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Studies on Relationship of Kernels Moisture Content, Percentage of Fungi and Aflatoxin Concentration on Preharvest Maize Kernels

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ABSTRACT

Seven varieties of maize including KS4, KS5, KS6, SW1, SW2, KSX 2301 and KTX 2602 were grown at the National Corn and Sorghum Research Center on July 20, 1987. Maize kernels were randomly collected from ears at 87, 94, 101, 108, 115 and 134 days after planting. Each sample consisted of ten ears, kernels from each ear were collected separately from the base, middle and tip of the ear. Moisture content (MC) of kernels was measured, the kind of fungi and percentage of kernel infection were determined whereas aflatoxin was analysed. The result revealed that kernels collected from all varieties and all parts of the ear at 87 days after planting had over 35% MC. Moisture in kernels was gradually decreased to 25% MC at 115 days after planting. Average values of all fungi found on kernels of all varieties collected at 87 days of the planting were 1 to 2% and *A. flavus* of 1-1.5%.

Percentage of the fungi-infected kernels increased to 15 when kernels collected at 101 days after planting. Among those fungi observed, *Penicillium* species (20%) were predominant while *A. flavus* was at 3.5%. Maize collected from 115 day old plants possessed less fungi and less *A. flavus*. However, more fungi were found on kernels from 134 day old plants. In all varieties, average of detected fungi on kernels collected from the base, middle and tip of the ears were 6.78, 4.76 and 5.11% whereas average percentage of *A. flavus* were 2.7, 1.96 and 1.79, respectively. Aflatoxin was not detected from kernels obtained from all parts of the ear and all varieties of 87 day old plants. However, less than 1 ppb of aflatoxin was found from 115 day old plants. Later, concentration of aflatoxin in kernels collected from all parts of the ear and all varieties of 134 day old plants increased to 5 ppb.

INTRODUCTION

A. flavus can infect the maize kernel through silk, particularly at the base of the ear rather than the middle and tip, under high temperature condition (Anderson, *et al.*, 1975; Jone, *et al.*, 1980; Marsh and Payne, 1984). Similar occurrence has been observed in Thailand (Chana, *et al.*, 1987) but low percentage of infection of *A. flavus* was detected at the base of maize ear. Occurrence of aflatoxin in the field, JICA (1984) reported that only 0.6 ppb of aflatoxin was detected from 30 samples of maize kernels collected from the field while Chana, *et al.* (1987) could not detect any aflatoxin from 216 maize kernel samples by using Velasco Flurotoxin. Aflatoxin in high moisture content (= 18%) maize kernels detected immediately after harvest would exceed 20 ppb within 2 days of storage and the highest level occurred within 7-11 days of storage (Chana,

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et al., 1987). The objective of this study was to determine the relationship of aflatoxin production, moisture content and percentage of the fungi on kernels of preharvest maize.

MATERIALS AND METHODS

Seven varieties of maize including KS4, KS5, KS6, SW1, SW2, KSX 2301 and KTX 2602 were planted in July 1987 at The National Corn and Sorghum Research Center, Nakhon Ratchasima Province. Ten maize ears from each variety were collected at the age of 87, 94, 101, 108, 115 and 134 days after planting. Each ear was divided into 3 parts; base, middle, and tip. Kernels from each part of the ear were detached and measured for moisture content with Protimeter Gramini Model D. 275. Fungi were observed from 200 kernels from each part and variety by using agar plate method. Kernels were surface sterilized with sodium hypochlorite before plating on Malt Salt Agar (MSA), 10 grains/plate. Observation of *A. flavus* was done under stereoscopic microscope after being incubated for 7 days at room temperature with alternate light and dark at 12 hours interval. Aflatoxin was detected through the use of minicolumn chromatography (Karunyawanich, 1982).

RESULTS

Moisture contents of newly-harvested maize kernels of all varieties during 87 to 94 days after planting were higher than 30% and then gradually decreased to 28% on the kernels of 101 day old plant. For SW2 variety, moisture contents of the kernels were 21-27, 18-24 and 16-19% when they were harvested at 108, 115 and 134 days after planting, respectively. (Table 1)

A. flavus was mostly found on maize kernels collected from the base of ears of KS4, KS5, KS6, SW2 and KSX 2301 varieties at the plant ages of 87-134 days. However, in SW1 and KTX 2602, the fungus was mostly found at the middle and top of the ears, respectively. *A. flavus* was detected first on KS5, KS6, SW1, KSX 2301 varieties at 87 days after planting (Table 1) while on KS4 and KTX 2602 varieties, it was found at 94 days (Table 2). Percentage of *A. flavus* infected kernels of seven varieties collected during 108-134 days after planting was in the range of 1-3%. Less than 1 ppb of aflatoxin was detected in maize kernels of 115 day old plants (Table 5), later the number gradually increased up to 5 ppb by the end of experimental period (134 days) (Table 6).

The other species of *Aspergillus* were also found in this experiment including, *A. chevalieri* var. *intermedius* (0.14%) from the middle part of the maize ear harvested from 87 day old plant (Table 1) and *A. niger* (0.57%) from 94 day old plant (Table 2). *A. candidus, A. niger, A ochraceus, A. terreus, A. auricomus, A. amstelodami* were found less than 1% on maize kernels of 101-134 day old plants (Table 6).

Penicillium sp. was found less than 1% on maize kernels from 94 day old plant (Table 2) and later, it increased to 12-17% then decreased to 5-7% when maize kernels were harvested during 101-108 (Table 3, 4) and 115-134 days (Table 5, 6) after planting, respectively.

Fusarium moniliforme was found ranging between 0.14-1.86% on all maize kernels of all varieties and all parts of the ear, harvested from 87-94 day old plants (Table 1, 2). Percentage of infected kernels increased to 17.86-78.71 when collected from the plant during 108-134 days after planting (Table 4-6). The fungus was mostly found on the tip followed by the middle and the base of maize ear.

DISCUSSION

Among the maize kernels of seven varieties, including KS4, KS5, KS6, SW1, SW2, KSX 2301 and KTX 2602 collected from the 87-134 day old plants, it was found that maize kernels collected from 101-108 day old plants had the highest incidence of fungi. *Fusarium moniliforme* was

mostly found from the tip of maize ear with 91% in KSX 2301 variety. In contrast, *Aspergillus* spp. was mostly found at the base of maize ear, especially *A. flavus* was predominantly found with 7% infection in KS4. This results indicated that *A. flavus* could infect maize ear from the milky stage to the harvest period and the kernels harvested from base of maize ear of KS4, KS5, KS6, SW2 and KSX 2301 varieties showed higher level of *A. flavus* infection than kernels from the middle and tip (Chana, *et al.*, 1987; Jone *et al.*, 1980). For SW1, *A. flavus* infected kernels were mostly found at the middle part of maize ear in contrast to the KTX 2602 which infected kernels were mostly obtained from the tip of ear. This might be attributed to the differences in genotypes that control the formation of pericarp and aleurone layer in different varieties as mentioned by Wallin (1986).

Harvesting period might relate to the infection of *Aspergillus* spp. on maize kernels since kernels harvested from 108 day old plant were mostly infected by *Aspergillus* spp. At this harvesting period, the level of moisture content in the kernels was rather high (21-27%) which was the most favorable condition for the growth of *Aspergillus* spp., especially *A. flavus* (Sauer and Burroughs, 1980). Aflatoxin could not be detected from maize kernels harvested from 87-108 day old plant while it could be detected from the base of maize ear of 115 day old plant and gradually increased till the end of the experiment. This could be explained by the work of Chanplung (1986) and Lee, *et al.*, (1966) which indicated that production of aflatoxin by *A. flavus* required sufficient period of time for the process.

CONCLUSION

Asperfillus flavus could infect maize kernel during 87-134 days after planting. However, infection percentage was rather low with the average value of about 2% and aflatoxin was undetected during 87-108 days of plant age. Low level of aflatoxin (less than 1 ppb) was detected from maize kernels collected from the ear base of the 115 day old plant and this increased up to 5 ppb from kernels of 134 day old plant. The maize kernels of 7 varieties from 101-108 day old plants showed the highest incidence of *Aspergillus* spp. Among seven varieties tested, *A. flavus* infected kernels were mostly obtained from the base of ear of KS4, KS5, KS6, SW2 and KSX 2301 whereas in SW1 and KTX 2602, they were mostly found on the kernels from the middle and tip of maize ear, respectively.

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