Mercury and cyanide in foods from the amazon: is this a risky diet?

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ABSTRACT

Mercury and cyanide are present in two important types of food that make up the Amazonian table and both are considered toxic to humans, which can cause various diseases and even lead to death. The objective of this study is to discuss the risks of human exposure to mercury and cyanide through food in the Amazon region. The present study is a narrative review developed with studies from the last 20 years (2003 to 2023) selected in the scientific databases Virtual Health Library, Pubmed and Science direct. The results of the selected studies confirm the presence of Hg in fish and cyanogenic residues in cassava flour. In addition, several studies demonstrate the high toxicity of both substances, and that they can favor several negative changes in fundamental systems for the maintenance of life such as the CNS, hematological and cardiac. We conclude that the chronic diet based on contaminated fish and cassava flour poses a risk to the health of fragile and special populations, since they depend mainly on these foods. However, one cannot fail to mention the cultural and economic importance of fish and flour for this population. Therefore, it deserves to be carefully evaluated.

Keywords: Mercury, Fish, Hydrocyanic acid, Amazon, Food.

1 INTRODUCTION

There are two food groups that are almost always available in the diet of Amazon residents: those derived from *Manihot esculenta crantz,* popularly known as cassava, and fish. However, these foods can present harmful toxins, such as hydrocyanic acid (HCN) and mercury (Hg), respectively (IBGE, 2016, ABTONES *et al*., 2019).

Table flour is produced from the cassava root, which is widely consumed by the Amazonian population (SILVA *et al*., 2018). However, the plant has cellular components that naturally produce cyanogenic glycosides and extreme toxicity to humans, due to their deleterious effects on the CNS, hematological, renal, hepatic and thyroid (DOREA, 2004; CHISTE AND COHEN, 2006).

However, the consumption of flour and fish concomitantly is common in the northern region of Brazil. However, just as flour can present significant levels of HCN, some species of fish from the Amazon have shown significant levels of mercury, and above 0.5µg/g, the limit recommended by the World Health Organization (WHO) (CASTRO *et al.*, 2016).

In this context, it is observed that both substances are harmful to humans in situations of exposure through food and need to be discussed. This synergy needs to be better understood, in order to

understand the damage to biological systems in the long term. Therefore, the present study aims to discuss the risks of chronic exposure to mercury and cyanide through food in the Amazon region.

2 METHODOLOGY

This is a narrative review of the literature, descriptive and with a qualitative approach developed in the year 2023. Guided by the following question: Would exposure to mercury and cyanide through food be a diet that risks the health of its consumers? To answer the question of the present study, a survey of scientific articles published in the last 20 years (2003 to 2023) was carried out, freely available in the scientific databases in health Virtual Health Library, Pubmed and Science direct.

The search words in the databases were mercury, hydrocyanic acid, Amazon, fish, *Manihot succulenta crantz* and Amazon, in English and Portuguese languages. All the words are registered in the page of the Descriptors of the vocabulary in health - DEC'S. As a search strategy we used the Boolean operators *and* and *or*.

Inclusion criteria were articles in English and Portuguese that were available for full-text access. Articles that did not consider exposure to mercury and cyanide through food were considered ineligible.

The results of the research are addressed through a thorough analysis by at least two authors, on the main findings of the selected studies in a descriptive way from a theoretical and contextual point of view, prioritizing a critical and reflective approach to the selected literature.

3 DEVELOPMENT

MANDIOCA (Cyanide)

In Brazil, cassava production is well distributed, there are crops of the plant throughout the country. In the State of Pará, its relevance is due to the high production, demanding a large number of labor and generating about 200 thousand jobs in the State (GUSMÃO *et al.,* 2016). Cassava is highlighted in the group of temporary crops and agricultural production (FAPESPA, 2015).

In its cultivation, the presence of nitrogen in the soil can influence the cyanide concentration in cassava. The content decreases linearly with the age of the plant and may vary between its parts. The range of levels of these glycosides is used to classify cassava plants into tame (low levels), wild (high levels) and intermediate (GAZOLA *et al.,* 2018).

MERCURY (Hg)

There are several states in Brazil with great mining activity in the Amazon region contaminated by mercury (Hg). First the state of Amazonas (AM) with 0.02912 mg/g, followed by the state of Rondônia (RO) with the value of 0.1525 mg/g, after, the state of Pará (PA) with the value of 0.01106

mg/g and finally, Amapá (AP) with 0.0106 mg/g (GUIMARÃES; 2013). In these states, the most contaminated rivers are Rio Negro with 0.205, followed by Tapajós, 0.183, Madeira 0.86 and 0.5 and 0.6 Hg(mg/g) Xingu and Amazonas respectively (BASTOS, 2012. GUIMARÃES; 2013).

Consequently, fish species such as *Charasidae sp.* (Lambari), *Pseudoplatystoma corruscans (*Pintado), *Hoplias malabaricus (*Trairá), *Pseudoplatystoma Linnaus (*Surubin), *Pellona Valenciennes (*Sarda), *Astronotus sp.* (Cará/Apaiari) present the highest concentrations of total Hg (AMARO *et al*.,2014, CASTRO *et al.,* 2016, MILHOMEM *et al.,* 2016).

When compared to the 1980s, a period called the "gold rush", a decrease in mercury in the environment has been observed, it can remain for a long time in nature still offering risks to human health (MALAQUIAS, 2015).

TOXICOKINETICS AND TOXICODYNAMICS OF CYANIDE

The cassava root produces table flour, which is widely consumed by the Amazonian population (SILVA *et al*., 2018). However, the plant has cellular components that naturally produce cyanogenic glycosides. The release of the compound occurs by hydrolysis during the rupture of the plant cell wall, which, in the presence of linamarin and linamarase present in its composition, release hydrocyanic acid (HCN) as a product (OLIVEIRA *et al*., 2014; SHIBAMOTO AND BJELDANE, 2014).

Cyanide is rapidly absorbed by the body regardless of the route of introduction (respiratory mucosa, gastrointestinal tract, skin, and eyes if contact is continuous). This is due to its low molecular weight, solubility in water and lipids and its toxic effects can occur within minutes. The ingestion of cyanide salts favors the release of hydrocyanic acid by the action of hydrochloric acid present in the stomach, absorbed in the form of cyanide ions (AZEVEDO *et al.,* 2015).

Although hydrocyanic acid is considered a substance of ecological function for cassava, but of extreme toxicity for humans, due to its deleterious effects on the Central Nervous System, hematological, renal, hepatic and thyroid (DOREA, 2004; CHISTE AND COHEN, 2006; SHIBAMOTO AND BJELDANES, 2014, ABTONES *et al*.,2019).

The studies by Almeida (2015) and Baia and Melo (2017), carried out with flours marketed at a free fair in Belém and Bragança in the state of Pará, respectively, showed cyanide results above 10mg/Kg of cassava, considered an acceptable limit for safe consumption according to ANVISA.
In cases of suspected and confirmed intoxication, in addition to oxygen administration and measures aimed at maintaining the cardiovascular system, drug therapy should be performed, the essential measure to decrease the chances of death of the patient.

Among the drugs used, hydroxocobalamin is pointed out as a very effective antidote, it replaces its hydroxyl group with free cyanide in plasma forming cyanocobalamin, which is excreted in the urine,

rapidly improving heart rate and systolic blood pressure and reduces, in addition to reducing acidity (CONITEC, 2015).

TOXICOKINETICS AND TOXICODYNAMICS OF Hg

The rate of absorption of Hg depends on the route of exposure and the chemical form of the metal. Metallic mercury when inhaled is absorbed on average, 80% (FILHO, 2009) and in the form of methylmercury, 95%, through the consumption of contaminated food. Methylmercury present in fish is metabolized in the liver. However, this conversion is rather slow. Along with this, the fact that the human body has no other route of elimination of the metal, contributes to methylmercury accumulating continuously over time even if exposure is not so continuous (FILHO, 2012).

Neurological changes have been reported in populations exposed to mercury in the Amazon (SILVEIRA, *et al.,* 2004; KHOURY *et al.,* 2013, MORENO DOMINGUEZ, *et al.,* 2017). Methylmercury in the CNS may contribute to the increase of glutamate and the inhibition of the uptake of this neurotransmitter in the synaptic cleft of astrocytes. This condition in an adult person can cause impairment of the hippocampus and cerebellum, resulting in neuronal losses, directly affecting vision, hearing, somatic sensory and motor systems (ASCHNER *et al*., 2007).

It is important to consider exposure to Hg through food in the body, especially by population groups in the Amazon at easy risk of exposure. Studies show changes in several oxidative markers such as methemoglobin dosage, and plasma membrane lipoperoxidation widely used as markers of oxidation of biological organic molecules (SILVA, 2011; KHOURY *et al*., 2013; SILVA *et al.,* 2016; RIVADENEYRA-DOMINGUEZ *et al.,* 2017).

4 FINAL CONSIDERATIONS

Considering the findings, it is hypothesized that exposure to mercury and cyanide through food may cause harm to the health of certain population groups, especially those who focus on fish and cassava flour as their main sources of protein and carbohydrates, respectively.

Food is responsible for more than 30% of diseases today. This fact is due to chronic exposure, characterized by small doses, but not less important at the toxicological level. Therefore, fish and cassava flour need to be monitored for the presence of chemicals that are toxic to humans and affect various biological systems.

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