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

CCDN News

Cassava Cyanide Diseases & Neurolathyrism Network

(ISSN 1838-8817 (Print): ISSN 1838-8825 (Online)

Issue Number 17, June 2011

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Promotion of high quality cassava flour (HQCF) to avoid konzo in Africa

The Democratic Republic of Congo (DRC), Cameroon, Central African Republic, Mozambique, Tanzania and now Angola have had outbreaks of konzo from 1981 to the present time. Konzo is an epidemic upper motor neuron disease characterised by an abrupt onset of a varying degree of symmetrical isolated and permanently but not progressive spastic paraparesis that is associated with consumption of insufficiently processed bitter cassava.[1] Epidemics of konzo have resulted from prolonged drought (Tanzania 1984/85, 2002/2004 and Mozambique 1981/1983) that resulted in a food shortage and caused communities to consume insufficiently processed cassava which produced high cyanide intakes and konzo.[2] Konzo outbreaks have also occurred as a result of war, Mozambique in 1991-2 and recently in DRC, when people are displaced from their homes and forced to eat bitter cassava from the bush. Konzo outbreaks have also occurred in DRC and Cameroon due to people processing cassava rapidly, without proper removal of cyanide, for sale in cities and towns. The processors were themselves exposed to high cyanide cassava which resulted in konzo.[3]

In some populations cassava is processed for more than seven days followed by sufficient sun-drying before it is pounded/milled into flour to make the famous staple meals called *ugali, nshima* or *fufu*, which is a stiff porridge consumed with various relishes made from meat, fish, legumes or other vegetables. During droughts or under the influence of trading, processing methods are shortened to one or two days by pounding fresh peeled roots followed by alternative pounding and sun drying before sieving to produce flour. Such products are not sufficiently dried, contain large amounts of cyanogens and because of food shortages, may be consumed without proper supplementation by relishes containing proteins that supply S-containing amino acids, needed to detoxify the cyanide (CN) to thiocyanate (SCN).

Recent efforts in East Africa have resulted in the introduction of High Quality Cassava Flour (HQCF) which is a value added cassava product processed from fresh cassava roots within twenty four hours.[4] The procedure involves grating peeled cassava roots, dewatering/pressing, de-caking, sun-drying and milling into high quality cassava flour. The procedure is made simple when two important pieces of equipment, namely the grater and press, are available.[5] Individual farmers/groups of farmers or processors can acquire the equipment by adopting simple rural technologies to fabricate hand or manual graters. Three important steps namely grating, dewatering and sufficient sun-drying are crucial in the reduction of cyanogens to a minimum in the end-product. The product has extended shelf life that makes it safe and acceptable to various consumers. An added advantage of HQCF is its diversified use for domestic consumption, in the bakery, brewing, paper and food industries making it a potential tradable commodity. In the bakery industry substitution of wheat flour with suitable proportions of HQCF such as 20% HQCF: 80% wheat flour results in acceptable qualities of bread and biscuits. Other bakery products that can be made by substituting wheat with HQCF include doughnuts, cakes, and noodles.

Since 2003 two projects have been implemented in Eastern, Southern and West Africa, advocating value addition in cassava for income generation and to improve livelihoods of cassava farmers and processors. The first is the "Small scale cassava processing and vertical integration of the cassava sub-sector in Eastern and Southern Africa." Phase I was implemented in Madagascar, Mozambique, Tanzania, Uganda and Zambia from 2003 to 2007. Since 2009 Phase II of the same project is being implemented in Madagascar, Tanzania and Zambia and is funded by the Common Fund for Commodities in the Netherlands. The second project is "Cassava: Adding Value for Africa (C:AVA)" which was started in Ghana and Nigeria in 2008 and is being implemented in Malawi, Tanzania, and Uganda, funded by Bill and Melinda Gates Foundation and coordinated by the Natural Resources Institute of the U.K.

Both projects are adding value to cassava by mobilising and training rural farmers and processors to process HQCF for domestic consumption and for marketing. After implementation of phase one of the project on small scale cassava processing in Madagascar, Tanzania and Zambia, a high demand for HQCF was created in the biscuit industry in Tanzania. The farmer groups who were involved in the project could not meet the demand for HQCF by industry. This prompted initiation of phase two where the private sector and intermediate or large scale farmers are being mobilised to invest in cassava so that they can meet the demand of HQCF that was created.

If more farmer groups and the private sector are involved in the processing of high quality cassava flour the domestic supply will be satisfied and many rural populations will be able to process and consume HQCF. Providing that the cyanogen content of HQCF is kept low, it should be possible to avoid short cut traditional processing methods that expose people to high cyanide exposure and the risk of getting konzo.

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Neurolathyrism in Ethiopia: preliminary data

From epidemiological data obtained in several countries, it can be hypothesised that the combination of a high degree of illiteracy, poverty and the availability of either cassava or grass pea as the cheapest food are risk factors for either konzo or neurolathyrism. The geography and the climatic and edaphic conditions of Ethiopia are favourable for the cultivation of grass pea and according to the 2010 UNDP International Human Development Indicators, the rate of illiteracy among adults is 64%, while 90% of the people are living in poverty. Besides this, an average of 3.7% of the population is affected by natural disasters per year.[1] Perhaps these data can be discussed, but there is little doubt that grass pea has saved numerous Ethiopian lives during historical periods of drought.

A 2007 comprehensive preliminary survey in 57 Kebeles or "Development stations", distributed over 7 administrative zones of Ethiopia with grass pea cultivation, identified 1461 cases of neurolathyrism. The aim of the survey was to characterise and learn the neurolathyrism situation from a vast coverage. The area covered by the study is more than three quarters of the distribution of the disease in the country. The administrative zones North Gonder, South Wello, West Gojam, South Gonder and North Wello are in the Amhara Region and North Shoa and West Shoa are in the Oromia Region. Most of these areas belong to the central highlands of the country. As in other surveys, the males predominated with 80.18% of cases. There was little variation (from 76.1% to 85.6%) in this male/female ratio in the different zones.

Among the 1461 cases, 88.9% had no ox and suffered from food deficiency. This seems to be a more severe level of poverty than the norm used in official statistics.[1] The number of cases that developed during the year before the survey was 70 or 4.8% of the total. Three Kebeles had an exceptionally high incidence of recent cases: Workaye in South Gonder zone with 19% recent cases and Denbahsa and Getesendeke in the neighboring West Gojam zone with 27 and 100% recent cases respectively. These three Kebeles with high recent incidence also had a high rate of illiteracy (70.4%, 76% and 65% respectively) and a high rate of poverty (96.6%, 80.4% and 95% respectively) among the neurolathyrism cases. Of all cases, 15.3% had developed during the last 5 years before the survey.

Classification of the neurolathyrism cases according to the degree of severity of their paralysis using the traditional criteria (no walking aid, one walking stick, two walking sticks and crawler stages) was similar to the results of previous studies in other countries.[2,3] Among the neurolathyrism cases, 33.5% was in stage 1, needing no walking aid; 54.2% needed a stick to walk; 7.0% needed two sticks and 5.4% was in the most severe crawler stage. Among the most severe cases, 25 (1.7%) were bedridden and one person also had problems with hand movements. A small number (0.8%) of the cases claimed to have recovered from mild symptoms after using herbal or traditional medicines. It is very likely that these people also discontinued excessive grass pea consumption after noticing early mild symptoms.

These preliminary data indicate the presence of a high degree of possible neurolathyrism predisposing factors in many rural areas of Ethiopia. Because neurolathyrism is associated with poverty and illiteracy, the occurrence of many cases can be considered an objective indication of poverty, illiteracy and malnutrition. This is not necessarily under-nutrition because grass pea is rich in protein and carbohydrates. Epidemiological studies have identified protective factors against

neurolathyrism in Ethiopia.[4] Nevertheless, new cases continue to appear among the very poor and illiterate people as highlighted by these data. Protective factors were identified as consumption of cereals for at least one third of the diet and intake of antioxidant-rich foods such as onions and ginger.[4] Also the consumption of fish has been identified as a protective factor.[5]
In theory, prevention of neurolathyrism should be easy, but the local conditions in remote mountainous areas are not favourable for the cultivation of fish and distribution of perishable foods poses practical problems. A better solution with culturally acceptable crops that have a better supply of essential nutrients than grass pea or cassava may be a logical and simple strategy, but this strategy may be countered by the frequency of natural disasters, sometimes aggravated by political instability in those areas. Breeding of improved varieties of grass pea that contain optimized levels of essential nutrients and antioxidants may be the solution of the future. Both konzo and neurolathyrism are non-infectious diseases and not listed as reportable diseases by the WHO.[6] However, as both diseases can be considered an alarm-bell for poverty and malnutrition, this status should be reconsidered.

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Leaf protein concentrate from cassava

Cassava is cultivated over most of the tropics, mainly for its roots, which have been estimated to provide the staple food for over 500 million people in developing countries.[1] In some areas of Africa where cassava is grown, the leaves are also consumed as a vegetable. Unlike the roots that are essentially carbohydrates, the leaves are a good source of protein, minerals and vitamins. The proximate composition of cassava leaf compares favourably with the composition of other foods such as soybean and maize grain and amaranth leaves. The leaves contain 7 – 10% protein on fresh weight basis, and 30% on a dry weight basis. Cassava leaves are also rich in carotenoids, a range of 9 – 20 mg/100g has been reported in fresh leaves. The ascorbic acid level also is remarkably high, ranging from 300 – 700mg/100g fw, calcium 300mg/100g and iron 7.6mg/100g.[2] The major antinutritional factors present in cassava leaves are cyanoglucosides and tannin, and in order to utilize leaves for edible purposes, it is essential that cyanoglucoside content is reduced to the safe level (10ug HCN equivalents/g dry product) recommended by the Codex Alimentarius Committee of FAO for cassava flour.[3] The potential of cassava leaf as a protein rich source can be exploited by preparation of leaf protein concentrates (LPC) which can supplement available protein in food/feed. It would also result in removal of antinutrients and provide a product having higher nutritional value. The objective of this study was to prepare leaf protein concentrate from cassava, evaluate its nutritional and antinutritional characteristics. The cassava leaves used in the present study were harvested from cultivars H 1687 and Sree Padmanabha (SP), grown in the Institute farm.
Leaf protein concentrate (LPC) was prepared by the following method.[4] Leaves were harvested fresh, weighed, washed and homogenised with 2% sodium metabisulphite at pH 9.0. The slurry was sieved to remove the residue. The leaf extract was adjusted to pH 4.0 and heated at 90^{0}C to coagulate the protein. After cooling the solution was centrifuged and the coagulated protein was collected, washed with water and oven dried. The LPC was pulverized and kept in an airtight container in the refrigerator.
Studies on the nutrient composition of LPC showed that crude protein was 50 – 52%, crude fibre 5.2 – 6.2%, carbohydrate 9 – 10% and amino acids 0.4 – 0.5%. There was high retention of carotenoids (including β-carotene) in the LPC. Phenols (tannins) ranged from 2.5 – 3.5%. The total cyanogen content of LPC was <10mg/kg dw. The *in vitro* digestibility of LPC ranged from 59 - 62%.
Cassava leaf protein concentrate is a product rich in protein and carotenoids, with low levels of phenols and negligible cyanide. Earlier studies by Castellanos et al[4] and Aletor et al[5] had shown that cassava LPC has a low concentration of phenols and cyanogens, with crude protein content of 35 – 60%. It is possible to harvest 7-20 tons of cassava leaves/ha. Considering that the average protein content is 7%, cassava leaf harvest enables a harvest of 500 – 1400kg of crude protein/ha.[2]
There are a few but conflicting reports on the quality of cassava leaf protein. Studies on the amino acid composition of cassava leaf protein showed that, with the exception of methionine, the essential amino acid values exceed those of FAO reference protein.[6] The total essential amino acid content of cassava leaf protein has been reported to be similar to that of hen egg and better than that in oat, rice grain, soy seed and spinach leaf.[7] .Fasuyi and Aletor[8] studied the varietal composition and functional properties of cassava leaf meal and LPC and reported that the amino acid profile of LPC showed a favourable balance of both essential and non essential amino acids especially lysine, leucine, valine and tryptophan. while the limiting amino acid was methionine. A combination of LPC with other proteins which could complement the deficient amino acids would improve its nutritive value.
Plant proteins are widely utilized in industry as food/feed supplements. Cassava leaf protein concentrate can be incorporated in varying levels in food/feed mixes to partially substitute standard proteins This process would help in effective utilisation of cassava leaves, and

boost the value of this neglected crop.

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Effects of cyanide in cassava in South Sudan

We have observed what may be the effects of cyanide in cassava in Raja County, Western Bahr el Ghaza, South Sudan. No one has mentioned paralysis, but villages that are dependent on cassava are reporting high levels of vomiting and "epilepsy," in children but not in babies. Nearby villages eating more sorghum and less cassava aren't reporting the epilepsy. When I asked what they meant by epilepsy, they said the children would "fall down a lot". I also noticed a lot of goiters around. At the local hospital they confirmed that it isn't epilepsy but they didn't know what it is. They were thinking thiamin deficiency, but the diet seems to have sufficient thiamin (fish, okra, groundnuts, kale, occasional wild pig…).

Before I was even thinking that this was an issue, the women mentioned that the cassava was so bitter they usually soak it for three days, but sometimes they don't have time to soak the cassava long enough. They don't seem to eat the leaves too much, preferring the leaves of other things. They do not have doctors in the area so the diagnosis of epilepsy may not be correct. The local medical people simply said that "the children fall down a lot" but did not mention anything about convulsions or tremors. There is a significant amount of persistent diarrhea in the area. I am seeking a more detailed description of symptoms.

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Dr Julie Cliff (julie.cliff@gmail.com) has commented that "acute cyanide poisoning can cause vomiting, but not the convulsions associated with epilepsy. Cassava consumption can certainly cause goitre and there has been a report of its increased prevalence in Ethiopia associated with increased cassava consumption. It doesn't sound like konzo, as konzo is a paralysis and is permanent."

Ed. comment: Please let us know if anyone else has seen anything like this.Contact Howard.Bradbury@anu.edu.au.

CCDN News is the Newsletter of the Cassava Cyanide Diseases and Neurolathyrism Network (CCDNN). The CCDNN is a free, worldwide network commenced in June 2001, which is working towards the elimination of konzo, TAN and other cassava cyanide diseases.
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Conference Report

A team from Mozambique, South Africa and Australia met at the Johannesburg campus of Monash University in early June to discuss the effect of climate change on cassava. The aim was to produce a series of research priorities arising from an AusAID project led by Drs Tim Cavagnaro and Ros Gleadow. The small group included doctors, plant breeders, plant physiologists and health, agriculture, soil and social scientists. Topics ranged from yield considerations, development challenges, konzo, food processing and testing and climate models. It was a very stimulating time and it is hoped to hold another conference in 2012, to build on this positive and beneficial experience.

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Below:
Attendees of the Johannesburg conference