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Fumonisins in Foods from Cordoba (Argentina), Presence: Mini Review

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Abstract

This review emphasizes, specifically, the determination of fumonisins in different food substrates, made in different commercial centers of Córdoba, Argentina. The importance of reviewing this research is related to public health, since food is part of human development and this must be safe. These contaminations, which we try to determine in different food substrates, in some cases occurred in very small quantities, but in most cases, the consumption is through the children and for long periods of time. Among these foods are those based on corn, this cereal has a great possibility of being contaminated with fumonisins and other mycotoxins as evidenced by research conducted in our country.

Keywords: Fumonisins; Food; Cordoba; Public Health; Argentina

Introduction

Contamination of foodstuffs with toxigenic fungi may occur in different phases of production and processing, from sowing to transportation and storage. Besides, as mycotoxins are chemically stable, they may remain in the foodstuff even after fungi were removed by usual processing and packaging processes. Diseases caused by mycotoxins are called mycotoxicosis and are characterized by diffuse syndromes. However, depending on the type of toxin, lesions predominantly affect a given organ or tissue, such as liver, kidneys, epithelial tissue and Central Nervous System. The simultaneous occurrence of two or more mycotoxins is not rare, and toxic effects on the susceptible organism may be synergistic [1]. The economic impact of micotoxins includes mortality of the animal, increased costs with veterinary care, and decreased production efficiency. In the poultry production acute mycotoxicosis is rare and chronic exposure to low levels of mycotoxins is responsible for reduced productivity and increased susceptibility to infectious diseases [1]. Prevention of growth and mycotoxin production in fungi from the field is usually considered the best approach to impede the harmful effects of mycotoxins on animal and human health. So far lowering pre-harvest contamination, the treatment of field crops with fungicides is the traditional technique. The effect of fungicides on mold growth and mycotoxin biosynthesis is effected by several factors, including their chemical nature, rate of application, crop type, fungal species and storage conditions [2]. Mycotoxin production is dependent on a number of factors, e.g. water activity of the stored product, temperature, presence of chemical preservatives, and microbial interactions. Water availability or moisture content is one of the most important factors in the prevention of fungal growth and mycotoxin production [3]. Although the prevention of mycotoxin contamination in the field is the main goal of the agricultural and food industries, the contamination of various commodities with *Aspergillus* or *Penicillium* isolates and their mycotoxins is unavoidable under certain environmental conditions. Postharvest strategies aim at lowering fungal contamination and consequently the mycotoxin content of agricultural products during storage, handling, processing and transport.

Fumonisins are a family of mycotoxins produced mainly by *Fusarium verticillioides* and *Fusarium proliferatum*. These fungi are prevalent in corn grown in all regions of the world. They are often found as contaminants of corn for animal feed and also in corn-based foods intended for human consumption. Fumonisin B1 (FB1) is the most studied and considered potentially carcinogenic to humans and is classified as Group 2B [4].

Corn in Argentina accounts for approximately 30% of total cereals and oilseeds. The natural presence of fumonisin in Argentine corn has been reported by different studies [4-13]. On the other hand, numerous publications have been produced around the world documenting the co-contamination of corn in areas where human hepatocellular carcinoma (HCC), chronic liver disease and growth retardation in children are high. A recent survey in sub-Saharan Africa of 388 corn samples analyzed, 81 and 65% were positive for fumonisin and aflatoxin, respectively [14]. Since exposure is both a level of contamination and a level of consumption, some rural communities in developing countries may exceed the provisional maximum tolerable daily intake (PMTCT) of 2 µg/g per day of fumonisins if their diet contains amounts of corn [15]. Wild and Gong [16] analyzed available data on fumonisin levels (µg/g per day) in several African countries, especially Burkina Faso (0-2); Those in Kenya (Bomet (<0,1)) and those in South Africa (Bizana [1-19] and Centane [2-36], Transkei [4] and KwaZulu-Natal (0)). In the United Republic of Tanzania, Kimanya et al. [17] reported exposure levels of 0.2 to 26 µg/g pc/day in children. In Latin America, fumonisin intake was estimated at 3.5 µg/g pc/day (urban areas) and 15.5 g/g pc/day (rural areas). In Guatemala, a more recent study reported doses ranging from 0.20 to 23 µg/g pc/day [18].

As regards the regulation of the presence of fumonisins in foods, the Argentine Ministry of Agriculture, Livestock, Fisheries and Food [19] established a limit of 1000 µg/g fumonisins for quick cooking products to prepare polenta as flour corn or grains of corn.

The Common Market of the South (MERCOSUR), comprising Argentina, Brazil, Paraguay and Uruguay, applies common limits for

total aflatoxins in peanuts, maize, their derivatives and for aflatoxin M1 in milk and powdered fluids. MERCOSUR regulations also include official methods of sampling and analysis. Brazil and Uruguay apply additional limits for some combinations of mycotoxins/food type [20].

Materials and Methods

Samples

To better characterize the brands, we took three samples from each product from different lots using the sampling method of the International Commission on Microbiological Specification for foods [21]. We took 23 samples of corn flour, 6 of starch, 29 of rice, 9 of honey, and 9 of Ecuadorian bananas. The samples were kept in refrigerators until the analyses were made.

Standards and reagents

All solvent and reagents used were analytical-or liquid chromatographic-grade chemicals. Fumonisin B1 (FB1) and fumonisin B2 (FB2) standards were supplied by the Sigma Chemical Co (St. Louis, Mo). Fumonisin B3 (FB3) was supplied by the PROMEC (Programme on Mycotoxins and Experimental Carcinogenesis, Tygerber, Republic of South Africa). A stock solution of the pure crystaline FB1, FB2 and FB3 at 100 μg/g in; methanol was prepared and subsequently standard solutions of the toxin at diverse concentrations (0.5, 1.0, 2.0, 5.0 and 10 μg/g) were prepared diluting the stock solution. These standards were utilized for high performance liquid chromatography (HPLC).

Fumonisin ELISA and HPLC determination

The prepared samples were analyzed with the Veratox Quantitative Fumonisin test, enzyme-linked immunosorbent assay (ELISA) kit, Neogen (USA) and by the Shephard method [22] for HPLC.

Fungus quantification in food

The foods under research were rice, corn flour and starch. We used mold quantification techniques in foods as cover crop using the following culture means: Sabouraud agar with antibiotics, Czapeck-Dox agar. In the case of liquids and powders we used dilution methods [21]. In addition, in the case of grains, we used the listing technique with direct plating for grains, seeds and dried fruits [23].

Results and Discussion

Samples were analyzed by ELISA and HPLC and showed a linear correlation (r2=0.9527). Similar results were found by Broggi et al. [24].

In this work, fumonisin B1 was found at detectable levels (>1 μg/g) in eight of the 23 (35%) corn flour samples. We found 0.8-0.9 μg/g in three of the 29 rice samples (10%). In the rest of the samples, fumonisin levels below 0.1 μg/g were detected (Table 1). No fungal development was observed in the different rice culture media; however, in the different corn flour brands the following fungi were identified: *Acremonium*, *Mucor*, *Paecilomyce*s and *Alternaria*, but no colony of the genus Fusarium was observed. Federico et al. [25] found high concentrations of fumonisins in 20 samples of different brands of commercial stores in three Argentine provinces: Buenos Aires, Entre Río and Córdoba. The average fumonisins found were 257.5 μg/g

(n=19), 70.4 μg/g (n=14) and 73.3 μg/g (N=6) for FB1, FB2 and FB3 respectively, and FB1, FB2 and FB3 were not detected in a single sample. Doko and Visconti [26] in Italy detected levels of 420 to 3760 ug/g FB1 and 80 to 910 ug/g FB2 in polenta. Cano-Sancho et al. [27], in Cataluña, Spain found FB1 and FB2 in different food products including corn flakes and the groups most exposed were children.

Samples	Assay Methods	Fumonisin level (ug/g)			Total (ug/g)
		FB1	FB2	FB3	
Corn flour					
1	ELISA				0.9
	HPLC	1.0	0.1	ND	1.1
2	ELISA				0.8
	HPLC	1.0	ND	ND	1.0
3	ELISA				1.0
	HPLC	1.1	0.2	ND	1.3
4	ELISA				1.2
	HPLC	1.1	0.5	ND	1.6
5	ELISA				2.4
	HPLC	2.6	ND	ND	2.6
6	ELISA				1.0
	HPLC	1.4	0.4	ND	1.8
7	ELISA				1.1
	HPLC	1.5	ND	ND	1.5
8	ELISA				1.1
	HPLC	1.6	ND	ND	1.6
Rice grain					
1	ELISA				0.3
	HPLC	0.9	ND	ND	0.9
2	ELISA				0.4
	HPLC	0.8	ND	ND	0.8
3	ELISA				0.3
	HPLC	0.9	ND	ND	0.9

Table 1: Fumonisin levels in corn and rice samples. ND: Not detectable (<0.1 μg/g).

The level of fumonisins in grains, fruits and processed foods is a major public health problem. Most causes of human cancer are not well established [28], but FB1 can lead to it as a positive environmental tumor promoter [29], specifically if exposure to low concentrations occurs over long periods.

Marin et al. [30] present an interesting review of mycotoxins. I can continue to mention the work of other countries, but I think the debate on fumonisin and mycotoxins in general is as follows: that humans are

exposed to them by ingestion, contact and inhalation and the effects can be acute or chronic. That the scientific community knows very well what happens with each of the mycotoxins, but the general population does not know much about it. We are conducting different investigations on exposed animals, but there are also works on different cell lines, fungal metabolites as well as molecular level. Another aspect that is being investigated is the effect of multiple mycotoxins and this is related to the environment, specifically climate change [31].

Conclusion

As it is well known that Fumonisin B1 (FB1) is the most studied and considered potentially carcinogenic to humans, this involves greater care in the use of raw materials to produce food and especially those whose main matrix is corn. The food industry must deepen the controls of the same when receiving the grains to avoid the contamination. But the most important is that fumonisins such as mycotoxins in general are compounds that, in general, have a high thermal resistance, unlike what happens with microorganisms, that is why a heat treatment does not ensure the elimination of mycotoxins in a food contaminated. There are methods of chemical detoxification to destroy mycotoxins in food, but the danger of using this methodology is due to possible formation of products with some toxicity.

To avoid contamination of food with mycotoxins, we must act from the very moment of production, trying to minimize the entry of these mycotoxins in the food chain. This is achieved using the Good Practices in the field, the stages of collection, as in storage and marketing

In our country, as in other parts of the world, the climate has changed and this causes mycotoxins to be modified, that is, some fungal communities can be replaced by others, and the appearance of problems with certain types of mycotoxins where they do not exists.

The problem of mycotoxins is in the field, once incorporated into the plant, elimination is complicated, so Argentina must improve agricultural practices, prevention, control, resistance to plants to mold pollution and improve the conditions of storage of raw materials.

However, while it is not possible to attribute deaths or illnesses, fumonisins does not mean that they have no effect. In fact, in some regions of the world exposure to fumonisins could be higher and some populations more sensitive to toxicological effects. In addition, fumonisins levels in foods often exceed regulatory limits. Fumonisins monitoring and action to eliminate non-compliant food products is a financial burden for health authorities and food businesses alike. Therefore, it is possible for both public health and the economic benefits of reducing fumonisins contamination in food.

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