Geographical Distribution of Aflatoxin-producing Fungi Inhabiting in Southeast Asia

By MASARU MANABE and OSAMU TSURUTA

Food Protection and Preservation Division, National Food Research Institute

Aflatoxins belong to mycotoxins, and the group is closely related to secondary fungal metabolites. Mycotoxins represent a group of toxic fungal metabolites which have been found to contaminate certain foods. Some of these compounds have been shown to have a high order of acute toxicity to certain animal species and have exhibited potent carcinogenic properties.[10] Many cases of illness or death in cattle, swine, flocks of chickens and turkeys, and other animals are believed to have been caused by mycotoxins-contaminated animal feeds.[6] The demonstration of various biological effects resulting from the inquestion of contaminated foods by experimental animals proved the potential public health hazard which might arise from contamination of the food supply by mycotoxins.[1,10] Thus, the foods damaged by mycotoxin-producing fungi will result serious troubles, i.e., not only the deterioration of food quality but also the destruction to human health. All countries are under the pressure of necessity to consider the countermeasures for mycotoxin contamination.

The number of kinds of mycotoxins amounts over one hundred. Among the mycotoxins, aflatoxins are the strongest substance in carcinogenic effect, so that world-wide argument of aflatoxin-contamination in cereals is spreading from the stand point of the safety of food. The authors have examined the actual circumstances about aflatoxin contamination in cereals for a fairly long time, and the results obtained suggested that the possibility of aflatoxin contamination is higher with imported cereals than with domestic cereals, from the viewpoint of their mycoflora.[2,8] In fact, the aflatoxin-contamination in domestic cereals in Japan had never been detected so far.[3,7]

On the other hand, the distribution of aflatoxin-producing fungi inhabiting in soil in Japan was examined.[4,5,9] As a result, aflatoxin-producing fungi were not isolated from the soil samples collected from the northern part of Japan, but isolated from a few somples from the southern part of Japan. Consequently the authors have been keenly interested in the aflatoxin-producing fungi in Southeast Asia situated to the south of Japan. In the period from March to April 1976, the author had an opportunity to collect soil and grain samples on the spot in the Philippines, Indonesia, and Thailand, by the help of the Tropical Agriculture Research Center. The isolation of fungi from these samples by the culture method was carried out with a focus on *Aspergillus flavus* group including aflatoxin-producing strains, and the aflatoxin productivity of the strains belonging to *A. flavus* group selected from these isolates was examined.

Mycoflora: The samples examined were 24 soil samples and 16 samples of grain or other food from the Philippines, 21 soil and 8 grain samples from Indonesia, and 17 soil and 8 grain samples from Thailand. The frequency of fungi detected from the samples is shown in Table 1. *A. flavus* and *A. niger* showed high frequencies with every samples, and Mucorales also indicated high frequencies except with the soil samples collected in Indonesia. *A. terreus, Fusarium* spp., and *Tri-*

Table 1. Frequency of fungi detected from samples of soil and grain or other food collected from Southeast Asia

	Samples					
	Soil			Grain or other food		
	High	Low	None	High	Low	None
Philippines	*A. flavus* *A. niger* *A. terreus* *Fusarium* spp. Mucorales *T. viride*	*A. candidus* *A. nidulans* *A. tamarii*	*A. versicolor* *Eurotium* spp. *P. islandicum*	*A. flavus* *A. niger* *A. tamarii* Mucorales *P. islandicum*	*A. candidus* *Eurotium* spp. *Fusarium* spp. *T. viride*	*A. nidulans* *A. terreus* *A. versicolor*
Indonesia	*A. flavus* *Fusarium* spp. *T. viride*	*A. candidus* *A. nidulans* *A. niger* *A. tamarii* *A. terreus* Mucorales	*A. versicolor* *Eurotium* spp. *P. islandicum*	*A. flavus* *A. niger* *A. tamarii* Mucorales *P. islandicum*	*A. candidus* *A. terreus* *A. versicolor* *Eurotium* spp. *Fusarium* spp.	*A. nidulans* *T. viride*
Thailand	*A. flavus* *A. niger* *A. terreus* *Fusarium* spp.	*A. candidus* *A. tamarii* Mucorales *T. viride*	*A. nidulans* *A. versicolor* *Eurotium* spp. *P. islandicum*	*A. flavus* *A. niger* *A. tamarii* *Eurotium* spp. Mucorales	*A. candidus* *A. nidulans* *A. terreus* *A. versicolor* *Fusarium* spp. *P. islandicum*	*T. viride*

A.: Aspergillus, *P.: Penicillium*, *T.: Trichoderm.*

choderma viride showed higher frequencies in soil samples than in grain samples. In contrast, *A. tamarii* indicated the higher frequency in grains than in soils, and this high frequency of *A. tamarii* in the grain samples collected in Southeast Asia differs from the frequency observed with domestic grain samples in Japan. The detection of *A. candidus* and *A. nidulans* from the every samples was of equally low frequency in the case of Japan. The only strains detected from the grain samples were *P. islandicum, A. versicolor,* and *Eurotium* spp. (*E. chevalieri, E. repens, E. amstelodami* etc.). Very low frequency of *P. islandicum* was detected from domestic grains in a natural state. By contrast, high frequency of it was detected from the Southeast Asian grain samples. With those results, it can be concluded that the mycofloras of soils and grains vary with different localities.

Aflatoxin-producing fungi: Aflatoxin productivity of the strains of *A. flavus* group such as *A. flavus, A. parasiticus* and *A. tamarii* was examined with those isolated from 98 soil and grain samples which were collected from Southeast Asian countries such as the Philippines, Thailand and Indonesia. Forty strains out 84 strains of *A. flavus* showed the aflatoxin productivity on the rice culture containing Zn ion. And a strain of *A. parasiticus* that is only one isolated from the all collected samples also showed the productivity. None of 37 strains of *A. tamarii* produced any aflatoxins. The aflatoxin productivity of the strains isolated from the soil samples was of higher levels than that isolated from the grain samples. This result showed a similarity to the phenomenon that the aflatoxin productivity of the strains isolated from the natural substance tends to decrease as the successive culture of them is repeated.

The geographical distribution of aflatoxin-

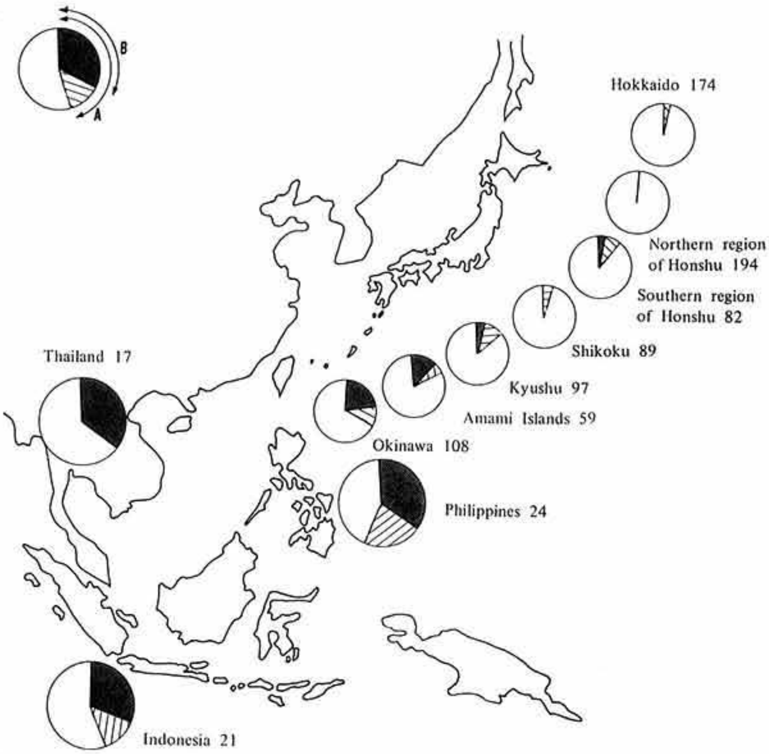

Fig. 1. Detection ratio of aflatoxin-producing fungi in the Soil samples collected from Southeast Asia and Japan.
A; Ratio of samples with *A. flavus* and *A. parasiticus* detected.
B; Ratio of samples with aflatoxin-producing fungi detected.
number; the nmbers of the examined samples.

producing fungi in soil in Southeast Asia and Japan is summarized in Fig. 1. It is evident from Fig. 1 that the isolation frequency of aflatoxin-producing fungi in soil becomes higher in the order from subtropical zone to tropical zone. Aflatoxin-producing fungi were isolated at the rate of about 0% in soil samples collected from the northern district of Japan, about 3% from Kyushu district except southern islands, about 10% from Amami islands, about 20% from Okinawa district, and about 30% from the Philippines, Thailand, and Indonesia. It was understood that the northern limit of the natural habitat for the aflatoxin-producing fungi exists somewhere in the south of Kyushu district. It suggests that the distribution of aflatoxin-producing fungi in soils in the world is being influenced by the climate of each regions. As a matter of fact, any aflatoxin-producing fungi were not isolated from the soil samples collected from the highland of about 800 meters above the sea level unlike the samples of the lowland in Indonesia. This fact supports our presumption.

The distribution of aflatoxin and nonaflatoxin-producing fungi in soils and crops in the world should continuously be studied with an aim of reducing the activity of such fungi; e.g., the geographical distribution of aflatoxin-producing fungi in Southeast Asia and Japan indicates the role of natural processes playing in controlling aflatoxin-producing fungi. Cause of strain variations in the ability of fungi to produce aflatoxin, if known, might help developing control measures.

References

1) Kraybill, H. F,. & Shimkin, M. B.: Carcinogesis related to foods contaminated by processing and fungal metabolites. *Advan. Cancer Res.*, **8**, 191 (1964).

2) Manabe, M., et al.: Aflatoxins in imported peanut meals. *J. Food Hyg. Soc. Japan*, **12** (5), 364 (1971) [In Japanese with English summary].

3) Manabe, M. & Matsuura, S.: Studies on the fluorescent compounds in fermented foods. III. Test on aflatoxin cotamination and its possibility on rice. *J. Jpn. Soc. Food Sci. Technol.*, **19** (6), 268 (1972) [In Japanese with English summary].

4) Manabe, M., et al.: Distribution of mycotoxin-producing *Aspergillus* in Japan. *Proc. Jpn. Assoc. Mycotoxicol.*, Nos. 3/4, 31 (1976) [In Japanese].

5) Manabe, M., et al.: Distribution of aflatoxin-producing fungi in soil in Japan. *Trans. Mycol. Soc. Japan*, **17**, 436 (1976) [In Japanese with English summary].

6) Nelson, G. H., Christensen, C. M., & Mirocha, G. J.: Feeds, fungi, and animal health. *Hinn. Sci.* **23**, 12 (1966).

7) Tsuruta, O., & Manabe, M.: Mycological demage of demestic brown rice during storage in warehouse under natural condition. 1. On the damage of brown rice by molds during long-term storage. *Trans. Mycol. Soc. Japan*, **15**, 401 (1974) [In Japanese with English summary].

8) Tsuruta, O. et al.: Survey on mycoflora and aflatoxin of contents imported corn for feeds. *Trans. Mycol. Soc. Japan*, **15**, 258 (1974 b) [In Japanese with English summary].

9) Tsuruta, O., & Manabe, M.: Distribution of aflatoxin-producing fungi in Okinawa, Japan. *Trans. Mycol. Soc. Japan*. **16**, 190 (1975) [In Japanese with English summary].

10) Wogan, G. N.: Chemical nature and biological effects of the aflatoxins. *Bacteriol. Rev.* **30**, 460 (1966).