

Carcass and antioxidative status of the brain and meat of two hybrids of broiler chicken fed *Ficus carica* leaf powder and vitamin C supplemented diets

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ABSTRACT

The study examined the effect of dietary supplementation of *Ficus carica* leaf powder and vitamin C on the antioxidative status of the meat and brain of two hybrids of broiler chicken. Two hundred- and forty-day-old chicks, each of Arbor Acres (AA) and Cobb 500 (C5) hybrids of broiler chicken were randomly assigned to diets. Diet 1 and 2 had no supplement; diets 3 and 4 supplemented with vitamin C (200mg/kg of basal), diet 5 and 6 received 1g *Ficus carica* Leaf Powder (FCLP)/Kg of basal diet while diets 7 and 8 had 1g FCLP/kg of basal diet + 200mg of vitamin C. The interactive effect of hybrid, vitamin C and FCLP significantly influenced the dressing percentage, gizzard, pancreas, heart and proventriculus. Brain catalase and glutathione were significantly influenced by the hybrid, vitamin C and FCLP inclusion. Dietary supplementation of FCLP and vitamin C significantly lower the lipid peroxidation of the meat. There was significant interactive effect of the factors on lipid peroxidation while meat catalase and glutathione were significantly increased by the inclusion of FCLP. This study revealed that the dietary inclusions of broilers' diets with 1g FCLP and 200mg vitamin C/kg of feed could influence carcass and organs weights as well as improve meat quality and brain antioxidant status of broiler chicken, with the C5 hybrid showing better antioxidative status.

Keywords: Antioxidative, interactive, dietary, supplementation, peroxidation

INTRODUCTION

The desire for safe food is unarguably a major global concern for healthy living among consumers (Lv et al., 2018). Coupled with this is the growing trend among consumers for organically produced substances rather than inorganic substances due to residues of the inorganic substances with their attendant health implication (Bhanu et al., 2020). Natural antioxidants from plant source have been reported to have great application potential for consumers' acceptability, palatability, stability and supporting longer shelf-life of meat products (Jung et al., 2010). The presence of endogenous antioxidants in brain tissues which have the potentials for Reactive Oxygen Species (ROS) reduction notwithstanding, brain cells are sensitive to oxidative damage due to their high oxygen uptake; thus, the inclusion of antioxidants in the diets of animals is important in achieving neuroprotection and promote redox homeostasis (Gabbianelli and Damiani, 2018).

A critical challenge for the meat industry is how to extend the shelf life by delaying or avoiding the oxidation of lipids and/or proteins to preserve quality (Velasco and Williams, 2011). Oxidative processes during the shelf life of meat will decrease sensory and nutritional values, such as colour, taste and tenderness (Kumar et al., 2015), and the incorporation of antioxidants in the meat matrix has been a strategy for maintaining meat quality during storage (Valenzuela-Grijalva et al., 2017), particularly the inclusion of natural antioxidants in the diets of animals (Brenes et al., 2016; Brewer, 2011). This technique is of great benefit in the meat industry because the inclusion of natural antioxidants in the diets of animals will ensure that they are deposited in the meat while the animals are alive, thus the addition of synthetic antioxidant compounds would be unnecessary after slaughter (Valenzuela-Grijalva et al., 2017). The concentration of vitamin C and 2,2-diphenyl- β -picrylhydrazyl (DPPH) in *Ficus carica* as reported by Osowe et al. (2021) with proton radicals scavenging ability indicates that the leaf powder can be a good substitute for inorganic based antioxidants. In meat products, vitamin C is widely used as a natural agent for color retention, which assists in inhibiting lipid oxidation and maintaining of color stability (Caiyun et al., 2021). This study was therefore designed to examine the carcass and antioxidative status of the brain and meat of two hybrids of broiler chicken fed *Ficus carica* leaf powder (FCLP) and vitamin C supplemented diets

MATERIALS AND METHODS

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. Osowe et al. (2021) investigated the proximate, phytochemical, antioxidant and mineral components of FCLP.

Arbor Acres (AA) and Cobb 500 (C5) were the two hybrids of broiler chicken used for this study. Basal diet was composed to meet the nutritional needs of the birds according to NRC (1994), for the starter phase (0 to 21 days) and finisher phase (21-42 days). The experiment lasted for a period of 6 weeks. The basal diet was divided into eight equal portions and named diets 1 to 8 for each of the phase. Diet 1 and 2 which had no supplement (negative control) were fed to AA and C5 respectively; diets 3 and 4 supplemented with vitamin C at the rate of 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 FCLP and vitamin C were included to the composed feed as supplements at the levels stated herein and not as a replacement for any other ingredient. The supplements were included in the diets from day old till the end of the finisher phase. The Broilers' premix used for the feeding trial was purchased in the compounded form from reputable veterinary outlet. The feeding trial was carried out the Federal University of Technology's Teaching and Research Farm in Akure, Nigeria.

Two hundred and forty (240) day-old chicks, each of AA and C5 hybrids of broiler chicks with average weight of 37.40 ± 0.45 g were randomly assigned to all the eight experimental diets in a completely randomized design (CRD). AA hybrid were randomly allotted to diets 1, 3, 5 and 7 while C5 hybrid were randomly allotted to diets 2, 4, 6 and 8, in six replicates per diet 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 $31 \pm 2^\circ\text{C}$ for the first week and then reduced by 2 degrees Celsius each week after that until the temperature reached $26 \pm 2^\circ\text{C}$ degrees Celsius. The birds were fed *ad-libitum*.

Data on feed intake were taken weekly. The birds were weighed weekly and weight changes recorded. The feed intake and weight changes were used to calculate the feed conversion ratio. At the end of the feeding trial 3 birds were randomly selected from each replicate and starved overnight, weighed after the fasting, slaughtered by severing the jugular vein, scalded in warm water for about a minute, de-feathered manually, eviscerated and dressed to determine carcass characteristics. Dressed weight and internal organs were expressed as percentage live weight (Ndelekwute et al., 2013). Lipid peroxidation was determined using the method of Botsoglou et al. (1994), meat cholesterol (Allain et al., 1974), catalase activity (Hadwan and Khabt, 2018), and glutathione peroxidase activity (Cichoski et al., 2012). The total

protein in the brain was determined as outlined by Boehringer Mannheim Diagnostica (1979) as reported by Bitto et al. (2000).

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
Total	100	100
Nutrient composition (g/kg)		
*Crude protein	22.18	20.03
*Metabolizable energy (Kcal/kg)	3018	3108.1
*Calcium	1.03	1.04
*Crude fibre	3.52	3.58
*Crude fat	4.23	2.38
*Available Phosphorus	0.48	0.43

Data collected on body weight, weight gain, feed intake, FCR, carcass and internal organs characteristics were subjected to Analysis of Variance (ANOVA) using procedure of SPSS version 20 (SPSS, 2010). Significant means were separated using Duncan Multiple Range Test

RESULTS

The carcass and organ characteristics of broiler chicken fed *Ficus carica* and vitamin C supplemented diet are presented in Table 2.

Table 2: The carcass trait and relative organ weight of different hybrids of broiler chicken fed *Ficus carica* leaf powder and vitamin C supplemented diets

Diet	HRD	VC mg/kg	FCLP %	DP %DW	LVR %DW	GZD %DW	SPLN %DW	PNCRS %DW	HRT %DW	GBLD %DW	LUNG %DW	PRVTLS %DW
1	AA	0	0	78.58 ^a	2.32	1.95 ^c	0.10 ^b	0.22 ^d	0.51 ^{cd}	0.10	0.50 ^{de}	0.34 ^{de}
2	C5	0	0	74.93 ^c	2.59	1.86 ^c	0.13 ^b	0.28 ^{abc}	0.57 ^{bc}	0.14	0.41 ^e	0.43 ^{bc}
3	AA	200	0	76.73 ^{abc}	2.58	2.03 ^c	0.11 ^b	0.26 ^{abcd}	0.69 ^a	0.15	0.47 ^{de}	0.38 ^{cd}
4	C5	200	0	75.17 ^{bc}	2.44	2.50 ^{ab}	0.14 ^b	0.29 ^{ab}	0.52 ^{cd}	0.14	0.61 ^b	0.38 ^{bcd}
5	AA	0	1	75.00 ^c	2.72	2.33 ^b	0.17 ^{ab}	0.30 ^a	0.68 ^a	0.20	0.80 ^a	0.55 ^a
6	C5	0	1	77.85 ^{ab}	2.17	1.78 ^c	0.11 ^b	0.21 ^d	0.46 ^d	0.14	0.65 ^b	0.30 ^e
7	AA	200	1	75.20 ^{bc}	2.50	2.68 ^a	0.25 ^a	0.24 ^{bcd}	0.62 ^{ab}	0.14	0.58 ^{bc}	0.44 ^b
8	C5	200	1	73.96 ^c	2.16	1.97 ^c	0.12 ^b	0.23 ^{cd}	0.56 ^{bc}	0.17	0.51 ^{cd}	0.41 ^{bc}
SEM				0.40	0.06	0.06	0.01	0.01	0.01	0.01	0.02	0.01
P-value				0.01	0.31	0.01	0.05	0.01	0.01	0.34	0.01	0.01
AA				76.38	2.53	2.24 ^a	0.16	0.26	0.63 ^a	0.14	0.58 ^a	0.43
C5				75.48	2.34	2.03 ^b	0.12	0.25	0.53 ^b	0.15	0.54 ^b	0.38
SEM				0.43	0.09	0.04	0.01	0.01	0.01	0.01	0.01	0.01
P-value				0.16	0.15	0.01	0.14	0.72	0.01	0.92	0.05	0.01
0				76.59 ^a	2.45	1.98 ^b	0.13	0.25	0.55	0.14	0.59 ^a	0.41
200				75.26 ^b	2.42	2.29 ^a	0.15	0.26	0.60	0.15	0.54 ^b	0.40
SEM				0.43	0.09	0.04	0.01	0.01	0.01	0.01	0.01	0.01
P-value				0.04	0.83	0.01	0.21	0.72	0.26	0.85	0.03	0.89
0				76.35	2.48	2.08	0.12	0.26	0.57	0.13	0.49 ^b	0.38
1				75.50	2.39	2.19	0.16	0.24	0.58	0.16	0.63 ^a	0.42
SEM				0.43	0.09	0.04	0.01	0.01	0.01	0.01	0.01	0.01
P-value				0.18	0.46	0.08	0.06	0.18	0.64	0.12	0.01	0.01
Interactions P-value												
HRD x VC				0.42	0.69	0.10	0.46	0.46	0.27	0.51	0.01	0.01
HRD x FCLP				0.01	0.06	0.01	0.01	0.01	0.02	0.45	0.01	0.01
VC x FCLP				0.40	0.51	0.43	0.30	0.05	0.23	0.30	0.01	0.79
BRD x VC x FCLP				0.02	0.23	0.01	0.41	0.04	0.01	0.07	0.10	0.01

Means with different superscript in the same column are significantly ($P < 0.05$) different; HRD: Hybrids; AA: Arbor Acres; C5: Cobb 500; VC: Vitamin C; FCLP: *Ficus carica* leaf powder; DW: Dressed Weight; DP: Dressing Percentage; LVR: Liver; GIZD: Gizzard; SPLN: Spleen; PNCRS: Pancreas; HRT: Heart; GBLD: Gall bladder; PRVTLS: Proventriculus; SEM: Standard error of the means.

Significant differences ($P<0.05$) were observed in dressing percentage, gizzard, spleen, pancreas, heart, lung and proventriculus while no significant difference ($P>0.05$) was observed in the liver and gall bladder. The result of the dressing percentage showed that the Control diets was significantly ($P<0.05$) higher but not significantly ($P<0.05$) different from the result of birds fed diets 3 (200mg of vitamin C/kg of feed) and 6 (1g FCLP/kg of feed). The relative weight of the gizzard of birds fed Diets 4 and 7 were significantly ($P<0.06$) higher than birds fed the other diets. The spleen of hybrid AA birds fed diet 7 was significantly higher ($P<0.05$) than the other diets while the relative weights of the pancreas of the birds fed diets 2, 3, 4 and 5 compared statistically and were higher than the values for other diets. For the relative weight of the heart, diets 3, 5 and 7 were significantly higher ($P<0.05$) than values obtained for the other diets. The relative weight of the lung and proventriculus for birds fed diet 5 were significantly higher ($P<0.05$) than birds fed the other experimental diets. The relative weight of the gizzard, heart and lungs of the AA hybrid of broiler chicken were significantly ($P<0.05$) higher than those of the C5 while the inclusion of vitamin C significantly ($P<0.05$) improved the dressing percentage, and relative weights of the gizzard and lung. The inclusion of FCLP significantly ($P<0.05$) influenced the relative weight of the lung. The interaction of hybrid and vitamin C significantly ($P<0.05$) influenced the relative weight of the lung and proventriculus while the interactive effect of hybrid and FCLP significantly ($P<0.05$) improved the dressing percentage, and the relative weight of the gizzard, spleen, heart, lung and proventriculus. The interaction of vitamin C and FCLP significantly ($P<0.05$) improved the relative weight of the lung; and the interactive effect of hybrid, vitamin C and FCLP significantly ($P<0.05$) improved the dressing percentage as well as the relative weight of the gizzard, pancreas, heart and proventriculus.

The result of the brain antioxidants analysis for the two hybrids of broiler chicken fed FCLP and vitamin C supplemented diets is presented in Table 3.

The value of the brain catalase and brain glutathione for birds fed diets 7 and 8 compared statistically and were higher than the values recorded for the other diets. The C5 hybrid showed higher significance ($P<0.05$) for the brain catalase and brain glutathione than that of the AA hybrid. Inclusion of vitamin C and FCLP significantly ($P<0.05$) improved catalase and glutathione while there was no significant ($P>0.05$) effect in the interactions of hybrid, vitamin C and FCLP.

Table 3: Brain analysis of two hybrids of broiler chickens fed *Ficus carica* leaf powder and vitamin C supplemented diets

Diet	HRD	VC mg/kg	FCLP %	BTP (mg/g)	BCAT (Ku)	BGSH (μ mol/mg)
1	AA	0	0	0.59	25.54 ^f	20.43 ^f
2	C5	0	0	0.53	38.92 ^e	39.08 ^e
3	AA	200	0	0.61	46.22 ^e	42.35 ^{de}
4	C5	200	0	0.62	53.16 ^{cd}	50.33 ^{cd}
5	AA	0	1	0.63	47.77 ^{de}	53.05 ^c
6	C5	0	1	0.56	57.96 ^{bc}	58.95 ^{bc}
7	AA	200	1	0.60	63.66 ^{ab}	65.72 ^{ab}
8	C5	200	1	0.58	67.62 ^a	70.36 ^a
SEM				0.04	2.80	3.28
<i>P</i> -value				0.87	0.01	0.01
	AA			0.60	45.80 ^b	45.39 ^b
	C5			0.57	54.41 ^a	54.68 ^a
	SEM			0.02	1.45	1.66
	<i>P</i> -value			0.29	0.01	0.01
		0		0.57	42.55 ^b	42.88 ^b
		200		0.60	57.66 ^a	57.19 ^a
		SEM		0.02	1.46	1.68
		<i>P</i> value		0.48	0.01	0.01
			0	0.58	40.96 ^b	38.05 ^b
			1	0.59	59.25 ^a	62.02 ^a
			SEM	0.02	1.45	1.68
			<i>P</i> value	0.91	0.01	0.01
	Interactions <i>P</i> -value					
		HRD x VC		0.44	0.14	0.22
		HRD x FCLP		0.79	0.46	0.11
		VC x FCLP		0.48	0.27	0.35
		HRD x VC x FCLP		0.85	0.98	0.33

Means with different superscript in the same column are significantly ($P < 0.05$) different; HRD: Hybrids; VC: Vitamin C; FCLP: *Ficus carica* leaf powder; BTP: Brain Total Protein; BCAT: Brain Catalase; BGSH: Brain Glutathione; AA: Arbor Acres; C5: Cobb 500; SEM: Standard error of the means.

The result of the breast muscle antioxidative status of the two hybrids of broiler chicken fed FCLP and vitamin C supplemented diets is presented in Table 4. The lipid oxidation, meat glutathione and meat catalase were significantly ($P < 0.05$) improved by the dietary supplementation of vitamin C and FCLP. Result of the lipid oxidation showed that birds fed the control diet 1 was significantly higher ($P < 0.05$) than the other diets.

Table 4: Breast Muscle analysis of two hybrids of broiler chickens fed *Ficus carica* leaf powder and vitamin C supplemented diets

Diet	HRD	VC mg/kg	FCLP %	LPDOX (mgMDA/g)	CHOL (mg/dl)	GSH (μ mol/mg)	CATLS (Ku)
1	AA	0	0	3.10 ^a	111.69	21.92 ^e	37.14 ^e
2	C5	0	0	2.16 ^b	105.12	30.22 ^d	41.06 ^d
3	AA	200	0	1.35 ^c	108.73	43.05 ^c	42.18 ^{cd}
4	C5	200	0	1.15 ^d	104.32	46.19 ^b	44.10 ^c
5	AA	0	1	1.00 ^e	100.09	51.86 ^a	51.63 ^{ab}
6	C5	0	1	1.14 ^d	108.70	52.46 ^a	54.37 ^a
7	AA	200	1	1.04 ^e	106.06	45.37 ^b	53.62 ^a
8	C5	200	1	1.19 ^d	109.24	47.62 ^b	54.76 ^a
SEM				0.14	3.65	2.54	1.79
P-value				0.01	0.99	0.01	0.02
	AA			1.62 ^a	106.64	40.55	46.14
	C5			1.41 ^b	106.84	44.12	48.57
	SEM			0.02	6.08	2.32	1.97
	P-value			0.01	0.98	0.29	0.39
		0		1.85 ^a	106.40	39.11	46.05
		200		1.18 ^b	107.09	45.56	48.66
		SEM		0.02	6.08	2.31	1.97
		P value		0.01	0.93	0.06	0.36
			0	1.94 ^a	107.46	35.35 ^b	41.12 ^b
			1	1.09 ^b	106.02	49.32 ^a	53.59 ^a
			SEM	0.02	6.08	2.32	1.97
			P	0.01	0.86	0.01	0.01
			value				
	Interactions P-value						
	HRD x VC			0.01	0.92	0.79	0.75
	HRD x FCLP			0.01	0.51	0.52	0.86
	VC x FCLP			0.01	0.76	0.01	0.61
	HRD x VC x FCLP			0.01	0.82	0.61	0.97

Means with different superscript in the same column are significantly ($P < 0.05$) different; HRD: Hybrids; VC: Vitamin C; FCLP: *Ficus carica* leaf powder; LPDOX: Lipid oxidation; CHOL: Cholesterol; GSH: Glutathione; CATLS: Catalase; AA: Arbor Acres; C5: Cobb 500; SEM: Standard error of the means.

The value for the meat glutathione showed that diets 5 and 6 were significantly higher ($P < 0.05$) than the rest of the diets while the meat catalase showed that diets 6, 7 and 8 were significantly higher ($P < 0.05$) though not significantly different from the value for diet 5. Hybrid, vitamin C and FCLP inclusions in the diets of tested birds significantly ($P < 0.05$) influenced lipid oxidation while the inclusion of FCLP significantly ($P < 0.05$) improved glutathione and breast meat catalase of the tested birds. The interaction between hybrid and vitamin C, hybrid and FCLP significantly ($P < 0.05$)

impacted the lipid oxidation and glutathione while the interactive effect of hybrid, vitamin C and FCLP significantly ($P<0.05$) influenced lipid oxidation.

DISCUSSION

It has been reported that the inclusion of organic substances as feed supplements in animal diets influence positively the internal organs, meat qualities and carcass characteristic of broiler chicken (Oloruntola et al., 2018). Kareem-Ibrahim et al. (2021) also reported that genetic and nutritional pathways have impact on carcass quality, particularly dressing percentage. The reported difference in the dressing percentage between hybrid AA and C5 due to vitamin C supplementation may be due to genetic differences between the two hybrids. This result agrees with the findings of Kareem-Ibrahim et al. (2021) who reported different dressing percentages in different strains of broiler chicken. The gizzard, spleen, pancreas, heart, lung and proventriculus were significantly different from that of the control diets indicating that the inclusion of FCLP and vitamin C had significant effect on internal organs than on muscle development. The result is an indication that the phytochemicals and mineral constituents of FCLP influences organs more than the edible parts of the tested birds. The result is consistent with the findings of Osowe et al. (2022) who reported the improved organs weight with the supplementation of broilers' diet with *Ficus exasperata*, and Valenzuela-Grijalva et al. (2017) who affirmed that phyto-supplements have modulatory effect on the development of some target tissues. Al-Kassie (2010) also reported significant improvement in carcass and liver weight of broiler chicken fed dry peppermint powder supplemented diets. Tariq et al. (2015) had reported a similar result with no significant effect with the supplementation of clove powder. However, Dabai et al. (2021) reported a significant increase in dressing percentage with the administration of carrot leaf meal. The interaction between hybrid and FCLP as well as hybrid, vitamin C and FCLP significantly influence the dressing percentage. A similar result by Olawumi and Fagbuaro (2011) showed that hybrid significantly affects carcass traits. The significant improvement in the dressing percentage of the AA hybrid above the C5 hybrid in this study is consistent with the findings of Lohakare et al. (2005), who reported significant effect of ascorbic acid on carcass traits. The relative weights of gizzard, spleen, pancreas, heart, lungs and proventriculus were significantly influenced as a result of the inclusions of FCLP and vitamin C in the diets of the tested birds. The increased gizzard weight could be an indication of increased digestive capacity of birds which agrees with the result reported by Mushtaq et al. (2014).

Herbal plants have been researched to be a proven sources of natural antioxidants with high amount of hydrogen ions which inhibits free radical

formation as well as interrupt increase of lipid oxidation in the muscle (Falowo et al., 2014) or enhance the proliferation of endogenous enzymes like glutathione peroxidase, catalase and superoxide dismutase (Dhama et al., 2015). Results from this study recorded a significant reduction in lipid oxidation in the breast muscle with the supplementation of FCLP while the cholesterol levels were not significantly affected. There was also significant increase in glutathione peroxidase and catalase concentration in the breast muscle when compared to the control. The reduction in lipid oxidation as a result of the supplementation of FCLP could be as result of the phytochemicals and antioxidant properties of FCLP as reported by Osowe et al. (2021) which disrupts the formation of free radicals and inhibits oxidative damage. Glutathione peroxidase as reported by Adu et al. (2020) is a vital antioxidant enzyme which scavenge, inactivate and remove free radicals and other reactive species in the tissue. The high level of glutathione peroxidase in FCLP could be responsible for the reduction in lipid oxidation as recorded in this study. A similar result by Valenzuela-Grijalva et al. (2017) reported on the potentials of herbal additives to inhibit lipid oxidation and increase the endogenous antioxidant enzymes in muscles as a result of the presence of bioactive components and antioxidant activities. The interactions between the factors significantly affected the lipid oxidation in the breast muscle as well as the interaction between vitamin C and FCLP which influences the concentration of glutathione peroxidase. The level of breast meat cholesterol reported in this study with the supplemented diets at the level of 1% of FCLP and vitamin C at 200mg/kg of feed though not significant was higher than the values reported by Milicevic et al. (2014) who reported a range of 37.41 to 79.9mg/100g and Ponte et al. (2004) who reported a range of 43.18 to 47.11mg/100g with the supplementation of Alfalfa at 3% level of inclusion. However, the result is below the values reported by Adu et al. (2020) who reported values ranging from 76.59 – 223.75mg/dl with dietary supplementation of *Myristica fragrans* seed meal (MSM), *Syzygium aromaticum* leaf meal (SLM) and *Myristica fragrans* seed meal and *Syzygium aromaticum* leaf meal composite mix (MSCM).

Catalase and glutathione are key antioxidant enzymes which ameliorate oxidative stress by destroying cellular hydrogen peroxide to produce water and oxygen. Deficiency or reduction in the levels of these enzymes has been associated with many degenerative diseases (Nandi et al., 2019). The brain is highly predisposed to oxidative damage because it discharges a number of signaling mechanisms involving different reactive molecules (Salim, 2017). The significantly higher levels of these antioxidant enzymes in the brain of the broiler chicken fed FCLP when compared to the control affirmed the antioxidant status of FCLP as reported by Osowe et al. (2021). The result showed that in the C5 hybrid, inclusion of vitamin C as well as the supplementation with 1% FCLP significantly influence the levels of these

antioxidant enzymes in this study. The significant improvement in the brain catalase and glutathione concentration in this study is beneficial because enzymes catalase and glutathione act as part of the first line of defense against reactive oxygen species, oxidative damage, blocking and capturing free radicals and removal of destroyed biomolecules (Lee et al., 2020). The improved antioxidative status of the brain suggests the neuroprotective potentials of phytochemicals as reported by Kumar and Khanum (2012) as well as the capacity of ascorbic acid to enhance brain antioxidative status which is consistent with the previous report of Coskun et al. (2005). The result is also consistent with the earlier study of Osowe et al. (2022) who reported on the increased brain's antioxidant capacity as well as improved meat quality with dietary supplementation of *Ficus exasperata* and vitamin C.

CONCLUSION

From the study, it was observed that 1g FCLP and 200mg vitamin C supplementation had no significant effect on the dressing percentage of the tested birds. Lipid oxidation was significantly reduced by the inclusion of 1g FCLP and 200mg vitamin C, and catalase as well as glutathione peroxidase of the brain and meat were increased by 1g FCLP, 200mg vitamin C. The carcass quality of the C5 hybrid had better catalase and glutathione concentration than the AA hybrid. Thus, the supplementation of broiler diets with 1g FCLP and 200mg/kg of vitamin C could significantly improve broilers' meat quality as well as boost the brain's antioxidant status of broiler chicken.

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