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THE ROLE OF POSTHARVEST MACHINERIES AND PACKAGING IN MINIMIZING AFLATOXIN CONTAMINATION IN PEANUT

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ABSTRACT

As a tropical country with relatively high humidity and temperature, Indonesia is struggling with aflatoxin which frequently contaminates peanut. Aflatoxin is a carcinogenic toxic substance that could cause liver cancer. Due to the increasing concern on food safety, the Indonesian Drugs and Foods Agency specifies the maximum aflatoxin allowed in peanut as much as 20 ppb. However, researches showed that aflatoxin contamination in peanut in Indonesia is much higher than the threshold. The study was carried out to observe the effect of using postharvest machineries and packaging treatments on aflatoxin contamination in peanut. Reduction of postharvest processes was conducted by using series of machineries, e.g. thresher, dryer, and sheller. Packaging treatments, e.g. vacuum plastic pack, hermetic glass chamber, and polyethylene (PE) plastic wrap were carried out during storage at ambient temperature (25-27°C). The results showed that using machineries in postharvest handling produced peanut free from aflatoxin contamination. However, without effective packaging, the aflatoxin level would increase during storage. Hermetic packaging could protect peanut from the mold as indicated by low level of aflatoxin contamination.

[***Keywords***: Peanuts, aflatoxin, postharvest machinery, packaging]

INTRODUCTION

Peanut is one of the most important agricultural commodities in Indonesia, and mostly cultivated by small farmers. The total harvest area of peanut in 2004 was 624,200 ha with the total production of 837,495 tons (CBS 2005). The number has not been able to meet the national demand, thus the country is still importing peanut. Import of peanut in 2002 amounted to 119,496 tons of dried seeds, whereas export of processed food noted 40,000 tons. Import of peanut grows on average of 100,575 tons or 43.74% yr^{-1}, and export of processed food of peanut grows on average of 2,115 tons or 193.84% yr^{-1} (CBS 2003).

Peanut is susceptible to mycotoxin. Dharmaputera *et al.* (1995) and Fardiaz (1995) reported that in public markets, aflatoxin level in peanut is much higher than the Codex requirement of 15 ppb. In Indonesia, BPOM (Indonesian Drugs and Foods Agency) regulates the maximum aflatoxin contamination in peanut as much as 20 ppb for aflatoxin B1 and 35 ppb for total aflatoxin (B1, B2, G1+G2) (Rahayu and Sparingga 2006). In some peanut products such as peanut butter, *pecel* condiment (*pecel* is a traditional Indonesian salad), and snacks made of peanuts, the aflatoxin level is also high (Fardiaz 1995).

Aflatoxin is a secondary metabolite produced by *Aspergillus flavus* and *Aspergillus parasiticus*, and sometimes by *Aspergillus clavatus* (Lopez-Diaz and Flannigan 1997). Mycotoxin frequently contaminates peanut and corn (Fardiaz 1995), and sometimes also rice, wheat, and other grains stored in unfavorable condition (Hell *et al.* 2000). It is not easy to identify the contaminated nuts and noncontaminated nuts (Dharmaputra *et al.* 1995).

Aflatoxin is potential to cause liver damage, cirrhosis, and liver cancer (Hongkong Food and Environmental Hygiene Department 2001), and aflatoxin B_1 is the most dangerous toxin for both animal and human health (Syarief *et al.* 2003). Aflatoxin has been recognized as a substance that retains to high temperature. Researchers are struggling to overcome the negative effects of aflatoxin B_1 by added promising natural substances or microorganisms such as soybean paste, lactic acid, and antagonist fungi of *A. flavus* (Bata and Latsztity 1999; Henry *et al.* 1999; Kim *et al.* 2003).

Aspergillus is a cosmopolite mold, therefore peanut beans have already contaminated since they are in the ground. However, the mycotoxin is produced when the mold being stress by severe change of temperature and humidity (Syarief *et al.* 2003). Such as it is, aflatoxin is normally produced after harvest. On very hot and dry condition, aflatoxin could be formed while the nuts are still inside the ground. Molds are frequently formed spores to protect themselves from unfavorable environmental condition, such as low

relative humidity and low water activity. The spore is resistant to very dry condition. When the environmental condition is altering into favorable condition, the mold grows. Based on the aforementioned information, postharvest handling has to be conducted rapidly. Harvest is frequently followed by drying until the moisture content of peanuts is unfavorable for the bats. The combination of moisture content in materials, high temperature and high relative humidity is an appropriate condition for the formation of aflatoxin. Therefore, extratreatment is needed for the peanut since the cultivation preparation.

Biologists use the antagonist *A. flavus* mold to decrease *A. flavus* growth. Agronomists keep on trying to solve the aflatoxin problems from the aspects of agronomic technology, starting from the breeding of aflatoxin-resistant peanut seeds, control of planting pattern including shifting planting, planting time or planting distance, control of pests and diseases and irrigation (Rahmianna and Ginting 2003). All are aimed at obtaining healthy peanut plants hence they would not be easily attacked by either *A. flavus* or *A. parasiticus* at the same time to prevent the molds from forming any aflatoxin when they are still in the soil. Harvest should be done at a proper time (Rahmianna and Ginting, 2003). Paramawati (2003) noted that quick postharvest handling could reduce the contamination of aflatoxin on peanut.

When peanuts are intended to be used as kernels, the peeling process needs to be conducted rapidly. Kernels are easily infected by *A. flavus* and *A. parasiticus* because there is no more natural protection. Therefore, kernels need to be stored in packaging to protect them from mycotoxin contamination during storage. The objective of the study was to observe the effect of using postharvest machineries and packaging treatments on aflatoxin contamination in peanut.

MATERIALS AND METHODS

Materials

Peanuts used in the study originated from farmers in Sragen (Central Java), Central Lampung, and Serpong Banten (Farm Laboratory Testing of the Indonesian Center for Agricultural Engineering Research and Development/ICAERD). The peanut was a local variety having two kernels each pod. Cultivation was carried out as commonly practiced by farmers, i.e. 5-7 times watering if there is no rain along the cultivation period and one time application of chemical fertilizer.

Methods

Postharvest were conducted by mechanized process and traditional process. Mechanized process was done by applying machineries (thresher, dryer and sheller) (Fig. 1), while traditional process was by hand and sun drying as commonly applied by farmers. Using machineries are intended to quicken the postharvest process, therefore the fungus has not got enough time to produce aflatoxin. All machineries were designed and manufactured by ICAERD.

The study was carried out on ready-to-harvest peanut (90-day old) which is the ideal harvest age and on 105-day old peanut plants which represents prolonged harvest age (late harvest). The harvest methods consist of wet harvest (in Sragen) and dry

Thresher Flat bed dryer Sheller

Fig. 1. Postharvest process of peanut by machineries in the farm level.

harvest (in Central Lampung). On the wet harvest, the plants were soaked in water for over night to yank out the plant easier, while dry harvest did not use any water before harvest (Fig. 2). Three samples (1 kg kernel) from each treatment were analyzed for aflatoxin B_1 contamination using Thin Layer Chromatography (TLC) method. Samples were wrapped by PE and analyzed in the day 1 and day 30.

Packaging-storage treatments were conducted by three types of packing materials, i.e. hermetic packaging (glass, air tight chamber), vacuum packaging (conventional polyethylene plastic PET/PE laminated) and PE, a common packaging as a control. Each packaging contained 1 kg kernels and stored at ambient temperature (25-27°C) for 1 month. Aflatoxin B_1 was measured in the first day storage and at the end of the storage. The research was replicated three times.

RESULTS AND DISCUSSION

Effect of Reducing Postharvest Processes

The result showed that reducing postharvest processes avoided aflatoxin B_1 contamination on peeled peanut (kernels). On wet harvest with ideal harvest age (90 days), where the plants were soaked in water during harvesting period, aflatoxin was not identified in all samples. That result also found in the dry harvest, which was no aflatoxin B_1 in accelerated postharvest process (Table 1). The minimum detection limit of aflatoxin by TLC method is 4 ppb. Under 4 ppb, it could be assumed that the sample is free from aflatoxin. Aflatoxin B_1 was found in manual postharvest process both of wet and dry harvest methods. The results is coherent with the theory which stated that in normal condition, aflatoxin would

Fig. 2. Peanut harvest by wet method (left) and dry method (right).

Table 1. The influence of accelerated process on the aflatoxin B_1 level in peeled peanut.

Harvesting method	Harvesting age (days)	Type of postharvest handling	Aflatoxin B_1 contamination (ppb)
Wet method	90	Accelerated postharvest processes by using machineries	Undetected
Wet method	90	Manual postharvest processes (without machineries)	6.62
Dry method	90	Accelerated postharvest processes by using machineries	Undetected
Dry method	90	Manual postharvest processes (without machineries)	12.33
Dry method	105	Accelerated postharvest processes by using machineries	Undetected
Dry method	105	Manual postharvest processes (without machineries)	18.23

be formed in 24 hours after peanuts were pulled from the ground on dry harvest method with prolonged harvest age (105 days). Samples produced by accelerated postharvest processes were also free from aflatoxin B_1. The result was proof of the statement that accelerated process eliminates the possibilities of *Aspergillus* from producing aflatoxin B_1.

Manual postharvest method produced aflatoxin B_1 contamination as much as 6.62 ppb for wet harvest and 12.33 ppb for dry harvest on harvest age of 90 days, and 18.23 ppb for dry harvest on harvest age 105 days. Basically, mold needs a relatively high water activity (a_W) (>0.70) for its growth (Syarief *et al.* 2003). Peanut harvested by wet method produced higher water activity compared to those harvested by dry method. However, in field, the contrary fact was found. Peanut harvested by wet method had lower aflatoxin contamination compared to those harvested by dry method. In this case, we may conclude that harvest method does not significantly influence the level of aflatoxin, but harvest age significantly influences the level of aflatoxin. On prolonged harvest age (105 days), aflatoxin contamination was relatively high, probably because few peanuts have already peeled naturally (as a preparation for germinating process). On such condition, mycotoxin easily invested the nuts and metabolized in dry condition (low a_W) to produce aflatoxin.

Effect of Storage Treatment

Kernels harvested with wet method (90-day old) and dry method (105-day old) were stored in room temperature for 1 month. The results showed that aflatoxin B_1 level increased both on peanut harvested by wet method (7.89 ppb) and dry method (12.03 ppb) (Table 2). It means that although the aflatoxin B_1 level was initially undetected, during storage, *A. flavus* or *A. parasiticus* might produce spores prior to drying. On favorable condition, the spores were growing into molds. The limited environmental condition would induce the production of aflatoxin. From this fact we may conclude that accelerating postharvest process should be continued by packaging process to protect the peeled peanuts from unfavorable environmental condition.

Effect of Packaging

After one month storing, peanuts stored in hermetic and vacuum packaging have lower aflatoxin level compared to control (Table 3). On hermetic packaging, there is no air transfer from the environment into the packaging and

Table 2. Increasing aflatoxin B_1 contamination on peeled peanut during storage.

Treatments	Aflatoxin B_1 contamination (ppb)	
	First day storage	1-month storage
Wet harvest, 90-day old, accelerated process	Undetected	7.89
Wet harvest, 90-day old, manual process	6.62	7.88
Dry harvest, 105-day old, accelerated process	Undetected	12.03
Dry harvest, 105-day old, manual process	18.23	19.90

Notes: Samples were wrapped by polyethylene (PE) plastics and stored at room temperature (25-27°C).

Table 3. The influence of packaging on the aflatoxin B_1 level in peeled-peanut during storage.

Type of packaging	Packaging materials	Aflatoxin B_1 contamination (ppb)	
		At the First day storage	After 1-month storage
Hermetic	Glass, air tight chamber	Undetected	Undetected
Vacuum	Conventional plastic PET/ PE laminated	Undetected	7.89
Control	Conventional plastic polyethylene	Undetected	12.03

from the packaging into the environment because the permeability of glass is very small (nearly zero). Such as it is, the inside condition of the packaging is very stabile and relatively lack of oxygen. Increasing the moisture content due to respiration process could be minimizing by inserting silica gel sachet prior to sealing.

On hermetic packaging, the initial condition of peeled peanut could be maintained well. Meanwhile, after 1 month of storage, vacuum packaging treatment still resulted in increment of aflatoxin B_1 level although the level was still safe (<20 ppb). The vacuum packaging (made of PET/PE) has permeability that air transfer from the packaging to the environment and from the other side is still possible.

CONCLUSION

The use of machineries to accelerate postharvest processes could produce peeled peanut with undetected aflatoxin B_1 level. However, without further protection through effective packaging or container, the molds could produce aflatoxin during storage. Compared to polyethylene and vacuum packaging (PE/PET), hermetic packaging provides a good solution to achieve low aflatoxin level after storage.

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