Growth, blood indices and carcass characteristics of japanese quail (*Coturnix coturnix japonica*) fed cassava grit as replacement for maize with or without β-glucanase

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Abstract

One hundred and eighty (180) unsexed twenty-one day-old growing Japanese quails (Coturnix coturnix japonica) were fed for 28 days with diets in which maize was replaced with cassava grit at 0, 25 and 50% with or without β-glucanase supplementation. The birds were randomly grouped into six treatments in three replicates of ten birds per replicate. Diet 1 was the control without cassava grit while diets 2 and 3 had 25 and 50% of their maize contents replaced with cassava grit respectively. Diets 4, 5 and 6 were the same as diets 1, 2 and 3 respectively but for the inclusion of β-glucanase at 100mg/kg. Feed and water were supplied ad libitum throughout the period of study. Feed intake (590.98g), weight gain (93.77g) and FCR (6.35) were significantly ($p< 0.05$) affected by the dietary treatments. Among the haematological parameters monitored RBC ($4.46x10^6$/UI) and WBC ($26.52x10^3$/UI) were significantly ($p< 0.05$) affected by dietary treatments. Thiocynate (2.57 mg/ml), AST (290.6 U.I/L) and ALT (33.6 U.I/L) were also significantly ($p< 0.05$) influenced by the experimental diets. Replacement of 25 or50% maize with cassava grit in diets of the Japanese quail diets did not have negative effect on haematology and serum biochemistry of the birds. There were however significant differences ($p<0.05$) in the weight of the animals after bleeding and dressing, in drumstick and breast weight of birds fed cassava grit. Weights of the GIT , caeca , empty gizzard, and liver were statistically ($p< 0.05$)affected by the treatments while caeca length and the lungs weight were statistically similar across the treatments. Replacement of maize with cassava grit at 25 and 50% in Japanese quail diets had no negative effect on haematology, serum biochemistry and carcass characteristics of the birds

Keywords: Cassava grit, β-glucanase, Hematology, serum indices and Japanese quail

Introduction

Human population growth, urbanization, and improvement in income are causes of increased demands for foods of animal origin in the developing countries (Abdullah *et al*., 2011). Poultry meat and egg production are more environmentally efficient animal protein production systems compared to ruminant production systems (Mengesha, 2011). The contribution of poultry meat is around 33% of the total global meat production (FAO, 2010). However, this phenomenon is not true for developing countries in Africa, but rather the declining ones (Kearney, 2010). Poultry meat and eggs are cheapest, highly nutritious, without taboos and efficient in feed utilization (Farrell, 2010 and Mengesha, 2011).

Maize is the major source of energy in diets of monogastrics animals in Nigeriaand it also constitutes the most important grain food for human population hence a great pressure on the available quantity of maize. Kubkomawa *et al.* (2013) reported that demand for maize by humans as food and other industrial uses coupled with it low production locally have placed additional

constraints on its continual use in poultry diets hence there is need to seek for readily available alternatives. Akinfala and Tewe (2001) reported that the high prices of conventional feed ingredients in Nigeria increased the feeding cost to about 60-80% of the total cost of intensive livestock production especially for poultry and pigs. There is therefore search for alternative non-conventional ingredients to replace maize in poultry diets (Tewe *et al.,* 1982; Edache *et al.*, 2006). However, there had been various efforts to replace maize in non-ruminant animals (Tewe, 2004; Okon *et al.,* 2007; Egena *et al.,* 2008). Various non-conventional feed ingredients had been used in livestock production to cut cost of production to reasonable levels.

Quail is about the smallest avian specie reared for meat and egg (Panda and Singh, 1990) and has assumed worldwide importance as a laboratory animal (Baumgartner, 1990). Japanese quail (*Coturnixcoturnix japonica*) belongs to the species Galliformes whose ancestral wild are widely distributed in Asian, Africa and Europe. The rearing of Japanese quail (*Coturnixcoturnix japonica*) is becoming more popular and more people are becoming aware of its importance (N.V.R.I., 1996). In the recent times quail nutrition has received increasing attention from the monogastrics and nutrition researchers because of its rapid growth rate, early sexual maturity and small body size, which result in lower cost of production when compared with other poultry species.

Cassava is an excellent source of energy with an average digestible energy (DE) of 1415MJ/Kg (3300-3400 Kcal/Kg). This makes cassava comparable to grains in terms of energy content. With an average dry matter digestibility of 75%, cassava has similar dry matter digestibility with cereals. Enzymes have several novel applications and play critical role in the metabolic activities of livestock (Slominski, 2011). Roxazyme G2G is an exogenous enzyme complex from *Trichodermaviride* with glucanase and xylanase activities reported to increase digestibility of fibrous feed ingredients by disrupting the plant cell walls and reducing the viscosity of the gut contents thereby enhancing nutrient absorption, however documented information on its use remains scanty (Ogunsipe *et al.,* 2001).

The level of cassava grits inclusion that could be tolerated by quails as replacement for maize at growing stage of production with or without β-glucanase supplementation was therefore investigated in this study.

Materials and Methods

The experiment was carried out at the Poultry Unit, Agricultural Extension and Management Research Farm, Federal College of Forestry, Ibadan. The site is on (7°9'N, 32°22'E) located in the rain forest vegetation of the south-west part of Nigeria. It receives an annual rainfall of 133- 1500mm and average relative humidity of about 65%.

Experimental Animal, Design and Diets**:** One hundred and eighty (180) unsexed day-old quail chicks were brooded and fed a common diet for 21 days and there after randomly distributed into six (6) treatments with three (3) replicates of 10 chicks each. All groups were subjected to similar management practices throughout the experimental period of 28 days. Six dietary treatments were formulated with three levels of cassava grit as replacement for maize (0%, 25%, and 50%) at two levels of enzyme (with enzyme and without enzyme) in Completely Randomized Design. Feed

and water were supplied ad-libitum throughout the brooding as well as experimental period. The composition of the experimental diets is presented in Table 1. Production of cassava grit: Cassava variety TME 7 ("OkoIyawo") was obtained and processed into cassava grit as described by Tewe (2004).

Table 1: Composition of experimental diets(%)

	-Enzyme			+Enzyme		
Ingredients	**Diet 1**	**Diet 2**	**Diet 3**	**Diet 4**	**Diet 5**	**Diet 6**
Yellow maize	47.00	35.20	23.50	47.00	35.20	23.50
Cassava grit	0.00	11.80	23.50	0.00	11.80	23.50
Soya Bean Meal	46.00	46.00	46.00	46.00	46.00	46.00
Wheat offal	3.00	3.00	3.00	3.00	3.00	3.00
Limestone	0.60	0.60	0.60	0.60	0.60	0.60
Di calcium phosphate	1.60	1.60	1.60	1.60	1.60	1.60
L-Lysine	0.10	0.10	0.10	0.10	0.10	0.10
DL- Methionine	0.20	0.20	0.20	0.20	0.20	0.20
Premix*	0.25	0.25	0.25	0.25	0.25	0.25
Palm oil	1.00	1.00	1.00	1.00	1.00	1.00
Total	100.00	100.00	100.00	100.00	100.00	100.00

**Premix-Vit A - 12,500,000.00 IU, D_3- 2,500,000.00 IU, Vit E - 40,000.00mg, Vit K_3- 2,000.00mg, Vit B_1- 3,000.00mg, Vit.B $_2$-5,500.00mg,Niacin 55,000.00mg,Calcium Pantothenate -11,500.00mg, B $_6$-5,000.00mg, Vitamin B_{12}-25mg, Choline Chloride - 500,000.00mg, Folic Acid - 1,000.00mg, Biotin - 80.00mg, Manganese - 120,000.00mg, Iron -100,000.00mg, Copper -8,500.00mg, Iodine - 1,500.00mg, Cobalt- 300.00mg, Selenium- 120.00mg, Anti-Oxidant- 120,000.00mg*

Data Collection and Analysis

The data on weekly body weight and feed intake were recorded while feed conversion ratio and body weight changes were calculated at weekly intervals. Meanwhile carcass characteristics of the birds were determined at the end of the experiment. Three quail birds from each replicate were selected and starved for 12 hours but given access to water before slaughtering. The live weight of the quail birds were taken before slaughtering and carcass yield measured as dressing percentage. The weights of the primal cuts were recorded. Haematological and serum parameters were also measured. Performance and Carcass Characteristics**:** Average daily feed intake (g), Average body weight gain (g), Feed conversion ratio (FCR), Mortality, Dressed weight weight (g), Dressing Percentage (%), Primal Cuts (%), Organ weights (% of dressed weight), Intestinal weight (%) and length (cm)

Blood Parameters: At the end of the feeding trial, fifty-four birds, nine per treatment, and three per replicate were selected very early in the morning. Two sets of blood samples were collected from each bird with one set collected into sample bottles containing Ethylene Diamine Tetra Acetic (EDTA) acid as anticoagulant for haematological analysis while the other set was collected into sample bottles without anticoagulant for serum biochemistry. The blood samples were transported to the laboratory in a cold pack.

Hematological parameters: Pack Cell Volume (%) was determined using haematocrit method as described by Dacie and Lewis (1991). Red Blood Cells ($x10^6$/UI) and White Blood Cells ($x10^6$/UI), were determined according to the method described by Jain (1986) and Haemoglobin concentration (g/100ml) was determined by the cynomethaemoglobin method Kachmar (1970). Serum Biochemistry Parameters: Total Protein (g/dl) was determined according to Biuret Method (Reinhold, 1953), while albumin (g/dl) level was obtained using Bromocresol green method as described by Peter *et al.,*(1982). Blood glucose (mg/dl) level was determined according to the method recommended by Cooper *et al.,* (1970). Creatinine (g/dl), Aspartate Transferase (AST), Alanine Transferase (ALT) and thiocynate were determined using spectrophotometric method.

Chemical analysis: The diets and the cassava grit were analyzed for proximate composition according to official methords of the association of the official analytical chemists (AOAC, 1989).

Statistical Analysis of Data

The data obtainable from the experiment were statistically analyzed using the procedure of SAS (2003) while differences in treatment means detected by ANOVA were separated using Duncan Multiple Range Test. Statements of statistical significance was based on a probability of $P<0.05$.

Results

Table 2 shows the proximate composition of cassava grit prepared from TME 7cassava variety. Dry matter was high (91.3%), crude protein was expectedly low (2.06%), crude fibre (2.95), Ether Extract (0.26), Ash (2.5) and Nitrogen Free Extract (92.23).

Table 3 shows the Proximate Composition of Experimental Diets in terms of dry matter (89.21-90.76), the crude protein of diet reduced with cassava grit inclusion (22.96-20.73). Ether extract increased with cassava grit inclusion (8.00-10.00), Crude Fiber (3.70-4.30) and Nitrogen Free Extract (49.90-57.57).

Table 2: Proximate composition (%) of test ingredient

Parameter	Percentage (%)
Dry matter	91.30
Crude protein	2.06
Crude fiber	2.95
Ether extract	0.26
Ash	2.50
Nitrogen free extract	83.53

Table 3: Proximate composition of experimental diets (%)

	-Enzyme			+Enzyme		
Nutrient (%)	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6
Dry matter	90.52	89.02	90.01	89.21	90.76	89.71
Crude protein	22.43	21.97	20.73	22.96	22.14	21.64
Crude fiber	4.00	3.70	4.20	4.30	4.00	4.10
Ether extract	8.00	9.00	10.00	10.00	9.00	10.00
Ash	12.00	9.00	9.00	12.00	15.00	12.00
Nitrogen free extract	54.03	57.57	54.37	52.06	49.90	51.94

Table 4 shows the effect of replacing maize with cassava grit on the growth performance of growing Japanese quail *(Coturnix coturnix japonica).* The result revealed that dietary treatments affected all the growth parameters considered significantly ($p < 0.05$). Although the initial body weights appeared to be the same when birds were moved into the cages, period they were allowed to adjust to the cage system may be indirectly responsible for the significant difference in the initial body weight (44.65-56.01g) as at the commencement of feeding trials.

The final body weights reduced with increase in the level of cassava grit in birds on enzyme supplementation from 145.49g – 129.27g. The average weight gain of the experimental birds on enzyme supplementation reduced significantly ($p < 0.05$) as the level of cassava grit in the diet increased. The result showed inverse relationship between the weight gained and feed conversion ratio which expectedly incased with increase in the inclusion rate of cassava grit

Table 4: Effect of replacement of maize with cassava grit with or without β- glucanase on growth parameters of growing Japanese quail (*Coturnix coturnix* japonica)

	-Enzyme			+Enzyme			
	Diet 1	**Diet 2**	**Diet 3**	**Diet 4**	**Diet 5**	**Diet 6**	**SEM**
Initial body weight (g)	52.06	53.01	44.65	47.93	44.83	50.69	±1.17
Final body weight (g)	140.81^{a}	130.29^{ab}	138.40^{b}	145.49^{a}	136.64^{b}	129.27^{b}	±1.98
Feed intake (g)	600.00^{ab}	609.53^{a}	590.98^{ab}	576.75^{c}	606.03^{a}	602.30^{ab}	±4.001
Weight gain (g)	88.75^{ab}	77.29^{a}	93.77^{a}	97.56^{a}	91.81^{ab}	80.31^{c}	±2.44
Feed conversion ratio	6.78^{ab}	7.89^{a}	6.35^{b}	5.96^{c}	6.62^{ab}	7.52^{a}	±0.22

^{abc}means in the same row with different superscripts are significantly different (P<0.05)

*SEM= Standard error of the means

Among the haematological and serum biochemical parameters investigated (table 5), packed cell volume (PCV) and Haemoglobin were statistically similar across the treatments with birds on diet 2 and 3 recording the highest (44 %) and lowest (41.89%) respectively. Meanwhile, red blood cells (RBC) and white blood cell (WBC) increased significantly ($p< 0.05$) with the level of cassava grit in the diets. It also appears that enzyme supplementation influenced these parameters as diet 6 had highest values (4.46 and 26.52) in them, respectively.

The results of serum biochemical indices showed significant (P<0.05) differences among the dietary treatment in thiocynate (1.09-2.57 mg/ml), AST (228.00-290.58 UI/L) and ALT (19.75-33.63 UI/L). However, albumin (1.09-1.53g/dl), creatinine (0.39-0.69mg/dl) and total protein (3.26-3.83mg/dl) remain similar across the treatments.

Table 6 shows the response of carcass characteristics of growing Japanese quail to replacement of maize with cassava grit with or without β- glucanase. The result showed that all the parameters examined with the exception of dressed weight, caecal weight and caecal length were significantly (p<0.05) affected by the dietary treatment. Moreover live body weight decreased significantly (p<0.05) with increasing levels of cassava grit in the diets from 133.6-121.45g. The heart weight in relation to the live weight increased with cassava grit levels in the diets and ranged from 0.89 % to 1.37 %. Other carcass characteristics do not follow specific pattern.

Table 5: Effect of replacement of maize with cassava grit with or without β- glucanase on serum and haematological parameters of growing Japanese quail (*Coturnix coturnix* japonica)

	-Enzyme			+Enzyme			
Serum parameters	**Diet 1**	**Diet 2**	**Diet 3**	**Diet 4**	**Diet 5**	**Diet 6**	**±SEM**
Thiocynate (mg/ml)	1.09^{c}	1.59^{bc}	2.57^{a}	1.52^{bc}	2.45^{ab}	2.04^{abc}	0.15
Total protain (mg/dL)	3.36	3.44	3.65	3.26	3.83	4.62	0.15
Albumin (g/dL)	1.51	1.39	1.42	1.40	1.53	1.48	0.02
Creatinin (mg/dL)	0.52	0.69	0.45	0.60	0.39	0.42	0.06
AST (U./I/L)	237.27^{c}	266.12^{ab}	290.58^{a}	228.00^{c}	251.47^{ab}	247.08^{b}	6.31
ALT (U.I/L)	27.90^{ab}	33.63^{a}	22.61^{b}	19.75^{b}	27.90^{a}	25.32^{ab}	1.25
Haematology parameters							
Packed cell volume (%)	42.33	44.11	41.89	43.44	42.78	42.25	±0.52
Haemoglobin (g/100ml)	14.31	14.90	14.10	14.60	14.21	16.77	±2.34
Red blood cell ($x10^{6}$/UI)	3.21^{b}	3.31^{b}	3.44^{a}	3.44^{b}	4.23^{a}	4.46^{a}	±0.11
White blood cell ($x10^{3}$/UI)	21.01^{bc}	20.46^{c}	21.73^{bc}	20.01^{c}	23.55^{c}	26.52^{a}	±0.45

^{abc}means in the same row with different superscripts are significantly different (P<0.05)
*SEM= St andard error of the means, AST= Aspartate amino transferase, ALT= Alanine amino transferase

Table 6: Effect of replacement of maize with cassava grit with or without β- glucanase on carcass characteristics of growing Japanese quail *(Coturnix coturnix* japonica)

	Diet 1	**Diet 2**	**Diet 3**	**Diet 4**	**Diet 5**	**Diet 6**	**±SEM**
Live weight (g)	133.66^{a}	125.67^{ab}	123.32^{b}	127.78^{ab}	125.47^{ab}	121.45^{b}	1.36
Warm carcass (%)	90.18^{a}	88.55^{ab}	91.07^{a}	86.26^{b}	85.97^{b}	90.92^{a}	0.54
Dressed carcass (%)	77.88	78.57	74.75	76.1	75.91	75.94	0.57
Breast weight (%)	23.06^{b}	23.44^{b}	22.88^{b}	25.18^{ab}	26.00^{a}	23.16^{b}	0.32
Gastro intestinal tract (%)	6.34^{a}	6.53^{a}	4.30^{b}	4.12^{b}	4.05^{b}	5.77^{a}	0.17
Caecal weight (%)	0.33	0.37	0.36	0.34	0.35	0.37	0.06
Caecal length (cm)	3.81	3.73	4.15	3.93	3.94	4.14	0.07
Heart weight (%)	0.89^{b}	1.00^{b}	1.12^{ab}	0.99^{b}	1.12^{ab}	1.37^{a}	0.10
Liver weight (%)	1.82^{ab}	1.53^{b}	2.38^{a}	1.60^{b}	2.48^{a}	2.21^{ab}	0.01
Empty gizzard (%)	2.14^{c}	2.67^{b}	2.25^{bc}	2.10^{c}	2.57^{abc}	2.80^{a}	±0.07

^{abc}means in the same row with different superscripts are significantly different (P<0.05)
*SEM= Standard error of the means

Discussion

Growth Performance: The growth performance of Japanese quails as revealed by this study shows the initial body weights to be statistically different across the treatments. This is possibly as a result of the birds' differential early response to change in housing system (from deep litter to cages). However, the results show that the initial weight differences did not necessarily influence the general response of the experimental birds to the dietary treatments. This agrees with the findings of Babangida and Ubosi, (2006). The general growth performance of the Japanese quail to the experimental diets show that enzyme supplementation influenced (positively or negatively? the performance of the birds fed cassava grit as replacement for maize. Feed intake were lower (576.75-606.03g) with enzyme supplementation than without enzyme (590.98-609.53g). This is constant with the findings of Hajati*et al.* (2009) and Ogunsipe *et al.* (2015).

The weight gain of Japanese quail (88.75-93.77g) do not follow specific pattern in birds without enzyme supplementation but were better (80.31-97.56g) in birds on diets with enzyme supplementation. The weight gained also declined with increase in cassava grit levels in the experimental diets. This agrees with the reports of Makled and

Afifi (2001) who reported reduced growth rate as maize was substituted with cassava grit. This may be due to the presence of NSPs and other possible anti- nutritional factors in the test ingredient, the effects of which were reduced by the supplementation with exogenous enzyme. This was clearer in the results of FCR where birds on diets 4 (5.97) had the best value.

The finding of this study agreed with past findings (Senkoylu *et al*., 2007) on the increasing changes in feed conversion ratios with increase in the level of cassava grit.

Blood Profile: The effect of replacement of maize with cassava grit with or without β-glucanase on the *hae*matological parameters of growing Japanese quail is as shown in Table 5, only the RBC and WBC were significantly ($P<0.05$) affected with birds on diet 4 (control with β- glucanase) recording the highest values of $4.46x100^6$/UI and $26.52x100^6$ UI respectively which are higher than past findings (Oladunjoye et al., 2010 and Akandeet al., 2012). This may be an indication that experimental diets influenced these haematological parameter significantly and that the birds on these diets were healthy. Although the WBC significantly differed from as found in quails fed other test ingredients but it is very close to the results ($25.45x100^6$ UI) of Abu et al. (2013) who fed cassava grit to broiler chickens. The results from the study showed that PCV and Haemoglobin were statistically similar among the treatments with birds on diet 3 recorded lowest values of 41.89% and 14.10g/100ml respectively which are higher than the results from broilers fed the same test ingredient. Since these parameters reflect the response of animal to its environment and diseases it shows that the animals were healthy and with ability to withstand stress.

Most of the serum parameters considered were significantly similar with only Asprtate transminase (AST) , Alanine transminase (ALT) and thiocynate being significantly 58UI/I) ($P<0.05$) affected by the treatment. Highest levels of AST (290.58) and ALT (33.63UI/I) were recorded in birds on diets 3 and 2 respectively. This result may indicate that quail has a little more challenge in handling digestion of cassava grit than broilers which are heavy consumers. Birds on diets containing 0% replacement of maize with cassava grit expectedly recorded lowest thiocynate (1.09 and 1.52) at both levels of supplementations.

Meanwhile experimental birds on control diet recorded the highest serum glucose level of 344.57 this was higher than that seen in broiler fed cassava grit (Abu *et al.,* 2013) which may be as a result that quails are far more active than broilers. It was also higher than findings on quails by other studies (Vijay *et al.,* 2010 and Jatoi*et al.,* 2013). The total protein and albumin which are not significantly different ($p > 0.05$) recorded in this experiment are lesser than that of Okpanachi*et al.,*(2014) which fed graded levels of cassavaTuber Meal, Brewer's Dried Grain and Palm Oil Mixture to broiler chicks. However the level is within the recommended range.The protein according to Okpanachi*et al.,* (2014)make up of an animal is of important diagnostic significance because they are involved in enzyme, hormones and antibodies synthesis and as a reserve source of nutrition for the body tissues and muscle.

Carcass Characteristics: The carcass characteristics of the Japanese quails as shown in this study revealed similarity between the carcass characteristics of

interest in the birds fed cassava grit as replacement for maize with or without β-glucanase at the growing stage. Although birds on diet 1 (control) and diet 3 (50% cassava grit as replacement for maize without β-glucanase) had the highest (142.61g) and lowest (115.33g) values respectively in terms of live weight of the birds.

The carcass dressing percentage values (75.91-7.57%) obtained in this study was lower than what was obtained in past study (73.85-88.67%) by Ani and Omeje *et al.* (2012) but higher than what was reported (68.7-73.7%) by Kana *et al.,*(2012). Although the live weight of birds on enzyme supplementation was significantly lower than those without enzyme supplementation but the result shows that their dressing percentage was similar across the treatments.

It appears that, birds that consumed the control diets had more feathers and viscera. The caecal weight (%), ceacal length (cm), heart weight (%), liver weight (%) and gizzard (%) which increased significantly with increased cassava grits could be attributed to the NSPs content of cassava grit. This result is consistent with past findings (Kana *et al.,* 2012 and Ani and Omeje, 2012).The breast meat of the birds were not significantly different with birds fed diets 5 and 4, yielding the highest (26.0%) and lowest (21.85%) breast meat respectively.

The increase in relative weight of empty gizzard (2.14-2.80%) is in agreement with that reported byIbiyo and Atteh (2005) and, Ani and Omeje (2012). The gizzard might have increased weight because of the extra muscular work required to digest the cassava grit diets which had higher fibre levels than the control diets. This agreed with reports of Iyayi and Egbarevba (1998) and Ani and Omeje (2012).

Conclusion and Recommendation

From this study, it has been shown that the usage of cassava grits in replacement of maize at 50% level of inclusion can yield rewarding results when fed to Japanese quail *(Coturnix coturnix japonica)* especially in the presence of appropriate exogenous enzyme.

According to the findings, one could deduce that diet 6 (50% inclusion of cassava grit as replacement for maize with enzyme) had an edge over other diets in most of the parameters considered. It is therefore recommended that:

1.Since Nigeria is the largest producer of cassava in the world, more work should be done in the area of developing and exploring other cassava based products that can be useful as animal feed.

2.The use of cassava grit in the livestock feed should be encouraged as it has high dry matter that can increase the shelf life and reduces the cost of the livestock feed.

3.Cassava breeders should develop cassava that is higher in crude protein using biotechnology so that it can close up with the crude protein value of maize as this could increase the substitution value of cassava for maize in livestock diets.

4.Quail production should be encouraged at commercial level as they can utilize most of the crops that can substitute maize with little or no production deficiency. From this study, it does not appear that feeding cassava grits to quails is advisable because the FCR values were too high.

5.That exogenous enzyme should be used when cassava is included in monogastric feeds for better response.

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