

CARCASS AND ORGAN TRAITS OF TWO BROILER CHICKEN STRAINS FED DIETARY *CITRUS SINENSIS* PEEL-BASED DIETS

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ABSTRACT

One hundred- and ninety-two-day-old chicks, comprising 96 Abor acres and 96 Cobb 500 breed, were randomly distributed across four different diets with inclusion levels of dried *Citrus sinensis* peel (DCSP) at 0, 2.50, 5.00, and 7.50% used to substitute wheat offal in the diet. Each treatment group was replicated three times, consist eight birds each in a 2 x 4 factorial design. Carcass and organ parameters were assessed. The highest live, slaughter, and eviscerated weight ($2518.33 \pm 115.75g$, $2379.33 \pm 108.81g$, $91.20 \pm 1.82g$ respectively) was observed in the control group followed by birds fed with 2.50% DCSP. Although the highest drumstick mean weight was observed among birds fed with 2.50% DCSP, it was statistically similar to the values recorded among the control group. For carcass cuts- thigh, back, neck, wing, and head, the control group had the highest weight while the least weight was observed among birds fed a diet containing 7.50% DCSP. No breed effect was recorded and the interactive effects were also non-significant ($P > 0.05$). The relative organ weight of the broiler chickens observed was significantly affected ($P < 0.05$) except for the pancreas and lungs. The weight of the heart ($11.78 \pm 0.94g$), liver ($50.72 \pm 2.83g$), gizzard ($54.72 \pm 0.37g$), proventriculus ($10.08 \pm 0.48g$), and spleen ($2.38 \pm 0.12g$) was highest among the control birds and the least value was also recorded among birds fed with Diet D. Strain did not affect ($P > 0.05$) organs weight except for the heart and proventriculus. Likewise, interaction effects were non-significant ($P > 0.05$). Hence, DCSP can only be utilized at a 2.50% inclusion level for optimal muscle growth, carcass, and organ outcomes.

Keywords: *Citrus sinensis* peel, carcass, organ, weight, broiler strains

INTRODUCTION

The exorbitant prices of feed ingredients have engendered the investigation of different plants and fruit by-products that are nutritionally beneficial to livestock. Fruit by-products such as *Citrus sinensis* (sweet orange) peel, are a potential alternative feed ingredient rich in bioactive compounds and dietary fiber (Oluremi *et al.*, 2018). *Citrus sinensis* peel is rich in phytochemicals, antioxidants, and essential oils, making it a valuable resource for enhancing the nutritional profile of broiler feeds (Rostagno *et al.*, 2011). It contains lipase that hydrolyzes triglycerides, diglycerides, and monoglycerides into free fatty acids and glycerol (Budyghifari *et al.* 2019). It is a good source of calories and protein comparable with maize (Agu, 2006) and possesses bioactive compounds that could reduce circulating cholesterol levels, and fat deposits in muscle and carcass tissues (Musara *et al.*, 2020). Due to their availability in most of the world as environmental pollutants, particularly in Nigeria, *C. sinensis* peels could serve as a cheap and yet nutritional dietary supplement, a potential therapeutic agent (Liew *et al.*, 2018), and a feedstuff in broiler diet.

For broiler producers, dressed carcass weight is a trait of economic importance, that affects the amount of income generated (Wang *et al.*, 2010). Different feeding systems, feeding periods, and slaughter ages influence carcass weight and quality. Therefore, the objective of this study is to evaluate the carcass and organ characteristics of broiler chickens fed varied levels of *Citrus sinensis* peel-based diets.

MATERIALS AND METHODS

Fresh *Citrus sinensis* peels were gathered from local vendors at the various markets in Akure, Southwestern Nigeria, and sundried until they were crispy and ground with the aid of a hammer mill. One hundred and ninety-two (96 Abor acres and 96 Cobb 500 strain) day-old chicks procured from reliable sources were counted, weighed, and randomly assigned to four different diet groups (A, B, C and D) comprising 0.0, 2.50, 5.0 and 7.50% dried *Citrus sinensis* peel (DCSP) on arrival in a 2 x 4 factorial experimental design. The diets were formulated according to NRC's (1994) nutritional

recommendations. The diet groups were replicated 3 times comprising 8 birds per replicate (24 birds/treatment group). The birds were fed *ad-libitum* with broiler starter and finisher's diet as shown in Table 1 from day old to 4 weeks and 5th to 8th week respectively. Fresh clean water was provided for the birds copiously and recommended vaccination and medication were provided when due. On the last day of the 8 weeks of the feeding trial, broiler chickens were fasted for 8 hours before slaughter. Eighteen (18) birds were randomly selected from each treatment group (3 birds/replicate), weighed, and sacrificed. The birds were dissected and organs such as the spleen, liver, kidney, lungs, pancreas, and proventriculus were carefully removed and weighed. The eviscerated weight was also recorded after which they were dipped in hot water for about 5 minutes and de-feathered. The dressed weight was taken and primal cuts such as breast, drumsticks with thighs, wings, back, head, and neck were dissected and weighed. All weight was read with the aid of a digital scale. All data obtained were analyzed using the SPSS version 2016 package.

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Table 1: Gross composition (g/100g) of the Broiler experimental diets (0– 8 weeks)

Table 1: Gross composition (g/100g) of the broiler experimental diets (0-8 weeks)								
INGREDIENTS	BROILER STARTER				BROILER FINISHER			
	DCSP INCLUSION LEVELS							
	0.00	2.50	5.00	7.50	0.00	2.50	5.00	7.50
Maize	46.00	46.00	46.00	46.00	51.00	51.00	51.00	51.00
DCSP	0.00	2.50	5.00	7.50	0.00	2.50	5.00	7.50
Wheat offal	7.50	5.00	2.50	0.00	7.50	5.00	2.50	0.00
Groundnut cake	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00
Soybean meal	25.15	25.15	25.15	25.15	21.00	21.00	21.00	21.00
Fishmeal	2.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00
DCP	---	---	---	---	0.50	0.50	0.50	0.50
Limestone	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
Bone meal	1.50	1.50	1.50	1.50	1.15	1.15	1.15	1.15
*Others	2.55	2.55	2.55	2.55	5.00	5.00	5.00	5.00
Total	100	100	100	100	100	100	100	100
Cal. nutrients:								
Crude protein (%)	22.55	22.21	22.02	201.82	20.49	20.11	19.74	19.36
ME (kcal/kg)	2916.60	2936.07	2955.54	2975.01	2953.85	2907.10	2860.35	2813.60
Crude fiber (%)	3.90	4.00	4.11	4.22	3.77	3.55	3.34	3.13

*Others include premix-0.25, methionine-0.10, lysine-0.10, salt-0.10, vegetable oil-2.00, cal. – calculated, ME- metabolizable energy, DCP-Di-calcium phosphate

Results and discussion

Table 2 shows the result of the carcass characteristics of Arbor Acres and Cobb 500 broiler chickens fed DCSP. Live weight, slaughter weight, dressed weight, eviscerated weight, drumstick, thigh, back, neck, wing, head, and shank were all significantly ($P<0.05$) influenced by DCSP except for the muscle of the breast. Broiler chickens fed the control diet had the highest live weight ($2518.33\pm115.75\text{g}$), slaughter weight ($2379.33\pm108.81\text{g}$), and eviscerated weight ($91.20\pm1.82\text{g}$) followed by birds fed with Diet B ($2310.83\pm115.75\text{g}$, $2245.00\pm108.81\text{g}$, $91.47\pm1.82\text{g}$, $74.43\pm0.37\text{g}$ respectively) while the least weight of all the parameters was recorded among birds fed Diet D ($1912.50\pm115.75\text{g}$, $1755.33\pm108.81\text{g}$, $88.45\pm1.82\text{g}$, $70.58\pm0.37\text{g}$ respectively) which was comparable with the 1.85 kg to 2.58 kg reported by Agu *et al.* (2010). Birds fed diets A and B had the highest dressed weight ($77.43\pm0.37\text{g}$, $76.38\pm0.37\text{g}$), and the least dressed weight was recorded among birds fed 7.50% inclusion level of DCSP. This suggested that DCSP at inclusion levels above 2.50% may inhibit muscle deposition and weight. For carcass cuts, broiler chickens fed diet B had the highest drumstick weight ($288.20\pm20.23\text{g}$) although it was not statistically different from the drumstick mean weight recorded for the control group ($271.87\pm20.23\text{g}$) while the lowest mean weights were recorded

in birds fed diet C and D (193.42 ± 20.23 g, 200.95 ± 20.23 g). The highest weight of the thigh (303.30 ± 14.83 g) was recorded in birds fed diet A and the lowest value (217.05 ± 14.83 g) was recorded

Table 2: Effect of DCSP on carcass characteristics of broiler chickens

Treatment		LWT(kg)	SWT(kg)	ET (%)	DT (%)	Breast(g)	DSK(g)	Thigh(g)	Back(g)	Neck(g)	Wing(g)	Head(g)
Diet	A	2518.33 ^a	2379.33 ^a	91.20 ^a	77.43 ^a	579.23	271.87 ^a	303.30 ^a	305.72 ^a	147.58 ^a	182.70 ^a	56.55 ^a
	B	2310.83 ^a	2245.00 ^a	91.47 ^a	76.38 ^a	566.33	288.20 ^a	269.72 ^{ab}	279.22 ^a	123.48 ^a	175.65 ^a	54.02 ^{ab}
	C	1952.50 ^b	1823.17 ^b	90.23 ^b	73.92 ^a	452.60	200.95 ^b	225.65 ^{bc}	248.05 ^b	108.98 ^b	154.75 ^b	47.08 ^b
	D	1912.50 ^b	1755.33 ^b	88.45 ^c	70.58 ^b	441.38	193.42 ^b	217.05 ^c	241.70 ^b	104.43 ^b	149.68 ^b	45.67 ^b
Strain	SEM	115.75	108.81	1.82	0.37	49.64	20.23	14.83	17.50	9.46	8.51	2.78
	PV	0.01	0.01	0.11	0.03	0.13	0.04	0.01	0.02	0.02	0.04	0.03
	AA	2118.33	2004.25	76.11	91.86	538.34	239.57	253.73	262.22	115.66	161.22	48.62
	Cobb	2228.75	2097.17	72.04	90.41	481.43	237.65	254.13	275.13	126.58	170.18	53.04
AA	±SE	81.85	76.94	1.29	0.26	35.10	14.30	10.48	12.38	6.69	6.02	1.97
	M											
	PV	0.35	0.41	0.40	0.10	0.27	0.93	0.98	0.47	0.27	0.31	0.13
	A	2523.33	2341.33	72.62	91.52	564.50	271.93	307.67	308.20	143.23	183.73	57.17
Cobb 500	B	2318.33	2123.67	77.13	92.12	625.30	320.07	278.93	279.40	123.20	171.73	51.30
	C	1745.00	1632.33	80.64	91.93	486.13	174.60	208.13	233.97	97.30	146.90	40.33
	D	1886.67	1720.67	74.07	90.88	477.43	191.67	220.17	227.30	98.90	142.50	45.67
	A	2513.33	2417.33	75.22	90.87	593.97	271.80	298.93	303.23	151.93	181.67	55.93
Cobb 500	B	2303.33	2167.33	71.74	90.83	507.37	256.33	260.50	279.03	123.77	179.57	56.73
	C	2160.00	2014.00	74.12	90.53	419.07	212.23	225.97	249.43	111.57	152.47	51.00
	D	1938.33	1790.00	67.08	89.41	405.33	210.23	231.13	268.80	119.07	167.00	48.50
	SEM	163.70	153.89	2.58	0.52	70.20	28.60	20.97	24.75	13.37	12.03	3.93
Cobb 500	PV	0.52	0.41	0.25	0.39	0.76	0.35	0.81	0.78	0.90	0.73	0.51

abcd -Means in the same column with different superscripts are significantly different ($P < 0.05$). LWT= Live weight, SWT = Slaughter weight, ET= Eviscerated weight, DT = Dressed weight, AA = Arbor acres, SEM = standard error mean, PV = p-value; A = 0% DCSP; B = 2.50% DCSP; C = 5.00% DCSP; D = 7.50% DCSP.

in birds fed diet C. Also, the highest mean weight of the back, neck, wing, and head was observed among broiler chickens in the control group while the least mean weight was observed among birds fed diet D. This study agreed with the findings of Alefzadeh *et al.* (2016) who reported a great reduction in the weight of most of the valuable carcass parts of broiler chickens at a 4% supplementation level. No significant variation ($P > 0.05$) was observed in the breed effect on the weight of all the carcass cuts of the broiler chickens as well as the interaction effect which concur with the findings of Kareem-Ibrahim *et al.* (2021) who stated that the growth performance of the Cobb and Arbor acre broiler chickens did not differ from one another.

The organ characteristics of the two breeds of broiler chickens are presented in Table 3. The diet significantly ($P < 0.05$) influenced all the organ parameters assessed except for the pancreas and lung. The highest weight for the heart (11.78 ± 0.94 g), liver (50.72 ± 2.83 g), gizzard (54.72 ± 0.37 g), proventriculus (10.08 ± 0.48 g) and spleen (2.38 ± 0.12 g) was recorded in broiler chickens fed diet A and lowest organ weight was observed in birds fed diet D (8.48 ± 0.94 g, 35.95 ± 2.83 g, 42.82 ± 0.37 g, 8.45 ± 0.48 g, 1.62 ± 0.12 g) respectively. This study partly agreed with the findings of Abbasi *et al.* (2015) who reported lower weight of the liver of broiler chickens fed dried *Citrus sinensis* pulp but contradicted the report of Agu *et al.* (2010) who stated a significant increase in the relative weight of the gizzard and proventriculus at higher sweet orange peel meal inclusion levels. However, there was no breed effect ($P > 0.05$) on the relative organ weight of the broiler chickens except for heart and proventriculus. Cobb 500 birds had the highest heart (11.25 ± 0.66 g) and proventriculus weight (10.08 ± 0.34 g) when compared with the Arbor acres broiler chickens. Also, no significant ($P > 0.05$) variation was observed in the interaction between the diets and breed except for the spleen.

CONCLUSION

In this study, the carcass evaluation and the relative organ weight of the two breeds of broiler chickens fed diets in which wheat offal was substituted with DCSP at 2.50%, 5.00%, and 7.50% revealed that the optimum utilization of DCSP to reduce the cost of feeding could be achieved at 2.50% level for better muscle deposition, live and dressed weight without causing any reduction in the visceral organ weights that could result in negative impacts. However, breed differences did not affect the use of DCSP in broiler production.

Table 3: Organ characteristics of Arbor Acres and Cobb 500 broiler chickens fed dietary DCSP

Treatment		Lung(g)	Heart(g)	Pancreas(g)	Gizzard(g)	liver(g)	Pro.(g)	Spleen(g)
Diet	A	12.90	11.78 ^a	5.20	54.72 ^a	50.72 ^a	10.08 ^a	2.38 ^a
	B	13.55	9.48 ^{ab}	4.75	51.98 ^{ab}	46.03 ^{ab}	9.85 ^{ab}	1.93 ^b
	C	11.78	10.73 ^{ab}	5.92	44.20 ^{ab}	38.82 ^{bc}	9.02 ^{ab}	1.60 ^b
	D	11.63	8.48 ^b	4.75	42.82 ^b	35.95 ^c	8.45 ^b	1.62 ^b
	±SEM	1.15	0.94	0.47	0.37	2.83	0.48	0.12
	PV	0.60	0.01	0.29	0.03	0.01	0.04	0.01
Strain	AA	12.59	8.99 ^b	4.94	46.40	40.50	8.55 ^b	1.91
	Cobb	12.34	11.25 ^a	5.37	50.46	45.26	10.15 ^a	1.86
	±SEM	0.82	0.66	0.33	2.45	2.00	0.34	0.08
	PV	0.83	0.03	0.38	0.26	0.11	0.01	0.68
Strain *Diet								
AA	A	13.67	11.40	4.80	52.23	43.10	8.93	2.27
	B	14.33	9.10	5.27	55.53	49.80	9.93	2.17
	C	10.87	7.97	5.37	38.53	33.07	8.17	1.40
	D	11.50	7.50	4.33	39.30	36.03	7.17	1.80
Cobb 500	A	12.13	12.17	5.60	51.73	58.33	10.77	2.50
	B	12.77	9.87	4.23	53.90	42.27	10.23	1.70
	C	12.70	9.00	6.47	47.10	38.83	9.87	1.80
	D	11.77	13.97	5.17	49.10	41.60	9.73	1.43
	±SEM	1.63	1.33	0.67	4.90	4.01	0.68	0.17
	PV	0.69	0.12	0.39	0.55	0.07	0.43	0.05

^{abcd} -Means in the same column with different superscripts are significantly different ($P < 0.05$); AA-Arbor acres, Pro – Proventriculus, SEM-standard error mean, PV- p-value; A - 0% DCSP; B- 2.50% DCSP; C - 5.00% DCSP; D - 7.50% DCSP.

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