

# EFFECT OF UPDATED 2005 TEFS ON PREVIOUS USDA FOOD SURVEYS OF PCDD/Fs AND CO-PLANAR PCBs AND COMPARISON TO INITIAL RESULTS FROM A NEW SURVEY

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## Introduction

In 2005 a World Health Organization (WHO) panel of experts reevaluated the toxic equivalency factors (TEFs) of dioxins and dioxin-like compounds incorporating a recently revised and updated database of relative effect potencies.<sup>1</sup> The outcome of this reevaluation was a change in several TEFs from the WHO 1998 values. TEF changes included: 1) 1,2,3,7,8-PeCDF decreased from 0.05 to 0.03, 2) 2,3,4,7,8-PeCDF decreased from 0.5 to 0.3, 3) OCDD, OCDF, and PCB-81 increased from 0.0001 to 0.0003, and 4) PCB-169 increased from 0.01 to 0.03. In preparation for a new survey on dioxins in domestic meat and poultry by the U.S. Department of Agriculture (USDA), we looked at the effect these new TEFs had on the toxic equivalencies (TEQ) determined in previous USDA food surveys. In addition, these new TEFs were applied to the data collected in the 2008 USDA dioxin survey to provide the most current and meaningful exposure values for dietary intake. TEQ comparisons between the old surveys and preliminary data from the new survey were then made on the same basis (using 2005 TEFs) to determine temporal trends.

## Materials and Methods

The 2008 dioxin survey is being conducted using the same methodology from the previous survey completed in 2002-2003.<sup>2</sup> Briefly, adipose tissue samples are collected by federal inspectors from slaughtering facilities across the U.S. on a weekly basis from September 2007 through August 2008. The sampling frame was designed to statistically represent major categories of domestic meat and poultry production within the constraints of the project's budget. Therefore, all operating facilities were eligible for sampling, and facilities were sampled proportional to their production volumes. The entire survey will consist of 510 samples: 139 beef (heifers and steers), 136 pork (gilts and barrows), 151 young chickens, and 84 young turkeys, with each class weighted according to its production volume. Analyses were done on 5 g homogenized adipose tissue samples according to EPA Method 1613 (modified to include the co-planar PCBs). A method blank was analyzed with each set of nine survey samples and used for blank subtraction as was done in the previous surveys. Detection limits were defined by the standard deviation of either methods blanks or low level spikes ( $DL = 2 \times SD$ ). TEQs were calculated from the current and previous survey data using the WHO 2005 TEFs and reporting non-detects as zero or  $DL/2$ . All values are expressed in pg/g lipid.

## Results and Discussion

The USDA conducted surveys of PCDD/Fs and co-planar PCBs in beef, pork, and poultry in the mid-1990s with the assistance of the U.S. Environmental Protection Agency<sup>3-5</sup> and again in 2002-2003 using in-house resources.<sup>2</sup> Both of these surveys reported TEQs based on earlier TEF values, the mid-1990s surveys using TEFs established in 1993, and the 2002-2003 survey using TEFs revised in 1998. The effect of converting average TEQs from these surveys to the recent 2005 TEFs is shown in Table 1. When data were converted from the 1998 to 2005 TEFs (2002-2003 survey), PCDD/F TEQs decreased 4-8% in each slaughter class. This decrease in the TEQs is mainly produced by the reduced relative toxicity of 2,3,4,7,8-PeCDF which contributed 11-20% to the original PCDD/F TEQs. The PCB TEQs increased 5-25% due to the increasing toxicity of PCB-169. If the total TEQ is considered, levels

decreased 2-4% similar to the PCDD/F TEQs which were the dominant contributors in U.S. meat and poultry. The mid-1990s survey data in Table 1 show the effect when TEQs are converted from the earliest (1993) TEFs to the 2005 TEFs. In addition to the revisions made to the 1998 TEFs, the most important change affecting the TEQs is the increase in relative toxicity of 1,2,3,7,8-PeCDD from 0.5 to 1.0. This TEF change, along with decreases to OCDD, OCDF, and PCB-77 TEFs, was made during the WHO 1998 reevaluation.<sup>6</sup> The results show a 5-10% increase in PCDD/F TEQs and a slight decrease in PCB TEQ after converting from the 1993 to 2005 TEFs.

To date, 220 samples have been analyzed from the 2008 dioxin survey, approximately 43% of the total scheduled samples. The average congener concentrations for each slaughter class are given in Table 2 along with the mean, median, and range of TEQs. The contribution of co-planar PCBs to the total mean TEQ ranged from 14% in market hogs to over 37% in turkeys. In general, poultry had a higher portion of the TEQ coming from PCBs than did beef and pork (>25% vs <16%) and may reflect different dietary regimens or different metabolizing capabilities of these animals. Beef had the widest range of TEQs found thus far in the survey. This is not surprising given that cattle in the U.S. graze on a wide variety of pastureland across the country; whereas, poultry and pork production is typically confined and vertically-integrated.

Four individual congeners (1,2,3,7,8-PeCDD, 2,3,4,7,8-PeCDF, 1,2,3,6,7,8-HxCDD, and PCB-126) contributed the most to the overall TEQs, and together these four congeners accounted for 54-78% of the mean TEQ in each animal class. These same four congeners dominated the TEQs in the mid-1990 and 2002-2003 surveys contributing 55-70% and 39-72%, respectively (data converted to 2005 TEFs). TCDD was not detected above the detection limit (0.014 ppt) in 65% of the 2008 survey samples and has only contributed 3-7% to the total TEQ whether non-detects were set to zero or half the detection limit (DL/2). In the previous survey, a higher detection limit for TCDD (0.06 ppt) led to non-detection in almost 90% of the samples and, therefore, a relatively higher contribution to TEQ when non-detects were set equal to half the detection limit (7-17%).<sup>2</sup> A preliminary comparison of the survey data (Figure 1) shows that for most slaughter classes TEQs appear to have declined in the last decade, but this decline may be slowing down or leveling off in the past five years. During each survey, outlier values have been identified that do not reflect the general population. In some cases, these samples could be tracked to a contaminated feed source which was subsequently removed from the production chain.<sup>2,5</sup>

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Table 1. Mean PCDD/F and co-planar PCB TEQs from previous USDA surveys of meat and poultry calculated using the 1993, 1998, or 2005 TEF values. The % change in TEQ due to the change in TEF values is also given. All values are expressed as pg/g lipid with nd=DL/2. *N* = number of samples in each slaughter class.

		Mid-1990s Survey			2002-2003 Survey				
		<i>N</i>	1993 TEFs	2005 TEFs	% Change	<i>N</i>	1998 TEFs	2005 TEFs	% Change
Beef	D/F	51	0.867	0.941	8.5	139	0.744	0.713	-4.2
	PCB		0.367	0.366	-0.3		0.127	0.133	4.7
Pork	D/F	56	1.31	1.380	5.1	136	0.207	0.193	-6.8
	PCB		0.043	0.042	-2.3		0.024	0.030	25.0
Chicken	D/F	39	0.641	0.703	9.7	151	0.220	0.207	-5.9
	PCB		0.193	0.190	-1.6		0.072	0.080	11.1
Turkey	D/F	15	0.925	0.974	5.3	84	0.411	0.377	-8.3
	PCB		0.458	0.456	-0.4		0.177	0.193	9.0

Figure 1. Comparison of data (pg TEQ/g lipid, nd=DL/2, WHO 2005 TEFs) from surveys in the mid-1990s, 2002-2003, and 2008 across four slaughter classes. Horizontal lines represent the 5<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup> (median), 75<sup>th</sup>, and 95<sup>th</sup> percentiles. Dots represent individual values outside the 5<sup>th</sup> and 95<sup>th</sup> percentiles.

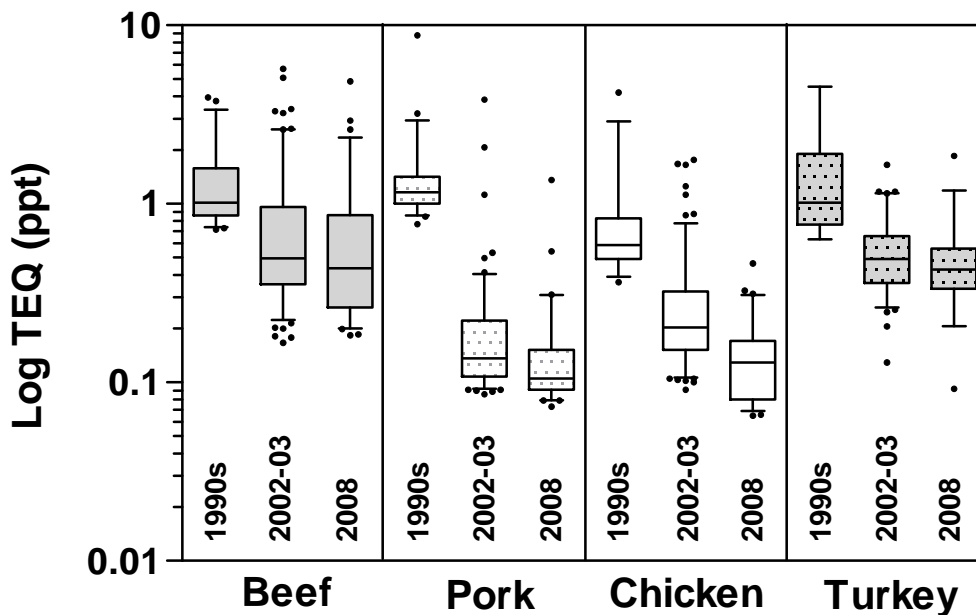


Table 2. Mean levels of seventeen PCDD/Fs, three co-planar PCBs, and TEQs in four domestic slaughter classes from the 2008 survey. Levels are reported in pg/g lipid (ppt) with nd=DL/2 and nd=0 in parentheses. TEQs were calculated with WHO 2005 TEFs.

Congener	WHO 2005 TEFs	Beef <i>N</i> = 63	Pork <i>N</i> = 61	Chicken <i>N</i> = 62	Turkey <i>N</i> = 34
2378-TCDD	1	0.04 (0.04)	0.01 (0.00)	0.01 (0.00)	0.04 (0.03)
12378-PeCDD	1	0.22 (0.22)	0.03 (0.02)	0.04 (0.03)	0.15 (0.15)
123478-HxCDD	0.1	0.22 (0.21)	0.05 (0.04)	0.03 (0.02)	0.07 (0.07)
123678-HxCDD	0.1	1.23 (1.23)	0.21 (0.20)	0.10 (0.09)	0.35 (0.35)
123789-HxCDD	0.1	0.24 (0.24)	0.02 (0.01)	0.03 (0.02)	0.04 (0.04)
1234678-HpCDD	0.01	3.28 (3.28)	1.24 (1.23)	0.41 (0.40)	0.29 (0.27)
OCDD	0.0003	4.53 (4.22)	6.24 (5.94)	3.58 (3.31)	1.16 (0.60)
2378-TCDF	0.1	0.05 (0.00)	0.06 (0.00)	0.08 (0.04)	0.14 (0.12)
12378-PeCDF	0.03	0.03 (0.00)	0.03 (0.00)	0.04 (0.02)	0.06 (0.05)
23478-PeCDF	0.3	0.10 (0.08)	0.05 (0.02)	0.05 (0.02)	0.13 (0.12)
123478-HxCDF	0.1	0.28 (0.27)	0.08 (0.05)	0.05 (0.02)	0.08 (0.06)
123678-HxCDF	0.1	0.16 (0.15)	0.05 (0.02)	0.04 (0.01)	0.05 (0.03)
234678-HxCDF	0.1	0.13 (0.12)	0.05 (0.02)	0.04 (0.01)	0.05 (0.02)
123789-HxCDF	0.1	0.02 (0.01)	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)
1234678-HpCDF	0.01	0.67 (0.62)	0.39 (0.30)	0.11 (0.00)	0.11 (0.01)
1234789-HpCDF	0.01	0.06 (0.05)	0.06 (0.04)	0.04 (0.02)	0.03 (0.02)
OCDF	0.0003	0.19 (0.12)	0.18 (0.11)	0.09 (0.02)	0.09 (0.02)
PCB-77	0.0001	5.26 (0.00)	6.01 (0.45)	5.40 (0.52)	5.40 (1.02)
PCB-126	0.1	0.90 (0.90)	0.16 (0.08)	0.33 (0.30)	1.66 (1.66)
PCB-169	0.03	0.33 (0.33)	0.20 (0.20)	0.14 (0.14)	0.68 (0.68)
Mean D/F TEQ		0.56 (0.54)	0.13 (0.08)	0.11 (0.07)	0.31 (0.29)
Mean PCB TEQ		0.10 (0.10)	0.02 (0.01)	0.04 (0.03)	0.19 (0.19)
Mean Total TEQ		0.66 (0.64)	0.15 (0.09)	0.15 (0.10)	0.50 (0.48)
Median Total TEQ		0.41 (0.39)	0.10 (0.03)	0.12 (0.08)	0.43 (0.41)
TEQ Range		0.18–4.85 (0.15–4.85)	0.07–1.36 (0.00–1.33)	0.07–0.47 (0.00–0.43)	0.09–1.86 (0.03–1.84)

Trade names are necessary to report factually on available data; however, the USDA neither guarantees nor warrants the standard of the product, and the use of the name by USDA implies no approval of the product to the exclusion of others that may also be suitable.