**Supplementary information**

**Concentration, source identification and potential human health risk assessment of heavy metals in chicken meat and hen egg in Bangladesh**

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**Table S1** Analytical conditions for measurement for trace elements in aqueous solution using AAS

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Elements | Wavelength (nm) | Slit width (nm) | Lamp current (mA) | Mode | Limit of Detection (LOD)  (mg/kg) |
| Pb | 283.3 | 1.0 | 10.0 | GF-AAS | 0.06 |
| Cd | 228.8 | 0.2 | 7.0 | GF-AAS | 0.02 |
| Cr | 357.9 | 0.5 | 4.0 | GF-AAS | 0.05 |
| As | 193.7 | 0.5 | 10 | HG-AAS | 0.08 |
| Hg | 253.7 | 0.5 | 4.0 | CV-AAS | 0.02 |
| Mn | 279.5 | 0.2 | 7.0 | F – AAS | 0.30 |
| Fe | 248.3 | 0.2 | 6.0 | F – AAS | 0.02 |
| Zn | 213.9 | 0.5 | 4.0 | F – AAS | 0.3 |

**Table S2** Heavy metal concentrations (mean ± SD) in certified reference material (NIST CRM 1566a, Oyster Tissue)

|  |  |  |  |
| --- | --- | --- | --- |
| Heavy metal | Certified value (mg/kg) | Found value (mg/kg) | Mean recovery (%) |
| Pb | 0.371 ± 0.014 | 0.365 ± 0.026 | 98.3 |
| Cd | 4.15 ± 0.38 | 3.97 ± 0.24 | 95.7 |
| Cr | 1.43 ± 0.46 | 1.39 ± 0.11 | 96.9 |
| As | 14.0 ± 1.2 | 13.30 ± 0.53 | 94.8 |
| Hg | 0.0642 ± 0.0067 | 0.060 ± 0.005 | 93.5 |
| Mn | 12.3 ± 1.5 | 12.74 ± 0.51 | 103.6 |
| Fe | 539 ± 15 | 546 ± 11 | 101.3 |
| Zn | 830 ± 57 | 867 ± 17 | 104.5 |

**Table S3** Concentration of heavy metals in chicken meat collected from four different wholesale markets of Dhaka, Bangladesh.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Location | Type of chicken | Concentration of heavy metals (mg/kg) | | | | | | | |
| Pb | Cd | Cr | As | Hg | Mn | Fe | Zn |
| Kawranbazar | Broiler | 1.21 ± 0.12 | < 0.02 | 0.16 ± 0.02 | <0.08 | < 0.02 | < 0.3 | 5.40 ± 0.53 | 10.85 ± 1.08 |
| Local | < 0.06 | < 0.02 | 0.14 ± 0.01 | <0.08 | < 0.02 | < 0.3 | 4.38 ± 0.43 | 8.92 ± 0.89 |
| Sonali | 0.71 ± 0.07 | < 0.02 | 0.33 ± 0.03 | <0.08 | < 0.02 | < 0.3 | 2.50 ± 0.24 | 1.02 ± 0.01 |
| Mirpur-1 | Broiler | < 0.06 | < 0.02 | 0.17 ± 0.02 | <0.08 | < 0.02 | < 0.3 | 17.50 ± 1.71 | 9.23 ± 0.92 |
| Local | 0.54 ± 0.05 | < 0.02 | 0.15 ± 0.02 | <0.08 | < 0.02 | 0.33 ±0.03 | 15.46 ± 1.54 | 14.24±1.42 |
| Sonali | 2.73 ± 0.27 | < 0.02 | 0.67 ± 0.07 | <0.08 | < 0.02 | < 0.3 | 10.94 ± 0.10 | 9.32 ± 0.93 |
| New Market | Broiler | < 0.06 | < 0.02 | 0.08 ± 0.01 | <0.08 | < 0.02 | 0.38 ± 0.03 | 25.32 ± 2.53 | 9.03 ± 0.90 |
| Local | 0.13 ± 0.01 | < 0.02 | 0.15 ± 0.01 | <0.08 | < 0.02 | 0.43 ±0.04 | 27.42 ± 2.74 | 19.40 ±1.94 |
| Sonali | 0.62 ± 0.06 | < 0.02 | 0.20 ± 0.02 | <0.08 | < 0.02 | 0.36 ± 0.03 | 20.16 ± 2.01 | 9.66 ± 0.96 |
| Mohammadpur Bazar | Broiler | 1.10 ± 0.11 | < 0.02 | 0.26 ± 0.03 | <0.08 | < 0.02 | 0.56 ±0.05 | 28.56 ± 2.85 | 10.9 ± 1.09 |
| Local | 1.84 ± 0.18 | < 0.02 | 0.27 ± 0.03 | <0.08 | < 0.02 | 0.63 ±0.06 | 24.04 ± 2.40 | 8.87 ± 0.88 |
| Sonali | < 0.06 | < 0.02 | 0.07 ± 0.01 | <0.08 | < 0.02 | 0.51 ±0.05 | 20.62 ± 2.06 | 12.78 ±1.27 |

**Table S4** Concentration of heavy metals in hen egg collected from four different wholesale markets of Dhaka, Bangladesh.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Location | Types of Egg | Concentrations of heavy metals (mg/kg) | | | | | | | |
| Pb | Cd | Cr | As | Hg | Mn | Fe | Zn |
| Kawranbazar | Layer | < 0.06 | < 0.02 | < 0.05 | <0.08 | < 0.02 | < 0.3 | 15.02 ± 1.50 | 7.96 ± 0.79 |
|  | Local | < 0.06 | < 0.02 | < 0.05 | <0.08 | < 0.02 | < 0.3 | 22.28 ± 2.22 | 12.18 ± 1.21 |
| Mirpur 1 | Layer | 0.16 ± 0.02 | < 0.02 | < 0.05 | <0.08 | < 0.02 | < 0.3 | 6.82 ± 0.68 | 10.74 ± 1.07 |
|  | Local | 0.68 ± 0.07 | < 0.02 | < 0.05 | <0.08 | < 0.02 | < 0.3 | 11.61 ±1.16 | 11.33 ± 1.13 |
| New Market | Layer | 0.09 ±0.01 | < 0.02 | 0.05 ± 0.01 | <0.08 | < 0.02 | < 0.3 | 22.37 ± 2.23 | 11.39 ± 1.13 |
|  | Local | 0.23 ± 0.02 | < 0.02 | < 0.05 | <0.08 | < 0.02 | < 0.3 | 24.65 ± 2.46 | 10.50 ± 1.05 |
| Mohammadpur Bazar | Layer | 0.13 ± 0.01 | < 0.02 | < 0.05 | <0.08 | < 0.02 | < 0.3 | 7.44 ± 0.74 | 10.45 ± 1.04 |
|  | Local | < 0.06 | < 0.02 | 0.06 ± 0.01 | <0.08 | < 0.02 | < 0.3 | 14.63 ± 1.46 | 12.82 ± 1.28 |
| Shapna | Organic | < 0.06 | < 0.02 | < 0.05 | <0.08 | < 0.02 | < 0.3 | 19.68 ± 1.96 | 10.89 ± 1.08 |
| G-Mart | Organic | < 0.06 | < 0.02 | < 0.05 | <0.08 | < 0.02 | < 0.3 | 38.64 ± 3.86 | 15.38 ± 1.53 |
| Meena Bazar | Organic | 0.07 ± 0.01 | < 0.02 | < 0.05 | <0.08 | < 0.02 | < 0.3 | 24.11 ± 2.41 | 11.91 ± 1.19 |
| Agora | Organic | 0.09 ± 0.01 | < 0.02 | < 0.05 | <0.08 | < 0.02 | < 0.3 | 20.20 ± 2.02 | 11.48 ± 1.14 |

**Table S5** Principal component loadings (varimax-normalized) and communalities for heavy metals in chicken meat and egg samples (n = 24).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Heavy metals | PC1 | PC2 | PC3 | Communalities |
| Pb | 0.444 | 0.783 | 0.297 | 0.899 |
| Cd | 0.947 | -0.274 | 0.159 | 0.996 |
| Cr | 0.290 | 0.889 | 0.150 | 0.897 |
| As | 0.947 | -0.274 | 0.159 | 0.996 |
| Hg | 0.947 | -0.274 | 0.159 | 0.996 |
| Mn | -0.179 | 0.322 | 0.748 | 0.695 |
| Fe | -0.516 | -0.225 | 0.678 | 0.777 |
| Zn | -0.224 | -0.508 | 0.637 | 0.714 |
| Eigen value | 3.317 | 2.041 | 1.612 |  |
| % of total variance | 41.461 | 25.515 | 20.146 |  |
| Cumulative % of variance | 41.461 | 66.976 | 87.122 |  |

**Table S6** Comparison of the estimated daily intake of heavy metals through the consumption of chicken meat and egg with the maximum tolerable daily intake.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Food items | Estimated daily intake of heavy metals (mg/kg-bw/day) | | | | | | | |
| Pb | Cd | Cr | As | Hg | Mn | Fe | Zn |
| **Chicken meat** | | | | | | | | |
| Broiler | 1.70E-04 | 2.89E-06 | 4.91E-05 | 1.16E-05 | 2.89E-06 | 8.95E-05 | 5.55E-03 | 2.83E-03 |
| Local | 1.85E-04 | 2.89E-06 | 5.20E-05 | 1.16E-05 | 2.89E-06 | 11.3E-05 | 5.14E-03 | 3.78E-03 |
| Sonali | 2.95E-04 | 2.89E-06 | 9.24E-05 | 1.16E-05 | 2.89E-06 | 8.38E-05 | 3.93E-03 | 2.37E-03 |
| Mean | 2.17E-04 | 2.89E-06 | 6.50E-05 | 1.16E-05 | 2.89E-06 | 9.53E-05 | 4.87E-03 | 2.99E-03 |
| **Hen egg** | | | | | | | | |
| Layer | 2.31E-05 | 2.31E-06 | 6.94E-06 | 9.25E-06 | 2.31E-06 | 3.47E-05 | 2.98E-03 | 2.34E-03 |
| Local | 5.55E-05 | 2.31E-06 | 6.94E-06 | 9.25E-06 | 2.31E-06 | 3.47E-05 | 4.23E-03 | 2.71E-03 |
| Organic | 1.39E-05 | 2.31E-06 | 5.78E-06 | 9.25E-06 | 2.31E-06 | 3.47E-05 | 5.95E-03 | 2.87E-03 |
| Mean | 3.08E-05 | 2.31E-06 | 6.60E-06 | 9.25E-06 | 2.31E-06 | 3.47E-05 | 4.39E-03 | 2.64E-03 |
| MTDI | 3.50E-03a | 8.30E-04a | 8.30E-03a | 3.0E-03a | 5.7E-04a | 0.183b | 0.667b | 0.667b |
| MTDI = Maximum tolerable daily intake | | | | | | | | |
| aJAECA (Zheng et al., 2020) | | | | | | | | |
| bCNS (Zheng et al, 2020) | | | | | | | | |

**Table S7** Target hazard quotient of heavy metals from consumption of chicken meat and hen egg samples.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Food items | Target hazard quotient (THQ) | | | | | | | | TTHQ |
| Pb | Cd | Cr | As | Hg | Mn | Fe | Zn |
| **Chicken meat** | | | | | | | | | |
| Broiler | 0.0487 | 0.0035 | 0.0059 | 0.0039 | 0.0051 | 0.0005 | 0.0083 | 0.0042 | 0.0801 |
| Local | 0.0528 | 0.0035 | 0.0063 | 0.0039 | 0.0051 | 0.0006 | 0.0077 | 0.0057 | 0.0855 |
| Sonali | 0.0842 | 0.0035 | 0.0111 | 0.0039 | 0.0051 | 0.0005 | 0.0059 | 0.0036 | 0.1176 |
| Mean | 0.0619 | 0.0035 | 0.0078 | 0.0039 | 0.0051 | 0.0005 | 0.0073 | 0.0045 | 0.0944 |
| **Hen egg** | | | | | | | | | |
| Layer | 0.0066 | 0.0028 | 0.0008 | 0.0031 | 0.0041 | 0.0002 | 0.0045 | 0.0035 | 0.0255 |
| Local | 0.0159 | 0.0028 | 0.0008 | 0.0031 | 0.0041 | 0.0002 | 0.0063 | 0.0041 | 0.0372 |
| Organic | 0.0040 | 0.0028 | 0.0007 | 0.0031 | 0.0041 | 0.0002 | 0.0089 | 0.0043 | 0.0280 |
| Mean | 0.0088 | 0.0028 | 0.0008 | 0.0031 | 0.0041 | 0.0002 | 0.0066 | 0.0039 | 0.0302 |

**Table S8**: Carcinogenic risk of heavy metals from consumption of chicken meat and hen egg samples.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Food items | Carcinogenic risk (CR) | | | |
| Pb | Cd | Cr | As |
| **Chicken meat** | | | | |
| Broiler | 1.45E-06 | 1.82E-05 | 2.46E-05 | 1.73E-05 |
| Local | 1.57E-06 | 1.82E-05 | 2.60E-05 | 1.73E-05 |
| Sonali | 2.50E-06 | 1.82E-05 | 4.62E-05 | 1.73E-05 |
| Mean | 1.84E-06 | 1.82E-05 | 3.23E-05 | 1.73E-05 |
| **Hen egg** | | | | |
| Layer | 1.97E-07 | 1.46E-05 | 3.47E-06 | 1.39E-05 |
| Local | 4.72E-07 | 1.46E-05 | 3.47E-06 | 1.39E-05 |
| Organic | 1.18E-07 | 1.46E-05 | 2.89E-06 | 1.39E-05 |
| Mean | 2.62E-07 | 1.46E-05 | 3.28E-06 | 1.39E-05 |

**References**

Zheng, L., Zhang, Q., Li, Z., Sun, R., Zhong, G., 2020. Exposure risk assessment of nine metal elements in Chongqing hotpot seasoning. RSC Adv. 10, 1971–1980.