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cassava toxicity and thyroid: research and public health issues

proceedings of a workshop held in Ottawa, Canada, 31 May – 2 June 1982

Editors: F. Delange and R. Ahluwalia

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RESEARCH AND PUBLIC HEALTH ISSUES

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CASSAVA TOXICITY AND THYROID:

RESEARCH AND PUBLIC HEALTH ISSUES

Proceedings of a workshop held in Ottawa, Canada, 31 May - 2 June 1982

Editors: F. Delange[1] and R. Ahluwalia[2]

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Résumé

Cette publication est un résumé des actes d'un atelier qui a porté sur les relations entre la consommation de manioc et les troubles thyroïdiens chez l'homme. L'atelier a rassemblé des spécialistes de la médecine, de l'agriculture et de l'hygiène publique pour (1) examiner les résultats des études subventionnées par le CRDI sur le rôle du manioc dans l'étiologie du goitre endémique et du crétinisme ; (2) passer en revue les travaux de recherche sur les aspects du manioc intéressant l'agriculture ; (3) échanger des informations sur la méthodologie et les résultats d'études dans des domaines connexes ; et (4) définir les priorités de recherche et faire des recommandations touchant les programmes d'hygiène publique. La poursuite des travaux de recherche dans ces domaines contribuera grandement à prévenir et à contrôler le goitre endémique qui, par les anomalies de développement dont il est la cause constitue toujours un grand danger pour les populations des pays en développement.

Resumen

Esta publicación informa sobre las exposiciones presentadas en un seminario dedicado a la relación entre el consumo de yuca y el problema de la tiroides en los humanos. El seminario reunió científicos de los sectores médico, agrícola y de salud pública con el objeto de (1) reseñar los resultados de los estudios financiados por el CIID sobre el papel de la yuca en la etiología del bocio endémico y el cretinismo, (2) reseñar las actividades investigativas sobre aspectos agrícolas de la yuca, (3) intercambiar información sobre metodologías y hallazgos de otros estudios relacionados, y (4) identificar prioridades específicas para la investigación y hacer recomendaciones para los programas de salud pública. Los esfuerzos continuos en estas áreas de la investigación se dezicarán en buena parte a prevenir y controlar el bocio endémico y sus anormalidades acompañantes en el desarrollo, las cuales siguen constituyendo un problema serio de salud pública entre las poblaciones del mundo en desarrollo.

Contents

Foreword 7

Cassava and Endemic Goitre

Role of Cassava in the Etiology of Endemic Goitre and Cretinism *A.M. Ermans, P. Bourdoux, J. Kinthaert, R. Lagasse, K. Luvivila, M. Mafuta, C.H. Thilly, and F. Delange* **9**

Nutritional Factors Involved in the Goitrogenic Action of Cassava *F. Delange, P. Bourdoux, E. Colinet, P. Courtois, P. Hennart, R. Lagasse, M. Mafuta, P. Seghers, C. Thilly, J. Vanderpas, Y. Yunga, and A.M. Ermans* **17**

Role of Other Naturally Occurring Goitrogens in the Etiology of Endemic Goitre *Eduardo Gaitan* **27**

Discussion: Cassava and Endemic Goitre **35**

Public Health and Nutritional Aspects of Endemic Goitre and Cretinism

Public Health and Nutritional Aspects of Endemic Goitre and Cretinism in Asia *N. Kochupillai and V. Ramalingaswami* **43**

Public Health and Nutritional Aspects of Endemic Goitre and Cretinism in Africa *M. Benmiloud, H. Bachtarzi, and M.L. Chaouki* **49**

Nutritional and Public Health Considerations Relating to Endemic Goitre and Cretinism in South America *José R. Varea Terán* **55**

Public Health and Nutritional Aspects of Endemic Goitre in Nepal — Summary *K.B. Singh* **62**

Endemic Goitre in the State of Sarawak, Malaysia *Tan Yaw Kwang* **64**

Cassava Consumption, Endemic Goitre, and Malnutrition in Costa Rica *Leonardo Mata, Emilce Ulate, Sandra Jiménez, and Carlos Díaz* **69**

Endemic Cretinism in the Andean Region: New Methodological Approaches *Ignacio Ramirez, Marcelo Cruz, and José Varea* **73**

Cassava Diet, Tropical Calcifying Pancreatitis, and Pancreatic Diabetes *P.J. Geevarghese* **77**

Discussion: Public Health and Nutritional Aspects of Endemic Goitre and Cretinism **79**

Overview of Production and Utilization of Cassava

An Overview of Cassava Consumption and Production *Truman P. Phillips* **83**

Utilization of Cassava in the European Community *D. Renshaw* **89**

Agricultural Research on Cassava

Cassava Research to Overcome the Constraints to Production and Use in Africa *S.K. Hahn* **93**

Agricultural Research on Cassava in Asia and Australia *Gerard H. de Bruijn* **103**

Discussion: Overview of Production and Utilization of Cassava and Agricultural Research on Cassava **108**

Animal and Genetic Research Trends in Cassava

Cassava, Cyanide, and Animal Nutrition *Guillermo Gomez* **109**

Thyroid Cassava Toxicity in Animals *Olumide O. Tewe* **114**

Toward Lower Levels of Cyanogenesis in Cassava *Gerard H. de Bruijn* **119**

Discussion: Animal and Genetic Research Trends in Cassava **123**

Cassava Processing and Nutrition Education

Processing and Detoxification of Cassava *O.L. Oke* **129**

Traditional Cassava Detoxification Processes and Nutrition Education in Zaire *P. Bourdoux, P. Seghers, M. Mafuta, J. Vanderpas, M. Vanderpas-Rivera, F. Delange, and A.M. Ermans* **134**

Effects of Cassava Processing on Residual Cyanide *Rodney D. Cooke* **138**

Discussion: Cassava Processing and Nutrition Education **143**

Conclusions and Recommendations **145**

Participants **147**

Traditional Cassava Detoxification Processes and Nutrition Education in Zaire[1]

P. Bourdoux, P. Seghers, M. Mafuta, J. Vanderpas, M. Vanderpas-Rivera, F. Delange, and A.M. Ermans[2]

In spite of its well-recognized toxic properties, cassava is eaten by millions of people throughout the world. This paper discusses some of the aspects of detoxification processes associated with the consumption of cassava in Zaire.

Earlier studies (Delange et al. 1982) have shown an increase in serum and urinary thiocyanate concentrations from Bas Zaire to Ubangi. These variations might result from either differences in the amount of cassava consumed or differences in the cyanide (HCN) content of the food ingested. The former hypothesis was ruled out on the basis of nutrition surveys conducted in three study areas in Zaire. The latter hypothesis was investigated in terms of the HCN content of cassava tubers and cassava-based foods. In a second step, a laboratory analysis was carried out on some currently used cassava detoxification processes. Finally, on the basis of the results obtained, a trial of nutrition education was attempted with one family in a small community of Ubangi.

HCN Content of Fresh Tubers

It is generally agreed that the amount of HCN in cassava tubers varies greatly due to a number of factors, including the variety of the cassava and environmental conditions under which it is grown.

Although the tubers from Bas Zaire, Kivu, and Ubangi belonged to the same botanical species (*Manihot esculenta*), morphological differences were evident for plants and tubers from Kivu when compared with those from Ubangi and Bas Zaire, which appeared to be nearly identical. Because of the differing geographical location of the three study areas, the respective environmental conditions were also different, with equatorial forest in Ubangi, savanna in Bas Zaire, and highlands in Kivu.

The tubers in these regions showed an extremely wide variation in HCN content, ranging from 5–142 mg HCN/kg in Bas Zaire to 12–205 mg HCN/kg in Kivu and 2–309 mg HCN/kg in Ubangi (Bourdoux et al. 1982). Within each of the three areas, this variation was probably a result of varietal differences among the fresh tubers studied and the different environmental conditions.

A relative comparison of the tubers from the three areas was made based on the arbitrary categories originally proposed by Bolhuis (1954). The percentage of tubers containing less than 50 mg HCN/kg increased from 45% in Ubangi to 80% in Bas Zaire, whereas the percentage of tubers with greater than 100 mg HCN/kg was similar in Ubangi and Kivu (24 and 21% respectively) but significantly lower in Bas Zaire (4%). Between areas, it was not possible to account for the difference in HCN content between the tubers. In summary, the HCN content of the tubers analyzed increases from Bas Zaire to Kivu to Ubangi.

HCN Content of Cassava Products

Cassava is subjected to various processes in

[1]The information in this paper has been summarized from *Nutritional factors involved in the goitrogenic action of cassava*, IDRC-184e. An extensive reference list can be found in this publication.

[2]Centre Scientifique et Médical de l'Université Libre de Bruxelles pour ses Activités de Coopération (CEMUBAC), Belgium, and Institut de Recherche Scientifique (IRS), Zaire, Goitre Program; Departments of Radioisotopes and Pediatrics, University of Brussels, Belgium.

an attempt to reduce the HCN content. A wide variety of traditional detoxification processes are used in different countries but all of them tend to bring the substrate (linamarin) and the enzyme (linamarase) into contact to liberate HCN.

In the three areas studied, the main food items consumed and the associated detoxification processes used by the inhabitants are as follows:

Area	Cassava product	Detoxification process
Ubangi	Paste (*fuku*)	Sun-drying + cooking
	Leaves (*mpondu*)	Washing + cooking
Kivu	Paste (*bugali*)	Fermentation + cooking
Bas Zaire	Paste (*fufu*)	Soaking + sun-drying + cooking
	Chickwangue	Soaking + sun-drying + cooking

Source: Bourdoux et al. (1982).

The typical food items in Ubangi are *fuku* and *mpondu*, which were found to have the highest mean HCN contents (17.3 and 8.2 mg HCN/kg respectively). A residual level of 6.3 mg HCN/kg was found in *bugali* from the Kivu district. Because *bugali* is prepared from cassava and sorghum grain, which is notorious for its cyanogenic content (dhurrin), the total HCN content cannot be related entirely to linamarin. The HCN content of food items from Bas Zaire, prepared through a process of soaking for several days, drying, and then cooking, is much less than in food items from either of the two other study areas.

These results suggest the presence of significant amounts of HCN in some cassava products prepared by traditional processes. It is also apparent that the efficiency of detoxification increases from Ubangi to Bas Zaire, where soaking is used widely. To determine whether or not the detoxification processes used by the inhabitants of these areas can lead to well-detoxified cassava products, the various steps in each of these processes were analyzed.

Detoxification Processes

Tubers and leaves were sampled at random at the local market and food items were prepared following the same procedures as those used by the local inhabitants (Bourdoux et al. 1982, Table 18). Extra care was taken during the test in an attempt to decrease the HCN content as much as possible.

The final HCN content, about 1.5 mg HCN/kg, of the foods prepared in the laboratory reflects the efficiency of the detoxification processes. For comparison, a series of *mpondu* samples prepared by workers of the IRS centre were examined and revealed an HCN content ranging from <1.0–25 mg HCN/kg. This demonstrates that well-detoxified foodstuffs can be obtained if the detoxification process is conducted with care.

Effect of Drying and Temperature

The most disturbing finding obtained during the preparation of *fuku* was an increase in the HCN content after sun-drying. Repeatedly, an increase in HCN content was observed in other similar experiments. The extent of the increase, however, varied from one experiment to another. This increase may have been due to the removal of water from the tubers. The variability observed might be accounted for by the time interval between the harvesting and processing of the tubers.

In a subsequent experiment, the tubers were dried for 1–8 days and the percentage of water removed from the tubers was determined (Bourdoux et al. 1982, Table 20). From the results, it is evident that the longer the drying period, the greater the amount of water removed from the tubers (e.g., 14.1% after 1 day, 70.0% after 8 days). This indicates that the main effect of sun-drying is the removal of water from the tubers, with a subsequent increase in HCN content.

Effects of Heating

The effects of heating were investigated further by dividing the tubers into four identical parts (longitudinal section) and oven-drying them at 60, 105, and 165°C to constant weight (Bourdoux et al. 1982, Table 21). These temperatures were chosen because they exceed sun-drying conditions and the decomposition temperatures reported for linamarase (72°C) (Joachim and Panditteseker 1944) and linamarin (150°C) (Cerighelli 1955). Such temperatures, however, are never achieved by the local inhabitants while preparing their meals.

Slight heating (60°C) produced a further loss of water and a concomitant increase in the HCN content. In contrast, increasing the temperature of drying beyond 60°C causes the HCN content to decrease.

Effects of Soaking on HCN Content

Prolonged soaking of the tubers (1–5 days)

resulted in lowering their HCN content, e.g., soaking for 1 day removed 45% of the HCN, whereas soaking for 5 days resulted in the removal of 97% of the initial HCN content (Bourdoux et al. 1982, Table 22).

When the HCN content is determined by autolysis, it is necessary to stress that the values obtained might be minimum values because if, for any reason, the linamarase was destroyed, HCN would not be produced from persisting linamarin.

This hypothesis, i.e., the destruction or elimination of linamarase by soaking, was evaluated by adding fresh cassava tubers with extremely low HCN content, which supposedly contained the enzyme, to bitter tubers after 6 days of soaking. Inasmuch as the sweet cassava contained excess linamarase, it was observed that the low HCN content in the bitter tubers after 6 days of soaking was actually due to the release of the linamarin originally present and not a result of the deactivation or release of the enzyme.

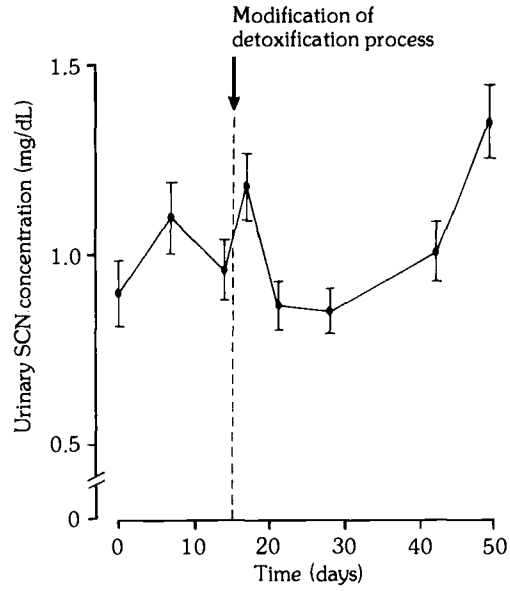

Fig. 1. Changes with time in urinary SCN concentrations (mean±SEM) in 29 persons in the village of Bokuda (Ubangi) during a trial of nutrition education.

Nutrition Education in Ubangi

Based upon the encouraging results obtained from the laboratory experiments, which indicated that improved detoxification of cassava foodstuffs is possible, a family of 29 persons was asked to modify the preparation of their main food item (*fuku*) by adding a 3-day period of soaking, a 1-day drying period for the soaked tubers, and cooking the flour for 30 min. The aim of these modifications was to reduce the thiocyanate (SCN) overload previously noted for this population. The reason for the changes were explained extensively and the consent of the whole family was obtained. The effect of this dietary manipulation was monitored by determining the concentration of urinary thiocyanate in samples collected on days 0, 7, 14, 21, 28, 42, and 49 (Fig. 1).

Before the introduction of the modifications, urinary SCN levels were fairly constant and close to 1 mg/dL. The urinary SCN concentration decreased slightly, but not significantly, on days 21 and 28 and then increased to similar or even higher levels than the initial values. A similar trend was observed in all of the people tested.

The results were shown to the villagers and, upon questioning, they explained that they had followed the modified procedures for only 3 days, after which time they decided to sell the well-detoxified cassava (i.e., *chickwangue*) at the market of Gemena to make some money. This unsuccessful trial indicates that, even with appropriately informed and apparently motivated people, changing the nutritional habits of a rural population is quite difficult.

Summary and Conclusions

The results of this study indicate that:

(1) The HCN content of tubers increases from Bas Zaire to Kivu to Ubangi.

(2) The HCN content of cassava products also increases from Bas Zaire to Kivu to Ubangi and is closely linked to traditional cassava processing methods. In this context, soaking may be regarded as the most efficient detoxification process.

(3) Well-detoxified food items can be prepared if the detoxification process is carried out carefully. Even in Ubangi, well-detoxified foodstuffs can be prepared with only slight modification of traditional cassava processing procedures.

(4) Modifying the food habits of rural populations in Africa is difficult.

The differences in the SCN levels observed in the inhabitants of the three areas investigated can be accounted for by the differences in the HCN content of fresh tubers or, more likely,

due to differences in the HCN content of the food items ingested.

Evidence indicates that if, for any reason, the efficiency of cassava detoxification decreased, thiocyanate overload and concomitant thyroid problems would occur in persons that would otherwise be unaffected by such problems. Taking into account the relative role of iodine and SCN intake, similar problems would occur as a result of an increase in the dietary supply of cassava in areas with moderate or low iodine intake.

Bolhuis, G.G. 1954. The toxicity of cassava roots. Netherlands Journal of Agricultural Science, 2, 176–185.

Bourdoux, P., Seghers, P., Mafuta, M., Vanderpas, J., Vanderpas-Rivera, M., Delange, F., and Ermans, A.M. 1982. Cassava products: HCN content and detoxification processes. In Delange, F., Iteke, F.B., and Ermans, A.M., ed., Nutritional Factors Involved in the Goitrogenic Action of Cassava. International Development Research Centre, Ottawa, Canada, IDRC-184e, 51–58.

Cerighelli, R. 1955. Plantes vivrières. In Cultures Tropicales. Librairie Baillière et Fils, Paris, France, 289–378.

Delange, F., Iteke, F.B., and Ermans, A.M. 1982. Nutritional factors involved in the goitrogenic action of cassava. International Development Research Centre, IDRC-184e, 100 p.

Joachim, A.W.R. and Panditteseke re, D.G. 1944. Investigation of the hydrocyanic acid content of manioc (*Manihot utilissima*). Tropical Agricultural Magazine of the Ceylon Agricultural Society, 100, 150–163.