Comparison of Blood Dioxin, Dibenzofuran, and Coplanar PCB Levels in Strict Vegetarians (Vegans) and the General United States Population

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Introduction

Beginning in the 1980's, dioxin (PCDD) and dibenzofuran (PCDF) congeners have been found in human tissues with 17 toxic congeners now commonly measured in the blood of persons living in industrialized countries. The total levels and the dioxin toxic equivalents (TEQs) are typically lower in tissues of persons living in less industrialized countries. A typical pattern is usually found in Europeans and an almost identical pattern is found in American blood (1).

It is believed that 95% or more of dioxin body burden in the general population comes from food intake, with the remainder from air and water. Dioxin levels found in fruit and vegetables are far lower than in foods of animal origin. Meat, fish and dairy products are believed to contribute almost all of the dioxin body burden with fruit and vegetables making a minor contribution. Currently estimated average US adult daily intake is between 1 and 6 pg/kg body weight TEQ (2,3).

To test the hypothesis that vegetables and fruit contribute relatively little to dioxin body burden, we collected blood from two adult American vegans. A vegan is a person who eats a strict vegetarian diet, with no milk, cheese, eggs or other animal products. With some difficulty we found one man and one woman who had been strict vegans for over twenty years, since 1970. They were 49 and 50 years of age at the time of blood collection. Their individual blood samples were analyzed for PCDDs, PCDFs, and coplanar PCBs and compared to two pooled blood samples of 100 men and 100 women each, collected in the same year, 1997.

Materials and Methods

One hundred ML of whole blood was collected from each person for the four analyses. The blood was frozen after collection and stored at -20° C. Blood from men and women from the general population pools was obtained from hospital anticoagulated whole blood in an anonymous fashion. The samples were shipped on dry ice from Binghamton, NY to ERGO laboratory in Hamburg, Germany and kept frozen there at -20° C until analyzed.

The analytic methods have been previously described and will not be repeated here (4). ERGO Laboratory is a laboratory certified by the World Health Organization in interlaboratory validation studies for blood dioxin analysis.

Results and Discussion

The data is presented in summary form for measured levels and TEQ in Table 1. PCDD, PCDF and coplanar PCB measured levels and TEQ in the general population exceed the levels for the two vegans. For both the general population and the vegans, levels also generally are higher in the female than in the male sample. The male and female vegan have 244 and 330 ppt, respectively, total measured levels of PCDDs, PCDFs and coplanar PCBs. Blood from men and women of the general population measures 643 and 906 ppt, respectively. The total dioxin TEQs are 4.4 and 8.7 ppt for the male and female vegans, and 24.2 and 29.3 ppt, for men and women, respectively, in the general population.

The TEQ results are shown graphically in Figure 1. PCDDs and PCDFs account for most of the blood TEQ concentrations except for the male vegan, where PCDFs contribute to most of the TEQ.

The data are consistent with the hypothesis that most of the dioxin body burden is from foods of animal origin. The data suggest that a diet high in fruits and vegetables and low in meat, fish, and dairy products can lead to lower than average American body burden of dioxins, dibenzofurans and coplanar PCBs. The two vegans began their vegan diets in 1970, 27 years prior to blood collection and analysis. The small sample size does not allow us to generalize but the results are striking and consistent with current scientific beliefs regarding food (meat, fish, and dairy as the major pathways of dioxins into humans in the general population).

At the present time nutritional advice for Americans given by public health specialists is to decrease intake of animal fat and increase intake of fruits and vegetables in order to reduce risks for cancer and cardiovascular disease, including coronary artery disease and cerebrovascular accidents. The findings of the present study support and possibly extend the rationale for this type of altered dietary consumption in the general American population.

Higher blood levels of PCDDs, PCDFs, and coplanar PCBs are found in the vegan woman than in the man, and the general population females sample also has higher levels than the sample from males.

Acknowledgments

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References

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Table 1. Dioxins, Dibenzofurans and Coplanar PCBs in Blood of Two Vegans and of the General American Population

pg/g (ppt), lipid basis

	Vegetarian				General Population			
	Man N=1		Woman N=1		Men N=100		Women N=100	
	Level	TEQ*	Level	TEQ*	Level	TEQ*	Level	TEQ*
Total PCDDs	190	0.9	266	4.1	627	14.6	774	17.4
Total PCDFs	12.4	0.7	14.7	1.6	33.1	5.1	35	5.8
Total PCDD/Fs	203	1.6	281	5.8	660	19.6	808	23.2
Coplanar PCBs								
77 3,3',4,4'-TCB	n.d.	0.0	n.d.	0.0	n.a.	–	n.a.	–
126 3,3'4,4',6-PeCB	27	2.7	27	2.7	42	4.2	57	5.7
169 3,3'4,4',5,5'-HxCB	15	0.1	22	0.2	42	0.4	41	0.4
Total Coplanar PCBs	41	2.8	49	2.9	83	4.6	98	6.1
Total PCDD/F/PCBs	244	4.4	330	8.7	643	24.2	906	29.3

n.a. = not analyzed due to interference n.d. = not detected

*Calculated with n.d. = ½ limit of detection, n.a. = 0

Figure 1. Blood TEQ Levels of Dioxins, Dibenzofurans and Coplanar PCBs in Two Vegans and in Men and Women of the General Population

pg/g (ppt), lipid basis