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

CCDN News

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LAST NEWS:
Prof Fernand Lambein passed away this Wednesday 04 march 2020

EDITORIAL

Lathyrus festival in Portugal

Ever since we heard about the annual gastronomic *Lathyrus* festival in Portugal, we were very interested to experience this once. Finally, in October of 2019 we were able to attend the 17th annual festival and flew to Lisbon with our daughter Kathleen.

Prof. Carlota Vaz Patto kindly drove us directly from Lisbon airport to Alvaiázere where the festival took place. Known as the capital of chícharo (Portuguese name for grass pea) Alvaiázere is situated about 167 km to the north of Lisbon. It's a town of a little over 7000 inhabitants, situated in one of three regions in Portugal with calcareous soil. The limestone relief of Serra do Sicó is a small mountain range with 553 meters of altitude, with beautiful karst landscapes. When we arrived after 2 hrs driving we right away immersed in the joyful atmosphere of the local people. The lady mayor welcomed us warmly with a big hug and also a bag of grass pea seeds produced locally. The vice mayor guided us to a huge tent amidst the festivities for lunch. It was a temporary food court, seating several hundred people and surrounded with many stands, supplying an abundant choice of local food. We were really surprised that the whole menu, including soup, main course and dessert all contained grass pea as main ingredient! Next to the food tent was a second tent with dozens of shops, all selling food products with Chícharo as main ingredient.

Left to right: Dr Yu-Haey Kuo, prof Fernand Lambein, the mayor of Alvaiázere and prof Carlota Vaz Patto

Prof. Vaz Patto also introduced her young and active research group to us and together we enjoyed these unique food preparations after our career long love for this legume. We had some kind of mixed feeling though!.

Local Lathyrus farmers selling their produce

We remember well the first time we really got to know this pulse was at the Lathyrus colloquium at Pau, France in 1985. There we presented the structures of a number of natural compounds we had isolated from several species of Lathyrus seedlings all containing the unstable isoxazolinone ring. When Professor Arthur Bell pointed out that one of these compounds (β isoxazolinone-alanine or BIA) might well be the precursor of the so called "neurotoxin ODAP" in the seeds, there and then we switched our research focus to find out the biosynthesis of this "toxin" present in L. sativus seed. This decision was also fuelled by the lack of interest for this biosynthesis by almost all participants to this Colloquium. We considered this information essential if ever a "toxin'-free variety was to be produced by genetic engineering. We left that colloquium with this moral obligation. In 1990 we published proof that BIA was indeed part of the biosynthetic pathway to ODAP.[1]

Enjoying a Lathyrus inspired meal

With more and more results from multidisciplinary research we finally realised that grass pea is not a toxic legume if you don't consume it as a staple. On the contrary the high content of homoarginine in the seeds can be beneficial to human health! The drought tolerance of this plant, making it a survival food during droughts and a staple during famines has made it into a victim with the reputation of a toxic plant! After all, legumes are not intended as staple food. At the end of our research career we are glad to witness grass pea grown in Alvaiázere to be promoted and celebrated each year after harvesting with music, a big crowd of people and delicious grass pea preparations! A life time experience indeed!

Yu-Haey Kuo and Fernand Lambein
International Plant Biotechnology Outreach (IPBO)/VIB/Ghent University, Belgium

Reference

[1] Lambein F.,Ongena G., Kuo Y.-H. 1990 β-isoxazolinone-alanine is involved in the biosynthesis of the neurotoxin β-*N*-oxalyl-L-α,β-diaminopropionic acid. Phytochemistry

ARTICLES

Konzo, neurolathyrism and methionine deficiency – new ways forward?

Introduction

This article represents a second discussion of the relationship of sulphur amino acids to neurological diseases (see Nunn, 2019). On this occasion we propose methods by which the diets of populations at risk from konzo and neurolathyrism might be fortified with methionine.

Background

Methionine deficiency was considered by Rudra and Chowdhury (1950) to provide the nutritional backdrop to the incidence of neurolathyrism in India. A deficiency of dietary sulphur amino acids (cysteine/cystine, but principally methionine) was causally related to the incidence of konzo in Mozambique by Cliff et al. (1985). Both konzo and neurolathyrism are primary upper motor neurone diseases. The consumption of a meal deficient in methionine depresses the plasma concentration of this amino acid by about one-half for approximately 6 hours thereafter and repeated meals of low methionine content maintain this situation for most of the day (Nunn et al., 2011). Thus, it is likely that subjects whose only food source is low in methionine will maintain chronically low plasma concentrations of the amino acid. These results suggest that the flow of methionine into the cerebrospinal fluid is reduced in nutritional methionine deficiency. Methionine has many biochemical functions, including being a precursor, via cysteine, of glutathione (see Nunn et al., 2011; Kusama-Eguchi et al., 2011).

Methionine is an essential amino acid to animals, in that it cannot be synthesised at a rate commensurate with its utilisation (Rose, 1938). Although methionine occurs free in animal and plant tissues, the amount is insignificant compared with that contained in proteins. Proteins of legume seeds, with the exception of soya, have a relatively low content of methionine, but even soya-based diets for feeding agricultural animals are fortified with added methionine. Indeed, fortification of poultry feed constitutes a large proportion of the annual tonnage of manufactured methionine; for the year 2013 the world market for methionine amounted to 600,000 tons (Willke, 2014).

Although neurolathyrism is probably a disease of former times in the Indian sub-continent due to the more ready availability of rice to even the poorest people (which may not be true in Ethiopia, where outbreaks of neurolathyrism occurred as recently as 1997-1998), konzo remains a contemporary problem in Africa. The incidence of konzo is correlated with the consumption of inadequately washed cassava, which retains its cyanogenic glycosides and free cyanide into the stage of food preparation. The precise mechanisms by which methionine protects subjects from cyanogenic glycosides/cyanide are poorly understood. However, if the retention of cyanides into prepared cassava cannot be prevented, would it be possible to supplement monotonous cassava diets with free methionine, in the hope of preventing the hypomethionaemia that appears to be the prelude to neurodegeneration? An immediate problem is that, because of the physiological response of humans and other animals to a protein source deficient in an essential amino acid (see Nunn et al., 2011), it is important that the supplement and the dietary deficient food are consumed at the same time.

How might this ideal be achieved? One of our proposals is that, since salt is likely to be added during the preparation of a cassava-based meal, a preparation containing a mixture of common salt admixed with methionine might be used as a preventative step. Although being aware that 'there is nothing new under the sun', it came as a surprise to discover, while preparing this article, that the concept is being considered as a means of supplementing diets with folic acid in Ethiopia (see Wadman, 2019; Li et al., 2011; McGee et al., 2017). Supplementation of wheat and rice flour with vitamins and minerals is widely practised in many countries of the world, but where consumption of wheat and rice products is low such potential nutritional benefits are lost to the relevant populations.

A second method by which improvements in methionine intake might be achieved is by preparing food supplements from plant sources that are relatively rich in methionine. This approach has been used with success in supplementing the diets of commercial poultry (Kalbrande et al., 2009), but is more complex and depends upon the ready availability of specific food items in a locality. However, it may be the method of choice where support agencies can intervene to provide the basic materials, technology and transport facilities required when an outbreak of konzo has occurred or is threatened.

Practicalities – daily requirements for methionine and salt

(i) Methionine. The recommended requirement for dietary sulphur amino acids (methionine + cystine) varies with the age of the subject (mg/Kg/day) (National Academy of Sciences, 1989):
Infants (3-4 months): 58; children (5 months-2 years): 27; children (10-12 years) 22; adults 13.

(ii) *Salt. The recommended intake of dietary salt also varies with the age of the subject (g/day) (Anon, 2018):
Age 1-3 years: 2; age 4-6 years: 3; age 7-10 years 5; age 11 years and older 6; adults 6. *These data are refer to the United Kingdom, which has a temperate climate. Loss of salt by perspiration, and hence the dietary need for salt, may be significantly higher in African countries.

Methionine is known to be among the most toxic of amino acids, but such toxicity is not attained until the intake of the amino acid is *ca* five times the recommended intake (Garlick, 2006). The toxicity is believed to be caused by homocysteine, a metabolic product of methionine (Chang et al., 2004).

Cassava-salt mixture

The stability of methionine when admixed with salt and stored under different atmospheric conditions would need to be investigated and advice given as to how to store the mixture in order to reduce the possibility of methionine becoming oxidised. No literature has been found that bears upon this matter. However, one oxidised derivative of methionine, methionine sulphone, is utilisable as methionine by experimental animals; a further oxidised derivative, methionine sulphoxide, is not utilisable as methionine.

Methionine – enriched food supplements

This approach adopts the principles of the food *Multimix* concept (Zotor and Amuna, 2008). A food multimix (FMM) is '*a blend of locally available, affordable, culturally acceptable and commonly consumed foodstuffs mixed proportionately, drawing on the "nutrient strengths" of each component of the mix in order to optimise the nutritive value of the end-product without the need for fortification'* (Amuna et al., 2000; Zotor et al., 2015; Zotor and Amuna, 2017). The FMM concept is one that, in our view, has universal application, borne out of our belief that by applying sound empirical scientific processes and knowledge of food science, human biology and nutrition, scant food resources in resource-poor communities can be harnessed drawing on the '*nutrient strengths*' of individual food ingredients. This concept allows the production not only of nutritionally balanced recipes to help alleviate nutritional problems where chronic hunger and food-insecurity exist, but also in improving the content of a particular nutrient, in this case cassava, to increase the intake of the methionine to benefit subjects at risk from developing konzo. The approach will be to combine methionine-rich ingredients and maximise the food-to-food fortification of components, thus enriching and improving the nutritive value of the composite meal within the mix. One such FMM might consist of the following foodstuffs; suitable substitutes could be made depending upon local availability.

Proposed ingredients and methionine content of an FMM product

Food source	**methionine content (mg/100g food)**
Blackeye beans	325
Sunflower seeds	494
Lentils	75
Soyabean	547

Suitable mixtures of these ingredients could be incorporated into a soup powder, prepared centrally, to which hot water could be added before consumption.

Conclusions

Either of these methods might be applied in situations where the incidence of konzo threatened populations, depending upon the resources available locally. An extension to these proposals is that a salt-methionine mixture might be applicable in local areas, for example of Ethiopia, that were threatened with neurolathyrism, when foodstuffs other than *Lathyrus sativus* (grass pea) were unavailable.

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Grasspea cultivation in India overlaps to a large extent with regions of arsenic rich ground- and riverine water resources. Does arsenic affect the human tolerance to ODAP and thus favour the onset of neurolathyrism?

Location, location, location, the mantra for assessing the value of real estate also appears to be a fruitful approach towards solving the riddle of neurolathyrism.

Inspired by the seminal geographic work of Mitchell[1], I have been looking at the distribution of arsenic in relation to neurolathyrism in India. This is the first report which links arsenic with neurolathyrism. While there is a significant overlap of the occurrence of arsenic and a history of neurolathyrism, there are also large areas of the former central provinces, where no arsenic has so far been documented.

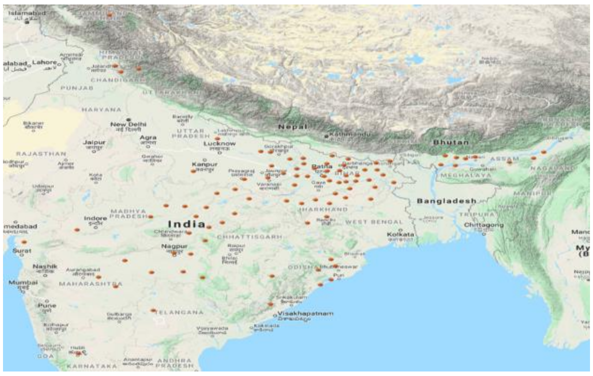
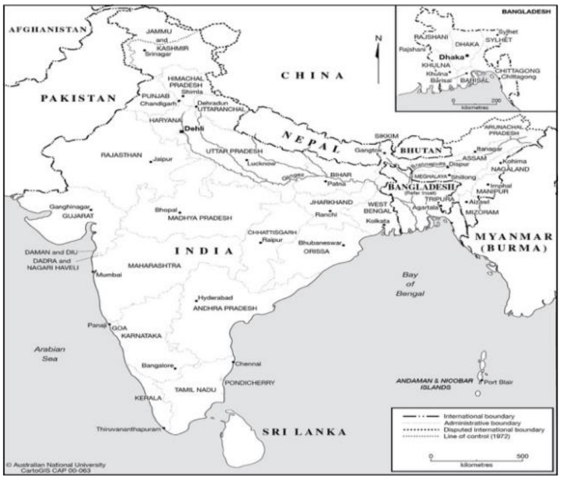


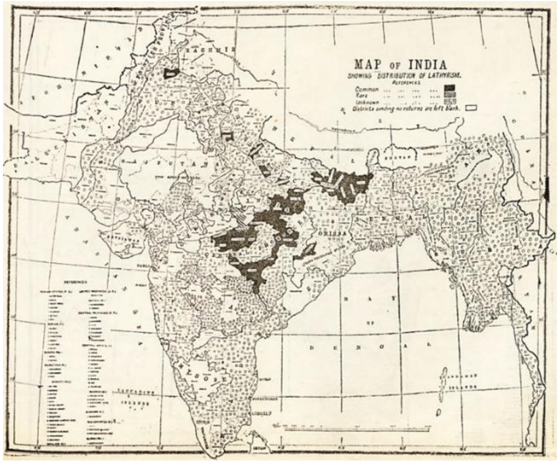
Fig 1. The Collecting sites of Lathyrus sativus germplasm held at the Indian National Genebank[2]



Grasspea is cultivated in Bihar, Jharkhand, Chhattisgarh, Madhya Pradesh, Eastern Uttar Pradesh, Orissa, Gujarat, West Bengal, Haryana, Punjab.

Uttar Pradesh was the first state to follow the Indian Central Government to ban sale and storage. Chhattisgarh and West Bengal have no ban on sale and storage. Maharashtra revoked the ban in 2015[3]

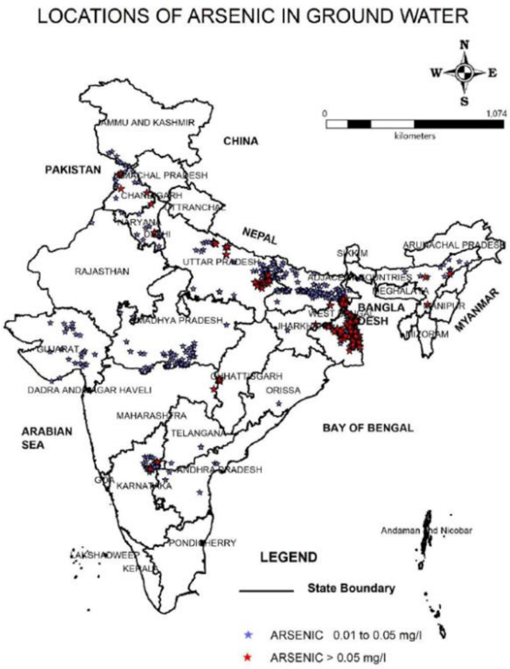
Occurrence of neurolathyrism in India



The above map by Megaw and Gupta (1927) [4] is based on a country wide Indian survey of surgeons carried out by correspondence. A useful summary of the geography of neurolathyrism in India, based on actual reports, is provided by a more recent map [5] . Using Dwivedi's [6] detailed review and update on his epidemiological studies in Rewa, now Chhattisgarh, a preliminary survey of the occurrence of neurolathyrism in areas with elevated levels of arsenic in the food chain, was carried out.

While recent maps show [7], [8] an almost perfect fit with the 1927 map, an more recent review reveals a map with finer detail[9].

This prompted a closer look at the evidence. A very nice map of arsenic distribution in the Indo-Gangetic Plain shows fine detail[10], however, in respect of copyright, a map published by the Indian Government may suffice.



Using the information about distribution of arsenic as depicted on the above map, at a district level, and comparing it to Dwivedi's 1989 table of districts with neurolathyrism (and additional sources where indicated), reveals that almost 50% of these have areas with high levels (> 10 - 50 ppb As) in drinking water (Table 1)

Table 1 – Districts in India[6] and Gilgit, Pakistan[11, 12] where people have been affected by neurolathyrism Presence of significant levels of Arsenic (As) in some parts of these districrs are indicated (x) and source of the As data is given. (U.P. = Uttar Pradesh, M.P. = Madhya Pradesh, Chh = Chhattisgarh, B.H. = Bihar, M.S. = Maharashtra, PAK = Pakistan)

Most notably in table 1 are all the districts of Bihar, where neurolathyrism has been reported from in the past, since they are all districts along the Ganges with high levels of arsenic in the groundwater as highlighted on a recent map[18].

While the availability of arsenic is a complex matter, the mere fact that it is widespread in areas where neurolathyrism has been reported, may have significance regarding the course, which the onset of neurolathyrism takes in individuals, who are exposed to elevated levels of arsenic while consuming significant quantities of grasspea (Lathyrus sativus) for even short periods.

Arsenic in the human body is metabolised through methylation, whereby the methyl group is provided by methionine.

The importance of methionine to protect against the toxicity of both, cassava and grasspea, has recently been discussed in this newsletter[19].

Methylated arsenic can be detected in the urine. Higher dietary intake of protein and sulfur amino acids correlates with an increase urinary secretion of methylated arsenic[20]; folate-related nutrients (niacin, vitamin B-12, and choline) were also beneficial to promote arsenic methylation. Therfore, a study designed to look at arsenic and ODAP metabolites in grasspea consumers exposed to both sources of toxins versus controls, while assessing the nutritive intake of sulfur amino acids and folate-related nutrients, may be quite informative.

As I have argued previously[21], there a whole range of antinutrients in legumes which, acting in concert, each providing an additive effect, all lead to a depletion of sulfur amino acids and hence to a lowering of defences against toxicity.

Arsenic may be an an additional external stressor for sulfur amino acid metabolism, most definitely it helps to deplete methylation capacity.

The presence of arsenic in the environment may lower the safe level at which grasspea, even the current low ODAP cultivars, can be consumed.

The rapid onset of neurolathyrism within 15-20 days, as reported by Dwivedi and Mishra (1975) [22] as summarised by Dwivedi (1989)[6] may be a testing case for the hypothesis that arsenic promotes and accelerates the onset of neurolathyrism in the presence of extensive grasspea consumption.

Closer scrutiny of neurolathyrism reports regarding the ratios of affected males:females and the length of time it took for the onset of neurolathyrism symptoms, may reveal locations where additional stressors such a arsenic play a role.

The district Rajnandgaon, Chhattisgarh is an area identified as having very high levels of arsenic [23], for maps see Pandey et al 2002 [24], and for the geology Shukla et al 2010 [25]. The area with very high arsenic levels is Ambagarh Chowki, while the regions from where Dwivedi and Mishra reported new cases are further to the North in the adjacent Durg and Bilaspur districts. Interestingly, these districts are provided with water from the Shivnath (Seonath) river[26], which seasonally carries high loads of arsenic rich sediment as it originates in the northern vicinity of Ambagarh Chowki [24] ,[27]. Furthermore, the rapid onset of neurolathyrism within 20 days, has been linked to the consumption of Ghotu balls, a food prepared from 75% grasspea flour and 25% rice, boiled to a thick consistency in water[22]. Rice grown in soil with arsenic levels, as can be found throughout the Shivnath river basin, has been found to accumulate high levels of this toxic metal [28], thus providing an additional plausible source of arsenic.

There is sufficient circumstantial evidence to warrant an assessment of the role of arsenic as a contributing factor to neurolathyrism, especially with respect to the rapidity of its onset and hence its possible utility for a neurolathyrism animal model.

DISTRICT	**State**	**As**	**Reference**
Allahabad	U.P.	x	[13]
Azamgarh	U.P.	x	[14]
Bahraich	U.P.	x	[14]
Ballia	U.P.	x	[15]
Bara	U.P.		
Bareilly	U.P.	x	[14]
Basti	U.P.	x	[14]
Budaun	U.P.		
Gorakhpur	U.P.	x	[14]
I1aruoi	U.P.		
Lakhimpura	U.P.	x	[14]
Lucknow	U.P.		
Mirzapur	U.P.	x	[14]
Pilibhit	U.P.	x	[14]

DISTRICT	State	As	Reference
Rampur	U.P.		
Sitapur	U.P.		
Unnao	U.P.	x	[14]
Balaghat	M.P.		
Betul	M.P.	x	[16]
Bhopal	M.P.		
Bilaspur	Chh		
Chhatarpur	M.P.		
Chhindwara	M.P.	x	[16]
Damoii	M.P.		
Durg	Chh		
Hoshangabad	M.P.		
Jabalpur	M.P.		
Khandwa	M.P.	x	[16]
Mandla	M.P.		
Narsingpur	M.P.		
Panna	M.P.		
Raipur	Chh		
Raisen	M.P.		
Rajnandgaon	M.P.		
Rewa	M.P.		
Sagar	M.P.		
Satna	M.P.		
Sehore	M.P.		
Seoni	M.P.		
Shahdol	M.P.		
Sidhi	M.P.		
Tikamgarh	M.P.		
Vidisha	M.P.		
Patna	B.H.	x	[14]
Monghyr	B.H.	x	[14]
Kharsawan	B.H.	x	[14]
Darbhanga	B.H.	x	[14]
Murshidabad	W.B.	x	[14]
Bhandara	M.S.		
Gilgit	PAK	x	[17]

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State of place on the konzo east of the DRCongo & Burundi : Possibilities of eradicating konzo and other diseases caused by bitter cassava consumption. Case Study: Uvira Territory in DR Congo

Context

According to the sustainable development goals (SDGs) and to the Geneva Convention on his first article, all human beings have the right to good nutrition, and should be protected and treated as human beings in all their dignity and respect and that assistance should be provided to the poorest, most vulnerable and at-risk populations, as they have innocently become so in spite of themselves.

In the eastern part of the DR Congo and throughout the region, including Burundi, cassava is the main staple food, and has been for decades. Fish, meat and vegetables should be consumed every day by the inhabitants for their daily life. However, due to repeated armed conflicts and poor governance, this population is becoming very poor and can currently live on less than a dollar a day. Add to this poverty, climate change having consumed thousands of fields by floods on the one hand and drought on the other, but also made cassava sweet to become bitter.

As a result, this poor peasant, who represents more than 75% of the population, who can no longer eat enough to satisfy his hunger, is content to eat a poor meal, and worse still, bitter cassava containing high levels of cyanuric acid, which causes a disease called konzo. This disease, which manifests itself shortly after consumption by diarrhoea, vomiting or stomach aches, dizziness...can lead to death or paralysis. It is a serious disease, which so far has not had any medicine, only that we are asked to practice the rules of prevention by consuming sweet cassava or by absorbing/hunting this cassava cyanide before consuming it.

We discovered that the poorest people suffer from konzo. More than 96% of these patients are the poorest and live in the villages. They suffer serious consequences of the disease including paralysis and even death. The loss of father/mother/family member considered as a pillar of the family is often falsely linked to witchcraft. This konzo disease must be fought. It also creates barriers between rich and poor which is unbearable.

Translated with www.DeepL.com/Translator (free version) ***Generalities on the territory of uvira***

Location

The Territory of Uvira has a surface area of 3,146 km² with a population of 1,181,207 inhabitants; it is between 3°20' and 4°20' south latitude, 29° and 29°30' longitude, bordering territories and/or countries:In the North: Walungu Territory, South: Fizi Territory, East: The territory is connected to Burundi, Tanzania and Zambia via the Ruzizi River and Lake

Tanganyika, West: Mwenga and Walungu Territory. To the East: Ruzizi River and Lake Tanganyika, both constitute common borders with Burundi, Tanzania and Zambia.

Climate

The territory of Uvira offers a semi-arid climate. According to Köppen Wladimir's climatic classification: Entities like Lubarika, Uvira, Kiliba, Luberizi are in the low tropical zone Aw1-3, altitude not exceeding 1000 m. Annual rainfall reaches 1600 mm. Part of Uvira Territory is located in the Uvira, Sange and Katobo Highlands which is included in the high and medium altitude tropical zone (between 1000 and 2800 m) with an annual rainfall of 1600 mm.

Season: A dry period runs from May to October, during which two or three thunderstorms bring some rain; the wet period runs from November to May.

Type of Soil: The soils are very sandy, in places sandy loamy, rarely clayey-sandy.

The north-western basin of Lake Tanganyika, which encompasses the Territory of Uvira, is characterized by outcrops of very ancient (Precambrian) and very recent (Quaternary) rocks.

In short, a quick morphological examination of the lands of this Ruzizi plain which occupies a large part of the Territory of Uvira suggests the following classification : Black soils of the Chernozium group; soils of the genus Solontchak and alkaline soils.

Temperature: The average monthly air temperature is between 22.5° and 25°C; the monthly averages of the maximum daily temperatures increase at the end of the dry season (30.5° to 32.5° in September) while the monthly averages of the minimum daily temperatures are the lowest during half of the dry season (14.5° to 17°C in July).

Relative monthly insolation generally oscillates between 35 and 60% from October to April and between 50 and 80% from May to September, with July being the sunniest month.

Vegetation: In the territory of Uvira there are five main types of vegetation:

Swamps and mussel meadows (predominantly all kinds of macrophytes or reeds). Grassy savannahs with predominance of Imperatacylindrica, Hyparrheniaspp, Eragostisspp, Brachiaria ruziziensis and Pennisetumspp constitute the main pastoral and agricultural reserves of the indigenous farmers and stockbreeders;

The wooded savannahs, mainly with Acacia kirkii; - The xerophytic groves; the forests, which now exist only as relics, especially in the transition zones between savannah and forest, for example.

Hydrography: The hydrography of the City of Uvira and the Ruzizi plain is characterized by several rivers of varying importance. The most important of these is the Ruzizi River, linking Lake Kivu to Lake Tanganyika. It collects water from several rivers coming from the hills of Burundi and the western part of the Ruzizi plain. Here are the most important ones as far as the Congolese part is concerned: the Luvimvi River in Katogota, the Luvubu River in Lubarika, the Luvungi River in Luvungi, the Luberizi River in Luberizi, the Sange River in Sange and the Runingu River in Runingu as far as the Ruzizi Plain in Uvira Territory is concerned. The rivers that are encountered in the City of Uvira are: the Kiliba River (which flows into the Ruzizi), Kavimvira, Mulongwe and Kalimabenge are the three major rivers that cross the City of Uvira and flow directly into Lake Tanganyika.

Eating and cultural habits

Uvira has monologue eating habits, including the consumption of cassava and its leaves as the main food, especially in villages where the population's standard of living is too low. Cassava cultivation accounts for more than 75% of the cultivation practiced by the inhabitants. This dependence on cassava dates back more than 10 decades, and continues from generation to generation, and is mainly due to the socio-economic and environmental benefits, including the possibility of growing cassava for more than 12 months, providing the farmer with the "sinking" leaves as vegetables, its stems as firewood and the permanence of cassava (tuber). The fact that cassava supports the tropical climate and poor soil, the case of the Ruzizi Plain in the villages of Luvungi and Sange.

Note the multiple uses of cassava products including chikwange, mitewe and fufu. The first two can be preserved for more than 5 days.

The varieties of cassava cultivated were often sweet cassava, as they could be sold fresh to be eaten with beans, somewe or fish; but with the flight of cassava in the field by passers-by and predators and rodents such as moles, rats and some birds, the farmer could only harvest less than 50% of his production, so he thought it would be a good idea to replace it with the bitter varieties.

In Uvira there are two general ways of preparing cassava for flour:

-wet cassava: this involves soaking the peeled cassava in water for 3-4 days, then removing it from the water and exposing it to the sun. Once the cassava is dried, it is crushed in a mortar or in the mill. Sometimes this wetting and drying practice takes place in the field (often if the field is next to a river or pond). But with thefts, many farmers prefer to do it in their houses by filling vases (basins or pots) with water.

This practice is good because soaking the cassava in water for 3-4 days eliminates or reduces the cyanide in the cassava, and the leg made is often healthy and fit for consumption.

The fact that it is a matter of going through several stages and work, the lack of water and especially the lack of materials including the basin and pot, the poor and hungry farmer wants to practice this second practice, a subject that allows the extension of Konzo.

-Dried cassava: this involves exposing the shelled cassava directly to the sun until it is dry, then being crushed or ground. Often the colour is chocolate if the peasant to favour the fungus by covering the cassava leaves before drying it. Or, it turns white if exposed to direct sunlight for 4-5 days. Both practices remain the most used because they are less demanding despite the danger of containing cyanide in the flour.

Armed conflicts and insecurity

The Great Lakes regions of Africa have gone through very difficult times of political turmoil where dictators have refused to leave power and as a result waves of demonstrations and popular demands, militias and armed and tribal groups have been created. Thousands of people have been forced to move in and out of the country, many families have lost their families, concessions and fields have been abandoned.

People moving to more or less safe areas or in the forest consumed raw bitter cassava to calm the end. The period of camping in the forest/brush depends on the lull in one's village, there are those who have spent more than 12 months in this isolation. This practice, which has endured, has undoubtedly contributed to Konzo's existence in and around Uvira Territory.

Some fields become inaccessible due to the armed groups, the latter can prevent the villagers from going to their fields, they can be abandoned to their fate. Some women may be victims of rape, kidnapping and torture. Men too may be forced to carry ammunition and food while they want to work in the fields.

Also, militias and soldiers who camp in the fields or on roads ransom villagers, asking them for money or the crops they bring from their fields.

Farmers no longer go about their business, agricultural production is declining, and the population no longer has enough to eat, and the Konzo is gaining ground due to food insecurity.

It should be pointed out that these conflicts and insecurity have reduced agricultural production by half. We regret to see that there has been no positive change for more than 20 years that we have been living in total insecurity, especially in rural areas where armed groups are born every day.

Poverty and community rites

Community conflicts and mismanagement of public assets have been at the root of hunger and poverty. The Africa Hunger Index puts the level of stunting in the DRC in 2016 at 43 percent; a very high level and one that has remained virtually unchanged since 2001, when the survey data indicated a level of 44 percent. In terms of hunger indicators, the DRC was unable to produce figures on the three indicators observed, i.e. stunting, wasting and child mortality rates in 2016, but nevertheless continues to show extremely alarming or alarming levels of hunger, due in particular to conflicts and political instability which have increased the level of hunger, with the World Hunger Index score in 2011 increasing by about 63%; the only country in the world to have gone from an alarming to an extremely alarming situation.

Many households cannot afford foods such as meat and fish, and are content to eat vegetables, including cassava leaves, which are often bitter.

Children may go to school in the morning without eating, but during breaks (many schools have no fences) they may leave the courtyard to beg farmers for cassava tubers. In 2018, more than 4 schoolchildren in the village of Luberizi were hospitalized because they vomited and had diarrhea after eating bitter cassava. Other people may also eat fresh bitter cassava just because they are hungry.

Agricultural practices and the effects of climate change

With global warming, some local crops such as maize can no longer produce enough because they have more than 5 months to mature whereas the rainy season is now only 5 months long. These crops, which constitute food supplements, are probably abandoned, which undermines food security in favour of bitter cassava.

Local agricultural practices remain backward as they consist in cutting down trees or burning fields before planting. These practices encourage deforestation and deforestation. The farmer is then forced to abandon his field early for another more or less fertile one.

Poor practices and climate not only change cassava but also reduce agricultural productivity.

Many farmers lament the fact that their cassava is changing from sweet to bitter, often they do not understand the causes when it is the fact that the stresses that cassava undergoes force it to become bitter and lose its original aspect. As a result, more than 95% of the cassava sown becomes bitter, only cassava grown in the medium plateau in Lemera, Mangwa, Muhungu and Kitala may not change taste because the temperature is less than 28 degrees Celsius.

Farmers have opted for cassava because of its resistance to disease and adaptation to climatic disturbances, of which in recent years there has been a considerable increase in temperature compared to previous years. Hundreds of people have been forced to leave their villages for refugee camps in Burundi and Tanzania.

Cases of konzo presumes

Since Konzo is a disease associated to the consumption of bitter cassava containing high levels of cyanide. The patient may experience cases of vomiting, stomach aches, or diarrhoea. We have just seen that current living conditions, including climate change, poverty, food practices and preparation, force bitter cassava containing cyanide to be the most cultivated, and therefore the possibility of cases of Konzo.

It is in poor villages that more cases are reported than in urban centres. Often in the village, where there are no markets for food (or there are only seasonal or weekly markets), the villagers cannot be satisfied not only because there are no markets but also because of poverty, they simply pick cassava leaves as condiments to be eaten with the cassava, even though these same poorly cooked leaves may contain cyanide.

Elderly people and children are the most vulnerable because of their lack of immobility in the search for nutritious food. They may wait until evening for their only meal of the day while young people and adults are on the move and may eat fruit and other foods outside the family home and thus reduce the level of cyanide toxicity in their bodies.

Possible solutions

Given that this konzo disease remains ignored in the region, and this ignorance is causing enormous problems including false accusations between communities and individuals, accusing each other of witchcraft, disease, paralysis and death; it is imperative to seek the solution in order to eradicate this scourge that is plaguing our communities.

Among the solutions, we have considered the following:

-installing a team of nurses on site to carry out actions to investigate cases of konzo and other similar diseases related to the consumption of bitter cassava and its leaves.

-organize a series of sensitization campaigns on the radio, leaflets or loudspeakers for the communities informing them that konzo is a natural disease and that it can be avoided by following the rules for sucking up the cyanide contained in this bitter cassava.

-create local committees in each village including health facilitators and local leaders, building capacity in konzo case management. Any project that does not include the community will not have a chance to continue; these committees will be in charge of the continuity of the project through sensitization and monitoring until there is a total change in behavior or habit that promotes cyanide consumption.

-strengthen the partnership between the Health Zone Office (Ministry of Health), the Agriculture Inspectorate (Ministry of Agriculture) for konzo prevention, treatment and research. The Agriculture Inspectorate will enable the production and multiplication of sweet cassava seeds, its distribution to farmers and the monitoring of its growth and harvest. Also, the possibility of using appropriate agricultural techniques, introducing the practice of polyculture to have the diversity of agricultural products, necessary for family food security.

-distribute medicinal products as a vitamin supplement to patients in order to correct the ailments caused by konzo. If necessary, for the poorest families, the distribution of food and oil for 6 months is of great importance.

-create a konzo health centre. This centre can receive all confirmed and unconfirmed cases of konzo. Unconfirmed cases will be referred to the nearest health centre, while confirmed cases are interned for treatment. Also, this center can have the possibility of massage and physiotherapy service for cases of paralysis. It should be noted that Konzo is not well known by the local health workers, and may be confused with other diseases such as polio, stroke-related paralysis...

Conclusion

We would like to thank CCDN our international network against konzo because we acknowledge the technical and financial support for previous activities in some villages, particularly in the context of prevention awareness. In particular, many thanks to the late Prof. James Bradbury.

After evaluation, we found that some villages have not been reached by the sensitizations due to lack of means, and that cases of konzo are reported and run the risk of strong extension.

We consider that the continuity of activities remains essential for the fight against the konzo and its impacts on community life. And we call on all organisations and people of good faith to assist us in the fight against the konzo in the east of the DR Congo and neighbouring countries.

Our thanks to all the APAA Team and its members for the konzo activities carried out, and we hope to continue with this fight in the coming days until eradicating this disease by all means.

Thanks again.

Project For Community Stabilization Through Food Security And Nutrition In Protracted Crisis Areas (PSCSAN-ZCP)

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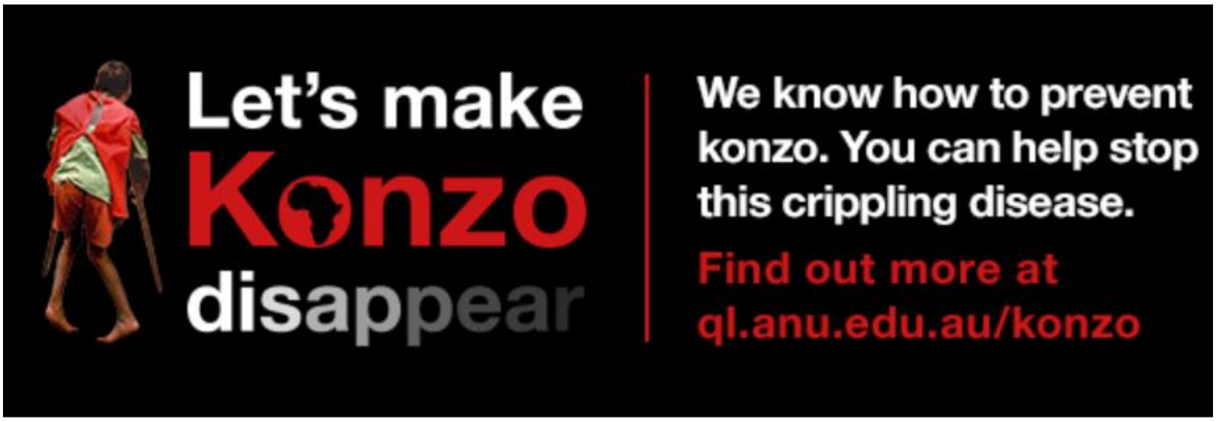

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