The First Hong Kong Total Diet Study Report No. 7

The First Hong Kong Total Diet Study: Mycotoxins

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Contents

KEY FINDINGS

The First Hong Kong Total Diet Study: Mycotoxins

Key findings of the Study

- The current report presents the levels of mycotoxins in food and the dietary exposure assessment of the Hong Kong adult population to five types of mycotoxins, namely "aflatoxins", "ochratoxin A", "fumonisins", "deoxynivalenol and acetyldeoxynivalenols" and "zearalenone".
- The mycotoxins were found at low levels and mainly in food of plant origins.
- All dietary exposure estimates were below their respective health-based guidance values, where available.
- Based on estimated aflatoxins intake and the prevalence of hepatitis B carriers in Hong Kong, aflatoxins contributed approximately eight cases of liver cancer per year in the whole Hong Kong population, which accounted for less than 1% of the age-standardized incidence rate of liver cancer in 2010 in Hong Kong. There is no cause of undue alarm.
- The study suggested that the general Hong Kong adult population was unlikely to experience major undesirable health effects of the above mycotoxins.

EXECUTIVE SUMMARY

The First Hong Kong Total Diet Study: Mycotoxins

The Centre for Food Safety (CFS) is conducting the First Hong Kong Total Diet Study (the 1st HKTDS) to estimate dietary exposure of the Hong Kong general population and various population subgroups to a range of substances, including contaminants and nutrients, and to assess any associated potential health risks. A total of 720 individual samples, comprising 60 TDS food items with three purchases on each of the four occasions were collected and prepared, and then combined into 240 composite samples for testing of various mycotoxins.

2. This is the seventh report of the TDS series. It presents analysis of mycotoxin levels in food and the dietary exposure assessment to five types of mycotoxins, namely "aflatoxins", "ochratoxin A", "fumonisins", "deoxynivalenol and acetyldeoxynivalenols" and "zearalenone".

3. Mycotoxins, which are toxic metabolites produced by moulds, can be present in certain grains and foods of plant origin in varying amounts. They can infect food plants, especially those under stress from weather or insect infestation. For ordinary adults, diet is the main source of exposure to common mycotoxins. The chronic toxicity associated with dietary exposure to mycotoxins is the main concern for Hong Kong population.

Results

4. The dietary exposure of average and high consumers of the population to aflatoxins (sum of AFB1, AFB2, AFG1 and AFG2) are 0.0002 – 0.0028 and 0.0009 – 0.0049 μg/kg bw/day respectively. The dietary exposure of average and high consumers of the population to ochratoxin A (OTA) are 0.0013 – 0.0054 and 0.0036 – 0.0092 μg/kg bw/week, which accounted for 1.3 – 5.4 % and 3.6 – 9.2 % of the PTWI of 0.1 μg/kg bw/week respectively. The dietary exposure of average and high consumers of the population to fumonisins (FUM) are 0.0016 – 0.0973 and 0.0008 – 0.1692 μg/kg bw/day, which accounted for 0.08 – 4.9 % and 0.04 – 8.5 % of the PMTDI of 2 μg/kg bw/day respectively. The dietary exposure of average and high consumers of the population to total deoxynivalenol and acetyldeoxynivalenols (DON and AcDON) are 0.0861 – 0.1426 and 0.2166 – 0.2824 μg/kg bw/day, which accounted for 8.6 – 14.3 % and 21.7 – 28.2% of the PMTDI of 1 μg/kg bw/day respectively. The dietary exposure of average and high consumers of the population to zearalenone (ZEA) are 0.0061 – 0.1015 and 0.0166 – 0.1724 μg/kg bw/day, which accounted for 1.2 – 20.3 % and 3.3 – 34.5 % of the PMTDI of 0.5 μg/kg bw/day respectively. All dietary exposure estimates were below their respective health based guidance values, where available. Based on estimated aflatoxins intake and the prevalence of hepatitis B carriers in Hong Kong, aflatoxins contributed approximately eight cases of liver cancer in Hong Kong population, which accounted for less than 1% of the age-standardized incidence rate of liver cancer in 2010 in Hong Kong, which there is no cause of undue alarm. The findings suggested that the general adult population was unlikely to experience major undesirable health effects of the above mycotoxins.

Advice to the Public

- Purchase from reliable retailers.
- Store cereals and grains products properly in cool dry places.
- Maintain a balanced and varied diet as to avoid excessive exposure to mycotoxins from a small range of food items.
- Look out for the durability and expiration date of food.
- Discard foods that look mouldy or damaged.
- Since nuts contain many nutrients, such as unsaturated fatty acids, high quality protein, fibre, vitamins and minerals, people may include unsalted nuts as part of a well-balanced diet and consume unsalted nuts in moderation.

Advice to the Trade

- Observe good agricultural practices and good manufacturing practices/HACCP to minimize mycotoxin contamination of foods.
- Obtain food materials from reliable suppliers.
- Maintain good storage conditions. Store food in cool and dry places and rotate stock on a first-in-first-out basis.
- Maintain proper records to enable source tracing when required.

Chapter 1

Background

1.1 Total Diet Study (TDS) has been recognised internationally as the most cost effective way to estimate dietary exposure to food chemicals or nutrients for various population groups and to assess their associated health risks. It provides a scientific basis for assessing food safety and regulating food supply. Since 1960s, various countries including the United Kingdom, the United States, Canada, Australia, New Zealand, France, Ireland and Mainland China have been conducting their own TDS.

Introduction of the First Hong Kong Total Diet Study (1st HKTDS)

1.2 This was the first time a TDS was carried out in Hong Kong by the Centre for Food Safety (CFS). It aimed to estimate dietary exposure of the Hong Kong general population and various population subgroups to a range of substances including contaminants and nutrients, and to assess any associated potential health risks.

1.3 The 1st HKTDS was a large and complex project that comprised food sampling and preparation, laboratory analysis and dietary exposure estimation. It covered the majority of foods normally consumed by the Hong Kong population, with laboratory analysis of over 130 substances including contaminants and nutrients.

Mycotoxins

1.4 Mycotoxins, which are toxic metabolites produced by moulds, can be present in certain grains and foods of plant origin in varying amounts. They can infect food plants, especially those under stress from weather or insect infestation. For ordinary adults, diet is the main source of exposure to common mycotoxins.[1] The acute toxicity of mycotoxins like aflatoxins due to dietary exposure is possible, but it is only reported sporadically from the developing parts of the world. Therefore, the chronic toxicity associated with dietary exposure to mycotoxins is the main concern for Hong Kong population. In Hong Kong, the control on mycotoxins in food is governed by the Harmful Substances in Food Regulations, Cap 132AF. The Cap 132AF stipulates the maximum levels for aflatoxins in foods, whereas Part V of the Public Health and Municipal Services Ordinance (Cap 132) provides general protection in terms of food safety.

Chapter 2

Methodology and Laboratory Analysis

Methodology of the 1st HKTDS

2.1 The 1st HKTDS involved purchasing samples of food commonly consumed throughout Hong Kong, preparing them as consumed, combining the foods into food composites, homogenising them, and then analysing them for a range of substances. The analytical results were then combined with food consumption information of various population groups, which were captured from the Hong Kong Population-based Food Consumption Survey (FCS),[2] in order to obtain the dietary exposure.

2.2 One hundred and fifty TDS food items were selected for the study, based on the food consumption data of the FCS. Three samples of each TDS food item were collected on four occasions from March 2010 to February 2011 and prepared in a form as normally consumed. A total of 1 800 samples were collected and combined into 600 composite samples for laboratory analysis.

2.3 Dietary exposure estimation was performed with the aid of an in-house developed web-based computer system, the Exposure Assessment System, also known as EASY in short, which involved food mapping and weighting of data. The mean and 95th percentile of the exposure levels were used to represent the dietary exposure of average and high consumers of the population respectively.

2.4 Details of the methodology are given in the same series of report on Methodology.[3]

Laboratory Analysis

2.5 Laboratory analysis of mycotoxins was conducted by the Food Research Laboratory (FRL) of the CFS. Having taken into account their likelihood of occurrence in food and resource limitations, 60 out of the 150 TDS food items taken from the four occasions (as 240 composite samples) have been tested for aflatoxin B_1 (AFB1), aflatoxin B_2 (AFB2), aflatoxin G_1 (AFG1), aflatoxin G_2 (AFG2), ochratoxin A (OTA), fumonisin B_1 (FB1), fumonisin B_2 (FB2), fumonisin B_3 (FB3), deoxynivalenol (DON), acetyldeoxynivalenol (AcDON), zearalenone (ZEA), alpha-zearalenol (α-ZOL) and beta-zearalenol (β-ZOL). The composite samples were extracted with acidified aqueous acetonitrile and then defatted by n-hexane. Isotopically labelled mycotoxins standards were added as internal standards for quantification. The mycotoxins in concentrated sample extracts were determined by ultra performance liquid chromatography–tandem mass spectrometry (UPLC-MS/MS). The limit of detections (LODs) and limit of quantifications (LOQs) are tabulated as follows:

Mycotoxins*	LOD (μg/kg)	LOQ (μg/kg)
Aflatoxins (AF)(B_1,B_2,G_1,G_2)	0.05	0.10
Ochratoxin A (OTA)	0.05	0.10
Fumonisins (FUM)(B_1,B_2,B_3)	2.5	5.0
DON & AcDON	2.5	5.0
Zearalenone (ZEA) & zearalenols (ZOLs)	2.5	5.0

* Mycotoxins tested included aflatoxin B_1, aflatoxin B_2, aflatoxin G_1, aflatoxin G_2, ochratoxin A, fumonisin B_1, fumonisin B_2, fumonisin B_3, deoxynivalenol, acetyldeoxynivalenol, zearalenone, α-zearalenol and β-zearalenol.

As only 60 TDS food items that are judged to be more likely to contain mycotoxins were analysed, underestimation of mycotoxins intake from food items that were not analysed cannot be excluded. However, since it is well understood that mycotoxins are mainly detected in certain plant-based food, the amount of underestimation should be limited. The method of surveying specific foods are useful when dietary exposure to chemicals (e.g. mycotoxins) are predominantly influenced by limited range of foods. The approach had been recommended by the World Health Organization (WHO).[4]

Treatment of Analytical Values below LOD

2.6 In this study, recommendation from the WHO regarding evaluation of low-level of contamination of food was followed when treating analytical value below LOD.[5] When more than 60% of results were below LOD, both lower bound (LB) and upper bound (UB) dietary exposure estimations (values of 0 and LOD were assigned to all analytical values below LOD respectively) were presented. However for simplification in presentation, medium bound results were also included in some tables for the ease of the understanding.

Chapter 3

Aflatoxins

3.1 Aflatoxins (AFs) are a group of fungal (mould) toxins that are produced mainly by two *Aspergillus* species of mould. The main species, *Aspergillus flavus*, produces the B toxins and is common worldwide especially in hot and humid areas. *A. parasiticus* is less widespread geographically and can produce both the B and G toxins.[6] *A. nomius* can also contaminate plants and plant products.[7] It was estimated that up to 25% of the world food crops are affected, potentially exposing up to five billion people in the developing world.[8] The main crops in terms of aflatoxins production are peanuts, maize (corn) and cottonseed. The M aflatoxins are the metabolite of B aflatoxins and can be found in milk of animals and humans.[6]

<u>Sources of Exposure</u>

3.2 The major route of chronic exposure to AFs for the general population is through consumption of contaminated maize and peanuts, which are reported to be at nanogram to microgram per day range internationally.[6] As a result, populations which maize (e.g. in Latin America) and peanuts (e.g. in Africa) are the main staples are particularly at risk.[8] Other sources of exposure from food include dried fruits, tree nuts, spices, figs, crude vegetable oils, cocoa beans, rice, cottonseed and copra (dried coconut meat). Inhalation intake in occupational setting in grain handling facilities like silos or oil seed press is also possible.[7] Acute exposures of AFs from food had occasionally been reported, where the intake levels (in mg/kg range) causes acute liver necrosis. This level is much higher than the levels associated with liver cancer.[9]

Toxicity and Carcinogenicity

3.3 AFs are among the most potent mutagenic and carcinogenic substances known.[7] The International Agency for Research on Cancer (IARC) has re-affirmed in 2012 that AFs are carcinogenic to humans (Group 1). Exposure to AFs have a role in liver cancer in humans, especially in persons who has hepatitis B surface antigens[6] and possibly for hepatitis C viruses.[7] It was reported that the risk of liver cancer in individuals exposed to both chronic hepatitis B virus infection and aflatoxins is up to 30 times more than individuals exposed to aflatoxins only.[10] Aflatoxin B_1 (AFB1) is genotoxic, producing adducts in humans and animals *in vivo*.[9] AFB1 also suppresses immunity in animals, especially on cell-mediated immunity, resulting in increased susceptibility to bacterial and parasitic infections. Aflatoxins can also cross placenta in humans and the exposure is associated with growth impairment in young children. Studies in rats and male rabbits suggest that aflatoxins may impair fertility.[6] It was reported that aflatoxins causes about 5 – 30% of all liver cancer cases in the world, and up to 40% in Africa.[8]

3.4 The Joint FAO/WHO Expert Committee on Food Additives (JECFA) stated in 1997 that as AFs are carcinogens, the intake should be reduced to as low as reasonably possible.[11] Taking the JECFA evaluations into reference, Codex Alimentarius has set up maximum levels of 10 to 15 μg/kg for certain types of nuts and has produced a series of guidelines in reducing aflatoxin levels in a range of food commodities and animal feeds in attempt to reduce the level of aflatoxins in the food supply.[12]

Local Regulations

3.5 The Harmful Substances in Food Regulations of Public Health and Municipal Services Ordinance (Cap. 132AF) regulates the maximum level of a number of chemicals in food, including aflatoxins. According to the Regulations, the limits for total aflatoxins are 20 μg/kg for peanuts and peanut products and 15 μg/kg for all other foods.

The Previous Local Study

3.6 The FEHD conducted a study on aflatoxins in food in 2001. The study used surveillance data from 1998 – 2000 of food products in which more commonly associated with AFs, namely peanuts and its products, vegetable oils and fat and cereal and cereal products. The results were compared against the statutory limits stipulated in Cap. 132AF and that only one peanut butter sample out of 526 samples were found to exceed the regulatory limit.[13]

Results and Discussions

Concentrations of Aflatoxins in TDS Foods

3.7 A total of 240 composite samples of 60 food items collected on four occasions were tested for AFs and the results in 12 TDS food groups are summarised in Table 3.1 and the results in 60 TDS food items are shown in Table A in Appendix I.

Table 3.1 Aflatoxins Content (µg/kg) in TDS Food Groups of the 1st HKTDS

Food Group	Number of composite samples	% of test results < LOD	Mean (µg/kg)	
			MB	LB - UB
Cereals and their products	76	97.0	0.14	0.05 - 0.24
Vegetables and their products	8	100.0	0.10	0.00 - 0.20
Legumes, nuts and seeds and their products	24	81.3	1.42	1.34 - 1.50
Fruits	4	100.0	0.10	0.00 - 0.20
Meat, poultry and game and their products	36	98.6	0.11	0.01 - 0.21
Fats and oils	4	56.3	0.46	0.41 - 0.52
Beverages, alcoholic	8	100.0	0.10	0.00 - 0.20
Beverages, non-alcoholic	16	100.0	0.10	0.00 - 0.20
Mixed dishes	44	100.0	0.10	0.00 - 0.20
Snack foods	4	100.0	0.10	0.00 - 0.20
Sugars and confectionery	4	87.5	0.15	0.06 - 0.24
Condiments, sauces and herbs	12	100.0	0.10	0.00 - 0.20
Total	240	96.0		

Notes: Medium bound (MD) figures (ND = LOD/2) were used for mean. Lower bound (LB) and upper bound (UB) figures (ND = 0, ND = LOD) were used for range. ND denotes non-detected, i.e. results less than LOD.

3.8 In this study, about 96 % of the test results were not detected with aflatoxins. The highest mean level was detected in food group "Legumes, nuts and seeds and their products" (mean: 1.42 µg/kg), followed by "Fats and oils" (mean: 0.46 µg/kg), "Sugars and confectionery" (mean: 0.15 µg/kg) and "Cereals and their products" (mean: 0.14 µg/kg) at lower levels (medium bound (MB) figures). By comparing the mean levels in 60 food items, peanut butter was found to contain the highest level (mean: 6.35 µg/kg, maximum: 14.48 µg/kg) followed by peanuts (mean: 1.72 µg/kg maximum: 5.46 µg/kg), Chinese pastries (mean: 0.88 µg/kg, maximum: 1.39 µg/kg) and vegetable oil (mean:

0.46 μg/kg, maximum: 1.12 μg/kg)) (MB). As for peanuts, they are known to be particularly prone to AF contamination when compared with other crops like dried fruit, seeds, cereals, which are also vulnerable to AF contamination.[14] The vegetable oil composite samples included peanut oil and corn oil in samples collected during all four quarters, which they are made from crops that are known to be major sources of AFs as described in paragraph 3.1. The mean AFs levels of other food items with detected levels are all lower than 0.2 μg/kg (range of mean: 0.11 to 0.17 μg/kg). AFMs was not included in the analysis because they exist only in dairy and dairy products, after the animals had ingested feeds contaminated with AFBs. AFM1 is also much less potent (ten times) when compared with AFB1, the AF with the most concern.

Dietary Exposure to Aflatoxins

3.9 JECFA stated in 1997 that as AFs are carcinogens, the intake should be reduced to as low as reasonably possible. Dietary exposures to aflatoxins of average and high consumers of the population were 0.0002 – 0.0028 μg/kg bw/day and 0.0009 – 0.0049 μg/kg bw/day. In Hong Kong, liver cancer is among the top five most common cancers from 1985 – 2004 for both sexes. Hepatitis B virus is often associated with liver cancer. The age-standardised incidence rates for liver cancer dropped significantly in the mid-1990s for both sexes, possibly due to the new-born vaccination programme for hepatitis B that began in 1988 in Hong Kong.[15] Approximately up to 10% of some groups of Hong Kong population is hepatitis B carrier.[16] With reference to method used in evaluating the potency of aflatoxins by JECFA, the estimated potency of aflatoxins for Hong Kong population is 0.033 to 0.039 cancers per year/100 000 people per ng of aflatoxins/kg of body weight per day.[17] Aflatoxins is estimated to possibly contribute up to 7.71 cancers per year in Hong Kong, using the Census and Statistics Department provisional data for 2010 mid-year Hong Kong population of 7.0612 million[18] and the average UB aflatoxins exposure level of 0.0028 μg/kg bw/day. Aflatoxins contribute to less than 1% of cancer cases when compare with the 17.3 incidence rate per 100 000 standard population (i.e. approximately 1 222 cases per year) of liver cancers in Hong Kong in 2010.[19]

3.10 The breakdowns of dietary exposure of the individual age-gender population subgroups are shown in Table A in Appendix II. For average consumers of various age groups in both genders, the exposure is very close to the mean level for the whole population (0.0002 – 0.0028 μg/kg bw/day).

Major Food Contributors

3.11 The main dietary source of AFs was "Cereals and their products" which contributed to 56 % of the total dietary exposure for the average of the population even though the mean concentration is not particularly high. However, due to the high consumption amount (491 g/person/day) of "Cereals and their products" of the Hong Kong population, they became the major food contributor of AFs. Similarly because of high consumption amount, the Second French TDS in 2011 where French adults estimated to have more than 70 % of the dietary AFs contributed by products of cereal origins with upper bound estimations, even though all samples in those categories are not detected with AFs.[14]

International Comparison

3.12 The dietary exposure to AFs found in current study were compared to those obtained from other places and are summarised in Table 3.2. The dietary exposure estimated in our study was comparable with exposure estimates obtained from other countries. However, direct comparison of the data has to be done with caution due to the difference in time when the studies were carried out, research methodology, methods of collection of consumption data, methods of contaminants analysis and methods of treating results below detection limits.

Table 3.2 A Comparison of Dietary Exposure to Aflatoxins (μg/kg bw/day)

	Average	High Consumer
France 2011[a]	0.000886	0.001537
Hong Kong	0.0002 – 0.0028	0.0009 – 0.0049
China 2007[b]	0.01109	0.4131
Ireland 2011[c]	0.003 – 0.018	0.006 – 0.039

Notes:

[a] The 2nd French TDS 2011 covers adults aged 18 - 79. The upper-bound (UB) exposure data are calculated from addition of exposure data of AFB1, AFB2, AFG1 and AFG2. High consumer is represented by 95th percentile data.[14]

[b] Exposure of a "standard person", i.e. adult male with light labour job. Converted from "person/day" data and a body weight of 60 kg is assumed. High consumer is represented by 97.5th percentile data.[20]

[c] High consumer is represented by 97.5th percentile data.[21]

Summary

3.13 The dietary exposure to AFs for average and high consumers of the population are 0.0002 – 0.0028 μg/kg bw/day and 0.0009 – 0.0049 μg/kg bw/day. The level is comparable to the levels reported in studies in other countries. As AFs are carcinogens, the intake should be reduced to as low as reasonably possible.

Chapter 4

Ochratoxins

4.1 Ochratoxins are toxic fungal metabolites. The most common one is ochratoxin A (OTA) and ochratoxin B (OTB) is less common. Ochratoxins are produced by members of three distinct groups of fungus, namely *Penicillium verrucosum*, *Asperigillus ochraceus* and related species (e.g. *A. westerdijikae* and *A. steynii*) and *Asperigillus carbonarius*. Other *Aspergillus* and *Penicillium* species like *A. niger* (related to *A. carbonarius*) and *P. nordicum* are also known to be a minor producer of ochratoxins.[22]

4.2 Ochratoxins are unusual in a sense that many of the fungi involved are not plant pathogens, but infect grains and crops after harvest and during storage. For example, while there is no evidence of infection before harvest, *P. verrucosum* can grow slowly at both low temperature (0 - 31°C, optimal 20°C) and low water activity (down to A_w = 0.80) in harvested cereals. These properties contribute to the presence of OTA in cereals in Europe. The exceptions include *A. carbonarius*, which can infect dried grapes (raisins) before or during harvest due to insect or mechanical damages, where the fungal growth can continue into the early stage of the drying process due to the favourable supply of substrates and moisture from grapes. Green coffee beans are also prone to ochratoxin infection, as weather is often misty or rainy during harvest in major coffee production areas in tropical highlands, where the condition is often not optimal for sun-drying.[22]

Sources of Exposure

4.3 The major source of ochratoxin exposure is mainly through consumption of cereals, even in temperate climate areas like Europe. The status of ochratoxins in cereals of the tropical zones is not clear, although there is a report that the OTA producing *A. ochraceus* has been isolated from Southeast Asian commodities like maize (corn), peanuts, soybeans, other beans, cashews and sorghum, probably due to storage. Through the cleaning, scouring, bran removal during grain processing and baking, white bread can achieve at most 75% removal of ochratoxins.[22] Other contributors include dried grapes (raisins) and beans like soy, cocoa and coffee.[1] Roasting of coffee beans are known to remove ochratoxins, but the amount varies greatly even though the darker roasts generally have higher percentage removed. In wine, ochratoxins are consistently removed during the wine-making process during the solid-liquid separation.[22] OTB occurs extremely rarely.[1]

Toxicity

4.4 OTA is mainly and effectively absorbed from the small intestine of the gastrointestinal tract. It is then distributed in the body through blood and mainly to the kidneys and lesser amount to the liver, muscles and fat. OTA can also transfer to milk in humans, rats and rabbits, but not in ruminants as the microorganisms in them can hydrolyze OTA. A rat study suggest that OTA are effectively absorbed through from the gastrointestinal tract, but elimination was slow and there was little biotransformation.[23]

4.5 Increased incidence of hepatocellular tumours in mice and renal-cell adenomas and carcinomas in male mice and rats of both sex were reported. In human, some studies suggested a correlation between exposure to OTA and

Balkan endemic nephropathy and correlation between the geographical distribution of Balkan endemic nephropathy and a high incidence of mortality from urothelial urinary tract tumours. The IARC classified OTA as Group 2B agent (i.e. possibly carcinogenic to humans) in 1993.[24]

4.6 JECFA has evaluated the safety of OTA. Based on the key toxicity effect of OTA to kidneys, and also nephropathy and immunosuppression in a number of animal species including pigs, JECFA has established a Provisional Tolerable Weekly Intake (PTWI) of 0.112 μg/kg bw/week in its 37th Meeting in 1991, rounding to 0.100 μg/kg bw/week in its 44th Meeting in 1995 and has re-affirmed the PTWI in its 56th Meeting in 2001.[23]

The Previous Local Study

4.7 The CFS conducted a study on OTA in Food of secondary school students in 2006. The dietary exposure to OTA for average and high consumers of the secondary school students were 0.00388 and 0.00897 μg/kg bw/week respectively. Both levels fell well below the PTWI of 0.1 μg/kg bw/week. The study concluded that both the average and high consumers of the secondary school students were unlikely to experience major toxicological effects of OTA.[25]

Results and Discussions

Concentrations of Ochratoxin A in TDS Foods

4.8 A total of 240 composite samples of 60 food items collected on four occasions were tested for OTA and the results in 12 TDS food groups are summarised in Table 4.1 and the results of OTA in 60 out of 150 TDS food items are shown in Table B of Appendix I.

Table 4.1 Ochratoxin A (OTA) Content (µg/kg) in TDS Food Groups of the 1st HKTDS

Food Group	Number of composite samples	% of analysis < LOD	Mean (µg/kg)	
			MB	LB - UB
Cereals and their products	76	61.8	0.09	0.07 - 0.10
Vegetables and their products	8	100.0	0.03	0.00 - 0.05
Legumes, nuts and seeds and their products	24	79.2	0.07	0.05 - 0.09
Fruits	4	100.0	0.03	0.00 - 0.05
Meat, poultry and game and their products	36	91.7	0.03	0.01 - 0.05
Fats and oils	4	75.0	0.03	0.02 - 0.05
Beverages, alcoholic	8	100.0	0.03	0.00 - 0.05
Beverages, non-alcoholic	16	100.0	0.03	0.00 - 0.05
Mixed dishes	44	88.6	0.03	0.01 - 0.06
Snack foods	4	100.0	0.03	0.00 - 0.05
Sugars and confectionery	4	0.0	0.22	0.22 - 0.22
Condiments, sauces and herbs	12	100.0	0.03	0.00 - 0.05
Total	240	80.4		

Notes: Medium bound (MB) figures (ND = LOD/2) were used for mean. Lower bound (LB) and upper bound (UB) figures (ND = 0, ND = LOD) were used for range. ND denotes non-detected, i.e. results less than LOD.

4.9 In this study, about 80 % of the composite samples were not detected with OTA. OTA was detected in low levels in food groups which are mainly of cereals and seeds origin, which agreed with those reported in literature.

Dietary Exposure to Ochratoxin A

4.10 The dietary exposure to OTA of average and high consumers of the population were 0.0013 – 0.0054 μg/kg bw/week and 0.0036 – 0.0092 μg/kg bw/week which accounted for only 1.3 – 5.4 % and 3.6 – 9.2 % of the PTWI established by JECFA respectively. Therefore, the general population was unlikely to experience major undesirable health effects of OTA. The breakdowns of dietary exposure of the individual age-gender population subgroups are shown in Table B of Appendix II. The estimated dietary exposure to OTA for average and high consumers of all age-gender groups are well below the PTWI.

Major Food Contributors

4.11 The major dietary source of OTA was "Cereals and their products" which contributed to 70 % of the total dietary exposure for the average of the population. This is in line with the other studies in other countries.

International Comparison

4.12 The dietary exposure estimated in our study were comparable with those reported by the French and Irish studies (Table 4.2). However, direct comparison of the data has to be done with caution due to the difference in time when the studies were carried out, research methodology, methods of collection of consumption data, methods of contaminants analysis and methods of treating results below detection limits.

Table 4.2 A Comparison of Dietary Exposure to Ochratoxin A (μg/kg bw/week)

	Average	High Consumer
Hong Kong	0.0013 – 0.0054	0.0036 – 0.0092
France 2011[a]	0.00196 – 0.01337	0.00427 – 0.02261
Ireland 2011[b]	0.0014 – 0.028	0.0063 – 0.070

Notes:
[a] The above data from the 2nd French TDS 2011 covers adults aged 18 - 79. High consumer is represented by 95th percentile data.[14]
[b] The range represents the lower and upper bound exposure. High consumer is represented by 97.5th percentile data.[21]

Summary

4.13 The dietary exposure to OTA for average and high consumers of the population accounted for only 1.3 – 5.4 % and 3.6 – 9.2 % of the PTWI of 0.1 μg/kg bw/week respectively. On this basis, the general population was unlikely to experience major undesirable health effects of OTA.

Chapter 5

Fumonisins

5.1 Fumonisins (FUMs) are mycotoxins produced by fungus (mould) of the *Fusarium* genus. Significant amount of fumonisins can be produced by two major species of fumonisin-producing *Fusarium*: *Fusarium verticillioides* (Sacc.) Nirenberg and related species and *F. proliferatum* (Matsushima) Nirenberg. They are most frequently associated with diseases of both damaged and undamaged maize worldwide. At least ten other *Fusarium* species are also known to produce fumonisin. Hot and dry climate and insect damage to crops are known to increase the chance of fumonisin formation.[26]

5.2 Fumonisins are classified into different "series", namely A, B, C, P and H. The fumonisin B_1 (FB1), fumonisin B_2 (FB2) and fumonisin B_3 (FB3) in the "B" series are the most common in nature.[26]

Sources of Exposure

5.3 The main pathways of exposure to fumonisins are believed to be through diet. Food of maize origin represents the major source of fumonisin exposure, but fumonisins are also found in millets, sorghum, and also rice and beans. Populations where maize and maize products are the staples (e.g. populations in Central and South America) have more chance of ingesting higher amount of fumonisins. On the other hand, researches noticed that fumonisin are generally not found in animal products, e.g. beef muscles, cow's milk and chicken eggs. Only cows that are fed with feed that are highly contaminated with fumonisins will lead to detection of fumonisins in beef muscles. Fumonisins are only found in pig kidneys and liver during feeding with contaminated feed.[26]

Toxicity

5.4 Acute mycotoxicosis with fumonisins is very uncommon. An investigation of a 1995 outbreak among low socio-economic status people in India revealed high levels of FB1 and AFB1 in unleavened bread made with mouldy maize and sorghum. As there are very few studies on the acute toxicity of fumonisins, some believe that pure FB1 is not acutely toxic. FB1 targets the liver in all animals and kidneys in many animals.[26]

5.5 IARC in 1993 classified toxins derived from *Fusarium moniliforme* (e.g. FB1, FB2, fusarin C) as Group 2B agents (i.e., possibly carcinogenic to humans).[27] Furthermore, IARC has classified FB1 as Group 2B agent in 2002.[28] JECFA had established a Provisional Maximum Tolerable Daily Intake (PMTDI) of 2 μg/kg bw for the sum of FB1, FB2 and FB3 in 2010.[26]

Results and Discussions

Concentrations of Fumonisins in TDS Foods

5.6 A total of 240 composite samples of 60 food items collected on four occasions were tested for fumonisins. The results in 12 TDS food groups are summarised in Table 5.1 and the results in 60 TDS food items are shown in Table C of Appendix I.

Table 5.1 Fumonisins (FUMs) Content (µg/kg) in TDS Food Groups of the 1st HKTDS

Food Group	Number of composite samples	% of analysis < LOD	Mean (µg/kg)	
			MB	LB - UB
Cereals and their products	76	95.6	6.17	2.58 - 9.76
Vegetables and their products	8	100.0	3.75	0.00 - 7.50
Legumes, nuts and seeds and their products	24	100.0	3.75	0.00 - 7.50
Fruits	4	100.0	3.75	0.00 - 7.50
Meat, poultry and game and their products	36	100.0	3.75	0.00 - 7.50
Fats and oils	4	100.0	3.75	0.00 - 7.50
Beverages, alcoholic	8	100.0	3.75	0.00 - 7.50
Beverages, non-alcoholic	16	100.0	3.75	0.00 - 7.50
Mixed dishes	44	100.0	3.75	0.00 - 7.50
Snack foods	4	91.7	4.41	0.98 - 7.85
Sugars and confectionery	4	100.0	3.75	0.00 - 7.50
Condiments, sauces and herbs	12	94.4	4.57	1.03 - 8.11
Total	240	98.2		

Notes: Medium bound (MB) figures (ND = LOD/2) were used for mean. Lower bound (LB) and upper bound (UB) figures (ND = 0, ND = LOD) were used for range. ND denotes non-detected, i.e. results less than LOD.

5.7 In this study, about 98 % of the composite samples were not detected with FUMs. The highest FUMs level was detected in food group "Cereals and their products" (mean: 6.17 µg/kg (MB)). By comparing the FUMs levels in the 60 TDS food items, breakfast cereals were found to contain the highest level (mean: 49.73 µg/kg (MB)). All other "Cereals and their products" samples were not detected. These results agreed with findings from literature that maize contained relatively higher levels of FUMs. Only two other food items (potato chips and cornstarch) were found to contain FUMs.

Dietary Exposure to Fumonisins

5.8 The PMTDI of 2 μg/kg bw/day for FUMs (sum of FB1, FB2 and FB3) had been established by JECFA in 2001. Dietary exposure to fumonisins the population were 0.0016 – 0.0973 μg/kg bw/day for average consumer and 0.0008 – 0.1692 μg/kg bw/day for high consumer, which accounted for 0.08 – 4.9 % and 0.04 – 8.5 % of the PMTDI, respectively. The breakdowns of dietary exposure of the individual age-gender population subgroups are shown in Table C of Appendix II. The dietary exposure of all individual age-gender population subgroups were well below the PMTDI. Therefore, the general population was unlikely to experience major undesirable health effects of FUMs.

Major Food Contributors

5.9 The main dietary source of FUMs was "Cereals and their products", which contributed to 63 % of the total dietary exposure for the average of the population. As stated in the previous paragraph, only "Breakfast cereals" was found to have FUM detected for that food group.

International Comparison

5.10 The dietary exposure to FUMs found in current study were compared to those obtained from other places and are summarised in Table 5.2. It can be seen that the dietary exposure estimated in our study are comparable with exposure estimates obtained from other places. However, direct comparison of the data has to be done with caution due to the difference in time when the studies were carried out, research methodology, methods of collection of consumption data, methods of contaminants analysis and methods of treating results below detection limits.

Table 5.2 A Comparison of Dietary Exposure to FUMs (μg/kg bw/day)

	Average	**High Consumer**
France 2011[a]	0.00989 – 0.0449	0.0325 – 0.1011
Hong Kong	0.0016 – 0.0973	0.0008 – 0.1692

Notes:
[a] Only FB1 and FB2 was analyzed. The above data from 2nd French TDS 2011 covers adults aged 18 - 79. High consumer is represented by 95th percentile data.[14]

Summary

5.11 The dietary exposure to FUMs for average and high consumers of the population accounted for about 0.08 – 4.9 % of the PMTDI for average consumer and 0.04 – 8.5 % of the PMTDI for high consumers. On this basis, the general population was unlikely to experience major undesirable health effects of FUMs.

Chapter 6

Deoxynivalenol

6.1 Deoxynivalenol (DON), which is also known as vomitoxin, is produced by moulds of the *Fusarium* family. It is mainly produced by *F. graminearum* and *F. culmorum* and can cause plant diseases like *Fusarium* head blight (FHB) in wheat and gibberella ear rot in maize. FHB is directly related to DON contamination in wheat and is strongly associated with moisture level during flowering, where timing of rainfall is the critical factor. DON is mainly found in grains like wheat, barley, oats, rye and maize, and less often in rice, sorghum and triticale.[29]

6.2 DON and the related acetyldeoxynivalenols (AcDONs) are type B trichothecenes and DON is the most commonly detected one. Trichlothecenes are heat stable at 120°C. DON is of limited systemic bioavailability based on animal studies in sheep (7.5%) and rats (25%). Most of them are excreted in faeces and urine in rats. DON has been implicated in mycotoxin poisoning cases in both humans and farm animals.[29]

Sources of Exposure

6.3 DON enters the body through the consumption of grains contaminated by *Fusarium*. Although DON can be transmitted to eggs, only very low percentages (0.19 % maximum) of the daily dose of DON ended up in eggs. No detection of DON in milk in a long term feeding study.[29]

Toxicity

6.4 DON can cause adverse effects in animals after single, short-term or long-term feeding, leading to the two major effects of feed refusal (in turn lead to reduced growth) and vomiting, plus skin irritations, diarrhoea, haemorrhage, neural disturbance, abortion and death. There have been possible interactions between OTA and DON. In animal experiments conducted with naturally contaminated feed seems to be more toxic than animals feed with pure DON, suggesting that the presence of mycotoxins other than DON. In humans, DON can cause nausea, vomiting, diarrhoea, abdominal pain, headache, dizziness and fever, which can develop within 30 minutes of exposure. Such symptoms are not easy to distinguish from other gastrointestinal illnesses like those caused by *Bacillus cereus*. No human death from exposure to DON was reported. Possible co-effect between trichothescenes and zearalenone in maize had been suggested.[29]

6.5 IARC in 1993 classified toxins derived from *Fusarium graminearum*, *F. culmorum* and *F. crookwellense*: zearalenone, deoxynivalenol, nivalenol and fusarenone X as Group 3 agent (i.e., not classifiable as to their carcinogenicity to humans).[30] JECFA had established in 2010 a group provisional maximum tolerable daily intake (PMTDI) of 1 μg/kg bw for DON and its acetylated derivatives.[31]

Results and Discussions

Concentrations of DON and AcDONs in TDS Foods

6.6 A total of 240 composite samples of 60 food items collected on four occasions were tested for DON and the results in 12 TDS food groups are summarised in Table 6.1 and the results in 60 TDS food items are shown in Table D of Appendix I.

Table 6.1 DON and AcDONs Content (µg/kg) in TDS Food Groups of the 1st HKTDS

Food Group	Number of composite samples	% of analysis < LOD	Mean (µg/kg)	
			MB	LB - UB
Cereals and their products	76	63.2	31.53	29.95 - 33.11
Vegetables and their products	8	100.0	2.50	0.00 - 5.00
Legumes, nuts and seeds and their products	24	100.0	2.50	0.00 - 5.00
Fruits	4	100.0	2.50	0.00 - 5.00
Meat, poultry and game and their products	36	100.0	2.50	0.00 - 5.00
Fats and oils	4	100.0	2.50	0.00 - 5.00
Beverages, alcoholic	8	100.0	2.50	0.00 - 5.00
Beverages, non-alcoholic	16	87.5	3.83	1.64 - 6.02
Mixed dishes	44	78.4	12.53	10.57 - 14.49
Snack foods	4	100.0	2.50	0.00 - 5.00
Sugars and confectionery	4	75.0	5.53	3.65 - 7.40
Condiments, sauces and herbs	12	100.0	2.50	0.00 - 5.00
Total	240	83.1		

Notes: Medium bound (MB) figures (ND = LOD/2) were used for mean. Lower bound (LB) and upper bound (UB) figures (ND = 0, ND = LOD) were used for range. ND denotes non-detected, i.e. results less than LOD.

6.7 In this study, about 83 % of the composite samples were not detected with DON and AcDON. The highest DON and AcDONs level was detected in food group "Cereals and their products" (mean: 31.53 µg/kg), followed by "Mixed dishes" (mean: 12.53 µg/kg) (MB). By comparing the total DON and AcDON levels in 60 food items, biscuits was found to contain the highest mean level (177.25 μg/kg) followed by Chinese steamed bread (67.25 μg/kg) and breakfast cereals (61.00 μg/kg) (MB). As the bounded form of DON (i.e. deoxynivalenol-3-β-glucoside (DON-3G)) is not analysed in this study, there are possibly some underestimation in the level of DON in food samples. This in turn may also affect the level of dietary exposure. However, the bioavailability of the bounded forms of DON in human is not clear, as some researchers suggest that the human bioavailability of DON-3G is low when compared with DON,[32] while others suggest that DON and ZEN can be effectively deconjugated by the human colonic microbiota.[33]

Dietary Exposure to DON and AcDONs

6.8 Dietary exposure to total DON and AcDON of average and high consumers of the population were 0.0861 – 0.1426 μg/kg bw/day and 0.2166 – 0.2824 μg/kg bw/day, corresponding to 8.6 – 14.3 % and 21.7 – 28.2 % of the PMTDI respectively.

6.9 The breakdowns of dietary exposure of the individual age-gender population subgroups are shown in Table D of Appendix II. The dietary exposure of all individual age-gender population subgroups were well below the PMTDI. Therefore, the general population was unlikely to experience major undesirable health effects of DON and AcDONs.

Major Food Contributors

6.10 The main dietary source of DON and AcDONs was “Cereals and their products”, which contributed to 80% of the total dietary exposure for the average of the population. The other major source was "Mixed dishes" which contributed to 10% of the total exposure.

International Comparison

6.11 The dietary exposure to total DON and AcDON found in current study were compared to those obtained from other places and are summarised in Table 6.2. It can be seen that the dietary exposure estimated in our study are comparable with exposure estimates obtained from other places. However, direct comparison of the data has to be done with caution due to the difference in time when the studies were carried out, research methodology, methods of collection of consumption data, methods of contaminants analysis and methods of treating results below detection limits.

Table 6.2. A Comparison of Dietary Exposure to total DON and AcDON (μg/kg bw/day)

	Average	**High Consumer**
Belgium 2013[a]	0.1162	0.4047
Hong Kong	0.0861 – 0.1426	0.2166 – 0.2824
China 2005[b]	0.1488	0.8785
France 2011[c]	0.373 – 0.411	0.716 – 0.768

Notes:

[a] The intake data were calculated with levels of sum of DON-equivalents and their masked forms. The bioavailability of the masked forms is unclear. High consumer is represented by 95th percentile data.[34]

[b] Study covered 6 provinces. Data here are for male above 15 years old. High consumer is represented by 95th percentile data.[35]

[c] The above data from 2nd French TDS 2011 covers adults aged 18 - 79. High consumer is represented by 95th percentile data. The analysis included DON, 3-AcDON and 15-AcDON.[14]

Summary

6.12 Dietary exposure to total DON and AcDON of average and high consumers of the population were 0.0861 – 0.1426 μg/kg bw/day and 0.2166 –

0.2824 μg/kg bw/day, which correspond to 8.6 – 14.3 % and 21.7 – 28.2 % of the PMTDI respectively.

Chapter 7

Zearalenone

7.1 Zearalenone (ZEA) is a mycotoxin that is produced by certain moulds of the *Fusarium* family, which are found in a wide range of geographical areas. ZEA have non-steroidal estrogenic activities and have been implicated in many mycotoxins poisoning cases in farm animals, especially in pigs, where swelling of vulva and alternations in reproductive tract was reported. ZEA is heat stable and are found in bread. It is also moderately stable under fermentation and is also found in beer in Africa. The concentration of ZEA varies widely and is likely to be related to the amount of rainfall and the method of crop production. Its presence in animal products is insignificant. It has a wide geographical distribution.[36]

Sources of Exposure

7.2 The source of exposure to ZEA in humans is through consumption of food. The major source is through grains and grain products, especially in maize and wheat. ZEA is also reported to be found in barley, oats, rice, sorghum, and to a lesser extent, in bananas. It is possible to find ZEA in animal products like meat, fish, poultry, milk and eggs in experimental setting.[36]

Toxicity

7.3 ZEA can cause acute toxicity in animal studies, causing young female pigs to have vulva vaginitis and enlarged reproductive tracts after taking ZEA orally in capsules for a week. Short term studies with mice suggests that it may affect reproductive organs and cause osteoporosis in both sexes. ZEA can depress weight gain and cause osteoporosis in both sexes in rats. It can also affect seminal vesicles, prostate, mammary gland, uterus and pituitary at higher levels. A study found that ZEA can cause oedematous swelling and reddening of vulva in suckling piglets.[36]

7.4 In long term studies, female pigs, and to a lesser extent rats and minks, found that ZEA can cause reproductive and developmental effects. Vulvar swelling and reddening was observed through exposure but symptoms disappeared slowly when ZEA was withdrawn. ZEA was found to significantly increase the inter-estrus interval in sexually mature female pigs when fed 200 or 400 µg/kg bw/day. ZEA was found to have some hormonal effects in cell line and animal studies. There was also a well-known case where zearalenone or zearalanol was suspected to cause an epidemic of premature breast development (thelarche) in girls 6 months to 8 years old in Puerto Rico from 1978 to 1981. Zearalenone or its metabolite zearalenol were found in blood plasma. Locally produced meat and natural estrogenic compounds were suspected to be the source. However, this could not be confirmed with the analysis of food samples at that time.[28] IARC had concluded in 1993 that ZEA has limited carcinogenicity in experimental animals (Group 3). It has little effect on genotoxicity in animal studies.[36]

Results and Discussions

Concentrations of ZEA in TDS Foods

7.5 A total 240 TDS food items of 60 food items collected on four occasions were analysed for ZEA and it metabolites alpha- and beta-ZOLs.

The results in TDS food groups are summarised in Table 7.1 and the results in 60 TDS food items are shown in Table E of Appendix I.

Table 7.1. Zearalenone Content (μg/kg) in TDS Food Groups of the 1st HKTDS

TDS Food Category	Number of composite samples	% of test results <LOD	Mean (μg/kg)	
			MB	LB - UB
Cereals and their products	76	98.3	3.88	0.19 - 7.56
Vegetables and their products	8	100.0	3.75	0.00 - 7.50
Legumes, nuts and seeds and their products	24	100.0	3.75	0.00 - 7.50
Fruits	4	100.0	3.75	0.00 - 7.50
Meat, poultry and game and their products	36	99.1	3.84	0.13 - 7.56
Fats and oils	4	66.7	51.25	48.75 - 53.75
Beverages, alcoholic	8	100.0	3.75	0.00 - 7.50
Beverages, non-alcoholic	16	100.0	3.75	0.00 - 7.50
Mixed dishes	44	100.0	3.75	0.00 - 7.50
Snack foods	4	91.7	5.69	2.25 - 9.13
Sugars and confectionery	4	41.7	16.59	15.03 - 18.15
Condiments, sauces and herbs	12	88.9	5.00	1.67 - 8.33
Total	240	97.0		

Notes: Medium bound (MB) figures (ND = LOD/2) were used for mean. Lower bound (LB) and upper bound (UB) figures (ND = 0, ND = LOD) were used for range. ND denotes non-detected, i.e., results less than LOD.

7.6 In this study, about 97 % of the composite samples were not detected with ZEA compounds. The highest level was detected in food group "Fats and oils" (mean level: 51.25 μg/kg, (MB)). All other food groups contained relatively low levels of ZEA (mean: less than 6 μg/kg except for the food group "Sugars and confectionery" at 16.59 μg/kg). Higher level of ZEA (4 600 μg/kg) had been reported in corn oil in New Zealand[28] and in comparison, the highest ZEA level in the vegetable oil composite sample in our study is 112.5 μg/kg. The reason may be due to the fact that the composite samples include corn oil, which is more likely to contain ZEA than other vegetable oils. The bounded form of ZEA are not analysed in this study, therefore there may be some underestimation in the level of ZEA in food samples. This in turn may also affect the level of dietary exposure. However, the bioavailability of the bounded forms of ZEA in human is not clear, although some researchers suggest that ZEN can be effectively deconjugated by the human colonic microbiota.[33]

Dietary Exposure to Zearalenone

7.7 JECFA has set a Provisional Maximum Tolerable Daily Intake (PMTDI) of 0.5 µg/kg bw/day in 2000 for zearalenone and its metabolites including zearalenol.[28] Dietary exposure to ZEA of average and high consumers of the population were 0.0061 – 0.1015 µg/kg bw/day and 0.0166 – 0.1724 µg/kg bw/day which account for 1.2 – 20.3 % and 3.3 – 34.5 % of PMTDI, respectively. It is estimated that all of the adult population had dietary ZEA exposure lower than the PMTDI.

7.8 The breakdowns of dietary exposure of the individual age-gender population subgroups are shown in Table E of Appendix II. The estimated dietary exposure to ZEA for average consumers of all age-gender groups are well below the PMTDI.

Major Food Contributors

7.9 The main dietary source of ZEA was “Cereals and their products” which contributed to 55 % of the total dietary exposure for the average of the population. Among “Cereals and their products”, only “breakfast cereals” (mean: 5.74 µg/kg, maximum: 9.10 µg/kg) and “biscuits” (mean: 4.16 µg/kg, maximum: 5.40 µg/kg) had detected level of ZEA. However, due to the high consumption amount (491 g/person/day) of "Cereals and their products" of the Hong Kong population, they became the major food contributor of ZEA.

International Comparison

7.10 The dietary exposure to ZEA found in current study was within similar order of magnitude when compared to exposure estimates obtained from overseas studies in general (Table 7.2). It has been reported that the highest prevalence of ZEA are in Canada, central and northern Europe and the United States. As cereals and cereal products (especially corn and wheat) are the major contributor of ZEA, it is expected that a population that has high consumption of cereals and their products would have higher exposure to ZEA. However, direct comparison of the data has to be done with caution due to the difference in time when the studies were carried out, research methodology, methods of collection of consumption data, methods of contaminants analysis and methods of treating results below detection limits.

Table 7.2 A Comparison of Dietary Exposure to Zearalenone (ZEA) (µg/kg bw/day)

	Average	**High Consumer**
France 2011[a]	0.0059 - 0.0255	0.0108 - 0.0425
Belgium 2013[b]	0.0447	0.1568
Hong Kong	0.0061 – 0.1015	0.0166 – 0.1724

Notes:

[a] The 2nd French TDS 2011 covers adults aged 18 - 79. High consumer is represented by 95th percentile exposure data.[14]

[b] The intake data were calculated with levels of ZEAs and their masked forms. The bioavailability of the masked forms is unclear. High consumer is represented by 95th percentile data.[34]

Summary

7.11 Dietary exposure to ZEA of average and high consumers of the population are 0.0061 – 0.1015 μg/kg bw/day and 0.0166 – 0.1724 μg/kg bw/day, which account for 1.2 – 20.3 % and 3.3 – 34.5 % of the PMTDI of 0.5 μg/kg bw/day respectively. The exposure of the Hong Kong adult population to ZEA does not suggest any significant health impact, even for high consumers.

Chapter 8

Conclusions and Recommendations

8.1 The dietary exposure of average and high consumers of the population to aflatoxins (sum of AFB1, AFB2, AFG1 and AFG2) are 0.0002 – 0.0028 and 0.0009 – 0.0049 μg/kg bw/day. The dietary exposure of average and high consumers of the population to ochratoxin A (OTA) are 0.0013 – 0.0054 and 0.0036 – 0.0092 μg/kg bw/week, which accounted for 1.3 – 5.4 % and 3.6 – 9.2 % of the PTWI of 0.1 μg/kg bw/week. The dietary exposure of average and high consumers of the population to fumonisins (FUM) are 0.0016 – 0.0973 and 0.0008 – 0.1692 μg/kg bw/day, which accounted for 0.08 – 4.9 % and 0.04 – 8.5 % of the PMTDI of 2 μg/kg bw/day. The dietary exposure of average and high consumers of the population to total deoxynivalenol and acetyldeoxynivalenols (DON and AcDONs) are 0.0861 – 0.1426 and 0.2166 – 0.2824 μg/kg bw/day, which accounted for 8.6 – 14.3 % and 21.7 – 28.2% of the PMTDI of 1 μg/kg bw/day. The dietary exposure of average and high consumers of the population to zearalenone (ZEA) are 0.0061 – 0.1015 and 0.0166 – 0.1724 μg/kg bw/day, which accounted for 1.2 – 20.3 % and 3.3 – 34.5 % of the PMTDI of 0.5 μg/kg bw/day. All dietary exposure estimates were below their respective health based guidance values, where available. Based on estimated aflatoxins intake and the prevalence of hepatitis B carriers in Hong Kong, aflatoxins contributed approximately eight cases of liver cancer per year in Hong Kong population, which accounted for less than 1% of the age-standardized incidence rate of liver cancer in 2010 in Hong Kong. There is no cause of undue alarm. The findings suggested that the general adult population was unlikely to experience major undesirable health effects of the above mycotoxins.

Recommendations

8.2 Based on the findings of this study advice to the public and trade were formulated for reducing the potential risks associated with dietary exposure to mycotoxins:

<u>Advice to the Public</u>

- Purchase from reliable retailers.
- Store cereals and grains products properly in cool dry places.
- Maintain a balanced and varied diet as to avoid excessive exposure to mycotoxins from a small range of food items.
- Look out for the durability and expiration date of food.
- Discard foods that look mouldy or damaged.
- Since nuts contain many nutrients, such as unsaturated fatty acids, high quality protein, fibre, vitamins and minerals, people may include unsalted nuts as part of a well-balanced diet and consume unsalted nuts in moderation.

<u>Advice to the Trade</u>

- Observe good agricultural practices and good manufacturing practices/HACCP to minimize mycotoxin contamination of foods.

- Obtain food materials from reliable suppliers.

- Maintain good storage conditions. Store food in cool and dry places and rotate stock on a first-in-first-out basis.

- Maintain proper records to enable source tracing when required.

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Appendix I

Table A: Aflatoxins (AFs) Contents (μg/kg) in TDS Foods of the 1st HKTDS

TDS Food Item	Number of composite samples	% of test results < LOD	Mean (μg/kg)	
			MB	LB to UB
Cereals and their products	**76**	**97.0**	**0.14**	**0.05 - 0.24**
Rice, white			0.10	0.00 - 0.20
Rice, unpolished			0.10	0.00 - 0.20
Corn			0.10	0.00 - 0.20
Noodles, Chinese or Japanese style			0.10	0.00 - 0.20
Pasta, Western style			0.10	0.00 - 0.20
Instant noodles			0.10	0.00 - 0.20
Noodles, rice			0.14	0.06 - 0.23
Bread, plain			0.10	0.00 - 0.20
Bread, raisin			0.10	0.00 - 0.20
"Pineapple" bun			0.10	0.00 - 0.20
Sausage/ham/luncheon meat bun			0.10	0.00 - 0.20
Chinese steamed bread			0.10	0.00 - 0.20
Biscuits			0.10	0.00 - 0.20
Cakes			0.10	0.00 - 0.20
Pastries			0.10	0.00 - 0.20
Pastries, Chinese			0.88	0.83 - 0.94
Oatmeal			0.10	0.00 - 0.20
Breakfast cereals			0.10	0.00 - 0.20
Deep-fried dough			0.10	0.00 - 0.20
Vegetables and their products	**8**	**100.0**	**0.10**	**0.00 - 0.20**
Potato			0.10	0.00 - 0.20
Potato, fried			0.10	0.00 - 0.20
Legumes, nuts and seeds and their products	**24**	**81.3**	**1.42**	**1.34 - 1.50**
Green string beans, with pod			0.10	0.00 - 0.20
Mung bean vermicelli			0.10	0.00 - 0.20
Beancurd			0.10	0.00 - 0.20
Fermented bean products			0.15	0.06 - 0.25
Peanut			1.72	1.64 - 1.79
Peanut butter			6.35	6.34 - 6.37
Fruits	**4**	**100.0**	**0.10**	**0.00 - 0.20**
Grapes			0.10	0.00 - 0.20
Meat, poultry and game and their products	**36**	**98.6**	**0.11**	**0.01 - 0.21**
Pork			0.10	0.00 - 0.20
Ham			0.10	0.00 - 0.20
Luncheon meat			0.17	0.07 - 0.26
Barbecued pork			0.11	0.02 - 0.21
Roasted pork			0.10	0.00 - 0.20

TDS Food Item	Number of composite samples	% of test results < LOD	Mean (μg/kg)	
			MB	LB to UB
Pig liver			0.10	0.00 - 0.20
Chicken, soy sauce			0.10	0.00 - 0.20
Roasted duck/goose			0.10	0.00 - 0.20
Meat sausage			0.10	0.00 - 0.20
Fats and oils	**4**	**56.3**	**0.46**	**0.41 - 0.52**
Oil, vegetable			0.46	0.41 - 0.52
Beverages, alcoholic	**8**	**100.0**	**0.10**	**0.00 - 0.20**
Beer			0.10	0.00 - 0.20
Red wine			0.10	0.00 - 0.20
Beverages, non-alcoholic	**16**	**100.0**	**0.10**	**0.00 - 0.20**
Coffee			0.10	0.00 - 0.20
Malt drink			0.10	0.00 - 0.20
Soybean drink			0.10	0.00 - 0.20
Fruit and vegetable juice			0.10	0.00 - 0.20
Mixed dishes	**44**	**100.0**	**0.10**	**0.00 - 0.20**
Siu Mai			0.10	0.00 - 0.20
Dumpling, steamed			0.10	0.00 - 0.20
Dumpling, pan-fried			0.10	0.00 - 0.20
Dumpling, including wonton			0.10	0.00 - 0.20
Steamed barbecued pork bun			0.10	0.00 - 0.20
Turnip cake			0.10	0.00 - 0.20
Steamed minced beef ball			0.10	0.00 - 0.20
Glutinous rice dumpling			0.10	0.00 - 0.20
Steamed rice-rolls with filling			0.10	0.00 - 0.20
Steamed rice-rolls, plain			0.10	0.00 - 0.20
Hamburger			0.10	0.00 - 0.20
Snack foods	**4**	**100.0**	**0.10**	**0.00 - 0.20**
Potato chips			0.10	0.00 - 0.20
Sugars and confectionery	**4**	**87.5**	**0.15**	**0.06 - 0.24**
Chocolate			0.15	0.06 - 0.24
Condiments, sauces and herbs	**12**	**100.0**	**0.10**	**0.00 - 0.20**
Soya sauce			0.10	0.00 - 0.20
Oyster sauce			0.10	0.00 - 0.20
Cornstarch			0.10	0.00 - 0.20

Table B: Ochratoxin A (OTA) Contents (μg/kg) in TDS Foods of the 1st HKTDS

TDS Food Group/Item	Number of composite samples	% of test results < LOD	Mean (μg/kg)	
			MB	LB to UB
Cereals and their products	**76**	**61.8**	**0.09**	**0.07 - 0.10**
Rice, white			0.03	0.00 - 0.05
Rice, unpolished			0.03	0.00 - 0.05
Corn			0.03	0.00 - 0.05
Noodles, Chinese or Japanese style			0.03	0.00 - 0.05
Pasta, Western style			0.04	0.02 - 0.06
Instant noodles			0.03	0.00 - 0.05
Noodles, rice			0.03	0.00 - 0.05
Bread, plain			0.19	0.19 - 0.19
Bread, raisin			0.23	0.23 - 0.23
"Pineapple" bun			0.18	0.18 - 0.18
Sausage/ham/luncheon meat bun			0.15	0.15 - 0.15
Chinese steamed bread			0.04	0.03 - 0.06
Biscuits			0.06	0.05 - 0.08
Cakes			0.06	0.04 - 0.07
Pastries			0.03	0.00 - 0.05
Pastries, Chinese			0.05	0.03 - 0.07
Oatmeal			0.03	0.00 - 0.05
Breakfast cereals			0.37	0.36 - 0.38
Deep-fried dough			0.11	0.11 - 0.12
Vegetables and their products	**8**	**100.0**	**0.03**	**0.00 - 0.05**
Potato			0.03	0.00 - 0.05
Potato, fried			0.03	0.00 - 0.05
Legumes, nuts and seeds and their products	**24**	**79.2**	**0.07**	**0.05 - 0.09**
Green string beans, with pod			0.03	0.00 - 0.05
Mung bean vermicelli			0.03	0.00 - 0.05
Beancurd			0.03	0.00 - 0.05
Fermented bean products			0.18	0.17 - 0.19
Peanut			0.08	0.07 - 0.10
Peanut butter			0.09	0.08 - 0.11
Fruits	**4**	**100.0**	**0.03**	**0.00 - 0.05**
Grapes			0.03	0.00 - 0.05
Meat, poultry and game and their products	**36**	**91.7**	**0.03**	**0.01 - 0.05**
Pork			0.03	0.00 - 0.05
Ham			0.04	0.02 - 0.06
Luncheon meat			0.03	0.01 - 0.05
Barbecued pork			0.03	0.02 - 0.05
Roasted pork			0.03	0.00 - 0.05
Pig liver			0.03	0.00 - 0.05

TDS Food Group/Item	Number of composite samples	% of test results < LOD	Mean (µg/kg)	
			MB	LB to UB
Chicken, soy sauce			0.03	0.00 - 0.05
Roasted duck/goose			0.03	0.00 - 0.05
Meat sausage			0.03	0.00 - 0.05
Fats and oils	**4**	**75.0**	**0.03**	**0.02 - 0.05**
Oil, vegetable			0.03	0.02 - 0.05
Beverages, alcoholic	**8**	**100.0**	**0.03**	**0.00 - 0.05**
Beer			0.03	0.00 - 0.05
Red wine			0.03	0.00 - 0.05
Beverages, non-alcoholic	**16**	**100.0**	**0.03**	**0.00 - 0.05**
Coffee			0.03	0.00 - 0.05
Malt drink			0.03	0.00 - 0.05
Soybean drink			0.03	0.00 - 0.05
Fruit and vegetable juice			0.03	0.00 - 0.05
Mixed dishes	**44**	**88.6**	**0.03**	**0.01 - 0.06**
Siu Mai			0.03	0.00 - 0.05
Dumpling, steamed			0.05	0.03 - 0.07
Dumpling, pan-fried			0.03	0.00 - 0.05
Dumpling, including wonton			0.03	0.00 - 0.05
Steamed barbecued pork bun			0.03	0.00 - 0.05
Turnip cake			0.03	0.00 - 0.05
Steamed minced beef ball			0.03	0.00 - 0.05
Glutinous rice dumpling			0.03	0.00 - 0.05
Steamed rice-rolls with filling			0.03	0.00 - 0.05
Steamed rice-rolls, plain			0.03	0.00 - 0.05
Hamburger			0.10	0.10 - 0.10
Snack foods	**4**	**100.0**	**0.03**	**0.00 - 0.05**
Potato chips			0.03	0.00 - 0.05
Sugars and confectionery	**4**	**0.0**	**0.22**	**0.22 - 0.22**
Chocolate			0.22	0.22 - 0.22
Condiments, sauces and herbs	**12**	**100.0**	**0.03**	**0.00 - 0.05**
Soya sauce			0.03	0.00 - 0.05
Oyster sauce			0.03	0.00 - 0.05
Cornstarch			0.03	0.00 - 0.05

Table C: Fumonisins (FUMs) Contents (μg/kg) in TDS Foods of the 1st HKTDS

TDS Food Item	Number of composite samples	% of test results < LOD	Mean (μg/kg)	
			MB	LB to UB
Cereals and their products	**76**	**95.6**	**6.17**	**2.58 - 9.76**
Rice, white			3.75	0.00 - 7.50
Rice, unpolished			3.75	0.00 - 7.50
Corn			3.75	0.00 - 7.50
Noodles, Chinese or Japanese style			3.75	0.00 - 7.50
Pasta, Western style			3.75	0.00 - 7.50
Instant noodles			3.75	0.00 - 7.50
Noodles, rice			3.75	0.00 - 7.50
Bread, plain			3.75	0.00 - 7.50
Bread, raisin			3.75	0.00 - 7.50
"Pineapple" bun			3.75	0.00 - 7.50
Sausage/ham/luncheon meat bun			3.75	0.00 - 7.50
Chinese steamed bread			3.75	0.00 - 7.50
Biscuits			3.75	0.00 - 7.50
Cakes			3.75	0.00 - 7.50
Pastries			3.75	0.00 - 7.50
Pastries, Chinese			3.75	0.00 - 7.50
Oatmeal			3.75	0.00 - 7.50
Breakfast cereals			49.73	49.10 - 50.35
Deep-fried dough			3.75	0.00 - 7.50
Vegetables and their products	**8**	**100.0**	**3.75**	**0.00 - 7.50**
Potato			3.75	0.00 - 7.50
Potato, fried			3.75	0.00 - 7.50
Legumes, nuts and seeds and their products	**24**	**100.0**	**3.75**	**0.00 - 7.50**
Green string beans, with pod			3.75	0.00 - 7.50
Mung bean vermicelli			3.75	0.00 - 7.50
Beancurd			3.75	0.00 - 7.50
Fermented bean products			3.75	0.00 - 7.50
Peanut			3.75	0.00 - 7.50
Peanut butter			3.75	0.00 - 7.50
Fruits	**4**	**100.0**	**3.75**	**0.00 - 7.50**
Grapes			3.75	0.00 - 7.50
Meat, poultry and game and their products	**36**	**100.0**	**3.75**	**0.00 - 7.50**
Pork			3.75	0.00 - 7.50
Ham			3.75	0.00 - 7.50
Luncheon meat			3.75	0.00 - 7.50
Barbecued pork			3.75	0.00 - 7.50
Roasted pork			3.75	0.00 - 7.50
Pig liver			3.75	0.00 - 7.50

TDS Food Item	Number of composite samples	% of test results < LOD	Mean (μg/kg)	
			MB	LB to UB
Chicken, soy sauce			3.75	0.00 - 7.50
Roasted duck/goose			3.75	0.00 - 7.50
Meat sausage			3.75	0.00 - 7.50
Fats and oils	**4**	**100.0**	**3.75**	**0.00 - 7.50**
Oil, vegetable			3.75	0.00 - 7.50
Beverages, alcoholic	**8**	**100.0**	**3.75**	**0.00 - 7.50**
Beer			3.75	0.00 - 7.50
Red wine			3.75	0.00 - 7.50
Beverages, non-alcoholic	**16**	**100.0**	**3.75**	**0.00 - 7.50**
Coffee			3.75	0.00 - 7.50
Malt drink			3.75	0.00 - 7.50
Soybean drink			3.75	0.00 - 7.50
Fruit and vegetable juice			3.75	0.00 - 7.50
Mixed dishes	**44**	**100.0**	**3.75**	**0.00 - 7.50**
Siu Mai			3.75	0.00 - 7.50
Dumpling, steamed			3.75	0.00 - 7.50
Dumpling, pan-fried			3.75	0.00 - 7.50
Dumpling, including wonton			3.75	0.00 - 7.50
Steamed barbecued pork bun			3.75	0.00 - 7.50
Turnip cake			3.75	0.00 - 7.50
Steamed minced beef ball			3.75	0.00 - 7.50
Glutinous rice dumpling			3.75	0.00 - 7.50
Steamed rice-rolls with filling			3.75	0.00 - 7.50
Steamed rice-rolls, plain			3.75	0.00 - 7.50
Hamburger			3.75	0.00 - 7.50
Snack foods	**4**	**91.7**	**4.41**	**0.98 - 7.85**
Potato chips			4.41	0.98 - 7.85
Sugars and confectionery	**4**	**100.0**	**3.75**	**0.00 - 7.50**
Chocolate			3.75	0.00 - 7.50
Condiments, sauces and herbs	**12**	**94.4**	**4.57**	**1.03 - 8.11**
Soya sauce			3.75	0.00 - 7.50
Oyster sauce			3.75	0.00 - 7.50
Cornstarch			6.20	3.08 - 9.33

Table D: Deoxynivalenol (DON) and Acetyldeoxynivalenols (AcDONs) Contents (μg/kg) in TDS Foods of the 1st HKTDS

TDS Food Item	Number of composite samples	% of test results < LOD	Mean (μg/kg)	
			MB	LB to UB
Cereals and their products	**76**	**63.2**	**31.53**	**29.95 - 33.11**
Rice, white			2.50	0.00 - 5.00
Rice, unpolished			2.50	0.00 - 5.00
Corn			2.50	0.00 - 5.00
Noodles, Chinese or Japanese style			27.83	26.58 - 29.08
Pasta, Western style			21.78	20.53 - 23.03
Instant noodles			13.60	12.35 - 14.85
Noodles, rice			2.50	0.00 - 5.00
Bread, plain			41.50	40.25 - 42.75
Bread, raisin			30.00	28.75 - 31.25
"Pineapple" bun			30.50	29.25 - 31.75
Sausage/ham/luncheon meat bun			26.00	24.75 - 27.25
Chinese steamed bread			67.25	66.00 - 68.50
Biscuits			177.25	176.00 - 178.50
Cakes			14.33	13.08 - 15.58
Pastries			26.25	25.00 - 27.50
Pastries, Chinese			35.60	34.35 - 36.85
Oatmeal			2.50	0.00 - 5.00
Breakfast cereals			61.00	59.75 - 62.25
Deep-fried dough			13.73	12.48 - 14.98
Vegetables and their products	**8**	**100.0**	**2.50**	**0.00 - 5.00**
Potato			2.50	0.00 - 5.00
Potato, fried			2.50	0.00 - 5.00
Legumes, nuts and seeds and their products	**24**	**100.0**	**2.50**	**0.00 - 5.00**
Green string beans, with pod			2.50	0.00 - 5.00
Mung bean vermicelli			2.50	0.00 - 5.00
Beancurd			2.50	0.00 - 5.00
Fermented bean products			2.50	0.00 - 5.00
Peanut			2.50	0.00 - 5.00
Peanut butter			2.50	0.00 - 5.00
Fruits	**4**	**100.0**	**2.50**	**0.00 - 5.00**
Grapes			2.50	0.00 - 5.00
Meat, poultry and game and their products	**36**	**100.0**	**2.50**	**0.00 - 5.00**
Pork			2.50	0.00 - 5.00
Ham			2.50	0.00 - 5.00
Luncheon meat			2.50	0.00 - 5.00
Barbecued pork			2.50	0.00 - 5.00
Roasted pork			2.50	0.00 - 5.00
Pig liver			2.50	0.00 - 5.00

TDS Food Item	Number of composite samples	% of test results < LOD	Mean (µg/kg)	
			MB	LB to UB
Chicken, soy sauce			2.50	0.00 - 5.00
Roasted duck/goose			2.50	0.00 - 5.00
Meat sausage			2.50	0.00 - 5.00
Fats and oils	**4**	**100.0**	**2.50**	**0.00 - 5.00**
Oil, vegetable			2.50	0.00 - 5.00
Beverages, alcoholic	**8**	**100.0**	**2.50**	**0.00 - 5.00**
Beer			2.50	0.00 - 5.00
Red wine			2.50	0.00 - 5.00
Beverages, non-alcoholic	**16**	**87.5**	**3.83**	**1.64 - 6.02**
Coffee			2.50	0.00 - 5.00
Malt drink			7.83	6.58 - 9.08
Soybean drink			2.50	0.00 - 5.00
Fruit and vegetable juice			2.50	0.00 - 5.00
Mixed dishes	**44**	**78.4**	**12.53**	**10.57 - 14.49**
Siu Mai			2.50	0.00 - 5.00
Dumpling, steamed			9.51	7.95 - 11.08
Dumpling, pan-fried			26.50	25.25 - 27.75
Dumpling, including wonton			7.55	6.30 - 8.80
Steamed barbecued pork bun			57.00	55.75 - 58.25
Turnip cake			2.50	0.00 - 5.00
Steamed minced beef ball			2.50	0.00 - 5.00
Glutinous rice dumpling			2.50	0.00 - 5.00
Steamed rice-rolls with filling			2.50	0.00 - 5.00
Steamed rice-rolls, plain			2.50	0.00 - 5.00
Hamburger			22.25	21.00 - 23.50
Snack foods	**4**	**100.0**	**2.50**	**0.00 - 5.00**
Potato chips			2.50	0.00 - 5.00
Sugars and confectionery	**4**	**75.0**	**5.53**	**3.65 - 7.40**
Chocolate			5.53	3.65 - 7.40
Condiments, sauces and herbs	**12**	**100.0**	**2.50**	**0.00 - 5.00**
Soya sauce			2.50	0.00 - 5.00
Oyster sauce			2.50	0.00 - 5.00
Cornstarch			2.50	0.00 - 5.00

Table E: Zearalenone (ZEA) Contents (μg/kg) in TDS Foods of the 1st HKTDS

TDS Food Item	Number of composite samples	% of test results < LOD	Mean (μg/kg)	
			MB	LB to UB
<u>Cereals and their products</u>	**76**	**98.3**	**3.88**	**0.19 - 7.56**
Rice, white			3.75	0.00 - 7.50
Rice, unpolished			3.75	0.00 - 7.50
Corn			3.75	0.00 - 7.50
Noodles, Chinese or Japanese style			3.75	0.00 - 7.50
Pasta, Western style			3.75	0.00 - 7.50
Instant noodles			3.75	0.00 - 7.50
Noodles, rice			3.75	0.00 - 7.50
Bread, plain			3.75	0.00 - 7.50
Bread, raisin			3.75	0.00 - 7.50
"Pineapple" bun			3.75	0.00 - 7.50
Sausage/ham/luncheon meat bun			3.75	0.00 - 7.50
Chinese steamed bread			3.75	0.00 - 7.50
Biscuits			4.16	0.73 - 7.60
Cakes			3.75	0.00 - 7.50
Pastries			3.75	0.00 - 7.50
Pastries, Chinese			3.75	0.00 - 7.50
Oatmeal			3.75	0.00 - 7.50
Breakfast cereals			5.74	2.93 - 8.55
Deep-fried dough			3.75	0.00 - 7.50
<u>Vegetables and their products</u>	**8**	**100.0**	**3.75**	**0.00 - 7.50**
Potato			3.75	0.00 - 7.50
Potato, fried			3.75	0.00 - 7.50
<u>Legumes, nuts and seeds and their products</u>	**24**	**100.0**	**3.75**	**0.00 - 7.50**
Green string beans, with pod			3.75	0.00 - 7.50
Mung bean vermicelli			3.75	0.00 - 7.50
Beancurd			3.75	0.00 - 7.50
Fermented bean products			3.75	0.00 - 7.50
Peanut			3.75	0.00 - 7.50
Peanut butter			3.75	0.00 - 7.50
Fruits	**4**	**100.0**	**3.75**	**0.00 - 7.50**
Grapes			3.75	0.00 - 7.50
<u>Meat, poultry and game and their products</u>	**36**	**99.1**	**3.84**	**0.13 - 7.56**
Pork			3.75	0.00 - 7.50
Ham			3.75	0.00 - 7.50
Luncheon meat			4.56	1.13 - 8.00
Barbecued pork			3.75	0.00 - 7.50
Roasted pork			3.75	0.00 - 7.50
Pig liver			3.75	0.00 - 7.50

TDS Food Item	Number of composite samples	% of test results < LOD	Mean (µg/kg)	
			MB	LB to UB
Chicken, soy sauce			3.75	0.00 - 7.50
Roasted duck/goose			3.75	0.00 - 7.50
Meat sausage			3.75	0.00 - 7.50
Fats and oils	**4**	**66.7**	**51.25**	**48.75 - 53.75**
Oil, vegetable			51.25	48.75 - 53.75
Beverages, alcoholic	**8**	**100.0**	**3.75**	**0.00 - 7.50**
Beer			3.75	0.00 - 7.50
Red wine			3.75	0.00 - 7.50
Beverages, non-alcoholic	**16**	**100.0**	**3.75**	**0.00 - 7.50**
Coffee			3.75	0.00 - 7.50
Malt drink			3.75	0.00 - 7.50
Soybean drink			3.75	0.00 - 7.50
Fruit and vegetable juice			3.75	0.00 - 7.50
Mixed dishes	**44**	**100.0**	**3.75**	**0.00 - 7.50**
Siu Mai			3.75	0.00 - 7.50
Dumpling, steamed			3.75	0.00 - 7.50
Dumpling, pan-fried			3.75	0.00 - 7.50
Dumpling, including wonton			3.75	0.00 - 7.50
Steamed barbecued pork bun			3.75	0.00 - 7.50
Turnip cake			3.75	0.00 - 7.50
Steamed minced beef ball			3.75	0.00 - 7.50
Glutinous rice dumpling			3.75	0.00 - 7.50
Steamed rice-rolls with filling			3.75	0.00 - 7.50
Steamed rice-rolls, plain			3.75	0.00 - 7.50
Hamburger			3.75	0.00 - 7.50
Snack foods	**4**	**91.7**	**5.69**	**2.25 - 9.13**
Potato chips			5.69	2.25 - 9.13
Sugars and confectionery	**4**	**41.7**	**16.59**	**15.03 - 18.15**
Chocolate			16.59	15.03 - 18.15
Condiments, sauces and herbs	**12**	**88.9**	**5.00**	**1.67 - 8.33**
Soya sauce			3.75	0.00 - 7.50
Oyster sauce			3.75	0.00 - 7.50
Cornstarch			7.50	5.00 - 10.00

Appendix II

Table A: Dietary Exposure to Aflatoxins (AFs) by Age-gender Groups (Average and High Consumers of the Population)

Age-gender groups	Dietary Exposure# (µg/kg bw/day)	
	Average	High Consumers@
Male aged 20 – 29	0.0002 - 0.0030	0.0006 - 0.0051
Female aged 20 – 29	0.0003 - 0.0028	0.0010 - 0.0050
Male aged 30 – 39	0.0002 - 0.0031	0.0010 - 0.0056
Female aged 30 – 39	0.0003 - 0.0028	0.0010 - 0.0052
Male aged 40 – 49	0.0002 - 0.0030	0.0008 - 0.0054
Female aged 40 – 49	0.0003 - 0.0026	0.0011 - 0.0044
Male aged 50 – 59	0.0002 - 0.0030	0.0010 - 0.0052
Female aged 50 – 59	0.0003 - 0.0026	0.0010 - 0.0046
Male aged 60 – 69	0.0002 - 0.0028	0.0010 - 0.0049
Female aged 60 – 69	0.0002 - 0.0023	0.0006 - 0.0040
Male aged 70 – 84	0.0001 - 0.0025	0.0006 - 0.0041
Female aged 70 – 84	0.0002 - 0.0022	0.0008 - 0.0039
Male aged 20 – 84	0.0002 - 0.0029	0.0009 - 0.0052
Female aged 20 – 84	0.0003 - 0.0026	0.0009 - 0.0046
Adult aged 20 – 84	**0.0002 - 0.0028**	**0.0009 - 0.0049**

The exposure is presented as a range, where the assumption "ND = 0" is used for lower bound (LB) figures and "ND = LOD" is used for upper bound (UB) figures.

@ Exposure of high consumers refer to the exposure at 95th percentile.

Table B: Dietary Exposure to Ochratoxin A (OTA) by Age-gender Groups (Average and High Consumers of the Population)

Age-gender groups	Dietary Exposure# (µg/kg bw/week)	
	Average	High Consumers@
Male aged 20 – 29	0.0013 - 0.0058	0.0034 - 0.0097
Female aged 20 – 29	0.0017 - 0.0056	0.0038 - 0.0093
Male aged 30 – 39	0.0013 - 0.0059	0.0036 - 0.0104
Female aged 30 – 39	0.0015 - 0.0055	0.0042 - 0.0094
Male aged 40 – 49	0.0012 - 0.0057	0.0036 - 0.0098
Female aged 40 – 49	0.0015 - 0.0053	0.0037 - 0.0088
Male aged 50 – 59	0.0014 - 0.0058	0.0038 - 0.0099
Female aged 50 – 59	0.0013 - 0.0050	0.0033 - 0.0086
Male aged 60 – 69	0.0011 - 0.0054	0.0035 - 0.0093
Female aged 60 – 69	0.0010 - 0.0045	0.0029 - 0.0077
Male aged 70 – 84	0.0009 - 0.0047	0.0028 - 0.0077
Female aged 70 – 84	0.0011 - 0.0044	0.0034 - 0.0076
Male aged 20-84	0.0012 - 0.0057	0.0035 - 0.0097
Female aged 20 – 84	0.0014 - 0.0052	0.0036 - 0.0089
Adult aged 20 – 84	**0.0013 - 0.0054**	**0.0036 - 0.0092**

The exposure is presented as a range, where the assumption "ND = 0" is used for lower bound (LB) figures and "ND = LOD" is used for upper bound (UB) figures.

@ Exposure of high consumers refer to the exposure at 95th percentile.

Table C: Dietary Exposure to Fumonisins (FUMs) by Age-gender Groups (Average and High Consumers of the Population)

Age-gender groups	Dietary Exposure# (μg/kg bw/day)	
	Average	High Consumers@
Male aged 20 – 29	0.0008 - 0.1064	0.0006 - 0.1866
Female aged 20 – 29	0.0010 - 0.0963	0.0008 - 0.1704
Male aged 30 – 39	0.0019 - 0.1087	0.0009 - 0.1894
Female aged 30 – 39	0.0020 - 0.0970	0.0008 - 0.1697
Male aged 40 – 49	0.0017 - 0.1051	0.0005 - 0.1854
Female aged 40 – 49	0.0015 - 0.0914	0.0008 - 0.1505
Male aged 50 – 59	0.0025 - 0.1064	0.0008 - 0.1828
Female aged 50 – 59	0.0015 - 0.0881	0.0007 - 0.1557
Male aged 60 – 69	0.0010 - 0.1000	0.0006 - 0.1719
Female aged 60 – 69	0.0021 - 0.0824	0.0189 - 0.1443
Male aged 70 – 84	0.0012 - 0.0898	0.0004 - 0.1443
Female aged 70 – 84	0.0019 - 0.0800	0.0010 - 0.1369
Male aged 20 – 84	0.0016 - 0.1043	0.0007 - 0.1809
Female aged 20 – 84	0.0016 - 0.0911	0.0008 - 0.1565
Adult aged 20 – 84	**0.0016 - 0.0973**	**0.0008 - 0.1692**

\# The exposure is presented as a range, where the assumption "ND = 0" is used for lower bound (LB) figures and "ND = LOD" is used for upper bound (UB) figures.

@ Exposure of high consumers refer to the exposure at 95th percentile.

Table D: Dietary Exposure to Deoxynivalenol (DON) and Acetyldeoxynivalenols (AcDONs) by Age-gender Groups (Average and High Consumer of the Population)

Age-gender groups	Dietary Exposure# (μg/kg bw/day)	
	Average	High Consumer@
Male aged 20 – 29	0.0873 - 0.1489	0.2165 - 0.2938
Female aged 20 – 29	0.1089 - 0.1630	0.2507 - 0.3278
Male aged 30 – 39	0.0832 - 0.1461	0.1858 - 0.2681
Female aged 30 – 39	0.0997 - 0.1547	0.2476 - 0.3177
Male aged 40 – 49	0.0789 - 0.1407	0.1908 - 0.2838
Female aged 40 – 49	0.0959 - 0.1480	0.2391 - 0.2897
Male aged 50 – 59	0.0792 - 0.1419	0.1919 - 0.2579
Female aged 50 – 59	0.0850 - 0.1362	0.2051 - 0.2619
Male aged 60 – 69	0.0668 - 0.1279	0.1664 - 0.2356
Female aged 60 – 69	0.0668 - 0.1154	0.1709 - 0.2238
Male aged 70 – 84	0.0636 - 0.1183	0.1646 - 0.2183
Female aged 70 – 84	0.0738 - 0.1211	0.1929 - 0.2452
Male aged 20 – 84	0.0786 - 0.1400	0.1943 - 0.2708
Female aged 20 – 84	0.0927 - 0.1450	0.2314 - 0.2910
Adult aged 20 – 84	**0.0861 - 0.1426**	**0.2166 - 0.2824**

The exposure is presented as a range, where the assumption "ND = 0" is used for lower bound (LB) figures and "ND = LOD" is used for upper bound (UB) figures.

@ Exposure of high consumers refer to the exposure at 95th percentile.

Table E: Dietary Exposure to Zearalenone (ZEA) by Age-gender Groups (Average and High Consumer of the Population)

Age-gender groups	Dietary Exposure# (µg/kg bw/day)	
	Average	High Consumer@
Male aged 20 – 29	0.0057 - 0.1109	0.0151 - 0.1829
Female aged 20 – 29	0.0063 - 0.1011	0.0169 - 0.1782
Male aged 30 – 39	0.0050 - 0.1116	0.0155 - 0.1945
Female aged 30 – 39	0.0063 - 0.1010	0.0173 - 0.1726
Male aged 40 – 49	0.0058 - 0.1090	0.0137 - 0.1942
Female aged 40 – 49	0.0063 - 0.0959	0.0178 - 0.1550
Male aged 50 – 59	0.0062 - 0.1100	0.0167 - 0.1781
Female aged 50 – 59	0.0062 - 0.0925	0.0156 - 0.1585
Male aged 60 – 69	0.0066 - 0.1053	0.0175 - 0.1776
Female aged 60 – 69	0.0069 - 0.0870	0.0175 - 0.1449
Male aged 70 – 84	0.0061 - 0.0944	0.0166 - 0.1499
Female aged 70 – 84	0.0060 - 0.0839	0.0172 - 0.1388
Male aged 20 – 84	0.0058 - 0.1083	0.0158 - 0.1841
Female aged 20 – 84	0.0063 - 0.0955	0.0171 - 0.1598
Adult aged 20 – 84	**0.0061 - 0.1015**	**0.0166 - 0.1724**

The exposure is presented as a range, where the assumption "ND = 0" is used for lower bound (LB) figures and "ND = LOD" is used for upper bound (UB) figures.

@ Exposure of high consumers refer to the exposure at 95th percentile.

Appendix III

A Summary of Estimated Dietary Exposure to Mycotoxins of the Hong Kong Adult Population

Contaminant	**Health Based Guidance Value**	**Estimated Dietary Exposure# (% Contribution to Health Based Guidance Value)**	
		Average Consumers	**High Consumers (95th percentile)**
Aflatoxins	NA (Intake as low as reasonably possible)	0.0002 – 0.0028 µg/kg bw/day (NA)	0.0009 – 0.0049 µg/kg bw/day (NA)
Ochratoxin A	PTWI: 0.1 µg/kg bw	0.0013 – 0.0054 µg/kg bw/week (1.3 – 5.4 % PTWI)	0.0036 – 0.0092 µg/kg bw/week (3.6 – 9.2 % PTWI)
Fumonisins	PMTDI: 2 µg/kg bw	0.0016 – 0.0973 µg/kg bw/day (0.08 – 4.9 % PMTDI)	0.0008 – 0.1692 µg/kg bw/day (0.04 – 8.5 % PMTDI)
Deoxynivalenol and acetyldeoxynivalenols	PMTDI: 1 µg/kg bw	0.0861 – 0.1426 µg/kg bw/day (8.6 – 14.3 % PMTDI)	0.2166 – 0.2824 µg/kg bw/day (21.7 – 28.2 % PMTDI)
Zearalenone	PMTDI: 0.5 µg/kg bw	0.0061 – 0.1015 µg/kg bw/day (1.2 – 20.3 % PMTDI)	0.0166 – 0.1724 µg/kg bw/day (3.3 – 34.5 % PMTDI)

The exposure is presented as a range, where the assumption "ND = 0" is used for lower bound (LB) figures and "ND = LOD" is used for upper bound (UB) figures