The Effect of Various Levels of Cassava on Protein Utilization by Rats

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Abstract

Cassava was substituted for maize starch at 0 – 100% level in rat diet using casein as source of protein. Apart from the 50% level where all the parameters determined were similar to those of the control, the general trend is that the PER decreased gradually from 2.5 for 0% level to 2.0 at 100% substitution. The digestibility *in vivo* (80.5 – 69.9) and *in vitro* (94.6 – 88.9) and the plasma thiocyanate levels (1.6 – 3.6 Mg/nl) followed the same pattern. The plasma urea level was the reverse, starting with 34.2 mg N/100ml at 0% cassava and increasing as the level of cassava to a maximum of 70.0 mg at 100% cassava level.

The high level of cassava did not seem to have any marked effect on the feed intake or on the available lysine (7.6 – 8.3 g/16gN). When leaf protein (LPC) from Amaranthus was used as sole source of protein at 100% cassava level the PER was low (1.26) but increased to 1.64 on supplementation with 0.2% methionine and the best result was obtained when 50:50 mixture of LPC and casein was used (PER 2.15), better than casein alone (2.01). The other parameters were not affected to any extent.

Introduction

In the United States, maize is produced abundantly and the excess is used profitably as animal feed. Maize, however, is used mainly as a source of energy although it contributes some protein to the ration. In the tropics, cassava is produced abundantly and it is the staple in many of the countries. Compared to maize, it is a much better energy source, but it is virtually devoid of protein. If on the other hand, cassava could be used to substitute maize in animal ration, then the nutritious maize could be used solely for human consumption.

If cassava replaces maize, it will require a good source of protein to make it a balanced ration and to supply enough methionine to detoxify the cyanide produced from the cyanogenic glucoside contained in the cassava. It is the aim of this paper to compare the efficiency of casein and leaf protein (LPC) as supplement in cassava – based diets.

Materials and Methods

The cassava used for the experiments was harvested from the University Research Farm, peeled, dried and milled into small granules. The test diets were prepared by replacing maize starch with cassava at 0,20,40,50,80 and 100% levels. In the first series of experiments the protein supplement was casein and a little amount of fishmeal to make the diets isonitrogenous as shown in Table 1.

In the second series of experiments LPC from Amaranthus was incorporated into the ration at the expense of the cassava which was contributing the total energy (Table 3). The metabolizable energy of each feed was calculated to be between 3,700 and 3,900 Kcal/Kg feed, with a protein content of about 10%. All the feeds were not, however, pelleted, but served in mash forum.

Weanling rats of the wistar strain weighing about 40g each were used. They were starved for 24 hours, weighed and randomly distributed into metabolic cages, one per cage. The animals were first conditioned to the experimental diets for 4 days. They were then fed *ad lib* the various diets for 2 weeks. At the end of the feeding period the animals were killed, blood was withdrawn into the anticoagulant acid – citrate – dextrose (ACD), centrifuged and the plasma frozen at $-20^{o}C$ until needed for analysis.

The cyanide content of the cassava was determined by the method of wood; available lysine content of the feed by the method of Carpenter ; *in vitro* digestibility of the feed by the method of Saunders et al. , serum thiocvanate by the method of Aldridge and serum urea by the method of De la Huerga et al .

Results

The cyanide content of the cassava used was 58mg/kg dry weight. Apart from high PER obtained for the 50% cassava ration (2.50) the amount of cassava in the diet did not seem to influence the PER to any extent (range 2.0 – 2.2) as shown in Table 2. However, the higher the amount, the higher the plasma thiocyanate (SCN) concentration, ranging from 1.6 Mg/ml for control to 3.6 Mg from the 100% cassava. Plasma urea levels tended to follow the same pattern (34.2 mg N/100ml – 70.0 mg). Cassava in addition tends to decrease the digestibility to a small extent and this is picked up in the *in vitro* digestibility as well. The available lysine is unaffected by the presence of cassava.

When LPC was used instead of casein at 100% cassava level, the PER was decreased to 1.26. Supplementation with 0.2% methionine increased this significantly to 1.64. A mixture of 50% casein and 50% LPC gave a PER of 2.15, better, though not significantly different from the control (2.01). This is also true for the digestibility both *in vitro* and *in vivo.* The lowest level of plasma SCN (3.2 Mg/ml) was recorded for the LPC diet that was supplemented with methionine and the highest for the casein LPC mixture (4.6 Mg).

Discussion

Maner and Gomez had earlier pointed out that cassava could be used as a substitute for maize. As energy source for animal feed provided there is a good protein supplement to go with it. They (Maner and Gomez, 1973) reported experiments where they found that the PER of a cassava – based ration with casein as the protein source increased with increasing level of methionine supplementation (from 20.4 for control to 2.72 for 0.27% methionine supplementation). When fresh cassava was used, about 3.69 mg SCN was excreted per day after 9 days of $FeCl_2$ application. This pattern was followed for 70 days. In our series of experiments the PER tended to decrease as the level of cassava increased starting from 2.50 for the control to 2.0 for 100% cassava replacement. The 50% cassava ration gave a different picture, having the same PER (2.50) as the control and in fact compares with it in every way (plasma urea, SCN etc). The plasma SCN level seems to follow a more regular pattern than that reported by Maner and Gomez with our own control (of cassava) starting from about the same level of SCN (1.6 Mg/ml) and this gradually increased to 3.6 Mg for the 100% cassava ration. This is probably because the cyanide content for our cassava is very low (58 mg/kg). By adding various amounts of KCN (0 – 800 ppm) to the ration, Maner and Gomez found that the plasma SCN increased from about 1.5 Mg/ml for control to about 3.2 Mg at 960 ppm CN and then remained at a fairly constant lower level (about 2.6 Mg) for the rest of the CN levels up to 3200 ppm.

The apparent digestibility decreases as the level of cassava is increased. This was also picked up by the *in vitro* digestibility but this gave higher values than the apparent digestibility but with the same pattern. At 100% cassava the digestibility has fallen from 80.5% to 88.9%. The available lysine remained virtually the same.

The parameter that seems to have varied markedly was the plasma urea level. This was low for the control (34.2 mgN/100 ml) and then increased gradually to 70 mg as the level of cassava increased to 100%. In an earlier work, Omole, Adewusi and Oke found an inverse relationship between the PER and the serum urea level with a correlation coefficient of r = –0.90 which was in agreement with the results of Eggum 8 who obtained a regression coefficient of r = 0.95 between BV and blood urea of rats using 42 different protein sources. As the level of cassava in the diet increases, so does the cyanide concentration which is defoxified by the enzyme rhodanese, with methionine as sulphur donor. The depletion of methionine would therefore result in the deamination of nonessential amino acids leading to the formation urea. The plasma urea levels should therefore follow the same pattern with the thiocyanate level as has been obtained and also the PER and digestibility.

Although methionine is first limiting amino acid in cassava – based diets, there is still the possibility of the carbohydrate of cassava reacting with lysine and thereby making it unavailable. This is why the available lysine was determined in all cases. There does not appear to be any change irrespective of the amount of cassava present.

Although leaf protein on its own (PER 1.26) is not as good a protein source as casein (PER 2.01), when supplemented with methionine there is a significant improvement (PER 1.64) and when a 50:50 mixture of LPC and casein was used the best PER (2.15) was obtained, better, though not significantly different from the control. LPC, however, does not have any effect on the digestibility or available lysine of the cassava ration. The different rations were still digestible to the same extent (70-80%) though those containing LPC were slightly higher. The plasma thiocyanate did not show any pattern.

On the whole it appears that in the presence of a good source of protein, cassava can successfully replace maize starch as source of energy contrary to previous findings that weight gain and feed conversion declined as increasing amount of cassava were added to the diet of pigs (Heward Hutagahung 1972) reports have indicated that indicated that supplementation of cassava – based diet with high quality protein would overcome the growth depression (Maner and Gomez, Khajarern and Khajarern), and when the quantity of the protein is reduced e.g. fishmeal from 10% to 5%, there is a significant reduction in growth and less efficiency of feed conversion in chicks (Muller *et al*). Eggum used dried fish as the protein source with cassava leaves and found a significant increases in the BV for rats.

LPC is a cheaper protein source and has been found to be very effective especially when supplemented with methionine and lysine than casein alone (2.5). LPC on its own could be used only at every low levels of cassava, maximum of 20% 14 (Mmoh and Oke, 1977) otherwise the PER is reduced significantly. In this report a better way is 50:50 mixture of LPC and casein.

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Table 1. Feeding experiment with rats cassava replacement feeding trials composition of diets

	% Energy source replacement by cassava					
Ingredients	0	20	40	50	80	100
Maize starch	77.05	61.63	46.24	38.54	14.43	0.00
Cassava	–	16.2	32.40	40.54	64.85	81.08
Non-nutritive Cellulose	2.55	2.25	1.92	1.72	1.24	0.92
Casein	12.00	12.00	12.00	12.00	12.00	12.00
Fishmeal	2.40	1.92	1.44	1.20	0.48	–
Palm-oil	2.00	2.00	2.00	2.00	2.00	2.00
Salt	0.50	0.50	0.50	0.50	0.50	0.50
Vitamin/Mineral Premiza	1.05	1.05	1.05	1.05	1.05	1.05
Dicalcium phosphate	1.65	1.65	1.65	1.65	1.65	1.65
Limestone	0.80	0.80	0.80	0.80	0.80	0.80
Total	100.00	100.00	100.00	100.00	100.00	100.00

*ME for starch = 4,000 Kcal/Kg   ME for cassava = 3,800 Kcal/kg
ME for palm-oil = 9,000 Kcal/Kg   ME for casein = 4.800 Kcal/Kg
calculated ME in each feed 3,836.8 kcal/kg..

Table 2. Feed and nitrogen intake, weight gain, PER, digestibility, available lysine and blood chemistry of various levels of cassava fed to rats

Leavils of Cassava	Feed Intake (g)	N Intake (g)	Weight gain (g)	Corrected PER	Plasma Thiocyan - ate ug/ml	Plasma Urea mgN urea/ 100 ml	Apparent Digestibi- lity %	In Vitro Digesti- bility %	FDNB-reactive Lysine g/16gN = /Kg feed
0%	95.6	10.4	18.3	2.50 + 0.53	1.6	34.2	80.5 + 3.4	94.6	7.8
20%	94.6	10.4	14.0	2.22 + 0.08	2.1	62.0	80.5 + 6.8	92.8	8.2
40%	100.9	11.65	18.3	2.23 + 0.09	2.5	60.2	69.7 + 4. 8	88.6	7.8
50%	102.3	11.98	21.2	2.50 + 0.29	2.4	36.6	75.5 + 4.9	92.1	8.2
80%	108.5	12.65	20.9	2.26 + 0.28	3.0	45.0	73.7 + 4.3	90.0	8.3
100%	99.7	10.9	15.7	2.00 + 0.24	3.6	70.0	69.9 + 11.7	88.9	7.6

Table 3. Results of LPC in cassava diets fed to rats: Feed and nitrogen intake, weight gain, PER digestibility, and available lysine and blood chemistry.

Treatments	Feed Intake*1 (g)	Nitrogen Intake*	Weight Gain (g)	Corrected PER*2	Plasma Thiocyanate UG ml	Apparent Digestibility %	In Vitro Digestibility %	FDNE-reactive Lysine g/16/g N = /Kg feed
Cassava Casein Diet	138.5	13.9	16.3	2.01 + 0.24[a]	3.6	70.0 + 11.7	88.9	7.6
Cassava – 50% Casein + 50% LPC Diet	172.7	17.3	26.4	2.15 + 0.10[a]	4.6	80.3 + 6.9	89.4	7.9
Cassava – LPC Diet	155.5	15.6	14.2	1.26 + 0.24[c]	4.1	79.8 + 6.3	86.4	7.12
Cassava – LPC + 0.2 % Methionine Diet	155.7	15.8	18.3	1.64 + 0.28[b]	3.2	76.2 + 6.5	84.8	7.00

*1 Mean Value of 4 Rats
*2 Figures bearing the same superscript are not significantly different from one another.