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Performance, haematological and serum indices of broiler chicken fed fig leaf powder and vitamin c supplemented diets

Clement Oluwafemi Osowe [1,*], Ademidun Olanrewaju [2], Olufemi Adesanya Adu [1], Olugbenga David Oloruntola [3] and Clifford Adinma Chineke [1]

[1] *Department of Animal Production and Health, The Federal University of Technology, Akure, Nigeria.*
[2] *Department of Animal Production Technology, Federal College of Agriculture, Moor Plantation, Ibadan, Nigeria.*
[3] *Department of Animal Science, Adekunle Ajasin University, Akungba-Akoko, Nigeria.*

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Abstract

Performance, haematological and serum chemistry of two broiler chicken breeds fed *Ficus carica* leaf powder and vitamin C supplemented diets were evaluated. Four hundred and eighty day-old broiler chicks (240 Arbor Acre and 240 Cobb 500) were allotted to eight treatments: diets 1 and 2 had no supplementation and fed to Arbor Acre and Cobb 500, respectively; diets 3 and 4 were supplemented with 200mg/kg vitamin C and fed to Arbor Acre and Cobb 500, respectively; diets 5 and 6 were supplemented with 1% *Ficus carica* leaf powder and fed to Arbor Acre and Cobb 500; while diets 7 and 8 were supplemented with 200mg/kg Vitamin C + 1% Ficus carica leaf powder and fed to Arbor Acre and Cobb 500, respectively. The result showed that feed intake, body weight gain and feed conversion ratio were significant. Also, the interaction of breed, vitamin C and *Ficus carica* leaf powder showed significance on feed intake, body weight gain and feed conversion ratio. The interaction of vitamin C and *Ficus carica* leaf powder showed significance on packed cell volume, red blood cell, mean cell haemoglobin concentration, mean cell volume, mean cell haemoglobin, white blood cell, granulocytes and lymphocytes. The different treatments also showed significance on aspertate aminotransferase, creatinine, cholesterol, globulin and total protein. Thus, the supplementation of broiler diets with *Ficus carica* leaf powder and vitamin C improved the performance as well as the haematological indices and serum chemistry of the tested birds.

Keywords: Supplementation; Interaction; Indices; Haemoglobin; Improved

1. Introduction

For decades, growth promoters have been used in feed for animals under intensive management systems [1]. However, the prohibition on the inclusion of antimicrobial growth promoters in feed has increased the urgency of research to find potential alternatives [2]. This has therefore compelled a growing interest in the study of phytogenic as alternatives to inorganic-based growth promoters, and herbs are of significant importance among phytogenic because of their secondary metabolites, such as tannins, flavonoids, and saponins, which are potential antioxidants, aiding in the prevention of heat stress-induced oxidative stress, lowering the risk of disease development, and improving performance [3]. Phytogenic compounds have been shown in studies to have antimicrobial, anthelmintic, detoxifying, and digestion-stimulating substances, anti-inflammatory and immunomodulatory [3] properties in animals. The inclusion of phytogenic substances in feed have shown positive effects on the performance and biological health of broiler chickens, improving haematological blood indicators and serum biochemical attributes [4], and they have been reported to regulate the kidney and liver functions [5]. Feeding of poultry with phytochemicals (products derived from plants e.g. essential oil, dried plant materials, pure isolated compound) has been reported as a reliable means of

* Corresponding author: Clement O Osowe. E-mail: coosowe2012@gmail.com

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combating the negative effect of oxidative stress in heat-stressed poultry [6]. The current trend in the use of phytochemicals in animal production is not limited to being used as replacement for antibiotic growth promoters, but also for other anabolic compounds used to improve animal performance [7]. Because health-conscious consumers are increasingly rejecting the use of inorganic substances in food production, plant derived compounds with performance-enhancing activity, also known as phytogenic compounds, are becoming prominent in the feed additive market [8].

Among such herbs, Fig tree (*Ficus carica)*, locally known as "opoto" is of important significance. The leaves of *Ficus carica* is said to contain anti-parasitic, anti-pyretic, anti-bacterial, anti-diarrheal, anti-inflammatory, free radical scavenging activities [9], which are beneficial to health because they can act as antioxidants in a variety of ways, such as reducing agents, hydrogen donors, free radical scavengers, and singlet oxygen quenchers [10]. The supplementation of animal feed with vitamin C has been described as a cost-effective strategy to mitigate oxidative stress and to improve antioxidant status and immune performance [11]. Studies have shown that supplementation of vitamin C in diets will enhance the antioxidant status of an organism by up to 30% which help the body's natural defenses to combat inflammation [12]. [13] had reported on the nutritional and antioxidant status of *Ficus carica* to be suitable as a supplement for animal production. Hence, this study was designed to examine the performance, haematological indices and serum chemistry status of breeds of broiler chickens fed *Ficus carica* leaf powder and vitamin C supplemented diets.

2. Material and methods

2.1. Collection, processing, and analysis of phytogens after ethical approval

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. *Ficus carica* leaves were freshly plucked and washed in clear running water before being drained and spread lightly on polythene in the shade for two weeks. FCLP was made from dried *Ficus carica* leaves. [13] investigated the proximate, phytochemical, antioxidant and mineral components of FCLP.

2.2. Vitamin C and experimental feed ingredients

Vitamin C powder with the trade mark of Avondale Laboratories Limited, Banbury, England and other feed ingredients used for this study were purchased at local markets in Akure.

2.3. Experimental birds, preparation of experimental diets, living conditions, and experimental design

Two breeds of broiler chicken, Arbor Acre (AA) and Cobb 500 (C5) were used for this study. To meet the nutritional needs of the birds [14], broiler chickens' basal diet was compounded for the starter phase (0 to 21 days) and finisher phase (21-42 days). For each phase, the basal diet was divided into eight equal portions and named diets 1 to 8. Diet 1 and 2 which had no supplement (negative control) were fed to AA and C5 respectively; diets 3 and 4 were supplemented with 200mg/kg of basal diet were fed to AA and C5 respectively; diets 5 and 6, received 1g FCLP/Kg of basal diet supplementation and fed to AA and C5 respectively while diets 7 and 8 had 1g FCLP/kg of basal diet + 200mg of vitamin C and were fed to AA and C5 respectively. The feeding trial was carried out 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 AA and C5 breeds of broiler chicks weighing 37.40±0.45g were randomly assigned to all the eight experimental diets. AA breed were randomly allotted to diets 1, 3, 5 and 7 while C5 breed were randomly allotted to diets 2, 4, 6 and 8. Each diet was replicated six times with ten birds (10 birds/replicate). Wood shavings were used to cover the floor of the experimental pen (2m x 1m) that housed each replicate to a depth of 3cm. 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.

2.4. Growth performance

The experimental birds' body weight (BW) and feed intake (FI) were measured and recorded every seven days. The average body weight gain (BWG) was calculated by subtracting the initial and final weights of the birds, and the feed conversion ratio (FCR) was calculated by dividing the feed consumed by the weight gained.

2.5. Collection and analysis of blood samples

On day 42 of the feeding trial, 18 birds per treatment were random selected for blood collection using syringe and needle through the wing vein from each dietary group. For the analysis of the serum proteins (total protein, albumin, globulin), biochemical indices (creatinine, and cholesterol), enzyme activities (aspartate aminotransferase, and alanine transaminase), a portion of the blood sample (4ml) was poured into a plain blood sample vial. Before analysis, each plain bottle's sample was spun, and the serum was decanted into another plain bottle before being frozen at -20°C. Within 2 hours of collection, the haematological indices were determined [15]. The serum biochemical concentrations were measured using a Reflectron ®Plus 8C79 (Roche Diagnostic, GombH Mannheim, Germany) and kits.

2.6. Analysis of data

The model: $Pxy = \mu + \alpha x + \beta xy$, was used in this experiment, where Pxy is any of the factors of response; x = the overall average; αx = the xth treatment's effect (*P*= 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. Results

Table 1 shows the growth performance of different breeds of broiler chickens fed FCLP and vitamin C supplemented diets. The FI at the starter phase (1–3 weeks) was significantly (P<0.05) influenced by the dietary treatment. The FI for diet 5 was significantly lower (P<0.05) than the other diets. Also, the FI for diets 2 and 6 were not significantly different (P<0.05) from one another. Breed, vitamin C supplementation and the inclusion of 1% FCLP independently does not significantly (P<0.05) influence performance of the tested birds. The interaction between breed and FCLP were significant (P<0.05) for BWG and FI while the interactive effect of breed, vitamin C and FCLP was significant (P<0.05) for FI at the starter phase. At the finisher phase (4-6 weeks), the BWG and FI were significantly (P<0.05) affected by the dietary supplements. The BWG of birds in diet 8 was significantly (P<0.05) higher though not different from diets 4, 6 and 7. The FI and BWG of the breed C5 was higher (P<0.05) than AA while vitamin C inclusion has significance (P<0.05) on BWG. The interaction between breed and vitamin C has significant effect (P<0.05) on BWG; vitamin C and FCLP has significant (P<0.05) effect on FI while the interactive effect of breed, vitamin C and FCLP were significant (P<0.05) for FI and FCR.

At the overall phase (1-6 weeks), the BWG and FI were significantly (P<0.05) influenced by the dietary inclusions. The combination of 200mg/kg vitamin C and 1% FCLP has significant (P<0.05) effect on the C5 breed fed diet 8 for BWG and FI. In addition, the inclusion of vitamin C shows significant improvement (P<0.05) in the BWG of the tested birds while inclusion of FCLP has no significant effect. The interaction between breed and vitamin C has significant effect (P<0.05) on FI while the FCR tend to be significant (P=0.06). Vitamin C and FCLP tend to produce significant effect (P=0.06) on BWG. However, the interactive effect of breed, vitamin C and FCLP has improved (P<0.05) effect on FI and FCR.

Table 1 The growth performance response of different breeds of broiler chickens to Ficus *carica* leaf powder and vitamin C dietary supplementations

Diet	BRD	VC mg/kg	FCLP %	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 w
1	AB	0	0	37.52	791.09	970.03^{ab}	1.23	1343.98^{d}	2727.98^{c}	2.51	2188.09^{d}	3698.00^{c}	1.97
2	CO	0	0	37.43	844.11	1010.03^{a}	1.19	1741.30^{ab}	3264.05^{b}	1.59	2532.39^{ab}	4256.09^{b}	1.46
3	AB	200	0	37.20	811.35	974.16^{abc}	1.20	1458.50^{cd}	2540.13^{c}	1.74	2269.85^{cd}	3514.29^{c}	1.55
4	CO	200	0	37.42	805.76	989.96^{ab}	1.23	1769.13^{ab}	3505.26^{ab}	1.98	2574.89^{ab}	4495.22^{ab}	1.74
5	AB	0	1	37.47	770.52	924.15^{c}	1.20	1459.20^{cd}	2930.11^{bc}	2.02	2229.72^{cd}	3854.27^{bc}	1.73
6	CO	0	1	37.38	862.33	1012.94^{a}	1.17	1559.61^{bcd}	3476.07^{ab}	2.22	2421.93^{bcd}	4489.01^{ab}	1.85
7	AB	200	1	37.51	785.54	948.72^{bc}	1.21	1657.43^{bc}	3043.63^{abc}	1.83	2442.54^{bc}	3992.36^{abc}	1.63
8	CO	200	1	37.28	828.22	986.15^{ab}	1.19	1924.43^{a}	3692.85^{a}	1.92	2752.65^{a}	4679.01^{a}	1.69
SEM				0.04	8.81	8.03	0.01	43.58	102.22	0.08	43.41	107.35	0.04
P-value				0.60	0.11	0.05	0.50	0.01	0.02	0.13	0.01	0.02	0.13
	AB			37.42	802.88	964.27	1.20	1479.67^{b}	2939.98^{b}	2.02	2282.55^{b}	3904.25^{b}	1.72
	CO			37.38	821.85	989.77	1.21	1748.61^{a}	3350.54^{a}	1.92	2570.46^{a}	4340.31^{a}	1.68
	SEM			0.06	10.87	9.33	0.01	36.86	110.16	0.10	36.85	117.30	0.05
	P-value			0.60	0.23	0.07	0.81	0.01	0.01	0.51	0.01	0.01	0.69
		0		37.45	817.01	979.29	1.20	1526.02^{b}	3095.05	2.08	2343.03^{b}	4074.34	1.75
		200		37.35	807.72	974.75	1.21	1702.26^{a}	3195.47	1.87	2509.98^{a}	4170.22	1.65
		SEM		0.06	10.87	9.33	0.01	36.86	110.16	0.10	36.85	117.30	0.05
		P value		0.28	0.55	0.73	0.56	0.01	0.52	0.16	0.01	0.57	0.25
			0	37.39	813.08	986.04	1.21	1578.22	3004.85	1.95	2391.30	3990.90	1.68
			1	37.41	811.65	957.99	1.19	1650.06	3285.57	2.00	2361.71	4253.66	1.72
			SEM	0.06	10.87	9.33	0.01	36.88	110.16	0.10	36.85	117.30	0.05
			P value	0.82	0.92	0.19	0.14	0.18	0.09	0.76	0.19	0.13	0.57
	Interactions *P-value*												
	BRD x VC			0.63	0.97	0.93	1.00	0.70	0.02	0.09	0.71	0.02	0.06
	BRD x FCLP			0.24	0.01	0.01	0.07	0.12	0.24	0.11	0.49	0.19	0.15
	VC x FCLP			0.44	0.98	0.79	0.72	0.04	0.68	0.85	0.06	0.68	0.72
	BRD x VC x FCLP			0.21	0.13	0.05	0.81	0.24	0.04	0.04	0.46	0.04	0.03

Means with a different superscript in the same column are significantly (P<0.05) different; BRD: Breeds; VC: Vitamin C; FCLP: *Ficus carica leaf powder*; IW: Initial weight; BWG: Body weight gain; FI: Feed intake; FCR: Feed conversion ratio; AA: Arbor acre; C5: Cobb 500; SEM: Standard error of the means.

Data on haematological indices of breeds of broiler chickens fed FCLP and vitamin C supplemented diets is presented in Table 2. All the haematological indices considered in this study were significantly (P<0.05) affected by the dietary supplementation except (P>0.05) for mean cell haemoglobin concentration (MCHC) and monocytes (MON). The effects of the dietary supplementation tend (P=0.06) to show variations in the packed cell volume (PCV) and haemoglobin concentration (HB). The inclusion of vitamin C significantly (P<0.05) lower the PCV levels while the interaction of vitamin C and FCLP significantly improved (P<0.05) the PCV levels of the broiler chickens. The Red Blood Cell count (RBC) was significantly (P<0.05) higher in diets 7 and 8 when compared to the diets 1 and 2 which are the control and the supplementation with vitamin C and 1% FCLP significantly (P<0.05) affects the RBC. Also, the interaction between vitamin C and FCLP shows significance (P<0.05) for RBC. The HB concentration was significantly lower (P<0.05) with the supplementation of vitamin C while it tends (P=0.06) to influence the MCHC though there was significant (P<0.05) effect of the interaction of vitamin C and FCLP on the MCHC. The mean cell volume (MCV) was significantly (P<0.05) lower in diets 7 and 8 compared to diets 1, 2, 5 and 6. The inclusion of vitamin C and FCLP significantly (P<0.05) lower the MCV level while the interaction between vitamin C and FCLP significantly (P<0.05) affects the MCV. The mean cell haemoglobin (MCH) level was significantly lower in diets 7 and 8 when compared to diets 1 and 2 as well as 5 and 6. The supplementation with vitamin C and FCLP independently significantly (P<0.05) lower the MCH while there was significant (P<0.05) effect of the interaction between vitamin C and FCLP on the MCH. The white blood cell (WBC) count in diets 5 and 6 were significantly (P<0.05) lower than the control (diets 1 and 2), supplementation with FCLP significantly (P<0.05) lowers the WBC while the interaction between vitamin C and FCLP significantly (P<0.05) improved the WBC. The granulocytes (GRA) counts for diets 7 and 8 were significantly (P<0.05) higher than the other diets, supplementation with vitamin C significantly (P<0.05) affect the GRA counts while the interaction between vitamin C and FCLP significantly (P<0.05) increased the GRA count. The lymphocytes count recorded in diets 1 was higher (P<0.05), though not different from diet 2 while the inclusion of vitamin C and FCLP independently lowered (P<0.05) the lymphocytes count while the interaction between vitamin C and FCLP was significant (P<0.05).

Table 2 The haematological indices response of different breeds of broiler chickens to *Ficus carica* leaf powder and vitamin C dietary supplementations

Diet	BRD	VC mg/kg	FCLP %	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	2.15^{c}	10.16	33.34	142.97^{a}	47.66^{a}	3.85^{ab}	0.81^{cd}	2.98^{ab}	0.05
2	CO	0	0	30.19	1.99^{c}	10.06	33.33	151.60^{a}	50.53^{a}	4.50^{a}	0.79^{cd}	3.69^{a}	0.02
3	AB	200	0	30.00	2.75^{b}	10.00	32.88	109.15^{b}	36.38^{b}	2.75^{cd}	0.94^{bc}	1.77^{c}	0.03
4	CO	200	0	30.62	2.72^{b}	10.20	33.17	112.65^{b}	37.55^{b}	2.90^{dc}	1.06^{ab}	1.79^{c}	0.05
5	AB	0	1	32.00	2.10^{c}	10.67	33.39	152.39^{a}	50.79^{a}	2.45^{d}	0.76^{d}	1.64^{c}	0.02
6	CO	0	1	33.87	2.22^{c}	11.29	33.99	152.25^{a}	50.75^{a}	2.48^{d}	0.75^{d}	1.68^{c}	0.02
7	AB	200	1	29.50	3.80^{a}	9.83	33.34	77.39^{c}	25.80^{c}	3.40^{bc}	1.12^{a}	2.24^{bc}	0.02
8	CO	200	1	26.06	3.42^{a}	8.69	32.71	76.04^{c}	25.34^{c}	3.15^{bcd}	1.21^{a}	1.92^{c}	0.01
SEM				0.59	0.14	0.19	0.12	6.46	2.16	0.15	0.38	0.16	0.01
P-value				0.06	0.01	0.06	0.26	0.01	0.01	0.01	0.01	0.01	0.29
	AB			30.50	2.70	10.16	33.23	120.47	40.16	3.11	0.91	2.16	0.03
	CO			30.18	2.59	10.06	33.30	123.13	40.04	3.26	0.96	2.27	0.02
	SEM			0.69	0.07	0.23	0.16	1.73	0.57	0.13	0.03	0.13	0.07
	P-value			0.77	0.31	0.75	0.78	0.29	0.28	0.42	0.23	0.56	0.47
		0		31.64^{a}	2.11^{b}	10.54^{a}	33.51	149.81^{a}	49.93^{a}	3.32	0.77^{b}	2.49^{a}	0.03
		200		29.05^{b}	3.17^{a}	9.68^{b}	33.02	93.81^{b}	31.27^{b}	3.05	1.08^{a}	1.93^{b}	0.02
		SEM		0.69	0.07	0.23	0.16	1.73	0.57	0.13	0.03	0.14	0.01
		P value		0.02	0.01	0.02	0.06	0.01	0.01	0.15	0.01	0.01	0.69
			0	30.32	2.40^{b}	10.11	33.18	129.09^{a}	43.03^{a}	3.50^{a}	0.90	2.56^{a}	0.04
			1	30.36	2.88^{a}	10.12	33.35	114.52^{b}	38.17^{b}	2.87^{b}	0.96	1.87^{b}	0.02
			SEM	0.69	0.07	0.23	0.16	1.73	0.57	0.13	0.03	0.14	0.01
			P value	0.97	0.01	0.97	0.44	0.01	0.01	0.01	0.14	0.01	0.06
	Interactions *P-value*												
	BRD X VC			0.28	0.38	0.28	0.31	0.53	0.52	0.29	0.14	0.18	0.30^{b}
	BRD x FCLP			0.63	0.88	0.64	0.73	0.18	0.18	0.17	0.87	0.21	0.93^{a}
	VC x FCLP			0.02	0.01	0.43	0.02	0.01	0.01	0.02	0.01	0.01	0.57
	BRD x VC x FCLP			0.13	0.15	0.13	0.11	0.69	0.70	0.76	0.77	0.66	0.10

Means with a different superscript in the same column are significantly (P<0.05) different; BRD: Breeds; AA: Abore acre; C5: Cobb 500; VC: Vitamin C; FCLP: *Ficus carica* 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.

The result of serum biochemical indices of the two breeds of broiler chickens fed diets supplemented with FCLP and Vitamin C is presented in Table 3. 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 were significantly (P<0.05) higher than those in diets 3, 4, 6, 7 and 8 but not significantly different(P<0.05) from diet 5. The inclusion of 200mg/kg of vitamin C significantly (P<0.05) lowered the AST level while the interaction between vitamin C and FCLP was significant (P<0.05). The serum creatinine level of the control diets (diets 1 and 2) was significantly (P<0.05) higher than those of diets 2, 3, 4, 5, 6, 7 and 8. Supplementation with vitamin C and FCLP significantly (P<0.05) lowered the serum creatinine level while the interaction between vitamin C and FCLP was significant (P<0.05). The serum cholesterol level of diets 1, 2, 3 and 4 were significantly (P<0.05) higher than those of diets 5, 6, 7 and 8. Supplementation with FCLP significantly (P<0.05) lowered the serum cholesterol levels. 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. Vitamin C and FCLP supplementations independently significantly (P<0.05) improves the TP levels. Inclusion of 200mg/kg of vitamin C has significant (P<0.05) effect on the albumin level. The globulin performance of diets 5 and 6 (FCLP) and diets 7 and 8 (vitamin C + FCLP) were significantly (P<0.05) higher than those of diets 1, 2, 3 and 4. Also, the inclusion of 1% FCLP has significant (P<0.05) effect on the globulin levels of the treated birds.

Table 3: Serum biochemical profiles of different breeds of broiler chicken fed *Ficus carica* leaf powder and vitamin c supplemented diets

Diet	BRD	VC mg/kg	FCLP %	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	156.70^{a}	21.78	95.39^{a}	3.95^{a}	56.85^{b}	26.30	30.55^{b}	0.86
2	CO	0	0	154.25^{a}	20.84	96.86^{a}	3.76^{a}	58.14^{b}	26.54	31.60^{b}	0.83
3	AB	200	0	113.61^{d}	19.68	80.91^{b}	3.50^{a}	67.78^{ab}	34.93	32.85^{b}	1.06
4	CO	200	0	111.26^{d}	20.81	80.94^{b}	3.75^{a}	68.42^{ab}	37.33	31.10^{b}	1.19
5	AB	0	1	142.05^{ab}	19.27	83.06^{b}	2.55^{b}	66.28^{ab}	29.43	36.85^{a}	0.80
6	CO	0	1	136.35^{bc}	20.41	83.45^{b}	2.62^{b}	62.57^{ab}	27.42	35.15^{a}	0.77
7	AB	200	1	121.37^{cd}	20.07	79.30^{b}	2.83^{b}	71.14^{a}	34.79	36.35^{a}	0.95
8	CO	200	1	113.18^{d}	20.32	79.56^{b}	2.68^{b}	73.23^{a}	37.93	35.30^{a}	1.07
SEM				3.94	0.60	1.62	0.12	1.58	1,41	0.53	0.04
P-value				0.01	0.99	0.01	0.01	0.05	0.12	0.01	0.07
	AB			133.43	20.20	84.66	3.20	65.51	31.36	34.15	0.92
	CO			128.93	20.59	85.20	3.20	65.59	32.30	33.28	0.97
	SEM			2.16	0.99	1.45	0.08	1.85	1.75	0.38	0.04
	P-value			0.24	0.78	0.79	0.97	0.97	0.71	0.12	0.49
		0		147.33^{a}	20.57	89.69^{a}	3.22	60.96^{b}	27.42^{b}	33.53	0.82^{b}
		200		115.02^{b}	20.22	80.18^{b}	3.19	70.14^{a}	36.24^{a}	33.90	1.07^{a}
		SEM		2.61	0.99	1.45	0.08	1.85	1.75	0.38	0.04
		P value		0.01	0.80	0.01	0.82	0.01	0.01	0.51	0.01
			0	133.96	20.78	88.53^{a}	3.74^{a}	62.80^{b}	31.27	31.52^{b}	0.99
			1	128.40	20.02	81.34^{b}	2.67^{b}	68.30^{a}	32.39	35.91^{a}	0.90
			SEM	2.61	0.99	1.45	0,08	1.85	1.75	0.38	0.04
			P value	0.15	0.59	0.01	0.01	0.05	0.65	0.01	0.23
	Interactions *P-value*										
	BRD x VC			0.90	0.83	0.85	0.64	0.63	0.47	0.33	0.28
	BRD x FCLP			0.57	0.83	0.91	0.77	0.73	0.88	0.35	0.91
	VC x FCLP			0.01	0.62	0.01	0.11	0.59	0.72	0.33	0.70
	BRD x VC x FCLP			0.89	0.60	0.87	0.18	0.54	0.76	0.12	0.99

Means with a different superscript in the same column are significantly (P<0.05) different; BRD: Breeds; AA: Arbor acre; C5: Cobb 500; VC: Vitamin C; FCLP: *Ficus carica leaf powder*; AST: Aspartate aminotransferase; ALT: Alanine aminotransferase; CREA: Creatinine; CHOL: Cholesterol; TP: Total Protein; ALB: Albumin; GLB: Globulin; SEM: Standard error of the means.

4. Discussion

The use of medicinal plants as feed supplement in animal feed for nutritional and therapeutic purpose to enhance performance and improve health status in animal production has been widely reported [16]. Herbs are particularly important among phytogenic substances because of their secondary metabolites, such as tannins, flavonoids, and saponins, which are potential antioxidants, aiding in the prevention of heat stress-induced oxidative stress, lowering the risk of disease development, and improving performance [3]. The inclusion of phytogenic substances in feed have shown positive effects on the performance and biological health of broiler chickens [3]. The composition of *Ficus carica* leaf powder as reported by [13] shows that it could be employed as a natural feed supplement. Supplementation of broiler feed with plant extract containing secondary metabolites has been shown to promote growth performance and immune response in broiler chickens [2]. The improved performance of the C5 breed of broiler chicken feed diet 8 (vitamin C and FCLP) over AA breed at the finisher and overall phases shows the effect of breed, vitamin C and FCLP on body weight gain of broiler chickens. Genetics and breeding, diet, and management approaches have all been linked to improved broiler chicken growth performance [17]. Also, the improved performance observed in BWG of the C5 breed by vitamin C supplementation is in line with the work of [18], who reported that vitamin C assist in suppressing thermo-physiological response of broiler chicken and ameliorating heat stress induced oxidative stress effects which hampers performance. It has been reported that at temperature above 30^{0}C, broiler chickens reduce feed intake which leads to reduced weight, low immune status and increased mortality [19], and that ascorbic acid in vitamin C acts as a free radical, scavenging harmful oxygen derived species such as hydrogen peroxide, hydroxyl radicals and singlet oxygen [20]. Thus, the improved performance of the experimental birds due to FCLP supplementation in this study confirms the vitamin C status of the *Ficus carica* as reported by [13]. The feed conversion ratio (FCR) is a measure of efficiency with which the bodies of livestock convert animal feed into desirable output. The interaction between breed, vitamin C and FCLP has noticeable effect on the FCR of the experimental broiler chickens at the finisher and overall phase. This shows that improved breeding and genetical selection are factors responsible for improved performance in broiler chickens as reported by [17], as well as the presence of ascorbic acid from the supplementation of vitamin C and FCLP, which increases oxygen consumption when the ambient temperature is high [21].

Haematological markers are good indicators of an animal's physiological status, and variations in them are crucial in determining how the animal respond to various physiological settings [22]. Changes in haematological parameters are commonly used to assess animal stress caused by environmental, dietary and/or pathological factors [23]. The improved performance of the tested birds on haematological indices in this study shows that vitamin C and FCLP inclusion in animals' diets could enhance their performance and health status and this confirms the earlier work of [13] who reported on the nutritional benefits and antioxidant properties of *Ficus carica*. A PCV value that is too high is an indication of toxic factors which could have adverse effect on blood formation [24]. The PCV reported in this study falls within the normal range as reported by [25], who reported a range of 28 – 35% for broiler chicken of 5 to 7 weeks. The improved RBC count due to the interactive effect of vitamin C and FCLP could be as a result of increased feed intake due to rapid breakdown of amino acids and mineral absorption, particularly iron [26] and this also confirms the previous study by [27] who reported that vitamin C could be used to moderate the performance of heat stressed birds. The interactive effect of vitamin C and FCLP also indicated a positive effect on the white blood cell count. It has been reported that ascorbic acid assists in the stimulation of the production of white blood cells as well as enhance the immune system of the body by scavenging free radicals and acting as antioxidant [28]. MCV is the expression of the average volume of individual red blood cell. The values reported in this study were higher than that reported by [24], who reported values of 120.02 and 121.47 for AA and C5 respectively. MCH is the mean mass of haemoglobin per red blood cell in a given sample of blood. HB, MCH and MCHC are important parameters whose values are used to determine the presence and severity of anaemia [29]. Values obtained in this study are within the range reported by [24] which falls within the normal range. This affirms the report of [13] which reported on the high iron concentration in *Ficus carica* which is necessary for the synthesis of red blood cells.

The liver is the center of several digestive, metabolic and productive activities and it is susceptible to a varying degree of chemical and biological damages. Such damages are made obvious by the serum levels of specific enzymes originating from the liver. These enzymes, depending on their levels may cause some disruptions to bodily functions, thereby resulting in poor health and production performance [30]. The activities of aspartate aminotransferase (AST), alkaline phosphatase (ALP), and alanine aminotransferase (ALT) in the blood are bioindicators of liver function and damage [31]. Increased levels of these enzymes are associated with liver or muscle damage, resulting from the body's response to stress [32]. The value of AST in the present study showed significant differences between the control and the treated groups. Thus, the reduction in AST due to inclusion of Vitamin C and FCLP can be deduced as an indication of better liver function. Creatinine 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 [33]. The level reported in this study is an indication of the positive effect of the supplementation of FCLP and vitamin C. 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 [33]. The significantly lower values of cholesterol with the inclusion of FCLP in comparison to the control diet 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 [34]. 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 [35]. The level of total protein in this study which is higher than what is obtained in the control diets could be attributed to the higher protein content of *Ficus carica*. [13] reported that *Ficus carica* contains 15.76% of crude protein which could make it a good source of supplement in animal feed.

5. Conclusion

The result of this study revealed the potentials of *Ficus carica* leaf powder to enhance performance and ameliorate the effect of heat stress in broiler chickens when used as organic supplement in feed. The antioxidants and phytochemical properties of FCLP resulted in increased feed intake and enhanced BWG as well as improving haematological and serum chemical profiles of the tested birds which is an indication that effect of heat and oxidative stress were mitigated.

Compliance with ethical standards

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Disclosure of conflict of interest

There was no conflict of interest in the course of carrying out this study.

Statement of ethical approval

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.

Authorship

All named authors take the responsibility for the integrity of the work as a whole and have given their approval for this version to be published. The contents published herein represents the views of the authors and does not in any way represent the views of any organization. The details published herein are intended for educational, academic, and/or research purposes.

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