Working together to eliminate cyanide poisoning, konzo and tropical ataxic neuropathy (TAN).

CCDN

Cassava Cyanide Diseases Network

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Contents

CCDN Coordinator:
Dr. J. Howard Bradbury
School of Botany and Zoology
Australian National University
Canberra ACT 0200, Australia
Phone: +61-2-6125 0775
E-mail: howard.bradbury@anu.edu.au

Coordinating Group:
Julie Cliff, Ian Denton, Humberto Muquingue, Arnaldo Cumbana, Dulce Nhassico

Country Contacts:
Cameroon: E.E Agbor;
D.R. Congo: D.D. Ngudi;
India: Bala Nambisan and K.T. Shenoy;
Indonesia: A.Hidayat;
Mozambique: Anabela Zacarias;
Nigeria: M.N.Adindu and P.N.Okafor

Website:
www.anu.edu.au/BoZo/CCDN

Konzo, TAN and cyanogens from cassava flour and gari

Konzo is an irreversible paralysis of the legs that occurs mainly in children and women of child bearing age in Mozambique, Tanzania, Democratic Republic of Congo (DRC), Cameroon, Central African Republic (CAR) and probably other countries. It is an upper motor neuron disease of sudden onset due to large intakes of cyanide from cassava over a fairly short period.[1] Epidemics may occur as a result of drought and war.

There were 100 cases during the 2005 drought in Nampula and Zambezia Provinces of Mozambique.[2] During drought the total cyanide content of cassava flour increased from an average value in a good year of 45 ppm to greater than 100 ppm.[3] In wartime, people are displaced from their homes and villages and eat high cyanide cassava without proper processing and get konzo. It is estimated that there are 100,000 konzo cases in DRC as a result of the recent five year civil war and many refugees in Cameroon from the recent war in CAR have konzo.[4]

By mixing cassava flour with water, spreading the wet flour in a thin layer and leaving in the shade for five hours the cyanide content is reduced 3-6 fold.[5-7] This method is acceptable to rural women and is being introduced into Mozambique and Tanzania funded by AusAID, but funding is still urgently needed for its introduction into DRC. Multiple copies of coloured laminated posters are available free of charge which describe the method in Kiswahili, Kifuliru, English, French and Portuguese.[7,8] **We wish to obtain translations into other African languages, so that posters can be produced for distribution to rural women in those languages too.**

Tropical ataxic neuropathy (TAN) is a disease that occurs mainly amongst older people who have consumed a monotonous cassava diet over many years. TAN produces unsteady walking, blindness, deafness, weakness and loss of feeling in hands and feet. It has been reported from West Africa (particularly Nigeria), Tanzania, Uganda, Kenya, the West Indies and tropical Asia.[9.10] Gari which is the most popular form of processed cassava in Nigeria, has an average total cyanide content of 15-20 ppm.[11,12]

Cyanide intake from cassava flour and gari. The cyanide present in cassava flour is mainly present as linamarin whereas that present in gari is mainly present as acetone cyanohydrin.[13] The cyanide in linamarin is only about 50% absorbed by the body,[14] whereas acetone cyanohydrin is 100% broken down to hydrogen cyanide in the alkaline conditions of the gut. Thus the cyanide *intake* from cassava flour with an average cyanide content of 45 ppm would be about 22-25 ppm, whereas the cyanide *intake* from Nigerian gari would be not greatly smaller at 15-20 ppm.

Konzo clearly results from high cyanide intake from consumption of high cyanide cassava flour produced during drought, disruption due to war, or poor processing of bitter cassava which probably produces endemic konzo which persists over the years in Mogincual District of Mozambique.[1] A direct link between TAN and intake of cyanide from gari has been questioned,[15] but the recent outbreak in south India[10] supports the strong circumstantial evidence of Osuntokun[9] for a direct link. It is therefore likely that the incidence of TAN would be reduced by reduction of the total cyanide content of gari.

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J Howard Bradbury
Howard.Bradbury@anu.edu.aau

Cassava utilization, processing and marketing in Busia District, Western Kenya

In Kenya cassava has limited utilization due to lack of knowledge and skills in processing, stigmatization as a poor mans' crop, lack of awareness on crops' potential by policy makers and poor market strategies.[1] Apart from cassava flour and starch there are myriad products with short shelf lives of one to four days that lack commercial viability.[2] Media reported cases of cassava poisoning and sometimes deaths in Western Kenya are linked to limited knowledge concerning cassava cyanide and its toxic potential to consumers. The objective of this study was to assess the scale of cassava utilization, processing and marketing in western Kenya.

A cross sectional survey was conducted in cassava consuming households in the Busia district of Western Kenya. 77% of the households, grew cassava among other crops. Nine varieties of cassava, SS4, Migyera, Magana, MM 96/5280, Serere, Bamba, Opangi, Matuja and MM 95/0183 were grown. 54% grew a combination of SS4, Migyera and Magana. Magana is a local variety believed to be very poisonous but the amount of cyanide has not been measured. Migyera was most preferred by 53% of households for cooking, followed by a combination of SS4 and MM 96/5280 preferred by 15%. Utilization of cassava by households was limited to traditional products; porridge, boiled roots and ugali by 94%, followed by porridge and whole meal boiled or roasted by 5%, while only 1% use cassava leaves as a vegetable. In the study population cassava was the second source of carbohydrate used by households.

The majority of households (84%) preferred Magana for processing followed by Migyera (10%). Processing methods are (1) the traditional method which is to peel the roots, cover with banana leaves and ferment for 3 days, remove moulds, sun dry and grind in a mechanical mill; used by 98%. (2) The traditional method and also for sweet cassava varieties, cassava chips are sun dried for one day and milled which is used by 2%. This study confirms a limitation of cassava processing methods compared with other studies[2-6].

The method of transporting cassava products to the market affects the quantity to be sold. Studies in Uganda[4-7] show that trucks delivered high quality cassava flour which gained premium price. In this study, carrying in baskets on the head by individuals' was the main method used by (73%) followed by carrying on bicycles in bags used by (27%). 71% of households sold cassava, and dry fermented chips was the most popular form. Fresh cassava roots were sold counting according to size by 50%, mixed heaps were used by 48% and 2% sold in baskets. Cassava buyers were mainly villagers (79%) followed by middlemen (20%)& processors 1%.

This study confirms the importance of cassava in the food system and is evidenced by its ranking second in carbohydrate source. The limitation of different processing methods and knowledge concerning cyanide content also hampers diverse utilization and marketing. There is an urgent need for development and transfer of technologies to enhance processing and utilization.

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Nungo, Rhoda A,
Kenya Agricultural Research Institute, Box 169, 50100 Kakamega, Kenya.
Azikoyo@yahoo.com

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Related Articles, Links

Clinical and Etiological Profile of Tropical Ataxic Neuropathy in Kerala, South India.

Madhusudanan M, Menon MK, Ummer K, Radhakrishnanan K.
Department of Neurology, Medical College Hospital, Kottayam, India.

Background/Aims: Very little is known about the occurrence of tropical ataxic neuropathy (TAN) from southern India. This study describes the clinical spectrum of TAN from Kerala, southern India, and explores its etiology. Methods: We reviewed the clinical and laboratory profile of 40 TAN cases diagnosed in a tertiary referral center in central Kerala. We enquired the consumption of cassava foods and estimated the thiocyanate levels in the serum, urine and sural nerve. Results: The notable demographic characteristics included female preponderance, peak age at onset in the thirties, rural residence and poor socioeconomic status. The diet in the majority comprised a large amount of tapioca, which is low in protein. In addition to sensory peripheral neuropathy, 90% had decreased hearing, 50% had decreased vision, and 25% had spasticity involving the lower extremities. None had signs of overt vitamin deficiencies or malabsorption syndrome. Compared to the controls, the serum, urine and sural nerve thiocyanate levels were significantly elevated in the patients. With cessation of cassava intake and better nutrition, improvement in the neurological disability occurred in the majority. Conclusions: This study, for the first time, provides evidence for the occurrence of TAN in south India and the possible etiological role of cassava intake.

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Nematicidal action of cassava cyanogens

Aqueous extracts of cassava roots show marked nematicidal activity against the root knot nematode *Meloidogyne incognita*.[1] The *Meloidogyne* species of root knot nematodes represent a very important animal pest of agriculture. The root knot nematode *M. incognita* attacks a wide range of crops accounting for losses in crop production of 10 – 40%. Control of the nematode has been accomplished primarily through the use of chemical nematicides, crop rotation and resistant cultivars. However many nematicides are highly toxic chemicals and concerns have been raised regarding environmental contamination and human health. Therefore alternative safer measures to control nematodes are urgently needed.

Aqueous extracts of cassava tuber and/or peel (rind) contain significant amounts of cyanogenic compounds viz. linamarin and its degradation products, acetone cyanohydrin and cyanide. *In vitro* studies on the effect of cassava cyanogens on second stage juveniles of *M.incognita* showed that both cyanide and acetone cyanohydrin displayed significant and similar nematicidal activity .The toxicity was related to the concentration of these compounds and the exposure time. Linamarin by itself was non toxic but addition of linamarase released acetone cyanohydrin and cyanide, which produced toxicity.[2] The *in vitro* activity of cassava root tuber and peel (rind) extracts was comparable to that produced by pure sodium cyanide and acetone cyanohydrin, with respect to concentration (cyanide equivalents) and exposure time, indicating that the presence of these compounds in the extracts was the primary factor responsible for nematicidal activity.

The minimum concentration of sodium cyanide or acetone cyanohydrin required to produce 100% mortality was 5 micro g CN equivalents / mL = 5 ppm. Concentration versus exposure time curves showed good agreement in the case of cassava extracts and pure sodium cyanide or acetone cyanohydrin.

Free cyanide is volatile and acetone cyanohydrin breaks down readily to hydrogen cyanide at about pH 7 and is easily lost from the medium, hence the desired activity would be produced only if these compounds are stabilized. Megalhaus et al[3] reported that the toxicity of manipeura (a liquid extract from cassava roots)[4] may be related to acetone cyanohydrin and observed that the stability of acetone cyanohydrin is a crucial factor which determines the toxicity of the extracts. The cassava effluents undergo fermentation on storage, which leads to a lowering of pH, and this results in stabilization of acetone cyanohydrin in the extracts.

It has been reported that the biocidal effects of glucosinolates and cyanogenic glucosides are attributed to their enzymic decomposition products. Plant glucosinolates are hydrolysed by the enzyme myrosinase and the decomposition products consist mostly of allyl isothiocyanate and allyl cyanide. Cyanoglucosides are hydrolysed by beta-glucosidases giving rise to cyanohydrins which decompose to form free cyanide. Donkin et al[5] assessed the toxicity of the glucosinolate sinigrin and its enzymatic breakdown products on the nematode C. elegans and showed that sinigrin was nontoxic while addition of myrosinase released allyl thiocyanate and allyl cyanide which had LC50 values of 0.04g/lit and 3g/lit respectively. (LC 50 is the concentration resulting in 50% mortality). Sudan grass which contains the cyanoglucoside dhurrin inhibited root infection by juveniles of the nematode *M hapla.,* when applied to the soil. The toxic effect of cyanide released from dhurrin, was found to be comparable to that produced by pure cyanide, indicating that cyanide was the primary factor responsible for the nematocidal effect of Sudan grass.[6]

Cassava tubers are an industrial source of starch. Cassava starch factories generate large quantities of liquid waste (effluent) during the process of starch extraction. The effluent, which is essentially a water extract of cassava roots, contains moderate amounts of cyanogenic compounds[7] and can therefore be exploited for its nematicidal properties against *M incognita* and further developed into a biopesticide.

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Mohandas, C and Nambisan, Bala
Central Tuber Crops Research Institute
Trivandrum 695017, India.
balanambisan@yahoo.co.uk

Potential dangers due to rising cassava consumption in tropical Africa

For 24 African countries where cassava is grown the population in 2005 was divided by the population in 1980. It was found that the average over 24 countries of the ratio of population in 2005/1980 was 2.1 compared with a ratio of 1.5 for Brazil, Indonesia and for the world as a whole. The rapidly increasing population in these 24 African countries is matched by a rapid increase in cassava production. The ratio of production in 2005/1980 averages 3 for these 24 African countries but is only 1.1 for Brazil and 1.4 for Indonesia, which are the second and third largest cassava producers respectively in the world. The high growth of population in these 24 African countries is a likely major cause of increased cassava production and hence there is a need for increased health surveillance against cyanide diseases.[1]

In certain countries there were very large increases in cassava consumption in 2005 compared with consumption in 1990. The largest increase was in Malawi where there was a 13 fold increase in consumption from 1990 to 2005, followed by Senegal with a 3 fold increase and Guinea and Sierra Leone with greater than 2 fold increases. Over the same period there were decreases in maize production in Malawi and in production of rice paddy in Senegal and Sierra Leone. These nutritious grain crops are being replaced by nutritionally inferior cassava,[2] which may have deleterious effects on the nutrition of the people.

In these and other countries of tropical Africa cassava is now grown in districts where it was not grown previously and where there has been little or no experience of traditional methods to remove cyanogens. It is important that introduction of cassava into areas where it was not grown previously, is accompanied by information and training of the people in proper processing methods,[3] rather than simply ignoring the dangerous aspects of this crop.[4]

The average daily consumption per person in g/day of fresh and dried cassava in 2005, was obtained from FAO statistics.[5] The worlds three largest producers of cassava are first Nigeria with 290 g/day, Brazil with 105 g/day and Indonesia with150 g/day. It is clear that Nigeria has about twice the daily consumption of cassava of Indonesia and three times that of Brazil, which shows the greater diversity of the diet and hence better nutrition of people in Brazil and Indonesia than in Nigeria.

The top three countries for cassava consumption are Angola with 780 g/day, Mozambique with 680 g/day and Democratic Republic of Congo (DRC) with 650 g/day. In Nampula Province of Mozambique it was found that there was an estimated maximum cassava flour intake of children in an area prone to konzo of 700-900 g flour/day and in a non-konzo area of 20-140 g flour/day.[6] The estimated consumption rates of cassava flour for children in a konzo prone area are being approached by the average daily rates of consumption of fresh and dried cassava in Angola, Mozambique and DRC.

In two of these countries there have been recent outbreaks of konzo and for the third (Angola) we have no information. These large figures show the great dependence of these countries on cassava as a staple food and underline the importance of proper processing of cassava to remove cyanogens. By contrast, the consumption of cassava flour in a non-konzo region of 20-140 g/day is similar to the consumption in Brazil and Indonesia, where as expected, there are no reports of the occurrence of konzo.

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J Howard Bradbury
Howard.Bradbury@anu.edu.au

CCDN News is the Newsletter of the Cassava Cyanide Diseases Network (CCDN). The CCDN is a free, worldwide network commenced in June 2001, which is working towards the elimination of konzo, TAN and other cassava cyanide diseases.
CCDN News will consider for publication short articles and letters (1-3 pages A 4 double spaced) written in English concerned with the following subjects:
1. Cyanide poisoning, konzo, TAN, goitre and cretinism facilitated by cyanide intake from cassava and any other cyanide diseases.
2. Reduction of cyanide intake from cassava through agricultural and nutritional means such as by broadening the diet of cassava consumers through introduction of new crops, pulses, vegetables and fruits, and by reducing the cyanide content of cassava varieties through selection and breeding. The effect of environmental factors such as drought on cyanide levels in cassava.
3. Processing methods for conversion of cassava roots to stable food products of low cyanide content.
4. Other relevant matters of interest.
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