



Supplementary material

Potentially Harmful Element concentrations in the vegetables cultivated on arable soils, with human health-risk implications

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Figure S3. Daily intake rates of PHEs via consumed vegetables, as a percentage of provisional maximum tolerable daily intake (%PMTDI).

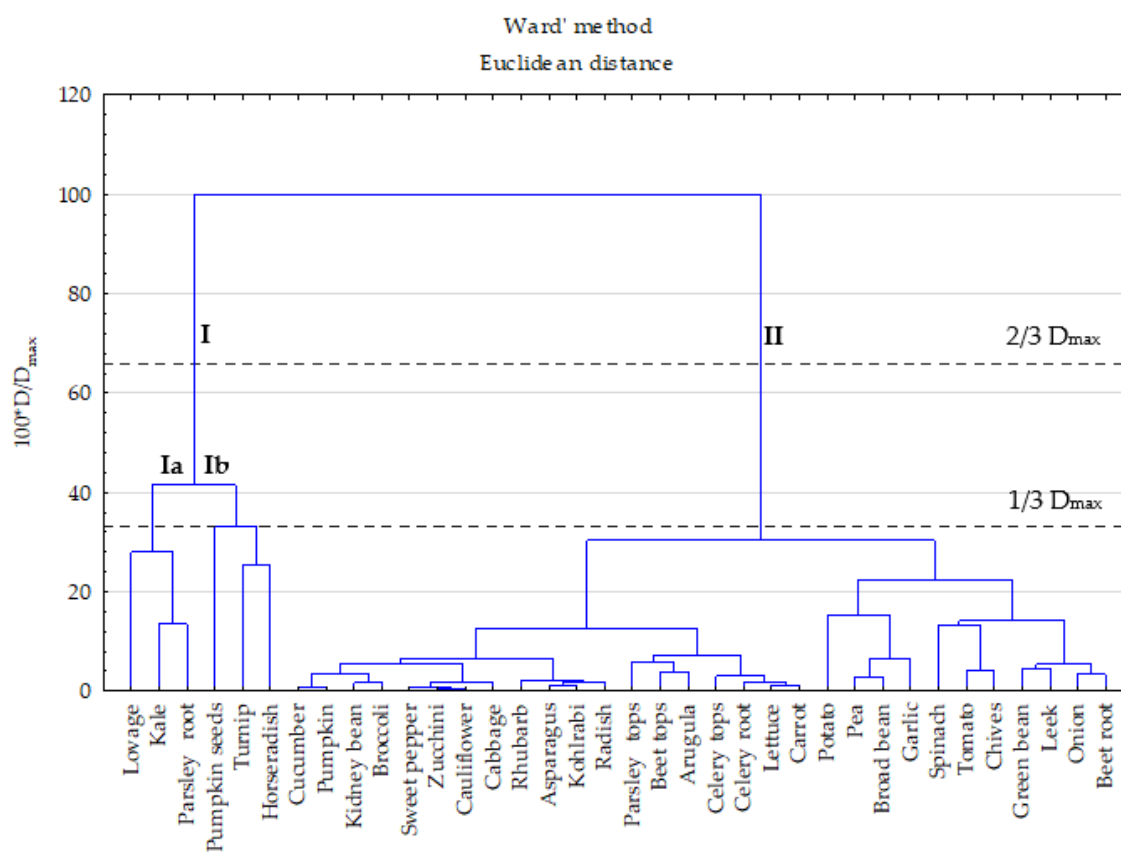
Figure S4. The contribution of various groups of vegetables to the PHE daily intake rates.

Table S1. Results of one-way ANOVA of differences between average concentrations of PHEs in groups of vegetables.

PHE	F	p	Confidence interval	
As	0.9528	0.4834	0.95	Non-significant differences
Cd	1.4546	0.2238	0.95	Non-significant differences
Co	0.4921	0.8321	0.95	Non-significant differences
Cu	1.3574	0.2617	0.95	Non-significant differences
Hg	0.5794	0.7666	0.95	Non-significant differences
Ni	1.1671	0.3525	0.95	Non-significant differences
Pb	0.7209	0.6554	0.95	Non-significant differences
Sb	1.0261	0.4352	0.95	Non-significant differences
Tl	0.5313	0.8033	0.95	Non-significant differences
Zn	0.8989	0.5210	0.95	Non-significant differences

F – F-ratio

p – probability

**Figure S1.** Dendrogram of PHEs in vegetable samples according to Sneath's criteria

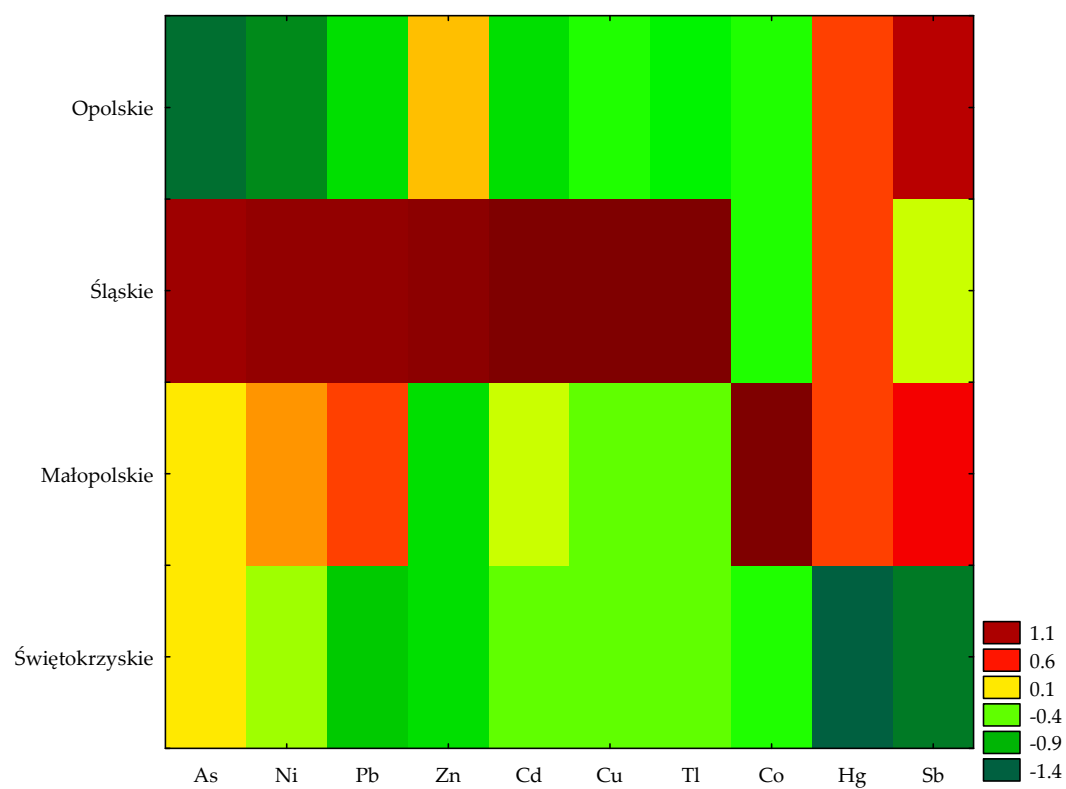


Figure S2. The color-scale map representing standardized contents of PHEs in vegetables.

Table S2. Results of one-way ANOVA of differences between average concentrations of PHEs in investigated regions of southern Poland.

PHE	F	p	Confidence interval	Fisher's LSD test, probabilities for post-hoc tests			
As	0.4209	0.7387	0.95	Non-significant differences			
Cd	6.1892	0.00094	0.95	Error: between MS=0.0662, df=63.000			
				{1}	{2}	{3}	{4}
				0.0158	0.3787	0.0892	0.0574
				Opolskie	0.0136	0.5971	0.7689
				Śląskie	0.0136	0.0006	0.0003
				Małopolskie	0.5971	0.0006	0.6789
				Świętokrzyskie	0.7689	0.0003	0.6789
Co	6.5004	0.00067	0.95	Error: between MS=0.00011, df=63.000			
				{1}	{2}	{3}	{4}
				0.0068	0.0008	0.0126	0.0005
				Opolskie	0.3102	0.3115	0.2848
				Śląskie	0.3102	0.0007	0.9463
				Małopolskie	0.3115	0.0007	0.0003
				Świętokrzyskie	0.2848	0.9463	0.0003
Cu	2.5365	0.0646	0.95	Non-significant differences			
Hg	1.8195	0.1527	0.95	Non- significant differences			
Ni	0.5581	0.6447	0.95	Non- significant differences			
Pb	2.0414	0.1171	0.95	Non- significant differences			
Sb	1.6992	0.1762	0.95	Non- significant differences			
Tl	0.8403	0.4769	0.95	Non- significant differences			
Zn	3.0565	0.0347	0.95	Error: between MS=246.14, df=63.000			
				{1}	{2}	{3}	{4}
				32.860	9.3709	8.3052	7.9311
				Opolskie	0.0090	0.0049	0.0051
				Śląskie	0.0090	0.8283	0.7818
				Małopolskie	0.0049	0.8283	0.9364
				Świętokrzyskie	0.0051	0.7818	0.9364

F – F-ratio

p – probability

values <0.05 are shown in **bold**

Table S3. Results of one-way ANOVA of differences between average BA_{total} values of PHEs in groups of vegetables.

PHE	F	p	Confidence interval	Fisher's LSD test, probabilities for post-hoc tests							
As	0.7886	0.5980	0.95	Non-significant differences							
Cd	1.8473	0.0831	0.95	Non-significant differences							
Co	1.8195	0.0883	0.95	Non-significant differences							
Cu	3.3332	0.0026	0.95	Error: between MS=0.0150, df=136.000							
				{1}	{2}	{3}	{4}	{5}	{6}	{7}	{8}
				0.0227	0.0269	0.0184	0.0129	0.0120	0.0061	0.0471	0.1751
			root		0.9123	0.8817	0.8418	0.7660	0.8007	0.7096	0.0001
			tuber	0.9123		0.8087	0.7914	0.7168	0.7618	0.7685	0.0008
			leaf	0.8817	0.8087		0.9069	0.8458	0.8483	0.6524	0.0000
			inflorescence	0.8418	0.7914	0.9069		0.9864	0.9286	0.6486	0.0027
			fruit	0.7660	0.7168	0.8458	0.9864		0.9305	0.6014	0.0001
			shoot	0.8007	0.7618	0.8483	0.9286	0.9305		0.6368	0.0149
			legume	0.7096	0.7685	0.6524	0.6486	0.6014	0.6368		0.0640
			seed	0.0001	0.0008	0.0000	0.0027	0.0001	0.0149	0.0640	
Hg	1.0444	0.4032	0.95	Non-significant differences							
Ni	0.8287	0.5652	0.95	Non-significant differences							
Pb	3.7570	0.00094	0.95	Error: between MS=0.00000, df = 136.000							
				{1}	{2}	{3}	{4}	{5}	{6}	{7}	{8}
				0.00024	0.00033	0.00058	0.0000	0.00042	0.00020	0.00329	0.00018
			root		0.80688	0.23588	0.62058	0.60228	0.94843	0.00000	0.88019
			tuber	0.8069		0.47592	0.52544	0.82069	0.84235	0.00002	0.72616
			leaf	0.2359	0.47592		0.20902	0.62550	0.54249	0.00003	0.25434
			inflorescence	0.6206	0.52544	0.20902		0.40180	0.78891	0.00001	0.72684
			fruit	0.6023	0.82069	0.62550	0.40180		0.73254	0.00002	0.55147
			shoot	0.9484	0.84235	0.54249	0.78891	0.73254		0.00036	0.98192
			legume	0.0000	0.00002	0.00003	0.00001	0.00002	0.00036		0.00001
			seed	0.8802	0.72616	0.25434	0.72684	0.55147	0.98192	0.00001	
Sb	2/7197	0.0114	0.95	Error: between MS=0.00042, df = 136.000							
				{1}	{2}	{3}	{4}	{5}	{6}	{7}	{8}
				0.00584	0.02986	0.00730	0.00972	0.00527	0.00246	0.01195	0.00696

		root		0.0003	0.7635	0.6352	0.9250	0.7574	0.5756	0.8603
		tuber	0.0003		0.0002	0.0242	0.0005	0.0176	0.1186	0.0019
		leaf	0.7635	0.0002		0.7560	0.7097	0.6494	0.6616	0.9547
		inflorescence	0.6352	0.0242	0.7560		0.6028	0.5619	0.8585	0.7551
		fruit	0.9250	0.0005	0.7097	0.6028		0.8017	0.5508	0.8053
		shoot	0.7574	0.0176	0.6494	0.5619	0.8017		0.5115	0.6936
		legume	0.5756	0.1186	0.6616	0.8585	0.5508	0.5115		0.6623
		seed	0.8603	0.0019	0.9547	0.7551	0.8053	0.6936	0.6623	
Tl	1.2842	0.2626	0.95	Non-significant differences						
Zn	1.3158	0.2474	0.95	Non-significant differences						

F – F-ratio

p – probability

values <0.05 are shown in **bold**

Table S4. Results of one-way ANOVA of differences between BA_{total} values of PHEs in investigated regions of southern Poland.

PHE	F	p	Confidence interval	Fisher's LSD test, probabilities for post-hoc tests			
As	1.6745	0.1753	0.95	Non-significant differences			
Cd	3.9663	0.0095	0.95	Error: between MS=0.01704, df=140.000			
				{1}	{2}	{3}	{4}
				0.01791	0.11980	0.04724	0.04853
				Opolskie	0.0012	0.3421	0.3214
				Śląskie	0.0012	0.0197	0.0220
				Małopolskie	0.3421	0.0197	0.9667
				Świętokrzyskie	0.3214	0.0220	0.9667
Co	5.7498	0.0010	0.95	Error: between MS=0.00000, df=140.000			
				{1}	{2}	{3}	{4}
				0.00049	0.00032	0.00150	0.00007
				Opolskie	0.6440	0.0071	0.2615
				Śląskie	0.6440	0.0017	0.5077
				Małopolskie	0.0071	0.0017	0.0002
				Świętokrzyskie	0.2615	0.5077	0.0002
Cu	0.7884	0.5023	0.95	Non-significant differences			
Hg	0.8759	0.4553	0.95	Non-significant differences			
Ni	1.5516	0.2039	0.95	Non-significant differences			
Pb	2.2386	0.0864	0.95	Non-significant differences			
Sb	5.7403	0.00099	0.95	Error: between MS=0.00041, df=140.00			
				{1}	{2}	{3}	{4}
				0.01762	0.00509	0.01443	0.00019
				Opolskie	0.0096	0.5050	0.0004
				Śląskie	0.0096	0.0524	0.3065
				Małopolskie	0.5050	0.0524	0.0034
				Świętokrzyskie	0.0004	0.3065	0.0034
Tl	1.1052	0.3493	0.95	Non-significant differences			
Zn	5.9848	0.00072	0.95	Error: between MS=9.6152, df=140.00			
				{1}	{2}	{3}	{4}
				2.5647	0.01519	0.01478	0.08058
				Opolskie	0.0007	0.0006	0.0009
				Śląskie	0.0007	0.9996	0.9288
				Małopolskie	0.0006	0.9996	0.9284
				Świętokrzyskie	0.0009	0.9288	0.9284

F – F-ratio

p – probability

values <0.05 are shown in **bold**

Table S5. Results of one-way ANOVA of differences between average BC_{F1} values of PHEs in groups of vegetables.

PHE	F	p	Confidence interval	Fisher's LSD test, probabilities for post-hoc tests							
As	0.6225	0.7366	0.95	Non-significant differences							
Cd	2.5052	0.0188	0.95	Error: between MS=0.01181, df=136.000							
				{1}	{2}	{3}	{4}	{5}	{6}	{7}	{8}
				0.08801	0.05192	0.11172	0.02364	0.01614	0.00131	0.03487	0.04478
	root				0.2911	0.3604	0.1418	0.0255	0.1378	0.3618	0.2064
	tuber			0.2911		0.0587	0.5488	0.3280	0.4061	0.7794	0.8527
	leaf			0.3604	0.0587		0.0356	0.0012	0.0529	0.1764	0.0346
	inflorescence			0.1418	0.5488	0.0356		0.8693	0.7376	0.8662	0.6540
	fruit			0.0255	0.3280	0.0012	0.8693		0.8035	0.7535	0.4334
	shoot			0.1378	0.4061	0.0529	0.7376	0.8035		0.6629	0.4754
	legume			0.3618	0.7794	0.1764	0.8662	0.7535	0.6629		0.8707
	seed			0.2064	0.8527	0.0346	0.6540	0.4334	0.4754	0.8707	
Co	1.4743	0.1814	0.95	Non-significant differences							
Cu	2.5702	0.0162	0.95	Error: between MS=18.751, df=136.000							
				{1}	{2}	{3}	{4}	{5}	{6}	{7}	{8}
				1.4005	1.6490	1.1088	0.6768	0.5144	0.0898	4.5618	5.5605
	root				0.8550	0.7774	0.6775	0.4858	0.5722	0.1742	0.0026
	tuber			0.8550		0.6663	0.6050	0.4361	0.5206	0.2309	0.0117
	leaf			0.7774	0.6663		0.7943	0.6069	0.6519	0.1278	0.0005
	inflorescence			0.6775	0.6050	0.7943		0.9287	0.8251	0.1452	0.0102
	fruit			0.4858	0.4361	0.6069	0.9287		0.8582	0.0902	0.0007
	shoot			0.5722	0.5206	0.6519	0.8251	0.8582		0.1465	0.0254
	legume			0.1742	0.2309	0.1278	0.1452	0.0902	0.1465		0.6806
	seed			0.0026	0.0117	0.0005	0.0102	0.0007	0.0254	0.6806	
Ni	1.3397	0.2363	0.95	Non-significant differences							
Pb	2.4915	0.0194	0.95	Error: between MS=1.1125, df = 136.000							
				{1}	{2}	{3}	{4}	{5}	{6}	{7}	{8}
				0.26604	0.25813	0.58089	0.0000	0.54086	0.13433	2.2936	0.16528
	root				0.9809	0.2115	0.5303	0.3751	0.8156	0.0005	0.7610
	tuber			0.9809		0.2910	0.5729	0.4256	0.8340	0.0007	0.8038

				leaf	0.2115	0.2910		0.1516	0.8868	0.4173	0.0022	0.1745
				inflorescence	0.5303	0.5729	0.1516		0.2224	0.8356	0.0005	0.7180
				fruit	0.3751	0.4256	0.8868	0.2224		0.4828	0.0029	0.2903
				shoot	0.8156	0.8340	0.4173	0.8356	0.4828		0.0044	0.9582
				legume	0.0005	0.0007	0.0022	0.0005	0.0029	0.0044		0.0004
				seed	0.7610	0.8038	0.1745	0.7180	0.2903	0.9582	0.0004	
Sb	2.6558	0.0132	0.95	Error: between MS=13.048, df = 136.000								
					{1}	{2}	{3}	{4}	{5}	{6}	{7}	{8}
					0.02977	0.15037	0.03624	0.05051	0.02706	0.01270	0.05978	0.03637
				root		0.0003	0.7935	0.6188	0.9290	0.7587	0.5892	0.8394
				tuber	0.0003		0.0002	0.0279	0.0005	0.0190	0.1206	0.0023
				leaf	0.7935	0.0002		0.7193	0.7400	0.6635	0.6635	0.9965
				inflorescence	0.6188	0.0279	0.7193		0.5898	0.5527	0.8841	0.7534
				fruit	0.9290	0.0005	0.7400	0.5898		0.8009	0.5656	0.7894
				shoot	0.7587	0.0190	0.6635	0.5527	0.8009		0.5220	0.6838
				legume	0.5892	0.1206	0.6635	0.8841	0.5656	0.5220		0.6870
				seed	0.8394	0.0023	0.9965	0.7534	0.7894	0.6838	0.6870	
Tl	1.4308	0.1979	0.95	Non-significant differences								
Zn	2.1520	0.0423	0.95	Error: between MS=0.12709, df = 136.000								
					{1}	{2}	{3}	{4}	{5}	{6}	{7}	{8}
					0.09476	0.11840	0.16816	0.08478	0.04111	0.01310	0.09617	0.44996
				root		0.8327	0.3881	0.9444	0.6081	0.6690	0.9941	0.0018
				tuber	0.8327		0.6295	0.8279	0.5191	0.5981	0.9113	0.0095
				leaf	0.3881	0.6295		0.5412	0.1828	0.4048	0.6986	0.0070
				inflorescence	0.9444	0.8279	0.5412		0.7701	0.7432	0.9584	0.0194
				fruit	0.6081	0.5191	0.1828	0.7701		0.8862	0.7784	0.0008
				shoot	0.6690	0.5981	0.4048	0.7432	0.8862		0.7423	0.0301
				legume	0.9941	0.9113	0.6986	0.9584	0.7784	0.7423		0.0781
				seed	0.0018	0.0095	0.0070	0.0194	0.0008	0.0301	0.0781	

F – F-ratio

p – probability

values <0.05 are shown in **bold**

Table S6. Results of one-way ANOVA of differences between BC_{F1} values of PHEs in investigated regions of southern Poland.

PHE	F	p	Confidence interval	Fisher's LSD test, probabilities for post-hoc tests			
As	2.3622	0.0739	0.95	Non-significant differences			
Cd	4.9854	0.0026	0.95	Error: between MS=0.01170, df=140.000			
				{1}	{2}	{3}	{4}
				0.03273	0.04120	0.11892	0.08577
				Opolskie	0.7402	0.0009	0.0393
				Śląskie	0.7402	0.0027	0.0826
				Małopolskie	0.0009	0.0027	0.1957
				Świętokrzyskie	0.0393	0.0826	0.1957
Co	8.8440	0.000021	0.95	Error: between MS=0.00018, df=140.000			
				{1}	{2}	{3}	{4}
				0.00277	0.00237	0.01508	0.00078
				Opolskie	0.89884	0.00014	0.52796
				Śląskie	0.89884	0.00009	0.61412
				Małopolskie	0.00014	0.00009	0.00001
				Świętokrzyskie	0.52796	0.61412	0.00001
Cu	1.0174	0.3870	0.95	Non-significant differences			
Ni	0.8124	0.4890	0.95	Non-significant differences			
Pb	3.0255	0.0317	0.95	Error: between MS=1.1451, df=140.000			
				{1}	{2}	{3}	{4}
				0.42949	0.05467	0.81446	0.44124
				Opolskie	0.1395	0.1292	0.9629
				Śląskie	0.1395	0.0031	0.1276
				Małopolskie	0.1292	0.0031	0.1412
				Świętokrzyskie	0.9629	0.1276	0.1412
Sb	6.4694	0.000393	0.95	Error: between MS=0.01044, df=140.00			
				{1}	{2}	{3}	{4}
				0.09085	0.02089	0.07645	0.00058
				Opolskie	0.0043	0.5508	0.0003
				Śląskie	0.0043	0.0225	0.4006
				Małopolskie	0.5508	0.0225	0.0020
				Świętokrzyskie	0.0003	0.4006	0.0020
Tl	0.6551	0.5810	0.95	Non-significant differences			
Zn	4.4558	0.0051	0.95	Error: between MS=0.12518, df=140.00			
				{1}	{2}	{3}	{4}
				0.07802	0.02284	0.20467	0.29881
				Opolskie	0.5092	0.1311	0.0090
				Śląskie	0.5092	0.0309	0.0012
				Małopolskie	0.1311	0.0309	0.2609
				Świętokrzyskie	0.0090	0.0012	0.2609

F – F-ratio

p – probability

values <0.05 are shown in **bold**

Table S7. Results of one-way ANOVA of differences between average BC_{EDTA} values of PHEs in groups of vegetables.

PHE	F	p	Confidence interval	Fisher's LSD test, probabilities for post-hoc tests								
Cd	2.4986	0.0191	0.95	Error: between MS=0.03309, df=136.000								
					{1}	{2}	{3}	{4}	{5}	{6}	{7}	{8}
					0.14508	0.08828	0.18766	0.04218	0.02745	0.00139	0.05725	0.07301
				root		0.3209	0.3267	0.1605	0.0289	0.1418	0.3680	0.2083
				tuber	0.320892		0.0606	0.5594	0.3205	0.3943	0.7607	0.8127
				leaf	0.326681	0.0606		0.0381	0.0012	0.0511	0.1706	0.0307
				inflorescence	0.160541	0.5594	0.0381		0.8468	0.7148	0.8926	0.6961
				fruit	0.028871	0.3205	0.0012	0.8468		0.7940	0.7653	0.4565
				shoot	0.141778	0.3943	0.0511	0.7148	0.7940		0.6648	0.4824
				legume	0.367969	0.7607	0.1706	0.8926	0.7653	0.6648		0.8770
				seed	0.208350	0.8127	0.0307	0.6961	0.4565	0.4824	0.8770	
Cu	1.8250	0.0872	0.95	Non-significant differences								
Ni	1.3224	0.2443	0.95	Non-significant differences								
Pb	2.1193	0.0455	0.95	Error: between MS=0.00003, df = 136.000								
					{1}	{2}	{3}	{4}	{5}	{6}	{7}	{8}
					0.00126	0.00148	0.00296	0.0000	0.00252	0.00058	0.01011	0.00092
				root		0.8893	0.1637	0.5411	0.4012	0.8047	0.0015	0.8362
				tuber	0.8893		0.3181	0.5051	0.5464	0.7532	0.0030	0.7592
				leaf	0.1637	0.3181		0.1320	0.7458	0.3728	0.0081	0.1703
				inflorescence	0.5411	0.5051	0.1320		0.2414	0.8535	0.0016	0.6770
				fruit	0.4012	0.5464	0.7458	0.2414		0.4902	0.0076	0.3548
				shoot	0.8047	0.7532	0.3728	0.8535	0.4902		0.0094	0.9041
				legume	0.0015	0.0030	0.0081	0.0016	0.0076	0.0094		0.0016
				seed	0.8362	0.7592	0.1703	0.6770	0.3548	0.9041	0.0016	
Zn	1.7471	0.1031	0.95	Non-significant differences								

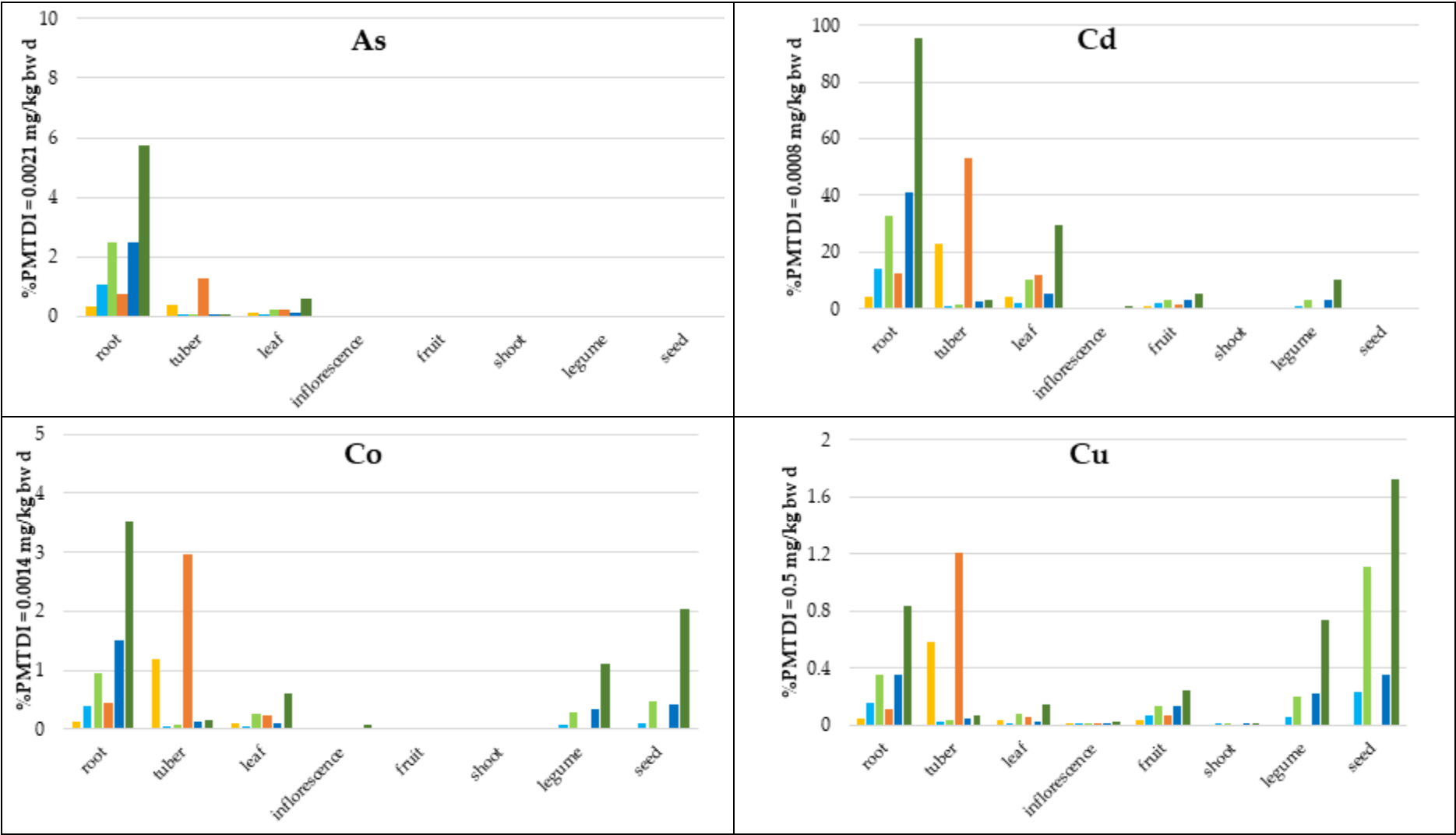
F – F-ratio

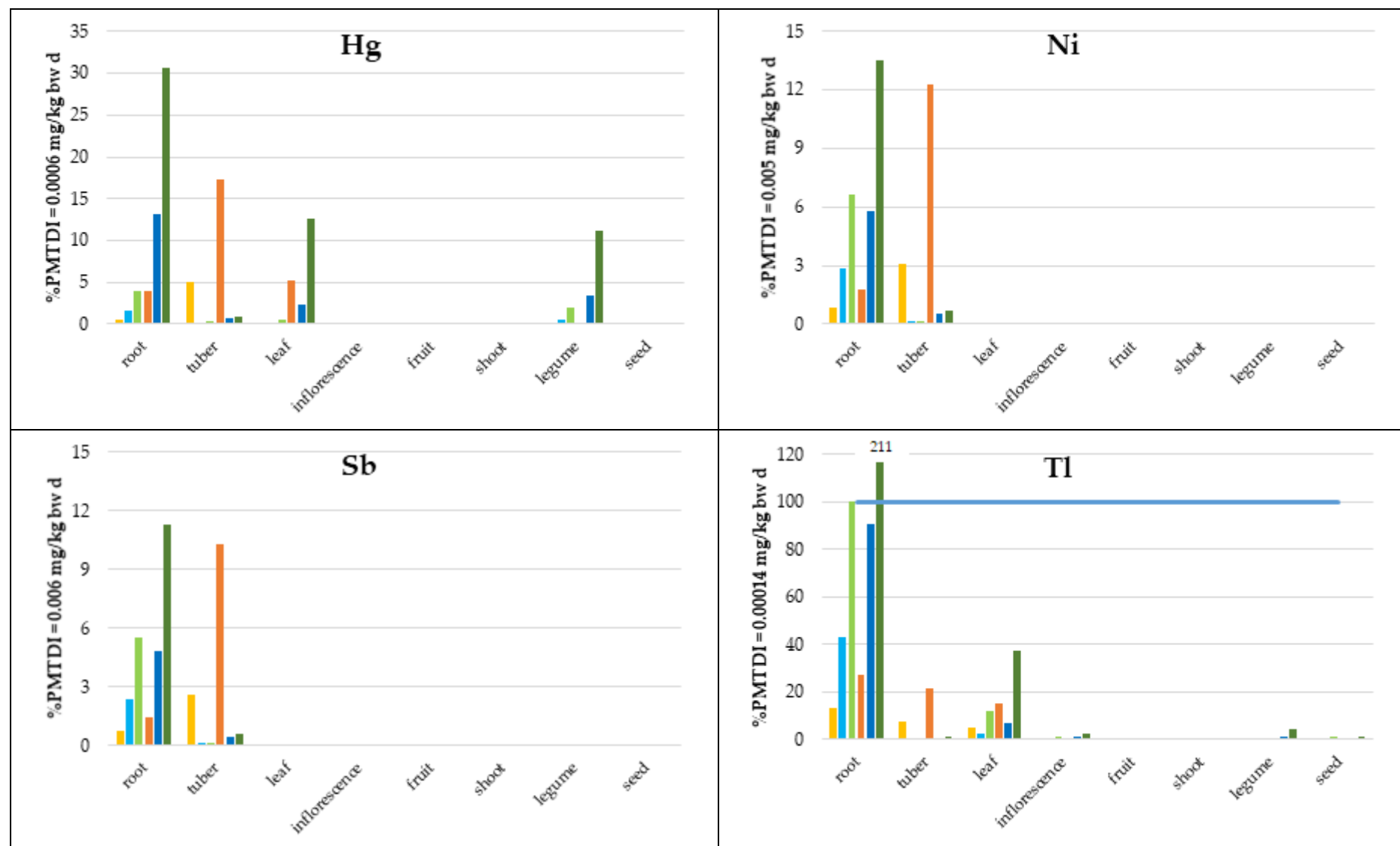
p – probability

values <0.05 are shown in **bold**

Table S8. Results of one-way ANOVA of differences between BC_{EDTA} values of PHEs in investigated regions of southern Poland.

PHE	F	p	Confidence interval	Fisher's LSD test, probabilities for post-hoc tests				
Cd	5.9461	0.00076	0.95	Error: between MS=0.03218, df=140.000				
					{1}	{2}	{3}	{4}
					0.00000	0.00093	0.00170	0.00114
				Opolskie		0.3337	0.0005	0.0019
				Śląskie	0.3337		0.0099	0.0296
				Małopolskie	0.0005	0.0099		0.6774
Świętokrzyskie	0.0019	0.0296	0.6774					
Cu	2.4120	0.0694	0.95	Non-significant differences				
Ni	0.8308	0.4790	0.95	Non-significant differences				
Pb	5.3714	0.0016	0.95	Error: between MS=0.00003, df=140.000				
					{1}	{2}	{3}	{4}
					0.00185	0.00035	0.00489	0.00148
				Opolskie		0.2065	0.0113	0.7558
				Śląskie	0.2065		0.0002	0.3400
				Małopolskie	0.0113	0.0002		0.0046
Świętokrzyskie	0.7558	0.3400	0.0046					
Zn	5.1167	0.0022	0.95	Error: between MS=1.0179, df=140.00				
					{1}	{2}	{3}	{4}
					0.1409	0.0670	0.4794	0.8997
				Opolskie		0.7566	0.1567	0.0017
				Śląskie	0.7566		0.0851	0.0006
				Małopolskie	0.1567	0.0851		0.0794
Świętokrzyskie	0.0017	0.0006	0.0794					





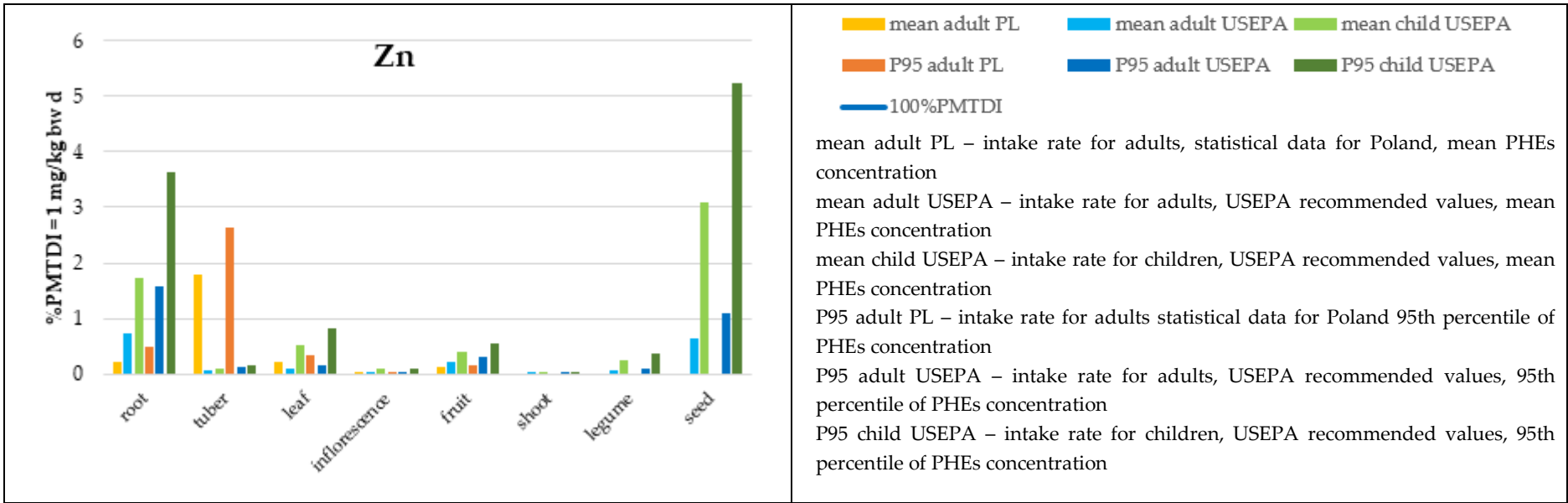
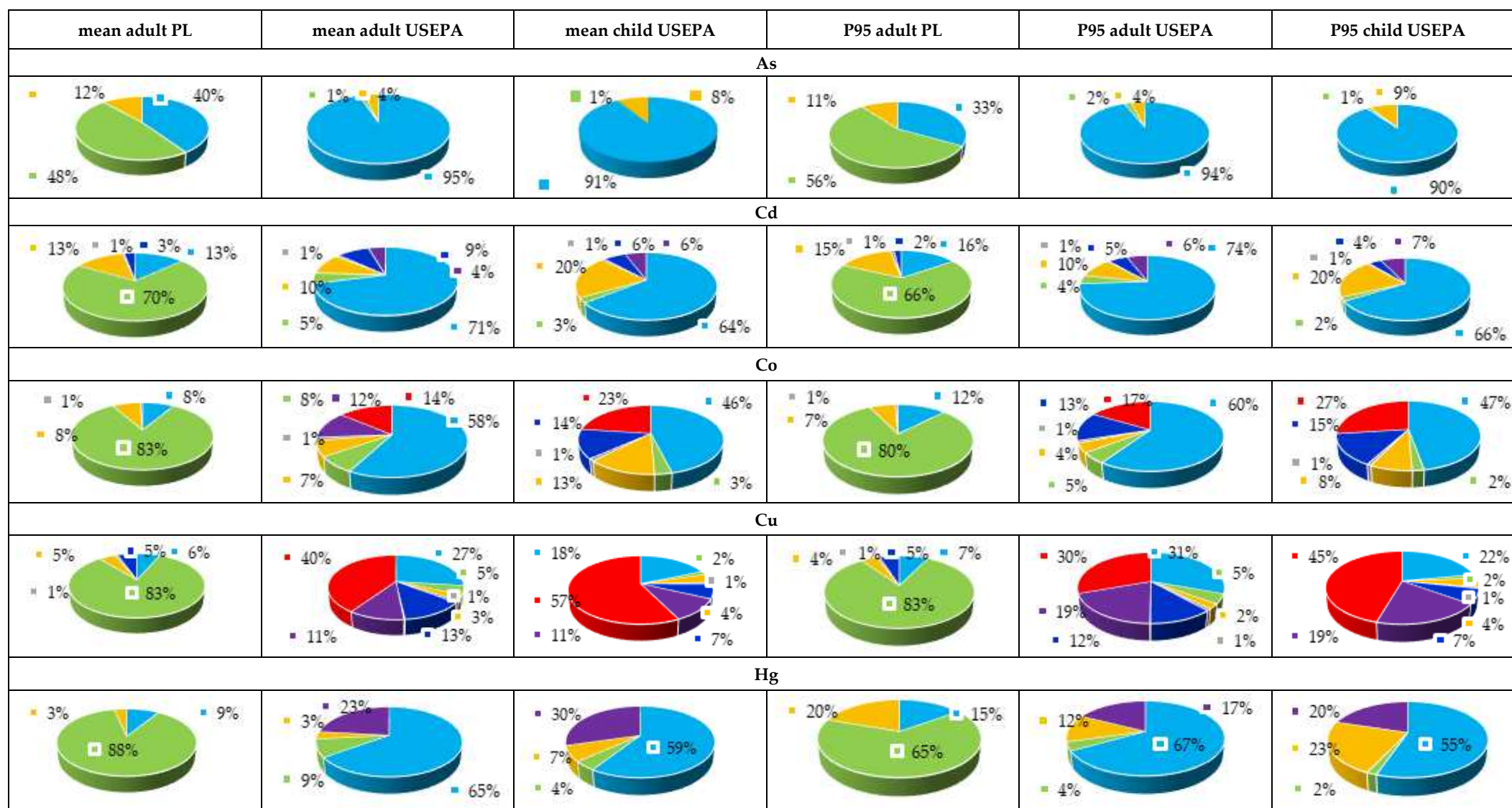
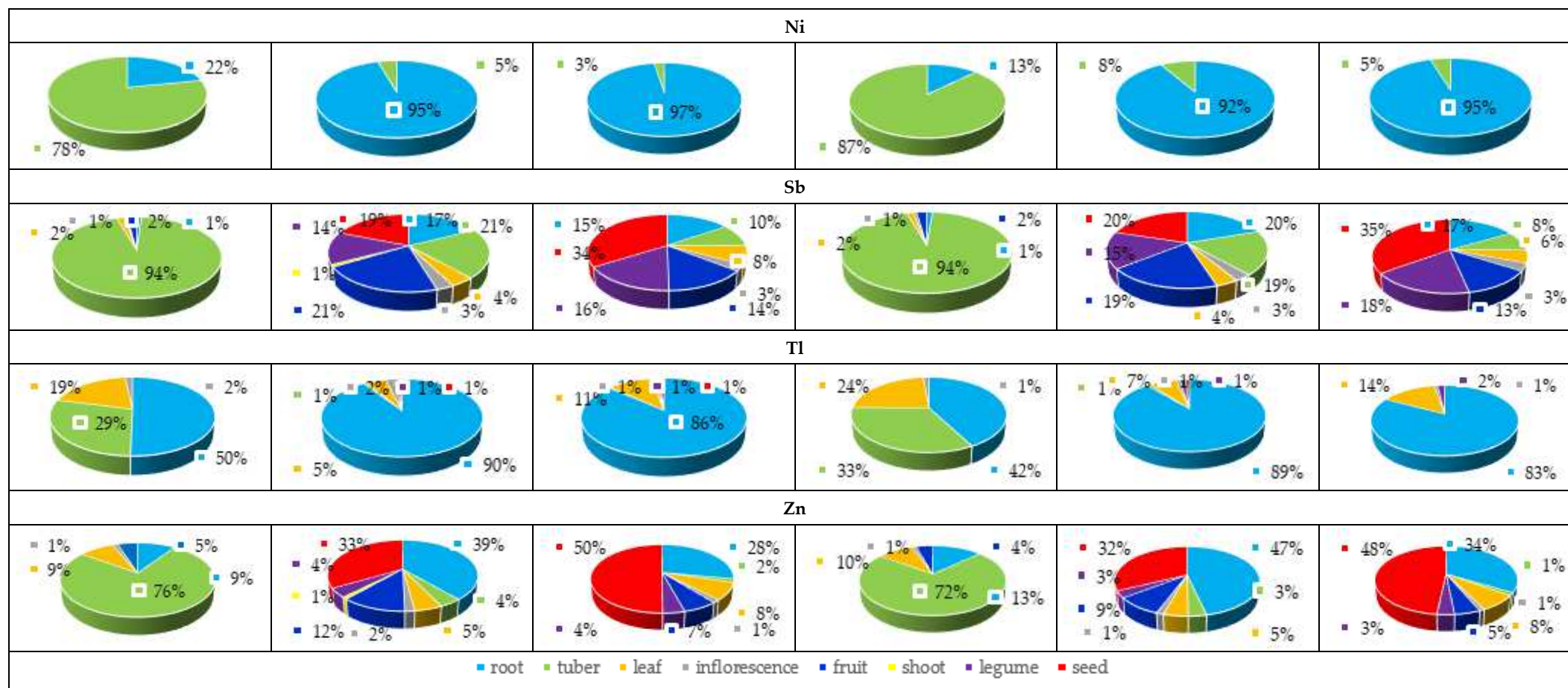


Figure S3. Daily intake rates of PHEs via consumed vegetables, as a percentage of provisional maximum tolerable daily intake (%PMTDI)





mean adult PL – intake rate for adults, statistical data for Poland, mean PHEs concentration; mean adult USEPA – intake rate for adults, USEPA recommended values, mean PHEs concentration, mean child USEPA – intake rate for children, USEPA recommended values, mean PHEs concentration; P95 adult PL – intake rate for adults statistical data for Poland 95th percentile of PHEs concentration; P95 adult USEPA – intake rate for adults, USEPA recommended values, 95th percentile of PHEs concentration; P95 child USEPA – intake rate for children, USEPA recommended values, 95th percentile of PHEs concentration

Figure S4. The contribution of various groups of vegetables to the PHE daily intake rates



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