

Supplementary Material: First Total Diet Study of Aflatoxins in Singapore: Exposure Risk, High-Risk Foods, and Public Health Implications

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Table S1. Total aflatoxin (AFT) concentrations of commonly consumed food in Singapore

Entry	Food Category	n ^a	n+ ^b	Mean AFT ^c Concentration (µg/kg)	
				MB ^d	LB – UB ^e
1	Nuts and seeds	4	3	0.28	0.27 – 0.30
2	Grains products	26	2	0.04	0.01 – 0.07
3	Rice products	17	2	0.04	0.01 – 0.07
4	Infant food	146	6	0.03	0.003 – 0.06
5	Bakery and confectionary	18	1	0.08	0.05 – 0.11
6	Other plant products	212	4	0.04	0.01 – 0.07
6.1	Vegetables	144	2	0.05	0.02 – 0.08
6.11	<i>Brassica vegetables</i>	10	0	0.03	0 – 0.06
6.12	<i>Fruiting vegetables</i>	21	0	0.03	0 – 0.06
6.13	<i>Fungi, seaweed</i>	12	0	0.03	0 – 0.06
6.14	<i>Leafy vegetables, herbs</i>	33	0	0.03	0 – 0.06
6.15	<i>Legumes</i>	18	2	0.16	0.13 – 0.19
6.16	<i>Root and tubers</i>	22	0	0.03	0 – 0.06
6.17	<i>Stalk, stem and bulb vegetables</i>	28	0	0.03	0 – 0.06
6.2	Fruits	57	0	0.03	0 – 0.06
6.3	Vegetable protein	6	0	0.03	0 – 0.06
6.4	Plant oils	5	2	0.11	0.09 – 0.13
7	Animal products	175	0	0.03	0 – 0.06
7.1	Meat products	54	0	0.03	0 – 0.06
7.2	Seafood products	91	0	0.03	0 – 0.06
7.3	Dairy products	16	0	0.03	0 – 0.06
7.4	Egg products	12	0	0.03	0 – 0.06
7.5	Animal Fats and oils	2	0	0.03	0 – 0.06
8	Sauces and condiments	28	5	0.12	0.09 – 0.14
9	Beverages	16	2	0.05	0.02 – 0.08
Total		642	25	26.55	7.81 – 45.49
Mean				0.04	0.01 – 0.07

^a n: number of composite samples. ^b n+: number of positive samples.

^c Total Aflatoxins (AFT): sum of Aflatoxin B1, Aflatoxin B2, Aflatoxin G1 and Aflatoxin G2.

^d Medium bound (MD) denotes ND = LOD/2.

^e Lower bound (LB) and upper bound (UB) denotes ND = 0 and ND = LOD respectively.

Table S2. Estimated Daily Intake (EDI) of Total Aflatoxins (AFT) for Singaporean consumers

Entry	Food Category	Mean Estimated Daily Intake (EDI) of AFT ^a (ng/kg bw/day)			
		LB – UB ^b			
		Entire population		Eaters-only	
		Mean Consumers	High Consumers (95th percentile)	Mean Consumers	High Consumers (95th percentile)
1	Nuts and seeds	0.001 – 0.001	0.008 – 0.009	0.037 – 0.042	0.108 – 0.125
2	Grains products	0.001 – 0.003	0.003 – 0.014	0.011 – 0.081	0.026 – 0.196
3	Rice products	0.001 – 0.012	0.007 – 0.073	0.013 – 0.113	0.028 – 0.260
4	Infant food	0.00001 – 0.001	0 – 0.003	0.002 – 0.035	0.002 – 0.040
5	Bakery and confectionary	0.0001 – 0.001	0 – 0.005	0.038 – 0.092	0.078 – 0.179
6	Other plant products	0.0001 – 0.002	0.00005 – 0.009	0.006 – 0.052	0.013 – 0.128
6.1	Vegetables	0.0002 – 0.002	0.00008 – 0.010	0.010 – 0.046	0.017 – 0.122
6.11	<i>Brassica vegetables</i>	0 – 0.004	0 – 0.017	0 – 0.039	0 – 0.108
6.12	<i>Fruiting vegetables</i>	0 – 0.002	0 – 0.009	0 – 0.046	0 – 0.139
6.13	<i>Fungi, seaweed</i>	0 – 0.0004	0 – 0.0004	0 – 0.040	0 – 0.105
6.14	<i>Leafy vegetables, herbs</i>	0 – 0.002	0 – 0.010	0 – 0.033	0 – 0.084
6.15	<i>Legumes</i>	0.002 – 0.003	0.0006 – 0.006	0.068 – 0.120	0.138 – 0.263
6.16	<i>Root and tubers</i>	0 – 0.004	0 – 0.024	0 – 0.050	0 – 0.159
6.17	<i>Stalk, stem and bulb vegetables</i>	0 – 0.002	0 – 0.006	0 – 0.014	0 – 0.046
6.2	Fruits	0 – 0.002	0 – 0.009	0 – 0.069	0 – 0.145
6.3	Vegetable protein	0 – 0.0002	0	0 – 0.053	0 – 0.129
6.4	Plant oils	0.0004 – 0.0007	0 – 0.001	0.021 – 0.028	0.067 – 0.089
7	Animal products	0 – 0.001	0 – 0.004	0 – 0.056	0 – 0.130
7.1	Meat products	0 – 0.001	0 – 0.004	0 – 0.070	0 – 0.168
7.2	Seafood products	0 – 0.0007	0 – 0.001	0 – 0.051	0 – 0.115
7.3	Dairy products	0 – 0.003	0 – 0.014	0 – 0.066	0 – 0.147
7.4	Egg products	0 – 0.003	0 – 0.015	0 – 0.031	0 – 0.072
7.5	Animal Fats and oils	0 – 0.0002	0 – 0.0006	0 – 0.003	0 – 0.007
8	Sauces and condiments	0.001 – 0.002	0.003 – 0.008	0.068 – 0.096	0.162 – 0.238
9	Beverages	0.0002 – 0.007	0 – 0.033	0.049 – 0.196	0.091 – 0.404
	Total	0.103 – 1.217	0.324 – 5.529	5.591 – 37.609	12.028 – 82.092
	Mean	0.0002 – 0.002	0.001 – 0.009	0.009 – 0.059	0.019 – 0.128

^a Total Aflatoxins (AFT): sum of Aflatoxin B1, Aflatoxin B2, Aflatoxin G1 and Aflatoxin G2.

^b Lower bound (LB) and upper bound (UB) figures denotes ND = 0 and ND = LOD respectively.

Table S3. Summary of Margin of Exposure (MOE) to Total Aflatoxins (AFT) for Singaporean consumers

Entry	Food Category	Margin of Exposure (MOE) to AFT ^a			
		LB – UB ^b			
		Entire population		Eaters-only	
		Mean Consumers	High Consumers (95th percentile)	Mean Consumers	High Consumers (95th percentile)
1	Nuts and seeds	47619 – 44321	5583 – 5196	1918 – 1785	779 – 725
2	Grains products	12850 – 8367	1932 – 1258	918 – 598	415 – 270
3	Rice products	17329 – 4541	2379 – 781	2149 – 843	557 – 393
4	Infant food	258097 – 2819	* – 439	1290 – 493	1290 – 168
5	Bakery and confectionary	70833 – 12891	* – 2750	248 – 248	122 – 122
6	Other plant products	7101 – 6519	15568 – 1674	167 – 153	87 – 80
6.1	Vegetables	7101 – 6519	15568 – 2089	167 – 153	87 – 80
6.11	<i>Brassica vegetables</i>	* – 24727	* – 4991	* – 2928	* – 1059
6.12	<i>Fruiting vegetables</i>	* – 21673	* – 4888	* – 501	* – 319
6.13	<i>Fungi, seaweed</i>	* – 75556	* – 87742	* – 1156	* – 525
6.14	<i>Leafy vegetables, herbs</i>	* – 15632	* – 2625	* – 1561	* – 918
6.15	<i>Legumes</i>	7101 – 6519	15568 – 8000	167 – 153	87 – 80
6.16	<i>Root and tubers</i>	* – 13600	* – 2089	* – 1504	* – 386
6.17	<i>Stalk, stem and bulb vegetables</i>	* – 40597	* – 12197	* – 3627	* – 863
6.2	Fruits	121429 – 12420	* – 1674	2840 – 654	1141 – 279
6.3	Vegetable protein	* – 709565	*	* – 3199	* – 1314
6.4	Plant oils	193182 – 176166	* – 35325	3247 – 2961	1010 – 921
7	Animal products	* – 6126	* – 877	* – 669	* – 166
7.1	Meat products	* – 20923	* – 3109	* – 842	* – 407
7.2	Seafood products	* – 21587	* – 10112	* – 669	* – 166
7.3	Dairy products	* – 6126	* – 877	* – 887	* – 405
7.4	Egg products	* – 20451	* – 3474	* – 3799	* – 1617
7.5	Animal Fats and oils	* – 906667	* – 302222	* – 51321	* – 25905
8	Sauces and condiments	15755 – 15183	2768 – 2552	106 – 102	53 – 51
9	Beverages	110390 – 3891	* – 654	327 – 258	171 – 135
	Minimum (worst-case)	7101 – 2819	1932 – 439	106 – 102	53 – 51

^a Total Aflatoxins (AFT): sum of Aflatoxin B1, Aflatoxin B2, Aflatoxin G1 and Aflatoxin G2.

^b Lower bound (LB) and upper bound (UB) figures denotes ND = 0 and ND = LOD respectively.

Note: Lowest figures were used to represent worst-case scenario.

* Unable to calculate MOE, due to either zero concentration (ND) or near zero consumption data, or small numbers of consumers-only resulting in a non-consumer at the 95th percentile position.

Table S4. Liver cancer potency in Singaporean from exposure to Total Aflatoxins (AFT)

		Liver Cancer Risk from exposure to AFT ^a (Excess liver cancer Cases/100,000 Persons/year)			
		LB - UB ^b			
Entry	Food Category	Entire population		Eaters-only	
		Mean Consumers	High Consumers (95th percentile)	Mean Consumers	High Consumers (95th percentile)
1	Nuts and seeds	0.0002 – 0.0003	0.002 – 0.002	0.006 – 0.007	0.015 – 0.016
2	Grains products	0.001 – 0.001	0.006 – 0.009	0.013 – 0.020	0.029 – 0.044
3	Rice products	0.001 – 0.003	0.005 – 0.015	0.010 – 0.014	0.021 – 0.030
4	Infant food	0.00005 – 0.004	0 – 0.027	0.009 – 0.024	0.009 – 0.071
5	Bakery and confectionary	0.0002 – 0.001	0 – 0.004	0.048 – 0.048	0.098 – 0.098
6	Other plant products	0.002 - 0.002	0.001 - 0.007	0.071 - 0.078	0.137 - 0.149
6.1	Vegetables	0.002 - 0.002	0.001 - 0.006	0.071 - 0.078	0.137 - 0.149
6.11	<i>Brassica vegetables</i>	0 - 0.0005	0 - 0.002	0 - 0.004	0 - 0.011
6.12	<i>Fruiting vegetables</i>	0 - 0.0005	0 - 0.002	0 - 0.024	0 - 0.037
6.13	<i>Fungi, seaweed</i>	0 - 0.0002	0 - 0.0001	0 - 0.010	0 - 0.023
6.14	<i>Leafy vegetables, herbs</i>	0 - 0.001	0 - 0.005	0 - 0.008	0 - 0.013
6.15	<i>Legumes</i>	0.002 - 0.002	0.001 - 0.001	0.071 - 0.078	0.137 - 0.149
6.16	<i>Root and tubers</i>	0 - 0.001	0 - 0.006	0 - 0.008	0 - 0.031
6.17	<i>Stalk, stem and bulb vegetables</i>	0 - 0.0003	0 - 0.001	0 - 0.003	0 - 0.014
6.2	Fruits	0 - 0.001	0 - 0.007	0 - 0.018	0 - 0.043
6.3	Vegetable protein	0 - 0.00002	0	0 - 0.004	0 - 0.009
6.4	Plant oils	0.0001 - 0.0001	0 - 0.0003	0.004 - 0.004	0.012 - 0.013
7	Animal products	0 - 0.002	0 - 0.014	0 - 0.018	0 - 0.072
7.1	Meat products	0 - 0.001	0 - 0.004	0 - 0.014	0 - 0.029
7.2	Seafood products	0 - 0.001	0 - 0.001	0 - 0.018	0 - 0.072
7.3	Dairy products	0 - 0.002	0 - 0.014	0 - 0.013	0 - 0.029
7.4	Egg products	0 - 0.001	0 - 0.003	0 - 0.003	0 - 0.007
7.5	Animal Fats and oils	0 - 0.00001	0 - 0.00004	0 - 0.0002	0 - 0.0005
8	Sauces and condiments	0.001 - 0.001	0.004 - 0.005	0.112 - 0.116	0.226 - 0.235
9	Beverages	0.0001 - 0.003	0 - 0.018	0.036 - 0.046	0.070 - 0.088
	Maximum (worst-case)	0.002 - 0.004	0.006 - 0.027	0.112 - 0.116	0.226 - 0.235

^a Total Aflatoxins (AFT): sum of Aflatoxin B1, Aflatoxin B2, Aflatoxin G1 and Aflatoxin G2.

^b Lower bound (LB) and upper bound (UB) figures denotes ND = 0 and ND = LOD respectively

Note: Highest figures were used to represent worst-case scenario.

Table S5. Hazard Quotient (HQ) of exposure to Total Aflatoxins (AFT) in Singaporean consumers.

Entry	Food Category	Hazard Quotient of AFT ^a (LB -UB ^b)
		Eaters-only High consumers (95th percentile)
1	Nuts and seeds	0.01 – 0.01
2	Grains products	0.02 – 0.04
3	Rice products	0.02 – 0.03
4	Infant food	0.01 – 0.06
5	Bakery and confectionary	0.08 – 0.08
6	Other plant products	0.11 – 0.13
6.1	Vegetables	0.11 – 0.13
6.11	<i>Brassica vegetables</i>	0 – 0.01
6.12	<i>Fruiting vegetables</i>	0 – 0.03
6.13	<i>Fungi, seaweed</i>	0 – 0.02
6.14	<i>Leafy vegetables, herbs</i>	0 – 0.01
6.15	<i>Legumes</i>	0.11 – 0.13
6.16	<i>Root and tubers</i>	0 – 0.03
6.17	<i>Stalk, stem and bulb vegetables</i>	0 – 0.01
6.2	Fruits	0 – 0.04
6.3	Vegetable protein	0 – 0.01
6.4	Plant oils	0.01 – 0.01
7	Animal products	0 – 0.06
7.1	Meat products	0 – 0.02
7.2	Seafood products	0 – 0.06
7.3	Dairy products	0 – 0.02
7.4	Egg products	0 – 0.01
7.5	Animal Fats and oils	0 – 0.0004
8	Sauces and condiments	0.19 – 0.20
9	Beverages	0.06 – 0.07
Maximum (worst-case)		0.19 – 0.20

^a Total Aflatoxins (AFT): sum of Aflatoxin B1, Aflatoxin B2, Aflatoxin G1 and Aflatoxin G2.

^b Lower bound (LB) and upper bound (UB) figures denotes ND = 0 and ND = LOD respectively.

Note: Highest figures were used to represent worst-case scenario.

Tolerable daily intake (TDI) of 0.017 µg/kg bw/day (lower reference point) was used as reference value for the assessment of immune impairment.