

Physical Prevention of Aflatoxin Contamination of Maize by Solar Drying

Koro Kato¹, Chintana Chana², Somsiri Sangchote²,
Ronnappop Bunjoedchoedchu³

ABSTRACT

Three types of solar dryers were constructed by using inexpensive local materials for drying the corn kernels. Aflatoxin and *Aspergillus flavus* were not detected from the dehusked corn dried in the two stationary layers of corn ears on the solar dryer No. 1. Moisture content of the kernels ranged 15-16 % within 9 days of drying. When dehusked corn ears and shelled corn kernels were dried on the solar dryer No. 2 with two layers of corn ears and 4-cm-thick respectively, *A. flavus* and aflatoxin were detected only from the latter samples. The best result was obtained from the dehusked and shelled corn dried on the solar dryer No. 3 in which the drying floor was elevated up to 0.3 m over the cement floor. Moisture content of the corn kernels was reduced to 15 % within 2 sunny days, whereas *A. flavus* and aflatoxin were non-detectable.

INTRODUCTION

Over 20 ppb of aflatoxin was usually detected in the corn kernels harvested during rainy season (Chana *et al*, 1988 a,b). Reduction of the kernel moisture content from 23-30 % to 14 % which is the acceptable level for non-aflatoxin production always face the problem of unpredictable rain. Recommendations proposed by the Department of Agricultural Extension (DAE) in order to solve the aflatoxin problem include hanging of the whole ears (with husk) or piling dehusked ears on the ground floor of the house. However, aflatoxin was usually detected in corn kernels obtained from the large pile, especially at the center or bottom of the pile. Using seed dryer for drying corn kernels or dehusked corn is another possible effective procedure to reduce the moisture content in kernels. This study was conducted in order to construct the various types of solar dryer by using inexpensive and locally available materials.

MATERIALS AND METHODS

Two tons of dehusked corn harvested from Pak-hong field were transported to Kamphaengsaen Campus, Nakhon Pathom for using in this study.

Three types of solar dryers (SD No. 1, 2 and 3) were constructed in different sizes and composition. SD No. 1 was 3.0 x 6.0 x 1.5 m in size with 0.2 m of drying shelf over the soil. The shelf was made of bamboo lattice set and covered with black vinyl sheet. For the roof, bamboo lattice set was covered with clear plastic (Fig 1 and Table 1). Six hundred kilograms of dehusked corn were scattered over the shelf with two stationary layers of corn ears. The size of SD. No.2 was 2.8 x 5.0 x 1.0 m and constructed in the same manner of SD No.1 except that black vinyl sheet covering the shelf was spread with 150 kg of dehusked corn with two stationary layers of corn ears (10-cm-thick) whereas the remaining area was used for distributing the 360 kg of shelled corn kernels with 4-cm-thick. SD. No. 3, was 2.4 x 2.6 x 1.25 m in size with 0.3 m of drying shelf over the cement floor. The roof was similar to SD No. 1 and 2 except for non-covering portion, 0.3 m distant from the end of the roof for rapid air circulation (Fig. 1 and Table 1). Total space of the shelf was equally divided into three parts. Shelled corn kernels (45 kg) with 2-cm-thick, newly harvested dehusked corn (60 kg; A) and old dehusked corn (60 kg; B), each with two stationary layers of corn ears (10-cm-thick) were scattered over the divided space.

1 Faculty of Agriculture, Kyoto University, Kyoto, 606 Japan

2 Department of plant pathology, Kasetsart University, Bangkok, Thailand

3 Department of plant pathology, Kasetsart University, Kamphaengsaen Campus, Nakorn Pathom, Thailand

Table 1 Dimensions of solar dryers

Set up place floor	Solar dryer 1	Solar dryer 2	Solar dryer 3
	ground Black vinyl	ground Bamboo lattice	concrete Bamboo lattice
height (m)	1.5	1.0	1.25
width (m)	3	2.8	2.4
length (m)	6	5	2.6
area (m ²)	18	14	6.2
dehusked corn (kg)	600	150	120
shelled kernel (kg)	-	360	45

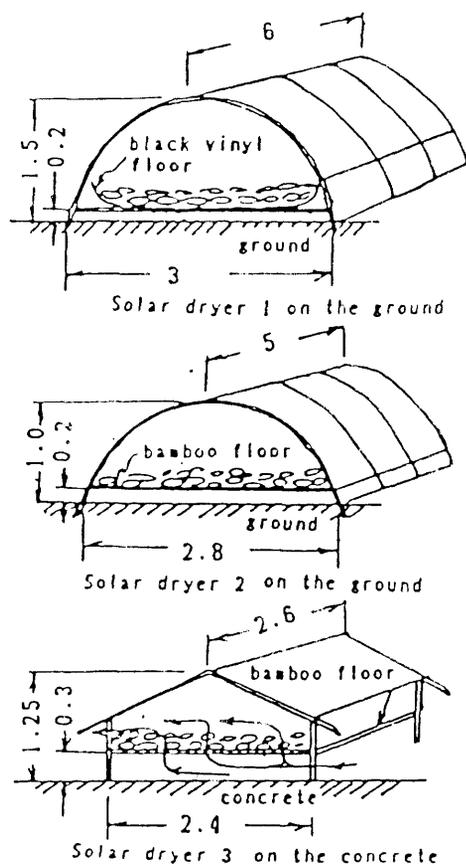


Fig. 1 Drawing of solar dryers

Ten corn ears and 0.5 kg of kernels were sampled daily during October 6-17, 7-17 and 14-23 from the SD. No. 1, 2, and 3, respectively. Moisture content was measured and the kind and percentage of storage fungi were determined. Kernels were surface disinfested with 1 % NaOCl, for 5 minutes, rinsed three times in sterile distilled water, blotted dry with filter paper before transferring to malt salt agar (10 seed/plate) and incubating under daylight fluorescent (40 watts), 12 hr/day at room temperature. Percentage of *A. flavus* were determined under stereomicroscope. Aflatoxin concentration in corn kernels were detected by using thin layer chromatography (TLC) procedure as described by Bunjoedchoedchu (1987).

RESULTS AND DISCUSSION

Within 4 days of drying in the SD. No. 1, moisture content in dehusked corn kernels was markedly decreased from 26.0 % to 17.7 %. However, fluctuation of moisture content occurred after the fourth day of drying by increasing to 20.6 % then decreased to 15.0 % at the ninth day. Moisture content in the cob was constantly decreased throughout the period of drying from 46.7 % to 21.6 % within 11 days (Fig. 2). Percentage of *A. flavus* on kernels was 0.5, while aflatoxin was non-detectable (Table 2).

Moisture content of dehusked corn dried in the SD No. 2 decreased from 26.1 % to 22.4 % within 4 days whereas reduction of moisture content in the shelled corn kernels from 26.0 % to 18.4 % was observed. Levels of moisture content remained constant in spite of rain then decreased to 13.2 % at 11 days after drying (Fig. 3). Percentage of kernels infected with *A. flavus* and aflatoxin production from the dehusked corn were similar to those found in corn dried in SD. No. 1. For the shelled corn kernels, 6 % of *A. flavus* infection and 18 ppb of aflatoxin were

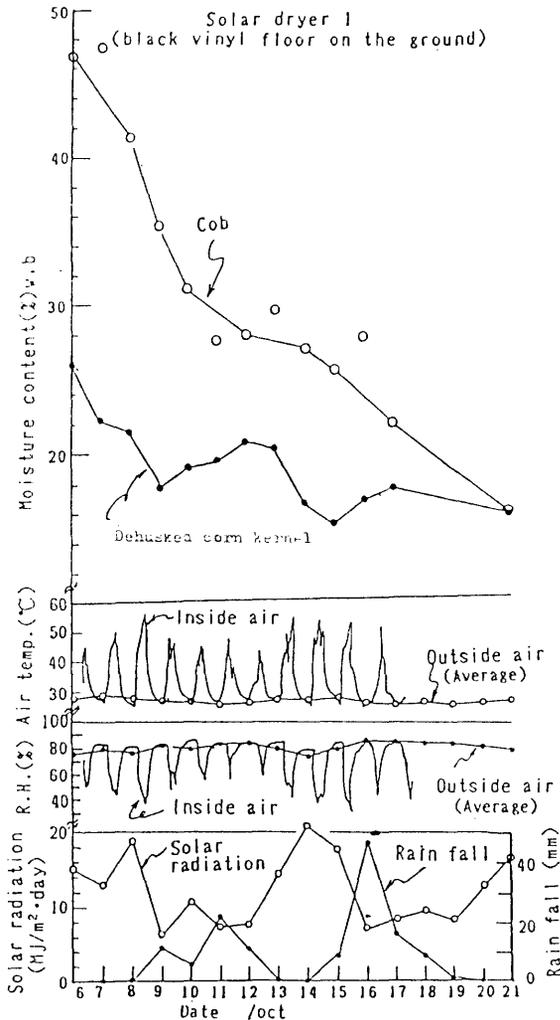


Fig. 2 Moisture content of corn in solar dryer 1 and weather condition.

found at the second day of drying. Percentage of infection and aflatoxin production raised up to 100% and 1,050 ppb, respectively at 8 days of drying (Table 3). This results indicated that once the corn kernels were infected with *A. flavus*, reduction of moisture content was unable to reduce the loss.

By using SD. No. 3, the reduction of moisture content in dehusked corn was similar to those dried in the SD. No. 1 whereas the moisture content of shelled corn kernels drastically decreased from 25.0% to 15.1% within 2 days (Fig. 4). This was attributed to the hot air produced over the cement floor circulated under the shelf and this circulation accompanied with wind which accelerated the reduction of moisture content. Aflatoxin and *A. flavus* infected kernels could not be detected from both dehusked and shelled corn by drying on this seed dryer (Table 4).

The results of this investigation indicated that drying of corn kernels under the solar dryers for less than 2 days could significantly limit the increase of aflatoxin production. However, under rainy period, high moisture condition potentially cause the increase of aflatoxin, which was similar to the result previously reported by Puangsuwan, *et al.* (1988). Moreover, our finding showed that storing of dehusked corn gave superior result to the shelled corn since low concentration of aflatoxin was detected from dehusked corn. This study also supported the results of Puangsuwan *et al.* (1988) which reported that only 21 ppb of aflatoxin was obtained from 2 to 14-days-storage of dehusked corn collected from farmer's storehouse whereas over 3-days-transporting shelled corn revealed 239 ppb of aflatoxin.

Table 2 Aflatoxin concentration and percentage of *Aspergillus flavus* in corn stored in solar dryer No. 1

Date's sampling	Dehusked corn kernel	
	aflatoxin(ppb)	<i>A. flavus</i> (%)
7 Oct. 88	0	0
8 Oct. 88	0	0
9 Oct. 88	0	0.5
10 Oct. 88	0	0
11 Oct. 88	0	0
12 Oct. 88	0	0
13 Oct. 88	0	0.5
14 Oct. 88	0	0
15 Oct. 88	0	0
16 Oct. 88	0	0
17 Oct. 88	0	0

Table 3 Aflatoxin concentration and percentage of *Aspergillus flavus* in corn stored in solar dryer No. 2

Date	Aflatoxin (ppb)		<i>A. flavus</i> (%)	
	Dehusked corn kernel	Shelled kernel	Dehusked corn kernel	Shelled kernel
8 Oct. 88	0	0	0	0
9 Oct. 88	0	18	0	6
10 Oct. 88	0	123	0.5	14
11 Oct. 88	0	250	0	50
12 Oct. 88	0	483	0	98
13 Oct. 88	0	677	0	100
14 Oct. 88	0	1050	0	100
15 Oct. 88	0	530	0	100
16 Oct. 88	0	609	0	100
17 Oct. 88	0	580	0	100

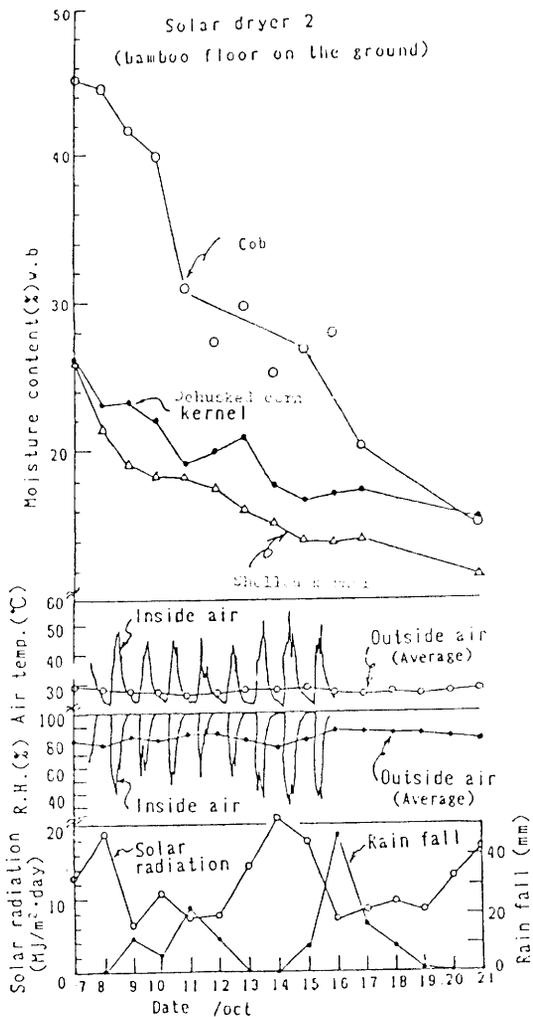


Fig. 3 Moisture content of corn kernels in solar dryer 2 and weather condition.

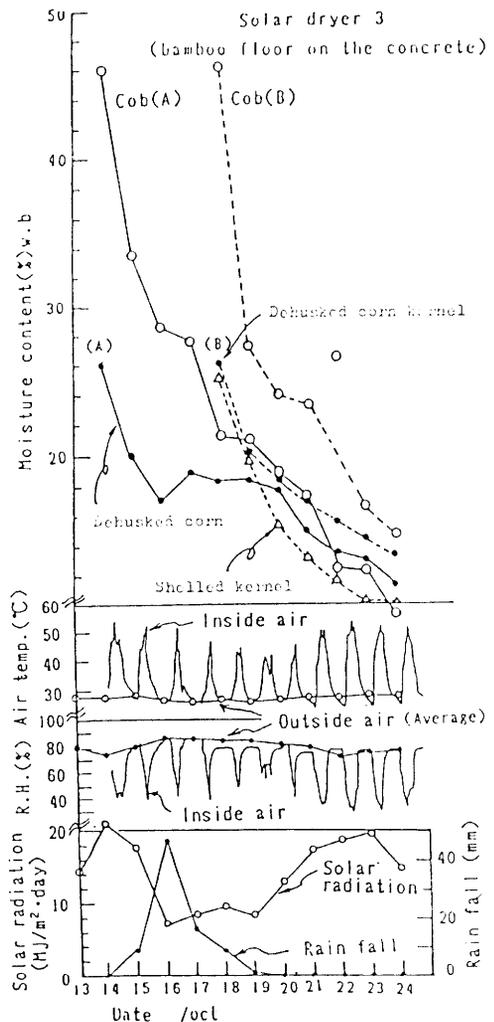


Fig. 4 Moisture content of corn in solar dryer 3 and weather condition.

Table 4 Aflatoxin concentration and percentage of *Aspergillus flavus* in corn stored in solar dryer No. 3

Date	Aflatoxin (ppb)			<i>A. flavus</i> (%)		
	Kernel A	Kernel B	Shelled kernel	Kernel A	Kernel B	Shelled kernel
	14 Oct. 88	0	-	-	0	-
15 Oct. 88	0	-	-	0	-	-
16 Oct. 88	0	-	-	0	-	-
17 Oct. 88	0	0	0	0	0	0
18 Oct. 88	0	0	0	0	0	0
19 Oct. 88	0	0	0	0	0	1
20 Oct. 88	0	0	0	0.5	0.5	0
21 Oct. 88	0	0	0	0	0	0
22 Oct. 88	0	0	0	0	0	0
23 Oct. 88	0	0	0	0	0	0

kernel A = new dehusked corn kernel

kernel B = old dehusked corn kernel

LITERATURE CITED

- Bunjoedchoedchu, R. 1987. Storage molds, aflatoxin in maize and their chemical control. M.S. Thesis. Kasetsart University, Bangkok. (in Thai)
- Chana, C., P. Hamelink, C. Chamswarn, S. Sangchote U. Farungsang, R. Bunjoedchoedchu and U. Ongsakul. 1988 a. The studies of aflatoxin of newly-harvested maize kernels with various levels of moisture. Report of 19th National Corn and Sorghum Conference, Surat Thani, Thailand 5 pp. (in Thai)
- Chana, C., P. Hamelink, C. Chamswarn, S. Sangchote U. Farungsang, R. Bunjoedchoedchu and U. Ongsakul. 1988 b. The investigation of the effect of maize varieties on post-harvest aflatoxin concentration. Report of 19th National Corn and Sorghum Conference, Surat Thani, Thailand 5 pp. (in Thai)
- Puangsuwan, D., P. Tanbun-ek, P. Siriacha, A. Wongurai, K. Puthasamai, C. Nakler and S. Thitathan. 1988. Control of Aflatoxin in Maize. Dept. of Agriculture. 63 pp.