Aflatoxin Contamination of Grains in Costa Rica

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INTRODUCTION

Aflatoxins are fungal secondary metabolites produced by *Aspergillus spp.* that are carcinogenic and toxic for humans and animals. In Costa Rica, a maximum limit (ML) of 20 µg kg^{-1} of total aflatoxins has been established for cereals, oilseeds and legumes, and a limit of 15 µg kg^{-1} for peanut. The Mycotoxin Laboratory at CIGRAS works in coordination with the Costa Rican State Phytosanitary Service (SFE) to monitor aflatoxin levels in imported agricultural commodities, as well as with the food processing industry that requires aflatoxin monitoring to assure quality control.

OBJECTIVE

The objective of this work was to summarize results for aflatoxin testing conducted in the Mycotoxin Laboratory during the past 13 years of monitoring.

MATERIALS AND METHODS

All samples received in the Mycotoxin Laboratory were analyzed for total aflatoxins (B_1+B_2+G_1+G_2). Samples received during 2003 to early 2010 were analyzed with method AACC 45-15 (confirmation with TLC), while samples received from June 2010 through December 2015 were analyzed with a fluorometric method and Aflatests immunoaffinity columns (AOAC 991.31 items A-G).

Figure 1. Sample sampling preparation and analysis

Table 1. Occurrence of aflatoxin contamination in agricultural commodities intended for human consumption in 2003-2015 in Costa Rica

Year	Number of samples						Samples above LoD (%)	Maximum aflatoxin concetration (µg kg^{-1})
		Concentration range (µg kg^{-1})						
	Total	x < LoD	LoD ≤ 5	5 ≤ x < 10	10 ≤ x < 20	x ≥ 20		
2003	435	414	0	6	5	10	5.0	400
2004	437	424	0	2	4	7	3.0	54
2005	364	351	2	2	1	8	3.6	350
2006	316	310	0	1	2	3	1.9	46
2007	134	106	1	4	5	17	20.1	500
2008	90	83	0	1	3	3	7.7	20
2009	142	127	1	8	1	5	10.5	100
2010	186	128	5	9	11	33	31.1	150
2011	295	250	20	10	4	11	15.2	230
2012	570	494	35	13	12	16	13.3	360
2013	912	800	53	23	17	19	12.3	350
2014	859	805	40	6	3	5	6.3	150
2015	753	675	46	12	3	17	10.3	420
Total	5493	4967 (90,4%)	203 (3,7%)	97 (1,8%)	71 (1,3%)	154 (2,8%)	$\bar{x}$ =10,8	

Table 2. Aflatoxin contamination of commodities intended for human consumption in Costa Rica

Food source	Number of samples			Maximum concentration (µg kg^{-1})	Samples above ML (%)
	Total	Concentration range (µg kg^{-1})			
		< LoD	> 20		
Semolina, rice/maize	4	0	3	370	75
White maize	453	278	47	420	10.3
Red beans	162	102	35	500	21.6
Pistachios	9	7	1	230	11.1
Peanut	574	441	46*	400	8.0
Flour maize/rice	8	7	1	110	12.5
Black beans	112	103	2	80	1.7
Paddy rice	319	294	8	69	21.6
Macadamia	78	72	0	11	0
Yellow maize	832	770	9	410	1.1
Almonds	65	62	0	8.9	0
Milled rice	2421	2386	1	28.5	0.04
Wheat	234	231	0	1.7	0
Nutmeg	49	49	0	-	0
Sunflower seeds	25	25	0	-	0
Cashews	11	11	0	-	0
Oats	10	10	0	-	0
Soybeans	10	10	0	-	0
Sorghum	9	9	0	-	0
Other	108	108	0	-	0

*Maximum limit for peanut is 15 µg kg^{-1} and for all other grains and seeds is 20 µg kg^{-1}

RESULTS

- A total of 5493 samples were analyzed for total aflatoxins over the 13-year period (Table 1).
- Since 2009 there was an increase in the number of samples analyzed per year (Table 1), driven by the number of milled rice samples, that went from 1 in 2009, to 438 in 2015 (Table 2).
- Only 10.8 % of the total number of samples had measurables amounts of total aflatoxins (Table 1), while 2.8 % had concentrations above the ML.
- A total of 42 different types of foodstuff were analyzed during the 2003-2015 period, with rice (*Oryza sativa*) (50 %) as the most frequently tested grain, followed by yellow maize (*Zea mays*) (15 %), peanut (*Arachis hypogaea*) (10 %), and white maize (5 %).
- Highest aflatoxin contamination levels were observed in red beans (*Phaseolus vulgaris*), followed by white maize, and peanuts (Table 2), however, detection of aflatoxins was greatest in white maize, followed by peanut and red beans.
- Aflatoxin contamination in milled rice was low (Table 2), with just 0.04% of the total number of milled rice samples with concentrations above the ML.

CONCLUSIONS

- Beans, rice, and maize are staple food in Costa Rica. Due to the high aflatoxin levels observed in red beans, further research needs to be conducted to study how and when beans can be affected by *Aspergillus* spp.
- The majority of the rice samples analyzed were from imported samples, therefore, there is also a need to verify that locally grown rice meets the national regulations.
- It is important to monitor aflatoxins levels of grain and grain products sold in markets and stores.