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A Limited Survey of Fumonisin B_1 Content of Domestic and Imported Corns in Korea

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ABSTRACT : *Fumonisin B_1 (FB_1) is hepatotoxic in all species, and initiator and promotor for hepatocarcinogenesis produced mainly by Fusarium moniliforme. This fungus is commonly natural contaminant of corn and other grains worldwide, and has been associated with animal and human diseases. In these study, natural occurrence of FB_1 was surveyed in 30 healthy domestic corn kernels in Chonbuk and Kangwon province, harvested in 1994 and intended for human consumption, and 15 imported American and Chinese samples of each, collected from different ship-loading at Inchon harbor for animal foodstuffs. FB_1 contents were measured by high-performance liquid chromatography (HPLC) with a flourescence detector. The data revealed that 2 out of 12 corn kernels from Kangwon province with 1.1 and 0.7 ppm, and 2 out of 18 corns from Chonbuk province with 0.5 and 1.3 ppm, respectively. However, there was no detection of FB_1 in imported corn samples, even though those were visibly moldy.*

Key Words : *Fumonisin B_1, Corn, Natural occurrence*

I. INTRODUCTION

Mycotoxin contaminated by mold in agricultural commodities is associated with food safety, and can affect animal and human health adversely (Coulombe, 1993). Contamination of *Fusarium* species is now recognized to be a major agricultural problem (Abbas *et al.*, 1993). Lee *et al.* (1988) showed that corn seed in Korea was contaminated with *Fusarium*, ranged 11 to 94%.

FB_1, secondary metabolites of several species of *Fusaria*, especially *F. moniliforme* and *F. proliferatum* is commonly contaminated in corn through the worldwide (Gelderblom *et al.*, 1992), and has been associated field outbreaks of equine leukoencephalomalecia in horses and porcine pulmonary edema in pig (Harrison *et al.*, 1990, Wilson *et al.*, 1990). Whereas the role of FB_1 in human health is not clear, the consumption of FB-contaminated corn has been epidemiologically correlated with increased risk of esophageal cancer in Transkei, South Africa, and some provinces of China (Yoshizawa *et al.*, 1994). Although the carcinogenic mechanism of FB has not been fully elucidated, the evidence indicates that FB_1 is a complete carcinogen in the sense that it effects the different stages of cancer development in rat liver, including cancer initiation, promotion, and progression (Norred *et al.*, 1994).

The occurrence of FBs has been reported in corn-based food or foodstuffs worldwide. FBs infested over 60% of corn samples in midwestern USA from 1988-1991 crops, up to 10% of samples had 10 to 59 ppm levels (Murphy *et al.*, 1993). Relatively high levels of FB_1, up to 2.8 ppm, was detected in commercially purchased food (Syderham *et al.*, 1991). In Transkei, South Africa, and northern China's Linxian province which were high-risk area of human esophageal cancer and corn was a major dietary staple, the highest levels of FB_1 were up to 155 and 117 ppm yet recorded from naturally infested corn, respectively (Rheeder *et al.*, 1992). This preliminay study was to investigate the contents of FB_1 in domestic and imported corns in Korea.

II. MATERIALS AND METHODS

1. Corn samples

A total of 30 domestic corn kernels, at least 100 g of each, were randomly sampled from different location in November 1994-February 1995. These were healthy corn ears harvested in 1994 intended for human consumption and seeds, and collected from Kangwon and Chonbuk province.

Imported USA and Chinese corns for animal feeds, 15 samples of each, were collected from different ship-loading at Inchon harbor in the same collection period of domestic corn. The samples were transported to Laboratory of Veterinary Diagnostic Medicine, University of Illinois, Urbana, Illinois, USA via the quarantine offices. Individual corn samples were kept at 4°C prior to analysis of FB_1.

2. Analytical methods

FB_1 was analyzed according to method of Ross *et al.* (1990) using HPLC chromatography. In brief, the corn samples were ground to a uniform consistency, and 10 g portions were extracted with CH_3CN/H_2O (50/50, v/v). After filtering extract though #4 Whatman filter paper, 2 m*l* aliquot diluted with 6 m*l* H_2O contained 100 μ*l* of 0.05 N potassium phosphate monobasic buffer was applied and clean up on a Sep Pak cartridge (C_{18}, Waters/Millipore, USA). The FB fraction was eluted with CH_3CN/H_2O (70/30, v/v). The FB fraction was derivatized with naphthalene-2,3-dicarboxaldehyde (NDA) reagent, and was chromatographed on a Perkin-Elmer 3 cm C_{18} analytical column (Perkin-Elmer, USA). Fluorescing derivatives were detected by a Perkin-Elmer LS-3 fluorescence detector (Perkin-Elmer, USA, excitation, 335 nm; emission, 440 nm). Standard FB_1 was obtained from the USDA-ARS (Peoria, IL, USA).

III. RESULTS AND DISCUSSION

Studies on the FBs are still at a relatively early stage, but it is already clear that they play an important role in animal mycotoxicosis and, by implication, in human disease. In this study, HPLC analysis of FB_1 in domestic corns harvested in 1994 revealed that 4 out of 30 samples were positive for FB_1 in the range of 0.5-1.3 ppm level. These samples were home-grown corn for human consumption or seeds following year. Those appearances were healthy and intact shapes. On the contrary, there was no detection of FB_1 in imported corn from China and USA, even if the most imported corn kernels were visibly moldy. The results are summarized in Table 1.

Table 1. Natural occurrence of fumonisin B_1 in domestic and imported corn kernels

Fumonisin B_1 (ppm)									
Domestic corn sample						Imported corn sample			
Kangwon			Chonbuk			China		USA.	
No. sample		ppm	No. sample		ppm	No. sample	ppm	No. sample	ppm
Hongcheon	K1	1.1	Jinan	K13	ND	C1	ND	A1	ND*
	K2	ND		K14	ND	C2	ND	A2	ND
	K3	ND	Sunchang	K15	ND	C3	ND	A3	ND
Choulwon	K4	ND		K16	ND	C4	ND	A4	ND
	K5	ND	Chilbo	K17	ND	C5	ND	A5	ND
	K6	ND		K18	ND	C6	ND	A6	ND
	K7	ND		K19	ND	C7	ND	A7	ND
	K8	ND		K20	ND	C8	ND	A8	ND
	K9	ND		K21	ND	C9	ND	A9	ND
	K10	ND		K22	ND	C10	ND	A10	ND
	K11	ND		K23	ND	C11	ND	A11	ND
	K12	0.7	Imshil	K24	ND	C12	ND	A12	ND
			Shintein	K25	ND	C13	ND	A13	ND
			Iksan	K26	ND	C14	ND	A14	ND
			Samrae	K27	ND	C15	ND	A15	ND
			Chonju	K28	ND				
			Pusan	K29	ND				
				K30	ND				
Positive/total		2/12			2/18		0/15		0/15

*ND=not detected

In fumonisin detection, one of the major problems is that often clean looking corn contained more fumonisin than moldy corn. Sydenham *et al.* (1990) reported that higher levels of FB_1 were present in the healthy corn samples from the high esophageal cancer rate area than in corresponding moldy samples from the low rate area. In corn model, *F. moniliforme* entered the kernel and occupied the internal space distal to the tip cap, and was primarily an internally seed-borne fungus (Kim *et al.*, 1984, Kochler *et al.*, 1942).

We are forced to import million tons of corn from USA and China; 4,370 thousand ton from USA and 795 thousand ton from China in the first 6 month this year. Furthermore, imported corns are undergrade and harvested 2 or 3 years earlier, which is likely to be contaminated with FBs and other mycotoxins such as aflatoxin (AF). We should consider the co-contamination of mycotoxins, because the toxic effect of the combination of AF and FB is synergistic (Harvey *et al.*, 1995). This study did not include the detection of AF, which was susceptible to the temperature.

For fumonisin fields, the goals include not only detection, analysis and destruction of these toxins in products, but, more importantly, the elimination of them as a health concern for human and animal. So far, no treatment appeares to efficiently eliminate FB_1 because little effect on FBs. Mycotoxis probably will never be eradicated, but the feed industry and agricultural interests have concerns to minimize mycotoxins as a food safety issue.

The risk of naturally-occurring toxicants in foods, such as FBs, although not nearly as regulated or studied as man-made chemicals, present at least as great a risk to humans. It is necessary to take some action for regulation of FB levels. The quarantine authorities have to monitor the shipment of corn, particularly in years when the climate conditions were favorable for FB formation. Climate conditions such as high temperature and high humidity are favorable for fungal growth as observed in southern Asian countries (Miller *et al.*, 1993, Wang *et al.*, 1995). Ueno *et al.* (1993) surveyed FB_1 contents in imported corn in Japan sampled in 1988, and average level of FB_1 was 1.6 ppm in corn from USA and 6.8 ppm from China. No detection of FB_1 on imported corn of this study is somewhat unexpected.

Although their positive rate and level were low and numbers of sample collection were limited in this study, there should be needed the guideline for the regulation of fumonisin level. Further continued study is required incidences and levels of FB_1. Additional surveys on the natural occurrence can provide valuable information on risk assessment of FBs.

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