

## The Levels of PCDFs and PCDDs in 3 Cereals, Rice, Barley and Bean, in Korea

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### Introduction

Oral exposure is the predominant route of exposure for most human populations. The background exposure from ingestion of contaminated water, fish, beef, dairy products and vegetables may be quite significant in some areas. Consumption of contaminated food is considered to be the major source of polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDDs/PCDFs) human body burden<sup>1</sup>. This study reports the concentrations and TEQ levels of PCDFs/PCDDs in three cereals in Korea, which are rice, barley and bean. These cereals are the most consumptive food sources in Korea.

### Materials and Methods

**Sample:** The samples measured in this study have been bought 3 sets of each cereal from different market in 5 big cities.

**Analytical Method:** The cereal samples 50 g were ground, transferred into the prewashed bottle and spiked with fifteen carbon-13 labeled isotope compounds (Cambridge Isotope Laboratories, Woburn, MA, USA). In this bottle, 30 g anhydrous sodium sulfate is added and mixed carefully. Methylene chloride 50 ml, as extracting solvent, was added and ultrasonicated for 20 min. The extraction was done 3 times. Extracts were concentrated to about 10 ml and passed through the activated florisil column and sep-pak cartridge for solid phase extraction (Waters, Milford, MA), with more two times of n-hexane 10 ml. Eluent concentrated to about 20ml by nitrogen stream and washed with conc. sulfuric acid, 5% NaCl and 20% KOH. Washed extracts passed through anhydrous Na<sub>2</sub>SO<sub>4</sub> and concentrated to 10 ml for solid phase clean-up; silica, alumina and carbon column by USEPA 1613 method. Eluent to be spiked recovery standards 20  $\mu$ l was concentrated to 20  $\mu$ l. 2  $\mu$ l was injected to HRGC/HRMS.

**GC/MS analysis;** Determination were performed with HP 5890 series II gas chromatograph and Finnigan MAT 95S mass spectrometer at resolution 10,000 using Ultra 2 capillary column (Hewlett Packard).

### Results and Discussions

The concentrations and TEQ levels of PCDFs in rice, barley and bean were 0~0.545 pg/g, 0.280~51.594 pg/g and 4.362~36.788 pg/g, respectively (Table 1). And TEQ levels of PCDFs were 0~0.040 pgTEQ/g, 0.003~4.660 pgTEQ/g and 0.004~2.648 pgTEQ/g. The total concentration and TEQ level of PCDFs in rice (2.380 pg/g and 0.159 pgTEQ/g) is the lowest. The concentrations of PCDDs in rice, barley and bean were 0~0.386 pg/g, 0~20.946 pg/g and 1.586~26.164 pg/g, respectively. And TEQ levels of PCDDs were 0~0.070 pgTEQ/g, 0.000~6.895 pgTEQ/g and 0.009~9.736 pgTEQ/g (Table 2). The total concentration and TEQ level of PCDDs in rice (1.049 pg/g and 0.111 pgTEQ/g) is the lowest. Fortunately, this cereal is main food material in Korea. From these results, we could guess the lower effect for daily intake of PCDFs/PCDDs by rice. Figure 1 and Figure 2 show the TEQ levels of PCDFs and PCDDs, respectively, in the three cereals in Korea by bar graph. Figure 3 and Figure 4 show the distributions of TEQ levels of PCDFs and PCDDs, respectively, in the three cereals in Korea by spot graph.

### References

1. Beck, H., Eckart, K., Mathar, W., Wittkowski, R., Chemosphere, 18 (1989) 417.

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Table 1. The Concentrations and TEQ Values of PCDFs in Some Cereals

Compound	Rice (n=15)					
	concentration (pg/g)			pgTEQ/g		
	mean	SD	min-max	mean	SD	min-max
2,3,7,8-TCDF	0.000	0.000	0.000-0.000	0.000	0.000	0.000-0.000
1,2,3,7,8-PeCDF	0.052	0.082	0.000-0.186	0.003	0.004	0.000-0.009
2,3,4,7,8-PeCDF	0.058	0.096	0.000-0.221	0.029	0.048	0.000-0.111
1,2,3,4,7,8-HxCDF	0.349	0.434	0.000-0.865	0.035	0.043	0.000-0.224
1,2,3,6,7,8-HxCDF	0.200	0.293	0.000-0.704	0.020	0.029	0.000-0.087
1,2,3,7,8,9-HxCDF	0.228	0.326	0.000-0.783	0.023	0.033	0.000-0.078
2,3,4,6,7,8-HxCDF	0.404	0.630	0.000-1.501	0.040	0.063	0.000-0.150
1,2,3,4,6,7,8-HpCDF	0.449	0.613	0.000-1.483	0.004	0.006	0.000-0.015
1,2,3,4,7,8,9-HpCDF	0.545	1.074	0.000-2.455	0.005	0.011	0.000-0.025
OCDF	0.093	0.133	0.000-0.323	0.000	0.000	0.000-0.000
Total PCDFs	2.380	3.681		0.159	0.237	
Compound	Barley (n=15)					
	concentration (pg/g)			pgTEQ/g		
	mean	SD	min-max	mean	SD	min-max
2,3,7,8-TCDF	0.280	0.626	0.000-1.400	0.028	0.063	0.000-0.140
1,2,3,7,8-PeCDF	13.792	29.704	0.000-66.920	0.690	1.485	0.000-3.346
2,3,4,7,8-PeCDF	9.320	19.662	0.000-44.480	4.660	9.831	0.000-22.240
1,2,3,4,7,8-HxCDF	14.224	30.074	0.000-68.000	1.422	3.007	0.000-6.800
1,2,3,6,7,8-HxCDF	17.426	37.280	0.000-84.100	1.743	3.728	0.000-8.410
1,2,3,7,8,9-HxCDF	23.544	52.646	0.000-117.720	2.354	5.265	0.000-11.772
2,3,4,6,7,8-HxCDF	35.656	79.729	0.000-178.280	3.566	7.973	0.000-17.828
1,2,3,4,6,7,8-HpCDF	51.594	115.368	0.000-257.970	0.516	1.154	0.000-2.580
1,2,3,4,7,8,9-HpCDF	32.486	72.641	0.000-162.430	0.325	0.726	0.000-1.624
OCDF	2.966	4.241	0.000-10.220	0.003	0.004	0.000-0.010
Total PCDFs	201.288	441.971		15.307	33.236	
Compound	Bean (n=15)					
	concentration (pg/g)			pgTEQ/g		
	mean	SD	min-max	mean	SD	min-max
2,3,7,8-TCDF	8.846	15.117	0.000-35.370	0.885	1.512	0.000-3.537
1,2,3,7,8-PeCDF	21.456	36.635	0.000-84.590	1.073	1.832	0.000-4.230
2,3,4,7,8-PeCDF	5.296	11.297	0.000-25.490	2.648	5.648	0.000-12.745
1,2,3,4,7,8-HxCDF	13.060	19.189	0.000-42.490	1.306	1.919	0.000-4.249
1,2,3,6,7,8-HxCDF	19.954	22.786	0.000-52.620	1.995	2.279	0.000-5.282
1,2,3,7,8,9-HxCDF	11.938	20.102	0.000-46.390	1.194	2.010	0.000-4.639
2,3,4,6,7,8-HxCDF	16.232	36.296	0.000-81.160	1.623	3.630	0.000-8.116
1,2,3,4,6,7,8-HpCDF	36.788	35.744	0.000-75.690	0.368	0.357	0.000-0.757
1,2,3,4,7,8,9-HpCDF	32.160	50.159	0.000-114.360	0.322	0.502	0.000-1.144
OCDF	4.362	4.194	0.000-8.950	0.004	0.004	0.000-0.009
Total PCDFs	170.092	251.519		11.418	19.693	

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Table 2. The Concentrations and TEQ Values of PCDDs in Some Cereals

Compound	Rice (n=15)					
	concentration (pg/g)			pgTEQ/g		
	mean	SD	min-max	mean	SD	min-max
2,3,7,8-TCDD	0.000	0.000	0.000-0.000	0.000	0.000	0.000-0.000
1,2,3,7,8-PeCDD	0.139	0.188	0.000-0.449	0.070	0.094	0.000-0.035
1,2,3,4,7,8-HxCDD	0.175	0.392	0.000-0.876	0.018	0.039	0.000-0.088
1,2,3,6,7,8-HxCDD	0.147	0.330	0.000-0.737	0.015	0.033	0.000-0.074
1,2,3,7,8,9-HxCDD	0.052	0.117	0.000-0.262	0.004	0.009	0.000-0.021
1,2,3,4,6,7,8-HpCDD	0.386	0.545	0.000-1.341	0.004	0.005	0.000-0.013
OCDD	0.150	0.115	0.000-0.350	0.000	0.000	0.000-0.000
<b>Total PCDDs</b>	<b>1.049</b>	<b>1.687</b>		<b>0.111</b>	<b>0.180</b>	
Compound	Barley (n=15)					
	concentration (pg/g)			pgTEQ/g		
	mean	SD	min-max	mean	SD	min-max
2,3,7,8-TCDD	0.000	0.000	0.000-0.000	0.000	0.000	0.000-0.000
1,2,3,7,8-PeCDD	13.790	30.835	0.000-68.950	6.895	15.418	0.000-34.475
1,2,3,4,7,8-HxCDD	12.976	29.015	0.000-64.880	1.298	2.902	0.000-6.488
1,2,3,6,7,8-HxCDD	12.420	26.744	0.000-60.240	1.242	2.674	0.000-6.024
1,2,3,7,8,9-HxCDD	1.848	4.132	0.000-9.240	0.185	0.413	0.000-0.924
1,2,3,4,6,7,8-HpCDD	20.946	46.837	0.000-104.730	0.209	0.468	0.000-1.047
OCDD	7.708	6.424	0.000-14.200	0.000	0.008	0.000-0.006
<b>Total PCDDs</b>	<b>69.688</b>	<b>143.987</b>		<b>9.829</b>	<b>21.883</b>	
Compound	Bean (n=15)					
	concentration (pg/g)			pgTEQ/g		
	mean	SD	min-max	mean	SD	min-max
2,3,7,8-TCDD	6.476	14.481	0.000-32.380	6.476	14.481	0.000-32.380
1,2,3,7,8-PeCDD	19.472	26.020	0.000-62.790	9.736	13.010	0.000-31.395
1,2,3,4,7,8-HxCDD	8.436	18.863	0.000-42.180	0.844	1.886	0.000-4.218
1,2,3,6,7,8-HxCDD	18.280	19.746	0.000-39.360	1.828	1.975	0.000-3.936
1,2,3,7,8,9-HxCDD	1.586	2.780	0.000-6.420	0.159	0.278	0.000-0.642
1,2,3,4,6,7,8-HpCDD	26.164	27.379	0.000-62.710	0.262	0.274	0.000-0.627
OCDD	9.276	3.802	3.370-13.280	0.009	0.004	0.000-0.013
<b>Total PCDDs</b>	<b>89.69</b>	<b>113.071</b>		<b>19.314</b>	<b>31.908</b>	