Effectiveness of wetting method for control of konzo and reduction of cyanide poisoning by removal of cyanogens from cassava flour

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Abstract

Background. *Konzo is an irreversible paralysis of the legs that occurs mainly among children and young women in remote villages in tropical Africa and is associated with a monotonous diet of bitter cassava. Konzo was discovered in 1938 by Dr. G. Trolli in the Democratic Republic of Congo (DRC). It also occurs in Mozambique, Tanzania, Cameroon, Central African Republic, and Angola. It was first controlled in Kay Kalenge village, DRC, in 2011 with the use of a wetting method to remove cyanogens from cassava flour. Fourteen months later, another visit was made to Kay Kalenge.*

Objective. *To determine whether Kay Kalenge women were still using the wetting method, whether there were new cases of konzo, and whether the wetting method had spread to other villages.*

Methods. *Meetings were held with chiefs, leaders, and heads of mothers' groups, women from 30 households were interviewed, and three nearby villages were visited. Total cyanide and thiocyanate were analyzed in cassava flour and urine samples, respectively.*

Results. *The women in Kay Kalenge village still used the wetting method. There were no new cases of konzo. The mean cyanide content of the flour samples was 9 ppm, and no child had a mean urinary thiocyanate content greater than 350 μmol/L. The use of the wetting method had spread naturally to three adjacent villages.*

Conclusions. *The wetting method has been readily accepted by rural women as a simple and useful method to control konzo by removing cyanide from cassava flour, and its use has spread to nearby villages. The wetting method should be promoted by health authorities to control konzo and reduce cyanide poisoning from high-cyanide cassava flour.*

Key words: Cassava flour, cyanide poisoning, Democratic Republic of Congo, konzo, urinary thiocyanate, wetting method

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Background

Konzo is an upper motor neuron disease that causes irreversible paralysis of the legs and that occurs mainly in children and women of childbearing age and is associated with a high intake of cyanogens from bitter cassava. Konzo occurs among rural people living on a monotonous diet of bitter cassava that is deficient in protein, and particularly the sulfur-containing amino acids methionine and cystine/cysteine, that are used up in the detoxification of cyanide to thiocyanate in the body. It occurs in the Democratic Republic of Congo (DRC), Mozambique, Tanzania, Central African Republic, Cameroon, and Angola [1–4].

Konzo was controlled for the first time by an intervention in Kay Kalenge village in Popokabaka Health Zone in Bandundu Province, DRC [1], where there were 34 konzo cases. This is the same health zone from which konzo was first reported by Dr. G. Trolli in 1938 [5]. Subsequently a further successful intervention was made in three villages in Boko Health Zone. In these interventions, all konzo patients were examined and rehabilitated, the total cyanide content of cassava flour and urinary thiocyanate levels of schoolchildren were determined, and the women were taught the wetting method to remove cyanogens from cassava flour [6–8]. The first intervention in Kay Kalenge was completed in September 2011 [1]. Fourteen months later, in

November 2012, Kay Kalenge village was visited again to see whether the women were still using the wetting method and to check on the number of new konzo cases, the cyanide content of cassava flour, and the urinary thiocyanate levels of schoolchildren. In this paper we present the results of this visit to Kay Kalenge and propose a strategy to help eliminate konzo from DRC.

Methods

Study area

The location of Kay Kalenge village in Imbela Health Area, Popokabaka Health Zone, Bandundu Province, DRC, is shown in **figure 1**. This village was subjected to an intervention to control konzo over the period from March 2010 to September 2011 [1] and was visited again in November 2012, during the wet season.

Meetings and visits

Meetings were held with chiefs, leaders, and 15 heads of mothers' groups to obtain permission to work in the village, and women from 30 households were interviewed with the use of a questionnaire. Information was also sought about any new cases of konzo, whether the wetting method was still being used in Kay Kalenge, and whether its use had spread to nearby villages. Bumbi, Masina, and Ngyengya, three villages about 5 km away, were visited.

Wetting method to remove cyanogens from cassava flour

In the wetting method [6–8], cassava flour is added to a bowl and the level of the flour on the inside of the bowl is marked. Water is added and mixed with the flour, and the volume of the wet flour initially decreases but then increases as more water is added until it reaches the mark on the bowl. The evenly wet flour is spread in a thin layer no greater than 1 cm thick on a mat or basket to allow hydrogen cyanide gas to escape and is left for 5 hours in the shade or 2 hours in the sun. The damp flour is then cooked in boiling water in the traditional way to make fufu, which is eaten with something to give flavor, such as pounded, boiled cassava leaves (saka saka).

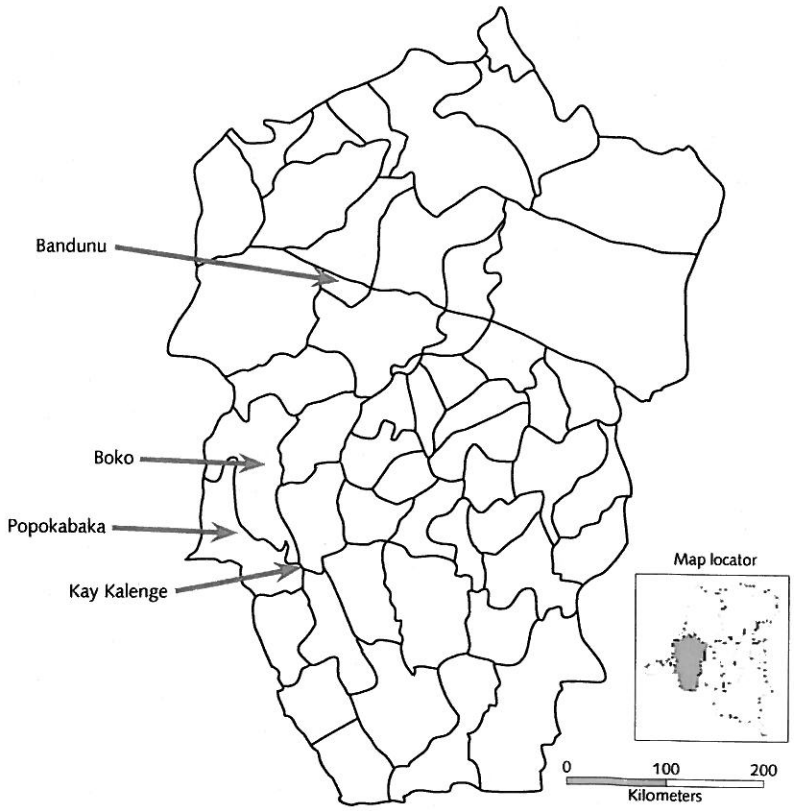

FIG. 1. Map showing health zones of Bandundu Province, DRC, including the location of Kay Kalenge village and Popokabaka and Boko Health Zones. Adapted from [1]

Urinary thiocyanate analysis

One hundred urine samples were collected from school-age children, and their age, sex, and whether they were living in a family with a case of konzo were recorded [1]. These samples were analyzed in Kay Kalenge with the simple picrate kit D1 (http://biology.anu.edu.au/hosted_sites/CCDN/) [9]. A color chart with 10 shades of color from yellow to brown was used, which corresponded to 0 to 1,720 μmol of thiocyanate/L.

Total cyanide analysis

Thirty samples of cassava flour about to be used to prepare fufu for consumption were obtained from households. Analyses of total cyanide content were performed with a simple picrate kit B2 (http://biology.anu.edu.au/hosted_sites/CCDN/) [10, 11]. A color chart was used with 10 shades of color from yellow to brown corresponding to 0 to 800 mg of HCN equivalents/kg cassava flour = ppm.

Ethical approval and consent

The study protocol was approved by the Ministry of Public Health Ethics Committee in DRC prior to the study. Village chiefs and community leaders were informed about the proposed study and the procedure for collecting samples, and they explained to their people the study and the procedures. They all accepted the study and procedures, and the chiefs of villages on behalf of their people asked PRONANUT to conduct the study in their villages. In addition, the day before the collection of cassava flour and urine samples, each household was informed of the sampling procedure and gave its free oral consent for the sampling to be done.

Results

The leaders in the village and the heads of the mothers' groups said that since the end of the project in September 2011 there had been no new cases of konzo in Kay Kalenge, and they identified three nearby villages where the wetting method was used. The women in the village continued to use the wetting method, but some had problems because their plastic basins were damaged, and also because during the rainy season in November some did not have a shaded, dry area in which to place their wet flour for 5 hours.

The survey of 30 Kay Kalenge households showed that the women soaked cassava roots in water for 2 or 3 days and then dried them for 2 or 3 days, before pounding them to make cassava flour. They all used the wetting method to remove residual cyanogens. Two households consumed three meals per day, 23 households had two meals per day, and 5 households had one meal per day. Cassava flour was consumed as fufu with pounded, boiled cassava leaves in 29 households, with mushrooms in 8 households, with meat in 8 households, and with salted fish in 1 household. Twenty-six of the plastic basins distributed during the intervention were still in good condition. In the nearby village of Bumbi, three women had been taught to use the wetting method by the senior woman coordinator from Kay Kalenge. They in turn trained all the women in the village, but because of lack of supervision and the heavy rains in November, the wetting method was not being used in many cases. In the villages of Masina and Ngyengya, women were taught the wetting method and there was some use of the method.

The 30 cassava flour samples had a mean ± SD total cyanide content of 9 ± 4 ppm. There were no significant differences in mean urinary thiocyanate content between boys and girls, between children of the two age groups (5 to 9 and 10 to 12 years), or between children who lived in a household with a case of konzo and those who did not. The mean urinary thiocyanate content of all samples was 139 ± 68 μmol/L. In this postintervention study, the detailed assignment of all urinary thiocyanate results to the different levels used in the thiocyanate kit is given in **table 1**, which also allows comparison with results obtained during the earlier intervention [1].

Discussion

The wetting method to remove cyanogens from cassava

TABLE 1. Urinary thiocyanate levels in 100 Kay Kalenge schoolchildren before and during intervention and 14 months after it ceased (no. of children)[a]

Urinary thiocyanate (μmol/L)	Nov 2012	Sep 2011	Dec 2010	Mar 2010
0	1	3	16	1
17	6	7	26	4
34	4	7	8	6
69	9	13	7	2
103	23	24	19	13
172	53	38	13	25
344	4	8	8	25
688	0	0	3	18
1032	0	0	0	6

a. The intervention was conducted from March 2010 to September 2011. Data for this period are taken from Banea et al. [1]. Data for March 2010 were obtained just before introduction of the wetting method. Follow-up data for November 2012 are from the present study. At each visit, 100 urine samples from 100 children were analyzed.

flour [6–8] is very acceptable to rural women because it removes the bitter taste of linamarin [12] and thus produces fufu that tastes much better, while requiring little extra work or equipment [13, 14]. The first consistent use of the wetting method to reduce cyanide intake from cassava flour was during a 1.5-year intervention in Kay Kalenge [1], which was followed by a 1-year intervention in three villages in Boko Health Zone [15]. We went back to Kay Kalenge village 14 months later and found that the women are still using the wetting method and that there had been no new cases of konzo. The mean cyanide content of the cassava flour samples was 9 ppm, which is less than the World Health Organization safe limit of 10 ppm [16]. The mean urinary thiocyanate content was 139 μmol/L, and no samples had contents higher than 350 μmol/L, the value above which children are considered to be in danger of contracting konzo [1, 17]. The urinary thiocyanate results in **table 1** show the effect of introduction of the wetting method in March 2010, which reduced the number of samples with values greater than 350 μmol/L to zero at the end of the intervention in September 2011 [1], a result that was still maintained 14 months after the intervention finished.

The survey of 30 women showed that in November 2012 one-sixth of the families had only one meal per day, as compared with a survey in Kay Kalenge in March 2010, which found that one-third of families had only one meal per day [1]. The village is not as isolated as it was in 2010, and there are now several traders and three shops in the village selling food products, including salted fish. Furthermore, a gift of a mill from Action Against Hunger has enabled households to consume more corn to diversify their diet. In early 2011 no family had a bicycle or a radio, but in November 2012 several families had these goods. These are signs of a slight reduction of poverty and a slightly improved dietary situation, which may help to prevent contraction of konzo. The wetting method to remove cyanogens from cassava flour spread naturally to three nearby villages (Bumbi, Masina, and Ngyengya); however, not every family used the method, partly because of the wet weather in November, which made it difficult to treat the wet flour. The natural spread of the method shows that the wetting method is viable and should be promoted by health authorities as a processing method to remove cyanogens and thereby control konzo and cyanide poisoning [18–20].

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