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Supplementary material

Data Cleaning and uncertainties

Heavy metal occurrence in PAD–data

We harmonized the nomenclature of FoodEx2 levels to be able to calculate the content of raw crops ingredients and merge the different sources of data. We selected only mixed food products containing more than 90% of studied crops as raw ingredient, for example, FoodEx2 category "Wheat coffee infusion" was rejected, while "Wheat flour white" was included in "wheat" group.

FoodEx names were grouped in 8 groups, called as follow: wheat, rye, barley, oat, maize, sunflower seed, carrot, and potato. In potato group was included dry potato—which in turn summarized Mashed potato powder and Potato flakes, and Processed potato—which included French fries from cut potato and Pan–fried potato. The occurrence values of Mashed potato, Potato flakes and Potato flour was reduced in a 20% since potatoes contain a 70% of water. After these transformations in dry potato and processed potato groups, we merged the subgroups with potato group for better visualization of occurrence and exposure results. Outliers of raw concentration data were first examined with boxplot graphs made with ggplot2 working package (Wickham 2016) in Rstudio (R Core Team (2023), R version 4.3.1 (2023-06-16 ucrt)). Secondly, values where compared against validation report included in original data. In few cases, values exceeded the mean concentration values—for that hazard–food product—more than 10 times, beside in the quality report was evaluated as a normal measurement or result. Those values were assumed to be reported in wrong units; thus, we transformed them by dividing the results by 1000.

Tables and figures

Table 1s. Methods most used (n in parenthesis) occurrence of heavy metals in studied crops in all countries, and the range of lowest observation quantification LOQ (min–max) values. Number or the total hazard, hazard–food pair, and method use shown in parenthesis.

Hazard_n	Crop_n	Method_n	LOQ
Cd (9105)	Carrots (975)	ICP–MS (301)	0–0.02
		Atomic absorption–spectrometry* (145)	0–0.05
		ICP–LR–MS (6)	0.01–0.02
		ICP–HR–MS (3)	0–0.02
		LC–MS (2)	0.004–0.004
		HPLC–HG–AFS (1)	0.01–0.01
		Electhochemical–potentiometry (1)	0.02–0.02
	Cereals (5118)	ICP–MS (1566)	0–0.063
		Atomic absorption–spectrometry* (161)	0–0.15
		ICP–HR–MS (17)	0–0.02
		Microbiological tests (15)	0.009–0.009
		ICP–LR–MS (12)	0.005–0.02
		ICP–OES (7)	0.028–0.056
		LC–MS (5)	0.004–0.004
		Electhochemical–potentiometry (4)	0–0.02
	Maize (666)	Atomic absorption–spectrometry* (253)	0–0.15
		ICP–MS (129)	0.001–0.025
		ICP–HR–MS (4)	0–0.02
		LC–MS (4)	0.004–0.004
		Electhochemical–potentiometry (3)	0.02–0.02
		ICP–OES (1)	0.05–0.05
	Potatoes (1866)	ICP–MS (463)	0.001–0.2
		Atomic absorption–spectrometry* (275)	0–0.06
		HPLC–ICP–MS (8)	0.02–0.02
		ICP–HR–MS (4)	0–0.02
		ICP–LR–MS (3)	0.01–0.02
		HPLC–HG–AFS (2)	0–0.01
		LC–MS (2)	0.002–0.004
		Electhochemical–potentiometry (1)	0.02–0.02
	SF seeds (480)	ICP–MS (127)	0.001–0.063
		ICP–OES (11)	0.017–0.139
		Atomic absorption–spectrometry* (3)	0.03–0.05
		ICP–MS (14)	0.02–0.02

Pb (10882)	Carrots (1282)	ICP–MS (337)	0.001–0.02
		Atomic absorption–spectrometry* (151)	0.005–0.06
		ICP–LR–MS (7)	0.012–0.02
		HPLC–HG–AFS (4)	0.06–0.06
		ICP–HR–MS (3)	0–0.02
		LC–MS (2)	0.02–0.02
		Electhochemical–potentiometry (2)	0.02–0.02
	Cereals (6326)	ICP–MS (1864)	0–0.1
		Atomic absorption–spectrometry* (217)	0.005–0.3
		Microbiological tests (15)	0.005–0.005
		ICP–HR–MS (8)	0–0.04
		ICP–LR–MS (7)	0.011–0.012
		LC–MS (5)	0.02–0.02
		ICP–AES (1)	0.14–0.15
		Electhochemical–potentiometry (1)	0.04–0.04
	Maize (697)	Atomic absorption–spectrometry* (256)	0.02–0.5
		ICP–MS (131)	0.001–0.05
		LC–MS (4)	0.02–0.02
		ICP–HR–MS (4)	0–0.04
		Electhochemical–potentiometry (3)	0.04–0.04
	Potatoes (2208)	ICP–MS (557)	0.001–0.6
		Atomic absorption–spectrometry* (282)	0.002–0.15
		HPLC–ICP–MS (8)	0.02–0.02
		ICP–HR–MS (4)	0–0.02
		ICP–LR–MS (3)	0.012–0.02
		LC–MS (2)	0.01–0.02
		HPLC–HG–AFS (1)	0.06–0.06
		Electhochemical–potentiometry (1)	0.02–0.02
	SF seeds (369)	ICP–MS (115)	0.005–0.05
		Atomic absorption–spectrometry* (55)	0.008–0.5
		ICP–AES (10)	0.025–0.025
		ICP–HR–MS (5)	0.02–0.02
		Electhochemical–potentiometry (1)	0.02–0.02
		HPLC–ICP–MS (1)	0.001–0.001
		ICP–LR–MS (1)	0.02–0.02

Ni (5715)	Carrots (430)	ICP–MS (153)	0.006–0.201
		ICP–LR–MS (3)	0.05–0.2
		ICP–HR–MS (2)	0–0
		LC–MS (2)	0.2–0.201
		HPLC–ICP–MS (1)	0.2–0.2
		Electhochemical–potentiometry (1)	0.2–0.2
	Cereals (3551)	ICP–MS (1186)	0.002–0.5
		Atomic absorption–spectrometry* (25)	0.042–0.13
		ICP–OES (9)	0.1–0.1
		ICP–LR–MS (6)	0.023–0.023
		ICP–HR–MS (4)	0–0.2
		Electhochemical–potentiometry (1)	0.2–0.2
	Maize (331)	ICP–MS (116)	0.001–0.2
		Atomic absorption–spectrometry* (15)	0.053–0.6
		LC–MS (4)	0.199–0.201
		ICP–HR–MS (4)	0–0.2
		Electhochemical–potentiometry (3)	0.2–0.21
	Potatoes (1014)	ICP–MS (373)	0.005–0.25
		ICP–HR–MS (3)	0–0.2
		LC–MS (2)	0.1–0.199
		Electhochemical–potentiometry (1)	0.2–0.2
		HPLC–ICP–MS (1)	0.2–0.2
	SF seeds (389)	ICP–MS (102)	0.003–0.202
iAs (441)	Carrots (45)	ICP–MS (30)	0.01–0.01
		HPLC–ICP–MS (3)	0.02–0.02
		Atomic absorption–spectrometry* (1)	0.008–0.008
	Cereals (236)	ICP–MS (52)	0.01–0.04
		HPLC–ICP–MS (22)	0–0.09
		Atomic absorption–spectrometry* (17)	0.014–0.06
		ICP–OES (1)	0.04–0.04
	Maize (63)	Atomic absorption–spectrometry* (11)	0.001–0.016
		ICP–MS (5)	0.02–0.04
		HPLC–ICP–MS (3)	0.02–0.09
	Potatoes (41)	ICP–MS (38)	0.01–0.01
		Atomic absorption–spectrometry* (1)	0.008–0.008

As (6012)	Carrots (636)	ICP–MS (157)	0.001–0.05
		Atomic absorption–spectrometry* (25)	0.003–0.03
		LC–MS (2)	0.1–0.1
		ICP–LR–MS (1)	0.02–0.02
		HPLC–ICP–MS (1)	0.02–0.02
	Cereals (3823)	ICP–MS (1601)	0.001–0.25
		Atomic absorption–spectrometry* (124)	0.003–0.06
		HPLC–ICP–MS (30)	0–0.02
		Microbiological tests (15)	0.01–0.01
		ICP–LR–MS (6)	0.016–0.016
		LC–MS (5)	0.099–0.1
		ICP–HR–MS (2)	0.02–0.02
	Maize (413)	ICP–MS (121)	0.001–0.1
		Atomic absorption–spectrometry* (58)	0.001–0.15
		LC–MS (4)	0.1–0.101
	Potatoes (881)	ICP–MS (394)	0.001–0.1
		Atomic absorption–spectrometry* (21)	0.002–0.03
		LC–MS (2)	0.05–0.099
		HPLC–ICP–MS (1)	0.02–0.02
		ICP–LR–MS (1)	0.1–0.1
	SF seeds (259)	ICP–MS (98)	0.004–0.101
		Atomic absorption–spectrometry* (6)	0.02–0.05

(*) Atomic absorption–spectrometry methods include AAS|CVAAS|FAAS|ETAAS (GFAAS)|HGAAS methods.

Table 2s. Mean, standard deviation (in parenthesis), and minimum–maximum range (in squared parenthesis) of the current HM occurrence values ($\mu g\ kg^{-1}$) in in target crops and countries except France. Countries´ names are codified. If the number of analyses were under 8 are not reported in this table and marked as “(*)n<8”. Values under LOQ and or LOD are marked as “<LOD”

Hazard	Country	Barley	Oat	Rye	Wheat	Maize	SF seeds	Carrot	Potato
Cd	1	(*)n<8	12.1 (9.6) [0–29.8]	(*)n<8	49 (48.5) [0–156.6]			31.5 (20.2) [11.2–101]	17.4 (10.5) [4.2–60]
	2	1 (2.7) [0–7.8]	0.6 (2.1) [0–7.8]	1 (2.7) [0–7.8]	7.6 (16.6) [0–110]	0.8 (3.9) [0–24]	(*)n<8	2 (6.7) [0–43]	17.6 (25.5) [0–210]
	3	12.4 (14.3) [0–90]	17.2 (18.3) [0–97]	14.5 (11.6) [0–46]	30.2 (22.4) [0–101]		290.9 (198.2) [96.4–748.5]	15.5 (14.2) [0–53]	6.6 (8.2) [0–26]
	4	11.1 (12.8) [0–35]	21 (36.2) [0–120]	8.8 (9.3) [0–25]	18.5 (18.9) [0–146]	0.4 (1.4) [0–6]	165.1 (197.4) [0–710]	2.4 (4.2) [0–15]	11.5 (15.3) [0–79]
	5	14.7 (16.7) [0–135]	31.4 (58.2) [0–794]	11.8 (15.2) [0–170]	54.8 (89.7) [0–945.4]	1.7 (3.5) [0–26]	178.3 (130.5) [0–540]	27.3 (35.8) [0–475]	19.9 (16.6) [0–335]
Pb	1	(*)n<8	<LOD	(*)n<8	1.5 (4.2) [0–19]	(*)n<8		10 (11.2) [0–53.9]	0.2 (1.7) [0–18]
	2	39.4 (85.2) [0–240]	(*)n<8	9.4 (26.5) [0–75]	8.9 (29.6) [0–150]	5.9 (34.1) [0–300]	1.6 (7.4) [0–40]	2.1 (8.1) [0–44]	4.2 (16.2) [0–122]
	3	21.7 (23.6) [0–80]	17.3 (36) [0–203.6]	14.2 (34.2) [0–100]	19.6 (34.3) [0–145]		<LOD	1.2 (3.8) [0–14]	0.8 (3.6) [0–17]
	4	(*)n<8	(*)n<8	9.9 (18.5) [0–45]	26.8 (51.8) [0–350]	29.5 (92) [0–480]	8.8 (18.1) [0–76]	5 (10.1) [0–36]	20.2 (32.5) [0–197]
	5	14.3 (38.7) [0–497]	8.5 (26.2) [0–200]	10.9 (27.6) [0–216]	14.9 (45.1) [0–468]	8.5 (23.1) [0–173]	8.9 (18.6) [0–122]	17.9 (22) [0–385]	3.5 (13.9) [0–180]
Ni	1		(*)n<8		88.4 (136.1) [0–467.4]			48 (53.7) [0–171.5]	26.2 (28.6) [0–257]
	2				<LOD	75.7 (120.2) [0–282]	(*)n<8	24.2 (31.8) [0–87]	42.9 (100.4) [0–351.3]
	3	197 (178.8) [0–400]	674.1 (867.4) [0–3800]	(*)n<8	241 (385.9) [0–2707]		5409.5 (3790.7) [1256.7–13103]	75.3 (72.8) [0–372]	98 (126.6) [0–659]
	4					199.2 (181.1) [0–600]	3246.6 (3466) [0–9000]		
	5	202.8 (400.8) [0–4250]	1170.5 (722.3) [0–4400]	107.5 (220.8) [0–3155]	147.8 (237.6) [0–1790]	80.8 (142.1) [0–885]	2177.2 (2242.3) [0–11100]	50.5 (123.6) [0–1790]	36.8 (39.3) [0–300]
iAs	1	(*)n<8	<LOD	(*)n<8	0.9 (3.4) [0–15.5]			<LOD	0.5 (1.2) [0–5.2]
	2			(*)n<8	2.1 (5.7) [0–28.4]	0.3 (1) [0–3.3]	(*)n<8	1.7 (5.6) [0–19.6]	<LOD
	3	<LOD	16.5 (48.9) [0–280]	0 (0) [0–0]	0.4 (3) [0–21.7]		12.6 (17.1) [3.9–65.8]	<LOD	<LOD
	4	(*)n<8	13.1 (19.8) [0–56]	(*)n<8	8.5 (17.1) [0–102.2]	1.7 (7.3) [0–42]	0.8 (3.9) [0–19.6]	2.1 (3.3) [0–9.1]	(*)n<8
	5	6.9 (26.7) [0–179.2]	4.4 (22.1) [0–217]	2.4 (23) [0–460.6]	3.2 (12.3) [0–126]	1.2 (6.6) [0–58.3]	1.4 (4.1) [0–18.2]	0.9 (3.7) [0–49]	1.4 (9.2) [0–158.9]

Table 3s. Results from mass-balance models carried out in 6 European countries. Heavy metal concentration (µg kg^{-1}) in crops at current (S0) and in a hundred (S100) years, and their proportional change (S_{ch}, i.e. S100/S0) after using mineral fertiliser (SP) and low- and high-HM concentrated BBFs (L and H respectively), for each crop and country (codified). Cadmium in wheats were also compared with a very high Cd–contained BBF (E).

Cadmium													
Crop	Country	SP			L			H			E		
		S0	S100	Sch	S0	S100	Sch	S0	S100	Sch	S0	S100	Sch
Wheat	1	7.9	9.9	1.3	7.9	7.5	0.9	8	10.5	1.3	8	16	2
	3	22.4	22.4	1	22.4	22.2	1	22.5	26.9	1.2	22.6	35.6	1.6
	5	36.1	33.3	0.9	36.1	31.4	0.9	36.2	43.5	1.2	36.5	65.9	1.8
	4	22.5	31.5	1.4	22.4	22.7	1	22.5	33.8	1.5	22.7	54.4	2.4
	2	5.9	8.5	1.4	5.8	5	0.9	5.9	7.2	1.2	5.9	11.2	1.9
Barley	1	31.1	38.6	1.2	31	28.4	0.9	31.1	41.3	1.3			
	3	6.2	6.3	1	6.2	6.2	1	6.2	7.5	1.2			
	5	48.9	44.5	0.9	48.8	42.1	0.9	49	57.3	1.2			
	4	33.8	46	1.4	33.7	33.7	1	33.8	49.3	1.5			
	2	46.9	57.9	1.2	46.7	39.2	0.8	46.8	51	1.1			
Carrot	1	19.5	25.2	1.3	19.4	17.6	0.9	19.5	27.2	1.4			
	3	65.6	63.1	1	65.6	62.1	0.9	66.1	92.8	1.4			
	5	22.2	20.2	0.9	22.2	19.1	0.9	22.3	25.6	1.1			
	4	15.4	20.6	1.3	15.3	15.4	1	15.4	22	1.4			
	2	15.6	20	1.3	15.6	13	0.8	15.6	17.4	1.1			
Maize	5	36.9	32.3	0.9	36.9	31.8	0.9	36.9	35.3	1			
	4	38.3	41.8	1.1	38.3	37.6	1	38.3	42.9	1.1			
	2	21.5	28.2	1.3	21.4	17.6	0.8	21.5	24.3	1.1			
Oat	1	19.5	25.2	1.3	19.4	18.2	0.9	19.5	27.1	1.4			
	3	14.3	14.4	1	14.3	14.3	1	14.3	17.3	1.2			
	5	30.7	28.3	0.9	30.7	27.3	0.9	30.7	33.7	1.1			
	4	21.2	26.9	1.3	21.1	21.7	1	21.2	28.3	1.3			
	2	21.6	25.3	1.2	21.5	18.5	0.9	21.5	22.8	1.1			
Potato	1	23.9	30.9	1.3	23.8	21.6	0.9	23.9	33.4	1.4			
	3	20.5	20.7	1	20.5	20.3	1	20.7	32.9	1.6			
	5	19.4	17.8	0.9	19.4	16.8	0.9	19.5	22.9	1.2			
	4	192.1	242.4	1.3	191.3	175.3	0.9	192.3	260.2	1.4			
	2	16.2	20.6	1.3	16.1	13.5	0.8	16.2	18	1.1			
Rye	1	19.5	23.6	1.2	19.4	18.1	0.9	19.5	25.1	1.3			
	3	14.3	14.4	1	14.3	14.3	1	14.3	17.3	1.2			
	5	30.7	28.2	0.9	30.7	27.1	0.9	30.7	34.4	1.1			
	4	21.2	27.5	1.3	21.1	21.7	1	21.2	29.1	1.4			
	2	21.6	24.3	1.1	21.5	18.4	0.9	21.5	22.1	1			
SF seed	5	347	290	0.8	346.9	280.6	0.8	347.6	340.2	1			
	4	239.7	263.2	1.1	239.2	216.1	0.9	239.8	275.6	1.1			
	2	243.9	264.3	1.1	243.1	198.1	0.8	243.6	239.9	1			

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Lead

Food	Country	SP			L			H		
		S0	S100	Sch	S0	S100	Sch	S0	S100	Sch
Barley	1	12.6	12.8	1	12.6	12.8	1	12.7	12.8	1
	3	10.5	10.7	1	10.5	10.7	1	10.5	10.8	1
	5	27	23.9	0.9	27	23.8	0.9	27	24.1	0.9
	4	18.1	17.5	1	18.1	17.5	1	18.3	17.5	1
	2	22.9	20.1	0.9	22.9	20	0.9	22.9	20.1	0.9
Carrot	1	164.7	170.3	1	163.9	170.3	1	166.7	170.3	1
	3	51.8	52.6	1	51.8	52.6	1	51.8	53.5	1
	5	358.1	315.1	0.9	358.1	314.7	0.9	358.1	317.2	0.9
	4	240.2	232.6	1	239.8	232.6	1	242.3	232.7	1
	2	304.4	265.3	0.9	304.4	264.2	0.9	304.4	265.9	0.9
Maize	1	14.1	14.3	1	14	14.3	1	14.3	14.4	1
	5	2.1	1.8	0.9	2.1	1.8	0.9	2.1	1.8	0.9
	4	489.8	478	1	489.6	478	1	491.3	478	1
	2	0	0		0	0		0	0	
Oat	1	122.5	124.8	1	121.9	124.8	1	123.8	124.8	1
	3	55.1	56	1	55.1	56	1	55.1	56.4	1
	5	262.4	231.8	0.9	262.4	231.6	0.9	262.4	232.9	0.9
	4	176.1	170.5	1	175.9	170.5	1	177.2	170.5	1
	2	223.1	195	0.9	223.1	194.4	0.9	223.1	195.2	0.9
Potato	1	16.6	16.9	1	16.5	16.9	1	16.8	16.9	1
	3	10.3	10.5	1	10.3	10.5	1	10.3	10.7	1
	5	35.6	31.4	0.9	35.6	31.4	0.9	35.6	31.6	0.9
	4	738.7	717	1	737.4	717	1	745.8	717.1	1
	2	30.2	26.4	0.9	30.2	26.3	0.9	30.2	26.4	0.9
Rye	1	122.3	124.8	1	121.9	124.8	1	123.4	124.8	1
	3	55.1	56	1	55.1	56	1	55.1	56.4	1
	5	262.4	231.6	0.9	262.4	231.4	0.9	262.4	232.9	0.9
	4	176.1	170.5	1	175.9	170.5	1	177.3	170.5	1
	2	223.1	194.8	0.9	223.1	194.3	0.9	223.1	195.1	0.9
SF seed	5	115.3	102	0.9	115.3	101.9	0.9	115.3	102.4	0.9
	4	77.4	74.9	1	77.3	74.9	1	77.8	74.9	1
	2	98	85.7	0.9	98	85.4	0.9	98	85.8	0.9
Wheat	1	1.9	2	1.1	1.9	2	1.1	2	2	1
	3	99.7	101.3	1	99.7	101.3	1	99.7	102	1
	5	4.2	3.7	0.9	4.2	3.7	0.9	4.2	3.7	0.9
	4	3.9	3.7	0.9	3.9	3.7	0.9	3.9	3.7	0.9
	2	11.7	10.3	0.9	11.7	10.2	0.9	11.7	10.3	0.9

Nickel

Food	Country	SP			L			H		
		S0	S100	Sch	S0	S100	Sch	S0	S100	Sch
Barley	3	38.8	38.1	1	38.8	38	1	38.9	39.8	1
	5	530.4	461.1	0.9	530.3	458.7	0.9	530.7	488.9	0.9
Carrot	1	458.5	317.3	0.7	458.1	291.9	0.6	459.7	397.8	0.9
	3	292.8	285.9	1	292.8	285.7	1	293.4	316.4	1.1
	5	2153.4	1835.7	0.9	2153.3	1826.4	0.8	2154.4	1941.2	0.9
	2	1802.5	2260.6	1.3	1788.6	2260.4	1.3	1865.1	2261.3	1.2
Maize	5	121.6	105.8	0.9	121.6	105.6	0.9	121.7	107.7	0.9
	4	111.4	118.9	1.1	111.2	118.9	1.1	113.4	119	1
	2	333.8	414.1	1.2	331	414	1.3	346.7	414.2	1.2
Oat	1	234.9	176.7	0.8	234.7	164.3	0.7	235.4	216.1	0.9
	3	75.8	74.2	1	75.8	74.2	1	75.9	77.7	1
	5	1103.3	955.7	0.9	1103.3	952.3	0.9	1103.8	994.2	0.9
Potato	1	110.7	82.4	0.7	110.6	76	0.7	111	102.6	0.9
	3	141.6	138.6	1	141.6	138.5	1	141.9	157.4	1.1
	5	519.7	450	0.9	519.7	447.6	0.9	520	477.4	0.9
	2	438.7	545.6	1.2	435.4	545.5	1.3	453.5	545.7	1.2
Rye	3	75.8	74.2	1	75.8	74.2	1	75.9	77.7	1
	5	1103.4	953.7	0.9	1103.3	949.9	0.9	1103.8	997.2	0.9
SF seed	5	799.5	695.7	0.9	799.5	693.6	0.9	799.8	719.6	0.9
	4	732.1	781.8	1.1	729.6	781.8	1.1	755.9	782	1
	2	677.9	839.3	1.2	674.7	839.3	1.2	692.4	839.5	1.2
Wheat	1	101	75.3	0.7	100.9	70.8	0.7	101.2	89.3	0.9
	3	112.8	110.4	1	112.8	110.4	1	112.8	115.6	1
	5	474.4	412.7	0.9	474.4	410.3	0.9	474.7	439.3	0.9
	2	1174.1	1454.8	1.2	1162.5	1454.7	1.3	1226.4	1455.4	1.2

Inorganic arsenic

Food	Country	SP			BBFL1			BBFL2		
		S0	S100	Sch	S0	S100	Sch	S0	S100	Sch
Barley	1	52.2	51.7	1	52.2	50.9	1	52.2	51.8	1
	3	47.8	46.2	1	47.8	46.2	1	47.8	46.6	1
	5	165.8	136.8	0.8	165.8	136.2	0.8	165.8	137.2	0.8
	4	110.8	103.1	0.9	110.8	102.7	0.9	110.8	103.7	0.9
Carrot	1	31.7	31.2	1	31.7	30.6	1	31.7	31.3	1
	3	25.3	24.5	1	25.3	24.4	1	25.3	25	1
	5	100.6	82.6	0.8	100.5	82.3	0.8	100.6	82.9	0.8
	4	67.2	62.4	0.9	67.2	62.2	0.9	67.2	62.8	0.9
	2	68.2	45.3	0.7	68.2	44.9	0.7	68.2	45.3	0.7
Maize	5	33	27.2	0.8	33	27.2	0.8	33	27.2	0.8
	4	22	20.5	0.9	22	20.5	0.9	22	20.5	0.9
	2	16.3	10.9	0.7	16.2	10.8	0.7	16.3	10.9	0.7
Oat	1	75.1	74.3	1	75.1	73.1	1	75.1	74.5	1
	3	25.5	24.7	1	25.5	24.7	1	25.6	24.9	1
	5	238.3	196.4	0.8	238.3	195.9	0.8	238.3	196.8	0.8
	4	159.2	148.1	0.9	159.2	147.7	0.9	159.2	148.7	0.9

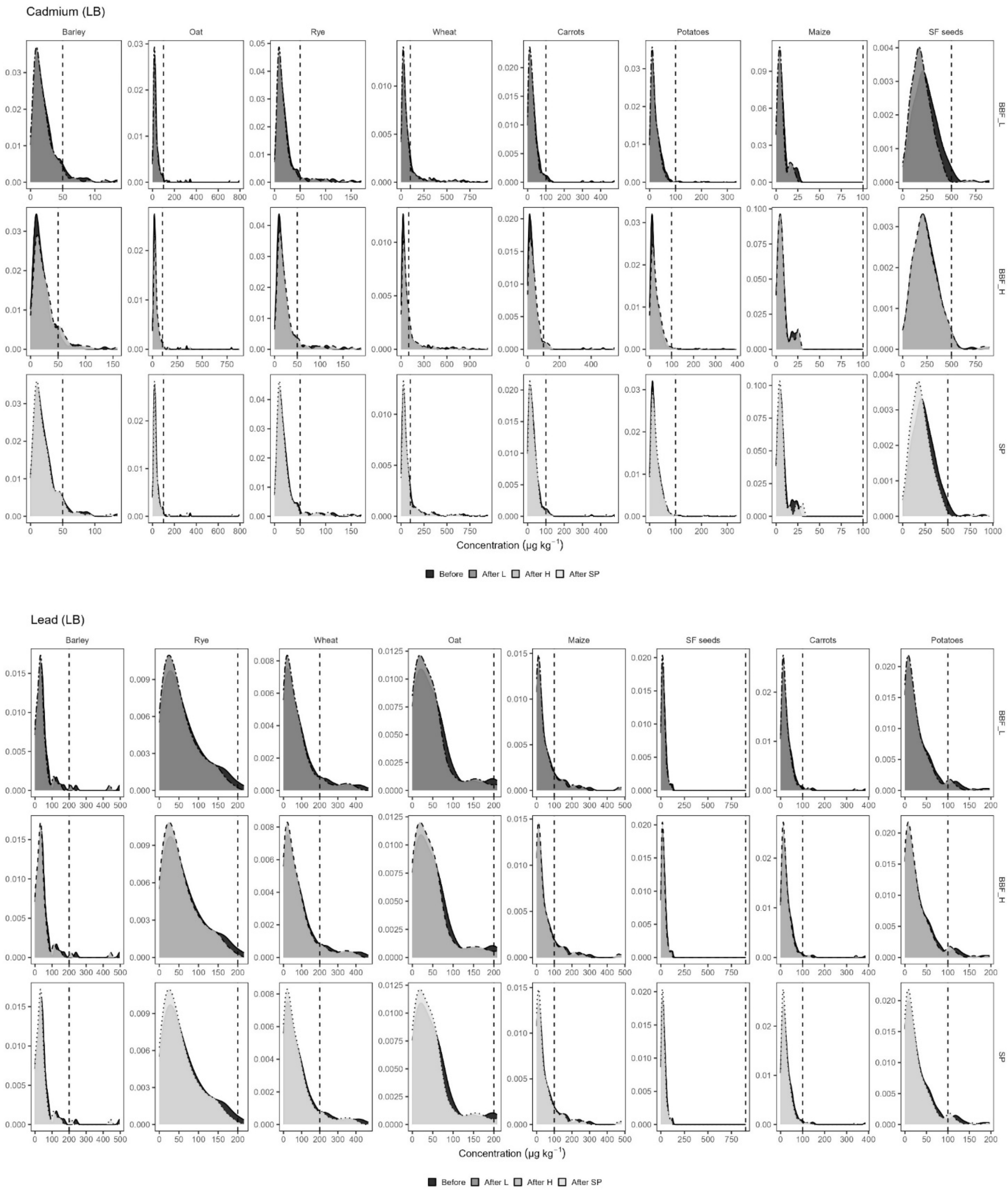
Potato	1	20.5	20.2	1	20.5	19.9	1	20.5	20.3	1
	3	16.4	15.8	1	16.4	15.8	1	16.4	16.3	1
	5	65	53.4	0.8	65	53.2	0.8	65	53.6	0.8
	4	43.4	40.4	0.9	43.4	40.2	0.9	43.4	40.6	0.9
	2	44.1	29.3	0.7	44.1	29	0.7	44.1	29.3	0.7
Rye	1	75.1	74	1	75.1	73.1	1	75.1	74.2	1
	3	25.5	24.7	1	25.5	24.7	1	25.6	24.9	1
	5	238.3	196.3	0.8	238.3	195.7	0.8	238.3	196.7	0.8
	4	159.2	148.1	0.9	159.2	147.7	0.9	159.2	148.8	0.9
	2	161.7	107.8	0.7	161.6	107.3	0.7	161.7	107.8	0.7
SF seeds	5	623.3	513.1	0.8	623.2	511.9	0.8	623.3	514	0.8
	4	416.5	385.8	0.9	416.5	385.1	0.9	416.5	387.2	0.9
	2	422.8	281.9	0.7	422.8	280.6	0.7	422.8	281.9	0.7
Wheat	1	97.9	96.3	1	97.9	95	1	97.9	96.5	1
	3	3.3	3.2	1	3.3	3.2	1	3.3	3.2	1
	5	310.8	255.6	0.8	310.8	254.4	0.8	310.8	256.4	0.8
	4	41.9	39.1	0.9	41.9	39	0.9	41.9	39.4	0.9
	2	1502.4	985	0.7	1502.2	975.5	0.6	1502.4	985.2	0.7

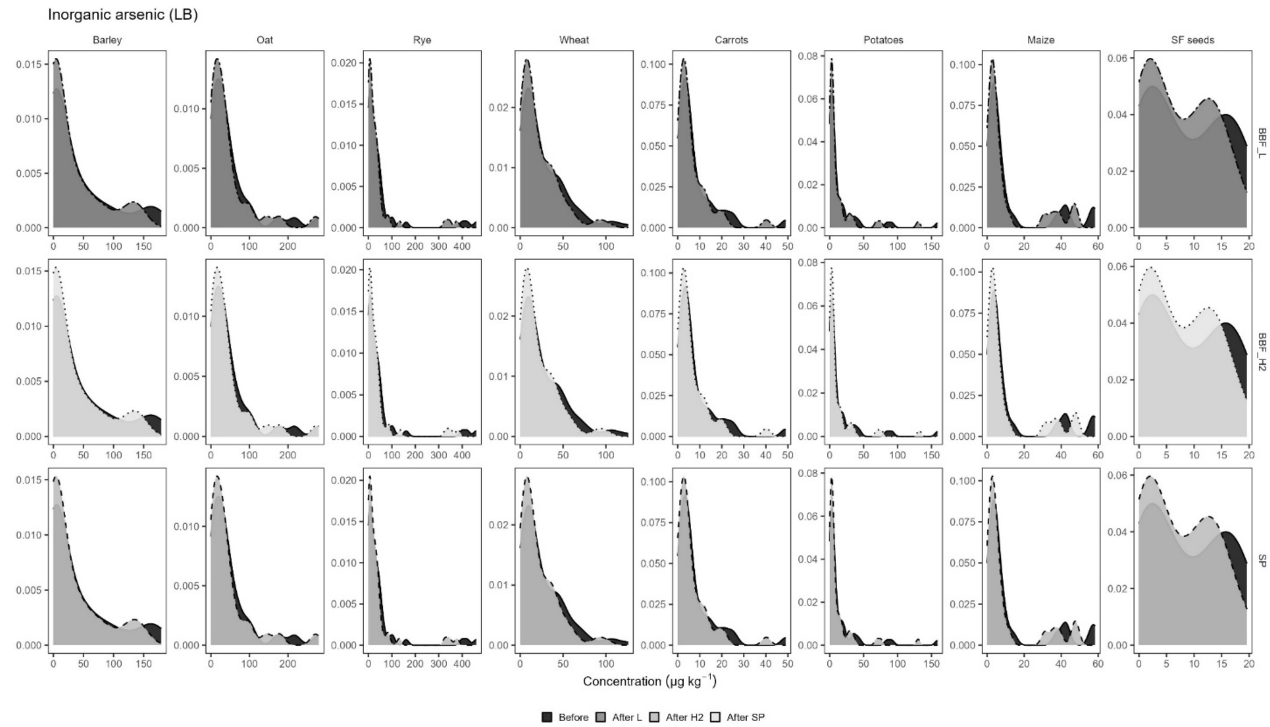
Table 4s. Posterior predictive distribution median and Q95 values of heavy metals dietary exposure of Finnish adults (18 to 64) through wheat, rye, barley, oat, sunflower seed, carrot, potato and maize, under current (C) fertilisation use and after using mineral superphosphate (SP) fertiliser or lower- (L) or higher- (H) heavy metal concentrated biobased fertilisers. Estimations from BIKE-assessment tool.

	C		SP		L		H	
	Median	Q95	Median	Q95	Median	Q95	Median	Q95
Cd (ug/kg/bw week)	0.41	0.72	0.41	0.72	0.4	0.72	0.5	0.88
Pb(ug/kg bw d)	0.05	0.13	0.05	0.13	0.05	0.12	0.05	0.13
Ni (ug/kg/bw d)	0.7	2.83	0.68	2.74	0.67	2.67	0.71	2.85
iAs (ug/kg bw d)	0.02	0.24	0.02	0.23	0.02	0.21	0.02	0.23

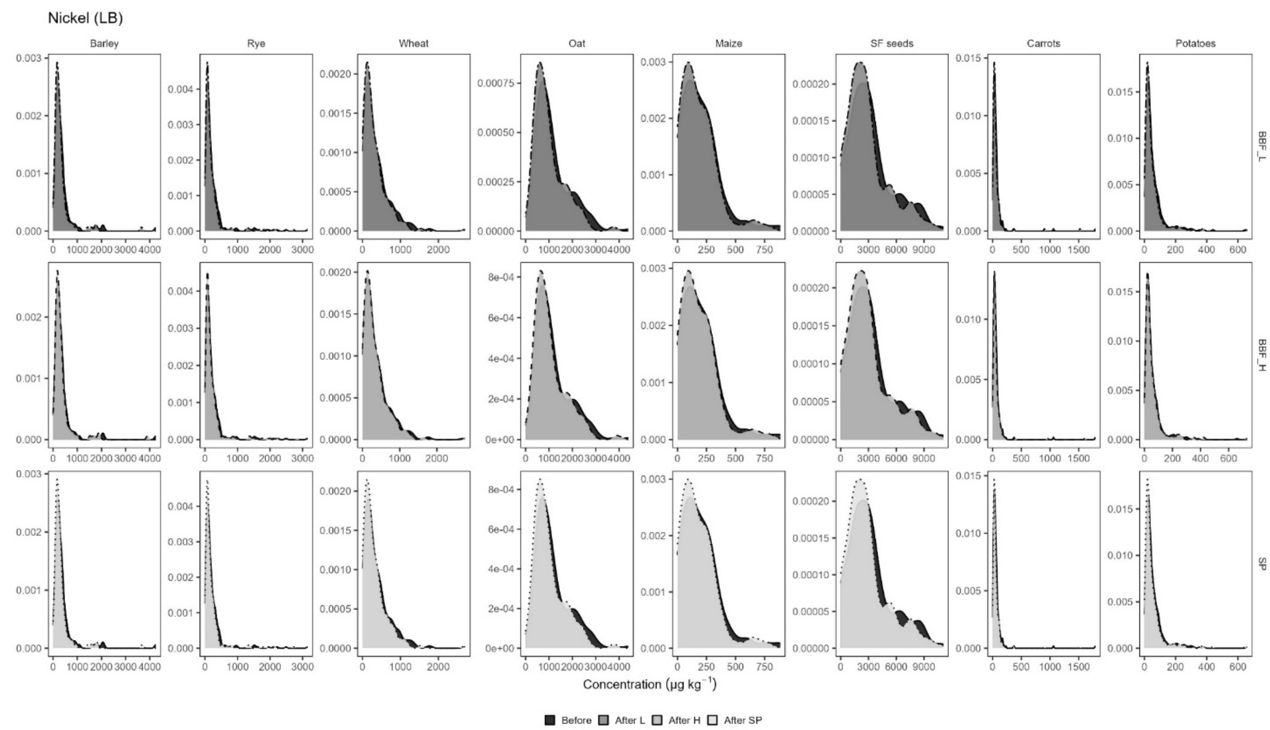
*H used for iAs was different than the used for the rest of heavy metals

Fig. 1s. Density distribution curves of heavy metals occurrence values before and after treatment. In cadmium and lead, vertical dot-line indicate the maximum levels established in EC. Higher concentrated BBF used for iAs case (BBF-H2) differed from BBF-H used for the rest. Lower bound values (nondetects calculated as zeros) were used.





Inorganic arsenic (LB)
Barley
Oat
Rye
Wheat
Carrots
Potatoes
Maize
SF seeds
BBF_L
BBF_H2
SP
Concentration (µg kg⁻¹)
Before
After L
After H2
After SP



Nickel (LB)
Barley
Rye
Wheat
Oat
Maize
SF seeds
Carrots
Potatoes
BBF_L
BBF_H
SP
Concentration (µg kg⁻¹)
Before
After L
After H
After SP

Fig. 2s. Current variability distribution of positive concentration values of Cd, Pb, Ni and iAs in wheat (occurrence data from Finland), modelled by BIKE tool (Ranta et al. 2023). Variability distribution for positive hazard concentrations in food. The uncertainty of the true variability distribution is expressed by plotting a range (e.g. pointwise 95%CI) of probable variability distributions (straw color). The uncertainty distribution for mean concentration (yellow color) and median concentration (black color) are plotted in bold lines. In log-scale, the mean and median are equal. For comparison with data, the raw data are represented as cumulative empirical distribution. For data containing censored concentration values, two empirical distributions are plotted, one with lower bound substitution (blueberry color) and one with upper bound substitution method (raspberry color). These represent the best case and worst case interpretations for censored values. Also, data points are plotted as tick marks on the x-axis, showing exact measurements in raspberry color, LOQ-values in green color, and LOD-values in blueberry color. Note that the distributions in the figures represent truly positive concentrations, excluding zeros.