EFFECT OF MAIZE – CASSAVA BASED DIETS FORTIFIED WITH BAOBAB (*ADANSONIA DIGITATA*) SEED MEAL ON GROWTH RESPONSE, BLOOD PROFILE AND LIPID STATUS OF BROILER CHICKENS

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Abstract: Seasonal fluctuation in the supply of maize requires alternative energy sources to be explored to ensure optimum performance of the birds at low feed cost. The effect of replacing maize with graded levels of cassava root meal (CRM) – baobab seed meal (BSM) blend as energy source in the diets of broiler chickens is evaluated. Two hundred and forty (240) broiler chicks were used in 4 weeks of feeding trials. The prepared CRM-BSM blend were used to formulate six diets such that maize was replaced by CRM-BSM blend at 0, 10, 20, 30, 40 and 50% in nutrient to nutrient inclusion rates respectively which represent T1, T2, T3, T4, T5 and T6. The birds were weighed and allotted to six dietary treatments of 40 birds each and replicated 4 times in a completely randomized design of 10 birds per replicate. The results of the final weight, weight gain, feed intake and feed conversion ratio were significantly ($p< 0.05$) influenced by graded levels of cassava root meal – baobab seed meal (CRM-BSM) blend. Similar ($p>0.05$) statistical values of 605.33g, 524.00g, 552.67g and 495.00g were recorded for final weight in the birds fed diets containing 0% (Control), 10%, 20% and 30% CRM-BSM blend. Dietary treatment had no significant ($p>0.05$) effect on haematological parameters determined. The serum biochemical indices of albumin was significantly influenced by the dietary treatments. In conclusion, inclusion of cassava root meal– baobab seed meal blend up to 30% replacement level for maize improved growth response without hazardous effect on starter broiler chicks.

Keywords: Baobab; cassava; chickens; growth response; lipid; serum biochemical

Introduction

The poultry industry is currently facing numerous challenges, not only regarding the availability of feed ingredients but also the ability to produce high quality products in a cost-effective manner. There is a need to exploit cheaper energy sources in order, to replace expensive cereals for livestock production, to relieve the food-feed competition in the future. In the coming years, poultry producers will definitely have to look beyond maize and other cereal grains because of their low availability; cost and inability to keep pace with ever-increasing poultry production (Chauynarong *et al*., 2009).

Alternatives to conventional energy and protein feed ingredients for poultry must be cheap or cost-effective, readily available, have suitable nutrient composition and should have minimal negative effects on birds. Bearing this in mind, researchers, animal feed industries and poultry producers have over the years directed their attention towards finding alternative energy sources that meet the above-mentioned requirements (Okereke 2012). One such alternative is cassava (*Manihot esculenta*).

Cassava has the ability to withstand poor soil and drought, and the plant can yield 25 to 60 tons/ha, depending on variety and cultivation practice. Nigeria is the largest producer, growing 38 million metric tons in 2010. Other major producers are Brazil, Indonesia, Thailand, and the Democratic Republic of Congo (CGIAR, 2017). Broadly, roots and leaves are the two main products from cassava but several different products can be obtained from these through further processing. Cassava processing methods used in improving the nutritional composition and reducing the anti-nutrient content include drying, boiling, parboiling/cooking, steaming, frying, roasting, addition of oil, molasses, leaf meal and application of natural fermentation processes. These processes result in HCN losses ranging from 25 to 98% (Nambisan, 2011). Drying has been reported to improve the shelf life and also reduce several ANF present in cassava roots (Girma *et al*., 2015).

Cassava products are low in protein or deficient in amino acids (Ngiki *et al*., 2014), supplementation of amino acids, especially methionine and lysine, has been reported to be a viable method for improving the quality of diets containing cassava and its products in poultry feeding (Tewe and Egbunike 1992). This challenge could be addressed through fortification with a cheap protein source. Voluntary intake, feed digestibility and animal performance can be improved by using alternative low quality multipurpose trees (Melesse *et al*., 2011). Seed and leaf meals function as protein sources and aid in providing some essential vitamins, minerals, oxycaretenoids as well as bioactive compounds that function at cellular level (Melesse *et al*., 2013). African baobab seeds have been shown to be a superb source of protein, with most of the essential and non-essential amino acids (De Caluwé *et al*., 2010). From previous reports the baobab seed cake is a potential low-cost and locally available protein source for livestock feeding (Chimvuramahwe *et al*., 2011).

Baobab seed meal is a probable alternative feed resource; however, there is limited information on its potential use in livestock production. When incorporated into livestock diets, baobab seeds can provide some of the necessary amino acids, in particular methionine and lysine, which are usually the lacking amino acids in most cereals.

Materials and Methods

Experimental site

The study was conducted at the Poultry unit of the Teaching and Research Farm of Taraba State University, Jalingo located between latitude 6° 30' and 9° 30' N and longitude 9° 00' and 12° 00' E in Guinea Savannah Zone of Northern Nigeria (Kefas *et al*., 2020). It has an annual rainfall range of 1000mm – 1500mm, the ambient temperature of the area range between 30 – 38°C with an average of 29°C.

Source and processing of test ingredient

The cassava used for this study were obtained from Bali town, Bali Local Government Area of Taraba State, Nigeria. The fresh cassava roots were peeled, washed and sliced. The sliced cassava were poured into a sack, fermented for 5days under an air-tight container. The sliced cassava were sun dried for 3 days on clean concrete floor, after which it was packed in bags and milled to have cassava root meal (CRM). Baobab seeds meal were sourced from Zing town, Zing local Government Area of Taraba State, Nigeria. The seeds were boiled and dry after which it was milled to have baobab seed meal (BSM).

Experimental diets

Cassava root - Baobab seed meal blend was mixed at a ratio of 4kg cassava root meal (CRM) to 1kg baobab seed meal (BSM). The prepared CRM-BSM mixture was used to formulate six diets such that maize was replaced by CRM-BSM blend at 0, 10, 20, 30, 40 and 50% in nutrient to nutrient inclusion rates respectively which represent T1, T2, T3, T4, T5 and T6. The composition of the six formulated diets is presented in Table 1.

Table 1: Percentage composition of broilers starter diets (0-4 weeks)

CRM – BSM Blend levels	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**
	T1	**T2**	**T3**	**T4**	**T5**	**T6**
Ingredients:						
Maize	51.50	46.35	41.2	36.05	30.90	25.75
CRM-BSM	0.00	5.15	10.30	15.45	20.60	25.75
Soy bean meal	30.00	30.00	30.00	30.00	30.00	30.00
Groundnut cake	6.70	6.70	6.70	6.70	6.70	6.70
Fish meal	3.00	3.00	3.00	3.00	3.00	3.00
Maize offal	5.00	5.00	5.00	5.00	5.00	5.00
Bone meal	2.00	2.00	2.00	2.00	2.00	2.00
Lime stone	1.00	1.00	1.00	1.00	1.00	1.00
DL-Methionine	0.2	0.2	0.2	0.2	0.2	0.2
L-Lysine	0.1	0.1	0.1	0.1	0.1	0.1
Salt	0.25	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated analysis:						
ME (kcal/kg)	2921.31	2919.83	2919.11	2918.52	2918.13	2917.83
Crude protein (%)	22.56	22.88	23.11	23.15	23.22	23.27
Crude fibre (%)	4.01	4.01	4.01	4.01	4.01	4.01
Ether extract (%)	3.74	3.74	3.74	3.74	3.74	3.74
Calcium (%)	1.07	1.07	1.07	1.07	1.07	1.07
Phosphorus (%)	0.55	0.55	0.55	0.55	0.55	0.55
L-Lysine (%)	1.26	1.26	1.26	1.26	1.26	1.26
DL-Methionine (%)	0.54	0.54	0.54	0.54	0.54	0.54

Experimental birds and management

A total number of 240 day-old unsexed broiler chicks of commercial strain (Ross) were purchased from a reputable hatchery. The chicks were weighed and allotted to six dietary treatment groups of four replicates each in a Completely Randomized Experimental Design. Each replicate consists of 10 chicks, to have a total of 40 birds per treatment group. The birds were brooded for two weeks. Birds were reared on deep litter housing system for 4 weeks. Routine vaccinations and medications were strictly followed and feed and water were provided *ad libitum*.

Data collection

Performance characteristics

The initial weights of the birds were taken on arrival. The live weights of the birds as well as the feed consumption of each replicate were measured weekly. Feed conversion ratio for each replicate was calculated by dividing the feed intake by the weight gain.

$$Feed\ intake/bird\ (g) = \frac{Quantity\ of\ feed\ fed - Quantity\ of\ feed\ left\ over}{Number\ of\ birds\ \times 28\ days}$$

$$Daily\ weight\ gain\ (g) = \frac{Final\ live\ weight - Initial\ weight}{Number\ of\ birds\ \times 28\ days}$$

$$Feed\ conversion\ ratio = \frac{Quantity\ of\ feed\ consumed}{Weight\ gain}$$

Haematological analysis

At 28 days of age, blood samples were drawn from the wing vein of 4 birds per treatments that is one from each replicate. 2ml of blood sample was transferred into a bottle containing Ethylene Diamine Tetra Acetic Acid (EDTA) anticoagulant for haematological analyses. The following parameters were determined according to Schalm *et al*. (1975): Packed Cell Volume (PCV), White Blood Cell (WBC), Haemoglobin (Hb), Red Blood Cell (RBC), Mean Cell Haemoglobin Concentration (MCHC), Mean Cell Haemoglobin (MCH) and Mean Cell Volume (MCV).

Serum biochemical analysis

At 28th day of age, blood samples were drawn from the wing vein of 4 birds per treatments that is one from each replicates. 2ml of blood sample was transferred into sterilized plane bottle. Serum biochemical procedure was carried out according to Kelly (1979) and Jain (1986) in determining the following parameters: total protein, albumin, globulin, creatinine, uric acid and glucose.

Lipid status

At the end of 28th day of the experiment, 2 ml of blood sample was collected from one chicken per replicate into a clean syringe and put in sterilized plane bottle. Commercially available kits (Randox Laboratories Ltd) was used for analysis of lipid according to procedure of Trinder (1969). Parameters determined for lipid includes: Cholesterol, Triacylglycerol, high density lipoprotein (HDL), low density lipoprotein (LDL) and very low density lipoprotein (VLDL).

Statistical analysis

Data collected were subjected to One–way Analysis of Variance (ANOVA) in a Completely Randomized Design using SAS (2000) while significant means were separated using Duncan's Multiple Range Test at 5% level of significance.

Results and Discussion

The results of growth response of starter broiler chicks fed diets containing graded levels of cassava root meal – baobab seed meal (CRM-BSM) blend is presented in Table 2. With the exception of cost/kg gain, dietary treatments had significant (p< 0.05) on parameters measured. Final weight, weight gain, feed intake and feed conversion ratio were significantly (p< 0.05) influenced by graded levels of cassava root meal – baobab seed meal (CRM-BSM) blend. Similar statistical values 605.33g, 524.00g, 552.67g and 495.00g were recorded for final weight in the birds fed diets containing 0% (Control), 10%, 20% and 30% CRM-BSM blend. Birds fed diets containing 40% and 50% CRM-BSM blend showed least (p <0.05) values 455.00g and 454.67g respectively for final weight. The observation in this study corroborated the literature (Uchegbu *et al.,* 2011) in an experiment reported decrease in weight gain with diet containing higher proportion of cassava which was associated to high fibrous level. The observation in this study is at variance with the report of Rougière and Carré (2010) who reported that feeding concentrates supplemented with 50 % cassava root meal showed advantages in broiler chickens compared to the use of conventional feedstuff.

Weight gain followed similar trend with final weight. Birds fed diet containing 0% , 10%,20% and 30% CRM-BSM blend revealed similar (p<0.05) statistical value 493.05g, 411.53g, 440.48g and 382.53g for weight gain. Least (p<0.05) values 342.70g and 342.21g were obtained for weight gain in the birds fed diets containing 40% and 50% CRM-BSM blend. This observation is in contrast with the findings of Kana *et al.* (2012) who reported that body weight was the highest when cassava was replaced with 50 % maize. Also, observation in this study is in variance with findings of (Changa *et al.*, 2020) in his assertion that broiler birds can perform better if maize is replaced by cassava.

Least (p<0.05) values 888.00g and 889.00g were recorded for feed intake in the birds fed diets containing 0% and 10% CRM-BSM blend. Higher and similar numerical values 908.33g, 912.66g and 910.33g were obtained for birds fed diets containing 305, 40% and 50% CRM-BSM blend. The trend of the results for feed intake revealed progressive increase in value with increased level of CRM-BSM blend. This observation of increased in feed intake could be attributed to need to meet up with the nutritional requirement of chickens. Sobayo *et al.* (2012) also opined that high fibre increases the bulkiness of the diet, exact effect on gut transient time and reduce nutrient digestibility. Birds fed 0% CRM-BSM blend revealed improved value of 1.82 for feed conversion ratio (FCR). Similar values were recorded for FCR in the birds fed 20%, 30%, 40% and 50% CRM-BSM blend. The FCR of birds fed CRM-BSM blend diets recorded higher values compared with the control group. Cost/kg gain was not significantly (p>0.05) influenced by dietary treatments.

Table 2: Effect of graded levels of cassava root meal – baobab seed meal (CRM-BSM) blend on growth response of starter broiler chicks

CRM – BSM Blend levels	0%	10%	20%	30%	40%	50%	
	T1	T2	T3	T4	T5	T6	SEM
Parameters:							
Initial weight (g)	112.28	112.46	112.18	112.46	112.30	112.46	0.04
Final weight (g)	605.33[a]	524.00[ab]	552.67[ab]	495.00[ab]	455.00[b]	454.67[b]	17.79
Weight gain (g)	493.05[a]	411.53[ab]	440.48[ab]	382.53[ab]	342.70[b]	342.21[b]	17.81
Daily weight gain (g)	23.47[a]	19.59[ab]	20.97[ab]	18.21[ab]	16.31[b]	16.29[b]	0.84
Feed intake (g)	888.00[c]	889.00[c]	898.33[b]	908.33[a]	912.66[a]	910.33[a]	2.59
Daily feed intake	42.28[c]	42.33[c]	42.77[b]	43.25[a]	43.46[a]	43.34[a]	0.12
FCR	1.82[b]	2.16a[b]	2.06[ab]	2.45[ab]	2.68[a]	2.70[a]	0.10
Cost/kg gain	786.10	902.70	834.20	962.10	1015.00	988.10	33.45

[abc] Means on the same row having different superscript are significantly (P<0.05) different

The results of haematological indices of starter broiler chicks fed diets containing graded levels of cassava root meal – baobab seed meal (CRM-BSM) blend is presented in Table 3. Varying inclusion level of (CRM-BSM) had no significant (p>0.05) effect on parameters determined. Packed cell volume ranged between 32.33 – 36.33%. PCV values obtained in this study were within the normal range 24 – 45% reported in the literature (Mirtuka and Rawnsley, 1997). However, the values were higher than 24.5 – 29.0% reported for PCV by (Odunsi, *et al*., 2007). Sufficient crude protein in the diet contributed to higher PCV because net protein furnishes body with required amino acid needed for physiological activities such as biosynthesis of body protein including blood protein. The normal value recorded for PCV in this study indicated increased availability of protein, energy thus improving broiler performance (Cary, *et al*., 2002). Highest (P>0.05) value of 36.33% recoded for PCV in this study suggested that the birds were normally hydrated. PCV greater than 56% is an indicator of polycythemia caused by dehydration (Trîncă, *et al*., 2012).
Value recorded for white blood cell ranged between 38.33 – 53.67× 10^9/L. Birds fed diet containing 40% and 50% (CRM-BSM) blend revealed higher numerical values 53.67 and 50.33 × 10^9/L for white blood cell. This elevated range value recorded for WBC were slightly higher than 20.90 ×10^9/L -37.40 ×10^9/L reported for starter broiler chicks in literature (Tirmidhi *et al*., 2022) when starter broiler chicks were fed diets containing varying levels cassava root meal fortified with roselle seed meal as a replacement for maize . White blood cells are known to fight defects thus animals with low WBC are exposed to high risk. Normal range value obtained in this study indicated that birds were capable of producing antibodies for phagocytosis. Close ranged values 10.33 – 11.86g/dl were recorded for haemoglobin. The observation in this study for haemoglobin is at a close range to 9.80g/dl reported for experimental birds in literature (Miturka and Rawnsely, 1997). Range values obtained for Hb in this study were within range of 7 – 13g/dl reported for normal chickens (Nkwocha, *et al*., 2014). This observation showed that the birds had improved value for efficient oxygen carrying capacity. Haemoglobin concentration is useful in detecting anaemia in avian species in general (Akpodiete, and Ologhobo, 1998). Values recorded for MCH, MCHC and MCV were within the range reported for broiler chickens. Range values 100.00 – 104.00 fl obtained for MCV in this study were within 90 – 140fl reported for birds in the literature (Miturka and Rawnsely, 1997). Ranged values 32.00 - 34.66pg obtained for MCH in this study was close to 39.11pg reported by (Simarak, *et al*., 2004). MCH is an indicator of blood carrying capacity of RBC. Normal value for MCH suggested that birds were efficient in the respiratory functions (Soetan, *et al*., 2013).
White blood cell derivatives: lymphocyte and neutrophil showed numerical values adequate for broiler chickens. Lymphocyte had range value of 55.66 – 73.66 %. Neutrophil recorded range value of 25.33 – 38.00 %. The elevated values obtained for WBC differentials were slightly above 12.1 – 64.2% and 4.57 – 24.2% reported for lymphocyte and neutrophil for experimental birds in the literature (Miturka and Rawnsely, 1997).

Table 3: Effect of graded levels of cassava root meal – baobab seed meal (CRM-BSM) blend on haematological indices of starter broiler chicks

CRM – BSM Blend levels	0% T1	10% T2	20% T3	30% T4	40% T5	50% T6	SEM
Parameters:							
Packed cell volume (%)	32.33	34.33	36.33	35.33	33.33	36.33	0.65
White blood cell ($\times10^9$/l)	44.33	46.00	46.33	38.33	53.67	50.33	1.72
Red blood cell ($\times10^{12}$/l)	3.13	3.30	3.12	3.05	3.21	3.10	0.05
Haemoglobin (g/dl)	10.33	11.33	12.50	11.13	11.03	11.86	0.24
MCHC (g/dl)	33.04	33.14	33.11	33.13	33.14	33.32	0.03
MCH (p/g)	32.66	34.00	34.66	34.33	33.66	33.66	0.28
MCV (fl)	100.00	103.66	104.00	100.66	101.66	103.66	0.67
Lymphocyte (%)	73.66	70.33	69.66	55.66	70.00	72.66	2.10
Heterophil (%)	25.33	28.00	29.66	38.00	29.66	28.66	1.82
Monocyte (%)	0.00	0.63	0.33	0.33	0.33	0.00	0.10
Eosinophil (%)	0.00	0.33	0.33	0.00	0.00	0.00	0.07
Basophil (%)	-	-	-	-	-	-	-

MCHC – mean corpuscular haemoglobin concentration MCH - mean corpuscular haemoglobin
MCV - mean corpuscular volume

The results of serum biochemical indices of starter broiler chicks fed diets containing graded levels of cassava root meal – baobab seed meal (CRM-BSM) blend are presented in Table 4. Serum biochemical constituents reflect the health, nutrition and management conditions to which animals are exposed (Minafra *et al*., 2010). The results of albumin in birds fed dietary T1, T2, T3 and T6 are similar ($p>0.05$) but significantly ($p<0.05$) different from group fed T4 and T5, respectively.

Birds fed 0% and 10% (CRM-BSM) blend revealed least ($p<0.05$) value of 23.33g/l and 23.00g/l respectively for albumin. Low level of albumin in serum of livestock indicate heavy loss in urine due to enteropathy or decrease production by the liver due to insufficient intake of protein in the diets (Kaslow, 2011). Improved value obtained for albumin in this study indicated adequate function of the liver in production of albumin and no loss inform of uric acid. Ranged values 23.00 35.00 g/l obtained for albumin were within the normal average value of 24 g/l reported in the literature (Lumeij, 2008). Serum albumin which is the most abundant in clear fluid portion of the blood typically decrease during inflammation (Peterson *et al*., 2004; Lumeij, 2008) and condition of anorexia. Decreased level of albumin leads to osmotic disequilibrium and dehydration (Peterson *et al*., 2004). Adequate values recorded for albumin as observed in this study indicated good appetite and absent of inflammation and dehydration. Though not statistically different ($p>0.05$), improved values were recorded for total protein and globulin. Range values 43.00 – 54.00 g/l obtained for total protein were within the normal ranged for poultry reported in the literature (Reznichenko *et al.*, 2017). This observation showed adequacy of the diets in protein composition and bioavailability. Proteins are the most abundant compound in the serum comprising amino acid building blocks and are in turn building block for cell and tissue (Kaslow, 2011). The observation in this study with improved total protein suggested adequate cell multiplication and tissue build up with consequence improved growth response. Serum protein have been known to play an important role in infection following invasion of body by pathogens (Eckersall, 2008; Oladele, *et al*., 2005) and a vital substrate for antibody formation. Values (17.66 – 25.00 g/l) obtained for globulin were within 12.00 – 36.00 reported in the literature (Lumeij, 2008). Ranged values of 89.11 – 89.28 iu/l recorded for aspartate amino transferase were lesser than 110 – 174 iu/l reported in the literature (Lumeij, 2008). Values of 7.33 – 10.00 iu/l obtained for alanine aminotransferase were lesser than 21.70 – 46.50 iu/l reported in the literature (Reznichenko *et al.,* 2017). Aspartate amino transferase is a sensitive indicator for liver function which may be used to detect functional and /or morphological liver damage in chickens (Kraljevic *et al*., 2008). Ranged values 162.41 – 238.47 mg/dl obtained for cholesterol were close to 100 – 250 mg/dl reported by Lumeij (2008). Triacylglycerol, HDL, LDL and VLDL were within the normal values for birds. Glucose and triacylglycerol are the main metabolites which are closely related to the sustainability of the energy supply for the implementation of physiological and biochemical function of animals (Hernawan *et al*., 2012). Improved value obtained for triacylglycerol could be attributed to adequacy of energy supply in the diets.

Table 4: Effect of graded levels of cassava root meal – baobab seed meal (CRM-BSM) blend on serum biochemical and lipids profiles of starter broiler chicks

CRM – BSM Blend levels	0%	10%	20%	30%	40%	50%	
	T1	T2	T3	T4	T5	T6	SEM
Parameters:							
Total protein (g/l)	48.33	43.00	52.00	52.66	54.00	51.00	1.87
Albumin (g/l)	23.33^{b}	23.00^{b}	27.33^{ab}	35.00^{a}	33.66^{a}	28.00^{ab}	1.38
Globulin(g/l)	25.00	20.00	24.66	17.66	20.33	23.00	1.68
Asat (iu/l)	89.17	89.18	89.11	89.12	89.14	89.28	0.03
Alat (iu/l)	9.46	8.00	7.33	8.66	8.90	10.00	0.38
Glucose (mg/dl)	42.00	39.00	36.00	42.60	50.40	42.60	2.38
Uric Acid (mg/dl)	23.25	21.77	25.39	22.32	22.79	24.17	1.04
Cholesterol (mg/dl)	228.15	238.47	180.46	162.41	166.41	206.50	9.69
Triacylglycerol (mg/dl)	129.90	133.45	124.59	141.42	107.46	109.53	8.29
HDL (mg/dl)	70.50	60.84	58.13	62.77	60.06	51.94	2.12
LDL (mg/dl)	162.80	189.48	121.17	110.85	116.27	137.92	9.16
VLDL (mg/dl)	19.85	20.62	20.75	18.43	12.76	12.76	0.03

^{ab} Means on the same row having different superscript are significantly ($P<0.05$) different
Asat – aspartate aminotransferase Alat – Alanin aminotransferase
HDL – high density lipoprotein LDL – low density lipoprotein V LDL – very low density lipoprotein

Conclusion

1. Graded inclusion levels of cassava root meal – baobab seed meal (CRM-BSM) blend up to 30% improved weight gain, feed intake and feed conversion ratio of starter broiler chicks.

2. CRM-BSM blend could replace maize up to 30% replacement level for improved growth performance.

3. Varying inclusion levels of CRM-BSM blend could be fed to starter broiler chicks without any hazardous effect on haematological and biochemical indices

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