Risk Assessment Studies
Report No.5

Chemical Hazards Evaluation

AFLATOXIN IN FOODS

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An Evaluation of Aflatoxin Surveillance Findings in Hong Kong
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Abstract

Aflatoxin belongs to a group of fungal toxins known as mycotoxins, and is widespread in agricultural products and food. Aflatoxin is associated with both acute and chronic toxicity in animals and humans including acute liver damage, liver cirrhosis, and liver cancers. Chronic toxicity associated with ingestion of low dose aflatoxin in peanuts, cereals and other at risk items are of greater concern. We evaluated the aflatoxin surveillance from 1998 to 2000 in this report. Throughout this period, a total of 526 food samples, under the three food groups namely peanuts and peanut products, vegetable oil and fat, cereal and cereal products, were taken for aflatoxin analysis and the findings were compared against the statutory limits stipulated in the Harmful Substances in Food Regulations of Public Health and Municipal Services Ordinance (Cap.132). One sample of peanut butter collected in 1998 contained aflatoxin above the limit, representing an overall non-compliance rate of 0.19%. A further quantitative analysis revealed that 92.4% of the samples were free of detectable aflatoxins, the remaining 40 samples had detectable levels of aflatoxin ranging from 0.1µg/kg to 26µg/kg. The mean levels of aflatoxin in peanuts and peanut products remain the highest at 1.45µg/kg among the three groups. While the complete elimination of aflatoxin in agricultural products is extremely unlikely, efforts should be made to reduce the amounts in crops and foods the lowest levels that are technologically feasible. This can be achieved through adopting effective Good Manufacturing Practice and integrating it with HACCP based safety programme.

Aflatoxin in Foods

- *An Evaluation of Aflatoxin Surveillance Findings in Hong Kong 1998 -2000*

Objective

The aim of this paper is to assess the health hazard related to aflatoxin. The surveillance results of aflatoxin from 1998 to 2000 are reviewed and analysed. Recommendations on minimizing the risk of exposure to aflatoxin are put forward to the trade and the public.

Introduction

2. Aflatoxin belongs to a group of fungal toxins known as mycotoxins. It was discovered some 30 years ago in England following a poisoning outbreak causing 100,000 turkey deaths. Mycotoxins have received considerable attention due to their significance in agricultural loss and human health. Amongst the mycotoxins that are known to cause human diseases, aflatoxins have been studied most.

3. Aflatoxin poses a potential threat to food safety. As aflatoxin is epidemiologically implicated as carcinogen in humans and an environmental contaminant which is widespread in nature, its possible chronic toxicity is therefore of greater concern than acute toxicity.

Natural Occurrence

4. Aflatoxin is the secondary metabolite produced by specific strains of *Aspergillus*. These species contaminate various agricultural commodities either before harvest or at post-harvest stages under favourable conditions of temperature and humidity.

5. *Aspergillus* is a large genus of mould which grows at an optimal range of temperature of 28-33°C and at the water activity of about 0.83-0.97. The aflatoxigenic moulds, namely *A flavus*, *A parasiticus* and *A nomius* are principally found in soils and decaying vegetation. They occur in warmer parts of the world such as tropical region where temperature and moisture are high. They have a higher affinity of growth in nuts and oilseeds.

6. Aflatoxin is found in a wide range of tropical or subtropical food commodities peanuts in particular. Other food commodities include corn, figs, nuts and cereals. The contaminated foods reported to be associated with aflatoxin in Asian region include maize, peanuts, rice, and other oil products.

Characteristics of Aflatoxin

7. Aflatoxin is classified into a number of subtypes. However, the most important ones are B1, B2, G1 and G2, distinguished by their fluorescenct colour under ultraviolet light. In addition, aflatoxin M1 and M2 are hydroxylated metabolites of aflatoxin B1 and B2.

8. Unlike *Aspergillus*, which often look greenish to the naked eyes, aflatoxins are odourless, tasteless and colourless. Chemically, they are stable in foods and resistant to degradation under normal cooking procedures. It is difficult to eliminate aflatoxin once it is produced.

9. Accumulation of aflatoxin is dependent upon weather conditions. Before harvest, the risk for the development of aflatoxin is greatest during major droughts. When soil moisture is below normal and temperatures are high, the number of *Aspergillus* spores in the air increases. These spores infect crops through areas of damage caused by insects, and inclement weather. Once infected, plant stress occurs, the production of aflatoxin is favoured.

10. During post-harvest stage, proliferation of aflatoxin can be exacerbated in susceptible commodities under storage conditions such as hot and humid storage environment.

Health Implication

11. Human exposure to aflatoxin is principally through ingestion of contaminated foods. Inhalation of the toxins may also occur occasionally due to the occupational exposure.

12. Aflatoxin can cause both acute and chronic toxicity in animals. Effects such as acute liver damage, liver cirrhosis, induction of tumours and teratogenic and other genetic effects are well documented.

13. In modern days, acute toxicity of aflatoxin to humans has been encountered only rarely. Symptoms may include fever, vomiting and jaundice. Acute liver damage can occur which may be fatal in severe cases. There has not been any food poisoning case related to dietary aflatoxin reported in Hong Kong.

14. Long term intake of aflatoxin can be associated with hepatic cancer. Animal studies have showed that hepatocellular liver tumors may develop in animals like rats, hamsters and monkeys after prolonged oral administration.[1]

15. Human data concurred these findings. Epidemiological studies in Africa and South East Asia supported a positive correlation between the logarithm of aflatoxin ingestion and the occurrence of human primary liver cancer.[2] Studies revealed that the co-existence of hepatitis B virus infection might contribute to higher incidence of liver cancer in aflatoxin exposed populations.[3] Unfortunately, the mechanism has yet to be established.

16. The complete elimination of aflatoxin in agricultural products is extremely unlikely. They are stable in foods and resistant to degradation under normal cooking procedures. Thus,

recommendation from Joint Expert Committee on Food Additives (JECFA) is that the amounts present in crops and foods should be reduced to the lowest levels that are technologically achievable.

Surveillance of Aflatoxin in Foods from 1998-2000

17. The surveillance results obtained in the period between 1998 and 2000 in HKSAR were reviewed to examine the potential hazards of aflatoxin in foods.

Method and Results

18. Food samples collected fell under three main food categories, namely peanuts and peanut products, vegetable oils and fat, and cereals and cereal products.

19. Food samples taken were sent to the Government Laboratory. High Performance Liquid Chromatography method was used for the chemical analysis.

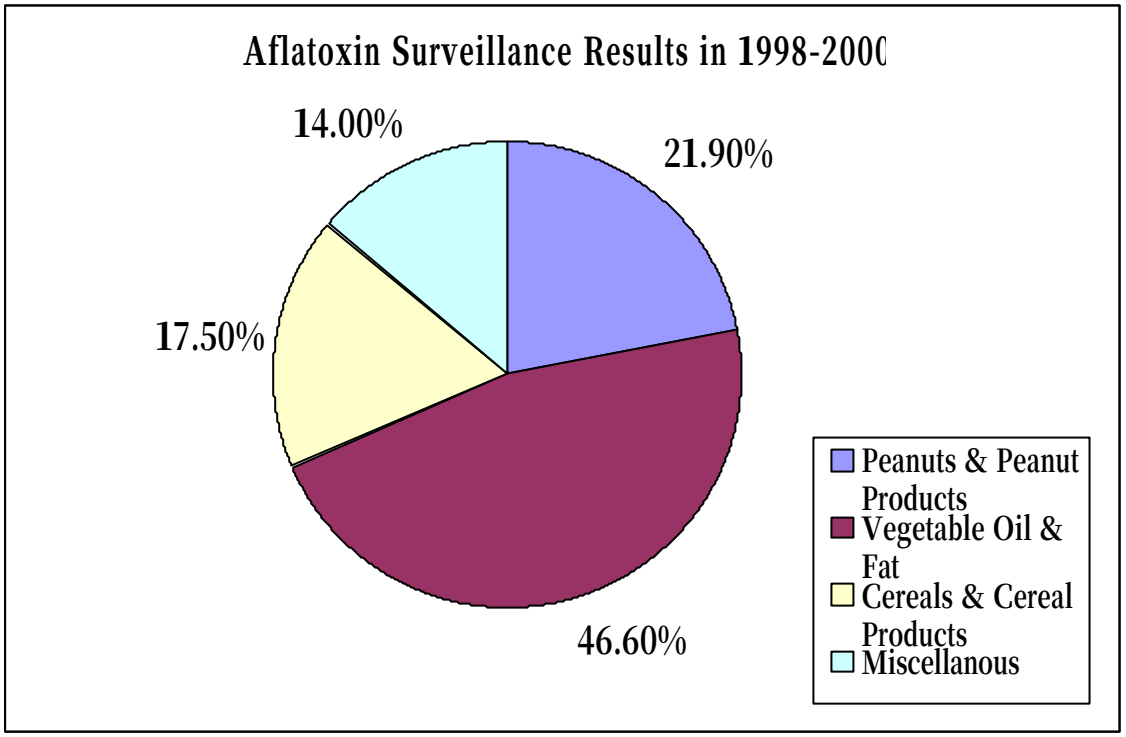
20. The results were compared against the statutory limits stipulated in the Harmful Substances in Food Regulations of Public Health and Municipal Services Ordinance (Cap. 132)

21. According to the Regulations, the limits are 20μg/kg for peanuts and peanut products and 15μg/kg for all other foods.

22. The distribution of samples according to food groups were as below:

(a) Peanuts and Peanut Products :115
(b) Vegetable Oil and Fat : 245

(c) Cereals and Cereal Products : 92
(d) Miscellaneous Products : 74



23. Out of the 526 samples, only one sample contained aflatoxin above the statutory limit of aflatoxin. In other words, the overall non-compliance for the past three years rate was 0.19%. This sample that exceeded the statutory limit was a peanut butter collected in 1998.

24. We performed a further quantitative analysis to examine the mean levels of aflatoxin contained in these foods. Out of the 526 samples, 486 (92.4%) samples were free of detectable aflatoxins. As for the remaining 40 samples, the levels of aflatoxin were at the range of 0.1µg/kg to 26µg/kg. Breakdown of the 40 samples by food group is shown in table 1

Table 1- Aflatoxin detected in food groups

Food Group	No. of sample	No. of sample with detectable aflatoxin (in percentage)	Range (µg/kg)	Mean Level
Peanuts & Peanut Products*	115	27 (23.5%)	1.6-26.0	1.45
Vegetable oil and fat	245	9 (3.7%)	0.1-5.8	0.20
Cereals & Cereal Products	92	4 (4.3%)	1.3-5.8	0.27
Miscellaneous	74	0 (0%)	0	0
Total	**526**	**40 (7.6%)**	**0.1-26.0**	

* Including Peanut Oil

Peanuts and peanut products

25. There was almost one quarter (23.5%) of the peanuts and peanut products were found to contain aflatoxin. This coincides with the understanding that the aflatoxin- producing fungus in particularly affiliated to peanut crops.

26. The 27 samples with detectable aflatoxin in peanuts and peanut products were at the range of 1.6µg/kg -26µg/kg. The mean level was 1.45µg/kg. It was also the highest among the three groups of food.

Vegetable Oil and Fat

27. As aflatoxin is found in oilseeds having a high fat content, oils extracted from nuts seeds may therefore also be susceptible to aflatoxin contamination.

28. The surveillance results indicated that of the 245 vegetable oils and fat samples analysed, none of them was higher than the permitted level of 15µg/kg. There were nine samples (3.7%) detected with levels ranging from 0.1µg/kg to 5.8µg/kg. The mean level was 0.20µg/kg.

Cereals and cereal products

29. Aflatoxin production is also found in association with cereals in the field. However, in our local food surveillance, only four samples out of the total 92 samples analysed were detected with levels of aflatoxin ranging from 1.3μg/kg-5.8μg/kg. The mean level was 0.27μg/kg

Conclusion and Recommendations

30. The above analysis showed that the potential hazard associated with aflatoxin in food in Hong Kong has not been serious. Even for peanuts and peanut products, the food group that is well known to be associated with aflatoxin, the mean level was low at 1.45μg/kg. The non-compliance rate as compared to the statutory limit was 0.19% in the past three years.

31. The risks posed to health in Hong Kong can be further lowered by reduced exposure. For instance, those who have pre-existing liver diseases may consider avoiding peanut and peanut products.

32. To minimize the risk of aflatoxin exposure, close tripartite cooperation among the trade, the public and the government is essential. The followings are some recommended risk reduction measure for the trade and the consumers.

Advice To Trade

33. The prime responsibility to ensure the wholesomeness of the foods lies with the trade. They are advised to adopt the Good Manufacturing Practice (GMP) and integrate it with HACCP based safety programme. The following measures are useful:

(a) Obtain raw materials from reliable and reputable suppliers
(b) Verify the specifications for quality product (e.g. decontamination process for reduction of aflatoxin level, if indicated)
(c) Maintain good storage conditions
-dry and cool environment
-stock rotation should be on a first-in first out basis
(d) Keep documentation well in place

Advice To Consumers

34. Consumers are advised to take the following measures to reduce the risk of aflatoxin exposure.

Upon Purchase
(a) Purchase from reliable and reputable retailers
(b) Observe whether foods are stored in ventilated cool condition.
(b) Reject any unclean, opened or damaged package

Storage
(a) Maintain at dry and cool environment (temperature preferably below 20°C and relative humidity below 80%)
(b) Avoid direct sunlight
(c) Watch out the durability of the products
(d) Avoid stocking up excessive foods

Consumption
(a) Consume foods within the designated "best before date".
(b) Discard any foods that look mouldy, damped, shriveled and discoloured.

References

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[8] Peraica M Radic B Lucic and A Pavlovic M, 1999 "Toxic Effects of Mycotoxins in Humans" *Bulletin of the World Health Organisation, 77(9)*

Annex A- Technical Notes on Mycotoxins

1. Mycotoxins are secondary metabolites produced by certain fungi in agricultural products that are susceptible to mould infestation under favourable conditions of temperature and humidity. These metabolites can exhibit acute, and chronic toxicological manifestations in humans and susceptible animals.

2. The occurrence of the mycotoxins in foods and feeds is unavoidable and influenced by certain environmental factors; hence the extent of mycotoxins contamination is unpredictable and may vary with geographic location, agricultural and agronomic practices and the susceptibility of commodities to fungal invasion during pre-harvest, post harvest, storage periods.

3. In addition to the various moulds occurring in crops which are improperly stored, certain plant diseases are responsible for the production of mycotoxins. Different weather conditions, such as unreasonable rains at the time of flowering and droughts during harvest and post harvest stages, mould growth and so mycotoxins contamination can also pose serious problems. In practice, mycotoxin-free foods are almost impossible and control measures taken over the world are solely focus on the reduction levels in feeds or foods.

4. The mycotoxins found to occur significantly in naturally contaminated foods and feeds include the aflatoxins, ochratoxin A, zearalenone, patulin, and fumonisins. The crops that may be affected by these mycotoxins include corn, peanuts, cottonseed, treenuts, cereal grains, dried beans and apples.

5. Some mycotoxins have proven to be teratogenic, mutagenic and /or carcinogenic in certain susceptible animal species and have been associated with various diseases in domestic animals, livestock and humans in many parts of the world.

6. Recognition of mycotoxins associated food-borne

diseases in humans is difficult and limited to few isolated observations only, because of the non-specificity of both clinical signs and pathologic changes in most instances. Epidemiology appears to be the key to reaching a diagnosis, however, this method cannot be employed in the clinical setting.

Annex B- Glossary

Aflatoxin
According to Cap.132, Harmful Substances in Food Regulations, aflatoxin means the group of bis-furanocoumarin compounds and includes aflatoxin B1,B2,G1,G2,M1,M2,P1 and aflatoxicol.

Hazard
According to Codex Alimentarius, hazard is a biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect.

Hazard analysis Critical Control Points
According to Codex Alimentarius, the HACCP system is a science based and systematic, identifies specific hazards and measures for their control to ensure the safety of food.

Joint FAO/WHO Expert Committee on Food Additives (JECFA)
JECFA serves as the scientific advisory body to the Codex Alimentarius Commission on all matters relating to food additives, contaminants and residues of veterinary drugs in food. JECFA is an independent FAO/WHO Expert Committee and is not part of the CAC, but most priorities for assessment by JECFA originate with the CAC.