A PRELIMINARY STUDY OF THE NUTRITIVE VALUE OF SOME DEHYDRATED TROPICAL ROOTS

— *by* —

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Root crops including cassava (*Manihot esculenta*); dasheen and eddoes (*Colocasia esculenta*); sweet potatoes (*Ipomoea batatas*) and yam (*Dioscorea spp.*) are commonly grown throughout the West Indies for food and contribute a major proportion of the total caloric intake (F.A.O. 1962). Despite their relative ease of propogation and high energy-yielding potential, research efforts on these crops has been negligible in comparison with that of the export crops, and cultivation has remained largely in the hands of peasant farmers (Campbell and Gooding 1962). Being highly perishable and of limited transportability, consumption is largely limited to domestic markets. Unlike other tropical countries where they constitute valuable sources of feed for all classes of livestock (Oyenuga 1955 and 1961) their use for this purpose in the West Indies is often associated with subsistence farming. The wastage and neglect which occurs needs little emphasis.

Recent investigations have demonstrated the possibilities for mechanical cultivation (Gooding and Campbell 1964; Chapman 1965) and the feasibility of commercial production (Haynes 1966) under Trinidad conditions. However little attention has been paid to problems involved in the transportation or utilization of these bulky high-carbohydrate, poor-protein foodstuffs. Although processing methods have long been developed (Martin and Leonard 1949, Holleman and Aten 1956), possibilities for the industrial utilization of roots for production of human livestock food have hardly been explored here.

Recognition that a deficiency of dietary protein is a major nutritional problem in this area suggests the urgent need for sources of high quality protein foods (F.A.O. 1962). Since a large proportion of our animal protein is now imported and is often too expensive for many in the lower income groups other sources must be sought. The development of low-cost protein-enriched foods based on dehydrated roots has been demonstrated (Tape 1963), and could be of value in augmenting the supply of dietary protein. On the other hand the use of dehydrated root flour or meal in stockfeeds, in place of cereals which are mainly imported, could aid the expansion of the local livestock industry.

Dehydrated sweet potatoes and cassava have long been used as a source of carbohydrate in rations for poultry and livestock (Holleman and Aten 1956; Mather *et al.* 1948; Singletary 1948 and Tillman and Davis 1948) but despite some reference to the suitability of the edible aroids (Barrett 1910) less is known about the value of these roots and yams for this purpose.

The present study was therefore designed as a preliminary attempt to determine and compare the feeding values of some commonly grown root crops when dehydrated and used as a major carbohydrate source in the diet of laboratory rats.

MATERIALS AND METHODS

Roots used in this study included cassava *(Manihot esculenta)*, dasheen and eddoes (*Colocasia esculenta*), sweet potatoes (*Ipomoea batatas*), tannia (*Xanthosoma sagittifolium*) and yam (*Dioscorea alata*).

Samples were obtained from the Central Experiment Station, Ministry of Agriculture, Centeno; the Central Marketing Agency, Port of Spain and the Texaco Food Crops Demonstration Farm and local retail outlets.

Preparation of materials

Fresh roots were cleaned, chopped and dehydrated in a force-draft oven at 80°C. and ground in a laboratory hammer-mill. Sub-samples were sieved and placed in glass bottles with plastic covers and stored in an air conditioned room until later analysis.

Proximate analysis and gross energy determinations

Moisture, ether extract, crude fibre and ash analyses in duplicate were determined according to A.O.A.C. (1960) methods and nitrogen as described by Metson (1956). Gross energy determination were done using a Ballistic Bomb Calorimeter.

Feeding trials

All ingredients were ground through the same sieve and mixed in a Hobart mixer. Rations were fed to groups of four weanling albino rats which were kept individually in wire mesh cages housed in an air conditioned room maintained at 75°F. All rations were fed *ad libitum*, a period of at least one week being allowed for rats to adjust to each ration. Fresh water was available at all times. Sub-samples of each ration were collected throughout the trials and composited for later analysis. Weekly liveweight and feed consumption data were recorded,

Experiment 1

A total of 48 rats was used in this experiment. Groups of male rats matched for initial weight were used to determine the effect of substituting cassava, sweet potato and yam meals at levels of 10, 20 or 30% in a commercial grower ration (Appendix Table II), during three consecutive five week periods.

Experiment 2

In this experiment groups of rats matched for initial weight were assigned at random for five weeks to a commercial grower ration alone or substituted with 10, 20 or 30% dasheen meal (Appendix Table III).

Experiment 3

Balanced rations containing dehydrated roots (60%) and supplemented with a commercial "concentrate mix," fortified with fish flour, were compared with a balanced whole wheat ration when fed for four weeks as the sole nutrient source. Groups of rats matched for initial weight were assigned at random to each of the six rations (Appendix Table IV).

Experiment 4

In this experiment the proportions of dehydrated roots were reduced from 60 to 55% and the level of commercial "concentrate" increased from 30 to 37%. These rations were compared with a supplemented corn diet when fed to rats as the sole ration for a period of four weeks (Appendix Table V).

Experiment 5

In this experiment mixed rations of dehydrated roots (48 or 50%) or corn (50%) and wheat middlings (30%) were compared. The protein supplement consisted of a fixed level of fishmeal (5%) with soybean meal being adjusted roughly in accordance with the crude protein contents of dehydrated roots. Groups of rats matched for initial weight were randomly assigned to the various ration treatments (Table 6) for a period of three weeks.

RESULTS

Composition of dehydrated roots (meals)

Proximate composition and gross energy data for different dehydrated roots are presented in Appendix Table 1. It is apparent that crude protein contents of dehydrated cassava in particular and dasheen meals were quite low when compared with the other dehydrated roots. While the levels of crude protein in sweet potato (6.3%) and tannia (6.5%) meals were lower than those of eddoe (8.5%) and yam (8.6%) meals,they compared favourably with levels usually reported for yellow corn (8.9%). Ether extract (.18 — 87%) and crude fibre (1.6 — 2.8%) contents were generally low as were levels of ash in cassava (1.3%) and sweet potato (1.6%). As estimated by difference nitrogen-free extract contents of all dehydrated roots were of a high order (82 — 92%) and levels of gross energy were fairly similar (3.92 — 4.20 k cals/gm).

Experiment 1

Appendix Table VII shows that the substitution of the commercial ration with 10 or 20% dehydrated roots apparently had little adverse effect on feeding value of the ration as indicated by the small magnitude of difference in weight gains and feed conversion efficiency. At the 30% level of substitution weight gains of rats fed dehydrated roots were depressed and efficiency of feed conversion lower, particularly in the case of sweet potato and cassava.

Experiment 2

A progressive decline in weight gain and efficiency of feed conversion occured with each level of substitution of dasheen meal for the commerical ration (Appendix Table VIII). Although these effects were quite marked at the 30% level, except for reduced growth, no gross deficiency symptoms were evident.

Experiment 3

When dehydrated roots were used as major (60%) basal ingredients in balanced rations and supplemented with a commercial "concentrate mix," fortified inferior to that of rats fed a supplement whole wheat diet (Appendix Table IX).

The poor performance of rats fed dasheen meal was particularly apparent in this trial.

Experiment 4

When the level of dehydrated roots was reduced to 55% and that of commercial "concentrate" increased in both the control and test rations, the general level of performance, as measured by gain in weight and efficiency of feed utilization was slightly improved (Appendix Table X). Performance of rats fed dasheen meal was worse than the previous trial.

Experiment 5

The addition of Wheat middlings and supplementation with a mixture of soybean meal and fishmeal resulted in some improvement in general performance. Weight gains and efficiency of feed conversion of rats fed sweet potato meal were superior to all others including the control ration. In order of average daily gains, sweet potato fed rats were followed by the control (2.9); yam (2.4); tannia (2.3); cassava (2.2) and dasheen (1.1) grams per day. In terms of efficiency of feed conversion sweet potato (4.5) were best with controls (5.3); cassava (5.6); tannia (6.8); yam (7.0) and dasheen (10.8) grams of feed per gram weight gained, in that order.

Although performance of dasheen fed rats was still poor, there was a marked improvement over previous trials.

DISCUSSION

Dehydrated roots were generally of inferior feeding value to corn or wheat, but to what extent this was attributable to specific nutrient deficiency is not certain. It appeared that supplementation with fishmeal and soybean meal improved feeding values of all roots except dasheen and could render these feedstuffs suitable as carbohydrate substitutes for a major proportion of the cereals in balanced rations. Other studies have emphasized the importance of high quality protein supplementation. Evans (1960) indicated the need for fishmeal or its equivalent of other high quality protein food when feeding pigs on roots and other bulky foods. Waugh (1963) also noted remarkably improved weight gains when sweet potato diets for pigs were supplemented with fishmeal or skim milk.

Studies of the amino acid composition of tropical roots (Close *et al.* 1953 and Concepcion and Cruz 1961) would suggest that because of the poor quality of protein, supplementation of tropical roots with the deficient amino acids is the obvious method for improving the nutritional value of these starchy foodstuffs. However, Adams *et al.* (1958) found that a condition resembling kwashiorkor, in adult rats fed high cassava diets, was corrected only when complete protein containing essential amino acids was fed. This is in accordance with observations by Friend *et al.* (1963) that the use of an easily digested source of animal protein may be an essential feature of the supplementation necessary for improving the feeding value of potato pulp.

It would also seem that the efficiency of utilization of nutrients is influenced by method of processing which could therefore determine the extent to which roots can be used as ration components for livestock and poultry. It is recognized (Holleman and Aten 1956; Oyenuga 1955) that boiling or heat treatment destroys enzyme action and accomplishes hydrolysis of certain toxic principles in some tropical roots. Inadequate pretreatment may therefore have been responsible for the poor performance observed when dasheen meal was fed. This could also have accounted for the poor growth and impaired feed utilization (Susaki and Hamakawa 1959; Tillman and Davis 1948; Vogt and Penner 1963; Yoshida and Morimoto 1955, 1960 and Yoshida *et al.* 1963) and even mortality (Yoshida and Morimoto 1957 and 1959) when dehydrated sweet potato and cassava were fed to rats and chickens. Toxic principles have been isolated from some species of yams which could prove fatal. In a recent study Gilbert and Gillman (1963) observed that when bioassays with *Dioscorea alata, D. cayenensis* and *D. rotundata* and *D. Xanthosoma sagittifolium* (Tannia) were carried out in weanling rats, none of these roots promoted growth nor was survival prolonged beyond 100 days. However, it was not determined whether the acute necrosis observed in rats fed yam was due to a toxic principle or was a consequence of sulphur containing amino acid deficiency. Although these workers deduced that the necrosis became manifest only in young rats, other studies (Adams *et al.* 1958) with adult rats and mice fed cassava gari, have shown physiological and morphological abnormalities which did respond to supplementation with complete protein containing essential amino acids.

Wood (1967) has recently suggested that for a food that plays such an important part in nutrition of large numbers of the human race, surprisingly little is known about cassava. Observations in particular about the paucity of knowledge which exists about amounts of toxic factors which may be consumed or of the long-term metabolic effects of ingesting them, may well apply to other tropical roots.

It is beyond the scope of this paper to determine whether commercial dehydration or other forms of processing tropical roots would be feasible. Certainly, indications are that these popular foods could become valuable carbohydrate substitutes for cereals in stockfeeds or enriched as "instant" or other foods for improving general nutritional levels. Increased utilization of roots could make certain developing countries less vulnerable to emergencies which could curtail imports (ICNND 1962) and warrants a far greater research effort to solve some of the problems which exist.

SUMMARY

Meals were prepared by grinding artificially dehydrated whole roots and tubers of cassava (*Manihot esculenta*), dasheen (*Colocasia esculenta*), sweet potato (*Ipomoea batatas*), tannia (*Xanthosoma sagittifolium*) and yam (*Dioscorea alata*). Groups of weanling albino rats matched for initial weight were used to determine feeding values of dehydrated roots as a replacement for 10, 20 or 30% of a commercial feed or as basal ingredients in balanced rations.

Dasheen meal was markedly inferior at all levels of substitution. Cassava, sweet potato and yam differed little from each other and produced satisfactory growth and performance at levels up to 20%.

When dehydrated roots were supplemented with a commercial "concentrate" mix (36%) all were inferior to controls containing corn or wheat; dasheen being particularly poor. Dehydrated roots (48 — 50%) when mixed with wheat

middlings (30%) and supplemented with fish meal (5%) and soybean meal (8 — 14%) produced generally better weight gains and efficiency of feed conversion than when supplemented with a commercial "concentrate." In particular it was noted that weight gains and Feed/gram Gain (gms) with respect to the sweet potato diet (3.2 and 4.5) were superior to the control ration (2.9 and 5.3) with cassava (2.2 and 5.6) being slightly inferior. Although some slight improvement occured, dasheen rations were quite poor.

It was concluded that with high quality protein supplementation dehydrated cassava, sweet potato, tannia and yam could satisfactorily replace cereals as main carbohydrate components of balanced rations. The poor performance of dasheen meal may have been attributable to the presence of calcium oxalate and other irritants and suggested that boiling or other treatment may be a prerequisite to dehydration.

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Appendix Table I. Composition of some Dehydrated Tropical Roots

No.	Common Name	Scientific Name	Mean chemical composition as determined per cent of dry matter						
			Dry Matter	Crude Protein	Ether Extract	Crude Fibre	Nitrogen Free Extract	Total Ash	Energy Gross k cals/gm
1.	Cassava—sweet, whole	*Manihot esculenta (utlissima)*	32.2	2.4	.87	2.8	92.6	1.3	4.20
2.	Cassava farine	,,	88.3	1.9	.39	2.2	82.6	1.3	3.94
3.	Dasheen—whole	*Colocasia esculenta*	23.7	3.1	.24	2.0	91.5	4.1	3.92
4.	Eddoes—whole	,,	——	8.5	.42	1.6	85.7	3.8	——
5.	Sweet Potato	*Ipomoea batatas*	30.0	6.3	.51	1.9	89.7	1.6	4.11
6.	Tannia	*Xanthosoma sagittifolium*	31.5	6.5	.18	2.4	87.0	3.9	4.02
7.	Yam—lisbon	*Dioscorea alata*	21.9	8.6	.42	2.5	83.7	4.7	4.15

Appendix Table II. Ration Formulation and Composition.

(Experiment I)

Ingredients (%)	Control Ration	Dehydrated Roots 10% Cassava Farine	Dehydrated Roots 10% Sweet Potato Meal	Dehydrated Roots 10% Yam Meal	Dehydrated Roots 20% Cassava Farine	Dehydrated Roots 20% Sweet Potato Meal	Dehydrated Roots 20% Yam Meal	Dehydrated Roots 30% Cassava Farine	Dehydrated Roots 30% Sweet Potato Meal	Dehydrated Roots 30% Yam Meal
Commercial Grower (16%)	95	85	85	85	75	75	75	65	65	65
Cassava Farine	—	10	—	—	20	—	—	30	—	—
Sweet Potato Meal	—	—	10	—	—	20	—	—	30	—
Yam Meal	—	—	—	10	—	—	20	—	—	30
Cod Liver Oil	5	5	5	5	5	5	5	5	5	5
	100	100	100	100	100	100	100	100	100	100
Analysis %										
Crude Protein	15.2	13.5	14.3	14.5	11.8	13.3	13.7	10.0	11.9	12.2
Ether Extract	7.5	7.5	6.6	7.3	7.3	7.4	6.7	7.0	7.1	6.8
Crude Fibre	2.9	3.0	2.9	3.0	2.3	2.7	2.4	3.0	2.9	3.0
Ash	4.9	4.7	4.8	5.0	4.6	5.0	5.5	3.8	4.0	4.7

Guaranteed Analysis: Crude Protein, Min. 16.0%; Crude Fat, Min. 3.0%; Crude Fibre, Max. 5.0%; Active drug ingredient Chlortetracycline.

Appendix Table III. Ration Formulation and Composition (Experiment 3)

Ingredients	Control Ration	Dasheen Meal (%) 10	20	30
Commercial Grower Ration (16%)*	95	85	75	65
Dasheen Meal	—	10	20	30
Cod Liver Oil	5	5	5	5
	100	100	100	100
Analysis %				
Crude Protein	14.9	13.9	12.8	11.6
Ether Extract	11.3	10.6	10.0	9.0
Crude Fibre	2.9	5.6	5.4	5.3
Ash	8.5	8.8	8.0	7.6

* Guaranteed Analysis : Crude Protein, Min. 16.0%; Crude Fat, Min. 3.0% Crude Fibre, Max. 5.0%. Active drug ingredient Chlorotetracycline.

Appendix Table IV. Ration Formulation and Composition (Experiment 3)

Ingredients	Control Ration			Dehydrated Roots		
		Cassava Meal	Dasheen Meal	Sweet Potato Meal	Tannia Meal	Yam Meal
Commercial Concentrate*	10	30	30	30	30	30
Whole Wheat Flour	80	—	—	—	—	—
Cassava Meal	—	60	—	—	—	—
Dasheen Meal	—	—	60	—	—	—
Sweet Potato Meal	—	—	—	60	—	—
Tannia Meal	—	—	—	—	60	—
Yam Meal	—	—	—	—	—	60
Fish Flour	2	2	2	2	2	2
Cod Liver Oil	3	3	3	3	3	3
Molasses	5	5	5	5	5	5
	100	100	100	100	100	100
Analysis %						
Crude Protein	16.6	12.7	12.6	14.3	15.4	16.9
Ether Extract	2.7	2.2	3.6	3.4	3.8	4.3
Crude Fibre	2.3	5.3	4.8	3.8	4.3	4.4
Ash	2.7	6.6	7.4	6.4	7.3	7.1

* Guaranteed Anaysis : Crude Protein, Min. 36.0%; Crude Fat, Min. 1.5%; Crude Fibre, Max. 9.0%; Ca. Min. 3.0%; Phosphorus, Min. 1.2%; Iodine, Min. 0.0002%; Salt (NaCl), Min. 1.5%; Max. 2.5%.

Appendix Table V. Ration Formulation and Composition (Experiment 4)

Ingredients	Control Ration	Dehydrated Roots: Cassava Meal	Dasheen Meal	Sweet Potato Meal	Tannia Meal	Yam Meal
Commercial Concentrate*	35	37	37	37	37	37
Ground Yellow Corn	60	—	—	—	—	—
Cassava Meal	—	55	—	—	—	—
Dasheen Meal	—	—	55	—	—	—
Sweet Potato Meal	—	—	—	55	—	—
Tannia Meal	—	—	—	—	55	—
Yam Meal	—	—	—	—	—	55
Molasses	5	5	5	5	5	5
Cod Liver Oil	—	3	3	3	3	3
	100	100	100	100	100	100
Analysis						
Crude Protein	15.6	13.7	13.7	14.9	15.1	16.2
Ether Extract	3.8	4.3	4.4	5.2	3.8	3.8
Crude Fibre	2.8	3.9	4.4	4.0	4.7	4.4
Ash	5.5	8.2	9.3	8.1	8.9	8.4

* Guaranteed Analysis : Crude Protein, Min. 36.0%; Crude Fat, Min. 1.5%; Crude Fibre,Max. 9.0%; Ca. Min. 3.0%; Phosphorus, Min. 1.2%; Iodine, Min. 0.0002%; Salt (NaCl), Min. 1.5%; Max. 2.5%.

Appendix Table VI. Ration Formulation and Composition (Experiment 5)

Ingredients	Control Ration	Dehydrated Roots: Cassava Meal	Dasheen Meal	Sweet Potato Meal	Tannia Meal	Yam Meal
Wheat Middlings	30	30	30	30	30	30
Ground Yellow Corn	50	—	—	—	—	—
Cassava Meal	—	48	—	—	—	—
Dasheen Meal	—	—	48	—	—	—
Sweet Potato Meal	—	—	—	50	—	—
Tannia Meal	—	—	—	—	50	—
Yam Meal	—	—	—	—	—	50
Fish Meal	5	5	5	5	5	5
Soybean Meal	8	14	14	12	12	8
Molasses	5	0	0	0	0	4
Vegetable Oil	—	1	1	1	1	1
Premix*—Mineral-Vitamin	2	2	2	2	2	2
	100	100	100	100	100	100
Analysis (%)						
Crude Protein	14.0	12.0	13.0	13.6	13.8	15.0
Ether Extract	2.8	1.8	1.1	1.3	1.2	1.9
Crude Fibre	2.6	4.7	4.2	3.9	4.5	4.1
Ash	6.2	7.7	7.7	6.7	8.0	7.7

* A Mixture of 88% "Churn" minerals and 12% vitamin premix, the latter supplying: Vit. A. USP units 10,570; Vit. D_2 , USP units 352, 420; Vit. E. I.U. 1,100; Riboflavin, mgs. 880; Calcium pentothenate mgs. 2,880; Choline chloride mgs. 31, 700; Vit. B_{12} mgs. 4,400; Zinc bacitracin mgs. 4,400, Iodine mgs. 760; manganese mgs. 24,430; Iron mgs. 19,220; Copper mgs. 1,460; Cobalt mgs. 520; Zinc mgs. 20,020. per kg.

Appendix Table VII. Weight gain, feed consumption and efficiency of feed utilization data

(Experiment 1)

RATIONS

	Level of Substitution	Control	Cassava Farine	Sweet Potato Meal	Yam Meal
No. of Rats		4	4	4	4
Av. Initial Weight (gms)		91.2	90.7	91.5	92.5
Av. Final Weight "		207.5	211.0	192.2	196.5
Av. Weight Gain "	10%	116.3	120.3	102.7	104.0
Av. Daily Gain "		3.3	3.4	2.9	3.0
Av. Feed Consumed "		466.5	424.4	464.5	433.2
Feed/gm Gain "		4.0	3.5	4.5	4.2
No. of Rats		4	4	4	4
Av. Initial Weight (gms)		78.2	78.0	79.0	79.7
Av. Final Weight "		192.7	189.2	176.7	196.7
Av. Weight Gain "	20%	114.5	111.2	97.7	117.0
Av. Daily Gain "		3.3	3.2	2.8	3.3
Av. Feed Consumed "		450.5	422.7	466.7	456.2
Feed/gm Gain "		3.9	3.8	4.6	3.9
No. of Rats		4	4	4	4
Av. Initial Weight (gms)		78.0	78.5	76.7	78.5
Av. Final Weight "		194.0	159.0	156.0	164.7
Av. Weight Gain "	30%	116.0	80.5	79.3	86.2
Av. Daily Gain "		3.3	2.3	2.3	2.5
Av. Feed Consumed "		510.0	376.2	485.7	396.0
Feed/gm Gain "		4.4	4.7	6.1	4.6

Appendix Table VIII. Weight gain, feed consumption and efficiency of feed utilization data.
(Experiment 2)

		RATIONS		
		Dasheen meal (%)		
	Control	10	20	30
No. of Rats	4	4	4	4
Av. Initial Weight (gms)	65	66	66	66
Av. Final Weight "	136.8	125.2	115.8	86.5
Av. Weight Gained "	71.5	59.5	49.8	86.5
Av. Daily Gain "	2.0	1.7	1.4	.58
Av. Feed Consumed "	460.0	380.2	336.5	247.0
Feed/gm Gain "	6.4	6.4	6.8	12.1

Appendix Table IX. Weight gain, feed consumption and efficiency of feed utilization data.

(Experiment 3)

RATIONS

	Control (Whole Wheat)	Cassava Meal	Dasheen Meal	Sweet Potato Meal	Tannia Meal	Yam Meal
No. of Rats	4	4	4	4	4	4
Av. Initial Weight (gms)	89.7	96.5	95.0	98.0	97.3	99.5
Av. Final Weight "	149.7	130.3	100.7	143.7	136.5	149.8
Av. Weight Gain "	60.0	33.8	5.7	45.7	39.2	50.3
Av. Daily Gain "	2.9	2.2	.27	1.6	1.9	2.4
Av. Feed Consumed "	233.5	215.0	203.0	257.5	365.0	355.0
Feed/gm Gain "	3.9	6.4	35.6	5.6	9.3	7.0

Appendix Table X. Weight gain, feed consumption and efficiency of feed utilization data.

(Experiment 4)

RATIONS

	Control	Cassava Meal	Dasheen Meal	Sweet Potato Meal	Tannia Meal	Yam Meal
No. of Rats	4	4	4	4	4	4
Av. Initial Weight "	65.8	66.0	66.0	65.8	66.0	66.0
Av. Final Weight "	162.2	119.8	70.0	120.2	130.2	133.0
Av. Weight Gain "	96.4	53.8	4.0	54.4	64.2	67.0
Av. Daily Gain "	3.4	1.9	.14	1.9	2.3	2.4
Av. Feed Consumed "	343.5	375.5	219.8	297.8	367.6	408.0
Feed/gm Gain "	3.6	7.0	54.9	5.5	5.7	6.1

Appendix Table XI. Weight gain, feed consumption and efficiency of feed utilization data.

(Experiment 5)

	Control	Cassava Meal	Dasheen Meal	Sweet Potato Meal	Tannia Meal	Yam Meal
			RATIONS			
No. of Rats	4		4	4	4	4
Av. Initial Weight (gms)	80.5	82.0	81.8	81.2	81.0	80.3
Av. Final Weight "	142.0	127.8	105.8	147.5	129.8	131.0
Av. Weight Gain "	61.5	45.8	24.0	66.3	48.8	50.7
Av. Daily Gain "	2.9	2.2	1.1	3.2	2.3	2.4
Av. Feed Conusmed "	323.4	254.5	259.8	299.8	331.6	392.3
Feed/gm Gain "	55.3	5.6	10.8	4.5	6.8	7.7

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