Blighia sapida, the Ackee tree, still a sword of Damocles over children in Africa?

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Abstract: Thirty years ago, in June 1984, for the first time in Africa, the Ackee tree, *Blighia sapida* Koenig, was proved responsible for massive deaths of children. This paper tells the story of this discovery and reviews the further cases of child poisoning identified on the continent since then. It also highlights the ever-present risk, that might be increased by global warming.

Reducing child mortality is a major public health issue in developing countries and one of WHO's Millennium Development Goals. Infections are the most common causes of child deaths, but they are sometimes locally supplanted by other lesser-known diseases. Poisoning by the arils of the Ackee tree, *Blighia sapida*, is one example. This tree, native to West Africa, was introduced to Jamaica in the late 18th century, where it caused the vomiting sickness that killed thousands of children during the 19th century. In 1916, Scott (1) eventually found out that the deaths were due to the consumption of arils of unripe fruit of *Blighia*, which contain hypoglycaemic toxins. In its native region however, the first mention of such poisoning dates back to only 1984, after many child deaths occurred in the region of Katiola, Côte d'Ivoire. This paper describes the difficult emergence and dissemination of this knowledge in Africa in order to remind people of the ever-present poisoning risk on this continent.

The occurrence of massive child deaths was revealed by the only Ivoirian daily newspaper at the time, Fraternité-Matin. On May 30-31 1984, the newspaper ran the headline: “Katiola. A mysterious sickness is killing the children” (fig. 1A). Within thirty days, more than fifty children from two villages had died. All were Tagouanas, the majority ethnic group in the region. The villagers suspected the corn they consumed. None of the treatments applied by the physicians had been effective.

On Tuesday, June 12th, 1984, the newspaper headline said: "Epidemic of Katiola: the danger is identified" (fig. 1B). On Friday afternoon, the Minister for Health announced that, as soon as he had been informed of the situation by the newspaper article, he sent two experts to Katiola. Their investigation concluded that the deaths had not been caused by food but, rather, by contact with the organophosphate pesticides supplied by CIDT for protecting crops. [CIDT, acronym for “Compagnie Ivoirienne pour le Développement des fibres Textiles”, is the state enterprise that supervises farmers in the north half of Côte d’Ivoire, the cotton-growing region. It was supplying cotton growers with the insecticides recommended by the local research institute, and it was taking all possible steps to limit poisoning hazards (2)].

On Monday, June 18th, 1984, the front page of Fraternité-Matin was mainly devoted to the visit of the Minister for Health, accompanied by a large delegation of experts, to Katiola, from Friday to Sunday (fig. 1C). The conclusion of the mission was that “The causes of the sickness remained unknown. Indeed, after the corn and organophosphate insecticides, they suspected now a local fruit called koum.”

The last article on this disease, published Thursday, June 28, 1984, was entitled "Katiola. The mysterious epidemic: the sickness is vanquished" (fig. 1D). On Monday, June 25, the journalists had met the chief doctor of the hospital of Katiola who had told them, "Only the Minister is empowered to tell you the cause of the disease. Today, what is certain is that the problem is identified. We know the mechanisms that lead to death: it is severe

hypoglycaemia. We apply the appropriate treatment. We have advised parents to give sugar to children while awaiting evacuation to health facilities. We no longer have a single case in the hospital. There has been no deaths since the Minister's visit."

The article ended with a box entitled " Congratulations to CIDT" (fig. 2A), which revealed the truth about the discovery of the real cause of the deaths.

The solution to the mysterious disease, which plunged into mourning many families, was finally found by CIDT. Mr. Moyal, Head of Plant Protection, was the one who submitted to the medical authorities the hypothesis of the toxic fruit, which has been ultimately unanimously approved [. . .] When the insecticides used by the farmers supervised by CIDT had been implicated, the manager of this company asked him to conduct an inquiry to determine whether these products could be the cause of the deaths. Several factors led him to conclude that the insecticides used for protecting cotton plants were not involved in the deaths [. . .] Mr. Moyal, who noticed that the villagers used the fruit "koum" to make a sauce [. . .] found that [. . .] the aril was very toxic when the fruit was unripe [. . .] On June 12, he submitted his hypothesis in a note to the Director of the hospital to the attention of the physicians, together with three bottles of medicine [. . .] The following morning three cases appeared. The treatment proved effective. The analyses of the sugar rate in the blood of the patients confirmed the thesis of the hypoglycaemic toxins proposed by Mr. Moyal. The amounts of atropine sulphate sent as additional help were soon abandoned and replaced by intravenous glucose. The collaboration of CIDT, which had been questioned, was too important for being ignored.

No mass poisoning due to the consumption of arils of *Blighia sapida* (koum in the dialect Tagouana) (fig. 2B) had ever been reported in Africa before. The father of the first three saved children confirmed they had consumed arils the day before. Fifty more sick children were sent to the hospital of Katiola until the end of the fruiting period of *Blighia*. All were saved.

Fig. 1. Headlines of the Ivoirian newspaper Fraternité-Matin: A. May 30-31, 1984; B. June 12, 1984; C. June 18, 1984; D. June 28, 1984.

BRAVO À LA CIDT

C'EST finalement la CIDT qui a trouvé la solution à «la maladie mystérieuse» qui a endeuillé de nombreuses familles de Kationon et de Fronan. L'hypothèse du fruit toxique qui a fait l'unanimité a été soumise aux sommités médicales par M. Moyal, responsable du service protection des végétaux. Comment en est-on arrivé à cette conclusion? Nous avons rencontré dans le cadre de notre enquête-bilan, M. Fofana Brahima, directeur du secteur CIDT de Katiola le lundi 25 juin. Il nous a fait la genèse de cette fructueuse collaboration.

Lorsqu'après le maïs, les insecticides employés par les planteurs encadrés par la CIDT ont été incriminés, la direction générale de cette société s'est aussitôt saisie du dossier. Il a demandé au responsable de la protection des végétaux de faire une enquête pour déterminer si les produits qu'il utilisait pouvaient être à l'origine des décès.

Plusieurs éléments lui ont permis de conclure que les insecticides organo-phosphorés utilisés pour le traitement des cotonniers n'étaient pas en cause. Cela fait 20 ans que les paysans de la région de Katiola pratiquent la culture du coton. Ils sont habitués à utiliser les insecticides. Par ailleurs, les produits en question ont une remanence courte: un mois au maximum après les traitements, ils ne sont plus toxiques. Les derniers traitements remontent au 4 décembre 83. Enfin, l'échec thérapeutique observé. Le sulfate d'Atropine est réputé efficace contre les organo-phosphorés. C'est pourquoi en prévision d'intoxication par imprudence, le secteur CIDT de Katiola donne gratuitement chaque année en début de campagne des boîtes de sulfate d'Atropine aux hôpitaux de Katiola, de Dabakala et de Niakaramandougou.

En considérant toutes ces données, M. MOYAL qui a remarqué que les paysans utilisaient le fruit «Koum» pour réaliser une sauce s'est penché sur le cas. Il a alors découvert que l'arille n'est pas toxique lorsque le fruit est mûr mais très toxique quand il est vert. Avec la famine qui a sévi dans la région du fait de la sécheresse, il n'était pas impossible que des enfants voyant leurs parents consommer ce fruit aient cueilli des fruits pas suffisamment mûrs et se soient intoxiqués de la sorte. Les recherches de M. Moyal lui permettent de déterminer la toxicité, les symptômes et les traitements correspondants. Dans une note datée du 12 Juin adressée au directeur de l'hôpital de Katiola à l'attention des docteurs Monou et Djélardjé, M. Moyal leur sommet son hypothèse avec trois flacons du médicament (c'était les seuls disponibles à bouaké).

A cause de l'urgence de la situation, cette note a été frappée jusque tard après les heures de service. M. Fofana est allé la remettre à domicile au docteur Monou après 20 h, avec les trois flacons du médicament préconisé par M. Moyal. Le lendemain matin, trois cas se présentent. Le traitement s'avère efficace. Aussi, lorsque le ministre débarque à Katiola accompagné de ses éminents spécialistes dont le professeur Bondurand, on leur soumet l'hypothèse de la CIDT. Aussitôt dit, aussitôt fait. Les analyses de taux de sucre dans le sang des patients confirme la thèse de toxines hypoglycémiantes (hypoglycine A et B) proposée par M. Moyal. Les quantités de sulfate d'Atropine envoyées en renfort seront vite abandonnées au profit des sérums glucosés. La collaboration de la CIDT (mise en cause) a été trop importante pour être ignorée.

A

B

Fig. 2. A. Text of the box “Congratulations to CIDT”; B. Ripe fruit of Blighia sapida; the white aril is visible at the base of the black seed.

I wrote two articles in order to disseminate the experience acquired in Côte d'Ivoire, which might have been of great use to medical staff in the regions of western Africa where this fruit is highly consumed (3,4). I pointed out the major risk in years of famine. Poisoning in Katiola indeed occurred after the severe drought of 1983, which had destroyed most of the food crops. Hypoglycaemia triggered by the Ackee is strongly aggravated by malnutrition. Unfortunately, these two articles, which were written in French and published in modest journals, remained largely unknown.

Two other articles were also published about this "mysterious disease". The first paper (5) aimed at checking on rats whether the aril of *Blighia sapida* was, indeed, toxic. According to the authors, "The many cases of poisoning in Jamaica might be explained by the relatively late introduction of this plant (late eighteenth century)." They questioned whether "the vomiting sickness of Jamaica can be justified in Côte d'Ivoire." They concluded, "The arils of *Blighia sapida* must have played a major role in the many child deaths in Katiola [. . .] It must, however, remain some unexplained cases; that is why all child deaths recorded in Katiola should not solely be attributed to the arils of *Blighia sapida*. Some people spoke of poisoning by pesticides that are widely used in the region without all the safety measures have been taken." This paper showed that if, as indicated in Fraternité-Matin, there was unanimous agreement of the doctors in Katiola's hospital about the origin of the deaths, disbelief was high in the academic circles of the capital. Not only did the authors have to check the toxicity of the aril, but they also, despite the proved toxicity and the successful treatment in the hospital, could not help suggesting that organophosphate insecticides might have been involved.

The second article (6), a letter to *the Lancet*, was even clearer on this matter: the two hypotheses were considered equally plausible. This letter contains several serious errors. Thus, the author wrote, "In 1979-82 the major insecticides used for cotton in this region were

synthetic pyrethroids. In 1983 organophosphate pesticides were introduced by CIDT. Uninformed of the potency of these new insecticides users may have kept back some of the powder for their own domestic use." These claims were false: not only were organophosphate insecticides introduced well before 1983 and peasants well trained, but CIDT did not use insecticide powder. Cotton plants were sprayed using oily ULV formulations (2). The author further states, "Furthermore, in Africa and Jamaica, the consumption of *B. sapida* has rarely proved fatal." Yet, the deaths due to *Blighia* in Jamaica were estimated at about 5000 from 1886 till 1950 (7).

Fourteen years after the case of Côte d'Ivoire, a fatal encephalopathy epidemic killed 29 children in South-western Burkina Faso (8). Symptoms were consistent with poisoning by *Blighia*. After performing various biological analyzes, the authors concluded, "Consumption of unripe ackee fruit probably caused this epidemic." However, unlike the case of Katiola, epidemiological studies failed to prove that the children had consumed this fruit. As in Côte d'Ivoire, this epidemic came after a year of drought. The authors indicated that most people interviewed in the affected villages were unaware of the danger of eating unripe ackee fruit. After this study, a national information campaign was organised by the Ministry of Health. Among the comments to this article was a letter from Benin, where the authors said that they had also identified many cases of infant mortality in the northwest of Benin that they eventually attributed to hypoglycaemia when they were able to make the blood test. Several years later, they made the link between this hypoglycaemia and consumption of fruits of *Blighia* (9). The cases were many: ten to fifteen children had died each year in the hospital from 1986 to 1991, forty in a single village in 1997.

These articles are the only ones I know that reported cases of poisoning attributed to *Blighia* in Africa. They show that the lethal effect of this plant had to be independently rediscovered in each of the nearby countries. Many children died before this was possible.

In some areas of West Africa, trade in fruit of *Blighia sapida* is a significant proportion of the income of villagers, for example 15% in Benin (10). The country plans to grow the tree, which has recently emerged as "high-priority species for domestication" (11). However, the danger posed by consuming arils of unripe fruit still seems little known. Villagers are often aware of the toxicity of the fruit but attribute it primarily to the membrane that is in contact with the aril (12). As early as 1937, Dalziel (13) noted about the Yoruba ethnic group, “The danger associated with it is recognised, and is attributed by the people entirely to the fibrous raphe, which is bitter; it often adheres partly to the seed and should be removed.” About Katiola’s Tagouanas, Badoual *et al*. (14) indicated that, "The adults eat the ripe fruit as well as children who are taught to remove the pellicle that surrounds the arils and the hilum that contains poison.”

Therefore, arils of unripe fruit may sometimes be mixed with ripe ones, without perceiving the risk from the moment the parts considered toxic are removed. The risk is even greater for children who believe that it is sufficient to remove these parts. In Benin, producers sell about 75% of the harvested arils (10), and there is no way for the buyer to know their maturity.

The surveys have shown that fatal poisoning occurred every year, but the massive deaths were observed after years of poor harvests due to drought, the frequency of which might increase in the future because of global warming. On the occasion of the 30th anniversary of the "mysterious disease of Katiola", it seemed appropriate to remind this sword of Damocles over children in West Africa, which might encourage national and international organizations to increase awareness about *Blighia* among both health staff and villagers.

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