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NUTRITIONAL EVALUATION OF SUNDRIED PROVITAMIN-A CASSAVA TUBER MEAL *(Manihot esculenta crantz)* SUPPLEMENTED WITH ENZYME AS ENERGY SOURCE IN BROILER CHICKEN PRODUCTION

[1]Anyaegbu, B.C., [2]Ogbonna, A. C., [1]Chukwu, J. C. and [1]Onunkwo, D. N.

[1]Department of Animal Nutrition and Forage Science;
[2]Department of Animal Production and Livestock Management,
Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria
Corresponding Author's email: batoanyaegbu@gmail.com

Abstract

Considering the inherent attributes of Pro vitamin-A cassava tuber meal (*manihot esculenta crantz*), its' appropriate utilization for chicken diets may enhance the performance of broiler chickens. The study was therefore carried out to determine the nutritional evaluation of sundried Pro vitamin-A cassava tuber meal (*manihot esculenta crantz*) supplemented with nonagrain enzyme as energy source in Broiler chicken production. Pro vitamin-A cassava tubers were harvested, cleaned of debris and chopped into bits of about 0.2cm and spread on flat polythene sheet and allowed to dry under the harmattan sunshine for four days to reduce the anti-nutrients and moisture content. The dried yellow cassava was milled and then used. The proximate chemical composition showed that sundried Pro vitamin-A yellow cassava tuber meal contained 2.85% moisture, 3.3°/o ash, 2.77% crude fibre, 1.30% ether extract, 3.30% crude protein, and 86.48% carbohydrate. Five experimental straight broiler chicken diets were formulated such that, diet 1, (control) contained maize as the main source of energy, while sundried Pro vitamin-A cassava tuber meal (SDCTM) supplemented with enzyme was used to replace maize at 25%, 50%, 75% and 100% respectively in the control diet. Each broiler chicken diet was fed to a group of 30 broiler chicks for 8 weeks using completely randomized design. Each treatment was further grouped into 3 replicates of 10 birds each. The broiler chickens were kept in deep litter and given feed and water ad-libitum. Parameters measured included initial body weight, final body weight, body weight gain, feed conversion ratio, cut parts weight, internal organs weight, dressed weight and cost of production. In the broiler chicken feeding trial, the broiler chickens on 75% (SDCTM) supplemented with enzyme compared favourably with those on the control diet ($P<0.05$) in terms of feed intake, feed conversion ratio and body weight gain and hence recorded the highest body weight gain which was significantly different ($P<0.05$) from those on the control diet and the rest of the treatment groups. It appeared that the broiler chickens could tolerate the sundried Pro vitamin-A cassava tuber meal supplemented with enzymes in their diets up to 100% inclusion level. The broiler group on 50% and 75% (SDCTM) supplemented with the nona grain multi-enzyme recorded similar feed conversion ratio of 2.39 and 2.32 which were significantly ($P<0.05$) better than those on other diets. The internal organs expressed as percent of the live weight were not affected by the treatments. The broiler chicken group on 75% (SDCTM) diets supplemented with enzyme recorded the highest dressing out percent of 74.34 followed by those on 50% (SDCTM) (68.33) diet. The percent cut parts weights were not affected by the treatment. The cost of production (cost/kg feed x feed conversion ratio) was lowest for the broiler chicken on control diet (N853.06) as against (N1,570.94) for those on 100% cassava tuber meal diet containing enzyme. For optimal performance of broiler chickens sundried Pro vitamin-A cassava tuber meal supplemented with nona-gram multi grain enzyme could be used up to 75% without affecting body weight gain, feed intake and feed conversion ratio as indicated in this study.

Keywords: Nutritional evaluation, Pro vitamin-A cassava supplementation, enzyme, broiler chickens

Introduction

The need for replacement of the conventional feeds ingredients especially maize has been paramount in the mind of animal nutrition experts for over a decade (Onyimonyi and Okeke, 2005). Animal feed constitutes at about 45-60% of the cost of animal production (Tewe *et al*., 1992). The rising costs of feed resources in livestock production have been established as a serious impediment to meet the demand for animal protein particularly in developing countries (Adejmmi *et al*., 2000). Means of reducing this cost should therefore be uppermost in the minds of poultry farmers. Depending on maize alone as the chief source of energy will not bring reduction in poultry production because production of maize now is at a very high cost following the high level of pest and disease attack on maize at the early stage of cultivation.

Cassava products are recognized as the cheaper carbohydrate sources, than grains or other tuber crops, thus yellow cassava also known as pro vitamin A cassava *(Manihot esculenta crantz)* is a non-conventional feedstuff that provides readily available energy with easily digestible carbohydrate. The cassava root is long and tapered, with a firm, homogeneous flesh encased in a detachable rind, about 1 mm thick, rough and brown on the outside. Commercial cultivars can be 5 to 10 cm (2.0 to 3.9 in) in diameter at the top, and around 15 to 30 cm (5.9 to 11.8 in) long. A woody vascular bundle runs along the root axis. The flesh is yellowish. Cassava roots are very rich in starch and contain small amounts of calcium (16mg/100g), phosphorus (27 mg/100g), and vitamin C (20.6 mg/100g) However, they are poor in protein and other nutrients. In contrast, cassava leaves are a good source of protein (rich in lysine), but deficient in the amino acid methionine and possibly tryptophan. Cassava, like other foods, also has antinutritional and toxic factors. Of particular concern are the cyanogenic glucosides of cassava (linamarin and lotaustralin). On hydrolysis, these release hydrocyanic acid (HCN). The presence of cyanide in cassava is of concern for human and for animal consumption. The concentration of these antinutritional and unsafe glycosides varies considerably between varieties and also with climatic and cultural conditions. Selection of cassava species to be grown, therefore, is quite important. Once harvested, bitter cassava must be treated and prepared prior to human or animal consumption, while sweet cassava can be used after simply boiling. There is limited work on the proximate and optimum inclusion level of sundried Pro vitamin-A cassava root meal supplemented with nona grain multi enzyme as a replacement for maize on the performance of broiler chickens and the economic implication of incorporating Pro vitamin-A cassava root meal supplemented with enzymes in broiler chickens' diet.

Materials and methods

Experimental Site

The experiment was carried out at the poultry unit of the teaching and research farm, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. The area is located on latitude 05°29'N and longitude 7°32'E and altitude of 122m above sea level. The environment of the study is suited within the tropical rain forest zone characterized by an annual rainfall of about 2,165 to 2,177mm, relative humidity in the range of 50 to 96% depending on the season and monthly ambient temperature ranging from 20° -30°C (N.R.C.R.I., 2021).

Source of Enzyme

The enzyme - NONA-GRAIN used in this study was purchased from the manufacturer (DSM Nutritional Product LTD, Wurmisweg, Switzerland). The product is an innovative thermostable multi-component carbohydrate derived from Trichodermareesei. It contains a complex range of different activities, of which xylanase (endo-1, 4-glucanase. Ec 3.2.1.8) and β -glucanases (endo-1,3 (4) -β - glucanase; Ec 3.2.1.6 and endo-1,4-glucanase; Ec 3.2.1.4) are guaranteed activities. But it also contains some amounts of beneficial side activities such as ferulic acid esterases and arabinafuranosidases NONA-GRAIN enzyme delivers improved energy utilization, ensures flexible formulation, improved performance, reduced feed cost and high retention after pelleting. This enzyme helps to improve the release of entrapped nutrients within the tight cell walls of fibrous feed materials.

Procurement and Processing of Feed Ingredients

Processing of sundried Pro vitamin A cassava

Yellow cassava tubers *(Manihot esculenta crantz)* were obtained from National Root Crop Research Institute (NRCRI) Umudike in Ikwuano L.G.A. in Umuahia, Abia State. The tubers were harvested, cleaned and chopped into bits of about 0.2cm and spread on flat polythene sheets and allowed to stay under the harmattan sun light for four days to completely dry. It was manually turned from time to time to ensure uniform drying. The dried yellow cassava was milled to produce sun dried cassava meal (SDCM). Other feed ingredients like maize, palm kernel cake, wheat offal, blood meal, soyabean meal, bone meal, vitamin premix, lysine, methionine, salt etc, were bought from Jocan Livestock Services, Umuahia, Abia State.

Chemical Analysis of fresh and sundried Pro vitamin A cassava (*Manihot esculenta crantz)*

Proximate composition of the fresh (Raw) and sundried Pro vitamin A cassava were determined according to the methods of A.O.A.C. (2003) where the % dry matter, % crude fibre, % crude protein, % ether extract, % nitrogen free extract, % Ash and gross energy was determined using bomb calorimeter. All analyses were based on 100% dry matter. This was done to use the value obtained to determine the nutrient composition of the experimental diets that were formulated from them.

Anti-nutrients Determination

The samples of the test materials, fresh (raw) and sundried Pro vitamin-A cassava meal were analyzed for anti-nutrients contents such as cyanogenic glycosides, Trypsin inhibitor, oxalates, phytate and tannin. The analysis was carried out using standard analytical techniques.

Experimental Broiler Chicken Diets

Five experimental straight broiler diets were formulated. Diet 1 (control) contained 50% maize as the main energy source and no enzyme was added, while diets 2, 3, 4, and 5 contained 25%, 50%, 75% and 100% of sundried cassava meal to replace maize and supplemented with the enzyme NONA-GRAIN at 100 g/ 100kg diet. The birds were fed with straight diets for eight weeks (8), as shown in (Table 1).

Management of the Experimental Broilers

One hundred and fifty (150) day old Anak broilers chicks (Amobyng broilers) were bought from Sapele. They were brood together for one week with commercial broiler starter diet (Top broiler starter feed) to stabilize them before distributing them into five experimental treatment groups. Each treatment group contained 30 broiler chicks. Then each treatment group was subdivided into three replicates of 10 birds each. Each replicate was kept in a pen and the pen was covered with polythene sheet to conserve heat. Heat was supplied with electricity and kerosene lantern during the brooding period. The floor of the pens was covered with wood shavings. Each group was randomly assigned to an experimental broiler chicken diet in a Completely Randomized Design (CRD) and was fed for eight weeks. Feed was supplied in feeding troughs built in such a way as to minimize wasting of feed. Water was supplied *ad-libitum*. Feeding was done once daily around 8am. The birds were weighed at the beginning of the feeding trial and weekly thereafter. Feed intake was recorded daily by weighing the quantity of feed given and the left over the following morning. The birds were fed with straight diets for eight weeks.

Health management practices were carried out on the broiler chickens. The chicks were given anti-stress on arrival to boost their energy level. They were given Newcastle disease vaccine strain (NPV) by intraocular (1/0). The first Gumboro vaccine was administered at the end of the second week through drinking water and Lasota vaccine against Newcastle disease (Lasota strain) was administered at the end of the third week and the final Gumboro vaccine was administered at the end of the fourth week against infectious bursa disease (Gumboro). Coccidiostat and other anti-biotics were also administered by drinking water when there were signs of infections.

Carcass Evaluation

At the end of the feeding trial, three (3) broiler chickens from each treatment were randomly selected, starved of feed but not water for 24 hours and then weighed and slaughtered for the determination of the following internal organ weights (hearts, kidney, spleen, lungs, abdominal fat), cut part weights (thigh, muscle, wings, back-cut, drumstick and breast muscle) and dressed weight. The internal organs weight was expressed as percentage of the live weight.

Data Collection

Parameters that were determined were daily feed intake, body weight gain, final live weight, weekly body weight gain, feed conversion ratio, mortality, dressed weight, internal organ weight and feed cost benefit.

Daily Feed Intake (FI)

The quantity of feed given to the broiler chicks was weighed and the leftover of the feed at the following morning was also weighed and recorded in grams. Daily feed intake was determined as follows:
FI = Quantity of feed given - left over feed.

Live weight Gain (LWG):

This was calculated as the difference between the final body weight and the initial live body weight.
LWF = Final body weight - initial body weight.

Daily Weight Gain:

This was calculated by dividing the body weight changed by the number of days the feeding trial lasted.
Feed Conversion Ratio (FCR):
This was determined by dividing the average daily feed intake by average body weight gain. These values were used to determine the total feed intake per bird per day, total weight gain per bird per day, and feed conversion ratio. The following formula was used for calculation;

$$\text{Feed intake/bird/day} = \frac{\text{Quantity of feed given} - \text{Leftover}}{\text{30 birds x 28 days}}$$

$$\text{Weight Gain/bird/body} = \frac{\text{Final live weight} - \text{Initial live weight}}{\text{30 birds x 28 days}}$$

$$\text{Feed Conversion Ratio (FCR)} = \frac{\text{Daily feed intake (g)}}{\text{Daily body weight gain (g)}}$$

Feed cost benefit

The economics of the experimental diets was calculated using the following;

$$\text{Cost/kg feed} = \frac{\text{Total cost of producing 100kg feed}}{100}$$

Cost of feed consumed = Cost/kg feed x Total fees consumed

$$\text{Cost / kg weight gain} = \frac{\text{cost of feed consumed}}{\text{Body weight gain}}$$

Cost of production = feed conversion ratio x Cost of feed/kg.

Revenue = Price of 1kg meat x weight gain

Gross margin - Revenue - Cost of production

$$\text{Return on investment} = \frac{\text{Gross margin x 100}}{\text{Cost of production}}$$

Data Analysis

The data collected were subjected to one-way analysis of variance (ANOVA) according to Snedecor and Cochran (1989) where significant treatment effects were detected from the ANOVA, means were separated using Duncan's New Multiple Range Test (Duncan, 1955).

Experimental Design

The design of the study was Completely Randomized Design (CRD) with statistical model thus;

$Yij = \mu + Ti + eji$

Where:

Yij = Individual observation

μ = Population mean

Ti = Treatment mean

eij = Random error effect

Results and Discussion

Anti-nutrient content of raw and sundried Provitamin-A cassava tuber meal are shown in Table 2. The cyanide content of the raw Provitamin-A cassava (*Manihot esculenta* crantz) was high but sun-drying for 4 days helped to reduce it from 24.99mg/kg in raw tubers to 12.4mg/100kg in the sundried cassava tuber meal. The other anti-nutrients content in the raw Provitamin-A such as trypsin inhibitor, phytate, tannin and oxalate were numerically reduced by sun drying for 4 days. Sun drying is probably the widely practiced technique to eliminate cyanide and improve the shelf life of cassava tubers in the tropics. Khajarern *et al.* (1982) observed a reduction of HCN content from 111.83ppm to 22.97ppm on sun drying of cassava roots for 6 days and the reduction was appreciable from within three days of sun drying. This is confirmed by the findings of Nambisam (2011) that extending the period of drying cassava with higher moisture levels would enhanced linamarin breakdown, thus explaining the fact that fast drying rates results in lower detoxification, while slower rates result in higher cyanogen removal. In addition, Famurewa and Emuekele (2014) reported that the higher the moisture contents of the cassava roots the greater the loss in cyanide content during drying. Gomez and Valdivieso (1983) also reported that on sun drying more than 86% of HCN present in cassava was lost probably due to the evaporation of free cyanide at about 28ºC. Erubetine *et al.* (2003) observed that the grinding together of cassava roots and leaves in the proportions of 50:50 before sun drying improved the texture and crude protein content of the material when included in the broiler diets. The cyanide content was also reduced significantly. However, drying alone is not an efficient means of detoxification, especially for cassava varieties with high initial cyanogen glycoside content as also observed by Mlingi and Bainbridge (1994). The nutrient compositions of raw and sundried Provitamin-A cassava root meal are shown in Table 3. There were no significant differences ($P > 0.05$) in crude protein, crude fibre, and nitrogen free extract content differ significantly ($P < 0.05$) with fresh tubers containing less of both components. The proximate composition showed that yellow cassava root meal is rich in carbohydrate of about 86.48% and 3.30 – 3.70% crude protein. Heuze *et al*. (2013 and 2014) indicated that cassava root meal is essentially a carbohydrate or energy source. Tewe (2004) reported 60 – 65% moisture, 20 – 30% carbohydrate, 1 – 2% crude protein and also low vitamin and mineral contents on a wet basis. The proximate composition of the experimental diets containing different levels of sundried provitamin A cassava tubermeal is shown in (Table 4). No significant differences ($P < 0.05$) were observed in crude protein %, ether extract%, crude fibre%, Ash%, moisture% and metabolizable energy ME(Kcal/kg) across the treatment diets. Diet 5 recorded the least % ash content. This implied that the test diets were isocaloric and isonitrogenous. Additionally, the lower ash content which signifies lower mineral matter content suggests that the diets may need to be supplemented with extra source of mineral.

Growth performance of broiler chickens

The growth performance of broiler chickens fed graded levels of sun-dried yellow cassava root meal *(manihot esculenta crentz)* is as presented in Table 5.

Feed intake

The daily feed intakes of the experimental groups was significantly different ($P < 0.05$) and were 120.69g, 121.26g, 122.80g, 134.93g and 130.77g for the control diet (1), 2, 3, 4 and 5 respectively as shown in (Table 5). The broiler chickens in diet 4 (75% SDC) and diet 5 (100% SDC) supplemented with Nonagrain enzyme had similar feed intake which were significantly ($P < 0.05$) better than those on the control diets, diet 2 (25% SDC) and diet 3 (50% SDC) supplemented with nonagrain enzyme. The high feed intake by broiler chickens on diet 4 (75% SDC) and diet 5 (100% SDC) could be as the result of enzyme supplementation of the diets. Enzymes improve feed intake and feed conversion efficiency (Seema and Johri, 1992; Bengmark, 1998; Pal and Chander, 1999; Dhama *et al,* 2011; Mokiah *et al.,* 2014). The use of enzyme in poultry diets improved apparent metabolization of energy of the diet and increased feed intake, weight gain and feed gain ratio (Campbell *et al*., 1992; Janson *et al*., 1990; Annison and Choct, 1991; Bedford *et al.,* 1996; Benabdelijehl, 1992).

Body weight gain

The broiler chickens on diet 4 (75% SDC) supplemented with nonagrain enzyme compared favourably with the control and recorded significantly ($P < 0.05$) the higher body weight gain. The body weight gain of the broiler chicken groups on the control diet, 2, 3 and 5 were similar and significantly ($P < 0.05$) lower than those on diet 4 (75% SDC) supplemented with nonagrain enzyme. Enzyme supplementation of the diets improved the growth rate and body weight of the broiler chickens (Seema and John, 1992; Bengmark, 1998; Pal and Chander, 1999; Dhama *et al*., 2011; Mookiah *et al*., 1992; Janson *et al*., 1990; Annison and Choct, 1991; Bedford *et al.,* 1992; Benabdelijeh, 1992) reported that the use of enzymes in poultry diets improved apparent metabolization of energy of the diet and increased weight gain, feed intake and feed gain ratio.

Feed conversion ratio (FCR)

The feed conversion ratio of the broiler chickens was 2.50, 2.61, 2.39, 2.32 and 2.63 for the control diet 2, 3,4 and 5 respectively. Significant differences ($P < 0.05$) existed among the groups in their feed conversion ratios the broiler chickens on diet 3 (50% SDC) and diet 4

(75% SDC) supplemented with nonagrain multienzyme had similar feed conversion ratio which were significantly (P < 0.05) better than other groups. Generally, the broiler chickens had better feed conversion ratios because of the inclusion of nonagrain enzyme. The use of enzyme in poultry diets increased feed conversion ratio (Bedford *et al.,* 1996).

Carcass Cut-parts of Broiler Chickens fed Diet containing Graded Levels of Sun-dried yellow Cassava root Meal (Manihot esculenta crantz)

The cut parts of broiler chickens fed graded levels of sun-dried yellow cassava root meal *(Manihot esculenta crentz)* is as shown in Table 6. The result findings of the carcass cut parts of broiler chickens fed graded levels of sun-dried yellow cassava root meal *(Manihot esculenta crentz)* showed that for all the parameters measured, there were only significant differences (p<0.05) in the live weight, de-feathered weight, dress weight and drum stick weight. The live weight and de-feathered weight values showed that diet 3and 4 were statistically similar and significantly higher (p<0.05) than those of diets 1 ,2 and 5. There were no significant difference (p>0.05) in the other parameters like the, dressed%, thigh, shank, breast, wings and back cut.

Internal Organ Proportions of Broiler Chickens fed Diet containing Graded Levels of Sundried yellow Cassava root Meal (manihot esculenta crantz) supplemented with enzyme

The organ weight expressed as percentage dress weight is as presented in Table 7. There were no significant differences (p>0.05) for all the parameters measured except the small intestine. The small intestine values showed that diet 2 was significantly higher (p<0.05) and diets 3 and 4 were statistically similar and significantly higher (p<0.05) than diets 1 and 3. There were no significant differences (P <0.05) in parameters in %liver, %gizzard, %heart, %spleen, %abdominal fat, %large intestine, %proventriculus, %kidney, %lungs and %crop. The result also showed that the anti-nutritional content of the cassava did not negatively affect the internal organs of the broiler chickens. The broiler chickens on diet 4 (75% SDC) supplemented with nonagrain enzyme recorded significantly (P<0.05) the highest percent dressed weight of 74.34% followed by those on diets 2, 3, and 5 the least was the control (61.12%).

Feed cost benefit analysis of broiler chickens fed diets containing graded level of Pro-vitamin A cassava root meal (*Manihot esculenta* crantz) supplemented with enzyme

The cost per kg feed (Table 8) showed that significant differences (P < 0.05) existed among the various groups. Diet 1 (control) was the cheapest (N94.50) while the costliest was diet 5 (100% SDCTM (N99.25) supplemented nonagrain enzyme. The cost of production was lowest for the broiler chickens on the control diet N853.06 as against (N1570.94) for those on 100% cassava tuber meal diet containing the nonagrain multienzyme.

Conclusion

The trials herein reported have shown that sun drying of pro-vitamin-A cassava tuber meal for 4 days was not effective for eliminating the anti-nutrients content such as cyanide, trypsin inhibitors, phytate, tannin and oxalate because there were still traces of anti- nutrients content in the sun-dried cassava root meal. The result showed that sundried Pro vitamin-A cassava tuber meal supplemented with NONA-GRAIN enzyme could be used optimal up to 75% in the diet of broiler chickens without affecting performance. The result also showed that sundried Pro vitamin-A cassava tuber meal supplemented with NONA-GRAIN enzyme could be used to replace maize in the diet of broilers up to 100% without affecting feed intake, body weight gain, feed conversion ratio and carcass characteristics.

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Table 1: Ingredient and Nutrient Composition of the Experimental straight Broiler Chicken Diets Supplemented with NONA-GRAIN enzymes (100g/100kg diet)

Ingredients (%)	Diet 1 (Control)	Diet 2 25% SDCTM	Diet 3 50% SDCTM	Diet 4 75% SDCTM	Diet 5 100% SDCTM
Maize	50.00	38.50	25.00	12.50	0.00
SDCTM **	-	11.50	25.00	37.50	50.00
Palm kernel cake	6.00	6.00	4.50	4.00	3.00
Wheat offal	7.00	7.00	7.00	7.00	7.00
Soya bean	30.00	30.00	30.00	30.00	30.00
Blood Meal	2.50	2.50	4.00	4.50	5.50
Bone Meal	3.00	3.00	3.00	3.00	3.00
vitamin/mineral premix*	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Common Salt	0.25	0.25	0.25	0.25	0.25
Palm Oil	0.50	0.50	0.50	0.50	0.50
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Calculated Nutrient Composition of the experimental broiler chickens diet					
Crude protein (%)	23.08	23.84	23.69	23.50	23.30
ME Kcal/Kg	2940.81	2874.81	2837.21	2892.91	2800.61

*****Sun Dried Cassava Tuber Meal***

****To provide per kg Diet: Vit. A, 2000000iu, Vit. D3, 4000iu; Vit E, 80g, Vit K, 0.49; Choline 48.00g; BHT, 32.00g; Manganese, 16.00g; Iron, 8.00mg; Zinc, 72gm; Copper, 0.32g; Iodine, 0.25g, Cobalt, 36.00g; Selenium, 16.00g***

Table 2: The Anti-nutrient composition of raw and sun-dried Pro-vitamin A cassava tubermeal

Parameters	Raw Pro-vitamin A Cassava (mg/100kg)	Sundried Pro-vitamin A cassava (mg/100kg)
Cyanide	24.99 mg/kg	12.4
Trypsin inhibitor	0.78	0.20
Phytate	624	120.00
Tannins	40.00	10.00
Oxalate	120	0.50

Table 3: Proximate composition of raw and sundried Pro-vitamin A cassava

Parameters	Raw Pro-vitamin A Cassava (G/100g)	Sundried Pro-vitamin A cassava tuber meal (G/100g)
Moisture (%)	3.28	2.85
Ash (%)	0.75	3.30
Crude fibre (%)	1.75	2.77
Ether extract (%)	0.87	1.30
Crude protein (%)	3.7	3.30
Carbohydrate (%)	89.65	86.48

Table 4: Proximate composition of the experimental broiler chicken diets

Parameters	Diet 1 Control	Diet 2	Diet 3	Diet 4	Diet 5
CP (%)	23.00	21.00	22.90	22.80	23.00
Fat (%)	3.24	2.05	2.59	2.64	2.24
Crude fibre (%)	4.92	4.65	3.52	1.39	3.88
Ash (%)	2.87	2.70	2.64	4.58	1.75
Moisture (%)	11.80	11.40	11.15	11.93	11.81
Metabolizable Energy ME (Kca/Kg)	2850.25	2643.87	2709.35	2692.52	2719.43

Table 5: Growth Performance of Broiler Chickens fed Diet containing Graded Levels of Sundried yellow Cassava Meal (*Manihot esculenta* crentz) supplemented with enzyme

Parameters	Diet 1 0%	Diet 2 25%	Diet 3 50%	Diet 4 75%	Diet 5 100%	SEM
Initial body weight (g/bird)	299.33	290.00	280.00^{b}	307.77	296.03	3.68
Final body weight (g/bird)	2660.00^{b}	2566.67^{b}	2800.00^{b}	3163.33^{a}	2730.00^{b}	64.89
Body weight gain (g/bird)	2360.67^{b}	2276.67^{b}	2520.00^{b}	2855.56^{a}	2433.97^{b}	
Daily body weight gain (g/bird/day)	48.18^{b}	46.46^{b}	51.43^{b}	58.28^{a}	49.67^{b}	1.28
Daily feed intake (g/bird/day)	120.69	121.26	122.80	134.93	130.77	2.71
Feed conversion ratio	2.50^{b}	2.61^{a}	2.39^{c}	2.32^{c}	2.63^{a}	0.03

[ab]Means within the rows with significant superscripts are significantly different (P < 0.05); SEM – Standard Error of the mean

Table 6: Carcass Cut-parts of Broiler Chickens fed Diet containing Graded Levels of Sun-dried yellow Cassava root Meal *(Manihot esculenta crantz*) supplemented with enzyme

Parameter	Diet 1 0%	Diet 2 25%	Diet 3 50%	Diet 4 75%	Diet 5 100%	SEM
Live weight (g)	2266.67^{ab}	2266.67^{ab}	2316.673	2390.00^{a}	1950.00^{b}	56.11
De-feathered weight (g)	2066.67^{ab}	2066.67^{ab}	2116.673	2190.00^{a}	1750.00^{b}	56.11
Dress weight (g)	1373.33^{bc}	1506.67^{b}	1583.33^{ab}	1766.67^{a}	1250.00^{c}	55
Dressed (%)	61.12^{d}	66.50^{b}	68.33^{b}	74.34^{a}	64.22^{c}	1.91
Thigh (%)	18.54	17.21	17.24	15.83	17	0.48
Drumstick %	18.26^{a}	15.65^{ab}	15.14^{ab}	14.27^{b}	15.26^{ab}	0.55
Shank (%)	6.99	6.43	6.47	6.23	6.14	0.25
Breast (%)	35.29	30.99	30.75	29.17	32.14	1.03
Wings (%)	14.53	13.69	13.24	12.01	14.45	0.38
Back (%)	22.29	20.49	21.56	18.54	21.77	0.66

[abc] Means within the rows with different superscripts are significantly different (P<0.05); SEM - Standard error of the mean

Table 7: Internal Organ Proportions of Broiler Chickens fed Diet containing Graded Levels of Sundried yellow Cassava root Meal *(manihot esculenta crantz)* supplemented with enzyme

Parameter	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	SEM
	0%	25%	50%	75%	100%	
Liver (%)	2.08	2.37	2.00	1.95	2.13	0.08
Gizzard	2.19	2.35	2.19	2.39	2.40	0.06
Heart (%)	0.44	0.46	0.44	0.45	0.43	0.01
Spleen (%)	0.10	0.10	0.09	0.08	0.12	0.01
Abdominal fat (%)	0.26	0.25	0.31	0.28	0.18	0.03
Large intestine (%)	0.65	0.82	0.64	0.66	0.64	0.03
Small intestine (%)	2.79^{b}	3.80^{a}	2.93^{b}	3.36^{ab}	3.57^{ab}	0.13
Proventriculus (%)	0.31	0.35	0.32	0.31	0.34	0.01
Kidney (%)	0.42	0.43	0.51	0.48	0.41	0.03
Lungs (%)	0.45	0.46	0.49	0.45	0.55	0.01
Crop (%)	0.50	0.55	0.57	0.60	0.49	0.02

^{ab} Means within the rows with different superscripts are significantly different (P<0.05); SEM - Standard error of the mean

Table 8: Feed cost benefit Analysis of Broiler Chickens fed Diets containing Graded Levels of pro vitamin A cassava root meal (*Manihot esculenta* crantz)

Parameter	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	SEM
	0%	25%	50%	75%	100%	
Cost/kg feed (N)	94.50^{e}	161.68^{d}	175.25^{c}	$187.3\ 8^{b}$	199.25^{a}	9.82
Cost of production (N/bird)	853.06^{e}	1254.83^{d}	1348.71^{c}	1533.04^{b}	1570.94^{a}	68.78

^{abcde} Means within the rows with different superscripts are significantly different (P<0.05); SEM- Standard error of the mean