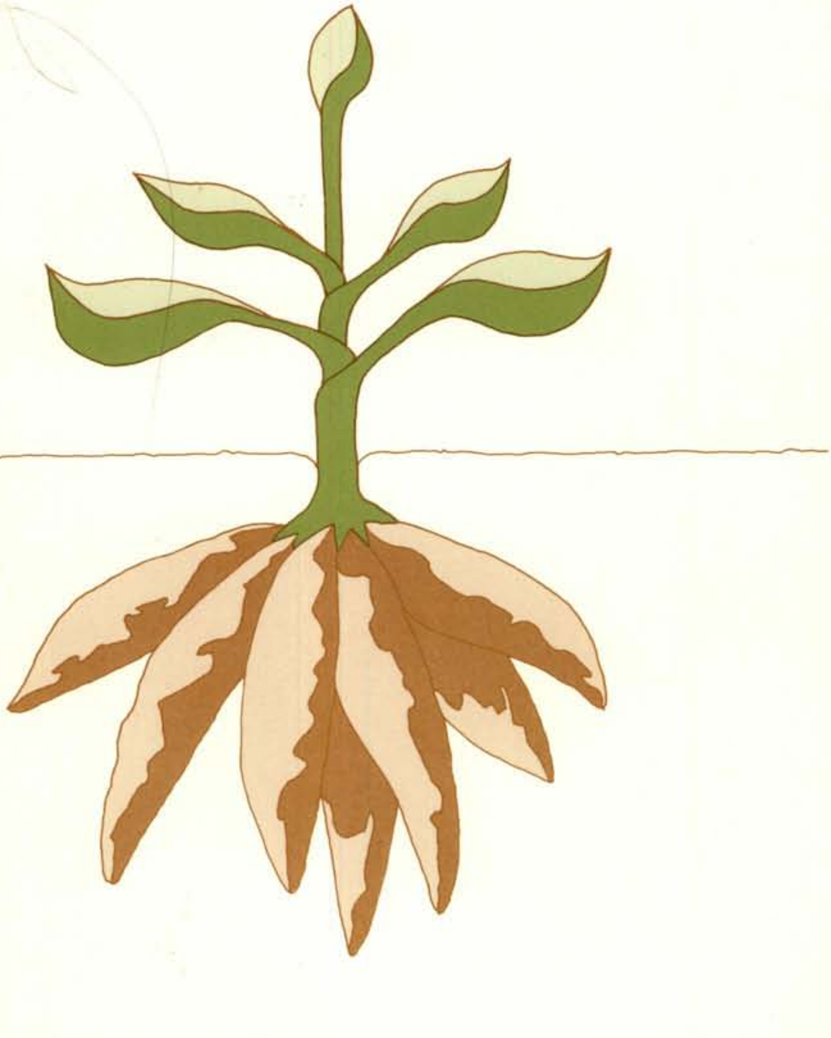
IDRC-080e

edings of the Fourth Symposium of the ational Society for Tropical Root Crops

Held at CIAT, Cali, Colombia, 1-7 August 1976

Edited by James Cock, Reginald MacIntyre, and Michael Graham



The International Society for Tropical Root Crops in collaboration with
Centro Internacional de Agricultura Tropical
International Development Research Centre
United States Agency for International Development

IDRC-080e

PROCEEDINGS

of the

FOURTH SYMPOSIUM

of the

INTERNATIONAL SOCIETY FOR TROPICAL ROOT CROPS

held at CIAT, Cali, Colombia, 1–7 August 1976

Edited by
James Cock, Reginald MacIntyre, and Michael Graham

The International Society for Tropical Root Crops
in collaboration with
Centro Internacional de Agricultura Tropical
International Development Research Centre
United States Agency for International Development

Postal Address: Box 8500, Ottawa, Canada K1G 3H9
Head Office: 60 Queen Street, Ottawa

Cock, J.
MacIntyre, R.
Graham, M.
International Society for Tropical Root Crops
CIAT
IDRC
USAID IDRC-080e
Proceedings of the Fourth Symposium of the International Society for Tropical Root Crops held at CIAT, Cali, Colombia, 1–7 August 1976, Ottawa, IDRC, 1977. 277 pp.

/ IDRC pub CRDI /. Proceedings of a symposium on / root crop / / plant production / in the / tropical zone / – includes / list of participants /, / bibliography/s, and / statistical data /.

UDC: 633.4(213) ISBN: 0-88936-115-0

Microfiche Edition $1

CONTENTS

Administration Générale à la Coopération et au Développement, Belgium, and Contract of the Ministère de la Politique Scientifique within the framework of the Association Euratom — University of Brussels — University of Pisa.

Aldridge, W. N. Analyst, 70, 1945, 474.

Degroot, L. J., and Stanbury, J. B. *The thyroid and its diseases.* John Wiley and Sons Inc., New York, 1975, 37–109.

Delange, F. *Endemic goitre and thyroid function in Central Africa.* Monographs on pediatrics, No. 2. Karger, S., ed., Basel, 1974, 6–14.

Delange, F., and Ermans, A. M. Amer. J. Clinical Nutr. 24, 1971, 1354.

Ekpechi, O. L. Brit. J. Nutrition, 2, 1967, 537.

Endemic goitre and cassava diets in Eastern Nigeria. In Nestel, B., and MacIntyre, R., eds., Chronic cassava toxicity: Proceedings of an interdisciplinary workshop, London, England, 29–30 January 1973, IDRC-010e, 1973, 139–145.

Ermans, A. M., Delange, F., van der Velden, M., and Kinthaert, J. *Possible role of cyanide and thiocyanate in the etiology of endemic cretinism.* In Stanbury, J. B., and Kroc, R. L., eds., Human development and the thyroid gland. Plenum Press, New York, 1972, 455–486.

Ermans, A. M., van der Velden, M., Kinthaert, J., and Delange, F. *Mechanism of the goitrogenic action of cassava.* In Nestel, B., and MacIntyre, R., eds. Chronic cassava toxicity: Proceedings of an interdisciplinary workshop, London, England, 29–30 January 1973, IDRC-010e, 1973, 153–157.

Kelly, F. C., and Snedden, W. W. *Prevalence and geographical distribution of endemic goitre.* In Endemic goitre. World Health Organization, Geneva, Monograph Series 44, 1960, 27–233.

Nwokolo, C., Ekpechi, O. L., and Nwokolo, U. Trans. Roy. Soc. Trop. Med. Hyg. 60, 1966, 97.

Oluwasanmi, J. O., and Alli, A. F. Trop. Geogr. Med. 20, 1968, 357.

Querido, A., Delange, F., Dunn, J. T., Fierro-Benitez, R., Ibbertson, H. K., Koutras, D. A., and Perinetti, H. *Definitions of endemic goitre and cretinism, classification of goitre size and severity of endemias, and survey techniques.* In Endemic goitre and cretinism: continuing threats to world health. Pan American Health Organization, Washington, D.C., Scientific Publication No. 292, 1974, 267–272.

Raben, M. S. Endocrinology, 45, 1949, 296.

Riley, M., and Gochman, A. *A fully automated method for the determination of serum protein bound iodine.* Technicon Symposium, New York, 1964.

Scranton, J. R., Nissen, W. M., and Halmi, N. S. Endocrinology, 85, 1969, 603.

Silink, K., and Marsikova, L. Nature, 167, 1951, 528.

Thilly, C., Delange, F., Camus, M., Berquist, H., and Ermans, A. M. *Fetal hypothyroidism in endemic goitre: the probable pathogenic mechanism of endemic cretinism.* In Endemic goitre and cretinism: continuing threats to world health. Pan American Health Organization, Washington, D.C., Scientific Publication No. 292, 1974, 121–128.

Vanderlaan, J. P., and Vanderlaan, W. P. Endocrinology, 40, 1947, 403.

van der Velden, M., Kinthaert, J., Orts, S., and Ermans, A. M. British J. Nutr. 30, 1973, 511.

Wollman, S. H. Amer. J. Physiol. 203, 1962, 517.

Yamada, T., Kajihara, A., Takemura, Y., and Onaya, T. *Antithyroid compounds.* In Greer, M. A., and Solomon, D. H., eds., Handbook of physiology, Section 7, Endocrinology, Vol. III, Thyroid. American Physiological Society, Washington, D.C., 1974, 345–357.

Utilization of Cassava as a Carbohydrate Source for Pigs

V. F. Hew and R. I. Hutagalung[1]

Cassava is shown to serve as an inexpensive source of valuable energy for pigs. The correct choice of cassava with low cyanogenic glucosides and the use of high quality proteins to make up for nutrient deficiencies in amino acids and vitamins makes the replacement of grains by cassava possible. The use of cassava would substantially reduce the cost of feed.

When 30 Landrace pigs were assigned to diets containing 0, 15, 30, 45, and 60% cassava as the energy source in their diets, no significant difference in performance nor carcass characteristics was observed. The increase in cassava levels was accompanied by an increase in fishmeal, a high quality and locally available protein source. The inclusion of fishmeal rather than other proteins of plant origin in high cassava diets is comparable to the supplementation in the cassava diets of methionine or other synthetic amino acids.

[1]Animal Improvement Division, Malaysian Agricultural Research and Development Institute, Serdang, Selangor, Malaysia, and Faculty of Agriculture, University of Malaya, Kuala Lumpur 22-11, Malaysia, respectively.

Table 1. Composition of diets for pigs (15–50 kg body weight).

	Cassava level (%)				
	0	15	30	45	60
Corn, yellow	71.00	54.50	37.15	20.50	2.50
Cassava root meal[a]	—	15.00	30.00	45.00	60.00
Soybean meal	18.00	18.00	18.00	18.00	18.00
Fishmeal	9.15	10.65	13.00	14.65	17.65
Iodized salt	0.50	0.50	0.50	0.50	0.50
Tricalcium phosphate	1.00	1.00	1.00	1.00	1.00
Vitamin premix[b]	0.05	0.05	0.05	0.05	0.05
Mineral mix[c]	0.25	0.25	0.25	0.25	0.25
Antibiotics[d]	0.05	0.05	0.05	0.05	0.05
	Calculated analysis				
Protein (%)	18.09	17.91	18.09	17.98	18.04
Dig. energy (kcal/kg)	3475	3506	3534	3566	3589
Calcium (%)	0.90	0.98	1.10	1.19	1.36
Phosphorus (%)	0.75	0.84	0.74	0.73	0.76
Vitamin A[e] (IU/kg)	2500	2500	2500	2500	2500
Vitamin D_3[e] (IU/kg)	500	500	500	500	500
Vitamin B_{12}[f] (mcg/kg)	16.05	17.37	19.44	20.89	23.53

[a]Contains 70 ppm HCN.
[b]Pfizer swine medicated premix.
[c]Biostock (ST5) I.C.I.
[d]Pro-strep '60' M.S.D.
[e]Amount, provided by the addition of vitamins only.
[f]Amount, provided by vitamin premix plus fishmeal, which contains 88 mcg vitamin B_{12}/kg fishmeal.

Cassava has been used as a feedstuff for livestock and provides a major source of energy for swine in the Philippines, Africa, Latin America, and Malaysia. Numerous experiments have shown that cassava could serve as an inexpensive source of energy for pigs. However, results have been variable. A number of reports indicate that large amounts of cassava in various forms have been fed to swine with satisfactory results and with no evidence of cyanide toxicity; however, others have found reduced gains as the level of cassava in the swine diet was increased.

There is no doubt that the differences could be due to genetic variation of HCN content, the kind of proteins included, the physical quality of the rations (whether pelleted, coarsely ground, or finely ground), as well as the method of processing the cassava.

In this investigation well dried cassava chips with only 70 ppm HCN were used as a carbohydrate base to replace corn. High quality protein was incorporated into the diets with the cassava.

Experimental Procedure

Thirty Landrace pigs averaging 14.6 kg were randomly assigned by weight and sex to five dietary treatments. The treatments were a basal corn-soybean-fishmeal diet and the basal plus four graded levels of cassava at 15, 30, 45, and 60%. Each treatment consisted of six pigs in two replicates of three. The animals were fed with isonitrogenous diets of 18% protein until they reached 50 kg, after which the level of protein was reduced to 16%. The composition of the diets is presented in Table 1.

Feed and water were given to the pigs *ad libitum*. Weight gains and feed consumption were recorded weekly and all data were subjected to analysis of variance. Each pig was slaughtered as it reached a weight of approximately 70 kg. The carcasses were chilled at 0 °C for 48 h after which records of carcass shrink were noted, length measured from the anterior edge of the first rib to the anterior edge of the aitchbone, backfat thickness taken at first rib, kidney and last lumbar positions and loin eye muscles were traced out at the fourth rib and second lumbar sections. Samples of liver, meat, and fat were collected and stored in a freezer at −43 °C. The liver and meat tissues were then ground and dried in a vacuum oven at 35 °C for 24 h for proximate analysis.

Results

There were no significant differences in average daily gain, feed intake, and feed efficiency in pigs fed different cassava levels.

The number of days taken by the animals to reach the 70 kg weight for all treatments was not significantly different, nor were the dressing percentage and percentage of shrink of all the pigs. However, the pigs on the control diet showed lower percentage shrink than the pigs on the cassava diets. The loin eye area of all pigs measured at the second lumbar position showed no significant difference among treatments, whereas the loin area taken at the fourth rib region showed significant difference ($p < 0.05$) for carcasses from the different treatments. The pigs fed the control ration had a bigger loin eye area than those on the other rations. The loin eye area decreases with increasing cassava level.

Data of haematocrit, crude protein, crude fat and moisture of the meat and liver tissues, and the iodine number of the backfat were collected. There was no significant difference in the haematocrit values taken from all the pigs. The results of the proximate analysis of the meat and liver showed no significant difference in moisture, dry matter crude protein, or in the dry matter crude fat content among the treatments. Although there was a decreasing trend in the iodine number values of backfat as cassava increased, the difference was not significant.

Discussion

The results of this trial have indicated clearly that cassava root meal can be used as a main carbohydrate source in pig rations without depressing their performance. No depression in growth rate, feed intake, or efficiency of feed conversion was observed in pigs fed cassava levels as high as 60%. Similar observations have been recorded by others. It has been observed that cassava has a beneficial influence on the quality of pork, and Castillo et al. (1963) found that carcasses, vitamin A in plasma and liver, as well as backfat thickness of pigs fed diets with and without cassava did not vary appreciably. Maner and Gómez 1973, using weanling pigs weighing 18.1 kg, found no difference between pigs fed a basal corn diet and pigs fed raw chopped cassava in combination with a well fortified protein supplement given *ad libitum*. Aumaitre (1969), Zausch et al. (1968), and Woodman et al. (1931) showed further that cassava improved the digestibility of organic matter.

On the other hand, Henry (1971) proved that substituting maize starch by cassava meal (57% of the total ration) caused a marked depression in weight gain and efficiency of feed conversion, and a lowering of the apparent digestibility coefficients of energy and protein. Such a depression in performance resulting from feeding cassava has been observed by others, and it has been found that this depression can be overcome by the addition of methionine. HCN may be the toxic factor depressing the performance of the animals.

Hill (1973) cautioned that inferior gains by diets high in potentially cyanogenic plant material cannot necessarily be attributed to HCN ingestion. Thus, while methionine supplementation improves performance of pigs fed high cassava levels, it may exert its effect in correcting methionine deficiency per se, due to the use of poor quality proteins or as a source of readily available sulfur for cyanide detoxication. However, the possibility of HCN cannot be disregarded. HCN may be a contributing factor to scouring. Coursey (1973) indicated that 50–100 ppm HCN in cassava tubers was moderately poisonous. Thus, the variety of cassava used in feeding trials should be very clearly specified. Certain varieties may be much more toxic than others and this may account for the contradictory results obtained by many workers. In this trial where cassava containing 70 ppm HCN was used, no evidence of HCN toxicity was observed. It is thus possible that a level of 42 ppm HCN (where 60% cassava was used) can be tolerated by growing pigs.

On the other hand, this trial may just support the statement made by Maner and Gomez (1973) that depression caused by consumption of cassava meal can be overcome by the utilization of high quality protein. In this experiment, the increase in percentage of cassava replacement from corn was accompanied by increasing levels of fishmeal to keep all the diets isonitrogenous. This is a variation from the previous experiment by Hew and Hutagalung (1972) where animal protein was kept constant while vegetable protein was increased with increasing cassava inclusion. They found reduced gains in the high cassava diets that were corrected by addition of methionine and/

or palm oil plus glucose. Contrary to their finding, cassava inclusion in this experiment had no effect on the performance of the pigs. The variation in results may be due to the source of cassava used and thus to the amount of HCN present. The use of a higher quantity of fishmeal may have improved the protein quality of the feed and thus supported better growth. Also fishmeal is a rich source of vitamin B_{12}, which may contribute to the detoxication process. There is evidence that hydroxocobalamin plays an active role in cyanide detoxication, where the hydroxocobalamin takes up the cyanide avidly to form harmless cyanocobalamin. With excess vitamin B_{12} to carry out this function it is possible that the methionine may not be needed in the detoxication process.

Thus cassava, when innocuous, is a good source of energy for pigs. The low fibre content and high energy in cassava makes it a valuable source of feedstuff. It has been shown that cassava improves the digestibility of organic matter. In this experiment, the 60% cassava diet had a digestibility value of 80.59%, whereas the control had 80.86%. The moisture content percentage of the faeces from pigs fed 60% cassava was 64%, whereas that of the corn control was 68%. Thus cassava did not appear to affect digestibility adversely although Muller et al. (1972) observed wetter faeces in pigs on high cassava diets and attributed it to the lower amylase content in cassava. Because HCN may be a contributing factor affecting scouring, it may be possible that scouring occurs if the pigs are fed cassava meal high in HCN.

The haematocrit values gave no significant difference among treatments. This confirms that the HCN has not exerted its effect on the haemoglobin level. The treatments did not have any effect on the dressing percentage and backfat thickness of the pigs. Castillo et al. (1963) also did not find any increase in backfat thickness due to use of cassava root meal. This is expected as cassava contains about the same energy content as corn and with the same rate of gain for all the pigs, there is no reason to expect a thicker backfat for the high cassava diets. Loin eye taken at the second lumbar region did not show any difference in cross-sectional area; however, that taken at the fourth rib showed a significant difference. Pigs fed higher cassava appeared to have a smaller loin eye area. Hutagalung et al. (1973) showed smaller loin eye area with increasing cassava content of diet and suggested that pigs fed cassava diets had neither adequate nor proper distribution of total protein intake to support maximum development of lean tissues, regardless of the energy content. The percentage shrink of the carcasses was not significantly different although control carcasses have definitely lower percentage shrink than all the other carcasses. The iodine number also appeared to decrease in the fats of pigs fed increasing levels of cassava. This may indicate a difference in saturation in the fat of pigs fed different levels of cassava. Other than these two factors, there did not appear to be any negative influence of cassava on carcasses and meat quality of pigs.

Cassava meal, when well processed, can be innocuous and well tolerated by pigs. It serves as a good energy source and the performance and carcass characteristics of the pigs depend very much on the composition of the whole ration. Cassava can be used as a main source of carbohydrate as long as the amino acid and mineral requirements are compounded with care.

The authors wish to thank Loh Wan Loy for statistical analysis. Special thanks are due to the junior research assistants, Nantha Kumaran, Balasubramanium and S. Poovan for their unfailing assistance in carrying out the trial. We are also indebted to the late Kassim Ismail who was a helpful consultant.

Aumaitre, A. *Nutritive value of Manioc and different cereals in early weaning diets for the piglet. Digestive utilization of feed and its effect on growth of the animals.* Annls. Zootech. 18, 1969, 385–398.

Castillo, L. S., Aglibut, F. B., Javier, T. A., Gerpacio, A. L., Garcia, G. V., Puyuoan, R. B., and Ramin, B. B. *Camote and cassava tuber silage as replacement for corn in swine growing-fattening rations.* Philippine Agric. 47, 1963, 460–474.

Coursey, D. G. *Cassava as food: toxicity and technology.* In Chronic cassava toxicity: Proceedings of an interdisciplinary workshop, London, England, 29–30 January 1973. International Development Research Centre, IDRC-010e, 1973, 27–36.

Henry, Y. *Nutritional effects of including purified cellulose in the diet of the growing-finishing pig. III. Influence upon the development of oesophagogastric ulcers.* Annls. Zootech. 19, 1971, 117–141.

Hew, V. F., and Hutagalung, R. I. *The utilization of tapioca (Manihot utilissima) root meal in swine feeding*. Mal. Agric. Res. 1, 1972, 124–130.

Hill, D. C. *Chronic cyanide toxicity in domestic animals*. In Chronic cassava toxicity: Proceedings of an interdisciplinary workshop, London, England, 29–30 January 1973. International Development Research Centre, IDRC-010e, 1973, 105–111.

Hutagalung, R. I., Phuah, C. H., and Hew, V. F. *The utilization of cassava (tapioca) in livestock feeding*. In Proceedings of the Third International Symposium on Tropical Root Crops, International Institute of Tropical Agriculture, Ibadan, Nigeria, 1973 (in press).

Maner, J. H., and Gómez, G. *Implications of cyanide toxicity in animal feeding studies using high cassava rations*. In Chronic cassava toxicity: Proceedings of an interdisciplinary workshop, London, England, 29–30 January 1973. International Development Research Centre, IDRC-010e, 1973, 113–120.

Müller, Z., Chou, K. C., Nah, K. C., and Tan, T. K. *Study of nutritive value of tapioca in economic rations for growing/finishing pigs in the tropics*. Pigs and Poultry Research and Training Institute, Singapore. UNDP Project ISIN6/505, 1972, 1–35.

Woodman, H. E., Menzies Kitchin, A. W., and Evans, R. E. *The value of tapioca flour and sago pith meal in the nutrition of swine*. J. Agric. Sci. 21, 1931, 526–546.

Zausch, M., Drauschke, W., and Lauterbach, A. *Digestibility and use of cassava meal by pigs*. Jahrb. Tierernährung u. Fütterung, 6, 1967–68, 256–260.

Use of Cassava as a Food Supplement for Broiler Chicks

Sarote Khajarern and Jowaman M. Khajarern

Two experiments were conducted to determine the substitutional value of cassava for corn in broiler rations. One-day-old Arbor Acres broiler chicks were used. In the first experiment, no significant differences in body weight gain and feed conversion were noted for chicks receiving 0, 7.5, 15, 22.5 and 30% substituted cassava pellets. However, in experiment 2, significantly poorer body weight gain and feed conversion ($p < 0.05$) were noted during 1–5 weeks of age when the rations contained 0, 10, 20, 30, 40 and 50% cassava root meal. It was also noted that body weight gain was not depressed until the rations contained more than 30% cassava root meal. The ability of chicks to utilize cassava root meal increased with age. Results indicated that, during 5–9 weeks of age and 1–9 weeks of age, there were no significant differences observed on body weight gain and feed conversion when the concentration of cassava root meal increased in the rations. Limiting factors in maximum replacement and economic feasibility in substituting cassava products for corn were: fibre and protein contents; prices of cassava compared to those of fish meal and soybean meal.

Cassava is Thailand's third major export crop next to rice and corn. More than 90% of the nation's cassava root products, approximately 2.4 million tons, is exported annually. The balance is eaten locally, mainly as flour. The Thai Tapioca Trade Association reported that Thailand exported a total of 1.1 million tons of tapioca pellets during the first 6 months of 1975, valued at 1976 million baht (approximately US$ 100 million), while 55 000 t of tapioca flour (137 million baht, US$ 7 million) was exported during the same period. Meanwhile, there has been a surplus of nearly 100 000 t of tapioca flour since early 1975 that resulted from a cut in imports by Japan of more than 200 000 t in 1973–74 to merely 90 000 t during 1975. Therefore, the economy of cassava growers in Thailand is almost totally dependent on exports.

Cassava root products are sold on the free market in Thailand and prices are totally regulated by supply and demand. Cassava growers sell their fresh root directly to the chip-drying agencies in the field, at the price set by the latter. Cassava chips and pellets are then prepared, and are exported mainly to EEC countries. Since cassava importing countries are limited, more of cassava and its products need

Animal Science Department, Faculty of Agriculture, Khon Kaen University, Khon Kaen, Thailand.