Food Chain, 7:2, 112–124
<http://dx.doi.org/10.3362/2046-1887.00005>

Effect of cassava grits as maize replacement on carcass characteristics of two strains of broiler chickens

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Abstract: *Carcass characteristics are measures of relative proportions of meat and bone, among others, of an animal's carcass and dictate the acceptability by processors and consumers. Carcass characteristics of two strains of broiler chickens fed diets containing varying levels of cassava grits (CG) were determined using 120 (four-week-old) broiler chickens for each of Arbor Acre Plus (AAP) and Marshall (MS) Strains. The birds were randomly distributed into four dietary treatments of CG as replacement for maize (0, 20, 40, and 60 per cent) at finisher phase. Each treatment had three replicates. At the end of the feeding trial which lasted 28 days, four birds with weights close to the group average were selected per replicate, fasted for 24 hours, weighed, and sacrificed for carcass analysis. Data were collected on carcass characteristics and cut parts and analysed using ANOVA. Results showed that strain had no significant ($p > 0.05$) influence on carcass characteristics and cut parts parameters except ($p < 0.05$) relative plucked weight. Broilers fed 0 per cent CG inclusion recorded highest ($p < 0.05$) live weight (2103.75 g). CG levels had no significant ($p > 0.05$) influence on dressed weight and choice cuts (breast, thigh, and drumstick) of chickens. The study concluded that CG could be used to replace up to 60 per cent of maize in finishing diets for broiler chickens without negative effects on dressed weight and choice cuts.*

Keywords: broiler strains, cassava grits, dressed weight, choice cuts, replacement level

Introduction

Carcass yield in livestock production has been identified as one of the measures of performance, and an indicator of biological productivity and economic profitability. Carcass studies give the understanding of the general performance of the animal in terms of weight gain and improved productivity of any class of livestock. According to Taiwo (1981) poultry meat is one of the most consumed meats across the globe. This is because of the improvement in growth and carcass yield, and the high quality carcass with a large amount of muscle, a small amount of bone and fat

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(Devendra and Fuller, 1979; Griffin, 1996), and other organoleptic characteristics such as tenderness and flavour.

A recent concern in broiler strain development, which is also an issue of competition between breeders, is the need to reach a balance between performance and meat yield (Fernandes et al., 2013). Also, the high demand for high quality cut parts such as breast has greatly driven breeding and marketing strategies to meet such demands (Wats and Kennet, 1995; Griffin, 1996; Le Bihan-Duval et al., 2001; Young et al., 2001; Ojedapo et al., 2008). Carcass yield is, therefore, an instrument for the producer and processor to measure profitability and for the consumer to measure value for expenditure, judging by wholesomeness, fat content, acceptability, and meat content among others.

Composition of the carcass, to a large extent, is influenced by a number of factors which include age of the animal, physiological state, species, management/environment, and nutrition profile (Kubena et al., 1972). To a considerable extent, nutrition plays a prominent role because carcass traits are dependent on dietary quality in livestock and poultry production. Taiwo (1981) reported that high fibre level in the diet leads to reduction in the fatness of the carcass. Similarly, dietary protein content, in addition to its effects on weight gain and feed efficiency, has a marked effect on the quality of edible meat and fat content (Poultry World, 2017). The energy component of the diet is also a factor that determines meat quality. Maize is the chief source of energy in diets for monogastric animals (especially poultry) and it constitutes up to 60 per cent of the ration (Afolayan et al., 2012). The high demand and increasing pressure on the use of maize by the human population and livestock feed companies has resulted in scarcity, high cost, and inadequate supply to the livestock industry with resultant high feed cost in developing countries. Means of reducing feed cost without sacrificing technical and biological efficiency are consequently of utmost importance to poultry researchers and farmers. This interest has spurred research with a focus on reduction of feeding cost without negative impacts on performance, product quality, and profitability (Onyimonyi and Onukwufor, 2003; Onyimonyi and Okeke, 2005; Morgan and Choct, 2016). One of the approaches is the use of alternative sources of energy such as cassava (Abubakar and Ohiaege, 2011; Abu et al., 2015).

Cassava (*Manihot esculenta* Crantz) has potential as a dependable alternative to maize (Tewe, 2004). It is one of the most important food crops grown in the tropics (Phillips et al., 2004) and a significant source of calories (Ogunniyi, 2011). Cassava has not been very popular in commercial feeds for livestock production; its utilization has been estimated to constitute only about 19 per cent in animal feed (Oluwole et al., 2004; Maziya-Dixon et al., 2007). Meanwhile, cassava has outstanding advantages. It adapts to diverse environments and farming systems; it is relatively drought tolerant (Morgan and Choct, 2016); and it is readily available in large quantities, but has not been well explored in terms of carcass quality in broiler chickens. Similarly, efficient use of cassava products has been shown to reduce feed costs in broiler production (Ochetim, 1991; Ezeh and Arene, 1994; Abubakar and Ohiaege, 2011; Dairo, 2011; Kana et al., 2014). However, the issue of dustiness of cassava-based feeds could be a major limitation to its adoption and use for poultry production. Processing of cassava into grits could alleviate this problem. There is a dearth of information on carcass performance especially with use of cassava in the grits form. Hence, this study sought to explore the carcass characteristics of two strains of broiler chickens fed diets with varying levels of cassava grits (CG) as energy source.

Materials and methods

Experimental site and location

This study was carried out at the Poultry Unit of the Sustainable Livelihoods and Development Network for Africa (SLIDEN AFRICA) Farm, Alagbede Village, Abeokuta, in Ogun State, Nigeria. This region lies in south-west Nigeria on latitude 7°10′N and longitude 3°2′E. It has a humid climate with mean annual rainfall of 1039 mm, 35.7°C temperature, and altitude of 76 m above sea level (Google Earth, 2016).

Test ingredient and experimental diets

Cassava grits was obtained from a reputable commercial outfit and was used to replace maize at 0, 20, 40, and 60 per cent levels in finisher diets (Table 1).

Table 1 Broiler finisher diets (4–8 weeks) containing varying levels of cassava grits as energy source

Ingredients (kg) As fed basis	*Replacement levels of maize with cassava grits*			
	0%	*20%*	*40%*	*60%*
Maize	550	440	330	220
Groundnut cake	200	200	200	200
Soybean meal	88	88	88	88
Cassava grits	0	110	220	330
Palm kernel cake	67	67	67	67
Wheat offal	38	38	38	38
Bone meal	25	25	25	25
Oyster shell	25	25	25	25
Lysine	1	1	1	1
Methionine	1	1	1	1
*Premix	2.5	2.5	2.5	2.5
Salt	2.5	2.5	2.5	2.5
Total	**1000**	**1000**	**1000**	**1000**
Components of experimental diets determined on a dry matter (DM) basis				
Metabolizable energy (kcal/kg)	3034.91	2990.98	2901.49	2876.87
Crude protein (%)	19.90	19.10	18.90	19.00

Ingredients (kg) As fed basis	*Replacement levels of maize with cassava grits*			
	0%	*20%*	*40%*	*60%*
Ether extract (%)	3.67	3.67	3.68	3.68
Crude fibre (%)	5.23	5.94	5.89	6.38
Components of experimental diets: calculated				
Calcium (%)	1.60	1.62	1.62	1.64
Phosphorus (%)	0.51	0.51	0.51	0.49
Lysine (%)	1.04	1.08	1.08	1.16
Methionine (%)	0.45	0.46	0.47	0.49

Note: * Premix comprised: Vitamin A (IU) 12,000; Vitamin D3 (IU) 2,500; Vitamin E (IU) 30; Vitamin K (mg) 2; Vitamin B1 (mg) 2.25; Vitamin B2 (mg) 6; Vitamin B6 (mg) 4.5; Vitamin B12 (mcg) 0.015; Niacin (mg) 40; Pantothenic acid (mg) 15; Folic acid (mg) 1.5; Biotin (mcg) 0.05; Choline chloride (mg) 300; Manganese (mg) 80; Zinc (mg) 50; Iron (mg) 20; Copper (mg) 5; Iodine (mg) 1; Selenium (mg) 0.2; Cobalt (mg) 0.5; and antioxidant (mg) 125.

Experimental birds and management

A total of 240 four-week-old broiler chickens comprising 120 Arbor Acre Plus (AAP) and 120 Marshall strains were used. Birds of each strain were weighed and randomly assigned to four dietary treatments in a cleaned deep litter open sided housing system. Each treatment was replicated thrice and contained 10 birds per replicate. The birds were fed with experimental diets (finisher diets), as indicated in Table 1, for four weeks between the ages of four and eight weeks. Feed and water were supplied *ad libitum*. Other management practices were carried out when due following the best practice.

Data collection

At the end of the feeding period, four birds whose weights were close to the average of the replicate were selected per replicate for carcass analysis. Selected birds were fasted for 24 hours to clear their guts of wastes, after which they were weighed and then sacrificed through neck decapitation and hoisted to ensure perfect bleeding. Thereafter, they were defeathered, eviscerated (all internal organs and visceral were removed), and dressed (shanks and neck removed). The thighs, wings, drumsticks, breast, and back were separated and weighed. Weights were expressed as percentage of the live weight.

Statistical analysis

Data obtained were subjected to analysis of variance (ANOVA) in a 2×4 factorial arrangement using SAS (2009) package. Means that were significantly different among variables were separated using Tukey as contained in the statistical package.

Table 2 Main effects of strain and cassava as replacement for maize on carcass weight of broiler chickens fed diets containing varying levels of cassava grits

Parameters	*Strain of broiler chickens*		*SEM*	*P Value*	*Replacement levels of maize with cassava grits*				*SEM*	*P Value*
	Arbor Acre Plus	*Marshall*			*0%*	*20%*	*40%*	*60%*		
Live weight (g)	1944.93	1951.67	53.34	0.94	2103.75[a]	2056.25[a]	1885.42[ab]	1747.78[b]	75.43	0.02
Bled weight (%)	95.93	94.63	0.55	0.36	95.91	93.39	95.61	95.14	0.78	0.14
Plucked weight (%)	90.42[a]	89.02[b]	0.45	0.04	90.28	88.89	90.42	89.29	0.63	0.28
Eviscerated weight (%)	75.64	75.69	0.93	0.96	76.62	75.14	76.52	74.36	1.31	0.57
Dressed weight (%)	66.53	65.09	0.67	0.19	67.53	65.45	65.60	64.66	0.95	0.22

Note: [ab] Means on the same row with different superscript are significantly different ($p < 0.05$)
SEM: Standard error of mean

Results

Main effects of strain of broiler chickens and cassava grits on carcass weights

Effects of strain on carcass weights of broiler chickens are presented in Table 2. Strain had no significant ($p > 0.05$) effects on live, relative bled, eviscerated, and dressed weights of broiler chickens. However, relative plucked weight was significantly ($p < 0.05$) influenced by the strain of broiler chickens. AAP recorded higher ($p < 0.05$) plucked weight (90.42 per cent) than Marshall which had a value of 89.02 per cent.

The results (Table 2) also revealed that CG inclusion in the experimental diets had significant effects ($p < 0.05$) on live weight of broiler chickens. Live weight significantly ($p < 0.05$) reduced with increasing levels of CG in place of maize. Birds fed the control diet had the highest live weight (2103.75 g) while the lowest (1747.78 g) was obtained with birds fed the diet in which CG replaced 60 per cent of the maize. However, birds fed a diet containing CG at 20 per cent and 40 per cent maize replacement had similar ($p > 0.05$) live weight (2056.25 g and 1885.42 g, respectively) to the birds fed the control diet. Replacement of dietary maize with CG had no significant ($p > 0.05$) effect on relative bled, plucked, eviscerated, and dressed weights of the broiler chickens.

Interactive effect of broiler strain and cassava grits diets on carcass characteristics

The interactive effect of strain and dietary treatments of CG as replacement for maize on the carcass of broiler chickens (Table 3) showed no significant ($p > 0.05$) differences in live weight and relative bled, plucked, eviscerated, and dressed weights of the birds.

Table 3 Interactive effect of broiler strain and cassava diets on carcass of broiler chickens fed diets containing varying levels of cassava grits at finisher phase

Parameters	*Arbor Acre Plus Strain*				*Marshall Strain*				*SEM*	*P Value*
	0%	*20%*	*40%*	*60%*	*0%*	*20%*	*40%*	*60%*		
Live weight (g)	2093.30	2095.00	1835.80	1755.60	2114.20	2017.50	1935.00	1740.00	106.68	0.10
Bled weight (%)	95.58	94.29	96.16	95.52	96.24	92.49	95.05	94.76	1.10	0.35
Plucked weight (%)	90.32	90.49	90.89	89.97	90.24	87.29	89.95	88.61	0.89	0.16
Eviscerated weight (%)	76.67	76.18	75.04	74.66	76.57	74.11	78.01	74.07	1.86	0.76
Dressed weight (%)	70.09	65.70	64.81	65.54	64.96	65.21	66.40	63.78	1.35	0.12

Note: SEM: Standard error of mean

Main effects of strains of broiler chickens and cassava on cut parts of broiler chickens

Results for the main effects of strains of broiler chickens and CG diets on cut parts of broiler chickens fed diets containing varying levels of CG are indicated in Table 4. Breast, back, wings, head, neck, drumstick, thigh, shanks, and gizzard were not significantly ($p > 0.05$) influenced by strain of broiler chickens.

CG diets had no significant influence ($p > 0.05$) on parameters of cut parts except ($p < 0.05$) head and gizzard. Broiler chickens fed a diet with 40 per cent replacement level had the highest ($p < 0.05$) relative head weight value of 2.65 per cent which

Table 4 Main effects of strains and cassava as replacement for maize on cut parts of broiler chickens fed diets containing varying levels of cassava grits

Parameters	*Strains of broiler chickens*		*SEM*	*P Value*	*Replacement levels of maize with cassava grits*				*SEM*	*P Value*
	Arbor Acre Plus	*Marshall*			*0%*	*20%*	*40%*	*60%*		
Breast (%)	20.21	19.18	0.42	0.10	19.38	20.14	20.14	19.12	0.59	0.52
Back (%)	13.67	14.51	0.39	0.15	14.68	14.63	13.01	14.06	0.55	0.16
Thigh (%)	11.77	11.16	0.26	0.11	11.86	11.62	11.13	11.26	0.37	0.48
Drumstick (%)	9.94	9.84	0.11	0.55	10.08	9.64	9.94	9.91	0.16	0.31
Wings (%)	8.69	8.52	0.08	0.15	8.60	8.64	8.57	8.62	0.11	0.99
Neck (%)	5.06	4.81	0.10	0.10	5.14	4.97	4.74	4.90	0.15	0.29
Head (%)	2.54	2.52	0.04	0.68	2.53^{ab}	2.31^{b}	2.65^{a}	2.63^{a}	0.06	0.004
Shank (%)	4.24	4.15	0.09	0.50	4.26	3.90	4.26	4.36	0.13	0.12
Gizzard (%)	2.34	2.30	0.06	0.60	2.14^{b}	2.21^{b}	2.34^{ab}	2.59^{a}	0.09	0.01

Note: ^{ab} Means on the same row with different superscripts are significantly different ($p < 0.05$)
SEM: Standard error of means

was similar to 2.63 per cent recorded for birds that received the diet with 60 per cent replaced with CG. These values compared with that of birds on the control diet (0 per cent replacement of maize) which recorded relative head weight of 2.53 per cent. Broiler chickens on the diet in which 20 per cent of maize was replaced with CG recorded the least significant ($p < 0.05$) relative head weight (2.31 per cent), but the value was similar to the control.

The relative weight of the gizzard of the birds increased from 2.14 to 2.59 per cent as the quantity of CG increased in the diets. Values recorded for broiler chickens on the control diet and those fed diets with 20 per cent and 40 per cent maize replacement were similar, while birds on the latter diet were comparable to those on the highest replacement level (60 per cent).

Interactive effect of strain and diets on cut parts of broiler chickens

Table 5 shows the interactive effect of strain and diets on cut parts of broiler chickens fed diets containing varying levels of CG as replacement for maize. Interaction had significant ($p < 0.05$) influence on the relative weights of the wing and head of the broiler chickens.

Relative weight of wings varied significantly ($p < 0.05$) as a consequence of interaction between strain of broiler and diets. AAP birds fed a diet containing 60 per cent maize replacement with cassava grits had the highest wing value (9.02 per cent) while the Marshall strain of broiler on the same diet recorded the least (8.22 per cent).

Values recorded for the relative head weight showed that AAP broiler chickens at 40 per cent replacement level had highest ($p < 0.05$) value of 2.76 per cent. This value was similar to the 2.67 per cent recorded for Marshall broilers fed a diet in which cassava grits replaced 60 per cent of maize.

Results revealed, however, that interaction had no significant ($p > 0.05$) influence on the relative weights of breast, back, thigh, drumstick, neck, shank, and gizzard of the broiler chickens.

Table 5 Interactive effect of broiler strain and diets on cut parts of broiler chickens fed diets containing varying levels of cassava grits as substitutes for maize

Parameters	*Arbor Acre Plus Strain*				*Marshall Strain*				*SEM*	*P Value*
	0%	*20%*	*40%*	*60%*	*0%*	*20%*	*40%*	*60%*		
Breast (%)	19.97	20.96	20.04	19.85	18.79	19.32	20.23	18.39	0.83	0.48
Back (%)	14.38	13.32	12.57	14.41	14.97	15.93	13.45	13.70	0.78	0.15
Thigh (%)	12.27	11.89	11.60	11.35	11.45	11.36	10.66	11.18	0.52	0.57
Drumstick (%)	9.95	9.83	10.07	9.92	10.20	9.45	9.81	9.90	0.23	0.52
Wings (%)	8.68^{ab}	8.73^{ab}	8.34^{ab}	9.02^{a}	8.53^{ab}	8.55^{ab}	8.80^{ab}	8.22^{b}	0.16	0.049
Neck (%)	5.26	5.21	4.81	4.97	5.02	4.72	4.66	4.83	0.21	0.40
Head (%)	2.57^{ab}	2.26^{b}	2.76^{a}	2.58^{ab}	2.48^{ab}	2.36^{ab}	2.55^{ab}	2.67^{ab}	0.09	0.02
Shank (%)	4.24	4.00	4.30	4.43	4.29	3.81	4.21	4.30	0.19	0.41
Gizzard (%)	2.08	2.19	2.45	2.64	2.20	2.22	2.22	2.55	0.13	0.06

Note: ^{abc} Means on the same row with different superscript are significantly different ($p < 0.05$)
SEM: Standard error of means

Discussion

The strains of broilers in this study had no influence on the relative dressed weight or carcass yield and the cut parts including the choice cuts (breast, thigh, and drumstick). The findings of Vieira and Moran Jr. (1998), Stringhini et al. (2003), and Moreira et al. (2003) that strains did not influence carcass yield and cut parts gave credence to the results of this study. However, these observations are in contrast with that of Fernandes et al. (2013) who reported that strain significantly influenced carcass parameters of broilers and that of Souza et al. (1994) who observed that breast yield varied across strains of broilers.

In this study, live weight of the broiler chickens had an inverse relationship with the maize replacement levels and thus the CG content of the diets. Influence of varying levels of CG on live weight of the birds is in line with the results of Okpanachi et al. (2014) who observed significant differences in the final weight of broilers. The authors showed that broilers fed 45 per cent cassava tuber meal had smaller weights than those on diets containing 0, 15, and 30 per cent cassava tuber meal. Variations had been found in results of live weight in broiler chickens regarding the use of cassava products. Abubakar and Ohiaege (2011), Kana et al. (2012), and Adeyemo et al. (2014) stated in their reports that live weight was highest in birds fed diets in which 50 per cent of maize was replaced by cassava flour meal while Oso et al. (2014) and Abu et al. (2015) reported that body weight and live weight reduced significantly with increasing cassava root meal level. In the present study, live weight significantly reduced with increased cassava grits level in line with the reports of Oso et al. (2014) and Abu et al. (2015).

The disparity in observations by different researchers could be due to variations in the cassava products utilized and perhaps the level of processing of the products that were used in the various studies. Morgan and Choct (2016) reported that method of cassava processing has a significant impact on its success as a replacement for maize in poultry diets. Cassava should consequently be well processed to reduce anti-nutritional factors while the cassava-based diets should be well formulated to meet nutrient requirements. Where energy requirement of a particular recommendation and composition is not met, reduction in live weight and inconsistency in performance may result. This opinion may explain the variations in live weight of finishing broiler chickens fed diets containing CG and those fed with diets containing other cassava products. However, results obtained in this study indicated that up to 60 per cent of maize could be replaced with CG in finishing broiler diet without significant loss in performance.

Diet influences performance and blood composition of livestock and this explains why blood components have been used for indirect nutrient assessment. Eggum (1989), Onifade et al. (1999), as well as Elagib and Ahmed (2011) reported that growth performance and haematopoiesis is engendered by good dietary level. In this study, relative bled weight of the experimental birds was not influenced by inclusion of cassava grits in broiler diets. According to Sturkie (1976) blood volume represents about 20 per cent of body weight. The low bleeding quantity result obtained could be due to the bleeding techniques employed rather than as a result of the CG utilized in this study as it has been reported by Stevens and George (1966) that different techniques facilitate quantity of bleeding from the jugular vein of chickens.

Higher plucked weight value obtained for AAP could be attributed to the fact that this strain has fewer feathers than Marshall. Feathers on chickens are important in providing protection, maintaining body temperature, enhancing energy utilization, preventing infections arising from bruising of the tissues, and by extension maintaining tissue (meat) quality and profitability. According to Cunningham (2008), chickens with poor feathering could require more feed to produce the energy necessary to compensate for the heat lost from the exposed areas. This could adversely affect feed conversion and result in greater feed costs with negative impact on profitability along the value chain. Feather growth and size have been reportedly influenced by genes, nutrient composition, environment, and hormones (Leeson and Walsh, 2004; Fowler, 2017).

In spite of the higher feather quantity, the Marshall strain of broiler chicken recorded similar dressed weights to those of AAP birds. This observation also corroborated the fact that CG diets in this study meet the nutritional requirement of broiler chickens for production and could be adopted for use in broiler chicken production irrespective of the strain.

From the results, relative bled, plucked, eviscerated, and dressed weights of birds compared well across the varying levels of CG inclusion as replacement for maize in diets of broiler finishers. Hence, diets in this study had no negative influence on these characteristics. This suggests that CG could be adopted in broiler finisher diets without impairing dressed weight or carcass yield of birds. A balanced diet could guarantee that the flock receives the necessary nutrients for overall growth performance, general maintenance, and good yield of carcass. Therefore, CG diets in this study could be adjudged to be adequate in the necessary nutrients required by broiler chickens. The non-significant differences in eviscerated and dressed weights is in accordance with the findings of Eruvbetine et al. (2003) who reported no difference in the eviscerated weight and dressing percentage of birds fed cassava meal diets. In the same vein, Hossain et al. (2013) reported that dressed weight and carcass characteristics were not affected when cassava meal replaced up to 30 per cent of maize in the diet of finishing broiler chickens.

The findings of Montilla (1997), Sahle et al. (1992), and Dahouda et al. (2009), who reported that cassava products had no negative impact on carcass of broiler chickens, geese, and guinea fowl, respectively, at inclusion level between 35 and 45 per cent, also gave credence to the findings of this study. Similarity in dressed weight of the broiler chickens expressed as percentage of live weights between treatment groups is in line with the findings of George and Sese (2012) for broiler finisher birds. Nevertheless, the dressing percentage recorded for birds on all dietary treatments was generally below the 67–68 per cent reported for six-week-old broilers by Patra et al. (2002), the 72 per cent for seven-week-old broilers reported by Fernandes et al. (2013), and the accepted value of 71 per cent for chicken (Schweihofer, 2011). This could be due to the dietary treatments or amount of bone and fat content, among other factors.

The carcass cut parts such as breast, back, thigh, drumstick, and neck and the total dressing percentage of the experimental birds were similar between treatment groups, indicating that dietary treatment did not negatively affect these cut parts. This finding agrees with that of George and Sese (2012) which indicated that the drumstick, neck, and breast showed no significant difference regardless of dietary inclusion of cassava meal. This suggests that the birds generally had good meat yield across the treatments. Superior carcass with maximum proportion of muscle, minimum proportion of bone, and optimum fat content characterized by a high proportion of the most expensive parts or choice cuts, mainly breast and thigh, is highly desirable (Fernandes et al. 2013).

The head weight varied with no definite trend with the inclusion of CG in the diet. The report of Zanu and Dei (2011) that the head weight was influenced by inclusion of processed cassava flour in the diets of broiler chickens gives credence to the result obtained in this study.

Conclusion

Replacement of maize with cassava grits in the diets of Arbor Acre Plus and Marshall broiler chickens had no detrimental effects on dressed weight and choice cuts of broiler chickens. Cassava grits could therefore be used to replace up to 60 per cent of maize in finishing diets for broiler chickens where carcass characteristics are paramount.

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