# Study on Prevention of Aflatoxin Contamination in Groundnut by Accelerated Post-harvest Processes

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Groundnut is one of important food crop commodities in Indonesia, which is susceptible to aflatoxin contamination. In tropical developing countries like Indonesia, *Aspergillus flavus* and *Aspergillus parasiticus*, both are cosmopolite fungals, growing in groundnut may produce aflatoxin B1, a suspected potential human carcinogen. Sampling of groundnut at some commercial level at 5 districts of 5 provinces showed different contamination levels at farm and market, viz. about 0-26.65 ppb and 6.60-49.98 ppb, respectively. In this study, an experiment by introducing machineries on post-harvest processing of groundnut was carried out to observe the aflatoxin contamination compared to the traditional technologies that farmers have been applying. Machineries used consist of groundnut thresher, flat bed dryer, groundnut sheller and vacuum packing sealer. The aflatoxin content at groundnut was analyzed by thin layer chromatography (TLC) method. Result showed that speeding up the post harvest processing activities resulted in absence of aflatoxin contamination within the groundnut. In contrast, traditional processing technologies resulted in the presence of aflatoxin in high contamination level. This experiment also noted that the hermetic storage of groundnut showed better result than the vacuum pack storage.

Key words: Groundnut, Aflatoxin, Prevention, Machinery, Storage
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## Introduction

Groundnut is one of quite important dry-land crops commodities in Indonesia. Groundnut statistics shows continuous increase with the average production growth rate of 3.7% in the last 5 years. Although the potential to produce this groundnut in Indonesia is quite high, however in reality the existing production is not able to meet domestic needs, hence it must import this commodity. Data noted the import of groundnut amounting to 119,496 tons dried seeds in 2002, whereas export in the form of processed food noted 40,000 tons (Anonim, 2003). On the national scale, import of groundnut grows on average by 100,575 tons or 43.74% per year, and the export of processed food based of groundnut grows on average 2,115 tons or 193.84% per year (Anonim, 2003). However, the export has to face the constrain of high level aflatoxin contamination. Sampling of groundnut at some commercial level at 5 districts of 5

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provinces showed different contamination levels at farm and market, viz. about 0-26.65 ppb and 6.60-49.98 ppb, respectively.

Aflatoxin is a secondary metabolite produced by molds of *Aspergillus flavus and Aspergillus parasiticus*. This mycotoxin is mostly found to contaminate the groundnut and maize commodities (Fardiaz, 1995). However, sometimes also find on *Aspergillus clavatus* (Lopez-Diaz and Flannigan, 1997). There are not easy to diferrentiate between no contaminated-nuts and contaminated-nuts (Dharmaputra *et al*., 1995). For human being, continuous consumption despite in a little dose may cause liver cancer. It is predicted that aflatoxin in groundnut, maize and spices causes 2300 deaths induced by liver cancer in Indonesia; whereas for domestic animals, it will cause interferences to the quantity and quality of the consuming animals. Observation carried out by Pang *et al*. (1974) to 71 liver-cancer patients in Jakarta, reported that aflatoxin was found within the urine of 94% patients. Results of research in 3 ASEAN countries report a total loss of 400 million US$ per year due to the decreasing productivity of animal farming because the foods are contaminated by aflatoxin. Besides, residue of aflatoxin in animals will also endanger the consuming human being.

Researchers reported that the conditions to form an aflatoxin are at temperature 10-40$^0$C and RH >80% (Syarief and Halid, 1993). Indonesian climate article, a relatively high temperature and humidity, is very suitable for the formation of such toxic compound. Therefore, the groundnut commodity in Indonesia is highly susceptible to the contamination of aflatoxin. The standard of CODEX Alimentarius for the limit of aflatoxin in groundnut that may be consumed by human being is 15 ppb, however FDA has higher limit, namely up to 20 ppb. Some researches reported that the content of aflatoxin ($B_1$) in groundnut in the market may reach hundreds to thousands ppb (Syarief *et al*., 2003). Aflatoxin $B_1$ is one of the most dangerous type of aflatoxin due to its highest toxicity.

The combination of moister content in materials, high temperature and high RH surrounding is an appropriate condition for the formation of aflatoxin. Therefore, extra treatment is needed for the groundnut since the cultivation preparation. Agronomist keeps on trying to solve the aflatoxin problems from the aspects of agronomic technology, starting from the breeding of aflatoxin-resistant groundnut seeds, control

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of planting pattern from the aspects of shifting planting, planting time or planting distance, control of pests and diseases and irrigation which meets the requirements (Rahmianna and Ginting, 2003). All are aimed at obtaining healthy groundnut plants hence they would not be easily attacked by either *A. flavus* or *A. parasiticus* molds at the same time to prevent the molds from forming any aflatoxin when they are still in the soil. Therefore, it is expected that the produced groundnut will be clean from aflatoxin since the beginning after harvest.

The objective of this research is to determine the effectiveness of the accelerated post-harvest processes in order to prevent aflatoxin contamination, and to assess the suitable storage packaging.

## Materials and Method

**Materials.** The main materials used in this research are groundnut from farms in Sragen, Central Java (Farmer field) and Serpong, Banten (Farm Laboratory Testing of ICAERD). Research was carried out in ready-for-harvest groundnut aged 90 days (ideal harvest age, Sragen), and 105 days (prolonged harvest age, Serpong).

**Methods.** Comparing postharvest handling, starting from harvest until packaging of peeled nuts, carried out between daily treatments by farmers with speeding up post-harvest handling process. The speeding up process was carried out by using (1) groundnut thresher; (2) flat bed type dryer, and (3) groundnut sheller. Packaging was carried out by a vacuum method, hermetic method and without treatment as control. Hermetic packaging uses air-tight glass chamber, whereas vacuum packaging uses conventional plastic packaging constituting PE/PET lamination. Packaging experiment was carried out by storing for 1 month. In each phase of activity, the content of aflatoxin is measure by using tin layer chromatography (TLC) method in samples with 3 to 5 replications.

## Results and Discussion

Experiment on speeding up postharvest handling process was carried out by comparing the aflatoxin contamination level between the processes which use processing machine and traditional process which is in general manual carried out. The experiment, also compared the age level of harvest between the on-time harvest age and delayed harvest age. As a note, the harvest in Sragen use the wet method, namely

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the groundnut plants are watered first before harvest. Whereas the harvest method in Serpong uses the dry method, namely the plants are directly pulled without watering. Data of experiment can be seen in table 1.

In general, the formation of aflatoxin almost occurs after harvest, unless serious drought takes place or the plants are unhealthy. Results of this research is promising to minimize contamination of aflatoxin through using the agricultural machineries on postharvest handling processes. Speeding up the process, even with relatively simple equipment that might applicable at the farmer level, is proved to produce aflatoxin-free groundnut. Besides, sun-drying at farmers level in some survey locations succeeded in reducing contamination of aflatoxin if the intensity of sun rays is quite high.

Table 1. Effects of speeding up postharvest handling process upon contamination of aflatoxin

| Harvest method | Harvesting age (days) | Type of postharvest handling | Aflatoxin (ppb) |
|---|---|---|---|
| Wet Method | 90 | (1) groundnut thresher; (2) flat bed-type dryer and (3) groundnut sheller. Quality sortation was carried out | FA |
| Wet Method | 90 | Tradional-farmer method (without any machineries). Quality sortation was not carried out | 6.62 |
| Dry method | 105 | (1) groundnut thresher; (2) flat bed-type dryer, and (3) groundnut sheller. Quality sortation was carried out | FA |
| Dry method | 105 | (1) groundnut thresher; (2) flat bed-type dryer, and (3) groundnut sheller. Quality sortation was not carried out | 18.23 |

Notes: Quality sorting was carried out by choosing visually good groundnuts
FA: free from aflatoxin contamination

Drying process that commonly carry out by farmers is traditionaly sun-drying. During dry season, in which the sun rays at all daylight hours, its requires 3 through 4 days. The moisture content decreases from 27-40% (wet basis) to 8-10% (wet basis). This method is considered the cheapest, however long time process, high humidity and quite conducive temperature, may trigger the growing of *A. flavus*. Molds will grow fast in high activity water (Aw, the amount of free water used by microorganism to grow). The longer drying time is, the more advantageous the growth of molds. Therefore, immediate drying need to be carried out in a relatively short time.

Introduction machineries in groundnut postharvest handling process tried in the wet-harvest system (with soaking of area), showed that the speed up process may prevent the formation of aflatoxin. Use of thresher, dryer and sheller have produced aflatoxin-free groundnuts both on groundnut with shell (pod) or without shell (peeled groundnut). Results of aflatoxin tested by TLC method showed there are no aflatoxin detected in all samples. In technical definition, being undetected means the contamination is below 4 ppb, which means 0, 1, 2 or 3 ppb. This is called in this paper as free aflatoxin (FA). Whereas using tradional farmer method noted the contamination of aflatoxin at 6.62 ppb in pod.

Experiment in dry-harvest system, carried out on groundnut aged more than 100 days, produces groundnut without shell whose aflatoxin exposure is undetected. From the same process, samples are taken without any selection of physical appearance quality. These samples produce average contamination of aflatoxin of 18.23 ppb. This phenomenon indicates that old harvest age (delayed harvest) with bad plant and bad environmental conditions (dry and high temperature) has caused the formation of aflatoxin since groundnut is still in the soil. However, groundnuts with good physical appearance show no contamination of aflatoxin, despite the fact that the environment is contaminated.

From the entire process, drying constitute the most critical phase processing for aflatoxin formation. Therefore, the speed up drying process becomes the most important factor in preventing high aflatoxin contamination. Drying does not have to use machinery. Drying under sun ray at quite high intensity and quite low relative humidity will accelerate the water evaporation process. Table 2 shows that immediate drying under the sun ray at relatively high temperature and low RH is able to accelerate the reduction of water content in groundnut up to the safe condition (below 10 ppb aflatoxin contamination).

Molds usually form spores to protect themselves from extinction, when the environmental conditions are not conducive to multiply. Spores is very resistant to any drought. When the condition becomes conducive for the growth of molds, the spores will start to grow to be molds. Based on this theory, drying must be accompanied with other fast postharvest handling. Therefore, immediately after drying, if the products will be marketed in peeled form, fast peeling must be carried out. Manual peeling will

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take a long time, and the peeled groundnuts will more easily contaminated by molds that grew from spores. Mechanical peeling need short time hence reducing the possibility of contact between spores or molds and the peeled groundnuts.

Table 2. Relationship of environmental factors with aflatoxin contamination in groundnut dried by sun-drying

| Location | Intensity of sun ray | T ($^0$C) | RH (%) | Moisture content (%) | Aflatoxin (ppb) |
|---|---|---|---|---|---|
| Cilegon (Banten) | High | 30-31 | 56-62 | 5.5-10.4 (very dry pod) | 26.65 |
| Subang (West Java) | High | 28-35 | 22-56 | 27.6-43.8 (wet pod) | 5.96 |
| Waikanan (Lampung) | High | 32 | 47-50 | 47-50 (wet pod) | 6.73 |
| Sragen (Central Java) | Very high | 32-40 | 50-52 | 8.7-28.1 (dry and wet pod) | FA |
| Tuban (East Java) | High | 31-32 | 56-57 | 8-8.5 (dry pod) | 9.32 |

Notes: FA: free from aflatoxin contamination

Susceptibility of peeled nuts to molds or spores requires protective treatment from any external effects. Starting from drying up to fast peeling is aimed to avoid the growth of molds that form mycotoxin. However, if finally the peeled groundnut is left in open air, it possible to be contaminated with aflatoxin. Therefore, the peeled groundnuts need to be stored in a clean place that can protect them from any contamination of spores or molds. In this case, the packaging method constitutes a quite important phase to preserve the food safety status of groundnut. Combination of packaging and storage condition is needed to prolong the safety status of peeled groundnut before consume.

Results of storage experience for one month to the peeled groundnut by using 3 methods of packaging (table 3), showed that packaging by hermetic (tight) system and vacuum system gives good results compared to control. However, hermetic system is better than the vacuum system. In the hermetic method, no transfer of air occurs from outside to inside of the container or vice versa. Therefore, such conditions in the packaging container are stable. Whereas vacuum packaging showed the increased contamination of aflatoxin after one month, although it is still in the safe status. The vacuum packaging is made of PET/PE materials which still allow for the transfer of air

from outside although in a very small amount. This trend shows that although at the beginning the groundnuts are free from aflatoxin, however during the storage, change in the status still possibly occurs to the increased contamination of aflatoxin. It is possible that the *A.flavus* or *A. parasiticus* molds have formed spores before dying due to drought. In conducive conditions, these spores develop into molds and start to form aflatoxin.

Table 3. Effects of packaging upon contamination of Aflatoxin in peeled groundnut

| Type of packaging | Packaging materials | Aflatoxin at the first day store (ppb) | Aflatoxin after 1-month storage (ppb) |
|---|---|---|---|
| Hermetic | Glass, tight | FA | FA |
| Vacuum | Conventional plastic PET/PE laminated | FA | 7.89 |
| Control | Conventional plastic Poly Ethylene | FA | 12.03 |

Notes: FA: free from aflatoxin contamination

## Conclusions

1. Other than the temperature and humidity of the environment, harvest which exceeds the age of harvest will affect the formation of aflatoxin in groundnut.
2. Speeding up the postharvest handling process of groundnut may reduce the contamination or even prevent the formation of aflatoxin.
3. Drying process constitutes important factor in preventing the formation of aflatoxin. High intensity of sun ray may accelerate the drying process, hence groundnuts with relatively small aflatoxin contamination (<10 ppb) are obtained.
4. Hermetic packaging shows good results in preserving the food safety status of groundnuts from aflatoxin during storage.

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