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THE USE OF CASSAVA ROOT MEAL AS A PARTIAL REPLACEMENT FOR CORN IN DIETS FOR ALBINO RATS

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ABSTRACT: The experiment was carried out to determine if partial replacement of maize with cassava root meal (CRM) in diets for albino rats will have an effect on performance, organ characteristics and blood parameters. Twenty five Sprague Dawley albino rats (F344 strain), initial body weight (216 ± 8g) were randomly assigned to five treatments (T1 to T5) in a completely randomized (CRD) arrangement. T1 was the control and contained zero CRM. T2 and T3 contained 30% CRM, while T4 and T5 contained 45% CRM. These levels of inclusion represented 50 and 75% replacement of corn in the diets respectively. T2 and T4 had 0.15% methionine (Met) while T3 and T5 had 0.3% Met. The rats were each fed a single diet for 28d. Average daily feed intake (ADFI) of rats on T1 was lower ($P<0.05$) than that for rats on T4 and T5 (12.12g vs. 12.77 and 12.64g) respectively. For diets with the same level of CRM, those with 0.3% Met had a lower consumption than those with 0.15% Met. There were no differences ($P > 0.05$) in average daily gain (ADG) and feed conversion efficiency (FCE). Similarly there were no differences ($P>0.05$) in carcass, viscera and other internal organ weights. Results of this trial indicate that albino rats can tolerate diets with added CRM (45% of the diet) with no adverse effects on growth and internal organ characteristics. Future work will need to look at the possibility of using CRM at similar or higher levels in diets for growing pigs.

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INTRODUCTION

Feed represents about 65-70% of the total cost of intensive animal production (Tewe, 1997). In monogastric feeds, energy providing ingredients make up approximately 60% of the ration (Oppong-Apane, 2013). In developing countries most of the major energy providing ingredients used in monogastric diets like maize and wheat are imported at great cost and with hard-earned foreign exchange. With rising populations and increasing income levels, meeting the accompanying demand for protein-rich diets at an affordable cost becomes a challenge for farmers.

Monogastrics (broilers and pigs) have the ability to grow fast and also turn plant material into animal protein. However due to the high cost of imported energy-providing feed ingredients, it is imperative that monogastric farmers look beyond the traditional cereal grains, and depend more on alternatives (Chauynarong et al., 2009). One such alternative is cassava root meal (CRM) which grows abundantly under tropical conditions.

The use of CRM in diets for monogastrics has provided conflicting results in terms of animal performance and productivity (Adeniji and Balogun, 2003: Obikaonu and Udedibie, 2006). Although CRM is high in starch content (60-70%) the protein content is very low ranging from approximately 2.5 to 3.25% (Garcia and Dale, 1999; Nortey et al., 2013). It is recommended to include a good source of protein such as soybean meal or fishmeal and synthetic amino acids (particularly methionine), in diets based on CRM since it is particularly deficient in this amino acid (Rakangtong and Bunchasak, 2010). In addition to a low protein (and amino acid) content, CRM is high in non-starch polysaccharides (NSP) and other toxins like cyanogenic glucosides, tannins, and phytates (Teguia and Beynen, 2004). Despite these challenges, CRM is a promising feed ingredient that can be used in monogastric feeds. When well formulated, CRM can replace maize in diets for poultry (Chauynarong et al., 2009: Nortey et al., 2013) and pigs (Lan et al., 2008). Increased use of CRM in monogastric diets will ultimately result in a lower cost of animal protein production to serve the needs of a rapidly growing middle class population in the developing world.

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The hypothesis of this study therefore was that cassava root meal can partly replace maize in diets for Sprague-Dawley outbred albino rats without negatively affecting growth, carcass composition and blood metabolite profiles. The objectives were to investigate the efficacy, growth related responses, carcass characteristics and blood profiles of albino rats fed two dietary levels of cassava root meal. Similar to other trials (Okai et al., 2013; Ogunleye and Omotoso, 2005) the rat is being used as a model for the pig.

MATERIAL AND METHODS

The experiment was carried out at the Noguchi Memorial Institute of Medical Research (NMIMR). The institute was established in 1979 in a building funded by the Japanese government to serve as a monument in memory of Dr Hideyo Noguchi, a Japanese medical scientist who died in Accra in May 1928 while investigating yellow fever. The institute provides a base for medical co-operation programmes between Ghanaian and Japanese scientists and a centre for conducting medical research relevant to Ghana's needs.

Processing of whole cassava root meal

Fresh cassava roots with a moisture content of about 80% were obtained from the open market, chopped into small bits with the skins still on, and sun-dried for about seven days to approximate moisture content of 11.5%. The sun-dried product was then ground through a hammer mill to a particle size of approximately 500 microns, stored in a cool, dry and airy environment prior to incorporation into feed.

Experimental diets

Five experimental diets were formulated with varying levels of CHP as follows: T1 was the control diet with zero CRM and with added methionine (Met) at a rate of 0.15%; T2 was similar to T1 but had 50% of the total maize content replaced with CRM; T3 was the same as T2 but with twice the level of added methionine (0.3%); T4 had 75% of the total maize content of T1 replaced with CRM and with 0.15% total Met; T5 was the same as T4 but with 0.3% added Met. All the diets were pelleted before being fed to the experimental animals.

Management of experimental animals

The animal protocol used followed principles recommended by the Institutional Animal Care and Use Committee of the Noguchi Memorial Institute for Medical Research, University of Ghana. Thirty albino rats (Sprague-Dawley F344 strain) supplied by the Animal Experimentation Unit of NMIMR were placed in their individual cages and allowed to acclimatize to their new environment for two weeks. On day 15, twenty five rats (Initial body weight: 198 ± 5g) were selected to be used as test animals. These were randomly assigned in a Completely Randomized Design (CRD) with five replicates per treatment to one of five diets and allowed a further seven days to get used to the feed before the start of experiment. The rats were housed in individual wire-mesh cages with plastic coated floors, each measuring 20cm x 24cm x 20cm (Length x Breadth x Height) and had freedom of movement. The cages were placed randomly on aluminum shelves. Each cage had a metallic feeding trough and nipple drinker provided. Rats were individually weighed at the start of the trial, and subsequently on a weekly basis. Rats in each replicate were given a known amount of feed and water daily. Feed left over after 24 hours was weighed to determine average daily feed intake (ADFI). The whole feeding and growth trial lasted for 28 days.

Carcass and haematological analysis

On day 29, blood from each anaesthetized rat was collected separately by holding the rats vertically and placing a 10 ml needle into either the tail artery or vein. The blood (about 3ml) was collected into a 4mL sample tube (Surgifield Medicals, Meddlessex, England) using K_3 EDTA as the anticoagulant. For serum profile, about 3 ml of blood was collected into 5mL Serum-separator vacuum tubes (Surgifield Medicals, Meddlessex, England). Both samples were analysed the same day for haematological and coagulation parameters. Next all the anesthetized rats were killed by cervical dislocation and internal organs (i.e.) viscera, liver, kidney lungs, heart and spleen were removed and weighed. The anaesthesia used was chloroform. Haematology parameters were analysed using an Advia 120 (Siemens AG, Munich, Germany) analyser. Parameters evaluated were: white blood cell (WBC), red blood cell (RBC), haemoglobin (HGB), haematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC) and platelet count (PLT)

Chemical analysis

Proximate analysis was carried out on both the ingredients and experimental diets according to methods outlined by the Association of Official Analytical Chemists, (AOAC, 1995). For Ca and P determinations, the methods according to James (1996) and AOAC (1995) were used.

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Statistical analysis

All the data gathered were subjected to statistical analysis using the Generalized Linear Model procedure of the Statistical Analysis Systems Institute (SAS, 1999). Significant differences among means were separated using the Student Newman-Kuels (SNK) Test.

RESULTS

Table 1 shows the analyzed chemical composition of whole CRM used in this trial. Table 2 shows the composition and calculated nutrient values respectively of the experimental diets.

Growth traits

Average daily feed intake (ADFI) of rats on T4 (45% CRM + 0.15% Met) was significantly more than (P<0.05) the ADFI of rats fed the control diet (T1), and those on T3 (30% CRM + 0.3% Met). Also rats on T5 (45% CRM + 0.3% Met) ate significantly more feed (P<0.05) than rats on the control diet (Table 3). There were no significant differences (P>0.05) in ADG and FCE among all the treatments.

Organ weights and haematological parameters

There were no significant differences (P>0.05) in organ weights (Table 3) and haematological parameters among all the treatments (Table 4).

Table 1 - Analysed chemical composition of cassava root meal used in trial (as is basis)

Parameter	Value (%)
Dry matter	88.12
Crude protein	3.32
Acid detergent fiber	2.14
Neutral detergent fiber	5.85
Ether extract	0.71
Ash	2.22
Calcium	0.16
Phosphorous	0.12

Table 2 - Composition and calculated analysis of the experimental diets

Ingredients	Control	30% CRM[1] 0.15% Met[2]	30% CRM 0.3% Met	45% CRM 0.15% Met	45% CRM 0.3% Met
Corn	60	30	30	15	15
Cassava root meal	0	30	30	45	45
Soya bean meal	22.5	22.5	22.5	22.5	22.5
Wheat bran	15.7	15.7	15.55	15.7	15.55
Oyster shells	1	1	1	1	1
Common salt	0.25	0.25	0.25	0.25	0.25
Vitamin premix	0.25	0.25	0.25	0.25	0.25
Lysine	0.15	0.15	0.15	0.15	0.15
Methionine	0.15	0.15	0.30	0.15	0.30
Total	100	100	100	100	100
Calculated Analysis					
ME (MJ/Kg)	11.75	11.57	11.59	11.48	11.50
CP %	19.96	16.99	17.10	15.50	15.61
CF %	3.43	4.15	4.14	4.51	4.5
Total Lysine %	1.09	1.00	1.00	0.96	0.96
Total Methionine %	0.42	0.36	0.48	0.33	0.45
Ca %	0.56	1.25	1.25	1.59	1.59
P %	0.62	0.80	0.8	0.89	0.89

*SEM; [1]Cassava Root Meal; [2]Methionine;

DISCUSSION

Growth traits

Generally monogastrics will eat more of a low-nutrient dense diet and vice versa, gut fill permitting. This phenomena has been observed in both birds (Plavnik et al., 1997; Leeson, 2000; Veldkamp et al., 2005; Nahashon

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et al., 2006) and pigs (Lan et al., 2007; Madrid et al., 2013). This is because monogastrics will eat to meet their requirements for particular nutrients. Once the requirement is met, intake is reduced. In this trial, the dietary nutrient densities were progressively (but gradually) lowered as the level of CRM increased in the diet. Thus the fact that rats on T1 ate the least amount of feed is in line with previous findings. Between diets with either 30% or 45% CRM, those with 0.3% Met were more balanced than those with 0.15% Met, hence the observed numerical decreases in ADFI when the Met levels were doubled at the different CPH inclusion levels. Also the fact that rats on T4 ate the most feed may be a direct reflection of the fact that this diet is the most unbalanced in terms of the essential amino acid, methionine.

Organ weights and haematological parameters

The observed similarities in organ weights between the control and the other dietary treatments is an indication that the presence of CRM in the diet presented no adverse effects on the internal organs of the rats. With increasing levels of CRM, the fibre contents tended to increase. Generally animals fed on diets that are high in fibre, tend to have more developed empty gastro-intestinal tracts (GIT) (JØrgensen et al., 2006). This is due to heavier musculature of the intestinal walls which is a direct response to the greater amount of feed that the animal will necessarily have to hold in the GIT.

Table 3 - Effect of cassava root meal on growth parameters and internal organ weight

Parameter	Control	30% CRM[1] 0.15% Met[2]	30% CRM 0.3% Met	45% CRM 0.15% Met	45% CRM 0.3% Met	SEM*	P-Value
ADFI (g)	12.12[c]	12.47[abc]	12.30[bc]	12.77[a]	12.64[ab]	0.16	0.03
ADG (g)	3.70	3.57	3.63	2.93	3.47	0.41	0.70
FCE	0.31	0.29	0.29	0.23	0.27	0.03	0.47
Organ Weights							
Carcass	250	258	250.8	273.5	260	9.07	0.39
Viscera	50.55	56.16	51.84	53.8	59.34	3.15	0.32
Kidney	1.43	1.46	1.46	1.53	1.46	0.07	0.89
Liver	8.08	8.58	7.58	8.7	8.7	0.43	0.30
Lungs	1.55	1.38	1.34	1.56	1.54	0.15	0.72
Heart	0.95	0.92	0.94	0.93	0.84	0.05	0.63
Spleen	0.63	0.64	0.70	0.68	0.60	0.04	0.46
GIT[3] (Full)	21	25.34	22.92	24.23	26.44	1.91	0.33
GIT (Empty)	16.93	17.84	16.9	16.10	19.76	1.45	0.47

*SEM; [1]Cassava Root Meal; [2] Methionine; [3]Gastro-intestinal tract

Table 4 - Effect of cassava root meal on blood parameters

Parameters[3]	Control	30% CRM[1] 0.15% Met[2]	30% CRM 0.3% Met	45% CRM 0.15% Met	45% CRM 0.3% Met	SEM*	P-Value
WBC ($x10^9$/L)	10.62	10.90	8.28	10.34	11.92	1.711	0.589
RBC ($x10^{12}$/L)	7.14	7.22	7.15	6.84	7.21	0.264	0.829
HGB (mmol/L)	14.07	14.16	14.06	11.84	14.26	0.266	0.066
0.63HCT (L/L)	44.70	45.06	44.12	42.18	45.20	1.561	0.637
MCV (fL)	62.57	62.46	61.64	61.80	62.64	0.741	0.804
MCH (fmol)	19.72	19.64	19.64	17.78	19.80	1.068	0.619
MCHC (mmol/L)	31.52	31.44	31.92	28.64	31.58	1.647	0.607
PLT ($x10^9$/L)	899.50	940.60	842.4	975.0	940.0	125.71	0.951

SEM; [1]Cassava Root Meal; [2] Methionine; [3] WBC, White Blood Cells Count; RBC, Red Blood Cell Count; HGB, Haemoglobin; HCT, Haematocrit; MCV, Mean Corpuscular Volume; MCH, Mean Corpuscular Haemoglobin; MCHC, Mean Corpuscular Haemoglobin Concentration; PLT, Platelet Count.

The absence of this phenomenon in this trial indicates that although feed intake tended to increase with increasing levels of dietary CRM, it was not significant enough to cause any marked increase in GIT musculature. Cassava root meal contains cyanogenic glucosides, polyphenols (tannins) and phytate (Teguia and Beynen, 2004). These are poisonous when consumed by monogastrics in large quantities. Enlargement of certain internal organs like the pancreas, liver, and kidney have been linked to an excessive consumption of these anti-nutritive factors

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(ANF) by broilers (Obun et al., 2011) and pigs (Adesehinwa et al., 2011). Methods to eliminate the ANF in cassava, particularly the cyanogenic glucosides, include drying and fermentation. The CRM used in this trial was sun-dried for 7 days. Again the variety of cassava that is grown in Ghana is of the low hydrocyanide variety. These two factors may have worked to ensure that the levels of the cyanogenic glucosides eaten by the rats were quite low and presented no health problems.

Hematological values obtained in this trial fell within the normal ranges of Sprague-Dawley rats (Johnson-Delaney, 1996; Adeyemi et al., 2015). This indicates that there was no effect of diet on haematological values.

CONCLUSIONS

Results of this trial have demonstrated that CRM can effectively replace up to 70% of the maize in diets for Sprague-Dawley albino rats when supplemented with a synthetic amino acid like Met, without affecting growth performance. At the recommended level of inclusion, there are no adverse effects on internal organ and blood parameters.

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