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

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Contents

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Konzo, Cassava Toxicity and Associated Nutritional Factors

Konzo is a neurological disorder characterized by sudden onset of paralysis of the legs. That disorder has been attributed to high dietary cyanide exposure from insufficiently processed roots of bitter cassava. Cassava contains cyanogenic glucosides, mainly linamarin, that after enzymatic conversion to cyanohydrins, may release spontaneously or enzymatically the toxic hydrogen cyanide gas.

The present research[1] was initiated with the objective of identifying associated nutritional factors involved in konzo.

Konzo is still occurring in Popokabaka District of D.R.Congo with an incidence rate of 1.3 % in 2002. The diet was largely dominated by cassava and almost all households consumed "luku" at least once a day, which is a stiff porridge made from cassava flour. Cassava leaves and cowpeas which are of poor quality in protein, especially in sulphur containing amino acids, were the major foods consumed as side-dishes to the staple food.

Cassava leaves cannot compensate for the dietary deficiency in sulphur containing amino acids in the staple food in konzo affected areas. Furthermore, cassava leaves could be an additional source of dietary cyanogen in the region, because the leaves require prolonged cooking and with the unavailability of electricity or gas and scarcity of firewood, they are consumed after a short cooking time. The FAO/WHO recommended safe limit is set at 10 mg HCN equivalents / kg cassava flour (ppm).

Based on 60% of daily energy requirements being met by stiff porridge obtained from "cossettes" (soaked and dried cassava roots) which contain 1.6-2.8 ppm HCN (dry weight) it is calculated that children (1-9 year old) consumed 39-52 μg cyanogens/kg body weight and moderately active females and males consumed 20-23 μg cyanogen/kg body weight. This could explain why children are more likely to contract konzo than adults. Similarly, there is an increased energy requirement and hence cyanide intake for pregnant and child bearing females. that could explain why they are more likely to contract konzo than older adults.

The urine samples from half of the participants contained more than 300 μ mol/L of thiocyanate. This showed a high cyanide overload. The low concentration of taurine found suggested that more sulphur is directed to the detoxification of cyanide by formation of thiocyanate. The populations of Popokabaka are still highly exposed to cyanogen dietary cassava and perhaps to environmental cyanogens. The increased risk of konzo in this region where the paralytic disease is still occurring requires a more efficient post harvesting process, a better balanced diet, particularly richer in the sulphur containing amino acids methionine and cysteine/cystine.

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Reduction of Cyanogenic Potential by Heap Fermentation of Cassava Roots

Heap fermentation of cassava roots is common in countries such as Uganda, Tanzania and Mozambique.[1-3] Heap fermentation has advantages over other methods such as grating roots which requires intensive labour, and over soaking the roots which needs a lot of water.
In six households in Uganda, it was found that heap fermentation followed by sun drying of cassava roots reduced the cyanogenic potential from 436 to 20 ppm (dry weight).[1] Heap fermentation for four days in three households in Mozambique followed by sun drying reduced the cyanogenic potential from 660 to 19 ppm (dry weight).[3]
Although heap fermentation is important in reducing total cyanogens in cassava roots, levels were still above the WHO safe level of 10 ppm.[4] Other studies found that removal of cyanogens by heap fermentation is less effective than those reported above and that an initial cyanogenic potential of less than 32 ppm is required for cassava roots, if the flour is to reach the WHO safe level of 10 ppm.[5]
Perhaps the WHO safe level of 10 ppm should be revised.[6] The human body, even with very low protein intake, is able to detoxify 12.5 mg of cyanide every 24 hours. In a well nourished adult, the body can detoxify about 50 to 100 mg of cyanide every 24 hours.[6] In a population where cassava is the main staple food, a basic daily energy need of 1500 kcal can be obtained from consumption of 500 g dry weight of cassava flour.[6] Cassava flour with 25 ppm cyanide may be used to prepare a cassava flour meal without disorder to human health. Indonesia has set a safe level for cyanide in cassava flour of 40 ppm.[5] Since some cyanogens will be lost during preparation of a cassava flour meal, the residual cyanogenic potential values of 19 and 20 ppm (dry weight) obtained by Essers *et al.* (1995)[1] and Tivana (2005)[3] after heap fermentation may be considered safe if the WHO safe level is revised upwards.[6] Reported high cyanogenic potential values, up to 150 ppm, of heap fermented cassava flour collected in different districts of Mozambique[7,8] may have been caused by shortcuts in the fermentation regime, or result from increased root cyanide levels due to a period of low rainfall.[5] Shortcuts in processing commonly occur when food supply is low or the product is for sale.
It is important to develop further processing techniques to reduce cyanide, such as a combination of grating of cassava roots, fermentation and sun drying or soaking of cassava roots in water and sun drying. Grating and crushing of cassava roots are very effective in removing cyanide because of the contact in the wet parenchyma between linamarin and the hydrolysing enzyme, linamarase.[5]

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Goitre, Konzo, and Cassava Consumption in Nigeria

Chronic cyanide poisoning remains in several areas of the world where cyanogenic plants such as cassava comprise the major item in the diet. Several diseases have been associated with toxic effects of cassava including acute cyanide intoxication, goitre and konzo. Goitre and cretinism due to iodine deficiency can be considerably aggravated by continuous dietary cyanide exposure from insufficiently processed cassava. Konzo (tied legs) is a neurological disease that causes irreversible paralysis of the legs. It is found among poor African communities who depend on a cassava diet as their major staple, and whose protein intake is low.[1] Konzo occurs in African countries such as Mozambique, Tanzania, DR Congo, Cameroon and Central African Republic in which cassava consumption is very high, but has not been reported from Nigeria.
Cassava contains two cyanogenic glycosides linamarin and a small amount of lotaustralin. Hydrolysis of these compounds catalysed by the enzyme linamarase, endogenous in cassava, leads to the release of hydrogen cyanide.
In Nigeria cassava is probably the most important staple food source and gari is produced in large amounts. As the price of gari has gone up by about 600 percent[2] some manufacturers of this staple food may be making gari not only from varieties meant for food consumption, but from a very high cyanide variety called “chop and die”, that is meant for industrial use only. Furthermore, it is alleged that in a bid to make more money, gari and fufu makers may no longer observe all the required processing procedures.[2] The implications are that cases of cassava cyanide toxicity may well increase. Cassava processing could also be hazardous, particularly to gari processors, because of discharge of hydrogen cyanide gas.
Following these reports we carried out an assessment of cyanide overload in cassava consuming populations and the cyanide content of some cassava based foods[3] using the kits B2 and DI for cyanide and thiocyanate determination respectively.[4] The urinary thiocyanate content (an index of cyanide exposure) of frequent cassava consumers was below 4 ppm while that of cassava processing workers ranged up to 9 ppm. No evidence of konzo was found amongst cassava processors in Ogbomoso, Oyo, Ibadan, Awgu, Ndioru and Umunede. The cyanide

levels of processed cassava foods sold in these places was found to be below 10 ppm, the FAO/WHO safe level. Goitre was found in Uburu (Ebonyi State), Nsukka (Egugu State) and Akwanga-Keffi, but not konzo. Another independent survey showed that about 22 million Nigerians may suffer from goitre in some parts of Ondo, Edo, Benue, Enugu, Cross-River and Plateau States. Further research is needed in all the states of Nigeria where goitre or tropical ataxic-neuropathy (TAN) still exist, with a view to eliminating these diseases.

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Konzo Count

There has been an estimated 1000 cases of konzo in Muetshi Province of DR Congo, detected by Medecins du Monde / Belgium, in a project sponsored by UNICEF. In DR Congo the problem of konzo is very serious, with an estimated total of 100,000 cases. especially where people have changed their food consumption habits, perhaps as a result of the war. Thus in Muetshi, they formerly mixed cassava flour and maize flour equally, but now maize is not available so they just cook cassava flour without any maize flour. 82 cases of konzo have been reported from the Kaziba/Burhinyi region of DR Congo with onset from 1999-2004.

There has been a drought in Central and Southern Africa which is associated with an outbreak of konzo. In four districts of Zambezia Province in Mozambique 92 cases have been reported so far and in Nampula Province there are 20 cases reported from Memba district (see also next article).

We thank readers of CCDN News who have provided information about konzo and ask you please to continue to inform us of outbreaks including the number of cases.

Field Trial in Mozambique of a New Method for Detoxifying Cyanide in Cassava Products

Outbreaks of konzo have been extensively reported in northern regions of Mozambique[1,2] and elsewhere in Africa.[3] The neurological condition results from sustained consumption of bitter cassava and has been associated with a general status of malnutrition and consequent poor access to sulphur-rich amino acids.[4]

The Mozambican Ministry of Health has led the process of community training on appropriate detoxifying procedures. The prevailing assumption is that careful household processing of fresh cassava roots or the use of alternative cassava-based foodstuff would alleviate the incidence of the disease. The assumption might be true if fresh cassava is available and the communities rely on relatively large stocks of well-processed bitter cassava. However, it would not be true if unfavourable climatic conditions reduced the availability of both dried and fresh cassava.

The unsolved issue of dry cassava detoxification

The picture resulting from climatic conditions such as drought may then be one or more of the following: a) the communities have large stocks of dried, untreated, bitter cassava; b) the communities do not have any dried cassava stocks and have to purchase bitter cassava of unknown origin, often untreated and perhaps mixed with sweet cassava; c) the communities still have fresh roots in their fields but the detoxifying processes[5] are ignored in order to quickly dry the cassava roots. This occurs if roots are affected by brown streak disease and their fermentation results in an uninviting, mouldy product.

The common factor in all of these cases is the unavailability of suitable methods to detoxify dried cassava and the subsequent exposure of people to cyanogens in the cassava consumed.

The recent development of a new wetting method to remove cyanogens from dried cassava products[6] has created the possibility to reduce the risk of konzo in communities facing unfavourable climatic circumstances. Laboratory tests of this method had shown a 2/3 rd to 5/6 th reduction of cyanide.[6,7]

The method consists of mixing water with cassava flour until the total volume of wet flour is about the same as that of the dry flour, spreading the resulting paste in a thin layer (1 cm or less) on a suitable surface and leaving it for at least 5 hours in the shade. The wet flour is cooked using customary procedures.

Some important questions remain regarding the method: a) how well could the method be adapted to a typical rural household, with insufficient access to water and lack of weighing and measuring equipment? b) would the taste and/or appearance of the cooked wet flour change substantially, probably compromising acceptance of the method? c) what implications would the wetting method have on the workload and routines of a typical, rural household?

A team from the medical school in Maputo, in coordination with local health authorities, worked in two provinces stricken by konzo with the following objectives: a) to diagnose and report new cases of konzo; b) to decide on the suitability of the wetting method in the rural reality; c) to present the wetting method to local health officers.

New cases of konzo

Over 100 new cases of konzo were identified in the following locations: Memba and Mogovolas in Nampula Province and Mocuba in Zambezia Province.

All cases seen by the team were interviewed, examined and recorded (identification, disease history, neurological findings) and a urine sample was analysed for thiocyanate. Cassava flour was also analysed for cyanide. Not surprisingly nearly all new cases were still excreting thiocyanate at levels of above 300 μ mole / L, which is consistent with the occurrence of konzo[2] and shows continued exposure to cyanide, even after the onset of konzo. In one locality in Mocuba, most cases were also receiving supplemental food. Given the constraints of time and resources, it was not possible to reach cases reported in the districts of Ile, Namarroi and Lugela, all in Zambézia Province.

Suitability of the wetting method

Two tasting sessions were carried out, in Nampula and Zambezia Provinces. Community volunteers were asked to taste and identify one flour they liked best, out of four unmarked plates. All sessions took place after demonstrations of the wetting method to both women and men, whereby four samples of cassava flour were processed, and left in a thin layer to release hydrogen cyanide gas in the shade before later cooking.

Household items were used to mix water with the flour until the wet flour reached the same height in the vessel as that of the dry flour, to spread the wet flour into a thin layer (less than 1 cm) and to add the flour to the cooking pot. Local participants checked the consistency of the wet flour and some were asked to rehearse the method. Local participants were sceptical that wetting would result in cooked flour with the usual "strength". One of the four cooks in Nampula even abandoned her pan temporarily and had to be convinced that the flour would gain "strength".

The results from the two tasting sessions show that local volunteers were not able to distinguish between porridge made from dry cassava flour and that from processed, wet flour.

The team learned that when cooking the wet, processed flour the cook used less water than usual. This is important as it proves that there is no wastage of precious water with the wetting method.

Samples of wet flour were tested for cyanide before and after the five hour processing time and showed in Cava (Nampula Province) a 92% reduction in the cyanide content. In Sassamanje (Zambezia Province) the reduction was 68%.

Conclusions

New cases of konzo are exposed to dietary cyanogen intake even after the onset of konzo. Given the irreversibility and burden of konzo, there is need to introduce a suitable method to remove cyanogens from the dry cassava consumed during times of food scarcity. The wetting method developed by Bradbury[6] has enormous potential in this regard. Under field conditions, the method does not significantly change the taste of the cooked flour, as proved by local tasters.

The wetting method is extremely simple and does not pose additional burdens on the rural household, other than the need to allow some time for the processing of the flour. Dissemination of the method should take place, with the help of appropriate tools, such as demonstration sessions and posters.

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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.

Because CCDN News is a newsletter, full-size original papers or reviews cannot be considered for publication.