IOP Conference Series: Earth and Environmental Science

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To cite this article: David Septian Sumanto Marpaung *et al* 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **537** 012039

IOP Conf. Series: Earth and Environmental Science **537** (2020) 012039 doi:10.1088/1755-1315/537/1/012039

Determination of Aflatoxin Contamination Risk along Maize Distribution Chain (Case study: A Maize Enterprise in East Lampung)

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Abstract. Aflatoxin is a dangerous secondary metabolite produced by some species in the Aspergillus genus. Aflatoxin contamination is considered as critical indicator for good quality of agricultural product, due to its carcinogenic effect to human and animal health. The contamination of aflatoxin in maize occurred at pre- and post-harvest stage when the environment condition is optimum for the mycotoxin growth. The contamination is possibly appeared along distribution chain from field to maize storage. However, the high risk of aflatoxin contamination point along maize distribution chain still unknown. Therefore, identification of high risk aflatoxin contamination along maize distribution chain for preventive handling is necessary. In this study, the aflatoxin contamination risk was determined along maize distribution chain, from field to maize storage. This study was conducted in one of maize enterprise in East Lampung. The distribution chain scope starts from harvest in the field until the maize ready to sell to feed company, without drying treatment. The distribution chain point was determined become 3 point: maize field (Point 1), before threshing/corncob in storage (Point 2) and before send to feed company/maize threshed (Point 3). The maize kernel was collected from each point for further analysis. Our results suggested for maize enterprise actor to put concern in maize handling at storage after threshing, especially controlling in environmental storage condition and time storage, to reduce aflatoxin contamination.

1. Introduction

Maize is an interested commodity in the world, because they are not only used as a source of energy through food consumption, but also fuel as a source of energy (Biofuel). In 2016, Lampung Province ranked 4th nationally in Indonesia as a maize producer with a production value of 1.72 million tones, accounting for 7.29 percent of total national production [1]. In particular, East Lampung was one of the largest producers of maize in the Lampung [2]. Therefore, the improvement of good handling practice for maize production is expected become concern issue to government in the Lampung Province, particularly the East Lampung region, in order to meet the needs of maize in Lampung and national.

Government programs in quantity improvement of maize productivity should be followed by quality improvement through good post-harvest handling processes. Approximately ± 57% of maize products potentially reduce the quality of post-harvest products during the rainy season. The value of post-harvest losses at farm level during rainy and dry seasons is between 5.2-15.2% [3]. Mycotoxins contamination is one of the cause in reducing the quality and profitability of agricultural products, due to the contamination occurring along the supply chain, beginning from the farm to the hands of consumers [4].

Aflatoxin, a secondary metabolite produced by *Aspergilus flavus,* is one of the most potential risks found in the maize, and become serious problem worldwide, especially in the tropical area [5]. That is very harmful when ingested in high concentrations in body. Not only to human, aflatoxins also genotoxic, carcinogenic, and teratogenic to animals [6]. Therefore, safety system for agricultural handling must be serious concern, in particular with regard to the handling of aflatoxin contamination in the maize supply chain in Indonesia.

Generally, the post-harvest process for maize in Indonesia consists of a number of activities, including processing, drying, threshing, packing and storage. Farmers, collectors and traders play important role as the actors along the maize supply chain. Thus, each actor has responsibility to prevent the aflatoxin contamination from *Aspergilus flavus*. The value of aflatoxin contamination in the maize supply chain is defined as the value of aflatoxin concentration in the maize sample. To date, the data of aflatoxin contamination in the maize supply chain in East Lampung is unavailable. The traceability system is very critical in determining sustainable agro-industry. Therefore, determining the contamination risk of aflatoxin at the level of production and post-harvest must be done, in order to make the recommendations on post-harvest management. The goal of this study was to assess the risk of aflatoxin contamination in the maize supply chain.

2. Materials and Method

2.1. Location and Sample Preparation

The study was carried out in East Lampung, Indonesia, from June to July 2019. This work was done through direct observation, interviews and field measurements. The participants of this research were farmers and traders who play a role in the maize supply chain. The participant selection is carried out by following the maize supply chain. Testing of aflatoxin concentration is performed at PT. Sucofindo and SEAMEO Biotrop.

2.2. Tools

In this study, grain moisture tester, oven, desiccator, plate, zip lock plastic, camera, thermohygrometer and stationery were used as tools. Grain moisture tester, oven, and desiccator were used for measurement of maize moisture content. Thermohygrometer was used for RH and temperature measurement. Plate, zip lock plastic, camera, and stationary was used for sampling activity purpose.

2.3. Sampling Method

In this study, purposive sampling was used as sampling method with 3 times replication. The sampling technique was followed to SNI 19-0428-1998 which consists for overlaying and packaging samples. The all collected samples then was quantified the aflatoxin concentration. The high risk aflatoxin contamination from each point was determined by incubation of sample until 26 days, and check the increases of aflatoxin concentration.

2.4. Sampling Point

The post-harvest activity of maize in this research could be seen in Figure 1. There 3 different point of kernel sampling, Point 1 in the Field, Point 2 in the Temporary storage and Point 3 in the Storage. In each point, the environmental parameters, includes temperature and relative humidity, were measured with 3 replications.

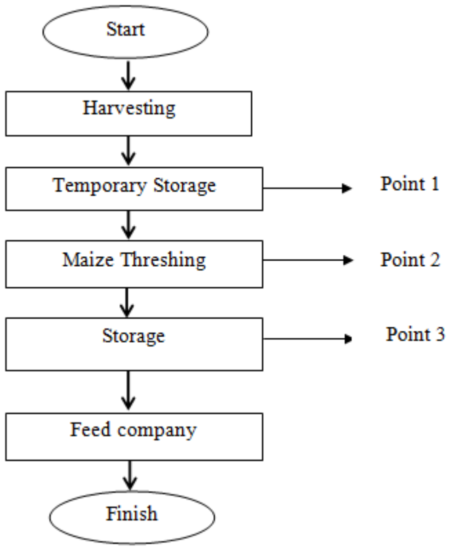

Figure 1. Post-harvest activity of maize

3. Results and Discussion

In order to determine the contamination risk of aflatoxin in the maize supply chain in East Lampung, sampling of maize was carried out at the level of farmers and large traders. Sampling was performed at 3 points, namely maize at harvested in the field (Point 1), maize cobs before threshing (Point 2) and maize after threshing (Point 3). Contamination risk of aflatoxin is known by measuring the aflatoxin content of days 0 and 26 at each sampling point. Businesses may take preventive action in post-harvest operations by understanding the contamination risk of aflatoxin.

On the basis of observations, the aflatoxin content of maize was found below the detection limit at each point of sampling. The aflatoxin content is below the detection limit, means that the A. flavus growth requirement is not met. In order to prevent aflatoxin from occurring in the maize supply chain of a maize company in East Lampung, the risk of aflatoxin contamination is measured by incubating the sample at room temperature for 26 days. The result of risk aflatoxin contamination was shown in Table 1. The results showed that, after storage for 26 days, aflatoxin was found at the point 3, with aflatoxin content at 24.4 µg / kg. Whereas, the other sampling points, the value of aflatoxin content after incubation for 26 days was still below the detection limit. Kamika et al [8], also found the highest content of aflatoxin at the end point of maize supply chain. The aflatoxin content of maize samples was found increased dramatically at a maximum of 47 to 500 times between the city store and the distribution system at market level in the Democratic Republic of Congo. In the optimum condition, *A. Flavus* grows well and produces aflatoxin.

Table 1. The risk aflatoxin contamination

Sampling Point	Time (Day)	Aflatoxin Concentration (µg/kg)
Point 1	0	<BL
	26	<BL
Point 2	0	<BL
	26	<BL
Point 3	0	<BL
	26	24.4

BL: Below limit

Based on the observations, there are differences in the appearance of maize at each point on day 0 and on day 26. Unknown fungus appeared more clearly in point 3 of day 26, compared to the other point. The appearances of maize each point after 26 days was shown in Figure 2. In maize which has high aflatoxin content, is clearly seen contaminated by unknown fungus. The highest contaminated sample percentage and mean AFB1 content were found in roasted peanuts with skin pods, i.e. 42 percent of 33 samples and 43.2 µg / kg, followed by flour-coated peanuts (30% of 33 samples and 34.3 µg / kg) and or (21% of 33 samples and 17.1 µg / kg) [8]. Aflatoxin exposure from maize and peanut consumption in Indonesia is concern. The urgency for risk management of aflatoxin is very important [9]. Aflatoxin control system must be established at the level of large traders on the basis of observations.

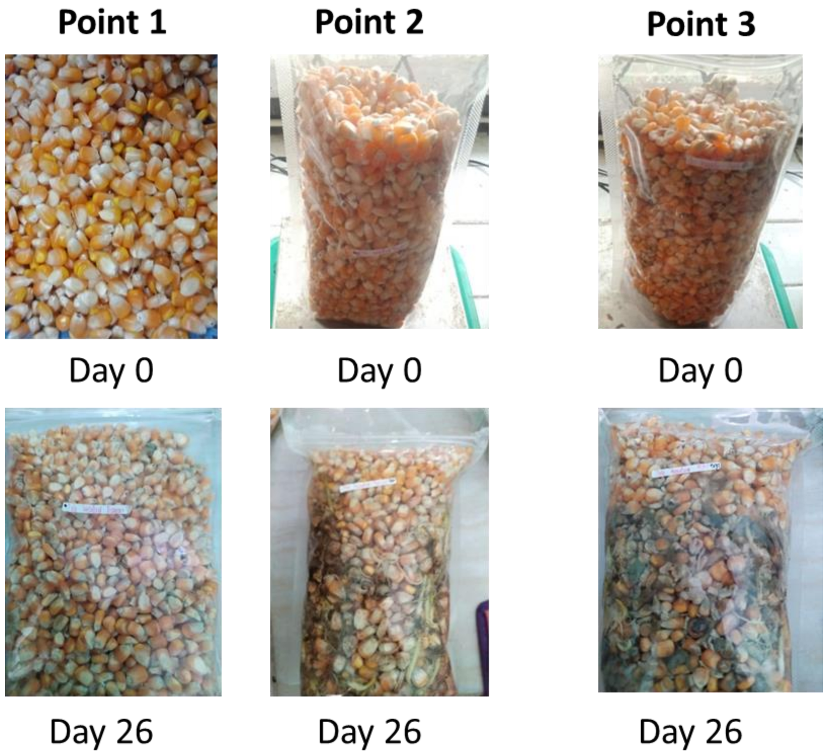

Figure 2. The appearances of maize each point after 26 days

Wicklow et al., [10] said that environmental conditions in the growing season and particularly temperature and relative humidity affect the presence of aflatoxin contamination in maize. Based on the results, relative humidity at point 1 about 70%, point 2 about 73.33%, and point 3 about 74%. While, the temperature at the time each point resulted, point 1 about 33.31 ^{o}C, point 2 about 31.33^{o} C, and point 3 about 31.17 ^{o}C. As well as the moisture content obtained from each point resulted, point 1 about 19.54%, point 2 about 19.65%, and point 3 about 20.02% (Table 2). The high risk aflatoxin in point 3 might be effect by optimum environmental condition.

Table 2. Moisture content, relative humidity and temperature condition

Sampling point	Point 1	Point 2	Point 3
Moisture content (%)	19.54 ± 1.02	19.65 ± 0.97	20.02 ± 1.23
RH (%)	70 ± 1	73.33 ± 2.30	74 ± 1.73
Temperature (^{0}C)	33.1 ± 0	31.33 ± 0.56	31.17 ± 0.49

Several factors determined the growth of *A. flavus* and the formation of aflatoxins, including moisture content, relative humidity, temperature and time storage. Among those factors, relative humidity and time storage are significantly correlated with the growth of *A. Flavus* [11]. However, as the analysis also shows, not all farm-level is contaminated with aflatoxins. This condition is most likely supported by good farming practices to avoid contamination of aflatoxin in maize. In order to reduce post-harvest losses in the distribution chain, suggestion to farmers and collectors on how to properly store threshed maize must be applied.

4. Conclusion

The aflatoxin contamination risk in the maize supply chain was found at point 3 on the 26th day with the aflatoxin content was obtained 24.4 µg / kg. The environment conditions at point 3 were found 20.02 ± 1.23% (Moisture content), 74 ± 1.73% (RH) and 31.17 ± 0.49 ^{o}C (Temperature). Our results suggested that the maize enterprise actor should be concerned with the prevention of aflatoxin contamination in the handling of maize after threshing, in particular in environmental storage and storage conditions.

Acknowledgement

This work was funded by Directorate of Research and Service Society, Directorate General of Research and Development Strengthening and Ministries of Research, Technology and Higher Education of the Republic of Indonesia. Contract number: 009/SP2H/LT/DRPM/2019.

References

[1] Agency for Regional Development of Lampung. 2017. Report of Action Plan for Food and Nutrition Lampung Province 2016. Avalaible: www.bappeda.lampungprov.go.id [Accesed on August 23 2018]

[2] BPS (Badan Pusat Statistika). 2013. Available: bps.go.id [Accessed on August 29 2018]

[3] Purwadaria, H.K. 1988. Postharvest Technology Handling of Maize. Handbook (2nd Edition). Department of Agriculture FAO, UNDP. Jakarta.

[4] Udomkun, P., Wiredu, A.N., Nagle, M., Müller, J., Vanlauwe, B., and Bandyopadhyay, R. 2017. Innovative technologies to manage aflatoxins in foods and feeds and the profitability of application – A review. Food Control 76, 127-138.

[5] Lillehoj, E. 1986. The aflatoxin in maize problem: the historical perspective. Proceeding; El Batan, 7-11 Apr 1986. Mexico: CIMMYT. p 13-32

[6] Shephard, G.S., 2008. Risk assessment of aflatoxins in food in Africa. Food Addit. Contam. 25 (10), 1246–1256.

[7] Aqil, M. 2010. Method Development to Reduce Postharvest Losses Maize Threshing. Prosiding Pekan Serealia Nasional, 2010. p 464-472.

[8] Ambarwati S, Dharmaputra O S, Retnowati I. 2011. Dietary Exposure Assessment For Aflatoxin B From Processed Peanut Products In Municipality Of Bogor 1. Biotropia, 18(1). doi:10.11598/btb.2011.18.1.133

[9] Kamika, I., Ngbolua, K.-N., & Tekere, M. 2016. Occurrence of aflatoxin contamination in maize throughout the supply chain in the Democratic Republic of Congo. Food Control, 69, 292–296. doi:10.1016/j.foodcont.2016.05.014

[10] Wicklow D T. Weaver D K. Throne J E. 1998. Fungal Colonists of Maize Grain Conditioned at Constant Temperatures and Humidities. J Stored Prod Res 34:355-361

[11] Kusumaningrum H D. Suliantari. Toha A D. Putra S H. Utami A S. 2010. Contamination Of Aspergillus Flavus And Aflatoxin At Distribution Chain of Maize Based Food Product and Its Influencing Factors. J.Teknol. dan Industri Pangan, Vol XXI No. 2 Th 2010