the serum. This agrees with [47], who recorded increased serum protein and globulin concentration in broiler chickens fed a 5g/kg rosemary leaves supplemented diet. Phytogenic can stimulate the intestinal walls, increasing the secretion of digestive enzymes, as well as enhancing the absorption of more nutrients and, as a result, an improved protein profile [48].

5. Conclusion

The findings of this study shows that supplementation of the diets of broiler chicken with FTLP and vitamin C ameliorated the damaging effects of oxidative stress on performance, haematology and biochemical indices of broiler chicken. The supplements enhanced red blood cell count, white blood cell count, mean corpuscular volume as well as regulating the levels of critical serum biochemical parameters which could predispose the liver and the kidney to disease conditions.

Compliance with ethical standard

The study was carried out with the approval of the committee on ethics for care and use of animal for research of The Federal University of Technology, Akure, Nigeria.

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