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Original Research Article

Blood chemistry of weaned rabbits fed cassava peel meal as replacement for maize in the tropics

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Abstract

This study investigated the haematological and serum biochemical indices of rabbits fed different levels of cassava peel meal as replacement for maize. The study utilized 60 crossed bred weaned rabbits of both sexes aged between 5 and 6 weeks old with an average initial weight of 698.38± 0.02g. There were 5 experimental diets formulated with 0, 25, 50, 75 and 100% replacement levels of cassava peel meal (CPM) for maize designated as treatments T_1, T_2, T_3, T_4 and T_5 respectively. The animals were randomly assigned to treatments after weight equalization using a completely randomized design with each dietary treatment having 12 rabbits. The feeding trial lasted for 25 weeks. At the 25th week, blood samples were collected from 30 rabbits (6 per treatment) via the prominent ear vein. Samples for haematological assay were collected into ethylene diamine tetra acetate (EDTA) bottles while blood samples for serum biochemical assay were collected into plain bottles without anticoagulant. The assay was carried out in the haematology laboratory using standard protocols and all results were subjected to one – way analysis of variance (ANOVA). Results showed that all the blood indices were within the normal acceptable biochemical ranges for apparently healthy rabbits, with only the white blood cell counts (WBC), red blood cell counts(RBC), platelets, neutrophils and serum creatine being significantly (P<0.05) influenced by dietary treatments. The study concluded that blood chemistry (haematological and serum biochemical indices) of rabbits fed up to 100% cassava peel meal as replacement for maize was not adversely affected. Hence, rabbit farmers are encouraged to utilize this readily available agro-industrial waste in rabbit feeding without fear of compromising the haematopoietic activity vis- a- vis the health status of the animals.

Keywords: Blood, Cassava peels, Nutrition, Rabbits

INTRODUCTION

The current geometric rise in human population has been identified as one of the main reasons for low protein intake, malnutrition and chronic hunger especially in developing countries (United Nations Development Programme, UNDP 2010). Population growth has a major impact on food availability, as it results in both increased competition for available resources and demand for food (FAO, 2012). According to UNDP (2010), an estimated 10.3% of the world's population is undernourished. Accordingly, one third of the protein needs is linked directly to animal products. This has neces-sitated researchers and producers to shift focus on the production and development of micro livestock like snails, grasscutters, rabbits and quails to meet this rising demand in the consumption of meat. Rabbits have the potential of alleviating the challenges of increase in meat consumption in developing countries (Oyadeyi et al., 2011). Rabbit production can strive favourably if the alternative feed resources that are able to withstand harsh environmental conditions are employed. According to Ayinde and Aromolaran (1998), in a study to determine the problems plaguing rabbit production in Nigeria; 48 % of the farmers considered high cost of feeds as their major problem, 22 % reported high cost of feed inputs, another 22 % reported inadequate supply of good parent stock for breeding while 8 % reported outbreak of diseases. Despite these identified problems; rabbit production has continued to strive owing to the fact that the animals are very prolific with short gestation length of 30 ± 2days and quick attainment of maturity (Oyadeyi et al., 2011). Rabbit meat is healthy as it is low in cholesterol (50g/100g); fat (4g/100g); energy (124Kcal/100g) but high in protein (22g/100g) (Aduku and Olukosi, 1990). The meat has complete amino acid profile compared to plant protein sources; it has good flavour, rich in nutrients as well as easily digestible (Cheeke, 1986).However, there are no organised markets for the sale of rabbit meat in Nigeria. This is unlike beef, mutton, chevon, broilers or spent layers. This could be attributed to the subsistence level of production and inadequate awareness on the nutritional value of rabbit meat (Ozung, 2016). But, the recent interest in rabbits among the elites is slowly but steadily creating more market for rabbit meat in the country (Onifade et al., 1999).

Increase in the use of conventional feedstuffs has led to a stiff competition between human and the livestock industry for available resources (Mmereole, 1996). The use of agro – industrial by- products has proffered solution to the problem of huge cost and non-availability of conventional ingredients (Babatunde et al., 2001).Non-conventional feeding stuffs include several agro-industrial wastes such as castor bean, kolanut husk, cocoa pod husk, pineapple waste, poultry waste, shrimp waste, brewers dried grain, wheat offal, maize bran, cassava peels, etc. Most of these non-conventional feed stuffs can pose a threat to the livestock if not properly processed and handled (Babatunde et al., 2001; Dairo et al., 2005).

One of the most effective ways of assessing the physiological and health status of livestock is through blood profiling. It is important to determine the effect of non-conventional feeding stuffs on animals (Esonu et al., 2001). Haematological studies are important tools for disease diagnosis and feed stress monitoring (Togun and Oseni, 2005). The influence of diets on haematological indices is very significant (Babatunde et al., 1987). Since the blood is the main means of transportation of nutrients in the body, haematological profiling provides valuable information on the body reaction to toxic damages (Ihedioha et al., 2004.). Blood indices change in response to the physiological status of livestock (Oke et al., 2007).Blood analysis in any feeding trial provides an accurate and faster means of evaluating the clinical and physiological status of the animals; since the effect of different dietary components consumed can be determined in the blood (Olabanji et al., 2007).

According to Hrubec et al.(2002), full blood counts provide vital information on the cellular constituents of blood, while biochemical examination shows the chemical parameters. Furthermore, examination of blood provides the opportunity to clinically investigate the presence of several metabolites and other constituents that play vital roles in the physiological, nutritional and pathological status of animals. Haematological studies enable easier diagnoses of various blood and non-blood diseases. Above all, the knowledge of the blood components in livestock will assists in associating certain inherent resistance to infections with certain blood characteristics (Anosa and Isoun, 1978), such studies give effective guidelines on blood transfusion, breeding programmes for disease resistance, control and treatment of certain disease disorders (Mmereole,1996).

This study was therefore designed to investigate the effect of replacing maize with cassava peel meal on the blood chemistry of rabbits in a tropical environment.

MATERIALS AND METHODS

Location of the study

The study was carried out at the Rabbitry Unit of the Teaching and Research Farm, University of Calabar, Calabar, Cross River State, Nigeria. According to the GeoNames geographical database by Google Earth (2019), Calabar is located at 4.9517º latitude and 8.322º longitude (in decimal degrees) with an elevation/altitude of 42 metres above sea level. The annual rainfall ranges between 3000and3500mm and the average daily temperature is 25ºC/77ºF increases to 30ºC (86ºF) in August. The relative humidity is between 70 and 80% while the wind speed/direction is 8.1km/h west and the cloud is broken at 1000ft with little cumulonimbus at 2200ft.

Processing of the test ingredient (Cassava peel meal, CPM)

Fresh composite cassava peels were collected from cassava processing locations within Odukpani and Akamkpa LGAs in Cross River State, washed and sun dried to constant weight before milling. The milled cassava peel samples were stored in sterile po-lythene bags at room temperature and kept to be used as

Table 1. Gross Composition of the experimental diets

Ingredient	T_1 (0%)	T_2 (25%)	T_3 (50%)	T_4 (75%)	T_5 (100%)
Maize	30.00	22.50	15.00	7.50	0.00
SBM	12.70	12.70	12.70	12.70	12.70
Cray fish dust	4.00	4.00	4.00	4.00	4.00
PKC	7.00	7.00	7.00	7.00	7.00
Wheat offal	15.00	15.00	15.00	15.00	15.00
Rice husk	25.00	25.00	25.00	25.00	25.00
Cassava peel meal	0.00	7.50	15.00	22.50	30.00
Bone meal	2.50	2.50	2.50	2.50	2.50
Methionine	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Premix	0.20	0.20	0.20	0.20	0.20
Salt	0.10	0.10	0.10	0.10	010
Palm oil	3.00	3.00	3.00	3.00	3.00
Total	100.00	100.00	100.00	100.00	100.00
Calculated values:					
% CP	16.62	16.71	16.79	16.89	16.98
% CF	9.98	10.13	10.45	10.92	10.96
Determined analysis:					
%CP	16.50	16.65	16.75	16.85	16.95
%CF	9.76	10.05	10.31	10.61	10.47
*ME (Kcal/kg)	2,482.05	2,391.53	2,279.28	2,155.90	2,022.02

Gross Composition of Bio –Super Premix per Kg; Vitamin A-1,500,000IU; Vitamin D3-300,000IU; Vitamin E-400mg; Vitamin B2-400mg; Vitamin B12-2,000mg; Nicotinamide-2,000mg; Calcium D Panto thenate-800mg; Choline Chloride-40,000mg; Ferrous Sulphate-2,000mg; Manganate Sulphate-5,000mg; Copper Sulphate-80mg; Zinc Oxide-3,000mg; Cobalt sulphate-10mg; Potassium Iodide-120mg; DL-Methionine-10,000mg and Antioxidant-18,000mg. The premix was manufactured by Bio-Phamachemic Company HCM city, CF-Crude fibre, CP- Crude Protein, SCPM- Sun dried cassava peel meal, SBM- Soybean meal, PKC-palm kernel cake, ME-metabolizable energy.
*ME calculated from Pauzenga (1985) equation:
ME= (37 × %CP + 81.8 × % EE + 35.5 × %NFE)

replacement for maize in the test diets. The proximate composition of experimental diets was determined using the A.O.A.C (2000) methods.

Experimental diets

Five experimental diets were formulated comprising ratios of 100:0, 75:25, 50:50, 25:75 and 0:100 maize: sun dried CPM for T_1, T_2, T_3, T_4 and T_5 respectively. Treatment 1 served as the control diet without CPM. The proximate composition of the experimental diets was carried out based on the procedures outlined by A. O. A. C. (2000). The gross composition of experimental diets is presented in Table 1.

Experimental animals and management

Sixty cross bred weaned rabbits (30 ducks and 30 does) between 5 and 6 weeks old with an average initial weight of 559.58 ± 0.42g/rabbit were used in the study. The rabbits were obtained from the rabbitry unit of the University of Calabar Teaching and Research Farm. They were randomly assigned to five different dietary treatments after equalizing for body weight. Twelve rabbits were assigned per treatment with each rabbit serving as a replicate. The rabbits were conditioned in the project site for two weeks and were screened against ecto and endo parasites using Ivermectin administered subcutaneously based on their body weight. The rabbits were provided with formulated diets and water *ad libitum* on a daily basis. A uniform quantity of partially wilted *Tridax procumbens* was also provided for the rabbits as supplementary forage in the evening hours. The experimental feeding trial lasted for nine weeks after the two weeks adjustment period.

Housing and equipment

The rabbits were housed in wooden double tier cages, covered with wire mesh and measuring 65 × 65× 65cm and raised 25cm from ground level. Concrete watering and feeding troughs were placed in each cage.

Experimental design

The rabbits were assigned to dietary treatments using a completely randomized design (CRD), with 12 rabbits per treatment.

Blood collection

At the end of the feeding trial, two blood separate samples were collected per rabbit from the prominent ear vein with hypodermic needle and syringe from 6 rabbits in each treatment into clean test tubes; one with anticoagulant (Ethylene Diamine Tetra Acetate, EDTA) for haematological analysis and the other without anticoagulant for serum biochemical assay.

Determination of haematological and serum biochemical indices

The haematological parameters were determined by conventional laboratory methods of Baker and Silverton (1992) as described in Bitto and Gemade (2001). Serum total protein (STP) was determined by the Biuret method as described in Kohn and Allen (1995). Albumin was determined using Bromocresol Green (BCG) method as reported in Peter *et al*. (1982). The albumin/globulin ratio was obtained by dividing the albumin value by the globulin value. Alanine amino transferase (ALT) and Aspartate amino transferase (AST) activity were determined using the spectrophotometric method. Serum glucose, cholesterol, sodium, calcium, phosphorus, potassium, chloride, urea, triglycerides and creatinine were also determined by standard laboratory methods described in Ochei and Kolhathar (2007).

RESULTS AND DISCUSSION

Results of haematological characteristics and serum biochemical indices of rabbits fed cassava peel meal as replacement for maize are presented in Tables 2 and 3 respectively. The results were compared with values in the control diet and also with the normal blood reference values for apparently healthy rabbits. Some of the haematological parameters (white blood cell counts, red blood cell counts, platelets and neutrophils) as well as serum biochemical indices (creatinine, sodium electrolyte, triglyceride, AST and ALT) were significantly ($P<0.05$) influenced by dietary treatments. The results of the haematological parameters obtained in this study were within the normal clinical ranges reported by Mitruka and Rawnsley (1997), Kronfield and Mediway (1975), Jones (2005) and Medirabbit (2011) for rabbits. This is an indication that the experimental diets did not adversely affect the haematopoietic processes of rabbits. There were significant differences ($P< 0.05$) across dietary treatments in some haematological indices like the white blood cell counts, red blood cell counts, platelets and neutrophils which were lowest in rabbits fed the control diet. This suggests that the cassava peel meal may not have interfered with the blood forming cells in the rabbits. Afolabi et al. (2010) opined that other factors like environmental and disease conditions may also alter the physiological status of an animal. Eheba et al. (2008) postulated that a reduction in white blood cell counts, showed a decline in the ability of the body to produce a defensive mechanism against infection. Increased red blood cell counts are indication that the dietary protein were of high quality with disease free animals (Eheba et al., (2008). The results of this study contradicted the reports of Okoye et al. (2006) and Ozung et al.(2011) who recorded non-significant ($P >0.05$) effect for dried cassava peel meal fortified with local species and 75% replacement of cassava peel meal formaize, respectively. The results however, corroborated the report of Etim and Oguike (2011) for rabbits fed *Aspilla africana* leaf meal based - diets.

Packed cell volume, haemoglobin concentration, mean corpuscular volume (MVC), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were not significantly ($P >0.05$) affected by dietary treatments. The values obtained in this study were similar to those reported by Etim and Oguike (2011), Ahamefule et al. (2006) and Njidda and Isidahomen (2010). Packed cell volume are responsible for nutrient absorption and oxygen transportation Normal range of values for haemoglobin revealed that the vital physiological relationship of haemoglobin with oxygen in the transport of gases to and from the tissues of the body has been maintained and was normal (Njidda and Isidahomen, 2010).The mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration are diagnostic tools in determining anaemia. Results obtained for neutrophils, eosinophils and lymphocytes were similar to the ranges reported by Ahamefule et al. (2006) for different forms of processed cassava peel meal but slightly lower than the reports of Bitto and Gemade (2001), Etim and Oguike (2011) and Ozung et al. (2011) for pawpaw leaf meal, *Aspilia africana* leaf meal and 75% replacement of cassava peel meal used in their respective investigations.

The Basophils were very low and almost negligible as well as not significantly ($P> 0.05$) affected by dietary treatments in this present study. This affirms the reports of Bitto and Gemade (2001) and Ozung et al. (2011) who reported low level and absence of basophils in their findings with pawpaw leaf meal and 75% replacement of

Table 2. Haematological characteristics of rabbits fed cassava peel meal-based diets

Parameter	T_1(0%)	T_2(25%)	T_3(50%)	T_4(75%)	T_5(100%)	S.E.M	Ref. ranges*
White blood cell counts ($x10^3$)	6.35^b	9.73^a	9.54^a	10.35^a	10.32^a	0.30	5.00-12.00
Packed cell volume (%)	36.45	40.90	39.92	39.94	40.50	0.92	30.00-50.00
Red blood cell counts ($x10^6$)	5.70^b	6.65^a	6.66^a	6.58^a	6.84^a	0.13	4.00-8.00
Haemoglobin (g/dl)	12.28	13.33	13.09	13.67	12.83	0.22	10.00-15.00
Mean corpuscular volume(mm^3)	70.06	66.24	70.85	67.20	65.08	0.88	60.00-69.00
Mean corpuscular haemoglobin (pg/cell)	20.63	21.41	21.36	21.78	21.33	0.20	19.00-22.00
Mean corpuscular haemoglobin concentration (g/dl)	32.71	30.58	30.70	30.10	31.53	0.45	30.00-35.00
Platelets($x10^3$/	148.33^b	182.66^b	188.50^b	333.66^a	387.08^a	20.75	250-600
Lymphocytes (%)	67.56	66.25	66.85	62.78	67.15	1.34	30.00-35.00
Monocytes (%)	1.35	2.04	1.92	1.90	2.09	0.09	1.00-4.00
Neutrophils (%)	30.35^b	30.71^b	31.45^{ab}	35.97^a	29.77^b	0.74	20.00-75.00
Eosinophils (%)	1.32	1.40	1.56	1.50	1.54	0.07	0.00-5.00
Basophils (%)	0.49	0.49	0.42	0.39	0.39	0.04	0.00-0.84**

a,b,c Means on the same row with different superscripts are significantly different (P<0.05)
Ref. ranges* obtained from http://wildpro.twycrosszoo.org/S/00Ref/Haematology/Haem (13/01/2019: 9:05am)
Ref. range** obtained from medirabbit.com (http://www.medirabbit.com/EN/Hematology/blood_chemistry.htm), 13/01/2019: 9:13am)

Table 3. Serum biochemical indices of rabbits fed cassava peel meal based diets

Parameter	T_1 (0%)	T_2(25%)	T_3 (50%)	T_4(75%)	T_5 (100%)	S.E.M	Ref. Ranges*
Cholesterol (mmol/L)	5.68	6.33	5.57	5.58	5.99	0.17	0.10-2.00
Total Protein (g/dl)	6.68	6.91	5.92	6.44	6.39	0.23	5.00-7.50
Albumin (g/dl)	3.24	3.14	3.01	2.99	2.77	0.12	2.5-4.00
Globulin (g/dl)	2.35	2.34	2.26	2.51	2.64	0.12	1.50-3.30
Glucose (mmol/L)	6.54	5.77	5.57	5.58	5.71	0.15	4.20-8.90
Urea (mmol/L)	8.65^a	6.47^b	7.94^{ab}	6.70^b	6.80	0.26	9.10-25.50
Creatinine (mmol/L)	86.58^c	92.97^{abc}	95.34^{ab}	89.35^{bc}	97.52^a	1.19	53.0-124.0
Sodium (Na^+) (mmol/L)	113.83^{ab}	138.63^a	121.42^{bc}	118.73^{bc}	116.12^c	2.68	130.0-155.0
Potassium (K^+) (mg/dl)	4.84	4.79	4.36	4.90	5.14	0.16	4.00-6.50
Calcium (Ca^+)(mg/dl)	2.80	2.85	2.05	2.02	2.05	0.13	3.00-5.00
Triglyceride(mg/dl)	1.46^b	1.69^b	1.93^a	1.39^b	1.81^{ab}	0.06	1.40-1.76
Chloride (Cl^-)(mg/dl)	97.05	99.50	100.18	94.80	92.26	1.72	92-120
AST (µ/l)	20.00^{ab}	19.83^{ab}	16.50^c	18.33^{ab}	23.32^a	0.78	10.0-98.0
ALT (µ/l)	22.33^a	13.00^b	16.15^{ab}	13.78^b	15.53^{ab}	1.19	12.0-67.0

^{a,b,c} Means on the same row showing different superscripts are significantly different (P<0.05)
ALT: Alanine amino transferase
AST: Aspartate amino transferase

cassava peel meal respectively. The result of this study shows that 100% replacement of CPM may not have adversely affected the haematological parameters of rabbits. This implies that rabbits fed cassava peel meal based diets in this study were apparently healthy, as the presence of high basophil content is indicative of chronic infection. Bitto and Gemade (2001) had reported that basophils were seldomly found in the blood of health animals. Haematological indices are good indicators of the physiological status of an animal (Adenkola and Durontoye, 2004; Khan and Zafar, 2005).

Results of serum biochemical characteristics obtained in this study were within the normal ranges reported by Mitruka and Rawnsley (1997).The results for cholesterol, total protein, albumin, globulin, glucose, potassium, calcium and chloride electrolytes were not significantly (P> 0.05) affected by dietary treatments. The cholesterol and glucose levels in this study ranged between 5.57 and 6.33 mmol/L, and 5.57 and 6.54 mmol/L respectively. The cholesterol and blood glucose were within the range of 4.2 and 8.9 mmol/L and4.8 and 7.6 mmol/L reported by Njidda and Isidahomen (2010). Since the cholesterol and glucose levels were within the normal range, the symptoms of abnormal glucose and cholesterol levels in blood which include diabetes, mal-absorption of fat, anorexia and liver dysfunction (Bush, 1991) were not evident in this study.

The albumin values fell within the normal ranges of 2.5 to 4.0g/dl, though lower than 3.07 – 4.50g/dl reported by Onifade and Tewe (1993), but higher than 1.94 – 2.26g/dl reported by Anon (1980) for rabbits fed tropical energy feed resources. Globulin ranged between 2.26 and 2.64g/dl in this study. This was fairly higher than the 1.02 – 2.02g/dl and 1.94 – 2 g/dl reported by Njiddah and Isidahomen (2010); Onifade and Tewe (1993); Etim and Oguike (2011) respectively. Total protein content ranged between 5.92 and 6.91g/dl and was similar to the range of 5.81 – 6.86g/dl reported by Onifade and Tewe (1993); Elsiddig (2008); Ewuola and Egbunike (2008); Olayemi and Nottridge, (2007). The values were lower than those reported by Van Praag (2004), Adu et al. (2009) and Marai et al.(2006) who documented values of 5-7g/dl, 6.63 -7.33g/dl and 7.25g/dl respectively for rabbits. Njiddah and Isidahomen (2009); Etim and Oguike (2011) had documented ranges between 4.41 – 5.51g/dl and 4.97 – 5.47g/dl respectively. Generally total protein, globulin and albumin are largely responsible for protein intake (Birth and Schuldt, 1982; Onifade and Tewe 1993; Njiddah and Isidahomen, 2010). The efficacy of the blood protein depends on the quality and quantity of dietary protein (Apata, 1990). Therefore, any abnormality in serum albumin is an indication that the normal systemic protein utilization has been altered (Awosanya et al., 1999). Urea level in the serum was significantly (P < 0.05) affected by the dietary treatments. The level of urea in the serum decreased with increasing levels of cassava peel meal. The values in this study ranged from 6.47 – 8.65mmol/L. The level of serum urea in this study was higher than 2.60 – 4.90mmol/L and 2.58 – 5.80 mmol/L reported by Njidda and Isidahomen (2010) and Njiddah and Hambagola (2006) but lower than the range of 14.73 – 17.93mmol/L documented by Etim and Oguike for rabbits fed *Aspilia africana* meal. The obvious sign of liver disease or protein malfunction in the body is the reduced level of urea in the blood (Bush, 1991).

Serum creatinine levels were significantly (P <0.05) affected by the cassava peel meal replacement in the dietary treatments. The values ranged between 86.58 and 97.52 mmol/L and were within the normal range, but was higher than 0.60 – 0.76 mmol/L and 52.10 – 66.10mmol/Lreported by Ahamefule et al. (2006) and Njidda and Isidahomen (2010) who fed processed cassava peel meal and grasshopper meal respectively. The normal blood creatinine level is an indication of normal muscle metabolism implying that there was no wasting of muscle tissues (Njidda and Isidahomen, 2010). Triglyceride in the serum was slightly higher than the range 1.40 – 1.76mmol/L reported by Njidda and Isidahomen (2010). The values recorded in this study ranged between 1.46 and 1.93mmol/L. Rizzi et al. (2010) reported lower values of 0.48 – 0.64mmol/L for rabbits kept under different nutritive levels. The higher triglyceride level in the serum maybe probably due to increase in feed intake (Rizzi et al., 2010).Among the electrolyte contents, only sodium was significantly different among the treatment groups. The values for sodium ranged between 113.83 and 138.63mmol/L. Other electrolytes including potassium, calcium and chloride were not significantly affected by dietary treatments. Calcium generally, presents higher homeostasis than other electrolytes (Swenson and Reece, 2002). The levels of these minerals depend on feed intake; another factor is the hormonal effect, which mobilizes skeletal mineral reserves.

CONCLUSION

Based on the results of this study, it is was concluded that blood parameters (haematological and serum biochemical indices) of rabbits fed up to 100% cassava peel meal as replacement for maize were not adversely affected, as they were within the normal blood ranges for apparently healthy rabbits.

RECOMMENDATION

In view of the high cost of conventional cereals like maize, the study recommended that rabbit farmers should be encouraged to utilize this readily available agro-industrial waste (100% cassava peel meal as replacement for maize) in rabbit feeding without fear of compromising the haematopoietic activity vis- a- vis the health status of the animals.

Conflict of Interest

The authors of this research work on the blood chemistry of rabbits fed cassava peel meal as replacement for maize wish to state clearly and unequivocally that there is no conflict of interest in this work.

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