



Effect of Different Levels of Cassava Roots on Growth Performance, Carcass Traits and Meat Quality of Broiler Chickens

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How to cite this paper: Elnour, Z., Babiker, M., & Habib, A. (2020). Effect of Different Levels of Cassava Roots on Growth Performance, Carcass Traits and Meat Quality of Broiler Chickens. *International Journal of Livestock Research*, 10(12), 20-28. doi: <http://dx.doi.org/10.5455/ijlr.20200627105321>

Received : Jun 27, 2020
Accepted : Sep 06, 2020
Published : Dec 31, 2020

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Abstract

This experiment was carried out to identify the influence of different levels of cassava roots as a source of energy in broiler diets on performance and carcass characteristics of broiler chicken. 160 unsexed one-day old (Ross 308) broiler chicks were distributed in a completely randomized design with four dietary cassava roots, viz. 0%, 15%, 25% and 40 % of the total rations, respectively. Each group was subdivided into 4 replicates with ten birds each. The weight gain, feed intake, and feed conversion ratio were recorded. Carcass, carcass cuts and internal organs were evaluated. During starter, finisher and entire experimental periods, all performance parameters were affected significantly by dietary treatments. The only exception was reported with the FCR during the starter period which was not influenced by treatments. Chemical composition of meat was not affected, except for crude protein and ether extract. It was concluded that adding cassava roots meal could be used at 25% of the total ration without any adverse effect on the performance of broiler birds.

Keywords: Broiler Performance, Cassava Roots, Carcass, Meat Quality

Introduction

In intensive poultry production, about 60-80% of the total cost of production is incurred by feed (Tewe, 1997). Means of reducing this cost is therefore uppermost in the minds of poultry farmers. This interest had resulted in researches that could help to reduce the cost of feeding and still have an improved output. This approach involves compounding of feed in a way that all the required nutrients are supplied by using cheaper energy sources. Cassava (*Manihot esculenta crantz*) is one of the most important food crops grown in the tropics (Hahn, 1989; FAO, 1990; Phillips *et al.*, 2004) and considered a significant source of calories for people more than 500 million world-wide (FAO, 2000; Mroso, 2003). The total production of cassava for human consumption has been estimated to be 65% of cassava products, while 25% is for industrial use, mostly as starch (6%) or animal feed (19%) and 10% lost as waste (Oluwole *et al.*, 2004); (Maziya *et al.*, 2007). Cassava has these outstanding advantages, adapts to diverse environment and farming systems, requires few skills and monitoring, also it remains relatively drought tolerant surviving for 4-6 months of dry matter, and it is very available. World annual cassava production has increased by approximately 100 million tons since 2000. This is driven by demand for food products in Africa and for dried cassava and starch for use in livestock feed in Asia. Cassava is believed to represent the future of food security in some developing countries. Approximately 500 million people currently depend on it as a major carbohydrate source (Montagne *et al.*, 2009), making it is third largest source of carbohydrate for human food in the world (Fauquet and Fargette, 1990). The reason of that it is tolerant to poor soils, diseases and drought (Chauynarong *et al.*, 2009). Under tropical condition it is the most productive crop terms of energy yield per unit land area, with a yield of between 25 and 60 tones/ha (Garcia and Dale, 1999). The Metabolizable energy (ME) levels of cassava roots have been presented by various authors, with values ranging from 3,000 to 3,200 kcal/kg (Buitrago *et al.*, 2002), 3,200 kcal/kg (Egena, 2006), 3145 kcal/kg (Khajarern, 2007) and 3,279 kcal/kg (Olugbemi *et al.*, 2010). Etalem (2013) concluded that, based on dry matter (DM) intake and growth performance of broilers obtained in the study, cassava root chips (CRC) could completely replace corn grain in broiler diets as energy feed ingredient. Cassava is considered a rich source of carbohydrates and very cheaper compared to the sorghum. Therefore, it is possible to replace sorghum by cassava roots in poultry feeding. For carcass parameters, CRC should substitute corn grain not more than 50%. Hence the present study was carried out to identify the influence of different levels of cassava roots as a source of energy in broiler diets on performance and carcass characteristics of broiler chicken.

Materials and Methods

Experimental Site and Duration

The experiment was conducted in Kenana Poultry Farm (Produce Farm), Kenana Sugar Company, White Nile State, Sudan. The duration of the experiment was lasted for five weeks (6th of July to 9th of August 2018).

Experimental Birds

A total of 160 unsexed one-day old broiler chicks (Ross 308) were purchased from a local company, weighed and vaccinated. To protect birds against Newcastle disease + Infectious bronchitis (ND+IB). They were vaccinated at 15 days' old using (ND+IB) and at 25 days using ND (Avinew). The birds were vaccinated against Gumboro using BUR706 at 12 and 18 days old. Gumboro vaccines were offered via drinking water and Newcastle vaccines were offered via spray and divided into 4 groups. Each group contained four replications with ten chicks each (10 birds/pen). Throughout the experimental period fresh water and feed were offered *adlibitum*.

Experimental Housing

The birds were kept in closed house situated on east- west direction making the long axis facing North and south wind. The dimensions of the house were (90 meters) length, (8 meters) width and the height of each longitudinal side was (3meters). The house was first cleaned using water and was second cleaned by detergent (Shift). The house was sprayed with GPC8 and FAM30, and fumigated with formalin. The drinker and feeder were also washed and disinfected three days before the arrival of the birds and they were cleaned daily throughout the experimental period. The house was divided into 16 Pens. The dimensions of each individual pen was (100cm) length, (100cm) width and (50 cm) height. Each pen contained ten chicks, one plastic feeder and one plastic drinker.

Experimental Diets

In a completely randomized design, the experiment was containing four dietary treatments to study the effect of dietary inclusion of cassava roots on broiler performance and carcass characteristics. The diets formulated contained four levels of cassava and sorghum as the main source of energy T1, T2, T3 and T4 at rates 0%, 15%, 25% and 40 % of the total rations respectively. The diets contain 0% cassava was considered as control. All diets were formulated iso-nitrogenous iso-caloric to meet or exceed the requirements of broiler starter and finisher diets according to (NRC, 1994). The composition of the diets used in experiment is shown in Table 1. The proximate composition and nutritional level in feed during starter and finisher are presented in Table 2. Proximate composition of the different diets was determined as per standard procedure of Association of Official Analytical Chemists (AOAC, 2005). In a completely randomized design, cassava tubers were harvested and collected. Whole fresh tubers were washed, cleaned and knife chopped into small manageable slices and then were spread on a plastic raincoat and dried under direct sunlight within 7days to eliminate anti-nutritional factors (HCN).

Table 1: Feed composition of broiler starter and finisher diets (0-5 weeks)

Ingredients	Treatments %							
	T ₁		T ₂		T ₃		T ₄	
	Starter	Finisher	Starter	Finisher	Starter	Finisher	Starter	Finisher
Sorghum Fetarita	54.5	68.0	36.9	45.0	25.5	33.0	11.0	14.0
Cassava roots	-	-	15.0	15.0	25.0	25.0	40.0	40.0
Groundnut cake	34.0	20.0	38.0	26.0	38.0	28.0	39.0	34.0
Wheat bran	3.4	3.4	2.0	5.4	3.4	5.4	1.9	3.4
Concentrate	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Vegetable Oil	1.5	2.0	1.5	2.0	1.5	2.0	1.5	2.0
DCP	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Anti-Toxins	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Anti-Coccidial	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Premix*	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
NaCl	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Methionine	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Lysine	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Limestone	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Total	100	100	100	100	100	100	100	100

*Vitamin = mineral premix provided the following per kilogram of diet: Vit. A 30789 IU, Vit. D 36 IU, Vit. E 115 IU, Vit. K 77 mg, Thiamine 39 mg, Pyridoxine 39 mg, Riboflavin 115 mg, calcium panthothenate 173 mg, Nicotinic acid 346 mg, VitB12 0.31 mg, Folic acid 19 mg, Manganese 3 g, Zinc 2 g, Iron 1 g, Copper 115 g, Iodine 38 mg, Cobalt 8 mg, Selenium 4 mg, Antioxidant 4 g, Chloride 8 g. T1=0% cassava roots, T2=15% cassava roots of the total rations, T3=25% cassava roots of the total rations and T4=40% cassava roots of the total rations. DCP= Di calcium phosphate.

Table 2: Proximate composition of broiler starter and finisher diets

Calculated analysis	Treatments %							
	T ₁		T ₂		T ₃		T ₄	
	Starter	Finisher	Starter	Finisher	Starter	Finisher	Starter	Finisher
ME* KaCl/Kg	3160.5	3283.9	3150.8	3240.4	3148.7	3232.9	3160.1	3213.0
CP %	22.57	18.1	22.32	18.61	21.4	18.27	20.2	18.62
CF %	5.09	4.15	5.02	4.59	5.06	4.6	4.77	4.6
EE %	4.65	3.90	4.52	3.85	4.28	3.72	3.98	3.7
Ash %	4.66	3.69	4.63	3.92	4.51	3.88	4.27	3.97
NFE %	51.64	58.17	51.77	56.8	52.82	57.08	54.45	56.31
Lysine %	1.03	0.86	1.045	0.9	1.024	0.9	1.0	0.94
Methionine %	0.39	0.34	0.38	0.34	0.36	0.33	0.34	0.32

ME* = Metabolizable energy Kcal/Kg, ME values of the feeds for poultry were estimated according to (MAFF, 1975) Equation, CP = Crude protein, CF = Crude fiber, EE = Ether extract, ASH = Ash, NFE = Nitrogen free extract, T1=0% cassava roots, T2=15% cassava roots of the total rations, T3=25% cassava roots of the total rations and T4=40% cassava roots of the total rations.

Data Collection

Initial body weight of chicks was recorded at the commencement of experiment. Feed consumption and weight gain were weekly measured. Accordingly feed conversion ratio value were calculated. Mortality was recorded throughout the experimental period. At the end of week five, two birds from each pen were selected based on their weights to the average weight of the particular pen, slaughtered. The relative weights of internal organs, carcass and cuts and the length of intestine were recorded.

Meat Characteristics

One sample of broiler meat (breast) from each experimental unit (three birds per treatment) was taken and subjected to chemical analysis to determine crude protein, crude fat, ash, moisture and nitrogen free extract. according to the method of (AOAC, 1990).

Statistical Analysis

Experimental data are presented as mean values \pm standard errors of the mean \pm St. Statistical analysis were carried out using the SPSS 22.0 program package (SPSS, 2013). The significance of the differences among the groups has been determined by Duncan's multiple range Tests (Petrie and Watson 1999).

Results and Discussion

Effect of Dietary Inclusion of Cassava Roots on Broiler Performance During Starter Period (1-3 weeks)

Table 3 shows the effect of inclusion of different dietary levels of cassava roots T1, T2, T3 and T4 on broiler performance. There were significant effects of different treatments on feed consumption and weight gain during this period. however, there was no significant ($0 \geq 0.05$) in feed conversion ratio. The current study showed that when the level of dietary inclusion of cassava roots exceeded T2 the feed intake and weight gain decreased. This current result disagreed with Uchegbu *et al.* (2011) who used cassava roots meal and maize/ sorghum brewers dried grains as replacement of maize at rates 15%, 30% and 45%, concluded that cassava root meal and maize/ sorghum brewers dried grains (CRM/MSBDG) can be successfully incorporated in broiler starter diets up to 30% dietary level. The lower feed consumption and weight gain in T3 and T4 may be attributed to anti nutritional factors in cassava roots. Other deleterious substances which may be present in the diets are protease inhibitors, HCN, tannin and non-starch polysaccharides (Reed *et al.*, 1982), these also affect feed consumption.

Table 3: Performance of broiler chicks fed different levels of cassava root meal at starter phase (1-3 weeks)

Treatments	Parameters		
	Feed intake (g)/ Bird	Weight gain (g)/ Bird	Feed Conversion Ratio (g:g)
T ₁	580.83 ^a	390.64 ^a	1.48
T ₂	587.72 ^a	377.91 ^{ab}	1.52
T ₃	578.19 ^{ab}	378.37 ^{ab}	1.49
T ₄	552.87 ^b	347.20 ^b	1.55
SEM	9.02	11.73	0.028
Sig	*	*	ns

ns= not significant * = significantly at $P \leq 0.05$; SEM= Standard error of mean; ^{a-b} means values within Colum with no common superscripts are significantly different ($P \leq 0.05$)

Effect of Dietary Inclusion of Cassava Roots on Broiler Performance During Finisher Period (4-5 weeks)

There were significant effects of different treatments on feed consumption, weight gain and feed conversion ratio showed in Table 4. In feed consumption values of the birds fed on T4 diets were lower than those were fed on other treatments. The high feed consumption of birds in T1 they had significantly ($P \leq 0.05$) higher body weight gain, and lower feed conversion ratio (FCR). The lowest weight gain was observed in T4 treatment. The poor performance of these birds fed diet T4 could also be due to lower feed consumption. The results obtained were not in agreement with the reports of (Enriquez and Ross 1967; Olson *et al.*, 1969; Tejada and Brambilla 1969; Chou and Muller 1972; Muller *et al.* 1974; Christensen *et al.*, 1977; De Brum *et al.*, 1990). They reported that the recommended maximum

possible inclusion level of cassava roots at rates 40- 60 % in broiler rations. This variation may be due to palatability of cassava-based ration which is an important factor limiting feed intake of poultry. Lower palatability of the diets might be another reason for minimized feed consumption by the broiler chickens (Mahmoudnia *et al.*, 2011). The results obtained not agree with Etalem (2013) who used cassava chips as a replace of corn at rates 0%, 25%, 50%, 75% and 100%. He concluded that, based on dry matter intake and growth performance of broilers, cassava root chips (CRC) could completely replace corn grain in broiler diets as energy feed ingredient. These it could be due to levels used of cassava. The current results agreed with Gowdh *et al.* (1990) who reported that cassava roots depressed the broiler growth when included in the diets at rate (48.6%).

Table 4: Performance of broiler chicks fed different levels of cassava root meal at finisher phase (4-5 weeks)

Treatments	Parameters		
	Feed intake (g)/bird	Weight gain (g)/bird	Feed conversion ratio (g:g)
T ₁	1298.5 ^a	854.29 ^a	1.50 ^b
T ₂	1266.16 ^{ab}	796.31 ^{ab}	1.55 ^{ab}
T ₃	1295.30 ^a	807.82 ^{ab}	1.54 ^{ab}
T ₄	1211.06 ^b	748.86 ^b	1.58 ^a
SEM	16.23	15	0.011
Sig	*	*	*

*= significantly at $P \leq 0.05$; SEM= Standard error of mean; ^{a-b} means values within colum with no common superscripts are highly significantly different ($P \leq 0.05$)

Effect of Dietary Inclusion of Cassava Roots on Broiler Accumulative Performance (Entire Period 1-5 Weeks)

Table 5 shows the accumulative performance of broiler fed varying dietary levels of cassava roots (T1, T2, T3 and T4) as a source of energy during entire period. The results showed that there were significant ($p \leq 0.05$) differences in all treatments in feed consumption and feed conversion ratio. The highest values of feed consumption were recorded in T1, T2 and T3, while the lowest value was recorded in T4. Highly significant ($0 \leq 0.01$) in body weight values were observed. The heaviest body weight was reported with birds fed on control diet (T1), whereas the lowest one observed with birds fed with (T4) diet. The birds fed on control diet had the better FCR than those fed on diets containing cassava. On the other hand, there were differences observed among cassava treatments. The current results disagreed with Stevenson and Jackson (1983) who observed that weight gain was not affected by diet containing 50% cassava roots meal. The lower feed consumption and weight gain may be attributed to anti nutritional factors in 40% inclusion level. Other deleterious substances which may be present in the diets are protease inhibitors, lectins, polyphenolic compounds, saponins, HCN, tannin and non-starch polysaccharides (Piva, 1987; Hughes and Choct, 1999), can also affect the feed consumption. The palatability of cassava ration which is an important factor limiting feed intake of broiler. Lower palatability of the diets might be another reason for minimized feed consumption by the broiler chickens (Mahmoudnia *et al.*, 2011).

Table 5: Accumulative performance of broiler chicks fed different levels of cassava root meal (entire period 1-5 weeks)

Treatments	Parameters		
	Feed intake (g)/bird	Body weight (g)/bird	Feed conversion ratio(g:g)
T ₁	2375.01 ^a	1549.77 ^a	1.53 ^b
T ₂	2283.82 ^{ab}	1423.91 ^{bc}	1.59 ^a
T ₃	2370.97 ^a	1452.00 ^b	1.63 ^a
T ₄	2198.35 ^b	1351.36 ^c	1.62 ^a
SEM	34.72	31.19	0.023
Sig	*	**	*

*= significantly at $P \leq 0.05$; **= highly significantly at ($P \leq 0.01$): SEM= Standard error of mean; ^{a-b-c} means values within Colum with no common superscripts are significantly different ($P \leq 0.05$) and ($P \leq 0.01$)

Effect of Dietary Inclusion of Cassava Roots on Meat Quality of Broiler

The chemical composition of broilers fed different levels of cassava root meal presented in Table 6. There were significant effects of different treatments on crude protein and ether extract. The highest values of crude protein

were recorded in T4 and T1, whereas the lowest values were recorded in T2 and T3. The highest values of ether extract were recorded in T1, T3 and T4 compared to lowest value of fat in T2. The current results showed that there was no significant ($0 < 0.05$) in moisture, dry matter, ash and nitrogen free extract of all treatments. The results obtained was not in agreement with Etalem 2013 who was used cassava chips as a replace of corn at rates 0%, 25%, 50%, 75% and 100%. And he was concluded that, for carcass parameters, cassava roots chips should substitute corn grain not more than 50%. On the other hand, current results showed there were no adverse effects on chemical composition of carcass when using cassava roots at 40% of the total ration (T4). These may be due to levels of cassava used.

Table 6: Chemical composition of meat fed different levels of cassava root meal

Treatments	Parameters %					
	Moisture	DM	CP	EE	Ash	NFE
T ₁	71.17	28.83	17.60 ^a	3.77 ^a	1.43	48.4
T ₂	67.5	32.5	16.37 ^b	3.30 ^b	1.53	46.43
T ₃	69.33	30.67	16.93 ^b	3.67 ^a	1.37	47.47
T ₄	70.17	29.83	17.63 ^a	3.67 ^a	1.3	47.73
SEM	2.07	2.07	0.18	0.073	0.086	2.09
Sig	ns	ns	*	*	ns	ns

*= significantly at $P \leq 0.05$; NS = Not significant; SEM= Standard error of mean; ^{a-b} means values within Colum with no common superscripts are significantly different ($P \leq 0.05$).

Effect of Dietary Inclusion of Cassava Roots on Carcass and Carcass Cuts

Table 7 show the effect of dietary inclusion of cassava roots on carcass and carcass cuts (T1, T2, T3 and T4) as a source of energy. There were no significant ($0 < 0.05$) differences in carcass weight, thigh, drumstick, breast and abdomen fat of all treatments.

Table 7: Carcass and carcass cuts of broiler chickens fed different levels of cassava root meal

Parameters	Treatments				SEM	Sig
	T ₁	T ₂	T ₃	T ₄		
Carcass weight %	73.85	72.29	72.05	73.11	1.29	ns
Breast%	24.82	25.29	24.76	26.06	1.18	ns
Thigh%	5.79	5.63	5.77	5.97	0.419	ns
Drumstick%	4.43	4.5	4.49	4.85	0.205	ns
Abdomen fat%	0.97	1.41	1.08	1.13	0.119	ns

ns= not significant SEM= Standard error of mean

Effect of Dietary Inclusion of Cassava Roots on Internal Organs of Carcass

Table 8 showed that the effect of dietary inclusion of cassava roots on internal organs of carcass (T1, T2, T3 and T4) as a source of energy. There were no significant ($0 < 0.05$) differences in liver. However, there were significant ($0 < 0.05$) differences observed in small intestine weight, pancreases, spleen and highly significant ($0 < 0.01$) in small intestine length. These results agree with Diarra *et al.* (2014) who used cassava roots meal at rate 34.0% concluded that pancreases, small intestine weight affected by cassava copra meal at finisher period. The increased weight of pancreas on the cassava feed was probably an attempt to increase the secretion of pancreatic juice to compensate the deficiency of some amino acids resulting from ant nutritional factors included in cassava meal. The increased in small intestine length and weight were attributed to increased retention time of digesta on fibrous diets. The increased in spleen weight could be due to Hydrogen Cyanide of cassava roots (HCN).

Table 8: Internal organs of broiler chickens fed different levels of cassava root meal

Parameters	Treatments				SEM	Sig
	T ₁	T ₂	T ₃	T ₄		
Pancreas %	0.23 ^b	0.28 ^a	0.27 ^a	0.23 ^b	0.01	*
Liver%	2.17	2.08	2.02	2.28	0.066	ns
Small intestine weight %	1.72 ^c	1.91 ^{bc}	2.36 ^{ab}	2.43 ^a	0.14	*
Small intestine length (cm)	78.69 ^b	90.00 ^b	125.68 ^a	115.81 ^a	4.79	**
Spleen	0.36 ^{ab}	0.51 ^a	0.44 ^{ab}	0.56 ^a	0.041	*

ns = not significant; * = significantly at ($P \leq 0.05$); ** = highly significantly at ($P \leq 0.01$); SEM = Standard error of mean; ^{a-b-c} means values within rows with no common superscripts are highly significantly different ($P \leq 0.01$)

Conclusion

Based on current study cassava roots could be included in broiler diets up to 25% without adverse effects in broiler performance. Also 40% cassava roots enhanced crude protein and ether extract of broiler meat.

Conflict of Interests

There is no conflict of interest.

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