

## PCDD/F-levels in human blood of vegetarians compared to those of non-vegetarians

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### Summary

The levels of polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) of 24 whole blood samples from vegetarians were determined and compared to those of a group of 24 non-vegetarians. Both groups include only persons with no known specific exposure to PCDD/F. Each vegetarian was matched to a participant of the comparison group. Matching criteria were sex, age ( $\pm 3$  years), body weight and height. In all samples the typical congener profile for human tissues was found. The PCDD/F-levels in the vegetarian group ranged from 14.64 to 52.85 pg I-TE/g (lipid basis) with a mean of 32.60 pg I-TE/g, in the comparison group from 14.26 to 97.98 pg I-TE/g with a mean of 34.32 pg I-TE/g (lipid basis). There was no significant difference ( $\alpha=0.05$ ) between the vegetarian and the non-vegetarian group in the mean levels of the 2,3,7,8-chloro-substituted congeners as well as the sum of PCDD, the sum of PCDF and of PCDD/F or I-TE, each on lipid basis and on whole weight basis. It is, therefore, concluded that the mean PCDD/F-body burden of the vegetarian and the non-vegetarian group are not different.

### Introduction

The contamination of our environment with PCDD/F results in an ubiquitous distribution of these compounds. PCDD/F, therefore, can also be detected in human tissues and lead to a considerable body burden of the general population. It is assumed that more than 90% of the intake of PCDD/F by humans takes place via food<sup>1</sup>. On the basis of the dietary habits of the German population dairy products, meat and meat products, and fish and fish products each contribute nearly 30% to the exposure via food<sup>2,3,4</sup>. People who live on a vegetarian diet do not eat meat, meat products, fish or fish products. Thus, they avoid some categories of food, which are relatively high contaminated with PCDD/F. Consequently, vegetarians should have a lower PCDD/F-body burden than non-vegetarians. This assumption is tested in the present

study. For this purpose 24 whole blood samples of vegetarians were examined for PCDD/F and the results were compared with the PCDD/F-levels of 24 non-vegetarians, matched for age, sex, body weight and height.

## Materials and methods

The vegetarians, who participated in this study, were volunteers, living in Northrhine-Westfalia, Germany. They practiced a diet without meat and fish for three years or longer. Only in two cases the period was shorter. The vegetarians were asked about their nutritional habits and food consumption as well as about personal data, breastfed children and possible occupational or private exposure to PCDD/F-contaminated materials or PCDD/F-sources by a standardized questionnaire. The subjects of the comparison group were taken from a previous study <sup>5,6</sup> and were questioned in the same way. They lived in the district Steinfurt (Northrhine-Westfalia). Matched pairs should guarantee a similar structure of both groups. Basic characteristics of the groups are presented in tab. 1.

Tab. 1: Characteristic data for the group of vegetarians and the comparison group of non-vegetarians

		vegetarians	non-vegetarians
age [years]	mean	36.0	36.1
	minimum	18	18
	maximum	67	66
sex	female	15	15
	male	9	9
body weight [kg]	mean	65	68
body height [cm]	mean	169	173
body-mass-index [kg/m <sup>2</sup> ]	mean	22.9	22.8

Tab. 2: Duration of the vegetarian diet

duration [years]	number of persons
1	1
2	1
3	4
4	4
5 - 10	9
11 - 20	2
> 20	3
sum	24

The blood samples were frozen immediately after collection and kept frozen until analysis. The extraction of the PCDD/F and the clean-up of the samples as well as the gas-chromatographic/mass-spectrometric conditions are described in detail elsewhere <sup>6</sup>.

## Results and discussion

The results of blood analyses of this investigation are presented in tab. 3 (lipid basis) and tab. 4 (whole weight basis). The TE-values were calculated according to the NATO/CCMS-model (I-TE) and to the proposal of the German Federal Health Office BGA (German TE). Fig. 1 and 2 show the mean levels of the 2,3,7,8-chloro-substituted congeners. All 24 samples of the vegetarians show the typical congener profile of human blood. 1,2,3,7,8-PentaCDF, 1,2,3,7,8,9-HexaCDF and 1,2,3,4,7,8,9-HeptaCDF could be determined only in a few samples near the detection limit. 2,3,7,8-TetraCDF and OctaCDF also could not be detected in all samples. For these congeners, therefore, there are no statistical statements practicable.

There is no significant difference ( $\alpha = 0.05$ ) between the mean values of the levels of any other 2,3,7,8-substituted PCDD/F-congener in both groups, both on lipid and on whole weight basis. This is also true for the sum of PCDD, the sum of PCDF, the sum of PCDD/F and the toxicity equivalents. These results lead to the conclusion that the mean body burden is the same in both groups.

It was expected that the mean PCDD/F-body burden in the vegetarian group is lower than in the non-vegetarian group because of the fact that vegetarians avoid the consumption of meat and fish and their products. This could not be confirmed.

Most vegetarians changed their consumption habits after a more or less long period of normal nutrition to a vegetarian diet. Probably the intake of PCDD/F in this first period was nearly the same as in the comparison group. It is assumed that the alteration of the body burden since the beginning of the vegetarian diet follows normal pharmacokinetic rules. Therefore one has to take into account the long biological half lives of PCDD/F in humans when estimating the relation between an assumed changed intake of PCDD/F and an altered body burden. Further investigations are necessary to find out whether a long duration of vegetarian diet for several decades leads to a decreased PCDD/F-body burden or not. Perhaps a larger consumption of other products with relative high PCDD/F-contents, for example dairy products, compensates a part of the PCDD/F-intake by meat and fish in non-vegetarians.

## References

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Tab. 3: PCDD/F-levels in whole blood samples of vegetarians and non-vegetarians, calculated on lipid basis

[pg/g] (lipid basis)	vegetarians					non-vegetarians				
	n	mean	median	min.	max.	n	mean	median	min.	max.
2378-TetraCDD	24	3.39	3.2	1.2	5.4	24	3.58	3.4	1.2	11
12378-PentaCDD	24	14.1	15	6.5	25	24	15.5	15	5.8	43
123478-HexaCDD	24	12.3	12	4.6	23	24	14.7	13	5.4	36
123678-HexaCDD	24	36.0	37	17	66	24	39.9	36	18	110
123789-HexaCDD	24	6.84	6.8	3.7	12	24	8.33	7.7	2.9	22
1234678-HeptaCDD	24	70.2	68	32	120	24	80.0	81	24	160
OctaCDD	24	447	390	180	1100	24	456	420	150	950
2378-TetraCDF	16*	0.94	0.68	0.16	2.3	9*	1.25	1.4	0.36	2.1
12378-PentaCDF	6*	0.64	0.61	0.42	0.89	11*	0.66	0.64	0.36	1.1
23478-PentaCDF	24	25.8	23	11	50	24	25.5	23	9.9	80
123478-HexaCDF	24	8.09	8.4	4.2	13	24	9.05	8.4	4.2	20
123678-HexaCDF	24	11.8	12	5.3	18	24	12.9	12	5.3	33
234678-HexaCDF	24	3.16	3.2	0.79	5.0	24	3.16	3.0	0.66	7.9
123789-HexaCDF	3**	***	***	***	***	1**	***	***	***	***
1234678-HeptaCDF	24	14.2	13	5.6	72	24	14.6	14	8.5	22
1234789-HeptaCDF	6*	0.40	0.39	0.25	0.52	5*	0.58	0.50	0.40	0.77
OctaCDF	14	2.02	1.3	0.21	6.7	17	1.36	1.1	0.66	3.3
Sum of PCDD	24	595	502	265	1330	24	623	602	242	1320
Sum of PCDF	24	67.2	68.8	33.6	122	24	68.4	63.2	35.5	160
Sum of PCDD/F	24	662	572	302	1400	24	691	674	297	1480
German TE***	24	16.67	16.50	7.660	24.76	24	18.02	16.78	7.880	48.86
1-TE	24	32.60	31.22	14.64	52.85	24	34.32	31.01	14.26	97.98

\* the statistical data were calculated on the basis of only those samples with levels above the detection limit

\*\* in consideration of the small number no statistical data were calculated

\*\*\* toxicity equivalents according to the proposal of the German Federal Health Office (BGA)

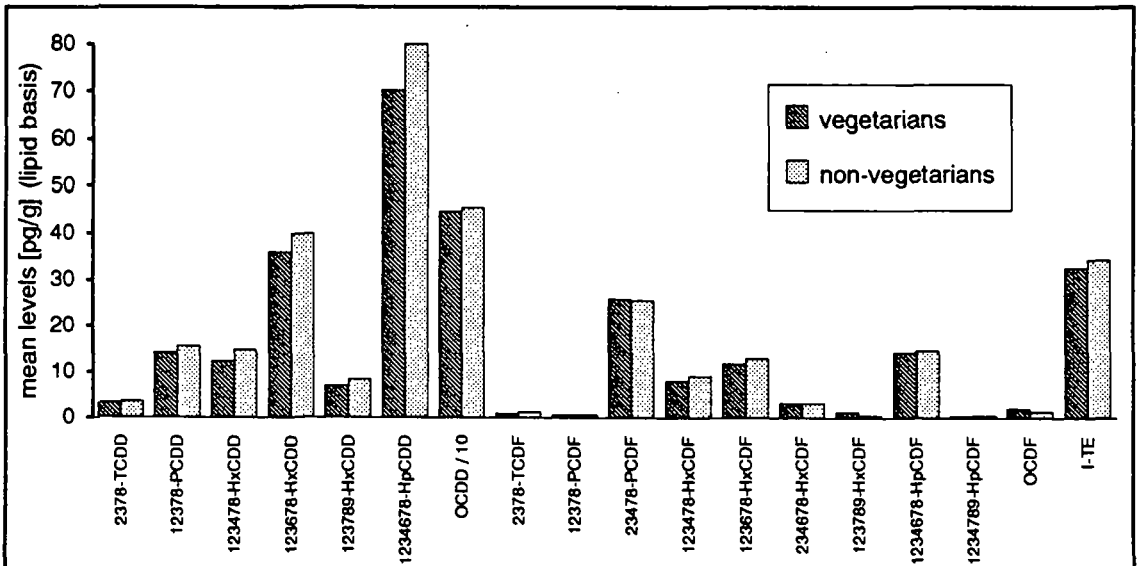


Fig. 1: Comparison of the mean PCDD/F-levels in the whole blood of the vegetarian group and the non-vegetarian group, calculated on lipid basis

Tab. 4: PCDD/F-levels in whole blood samples of vegetarians and non-vegetarians, calculated on whole weight basis

[fg/g] (whole weight basis)	vegetarians					non-vegetarians				
	n	mean	median	min.	max.	n	mean	median	min.	max.
2378-TetraCDD	24	18.8	17	5.9	34	24	20.4	19	5.5	66
12378-PentaCDD	24	77.8	77	32	140	24	86.8	75	28	250
123478-HexaCDD	24	67.9	67	23	130	24	82.9	72	27	210
123678-HexaCDD	24	199	190	91	340	24	225	200	86	660
123789-HexaCDD	24	38	38	18	68	24	47.1	38	16	130
1234678-HeptaCDD	24	394	370	170	710	24	455	440	120	920
OctaCDD	24	2500	2000	910	6000	24	2590	2500	800	5600
2378-TetraCDF	16*	5.18	3.8	0.98	14	9*	7.31	8.7	2.1	12
12378-PentaCDF	6*	3.62	3.6	2.2	5.1	11	3.90	3.7	2.2	6.1
23478-PentaCDF	24	142	130	52	310	24	143	120	46	470
123478-HexaCDF	24	45.1	43	20	83	24	50.8	47	20	120
123678-HexaCDF	24	65.5	62	26	110	24	72.2	65	25	190
234678-HexaCDF	24	17.3	17	3.8	30	24	17.9	16	3.7	46
123789-HexaCDF	3**	...**	...**	...**	...**	1**	...**	...**	...**	...**
1234678-HeptaCDF	24	81.3	64	32	490	24	81.5	80	46	140
1234789-HeptaCDF	6*	2.32	2.3	1.6	3.0	5*	3.40	2.9	2.2	4.9
OctaCDF	14	11.2	7.7	1.3	37	17	7.92	5.7	3.6	20
Sum of PCDD	24	3330	2840	1380	7280	24	3530	3380	1300	7810
Sum of PCDF	24	374	378	162	830	24	383	347	163	932
Sum of PCDD/F	24	3710	3100	1620	7920	24	3920	3720	1470	8740
German TE***	24	92.24	85.40	37.31	151.5	24	101.7	95.04	36.42	289.5
I-TE	24	180.0	167.9	70.79	331.2	24	193.4	172.4	65.92	577.1

\* the statistical data were calculated on the basis of only those samples with levels above the detection limit  
 \*\* in consideration of the small number no statistical data were calculated  
 \*\*\* toxicity equivalents according to the proposal of the German Federal Health Office (BGA)

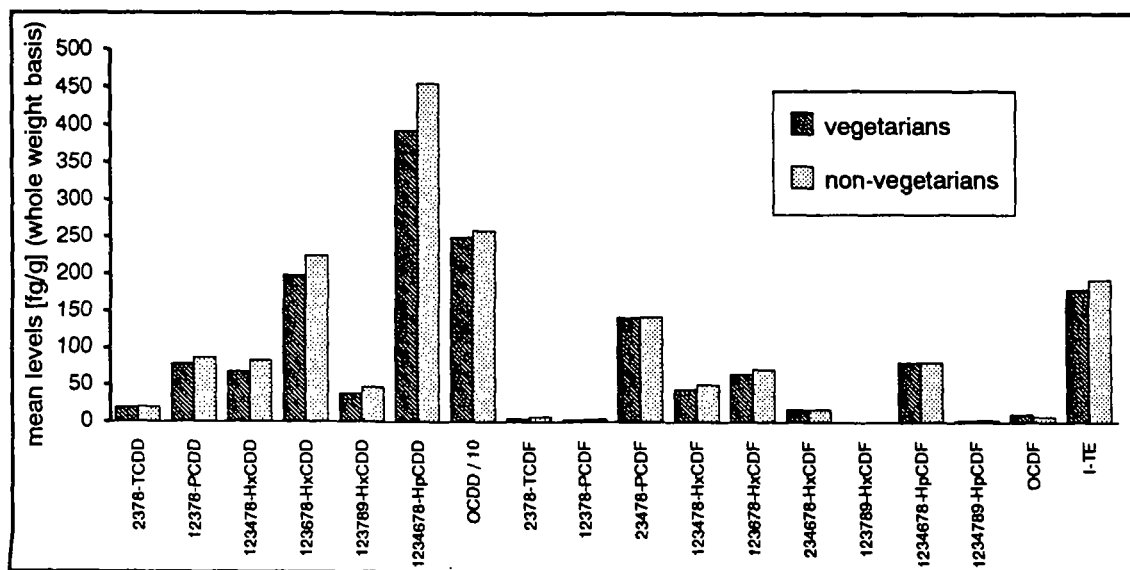


Fig. 2: Comparison of the mean PCDD/F-levels in the whole blood of the vegetarian group and the non-vegetarian group, calculated on whole weight basis