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CARCASS CHARACTERISTICS OF BROILER CHICKENS FED DIETS OF DIFFERENTLY PROCESSED CASSAVA-SOYA BLENDS

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ABSTRACT

This study was conducted to evaluate the carcass characteristics of broiler chickens fed diets of differently processed cassava-soya blends (CSB). Two differently dried blends of cassava pulp and soya beans (dry and wet heated), mixed at four (4) different ratios were subjected to two types of dehydration methods to obtain 12 types of blends. These blends were subsequently included in the diets of broiler chickens at 15% in a 2×2×3 factorial arrangement to obtain 12 dietary treatments. 360 one-day-old Cobb-500 broiler chicks used for this study were assigned to the 12 dietary treatment groups which were replicated three times with ten birds each. Eight weeks of feeding trials (starter and finisher phases) were observed. The blends were chemically analysed to determine their proximate, hydrocyanide (HCN) and trypsin inhibition unit (TIU) compositions. Carcass characteristics of the birds were evaluated at the end of the experiment. Results of the carcass characteristics shows that liver mass (2.03%) was higher ($p<0.05$) in birds fed diets containing wet heated soya bean, compared to those fed diets containing dry heated soyabean. Dehydration by frying of CSB resulted in a higher ($p<0.05$) dressing percentage (65.9%) and drumstick weight (10.0%). Birds fed diets containing CSB mixed in ratio 50:50 had higher liveweight (2170 g). It can be concluded that replacing 15% of maize in diets of broiler chickens with CSB of 50:50 mixing ratio resulted in higher live weight when compared to other mixing ratios.

Keywords: Cassava processing, Cassava-soya blend, hydrocyanide, Soyabean heat treatment, trypsin

INTRODUCTION

Adeyemi *et al.* (2013) opined that the potentials of poultry and poultry products as a panacea to insufficiency in animal protein intake among the Nigerian populace have continued to be a mirage principally because of astronomical increase in feed cost. The main reason for this being the competition among man, industry and livestock for grains and grain legumes. Maize makes up to 40 – 60% of the bulk of poultry feeds, as it is the major energy source used in the poultry industry. Due to insufficiency in its supplies, high prices and competition with human food and biofuel industries as reported by Morgan and Choct, (2016), there is always a continuous demand for alternative energy sources for poultry. And due to the availability of cassava in the tropical part of the world, the need to fashion a way of incorporating cheaper alternative ingredients into poultry feed is becoming increasingly important. However, compared with cereal grains, cassava is low in protein and its protein content is of poor quality with very low essential amino acid contents (Olugbemi *et al*., 2010). As a result, Morgan and Choct, (2016) opined that cassava-based diets must be supplied with protein sources that provide an adequate supply of methionine and lysine in form of synthetic amino acids - which can be costly. Other options for overcoming this problem include incorporating cassava leaves, oil seeds or cakes, which are richer in protein, into the diet (Ngiki *et al*., 2014). This is the basis for the incorporation of soyabean into the cassava-based diet in this study to make a Cassava-Soya blend. The utilisation of cassava is also limited by its high fibre, low energy content and the presence of anti-nutritional factors; primarily hydrocyanic acid (Gomez *et al*., 1988). This makes the need to improve the nutritional value of cassava food products through processing a necessary intervention (Morgan and Choct, 2016).

Its low crude protein content makes it insufficient in replacing maize adequately, thereby requiring fortification via oil seeds such as soya bean. The presence of antinutrients in both cassava and soyabean brings about the need for finding a cheap and affordable processing method. This current study thereby evaluated the carcass characteristics of broiler chickens fed diets of differently processed cassava-soya blends.

MATERIALS AND METHODS

Experimental site

The experiment was carried out at the Poultry Unit of the Directorate of University Farms (DUFARMS) of the Federal University of Agriculture, Abeokuta (FUNAAB), Ogun State Nigeria. The site is located in the rain forest zone of southwestern Nigeria on latitude $7^{0}10'$N and longitude $3^{0}2'$E. The climate is tropical humid with a mean annual rainfall of 1037mm, mean temperature of 34.7^{0}C (Federal University of Agriculture Abeokuta Meteorological Station).

Test ingredients and preparation of samples

Test ingredients for the experiments were roots of TMS 30572 cassava (*Manihot esculenta Crantz*) variety and grains of soya bean (*Glycine max*) TGX 923E variety. The cassava roots were obtained from local farmers within Abeokuta metropolis, Ogun State while the soya bean grains were obtained from International Institute of Tropical Agriculture (IITA), Ibadan. The cassava roots were peeled, washed and grated in a commercial grating machine. The grated cassava pulp was packed in hessian bags and allowed to ferment while dewatering gradually under pressure for 48 hours. Thereafter, the dewatered pulp was pulverized with hands and sifted on a local raffia sieve to remove the fibre. The soya bean grains of the variety TGX 923E were sorted to ensure homogeneity of samples, washed, sun-dried and divided into two, then subjected to two heat treatment methods (dry and wet heat treatments) viz:

i. Dry heat treatment: Portion of the cleaned raw soya beans was poured into a hot metal dry pan (common driers).

The soya beans were dried by continuous stirring in the drier until the beans were slightly roasted to a golden brown colour, following the method of Cheva-Isarakul and Tangtaweewipat (1995). The soya beans were spread to cool before milling into full fat soya meal.

ii. Wet heat treatment: The other portion of the cleaned raw soya beans was poured into a vat containing an unmeasured quantity of boiling water. This was done for each batch of kg of soya beans. The soya beans were allowed to soak in hot water at boiling point for 30 minutes according to the methods described by Kaankuka *et al.* (1996). Thereafter, the water was decanted and the boiled soya beans oven-dried before milling into full fat meal.

Cassava-soya blends were then prepared from mixtures of sieved cassava pulps and full fat soya beans (dry heated and wet heated) in the following ratios: 50:50, 60:40 and 80:20 (Table 1). The resulting mixtures were then further subjected to two types of dehydration methods; (sun drying or frying) to make twelve different Cassava-soya blend sample treatments (Table 1). Sun drying was carried out for 2 days at atmospheric temperature with continuous turning, while frying was done by continuous stirring in the drier at 45^{0}C until it turned crispy.

Table 1: Processing techniques and mixing ratios of cassava-soya blends (CSB)

Treatments	Components	Mixing ratio	Processing techniques
CDF_1	CP +DHTS	50:50	Frying
CDF_2	CP +DHTS	60:40	Frying
CDF_3	CP +DHTS	80:20	Frying
CDS_1	CP +DHTS	50:50	Sun drying
CDS_2	CP +DHTS	60:40	Sun drying
CDS_3	CP +DHTS	80:20	Sun drying
CWF_1	CP +WHTS	50:50	Frying
CWF_2	CP +WHTS	60:40	Frying
CWF_3	CP +WHTS	80:20	Frying
CWS_1	CP +WHTS	50:50	Sun drying
CWS_2	CP +WHTS	60:40	Sun drying
CWS_3	CP +WHTS	80:20	Sun drying

CP – cassava pulp, DHTS – dry heat-treated soya, WHTS – wet heat-treated soya

Experimental birds and management

The feeding trial was conducted with a total number of 360 one-day-old Cobb 500 broiler chicks with an average weight of 42g. The birds were intensively managed on a deep litter system in two phases (the starter and the finisher phases).

The starter phase lasted four weeks (day-old -4weeks) while the finisher phase also lasted four weeks (4-8 weeks). The deep littered pen and equipment were washed and disinfected prior to arrival of the birds. All the routine management practices including medications (vaccines and drugs) specified for Cobb 500 breed of chickens were strictly adhered to. Feed and water were supplied to the birds *ad libitum*. The experimental birds were managed under standard management conditions of broiler chicken rearing in the tropics.

Experimental diets and layout

The twelve dietary treatments were arranged in a 2×2×3 factorial experimental design to have 2 heat treatment methods of soyabean (wet and dry heat treatments), 2 dehydration methods of cassava-soya blends (sun drying and frying) and 3 mixing ratios of cassava-soya blends (50:50, 60:40, and 80:20). The cassava-soya blends (CSB) were included in the broiler chickens' diet at 15% inclusion. At the onset of the experiment, the 360 Cobb-500 one-day-old broiler chicks were randomly allotted to the 12 experimental groups (30 birds per treatment). Each treatment was replicated 3 times to have 10 chicks per replicate group on weight equalisation bases. At the end of the starter phase, the experimental birds were reassigned on weight equalisation bases to the same number of dietary treatment groups with the same number of replicates. This was done to remove any carryover effect of the starter phase to the finisher phase. Diets were formulated to follow the recommended procedures of NRC (1994) for starter (Table 2) and finisher (Table 3) phases.

Table 2: Percentage (%) composition of experimental starter diets (0 day old-4 weeks)

	Fried CSB blend						Sun dried CSB blend					
CSB	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
Maize	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
FFS	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
Soyabean meal	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1
Palm Oil	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Fish meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Bone meal	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Oyster Shell	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
*Premix	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Lysine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100	100	100	100	100	100	100
Calculated analysis												
ME(Kcal/Kg)	3187	3164	3170	3164	3168	3163	3169	3169	3163	3169	3170	3163
Crude Protein (%)	23.7	23.5	21.5	23.1	22.7	20.7	23.2	23.2	21.7	22.2	22.2	20.7
Crude Fibre (%)	3.67	3.68	3.73	3.67	3.68	3.73	3.68	3.73	3.6	3.67	3.68	3.73
Calcium (%)	1.20	1.20	1.21	1.20	1.20	1.21	1.20	1.20	1.21	1.20	1.20	1.21
Phosphorus (%)	0.68	0.67	0.67	0.68	0.67	0.67	0.68	0.67	0.67	0.68	0.67	0.67
Lysine (%)	1.20	1.21	1.21	1.20	1.21	1.21	1.20	1.21	1.21	1.20	1.21	1.21
Methionine (%)	0.47	0.47	0.46	0.47	0.47	0.46	0.47	0.47	0.46	0.47	0.47	0.46

CSB- Cassava-soya blend, FFS- Full fat soya, ME- Metabolizable energy

**Vitamin A, 12,000,000 IU; Vitamin D3, 2,500,000 IU; Vitamin E, 30,000 IU; Vitamin K, 2000mg; Vitamin B1, 2,250mg; Vitamin B2, 6,000mg Vitamin B6,4,500mg, Vitamin B12, 15mcg; niacin, 40,000mg; Pantothenic Acid,15,000mg; Folic Acid, 1,500mg; Biotin, 50mcg; Choline chloride, 300,000mg; Manganese, 80,000mg; Zinc, 50,000mg; Iron, 20,000mg; Copper, 5,000mg; Iodine, 1,000mg; Selenium, 200mg; Cobalt, 500mg; Antioxidant, 125,000mg*

Table 3: Percentage (%) composition of experimental finisher diets (4-8 weeks)

	Fried CSB blend						Sun dried CSB blend					
	Dry heated soyabean			Wet heated soyabean			Dry heated soyabean			Wet heated soyabean		
Ingredients	**50:50**	**60:40**	**80:20**	**50:50**	**60:40**	**80:20**	**50:50**	**60:40**	**80:20**	**50:50**	**60:40**	**80:20**
CSB	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
Maize	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
FFS	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Soyabean meal	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Palm Kernel Meal	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
Fish Meal	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Wheat Offal	3.05	3.05	3.05	3.05	3.05	3.05	3.05	3.05	3.05	3.05	3.05	3.05
Palm Oil	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Bone meal	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Oyster Shell	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Methionine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
*Premix	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100	100	100	100	100	100	100
Calculated analysis												
ME(Kcal/Kg)	2902	2903	2902	2902	2903	2902	2902	2903	2902	2902	2903	2902
Crude Protein (%)	20.5	20.2	19.7	20.5	20.2	19.7	20.5	20.2	19.7	20.5	20.2	19.7
Crude Fibre (%)	4.24	4.26	4.29	4.24	4.26	4.29	4.24	4.26	4.29	4.24	4.26	4.29
Calcium (%)	1.20	1.21	1.20	1.20	1.21	1.20	1.20	1.21	1.20	1.20	1.21	1.20
Phosphorus (%)	0.66	0.66	0.65	0.66	0.66	0.65	0.66	0.66	0.65	0.66	0.66	0.65
Lysine (%)	1.13	1.12	1.08	1.13	1.12	1.08	1.13	1.12	1.08	1.13	1.12	1.08
Methionine (%)	0.45	0.44	0.43	0.45	0.45	0.44	0.45	0.44	0.43	0.45	0.44	0.43

CSB- Cassava-soya blend, ME- Metabolizable energy, FFS- Full fat soya

**Vitamin A, 12,000,000 IU; Vitamin D3, 2,500,000 IU; Vitamin E, 30,000 IU; Vitamin K, 2000mg; Vitamin B1, 2,250mg; Vitamin B2, 6,000mg Vitamin B6,4,500mg, Vitamin B12, 15mcg; niacin, 40,000mg; Pantothenic Acid,15,000mg; Folic Acid, 1,500mg; Biotin, 50mcg; Choline chloride, 300,000mg; Manganese, 80,000mg; Zinc, 50,000mg; Iron, 20,000mg; Copper, 5,000mg; Iodine, 1,000mg; Selenium, 200mg; Cobalt, 500mg; Antioxidant, 125,000mg*

Data collection

Proximate composition of test ingredients

Proximate composition (moisture, crude protein [CP], crude fibre [CF], ether extract [EE], Nitrogen Free Extract [NFE] and ash content) of the cassava-soya blends were determined by method described by AOAC (2002) while the metabolizable energy was calculated using Pauzenga equation as follows: ME = 35 × % CP + 18.8 × % EE + 35.5 × % NFE. NB: ME- Metabolizable energy, CP- Crude protein, EE- Ether exract, NFE- Nitrogen free extract. Hydrogen cyanide (HCN) content was determined according to the procedure of Anhwange (2004) while the trypsin inhibition unit (TIU) was also determined. The analyses where carried out on dry matter (DM) bases.

Hydrogen cyanide (HCN) and Trypsin inhibitor unit (TIU) determination

Alkaline titration procedure was adopted (Anhwange, 2004) for the determination of the hydrogen cyanide content. Ten grams of each of the ground 12 samples was soaked in a mixture of 200 ml of distilled water and 10 cm^3 of orthophosphoric acid. The mixture was kept for 12 hours to release all the bound cyanide. The mixture was thereafter distilled until 150 ml of the distillate was collected. 20ml of the distillate was poured into a conical flask containing 40ml of distilled water. 8ml of ammonia solution (6 mol/dm^3) and 2ml of potassium iodide (5%) solution were added. The mixture was then titrated with silver nitrate (0.02 mol/dm^3) to faint but permanent turbidity (1ml 0.02 mol/dm3 AgNO3) which is equivalent to 1.08mg HCN.

The percentage hydrocyanide was calculated with the formula:

$$\% \, Hydrocyanide = \frac{Titre \times 10 \times 0.27 \times 100}{1000 \times weight \ of \ sample}$$

Trypsin inhibitor was determined by weighing 0.2 g each of the 12 samples into a screw cap centrifuge tube. 10 ml of 0.1M phosphate buffer was measured and the contents were shaken at room temperature for 1 hour on an orbital shaker. The suspension obtained was then centrifuged at 5000 rpm for 5 minutes and filtered through Whatman No. 42 filter paper. The volume of each was adjusted to 2ml with phosphate buffer. The test tubes were placed in a water bath, maintained at 37^0C. 6ml of 5% Trichloroacetic acid (TCA) solution was added to one of the tubes to serve as a blank. 2mls of casein solution were added to all of the tubes previously kept at 37^0C. They were then incubated for 20 minutes. The reaction was then stopped after 20 minutes by adding 6 ml of TCA solution to the experimental tubes and shaken. The reaction was allowed to proceed for 1 hour at room temperature after which the mixture was filtered through Whatman No. 42 filter paper. Absorbance of filtrate from sample and trypsin standard solutions were read at 280 nm. The trypsin inhibitor in mg/g sample was then calculated using the formula:

$$TIU \ (mg/g) = \frac{A \ standard - A \ sample}{0.19 \times weight \ of \ sample} \times \frac{Dilution \ factor}{1000 \times \ sample \ size}$$

Carcass characteristics

At the end of the experiment, three birds whose weights were close to the mean weight of the experimental birds were selected from each treatment, weighed, slaughtered, defeathered, eviscerated and weighed again. The live weight and the dressing percentages were recorded. The weight of the head, neck, breast, back, thigh, drumstick, shank, kidney, gizzard, GIT and liver were taken and recorded, using a sensitive electronic weighing scale. The weights were then expressed as gram per kilogram of live weight.

Statistical analysis

Data obtained in this study were subjected to analysis of variance in a 2×2×3 factorial arrangement, and were analysed using the general linear model procedure of SAS 9.1.3 computer software statistical package (SAS, 2002). Significant ($p<0.05$) means were separated using Duncan's Multiple Range Test as contained in the procedure of the statistical package.

Table 4: Proximate composition of cassava-soya blends

Samples	DM (%)	ME (Kcal/kg)	CP (%)	EE (%)	CF (%)	Ash (%)	NFE (%)	HCN (mg/kg)	TIU (mg/g)
CDF_1	70.2	3282	33.5	1.40	4.43	2.00	58.7	1.60	7.50
CDF_2	70.0	3320	31.6	1.11	4.51	1.00	61.6	1.61	7.40
CDF_3	68.7	3282	18.8	0.58	5.03	2.00	73.6	1.65	7.30
CDS_1	66.8	3280	35.7	1.35	4.48	2.00	56.5	1.68	7.80
CDS_2	68.6	3306	33.2	1.06	4.91	1.00	59.8	1.72	7.70
CDS_3	66.6	3270	20.1	0.48	5.37	2.00	72.1	1.76	7.60
CWF_1	70.0	3311	36.4	1.34	4.59	1.00	56.7	1.61	2.10
CWF_2	71.6	3318	34.7	1.08	4.55	1.00	58.7	1.61	2.00
CWF_3	69.4	3274	19.6	0.52	5.28	2.00	75.6	1.66	2.20
CWS_1	67.7	3315	37.7	1.34	4.47	2.00	55.5	1.70	2.60
CWS_2	67.9	3321	35.1	1.02	4.49	1.00	58.4	1.73	2.50
CWS_3	66.6	3273	20.1	0.47	5.32	2.00	72.1	1.77	2.30

DM- Dry matter; ME-Metabolizable Energy; CP- crude protein; EE- Ether extract; CF- Crude fibre; NFE- Nitrogen free extract; HCN- Hydrocyanide; TIU-Trypsin inhibition unit (CDF_1 -CDF_3)- Fried (cassava pulp+ dry heated soya beans) at 50:50, 60:40 and 80:20; (CDS_1-CDS_3)- Sun dried (cassava pulp+ dry heated soya beans) at 50:50, 60:40 and 80:20; (CWF_1-CWF_3)- Fried (cassava pulp+ wet heated soya beans) at 50:50, 60:40 and 80:20; (CWS_1-CWS_3)- Sun-dried (cassava pulp + wet heated soya beans) at 50:50, 60:40 and 80:20.

RESULTS

Proximate composition and antinutritional constituents of cassava-soya blends (CSB)

The proximate value range of crude protein was 18.18-37.72%; Ash digestability: 1.0-2.0%; Nirogen free extact: 55.47-75.57%; and Trypsin inhibition unit: 2.10-7.80mg/g (Table 4).

CSB containing dry heated soya beans and dehydrated by frying at 50:50 Sample (CDF_1) recorded the least values for crude fibre (4.43 %) and hydrogen cyanide (1.60 mg/kg) but recorded the highest value for ether extract (1.40 %). CSB containing dry heated soya beans and dehydrated by sun drying at 80:20 (CDS_3) had the least value for metabolizable energy (3270 kcal/kg) while CSB containing wet heated soya beans and dehydrated by sun drying at 60:40 (CWS_2) had the highest (3320 kcal/kg). CSB containing dry heated soya beans and dehydrated by sun drying at 80:20 (CDS_3) had the least dry matter (66.6 %) content and ether extract (0.47 %). CSB containing dry heated soya beans and dehydrated by frying at 80:20 (CDF_3) recorded the least value for crude protein (18.8 %) while CSB containing wet heated soya beans and dehydrated by sun drying at 50:50 (CWS_1) had the highest crude protein (37.7 %) value. The hydrogen cyanide content was highest (1.77 mg/kg) and least (1.60 mg/kg) in CSB dehydrated by sun drying and containing wet heated soya beans (CWS_3) and CSB containing dry heated soya beans and dehydrated by frying 50:50 (CDF_1) respectively. CSB containing dry heated soya beans and dehydrated by sun drying at 50:50 (CDS_1) recorded the highest value for trypsin inhibition unit (7.80 mg/g) while CSB containing wet heated soya bea ns and dehydrated by frying at 50:50 (CWF_1) recorded the least (2.10 mg/g) value (Table 4).

Main effects of soya bean heat treatment methods, dehydration methods and mixing ratio of CSB on carcass characteristics of broiler chickens at 8 weeks

Out of all the parameters measured only the liver was significantly ($p<0.05$) affected by heat treatment methods of CSB. (Table 5). However higher values of live weight, plucked weight and dressing percentage were obtained from birds fed dry heated soya beans. Other parameters measured were not significantly ($p>0.05$) affected. Birds fed wet heated soya beans had higher value for liver when compared with those fed with dry heated soya beans. Live weight, plucked weight, dressing percentage, thigh and drumstick were significantly ($p<0.05$) affected by the dehydration methods of cassava-soya blends (CSB). Birds fed diets containing fried CSB had higher values of live weight, plucked weight, dressing percentage, shank weight, thigh weight and drumstick weight when compared to birds fed diets containing sun-dried CSB. All the parameters measured except live weight were not significantly ($p>0.05$) influenced by mixing ratio of CSB fed to finishing broiler chickens. Birds fed diets containing 50:50 mixing ratios of CSB recorded higher ($p<0.05$) values for live weight while those fed diets containing 60:40 and 80:20 CSBs recorded similar values for live weights of the birds (Table 5).

Table 5: Main effects of soyabean heat treatment methods, dehydration methods and mixing ratio of CSB on carcass characteristics of broiler chickens

	Soyabean treatment methods				Dehydration methods of CSB				Mixing ratios of CSB				
Parameters	**DH**	**WH**	**SEM**	**p-val.**	**Fried**	**Sundried**	**SEM**	**p-val.**	**50:50**	**60:40**	**80:20**	**SEM**	**p-val.**
LW (g)	2090	2030	20.4	0.67	2240	1890	24.7	0.00	2170^a	2100^{ab}	1930^b	30.2	0.00
PW (g)	1814	1748	1.37	0.39	1955^a	1618^b	0.56	0.04	1897^a	1821^b	1645^c	1.37	0.04
DP (%)	64.81	64.42	1.36	0.62	65.6^a	63.7^b	0.56	0.02	65.8	64.1	64.0	0.68	0.12
Head (%)	2.56	2.53	0.09	0.49	2.56	2.54	0.04	0.67	2.60	2.53	2.51	0.04	0.67
Shank (%)	4.36	4.55	0.22	0.15	4.59^a	4.31^b	0.09	0.03	4.41	4.47	4.48	0.22	0.13
Thigh (%)	10.1	10.3	0.33	0.26	10.5^a	9.91^b	0.12	0.00	10.5^a	10.2^{ab}	9.97^b	0.35	0.00
Breast (%)	18.3	18.4	0.83	0.84	18.2	18.5	0.34	0.46	18.5	18.1	18.4	0.83	0.46
Back (%)	16.8	16.4	0.71	0.38	16.6	16.6	0.29	0.92	16.6	16.6	16.7	0.71	0.92
Wings (%)	8.64	8.61	0.27	0.87	8.61	8.64	0.11	0.88	8.48	8.89	8.49	0.27	0.88
Neck (%)	3.71	3.33	0.49	0.19	3.79	3.24	0.20	0.07	3.64	3.47	3.44	0.49	0.07
Drum stick (%)	9.38	9.83	0.39	0.06	10.0^a	9.20^b	0.16	0.00	9.54^b	9.43^b	9.83^a	0.20	0.00
Heart (%)	0.47	0.47	0.03	0.75	0.45	0.49	0.01	0.05	0.47	0.47	0.48	0.03	0.05
Liver (%)	1.99^b	2.03^a	0.09	0.03	1.98	0.04	0.04	0.06	2.02	1.98	2.03	0.04	0.06
Gizzard (%)	1.72	1.81	0.12	0.45	1.76	1.77	0.05	0.22	1.79	1.75	1.75	0.06	0.22
Spleen (%)	0.23	0.15	0.14	0.22	0.22	0.16	0.06	0.95	0.14	0.15	0.28	0.14	0.95
Lung (%)	0.52	0.54	0.09	0.33	0.54	0.53	0.04	0.44	0.55	0.53	0.53	0.09	0.44
Kidney (%)	0.34	0.34	0.05	0.73	0.33	0.35	0.022	0.71	0.35	0.34	0.34	0.05	0.71

[abc] *Means on the same rows having different superscript were significantly ($p<0.05$) different.* DH: dry heat; WH: wet heat; p-val: probability value

Interaction effects of soyabean heat treatments and dehydration methods of CSB on carcass characteristics of broiler chickens

All the parameters measured (Table 6) were not significantly (p>0.05) affected by the interaction of heat treatment methods and dehydration methods of CSB. Although birds fed dry heated soya beans in fried experimental diet had the highest values for live weight, plucked weight and neck weight expressed in percentage live weights (Table 6).

Table 6: Interaction effects of soyabean heat treatment methods and dehydration methods of CSB on carcass characteristics of broiler chickens

	Fried CSB		**Sun dried CSB**			
Parameters	**DH soyabean**	**WH soyabean**	**DH soyabean**	**WH soyabean**	**SEM**	**p-value**
Live weight (g)	2250	1950	2220	1850	34.9	0.26
Plucked weight (g)	1971	1677	1932	1577	1.79	0.93
Dressed weight (%)	65.4	64.2	65.7	63.1	1.79	0.39
Head (%)	2.55	2.58	2.56	2.49	0.09	0.32
Shank (%)	4.48	4.23	4.72	4.38	0.23	0.71
Thigh (%)	10.5	9.75	10.5	10.1	0.37	0.49
Breast (%)	17.9	18.7	18.5	18.3	0.83	0.31
Back (%)	16.7	16.9	16.5	16.4	0.74	0.67
Wings (%)	8.48	8.79	8.75	8.47	0.26	0.06
Neck (%)	3.96	3.45	3.61	3.04	0.49	0.91
Drum stick (%)	8.48	8.79	8.75	8.47	0.23	0.93
Heart (%)	0.46	0.48	0.45	0.49	0.03	0.59
Liver (%)	1.97	2.01	1.98	2.08	0.89	0.07
Gizzard (%)	1.76	1.68	1.76	1.85	0.17	0.55
Spleen (%)	0.30	0.16	0.14	0.16	0.15	0.19
Lung (%)	0.53	0.52	0.55	0.53	0.09	0.35
Kidney (%)	0.36	0.32	0.31	0.37	0.04	0.98

Means on the same rows with no superscript are not significantly (p>0.05) different

DH: dry heated; WH: wet heated

Interaction effects of soyabean heat treatment methods and mixing ratio of CSB on carcass characteristics of broiler chickens

The interaction effects of soyabean heat treatment methods and mixing ratio of CSB on carcass characteristics of finishing broiler chickens revealed that all the parameters measured were not significantly (p>0.05) affected by the interaction of heat treatment methods and mixing ratio of CSB(Table 7).

Table 7: Interaction effects of soyabean heat treatment methods and mixing ratio of CSB on carcass characteristics of broiler chickens

	Dry heated soyabean			Wet heated soyabean				
Parameters	**50:50**	**60:40**	**80:20**	**50:50**	**60:40**	**80:20**	**SEM**	**p-value**
Live weight (g)	2210	2160	1930	2130	2050	1920	32.7	0.47
Plucked weight (g)	1939	1877	1655	1855	1774	1626	1.97	0.94
Dressed weight (%)	66.7	64.5	63.3	64.9	63.6	64.8	1.96	0.23
Head (%)	2.60	2.57	2.52	2.60	2.49	2.50	0.09	0.78
Shank (%)	4.27	4.39	4.40	4.55	4.54	4.56	0.16	0.89
Thigh (%)	10.3	10.3	9.72	10.7	9.99	10.22	0.21	0.10
Breast (%)	18.5	18.1	18.3	18.6	18.2	18.3	0.83	0.99
Back (%)	16.8	16.6	16.9	16.4	16.5	16.4	0.76	0.92
Wings (%)	8.34	9.13	8.45	8.63	8.66	8.55	0.29	0.13
Neck (%)	3.86	3.74	3.52	3.43	3.19	3.35	0.45	0.86
Drum stick (%)	9.05	9.44	9.66	10.04	9.43	10.01	0.39	0.22
Heart (%)	0.45	0.48	0.47	0.48	0.46	0.48	0.03	0.33
Liver (%)	2.00	1.93	2.04	2.04	2.03	2.02	0.01	0.09
Gizzard (%)	1.78	1.64	1.75	1.82	1.86	1.74	0.12	0.66
Spleen (%)	0.14	0.15	0.41	0.14	0.16	0.16	0.14	0.38
Lung (%)	0.54	0.53	0.51	0.56	0.53	0.54	0.10	0.39
Kidney (%)	0.31	0.35	0.35	0.38	0.32	0.32	0.06	0.97

Means on the same rows with no superscript are not significantly (p>0.05) different

Interaction effects of dehydration methods and mixing ratio of CSB on carcass characteristics of broiler chickens

Only the gizzard was significantly (p<0.05) affected by the interaction of dehydration methods and mixing ratio of CSB fed to finishing broiler chickens, of all the parameters measured. Other parameters measured were not significantly (p>0.05) affected. Birds fed diet containing fried CSB at 50:50 mixing ratio had the highest (p<0.05) gizzard value (Table 8).

Table 8: Interaction effects of dehydration methods and mixing ratio of CSB on carcass characteristics of broiler chickens

	Fried CSB			Sun dried CSB				
Parameters	**50:50**	**60:40**	**80:20**	**50:50**	**60:40**	**80:20**	**SEM**	**p-value**
Live weight (g)	2360	2270	2070	1980	1930	1780	31.558	0.59
Plucked weight (g)	2061	2007	1784	1733	1641	1500	1.17	0.20
Dressing percentage (%)	65.9	65.7	65.2	65.7	62.5	62.8	1.16	0.29
Head (%)	2.54	2.55	2.58	2.66	2.50	2.44	0.12	0.12
Shank (%)	4.47	4.68	4.65	4.35	4.25	4.31	0.30	0.60
Thigh (%)	10.9	10.4	10.2	10.1	9.89	9.77	0.26	0.63
Breast (%)	18.0	18.3	18.2	19.0	18.0	18.5	0.71	0.55
Back (%)	16.3	16.6	16.9	16.9	16.5	16.5	0.61	0.55
Wings (%)	8.43	8.89	8.52	8.54	8.89	8.48	0.23	0.92
Neck (%)	3.87	3.72	3.78	3.42	3.21	3.09	0.42	0.94
Drumstick (%)	10.1	9.70	10.3	9.03	9.16	9.42	0.34	0.68
Heart (%)	0.45	0.45	0.46	0.49	0.49	0.49	0.02	0.91
Liver (%)	2.06	1.99	1.89	1.98	1.98	2.17	0.08	0.11
Gizzard (%)	1.86^{a}	1.72^{b}	1.71^{b}	1.74^{b}	1.78^{ab}	1.78^{ab}	0.16	0.02
Spleen (%)	0.13	0.13	0.41	0.15	0.18	0.16	0.12	0.45
Lung (%)	0.57	0.58	0.49	0.53	0.48	0.57	0.08	0.29
Kidney (%)	0.36	0.29	0.35	0.34	0.38	0.33	0.05	0.34

^{abc} Means on the same rows having different superscript are significantly ($p<0.05$) different

Interaction effects of soyabean heat treatment methods, dehydration methods and mixing ratio of CSB on carcass characteristics of broiler chickens

The back, liver and gizzard percentages (Table 9) were significantly ($p<0.05$) influenced by the interaction of heat treatment methods, dehydration methods and mixing ratio. The values of back, liver and gizzard ranged from 15.3% to 17.5 %, 1.87 % to 2.25 % and 1.61 % to 1.94 % respectively. Birds fed fried diets containing dry heated soya beans at 50:50 mixing ratio had similar values with birds fed fried diets containing wet heated soya beans at 60:40 and 80:20 mixing ratio together with those fed sun-dried diets containing dry and wet heated soya beans at 80:20 and 50:50 respectively for back weight. For liver weight, birds fed fried diets containing wet heated soya beans at 50:50 and 80:20 together with those fed sun dried containing wet heated soya beans at 60:40 and 80:20 mixing ratios had similar values (Table 9).

Table 9: Interaction effects of soyabean heat treatment methods, dehydration methods and mixing ratio of CSB on carcass characteristics of broiler chickens

	Fried						Sundried							
	Dry heated			Wet heated			Dry heated			Wet heated				
Parameters	**50:50**	**60:40**	**80:20**	**50:50**	**60:40**	**80:20**	**50:50**	**60:40**	**80:20**	**50:50**	**60:40**	**80:20**	**SEM**	**p-value**
	CDF_1	CDF_2	CDF_3	CWF_1	CWF_2	CWF_3	CDS_1	CDS_2	CDS_3	CWS_1	CWS_2	CWS_3		
Live weight (g)	2410	2270	2060	2000	2050	1800	2310	2270	2080	1960	1820	1760	36.8	0.23
PW (g)	2113	2010	1785	1757	1748	1528	2009	2004	1784	1709	1544	1472	0.38	0.99
DP (%)	66.6	65.6	64.1	66.7	63.5	62.4	65.1	65.7	66.4	64.7	61.5	63.2	0.39	0.92
Head (%)	2.57	2.51	2.57	2.63	2.63	2.48	2.51	2.59	2.59	2.69	2.38	2.41	0.03	0.21
Shank (%)	4.38	4.57	4.48	4.16	4.22	4.3	4.56	4.78	4.81	4.54	4.29	4.31	0.06	0.69
Thigh (%)	10.8	10.4	10.2	9.71	10.3	9.29	10.9	10.4	10.2	10.4	9.54	10.2	0.09	0.15
Breast (%)	17.1	18.2	18.3	19.8	18.0	18.3	18.8	18.4	18.1	18.2	17.9	18.8	0.25	0.23
Back (%)	17.3^{a}	16.1^{b}	16.7^{ab}	16.4^{b}	17.2^{a}	17.2^{a}	15.3^{c}	17.1^{ab}	17.1^{a}	17.5^{a}	15.9^{b}	15.7^{bc}	0.22	0.02
Wings (%)	8.13	8.90	8.40	8.55	9.36	8.49	8.73	8.83	8.64	8.53	8.43	8.47	0.08	0.69
Neck (%)	3.86	4.08	3.94	3.85	3.39	3.10	3.88	3.36	3.61	2.99	3.03	3.09	0.13	0.60
Drumstick (%)	9.64	9.65	10.1	8.45	9.22	9.24	10.5	9.75	10.4	9.60	9.11	9.59	0.13	0.90
Heart (%)	0.42	0.48	0.46	0.47	0.48	0.48	0.47	0.42	0.47	0.49	0.49	0.49	0.08	0.48
Liver (%)	1.89^{b}	1.99^{ab}	1.99^{ab}	2.06^{a}	1.87^{bc}	2.09^{a}	2.18^{a}	1.98^{ab}	1.79^{c}	1.91^{b}	2.08^{a}	2.25^{a}	0.03	0.01
Gizzard (%)	1.89^{a}	1.66^{c}	1.94^{b}	1.66^{c}	1.61^{c}	1.96^{a}	1.83^{ab}	1.77^{b}	1.98^{a}	1.82^{ab}	1.89^{ab}	1.94^{a}	0.04	0.01
Spleen (%)	0.13	0.13	0.65	0.15	0.18	0.16	0.13	0.14	0.16	0.14	0.17	0.15	0.04	0.93
Lung (%)	0.54	0.62	0.44	0.53	0.43	0.59	0.61	0.53	0.53	0.52	0.53	0.56	0.02	0.39
Kidney (%)	0.32	0.35	0.40	0.31	0.35	0.31	0.39	0.24	0.29	0.36	0.40	0.35	0.02	0.42

[abc] *Means on the same rows having different superscript are significantly ($p<0.05$) different*

PW – Plucked weight, DP – Dressing percentage

(CDF_1 _CDF_3)- Fried (cassava pulp+ dry heated soya beans) at 50:50, 60:40 and 80:20; (CDS_1-CDS_3)- Sun dried (cassava pulp+ dry heated soya beans) at 50:50, 60:40 and 80:20; (CWF_1-CWF_3)- Fried (cassava pulp+ wet heated soya beans) at 50:50, 60:40 and 80:20; (CWS_1-CWS_3)- Sun dried (cassava pulp + wet heated soya beans) at 50:50, 60:40 and 80:20

DISCUSSION

Live weight and dressing percentage have been reported to be important indices in broiler operations (Adeyemi *et al*., 2008). Although the live weight values did not differ significantly with the different processing methods, there was a corresponding significant reduction with increasing concentration of cassava in the diets. This trend was similar to that reported by Eruvbetine *et al.* (2003) when an increasing concentration of cassava leaf and tuber concentrate was fed to broiler chickens. The highest live weight recorded with birds fed CSB of 50:50 mixing ratio could be as a result of lower cyanide content which could impede growth, or the higher soyabean content which boosted the growth of the birds. The relative weights of the carcass cuts (dressing percentage, drum stick weight, thigh weight, back weight and breast weight) that were similar in this study indicates that the experimental diets promoted similar carcass characteristics. Similar results were reported by Eruvbetine *et al.* (2003) in broiler chickens fed cassava leaf and tuber concentrate. This report also corroborates those of Osei and Duodu (1988), who reported that dietary treatment had no influence on carcass quality characteristics such as dressed weights and eviscerated weight in broilers fed fermented cassava peel meal. Thus, identical carcass characteristics are attainable by feeding the diets.

The liver and gizzard weights that were influenced by the dietary treatments with no particular trend could notbe attributed to the treatment. Onibi *et al.* (2008) reported similar observations with broiler chickens fed with cassava and Leucaena leaf meals. The significantly higher gizzard weights in birds fed 80:20 CSB mixing ratio may be attributed to increase in size of the gizzard as a result of handling bulky feeds. Atulene *et al.* (1986) and Eruvbetine *et al.* (2003) reported similar observations. The liver weight, that showed a significant variation among treatment values, was not significantly affected by the treatment diets, implying that the variations could be attributed to the birds trying to adjust to their various diets as the liver in birds has been recognised (Zaefarian *et al.,* 2019) to be responsible for most of the synthesis, metabolism, excretion and detoxification processes in the body.

CONCLUSION

Based on the result of this study, it can be concluded that replacing 15% of maize in diets of broiler chickens with CSB blend of 50:50 mixing ratio resulted in higher live weight when compared to other mixing ratios. Further study is recommended to be conducted for higher percentage replacement of maize with CSB at varying mixing ratios and processing methods.

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