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ALTERNATIVE TROPICAL ENERGY FEED RESOURCES IN RABBIT DIETS : GROWTH PERFORMANCE, DIET'S DIGESTIBILITY AND BLOOD COMPOSITION

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SUMMARY:
The grain replacement value in rabbit diets of three tropical alternative feed resources, namely maize offal (MO), unpeeled cassava root meal (UCRM) and cassava peel meal (CPM) was investigated in a ten week feeding trial with growing rabbits, in comparison with maize. The introduction rates were 30.8% of the diets, and the initial age of the 24 rabbits was 5-6 week. The criteria for assessment were growth performance, nutrient digestibility and blood composition at the end of the experimental period.
Average daily gain and daily feed intake of the rabbits varied from 13.0 g on CPM diet to 14.2 g on MO diet, and 60.7 g on UCRM diet to 71.4 g on CPM diet respectively. However, both MO and CPM were significantly consumed ($P < 0.05$) more than the other diets. Feed conversion and protein efficiency ratios were significantly inferior ($P < 0.05$) on CPM diet than on others. The dry matter, crude protein, gross energy, ether extract and crude fibre digestibilities were numerically highest in the control diet, but statistically comparable for rabbits on UCRM diet; both were however significantly higher ($P < 0.05$) than records for rabbits fed on MO and CPM based diets.
The analysed blood parameters showed the rabbits fed on the control diet to be superior in haematocrit, haemoglobin concentration, red and white cells numbers. The mean corpuscular volumes and mean corpuscular haemoglobin were highest in the cassava root diet followed by cassava peel based diet, while the mean corpuscular haemoglobin concentration values were statistically similar in all the diets. Serum total protein varied between 6.75 g/100 ml in rabbits fed on maize offal to 5.81g/100 ml on cassava roots without any significant difference. A similar pattern was repeated for albumin and globulin fractions. Both creatinine and uric acid concentrations were respectively uniform amongst the rabbits on different treatments. However, a significantly lower ($P < 0.05$) level of urea-nitrogen was determined in the serum of rabbits fed on cassava peel diet. Serum glucose level ranged between 125 mg/100 ml in rabbits fed on the control diet to 192 mg/100 ml for their counterparts on cassava roots diet showing a significantly lower content ($P < 0.05$) on the control and cassava peel based dietary treatments. Cholesterol values were statistically higher ($P < 0.05$) in rabbits on the control and cassava roots diets than on the 2 others which have a higher fiber content.

RESUME : Matières premières énergétiques tropicales alternatives pour l'alimentation du lapin : performances de croissance, digestibilité des aliments et paramètres sanguins.
Cette étude, conduite sur 10 semaines, a pour but de déterminer, pour l'alimentation des lapins, la valeur de trois matières premières tropicales (son de maïs : MO , racines de manioc non pelées : UCRM et pelures de manioc : CPM) comparativement à celle du maïs. Les taux d'incorporation dans les aliments étaient de 30,8 %, et les 24 lapereaux étaient âgés de 5-6 semaines au début de l'essai. Les critères d'évaluation retenus sont les performances de croissance, la digestibilité et la composition sanguine en fin d'expérience.
La croissance moyenne journalière a varié de 13,0 g pour le régime contenant les pelures de manioc, à 14,2 g pour le régime à base de son de maïs ; la consommation journalière moyenne a varié de 60,7 g pour le régime racines de manioc non pelées, à 71,4 g pour le régime pelures de manioc. De plus, les régimes son de maïs et pelures de manioc ont été significativement plus consommés (P<0,05) que les 2 autres. L'indice de consomation et l'efficacité protidique ont été significativement dégradés (P<0,05) avec le régime pelures de manioc comparativement aux autres régimes. La digestibilité de la matière sèche, des protéines brutes, de l'énergie, des matières grasses et des fibres étaient plus élevés dans le régime témoin mais statistiquement comparable pour le régime racines de manioc non pelées. Les régimes son de maïs et pelure de manioc ont conduit à des digestibilités significativement plus faibles (P<0,05).
Les analyses sanguines montrent des taux d'hématocrite, d'hémoglobine, de globules rouges et blancs, supérieurs pour le régime témoin. Les volumes cellulaires moyens et les taux moyens d'hémoglobine cellulaire étaient supérieurs avec le régime contenant les racines de manioc, suivi par le régime contenant les pelures de manioc, et similaires pour les deux autres. Les protéines sériques totales ont varié de 6,75 g/100ml pour le régime son de maïs, à 5,81 g/100ml pour le régime racines de manioc, mais les différences n'étaient pas significatives. Les mêmes tendances sont à noter pour les taux d'albumine et de globuline sériques. Les taux de créatinine et d'acide urique sont les mêmes pour tous les régimes. Toutefois un taux d'azote uréique significativement plus bas (P<0,05) a été observé dans le sérum des lapins nourris avec les pelures de manioc. Le taux de glucose sérique a varié entre 125 mg/100ml pour le régime témoin et 192 ml/100ml pour le régime racines de manioc, avec un taux significativement faible pour le régime témoin et celui à base de pelures de manioc. Le taux de cholestérol est statistiquement plus élevé pour les lapins recevant le régime témoin et le régime à base de racines de manioc non pelées comparativement aux 2 autres régimes plus riches en fibres.

INTRODUCTION

The nutritional management of monogastric livestock animals in most developing economies is in a state of flux. This is largely derived from the exhorbitant price of finished feeds which incites soaring costs of production of animals and their products. The situation have forced the animal nutritionists to intensify research into alternative feed resources to attenuate the cost. Perhaps the most researched aspect of monogastric animal nutrition was a grain replacement.

Tropical agricultural extraction industry turns out a large quantity of by-products which have nutritive potential as animal feedstuffs. CHEEKE (1986) noted that further research on the nutritional content and digestibility of tropical feeds and by-products is needed to develop efficient feeding systems for rabbits in tropical and sub-tropical agricultural systems.

Utilization of cassava and its by-products by rabbits have been recognized by ESHIETT *et al.* (1979) OMOLE and SONAYIA (1981), OMOLE and ONWUDIKE (1982). However, information on comparative complete replacement of maize with maize offal (MO), unpeeled cassava root meal (UCRM) and cassava peel meal (CPM) in diets of rabbits was unavailable.

This paper reports the grain replacement value of these three tropical feed resources in rabbit diets, using growth performance and nutrient utilization as parameters. Blood values for selected characteristics were also determined at the end of the trial, to assess nutritional adequacy of the diets. Blood with its myriad of constituents provides a valuable medium both for clinical investigations and nutritional evaluation of the individual. The ingestion of numerous dietary components have measurable effects on blood constituants (CHURCH *et al.*, 1984). Although nutrient levels in the blood and body fluids mights not be valid indications of nutrient function at cellular level, they are considered to be proximate measures of long term nutritional status (KERR *et al.*, 1982). CHURCH *et al.* (1984) affirmed that the comparison of blood chemistry profiles with nutrients intake may, in human, indicate the need for adjustment of certain nutrients upward or downward for different population groups. So this data were colected in our experiment in order to establish a potential relation in rabbits.

MATERIAL AND METHODS

Management of experimental animals

Twenty-four 5-6 weeks old New-Zealand White littermates rabbits weighting an average of 604 g were randomly allocated to four dietary treatments on weight basis.

The rabbits were individually housed in metal cages which allowed *ad libitum* access to water and feed throughout the seventy days experimental period. Data on feed consumption and weight gain were recorded weekly. Faecal collection for nutrient digestibility was carried out during the last seven days of the trial.

Table 1 : Proximate composition of the experimental ingredients (dry matter basis)

	Maize	Maize offal	Cassava root meal	Cassava peel meal
Dry matter	90.75	91.30	90.32	92.15
Crude protein	9.89	12.40	2.25	5.52
Ether extract	2.43	2.11	0.85	0.56
Crude fibre	3.86	8.80	3.40	15.78
Ash	1.53	3.42	1.35	5.29
Gross energy (Kcal/kg)	4370	3640	4115	3580

Experimental diets

Four isonitrogenous full-fat soyabean based diets were formulated to provide 17 % crude protein. The control diet contained maize as the major energy source, while the three others have the maize totally replaced on percent basis by MO-diet 2, UCRM-diet 3, CPM-diet 4. The composition of the 4 main ingredients is summarized in table 1. The diets and their chemical composition are shown in Table 2.

Preparation and origin of dietary components

The maize offal was purchased from a local maize-milling factory. It is a by-product of the maize flour industry production. It consists essentielly of the aleurone layer (bran) of the grain wich is preliminarily revoved before grinding. Hoever, some broken particles of the endosperm are included depending on the efficiency of the milling machine. The unpeeled cassava root meal was prepared from harvested tubers of different varieties. Tubers were grated unpeeled and put in bags for 48 hrs to allow for microbial fermentation necessary for detoxifying the inherent cyanogenic glucoside. Proper sun drying followed before incorporation into diet 3. Fresh cassava peels collected from cassava processing industry were sundried for 5 days after which they were included in diet 4. Full-fat soyabean was prepared as described by BAMGBOSE (1988).

Chemical analysis

Proximate analysis of the diets and faeces were carried out according to the AOAC recommendations (1980). The gross energy of the samples was determined using bomb calorimeter.

Table 2 : Composition of experimental diets.

Treatments	1 Control	2 MO	3 UCRM	4 CPM
Ingredients				
Maize	30.84	-	-	-
Cassava root meal (unpeeled)	-	-	30.84	-
Cassava peel meal	-	-	-	30.84
Maize offal	30.00	64.42	25.46	25.26
Full-fat soyabean meal	20.86	17.28	25.40	24.60
Palm kermel meal	15.00	15.00	15.00	15.00
Salt	0.50	0.50	0.50	0.50
Vitamin/mineral premix[a]	0.30	0.30	0.30	0.30
Oyster shell	1.50	1.50	1.50	1.50
Bone meal	1.00	1.00	1.00	1.00
Chemical composition (on dry matter basis):				
Dry matter	88.05	87.98	87.78	88.24
Gross energy (kcal/kg)	4320	3950	4110	3850
Crude protein	18.24	17.28	18.13	18.97
Ether extract	3.00	4.60	3.80	4.10
Ash	5.70	8.22	7.24	9.90
Crude fibre	5.50	9.10	6.94	11.18

a : Roche Uni-vit 15 premix per kg provides :

Vitamins : A 8,000,000 I.U. ; D_3 1,500,000 I.U. ; E 3,000 I.U. ; K_3 3.00g ; B_2 2.50g ; Nicotinic acid 8.00g ; D-Pantothenate 3.00g ; B_6 0.30g ; B_{12} 8.00mg.

Minerals : Mn 10.00g ; Fe 5.00g ; Zn 4.50g ; Cu 0.20g ; I 0.15g ; Co 0.02g ; Se 0.01g.

Blood collection

Blood was sampled terminally at the tenth week of experimental from overnight fasted rabbits, by human puncture of the prominent veins of the ear. Haematological specimens were separately collected in bottles wherein EDTA-anticoagulant has been previously added, while serum was separated by centrifugation.

Haematological and biochemical analyses

The blood sample were analyzed using routinely available clinical methods in Faculty of Veterinary Medecine, University of Ibadan. Parked Cell Volume or haematocrit (PCV), Red Blood Cell number (RBC) and White Blood Cell (WBC), Haemoglobin concentration (Hb) were determined using Wintrobe's micro-haematocrit, improved Neubauer haemo-cytometer and cyano-methaemoglobin method respectively. The erythrocytic indices, Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin Concentration (MCHC) were computed according to JAIN (1986). Serum protein, albumin, globulin and urea were analysed using Sigma assay kits, glucose according to FETERIS (1965), creatinine according to SLOT (1965), uric acid according to HENRY *et al.* (1957) and cholesterol according to ROSCHLAN *et al.* (1974).

Statistical analysis

Results were subjected to analysis of variance followed by DUNCAN's multiple range test (STEEL and TORRIE, 1980).

RESULTS AND DISCUSSION

1/ Growth performance and feed utilization

Growth performance, feed intake, feed conversion and protein efficiency ratios of rabbits fed the dietary treatments are depicted in Table 3.

The significantly ($P < 0.05$) higher live weight gain recorded in treatment 2, can be attributed to higher feed intake by the rabbit on this diet. Besides, the adequate fibre and nutrient density of the diet (as shown in Table 2) might be responsible. The higher initial body weight albeit insignificant might also have stimulated higher intake by the rabbits and ultimatly better gain.

The average daily gain (ADG) for the treatments were similar to the 15.6-18.7 g/day reported for rabbits fed cassava root and cassava peel meals fortified with fish meal and palm oil as energy booster (ESHIETT *et al.*, 1979 ; OMOLE and ONWUDIKE, 1982). The ADG recorded were slightly higher than 12 g per day reported for rabbits on broiler mash (EKPENYONG, 1984.; OMOLE, 1990 - personnal communication) affirmed the ADG got in this study and attributed it to lack of high quality animal protein source in diets.

However, the lower ADG on CPM was associated with a higher protein intake. OMOLE and SONAIYA (1981) indicated that weight gain on CPM diet up to 40% is dependent upon protein source and balance of essential nutrients, especially sulphur aminoacids in the diets.

Table 3 : Growth performance, feed intake, feed conversion and protein efficiency ratios of rabbits on dietary treatments

Treatments	1 Control	2 MO	3 URCM	4 CPM	S.D.
Ave. initial LW (g)	587.5^{a}	617.5^{a}	605.0^{a}	607.0^{a}	12.44
Ave. final LW (g)	1525.0^{b}	1610.0^{a}	1545.0^{b}	1515.0^{b}	42.70
Ave. daily gain (g)	13.39^{b}	14.18^{a}	13.43^{b}	12.96^{c}	0.51
Daily feed intake (g)	61.25^{b}	69.07^{a}	60.71^{b}	71.39^{a}	5.43
Daily CP intake (g)	11.54^{b}	11.93^{ab}	11.01^{b}	13.54^{a}	1.10
Feed Conversion Ratio	4.57^{b}	4.87^{b}	4.52^{b}	5.51^{a}	0.46
Protein Efficiency Ratio	1.16^{a}	1.19^{a}	1.22^{a}	1.04^{b}	0.08

a, b, c : means without common superscript in the same row are significantly different ($P < 0.05$)
LW : live weight, CP : crude protein

None the less, the lower gain on CPM might be due to higher crude fibre of which OMOLE and OMWUDIKE (1982) noted growth depression above 10 % crude fibre level. Since, the total weight gain followed the same pattern, similar reasons as above could be adduced.

Rabbit feed intake is primarily to satisfy their energy requirement (LANG, 1981), hence the observed significantly ($P < 0.05$) higher total feed intake in diets 2 and 4 was explicable on the lower energy contents of both treatments. Inspite of the provoked intake of diet 4, there was no commensurate weight gain, indicating therefore, a poorest nutritional value of CPM.

Crude protein intake recorded followed the same trend as feed intake, while the highest protein intake recorded in diet 4 ostensibily accounted for the comparable growth on it.

The superior efficiency of conversion of diets 1 and 3 having more readily digestible carbohydrate was consistent with assertion of LANG (1981). The good growth performance on MO diet confirmed its nutritional potential as pointed out for rice bran (RAHARJO *et al.,* 1988). Thus its seems that maize offal can be fed as much as 64% in rabbit diet.

2/ Proximate nutrient digestibility

The data on proximate nutrient digestibility are shown in table 4.

The significantly lower ($P < 0.05$) dry matter (DM) digestibility in diets 2 and 4 might be attributed to higher fibre contents in both diets. ADEGBOLA and OSUJI (1985), ABDEL-RAHMAN (1978) noted that DM, crude protein (CP) and other nutrients digestibilities were decreased with increasing fibre levels.

CP digestibility in the diets was patterned as for DM. However, the high values indicated efficient utilization on concentrate feed protein (DE BLAS *et al.*, 1981) and forage protein (CHEEKE *et al.*, 1987) by rabbits. The crude fibre content was suspected to determine the digestibility pattern observed. The inorganic constituent digestibility depicted an insignificant difference among treatments. This corroborates the common observation that animals on diets withe proper energy-protein ratio and adequate mineral supplementation seldom vary in their total mineral digestibility (UNDERWOOD, 1980). However, the elemental mineral digestibility was investigated and reported elsewhere (ONIFADE and TEWE, 1980).

The rabbit digestion of ether extract (EE) of the diets were similarly high. Values gotten further

Table 4 : Proximate nutrient digestibility (%)

Treatments	1 Control	2 MO	3 URCM	4 CPM	S.D.
Digestibilty coefficients of :					
Dry matter	86.06^{a}	76.82^{b}	83.11^{a}	77.54^{b}	4.45
Crude protein	82.88^{a}	72.65^{b}	81.94^{a}	75.11^{b}	5.04
Gross energy	74.36^{a}	70.25^{ab}	73.12^{ab}	68.18^{b}	2.79
Ash	75.58^{a}	75.78^{a}	77.30^{a}	77.00^{a}	0.86
Ether extract	76.49^{a}	71.80^{a}	78.43^{a}	71.12^{a}	3.56
Crude fibre	55.61^{a}	39.60^{b}	53.43^{a}	33.08^{b}	10.86
Digestible Energy concentration (kcal/kg)	3112	2775	3005	2825	-
Dig. Energy daily intake (kcal/day)	176.5	171.2	162.5	167.3	-

a, b means without common superscript in the same row are significantly different ($P < 0.05$)

attested the good ability of rabbit to utilize dietary fat (PARTRIDGE *et al.*, 1985 ; BEYEN, 1988). Digestibility of crude fibre (CF) was significantly higher ($P < 0.05$) in diets 1 and 3 than in diets 2 and 4. This might be hinged on the higher crude fibre content and lower digestibility carbohydrate in the latter diets ; since LANG (1981) affirmed the high digestibility of crude fibre of root tubers, while DE BLAS *et al.* (1981) noted that the high digestibility of corn based diet was because of high availability of its carbohydrate content. Indeed, MAERTENS and DE GROOTE (1984) reported that non-lignifed materials could have crude fibre digestibility as high as 60 %. Digestibility of crude fibre was reported (LANG, 1981) to be dependent on the fibre content of the diet compared, and this was reflected in this result because fibre digestibility was low in both diets having relatively higher crude fibre content.

Despite the small but significant difference in the gross energy (GE) digestibility of the diets, the average value is high. This apparently indicates a considerable extraction of energy from the fibrous feeds in order that the rabbits could satisfy their energetic requirement. However, the increasing digestibility of GE with lower dietary fibre has been recognised (MITARU and BLAIR, 1984 ; RAHARJO *et al.*, 1988). The result of the GE digestibility showed that the rabbits can be raised on a lower energy content than as found in maize based diets, since no energetic supplementation was made.

From the energy digestibilty coefficients and the GE content of the 4 diets, the diet's digestible energy content and the rabbit's digestible energy daily intake can be calculted (table 4). The result indicates a good regulation for digestible energy intake among the 4 diets. So, the lower growth rate observed with CPM is not related with a lack of energy for growth, and this reinforces the previously mentionned hypothesis of a protein deficiency.

3/ Haematological and Erythrocitic Indices

The haematological and derived absolute values shown in Table 5 were within normal ranges reported earlier (HEWITT *et al.*, 1989 ; JAIN, 1986 ; JONES, 1975), save some exeptional values which were nutritionally interpreted.

PCV, Hb, RBC and WBC were normally preponderant in rabbits maintained on maize diets above other diets ; this obviously implied better nourishment, albeit the similar values obtained for all the rabbits equally indicated nutritional adequacy. The influence of diets on haematological traits is very strong (HACKBATH *et al.*, 1983), and PCV and Hb have been shown to indicate nutritional status of subjects (CHURCH *et al.*, 1984). BABATUNDE and POND (1987) showed that performance traits and haematological traits are strongly correlated, this assertion was conduced in our result. However, the relatively low PCV and Hb in rabbit fed maize offal tended to reveal normocytic iron deficiency anaemia, since GRAITCER *et al.* (1981) adjudjed both of them as good indices of iron deficiency anaemia. As iron deficiency progresses, Hb decreases, then microcytosis decrease in the erythrocyte volume, cell number decrease and also MCHC (GRAITCER *et al.*, 1981). The very low iron digestibility recorded on this diet further portends the likelihood of iron deficiency. KERR *et al.* (1982) observed a directed relationship between dietary iron, Hb, PCV and serum iron.

The higher WBC index of rabbits fed maize diet could speculatively be associated with superior nutrition, though it has not been shown to be directly predicated on the nutritional plane of the individual.

Haematological features of megaloblastic anaemia (macro-cytosis) due to folic acid and/or vitamin B_{12} deficiencies were indicated by the exaggerated MCV and MCH, and low RBC observed with the unpeeled cassava root meal, and to a lesser extent on cassava peel meal diets. Folic acid is assessed to be more potent (WHO, 1975), however, both vitamins deficiencies might be acting conceitedly. Diets that are predominantly based on roots tubers and its by-products could induce macrocytic anaemia in subjects, since they are deficient in folic acid. OYENUGA (1968) documented lower vitamin content

Table 5 : Haematological indices in rabbits fed on the 4 diets

Treatments	1 Control	2 MO	3 URCM	4 CPM	Mean	S.D.
Indices:						
Haematocrit (PCV)	40.00^a	35.50^a	38.00^a	37.50^a	37.75	1.85
Haemoglobin (Hb %)	12.30^a	11.20^a	11.50^a	11.75^a	11.69	0.47
RBC($10^6/\mu l$)	5.09^a	4.31^b	4.23^b	4.34^b	4.49	0.40
WBC($10^3/\mu l$)	9.84^a	5.84^b	5.16^b	5.44^b	6.57	2.20
MCV(FL)	89.50^a	88.75^a	111.00^b	98.00^b	96.81	10.35
MCH (Pg)	27.65^b	28.00^b	33.50^a	31.10^a	30.06	2.77
MCHC (%)	30.80^a	31.55^a	30.26^a	31.45^a	31.02	0.60

a, b : means without common superscript in the same row are significantly different ($P < 0.05$).

Table 6 : Serum biochemical indices in rabbits fed on the 4 diets

Treatments	1 Control	2 MO	3 UCRM	4 CPM	Mean	S.D.
Indices:						
Total protein (g/dl	6.14[a]	6.75[a]	5.81[a]	6.37[a]	6.27	0.40
Albumin (g/dl)	4.09[a]	4.50[a]	3.07[b]	4.21[a]	3.97	0.62
Globulin (g/dl)	2.05[a]	2.26[a]	1.94[a]	2.11[a]	2.09	0.13
Creatinine (mg/dl)	1.94[a]	1.78[a]	1.73[a]	1.85[a]	1.83	0.09
Uric acid (mg/dl)	1.29[a]	1.19[a]	1.15	1.23[a]	1.21	0.06
Urea nitrogen (mg/dl)	42.03[a]	42.43[a]	43.38[a]	37.56[b]	41.35	2.59
Glucose (mg/dl)	125.00[a]	178.37[b]	192.40[b]	140.00[a]	158.94	31.66
Cholesterol (mg/dl)	67.22[a]	57.10[b]	68.30[a]	56.90[b]	62.38	6.23

a, b : means without common superscript in the same row are significantly different ($P < 0.05$).

in pulp than peel of root tubers. Also, the suspected vitamin deficiency in rabbit on treatment 3, might also be adducted to the highly available carbohydrate content of root tubers (LANG, 1981) which might have altered the normal flora of the caecum microecology, and probably discouraged caecotrophic recycling of nutrients.

The somewhat higher haemoglobinization (MCHC) in rabbits fed on diets 2 and 4 can be tentatively nutritionally interpreted as a lower dietary energy intake since EDOZIEN and SWITZER (1977) report an elevated MCHC in birds raised on restricted (low) energy intake. But this hypothesis is not supported in the present case with rabbits, since the digestible energy intake with diets 2 and 4 is located between the values observed with diets 1 and 3.

4/ Serum Biochemical Indices

The serum biochemical constituent shown in Table 5, were generally in consonnance with reported references variables (HEWITT *et al.*, 1989 ; JONES, 1975).

Total protein, globulin and albumin especially were averagely responsive to total protein intake in agreement with findings of BIRT and SCHULDT (1982) and RAY *et al.* (1977). The concentration of glucose in rabbits on alternative feeds were significantly ($P < 0.05$) higher than the normal value in the control. The accentuated glycaemia index in treatments 2, 3 and 4 tended to suggest impaired glucose tolerance. FASHINA (1991) documented elevated blood glucose in pigs fed sweet patato in replacement for maize. Impaired glucose tolerance is common on low carbohydrate diet, with triggers gluconeogenesis in fasting subjects, and may also be due to chronic action of various toxins on the peripheral utilization of glucose (BARON, 1982). The hypoglycaemic influence of dietary fibre both on post-prandial and fasting conditions was reflected by the lower serum glucose concentration in rabbits fed on cassava peel meal (the most fibrous diet). The indentical creatinine values indicated normal muscle metabolism (LATNER, 1975). Uric acid was not influenced by protein intake, unlike the report in birds (HEVIA and CLIFFORD, 1977) but in accord with BOWERING *et al.* (1970) on human. Cholesterol contents were apparently negatively related with dietary fibre intake.

Urea nitrogen was negatively correlated with protein intake (Table 6). BABATUNDE and POND (1987) and EGGUM (1970), have asserted its responsiveness to protein intake quantity and quality. The low level of urea nitrogen in diet 4 is related more to the low protein quality than to protein quantity, since the daily intake of digestible protein is similar for diet 4 (9.23 g/day) and for the diets 1 to 3 (9.6 - 8.66 and 9.02 g/day respectively).

Besides vitamin B_{12} and folic acid, and dietary iron which were suspectedly deficient, and hence the need for fortification of diets which is predominantly composed of AFR, the physio-biochemical indices revealed nutritional adequacy of the diets. No health implied disorder was manisfested throughout the study. It is noteworthy that our results were comparable not only with laboratory rabbits, but also with patterns in pigs (FASHIMA, 1981) chickens (EDOZIEN and SWITZER, 1977) and baboons *Papio spp* (HACK and GLEISCER, 1982).

CONCLUSION

The total substitution of maize grain by maize offal in rabbit's feeding is possible without important restriction. The only point to be more precisely investigated is the iron availability in diets with very high MO content.

The utilization of unpeeled cassava root meal is also acceptable in rabbit feeding, as a maize substitute. But attention must be paid to a potential anaemia possibly related to a lower B vitamins production.

The cassava peel meal employed as maize substitue induces a lower growth rate and a worse feed efficiency. This is probaly due to a bad protein quality.

In addition, as for cassava root meal, attention must be paid to B vitamins. So the cassava peel meal may be employed only if locally no other ingredients, as maize offal or cassava roots, are available.

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