

Nutritional evaluation of differently processed cassava-soya blends in the diets of broiler chickens

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Abstract

A 56-day study was conducted to evaluate the nutritional value of differently processed cassava-soya blends (CSB) in the diets of broiler chickens. 360 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. Two differently dried blends of cassava pulp and soybeans (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 2x2x3 factorial arrangement to obtain 12 dietary treatments. 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. Growth parameters (Initial weight, final weight, weight gain, feed intake and feed conversion ratio) of the birds at both phases were also measured. Results showed that fried blend cassava and wet heated soybeans at 50:50 mixing ratio had the highest crude protein (37.72%) and metabolizable energy (3,314 kcal/kg) with low HCN residue of 1.70 mg/kg. At the starter phase, birds fed diets containing 50:50 mixing ratio of CSB had the highest final weights (904.00 g/b) and weight gain (31.08 g/b/day) while those fed diets containing 80:20 mixing ratio of CSB were least (839.00 g/b and 29.62 g/n/day respectively). Highest ($p < 0.05$) body weight gain per bird per day (43.95 g/b/d) and lowest feed conversion ratio (2.56) were recorded with birds fed fried blend of dry heated soybean and cassava pulp at 50:50 mixing ratio at the finisher phase. Lowest feed intake was recorded with birds fed fried blend of dry heated soybean and cassava pulp at 80:20 mixing ratio. It can be concluded that replacing 15% inclusion fried CSB blend of dry heated raw soya beans mixed with cassava at 50:50 of CSB blends in diets of broiler chickens resulted in higher weight gain at both starter and finisher phase, while dehydration by sun drying and 50:50 mixing ratio improved the feed conversion ratio of the birds at finisher phase.

Keywords: Broiler chicken, cassava-soya blend, growth performance, hydrocyanide, trypsin

L'Évaluation nutritionnelle des mélanges manioc-soja transformés différemment dans l'alimentation des poulets à griller



Résumé

Une étude de 56 jours a été menée afin d'évaluer la valeur nutritive des mélanges manioc-soja (CSB) transformés différemment dans les régimes alimentaires des poulets à griller. Les poussins 'cobb-500' de 360 jours utilisés pour cette étude ont été assignés aux 12 groupes de traitement diététique qui ont été reproduits trois fois avec dix oiseaux chacun. Deux mélanges différemment séchés de pulpe de manioc et de soja (chauffés secs et humides), mélangés à quatre (4) rapports différents, ont été soumis à deux types de méthodes de déshydratation

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pour obtenir 12 types de mélanges. Ces mélanges ont ensuite été inclus dans les régimes des poulets à 15% dans un arrangement factoriel 2x2x3 pour obtenir 12 traitements diététiques. Huit semaines d'essais d'alimentation (phases de démarrage et de finition) ont été observées. Les mélanges ont été analysés chimiquement pour déterminer leurs compositions proximate, hydrocyanide (HCN) et unité d'inhibition de trypsine (TIU). Les paramètres de croissance (poids initial, poids final, gain de poids, apport alimentaire et ratio de conversion des aliments pour animaux) des oiseaux aux deux phases ont également été mesurés. Les résultats ont montré que le manioc frit et le soja chauffé humide à 50:50 ratio de mélange avaient la protéine brute la plus élevée (37,72 %) et l'énergie métabolisable (3 314 kcal/kg) avec un faible résidu de HCN de 1,70 mg/kg. Lors de la phase de démarrage, les oiseaux nourris selon un régime alimentaire contenant 50:50 de CSB avaient les poids finaux les plus élevés (904,00 g/b) et le gain de poids (31,08 g/b/jour) tandis que ceux nourris avec un ratio de mélange de 80,20 g/n/jour respectivement étaient les moins nombreux (839,00 g/b et 29,62 g/n/jour respectivement). Le gain de poids corporel le plus élevé ($p < 0,05$) par oiseau et par jour (43,95 g/b/j) et le plus faible ratio de conversion des aliments pour animaux (2,56) ont été enregistrés chez les oiseaux nourris au mélange frit de soja chauffé à sec et de pulpe de manioc à 50:50 rapport de mélange à la phase de finition. La plus faible consommation d'aliments pour animaux a été enregistrée chez les oiseaux nourris au mélange frit de soja chauffé à sec et de pulpe de manioc à 80:20. On peut conclure que le remplacement de 15 % de soja crues chauffées à sec mélangées au manioc à 50:50 des mélanges CSB dans les régimes de poulets a entraîné un gain de poids plus élevé à la fois au démarrage et à la phase finale, tandis que la déshydratation par séchage au soleil et le rapport de mélange de 50:50 ont amélioré le ratio de conversion des aliments pour animaux à la phase de finition.

Mots-clés: Poulet à griller, mélange manioc-soja, performance de croissance, hydrocyanide, trypsine

Introduction

The cost of maize which has increased considerably in recent years due to competition with the human food industry, increased production of biofuel and droughts in some parts of Africa had led to increase in maize price (USDA, 2015) and some other conventional feedstuffs. These increase in the cost of conventional raw materials results in increased demand to find alternative feed resources that can be good alternatives to a proportion of these products in poultry diets at a lower cost of production. Maize makes up to 40 – 60% of the bulk of poultry feeds, as it is the major energy source used in the poultry industry. But due to insufficiency in its supplies, high prices and competition with the human food and biofuel industries as reported by means there is a continuous demand for alternative energy sources for poultry. And due to the availability of cassava in the tropical part of

the world, cassava is becoming an increasingly important ingredient in poultry diets.

Compared with cereal grains, cassava is low in protein, and which is of poor quality with very low essential amino acid contents (Olugbemi *et al.*, 2010). As a result, researchers (Tewe and Egbunike, 1992; Iyayi and Losel, 2001; Nagib and Sousa, 2007; Morgan and Choct, 2016) opined that cassava-based diets must be supplied with protein sources that provide an adequate supply of methionine and lysine, which can be costly, and can as well be supplemented with other amino acids (Adegbola, 1977). Other options for overcoming this problem include incorporating cassava leaves, seeds or cakes, which are richer in protein, into the diet (Ngiki *et al.*, 2014), hence the reason for incorporating soybean into the diets in this study to make a Cassava-Soya blend. Cassava can as well be subjected to

biofortification of micronutrients, such as vitamin A, iron and zinc, since it is a crop that thrive in areas deficient in minerals and vitamins (Montagnac *et al.*, 2009; Nnadi *et al.*, 2010) which can cause it to be deficient. The utilisation of cassava according to Morgan and Choct (2016) is also limited by its high fibre, low energy content and the presence of anti-nutritional factors; primarily hydrocyanic acid (Gomez *et al.*, 1988) which makes the need to improve the nutritional value of cassava food products through processing become a necessary intervention. With correct processing (sundrying, oven drying etc. after fermentation), the inclusion level of cassava in poultry diets could be increased.

The low protein content of cassava makes it insufficient in replacing maize adequately, and thus require protein fortification via oil seeds such as soybean - and the presence of anti-nutrients in both cassava and soybean brings about the need for finding a cheap and affordable processing method. This current study therefore aimed at evaluating the nutritional value of differently processed cassava-soya blends in the diets of broiler chickens.

Materials and methods

Study area

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 vegetation zone of South-Western Nigeria on latitude 7°10'N and longitude 3°2'E. The climate is tropical humid with a mean annual rainfall of 1037mm, mean temperature of 34.7°C. Humidity of the experimental location is lowest (37%–54%) at the peak of dry season in February and highest at the peak of the rainy season between June and September (78%–85%). (Federal University of Agriculture

Abeokuta Meteorological Station).

Test ingredients and preparation of samples

Test ingredients for the experiments were cassava (*Manihot esculenta Crantz*) of the variety TMS 30572 and SoybeanSoybeans (*Glycine max*) of the variety TGX 923E. The cassava tubers were obtained from local farmers within Abeokuta metropolis, Ogun state, while the soya beans were obtained from International Institute of Tropical Agriculture (IITA), Ibadan. The cassava tubers were processed according to the procedures described by Quaye *et al.* (2009). They were peeled, washed and grated in a commercial grating machine. The grated cassava pulps were packed in hessian bags and allowed to ferment while dewatering gradually under pressure for 48 hours. Thereafter, the dewatered pulps were pulverized with hands and sifted on a local raffia made sieve to remove the fibres. The soybean seeds of the variety TGX 923E were sorted to ensure homogeneity of samples, washed, sun dried and divided into two, then subjected to two heat treatments (dry and wet heat treatments);

Dry heat treatment: Part of the cleaned raw soya beans was poured into a hot metal dry pan (common driers). The soya beans were dry heated by continuous stirring until the beans were slightly roasted to a golden-brown colour, following the method of Cheva-Isarakul and Tangtaweewipat (1995). The dry heated soya beans were spread to cool before milling into full fat soya meal.

Wet heat treatment: The other part of the cleaned raw soybeansoybeans was poured into a vat containing 20 litres of boiling water per each batch of 10 kg of soya beans. The soya beans were allowed to boil at 100°C for 30minutes 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.

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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 as shown in Table 1.

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

(CDF₁ –CDF₃)- Fried (cassava pulp+ dry heated soya beans) at 50:50, 60:40 and 80:20; (CDS₁-CDS₃)- Sun dried (cassava pulp+ dry heated soya beans) at 50:50, 60:40 and 80:20; (CWF₁ –CWF₃)- Fried (cassava pulp+ wet heated soya beans) at 50:50, 60:40 and 80:20; (CWS₁-CWS₃)- Sun dried (cassava pulp + wet heated soya beans) at 50:50, 60:40 and 80:20.

Experimental birds and management

The feeding trial was conducted with a total number of 360 day-old Cobb 500 broiler chicks. The birds were intensively managed on a deep litter system in two phases (the starter and the finisher phases). The starter phase lasted for four weeks (0-4weeks), while the finisher phase also lasted for four weeks (5-8 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 2x2x3 factorial experimental design to have 2 heat treatments of soybean

(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) was included in the broiler chickens' diets 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 equalization bases. At the end of the starter phase, the experimental birds were mixed together and re-assigned on weight equalization 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 finisher phase. All diets were formulated following recommended procedures (NRC, 1994) as presented in Tables 2 and 3.

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

Ingredients	Fried CSB blend						Sun dried CSB blend					
	Dry heated soybean		Wet heated soybean		Dry heated soybean		Wet heated soybean		Dry heated soybean		Wet heated soybean	
	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	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Maize	40.0	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00
FFS	22.0	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00
Soybean meal	15.1	15.05	15.05	15.05	15.05	15.05	15.05	15.05	15.05	15.05	15.05	15.05
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(%)	23.72	23.46	21.52	23.06	22.68	20.72	23.16	23.16	21.65	22.16	22.17	20.71
Crude Fibre(%)	3.67	3.68	3.73	3.67	3.68	3.73	3.68	3.73	3.60	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

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Table 3: Percentage (%) composition of experimental finisher diets (5-8 weeks)

Ingredients	Fried CSB blend											
	Dry heated soybean				Wet heated soybean				Sun dried CSB blend			
	50:50	60:40	80:20	80:20	50:50	60:40	80:20	80:20	50:50	60:40	80:20	80:20
CSB	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Maize	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00
FFS	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Soybean 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	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
Meal												
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)	2902.28	2902.54	2902.16	2902.16	2902.28	2902.54	2902.16	2902.16	2902.28	2902.54	2902.16	2902.16
Crude Protein(%)	20.52	20.22	19.72	19.72	20.52	20.22	19.72	19.72	20.52	20.22	19.72	19.72
Crude Fibre(%)	4.24	4.26	4.29	4.29	4.24	4.26	4.29	4.29	4.24	4.26	4.29	4.29
Calcium(%)	1.20	1.21	1.20	1.20	1.20	1.21	1.20	1.20	1.20	1.21	1.20	1.20
Phosphorus(%)	0.66	0.66	0.65	0.66	0.66	0.66	0.65	0.65	0.66	0.66	0.66	0.65
Lysine(%)	1.13	1.12	1.08	1.08	1.13	1.12	1.08	1.08	1.13	1.12	1.08	1.08
Methionine(%)	0.45	0.44	0.43	0.43	0.45	0.45	0.44	0.44	0.45	0.44	0.43	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, 15mg; niacin, 40,000mg; Pantothenic Acid, 15,000mg; Folic Acid, 1,500mg; Biotin, 50mg; 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 (2005) while the metabolizable energy was calculated using Ponzenga (1985) equation as follows: $ME = 35 \times \% CP + 18.8 \times \% EE + 35.5 \times \% NFE$.

NB: ME- Metabolizable energy, CP- Crude protein, EE- Ether extract, 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.

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

Alkaline titration procedure was adopted (Anhwange, 2004) for determination of the hydrogen cyanide. Ten grams of each of the ground 12 samples will be soaked in the mixture of 200 ml of distilled water and 10 cm³ of orthophosphoric acid. The mixture was kept for 12 hours to release all the bound cyanide. The mixture was then distilled until 150 ml of the distillate was collected. 20ml of the distillate were poured into a conical flask containing 40ml of distilled water. 8ml of ammonia solution (6 mol/dm³) and 2ml of potassium iodide (5%) solution was added. The mixture was then titrated with silver nitrate (0.02 mol/dm³) to faint but permanent turbidity (1ml 0.02 mol/dm³ AgNO₃ is equivalent to (1.08mg HCN).

The percentage hydrocyanide was calculated with the formula:

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

Trypsin inhibitor was determined by weighing 0.2g each of the 12 samples into a screw cap centrifuge tube. 10ml of 0.1M phosphate buffer was measured and the contents were shaken at room temperature

for 1 hour on a UDY shaker. The suspension obtained were 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°C. 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°C. 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 then 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:

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

Growth performance characteristics

The live weight of birds per replicate was recorded on arrival and on weekly basis thereafter, using an electronic weighing scale. Afterwards weight gain was calculated by the subtraction of initial weight from the final weight. Feed intake of each replicate was calculated on a weekly basis by the subtraction of left over feed from the total feed supplied. Values obtained were used to compute feed conversion ratio by dividing the feed intake by weights gain.

Statistical analysis

Data obtained in this study were subjected to analysis of variance in a 2x2x3 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

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were separated using Duncan's Multiple Range Test as contained in the procedure of the statistical package.

Statistical model

$$Y_{ijkl} = \mu + T_i + L_j + M_k + (TL)_{ij} + (TM)_{ik} + (LM)_{jk} + (TLM)_{ijk} + o_{ijkl}$$

Where,

Y_{ijkl} = Observed values of the dependent variable

μ = Population mean

T_i = Main effects of soybean heat treatments (Wet and dry heat treatments)

L_j = Main effects of dehydration methods of cassava-soya blends (Sun-drying and frying)

M_k = Main effects of mixing ratio of cassava-soya blends (50:50, 60:40, 80:20)

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	70.23	3281.62	33.47	1.40	4.43	2.00	58.70	1.60	7.50
CDF ₂	70.00	3319.98	31.75	1.11	4.51	1.00	61.63	1.61	7.40
CDF ₃	68.64	3281.54	18.81	0.58	5.03	2.00	73.58	1.65	7.30
CDS ₁	66.82	3279.56	35.72	1.35	4.48	2.00	56.45	1.68	7.80
CDS ₂	68.64	3305.90	33.19	1.06	4.91	1.00	59.84	1.72	7.70
CDS ₃	66.59	3270.30	20.10	0.48	5.37	2.00	72.05	1.76	7.60
CWF ₁	70.00	3310.66	36.37	1.34	4.59	1.00	56.68	1.61	2.10
CWF ₂	71.59	3317.61	34.65	1.08	4.55	1.00	58.72	1.61	2.00
CWF ₃	69.36	3273.96	19.63	0.52	5.28	2.00	75.57	1.66	2.20
CWS ₁	67.73	3314.58	37.72	1.34	4.47	2.00	55.47	1.70	2.60
CWS ₂	67.95	3320.51	35.12	1.02	4.49	1.00	58.37	1.73	2.50
CWS ₃	66.59	3272.56	20.07	0.47	5.32	2.00	72.14	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

(CDF₁-CDF₃)- Fried (cassava pulp+ dry heated soya beans) at 50:50, 60:40 and 80:20; (CDS₁-CDS₃)- Sun dried (cassava pulp+ dry heated soya beans) at 50:50, 60:40 and 80:20; (CWF-CWF₃)- Fried (cassava pulp+ wet heated soya beans) at 50:50, 60:40 and 80:20; (CWS-CWS₃)- Sun dried (cassava pulp + wet heated soya beans) at 50:50, 60:40 and 80:20.

$(TL)_{ij}$ = Interaction effects of heat treatments of soybean and dehydration methods of cassava-soya blends

$(TM)_{ik}$ = Interaction effects of heat treatments of soybean and mixing ratio of cassava-soya blends

$(LM)_{jk}$ = Interaction effects of dehydration methods of cassava-soya blends and mixing ratio of cassava-soya blends

$(TLM)_{ijk}$ = Interaction effects of heat treatments of soybean, dehydration methods of cassava-soya blends and mixing ratio of cassava-soya blends

o_{ijkl} = Random/residual error

Results and discussion

Proximate composition and anti-nutritional constituents of cassava-soya blends

The proximate composition of cassava-

soya blends (CSB) is presented in Table 4. The analyses were carried out on dry matter (DM) basis. The proximate values (Crude protein, Ether extract, Crude fibre, Ash digestibility, Nitrogen free extract), hydrogen cyanide and Trypsin inhibition unit) values of the CSB ranged from 18.81-37.72%, 0.47-1.40%, 4.43-5.37%, 1-2%, 55.47-75.57%, 1.60-1.77mg/kg and 2.1-7.8 mg/g, respectively. CSB containing dry heated soya beans and dehydrated by frying at 50:50 Sample (CDF₁) 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 (CDS₃) 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 (CWS₂) had the highest (3320 kcal/kg). CSB containing dry heated soya beans and dehydrated by sun drying at 80:20 (CDS₃) had the least dry matter (66.59 %) content and ether extract (0.47 %). CSB containing dry heated soya beans and dehydrated by frying at 80:20 (CDF₃) recorded the least value for crude protein (18.81 %) while CSB containing wet heated soya beans and dehydrated by sun drying at 50:50 (CWS₁) had the highest crude protein (37.72 %)

value. The hydrogen cyanide had the highest (1.77 mg/kg) and least (1.60 mg/kg) values in CSB dehydrated by sun drying and containing wet heated soya beans (CWS₃) and CSB containing dry heated soya beans and dehydrated by frying 50:50 (CDF₁) respectively. CSB containing dry heated soya beans and dehydrated by sun drying at 50:50 (CDS₁) recorded the highest value for trypsin inhibition unit (7.80 mg/g) while CSB containing wet heated soya beans and dehydrated by frying at 50:50 (CWF₁) recorded the least (2.10 mg/g) value.

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	70.23	3281.62	33.47	1.40	4.43	2.00	58.70	1.60	7.50
CDF ₂	70.00	3319.98	31.75	1.11	4.51	1.00	61.63	1.61	7.40
CDF ₃	68.64	3281.54	18.81	0.58	5.03	2.00	73.58	1.65	7.30
CDS ₁	66.82	3279.56	35.72	1.35	4.48	2.00	56.45	1.68	7.80
CDS ₂	68.64	3305.90	33.19	1.06	4.91	1.00	59.84	1.72	7.70
CDS ₃	66.59	3270.30	20.10	0.48	5.37	2.00	72.05	1.76	7.60
CWF ₁	70.00	3310.66	36.37	1.34	4.59	1.00	56.68	1.61	2.10
CWF ₂	71.59	3317.61	34.65	1.08	4.55	1.00	58.72	1.61	2.00
CWF ₃	69.36	3273.96	19.63	0.52	5.28	2.00	75.57	1.66	2.20
CWS ₁	67.73	3314.58	37.72	1.34	4.47	2.00	55.47	1.70	2.60
CWS ₂	67.95	3320.51	35.12	1.02	4.49	1.00	58.37	1.73	2.50
CWS ₃	66.59	3272.56	20.07	0.47	5.32	2.00	72.14	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

(CDF₁-CDF₃)- Fried (cassava pulp+ dry heated soya beans) at 50:50, 60:40 and 80:20; (CDS₁-CDS₃)- Sun dried (cassava pulp+ dry heated soya beans) at 50:50, 60:40 and 80:20; (CWF₁-CWF₃)- Fried (cassava pulp+ wet heated soya beans) at 50:50, 60:40 and 80:20; (CWS₁-CWS₃)- Sun dried (cassava pulp + wet heated soya beans) at 50:50, 60:40 and 80:20.

Main effects of soybean heat treatments, dehydration methods and mixing ratio of CSB on performance of broiler chickens (0-8 weeks)

Table 5 shows the main effects of soybean heat treatments, dehydration methods and mixing ratio on performance characteristics of broiler chickens (0 – 8 weeks). At 0 – 4 weeks, the final weight and weight gain were significantly (p<0.05) affected by the heat treatments of soya beans in the CSB fed to starterbroiler chickens. Birds fed diets containing dry heated soybean had higher values for final weight and weight gain. At 5

– 8 weeks, the initial weight and feed intake were as well significantly (p<0.05) affected by the heat treatment of soya beans in the CSB fed to finisherbroilers. Birds fed diets containing dry heated soybeans had higher initial weight and feed intake values compared to those fed wet heated soya beans. The final weight and weight gain were significantly (pp<0.05) affected by the dehydration methods of CSB fed to starter broiler chickens. Birds fed diets containing fried CSB had higher values of final weight and weight gain. At 5 – 8 weeks, the initial weight, final weight, weight gain, feed intake and feed conversion ratio were all

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significantly ($p < 0.05$) affected by the dehydration methods of CSB fed to finisher broiler chickens. Birds fed diets containing fried CSB had higher values for all the parameters measured when compared to those fed diets containing sun dried CSB. At the starter phase, only the final weight and weight gain were significantly ($p < 0.05$) affected by mixing ratio of CSB fed to the birds. Birds fed diets containing 50:50 mixing ratio of CSB had the highest values for final weight and weight gain while those fed diets containing

80:20 mixing ratio of CSB had the least values for the same parameters. The initial weight, final weight, weight gain, feed intake and feed conversion ratio were however significantly ($p < 0.05$) affected at the finisher phase by the mixing ratio of CSB. Birds fed diets containing 50:50 mixing ratio of CSB had the highest values for initial weight, final weight, weight gain and feed intake. Birds fed 80:20 mixing ratio of CSB had the least values for initial weight, final weight, weight gain. The lowest FCR was recorded with birds fed 50:50 and 60:40 CSB mixing ratio.

Table 5: Main effects of soybean heat treatments, dehydration methods and mixing ratio of CSB on performance of broiler chickens (0-8 weeks)

Parameters	Soybean heat treatments				Dehydration methods of CSB				Mixing ratios of CSB				
	Dry heated	Wet heated	SEM	p-value	Fried	Sun dried	SEM	p-value	50:50	60:40	80:20	SEM	p-value
<i>0-4 weeks</i>													
IW (g/b)	40.14	40.17	0.088	0.219	40.39	40.43	0.036	0.470	40.43	40.38	40.41	0.044	0.684
FW (g/b)	902.00 ^a	898.00 ^b	15.000	0.003	908.00 ^a	846.00 ^b	10.483	0.000	904.00 ^a	889.00 ^b	839.00 ^c	12.838	0.004
WG (g/b/day)	30.78 ^a	30.60 ^b	0.381	0.021	30.98	28.75	0.934	0.021	31.08 ^a	30.03 ^{ab}	29.62 ^b	0.467	0.007
FI (g/b/day)	44.19	44.18	0.476	0.988	49.42	48.95	0.476	0.988	49.49	49.82	48.24	1.165	0.148
FCR	1.45	1.44	0.027	0.068	1.60	1.71	0.066	0.068	1.60	1.65	1.68	0.035	0.150
<i>5-8 weeks</i>													
IW (g/b)	902.00 ^a	898.00 ^b	15.222	0.047	908.00 ^a	846.00 ^b	12.000	0.000	904.00 ^a	889.00 ^b	839.00 ^c	13.374	0.020
FW (g/b)	2090.67	2078.33	30.666	0.250	2140.24 ^a	1880.56 ^b	31.333	0.000	2170.28 ^a	2110.23 ^b	1900.42 ^c	35.454	0.000
WG (g/b/day)	42.45	42.18	0.900	0.233	44.00 ^a	37.91 ^b	1.086	0.000	45.39 ^a	43.94 ^b	38.84 ^c	0.779	0.000
FI (g/b/day)	111.27 ^a	110.58 ^b	1.646	0.025	118 ^a	100.81 ^b	1.667	0.000	116.25 ^a	113.02 ^{ab}	109.09 ^b	1.399	0.008
FCR	2.61	2.62	0.520	0.481	2.68 ^a	2.59 ^b	0.035	0.000	2.58 ^b	2.57 ^b	2.78 ^a	0.043	0.001

^{abc} Means on the same rows having different superscript were significantly ($p < 0.05$) different
FCR- Feed Conversion Ratio; IW- Initial weight; FW- Final weight; FI- Feed intake

Interaction effects of soybean heat treatments and dehydration methods, soybean heat treatments and mixing ratio of CSB, dehydration methods and mixing ratio of CSB on performance of broiler chickens (0-8 weeks)

Interaction effects of soybean heat treatments and dehydration methods of CSB on performance of broiler chickens is presented in Table 6. All the parameters measured; initial weight, final weight, weight gain, feed intake and feed conversion ratio were not significantly ($p > 0.05$) affected by the interaction of heat treatments and dehydration methods of CSB fed to broiler chickens both at starter and finisher phases. Table 7 shows the interaction effects of soybean heat treatments and mixing ratio of CSB on

performance of broiler chickens (0-8 weeks). All the parameters measured were not significantly ($p > 0.05$) affected by the interaction of soybean heat treatment and mixing ratio of CSB at both phases. Nevertheless, birds fed toasted soya beans at 50:50 mixing ratio of experimental diet had the highest values for final weight, weight gain and feed intake. Table 8 shows the interaction effects of dehydration methods and mixing ratio of CSB on performance of broiler chickens (0-8 weeks). At 0 – 4 weeks, all the parameters measured, initial weight, final weight, weight gain, feed intake and feed conversion ratio were not significantly ($p > 0.05$) affected by the interaction of dehydration methods and mixing ratios of

CSB fed to starter broilers. At finisher phase however, the feed intake and feed conversion ratio of the birds were significantly ($p < 0.05$) affected by the interactions of dehydration methods and

mixing ratio of CSB. Birds fed diets containing fried CSB at 50:50 mixing ratios had the highest ($p < 0.05$) feed intake and best FCR while those fed sundried CSB at 80:20 mixing ration

Table 6: Interaction effects of soybean heat treatments and dehydration methods of CSB on performance of broiler chickens (0-8 weeks)

Parameters	Fried CSB		Sun dried CSB		SEM	p-value
	Dry heated soybean	Wet heated soybean	Dry heated soybean	Wet heated soybean		
0-4 weeks						
IW (g/b)	40.43	40.44	40.34	40.41	0.051	0.596
FW (g/b)	923	881	894	832	14.825	0.193
WG (g/b/day)	31.68	29.18	30.83	28.67	0.539	0.502
FI (g/b/day)	48.95	49.43	49.90	48.46	0.673	0.166
FCR	1.55	1.69	1.63	1.69	0.038	0.772
5-8 weeks						
IW (g/b)	923	881	894	832	15.443	0.353
FW (g/b)	2250	2120.65	2130.54	1950.89	40.939	0.566
WG (g/b/day)	47.37	44.27	44.16	40.01	0.899	0.256
FI (g/b/day)	119.37	112.87	117.46	105.95	1.697	0.304
FCR	2.55	2.54	2.66	2.64	0.050	0.416

FCR- Feed Conversion Ratio; IW- Initial weight; FW- Final weight; FI- Feed intake

recorded the least feed intake. Birds fed diets containing sundried CSB at 50:50, 60:40 and 80:20 mixing ratios had similar values for FCR.

Table 7: Interaction effects of soybean heat treatments and mixing ratio of CSB on performance of broiler chickens (0-8 weeks)

Parameters	Dry heated soybean			Wet heated soybean			SEM	p-value
	50:50	60:40	80:20	50:50	60:40	80:20		
0-4 weeks								
IW (g/b)	40.45	40.41	40.46	40.42	40.35	40.36	0.088	0.848
FW (g/b)	943	916	847	865	861	832	18.156	0.244
WG (g/b/day)	31.68	30.32	29.29	30.48	29.32	28.21	0.660	0.909
FI (g/b/day)	48.75	48.50	48.32	49.24	49.14	48.16	1.165	0.242
FCR	1.54	1.60	1.65	1.63	1.66	1.70	0.046	0.464
5-8 weeks								
IW (g/b)	943	916	847	865	861	832	18.913	0.965
FW (g/b)	2210	2160.12	1980.88	2140.42	2050	1975.81	40.139	0.270
WG (g/b/day)	45.99	43.52	40.49	45.78	42.36	40.15	1.101	0.177
FI (g/b/day)	118.56	115.72	112.49	115.54	111.25	107.46	1.978	0.953
FCR	2.59	2.64	2.78	2.58	2.66	2.67	0.062	0.122

FCR- Feed Conversion Ratio; IW- Initial weight; FW- Final weight; FI- Feed intake

Interaction effects of soybean heat treatments, dehydration methods and mixing ratio of CSB on performance of broiler chickens (0-8 weeks)

The interaction effects of soybean heat treatments, dehydration methods and mixing ratio of CSB on performance characteristics of broiler chickens is presented in Table 9. All the parameters measured were not significantly ($p > 0.05$) affected by the interactions of soybean heat

treatments, dehydration methods and mixing ratio of CSB fed to the birds at starter phase. At the finisher phase, the interactions of soybean heat treatments, dehydration methods and mixing ratio of CSB significantly ($p < 0.05$) affected the final weight, weight gain, feed intake and FCR of the birds. Birds fed CDF₃ recorded the lowest feed intake (100.84 g/b/day) and FCR (2.44), while those fed CDS₃ gained the least weight (35.97 g/b/day).

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Table 8: Interaction effects of dehydration methods and mixing ratio of CSB on performance of broiler chickens (0-8 weeks)

Parameters	Fried CSB			Sun dried CSB			SEM	p-value
	50:50	60:40	80:20	50:50	60:40	80:20		
<i>0-4 weeks</i>								
IW (g/b)	40.41	40.38	40.37	40.45	40.38	40.44	0.086	0.884
FW (g/b)	931.00	918.00	875.00	878.00	859.00	833.00	19.677	0.857
WG (g/b/day)	31.64	30.99	30.13	29.53	29.65	28.13	0.934	0.779
FI (g/b/day)	50.18	50.12	48.58	49.01	48.93	47.90	0.824	0.242
FCR	1.58	1.61	1.62	1.66	1.65	1.70	0.064	0.347
<i>5-8 weeks</i>								
IW (g/b)	931.00	918.00	875.00	878.00	859.00	833.00	26.748	0.877
FW (g/b)	2270.15	2170.42	2080.12	1980.78	1960.75	1830.89	44.139	0.881
WG (g/b/day)	47.83	44.75	43.52	40.05	39.83	35.77	1.557	0.317
FI (g/b/day)	119.69 ^a	117.51 ^{ab}	117.36 ^{ab}	113.55 ^b	109.28 ^{bc}	102.71 ^c	2.797	0.042
FCR	2.50 ^b	2.62 ^{ab}	2.67 ^{ab}	2.83 ^a	2.79 ^a	2.86 ^a	0.068	0.012

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

FCR- Feed Conversion Ratio; IW- Initial weight; FW- Final weight; FI- Feed intake

Discussion

The proximate composition of cassava-soya blends (CSB) revealed that the energy values ranged from (3272 to 3320 kcal/kg). Though the inclusion ratio of cassava in the blends differs, there was a similarity in the energy values of the blends prepared. This may be due to the fact that soya beans are also a high source of energy (3,300 kcal/kg) as reported by (Aduku, 2005). The energy values of blends obtained in this study were slightly higher than the reported value (3150 kcal/kg) of NIAS (2020). The crude protein values obtained from this study ranged from (18.81 to 37.72 %), which falls within the range reported by Eruvbetine and Adejobi (1999). Fasuyi and Aletor (2005) reported 42.3% crude protein for cassava leaf protein concentrate while Iheukwumere *et al.* (2008) reported 25.10 % crude protein for cassava leaf meal. It was observed that in blends where raw soya beans were wet heated, higher protein levels were recorded than when they were dry heated. This may be due to uneven high temperatures employed during toasting which might have slightly denatured some of the amino acids of the soybeans thus making it unavailable for detection during analysis as reported by Eruvbetine

and Adejobi (1999). The highest fat contents were obtained when the inclusion level of soya bean was 50% and the least values were obtained when the inclusion level was 20% which makes the fat contents dependent on the level of inclusion of soya beans. The high fat content recorded in 50% inclusion of soya beans may be due to the high oil content in soybean seeds. The crude fibre values (4.43 to 5.31) % falls within the range reported by Eruvbetine and Adejobi (1999) and was highest with blends containing 80% cassava, thereby making the crude fibre values dependent on the level of inclusion of cassava. The cyanide contents (1.60 mg/kg to 1.72 mg/kg) was generally lower than the optimum tolerance level (100mg/kg DM) recommended for livestock feeding by Tewe (1997). The cyanide levels of blends (CDS and CWS) which were higher than those of blends (CDF and CWF) could infer that frying is more effective in lowering cyanide levels compared to sun drying. The Trypsin Inhibitor Unit (TIU) values of blends CWF and CWS were lower compared to those of blends CDF and CDS, and falls within the range reported by Ari *et al.* (2012). This may be due to the fact that soybeans in these blends were subjected to more heat

Table 9: Interaction effects of soybean heat treatments, dehydration methods and mixing ratio of CSB on performance of broiler chickens (0-8 weeks)

Parameters	Fried						Sundried						SEM	p-value
	Dry heated		Wet heated		Dry heated		Wet heated		Dry heated		Wet heated			
	50:50	60:40	80:20	50:50	60:40	80:20	50:50	60:40	80:20	50:50	60:40	80:20		
<i>0-4 weeks</i>	CDF ₁	CDF ₂	CDF ₃	CWF ₁	CWF ₂	CWF ₃	CDS ₁	CDS ₂	CDS ₃	CWS ₁	CWS ₂	CWS ₃		
IW (g/b)	40.44	40.41	40.45	40.45	40.40	40.48	40.38	40.34	40.31	40.45	40.36	40.41	0.024	0.984
FW (g/b)	910.67	901	867.33	905	900.67	857	891	889.33	884.33	859.67	837.33	798.67	10.342	0.585
WG (g/b/day)	31.07	30.70	30.74	30.80	30.67	29.84	31.94	30.02	29.52	29.26	28.46	28.07	0.375	0.662
FI (g/b/day)	49.67	48.82	47.36	48.84	49.19	47.27	50.28	49.62	47.79	48.19	47.96	47.53	0.370	0.924
FCR	1.59	1.59	1.58	1.58	1.60	1.58	1.59	1.64	1.60	1.65	1.67	1.58	0.024	0.805
<i>5-8 weeks</i>														
IW (g/b)	910.67	901	867.33	905	900.67	857	891	889.33	884.33	859.67	837.33	798.67	3.055	0.786
FW (g/b)	2142 ^a	2127.26 ^{ab}	2060.55 ^b	2060 ^b	2050.13 ^b	1990.22	2012.34 ^{bc}	1998.31 ^c	1885.91 ^d	1992.54 ^c	1965.50 ^{cd}	1835.18 ^c	12.759	0.032
WG (g/b/day)	43.95 ^a	43.68 ^a	40.60 ^b	40.77 ^b	41.10 ^{ab}	40.07 ^b	40.01 ^b	39.61 ^{bc}	35.97 ^d	39.54 ^{bc}	40.21 ^b	37.01 ^c	0.169	0.012
FI (g/b/day)	112.85 ^{ab}	113.84 ^a	100.84 ^e	108.49 ^b	106.44 ^b	102.26 ^d	107.17 ^b	104.58 ^e	101.23 ^d	104.41 ^c	105.61 ^c	103.32 ^{cd}	0.195	0.003
FCR	2.56 ^{bc}	2.60 ^b	2.44 ^c	2.66 ^{ab}	2.59 ^b	2.56 ^{bc}	2.67 ^{ab}	2.63 ^{ab}	2.80 ^a	2.65 ^{ab}	2.62 ^{ab}	2.81 ^a	0.007	0.001

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

FCR- Feed Conversion Ratio; IW- Initial weight; FW- Final weight; FI- Feed intake

(CDF₁-CDF₃)- Fried (cassava pulp+ dry heated soya beans) at 50:50, 60:40 and 80:20; (CDS₁-CDS₃)- Sun dried (cassava pulp+ dry heated soya beans) at 50:50, 60:40 and 80:20; (CWF₁-CWF₃)- Fried (cassava pulp+ wet heated soya beans) at 50:50, 60:40 and 80:20; (CWS₁-CWS₃)- Sun dried (cassava pulp + wet heated soya beans) at 50:50, 60:40 and 80:20

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treatments than the other blends (i.e. they were wet heated, oven dried and then subjected to either frying or sun drying).

At the starter phase, birds fed diets containing 50:50 mixing ratio of CSB had the highest final weights (904.00 g/b) and weight gain (31.08 g/b/day) while those fed diets containing 80:20 mixing ratio of CSB were least. As reported by Morgan and Choct (2016), wide variation has been observed between studies with regards to the success of feeding cassava meal to poultry. Early research, such as McMillan and Dudley (1941) and Vogt (1966), found that inclusion of cassava in poultry diets reduced performance. However, later studies, such as Khajareern and Khajareern (1992), Tewe and Egbunike (1992), Aderemi et al. (2000) and more recent Ogunwole et al. (2016), found more encouraging results, likely due to increased awareness of how to balance the nutrients and the negative impact of HCN. The favourable result observed with the final weight and weight gain of birds fed 50:50 mixing ratio of CSB could be as a result of the impact of processing methods of the cassava and the incorporation of processed soybean to form a blend.

Feed intake decreased as the level of inclusion of cassava increased at the finisher phase, and was lowest for blends containing 80:20 mixing ratio of CSB. This could be an indication of the adequate energy contents of these diets as birds feed to satisfy their energy requirements, as this agrees with the findings of Hassan *et al.* (2012) and that of Ukachukwu (2005) who reported a significant difference in daily feed intake of birds when cassava root meal was fed. Omekan (1994) also reported a drop in feed intake of birds fed cassava leaf meal which could be due to the fact that the leaf meal imparted unpalatable taste to the feed which consequently inhibited the birds from consuming adequate quantities. Also,

the feed intake of birds fed sun dried CSB decreased significantly as the inclusion level of cassava increased at both starter and finisher phases. This is as well in line with the findings of Hassan *et al.* (2012) who fed broiler chickens graded levels of sun-dried cassava root meal. The best FCR was observed in the birds fed dry heated soya beans in fried CSB at 80:20 inclusion ratios (CDF₃). The reason for this could not be adjudged. At the finisher phase, birds on 50:50 inclusion level of CSB had the highest weight gain which was at par with birds on 60:40 inclusion level of CSB and were significantly higher than the rest of the treatments. This supports the findings of Montilla (1977) who reported a significant difference in the daily weight gain and feed conversion ratio when cassava root meal was added to the diets of broilers at graded levels. Authors (Gomez *et al.*, 1988; Eruvbetine and Afolami, 1992) reported that inclusion of cassava root meal at levels up to 30% in diets for broilers had no detrimental effect on body weight.

Conclusion and recommendation

Based on the result of this study, it can be concluded that replacing 15% inclusion fried CSB blend of dry heated raw soya beans mixed with cassava at 50:50 of CSB blends in diets of broiler chickens resulted in higher weight gain at both starter and finisher phase, while dehydration by sun drying and 50:50 mixing ratio improved the feed conversion ratio of the birds at finisher phase. Sundried blend of cassava and wet heated soybeans, mixed at 50:50 ratio yielded the highest CP (37.72%) and metabolizable energy (3314 kcal/kg) with low hydrocyanide residue of 1.70mg/kg, which is recommended for maize replacement of up to 15%. Further study is as well recommended to be carried out to establish a threshold to which this blend can replace maize in poultry diet.

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