THE UNITED STATES FOOD AND DRUG ADMINISTRATION'S (FDA) DIOXIN MONITORING PROGRAM

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Introduction

Dioxin-like compounds (DLCs) are a group of environmental contaminants whose primary route of human exposure occurs via the consumption of fatty foods of animal origin. Over the past 20 years, risk assessments have been conducted by national and international organizations to evaluate DLC dietary exposure. Starting in the mid-1990s, the U.S. Food and Drug Administration (FDA) began testing specific foods with the goal of describing and identifying possible mitigation steps for reducing DLC exposure in the US food supply. In 1999, FDA's DLC program began analyzing foods collected under its Total Diet Study (TDS). As a follow-up to the ongoing TDS collection and analysis, the FDA in 2001 expanded its monitoring program to obtain more comprehensive data on background levels of DLCs in specific foods. The expanded FDA dioxin monitoring program uses the analytical results from the TDS as the basis in developing a targeted sampling strategy. The targeted sampling strategy focuses on collecting and analyzing foods suspected of having both higher DLC levels and more variability in those levels than other foods. After the analysis of DLCs in TDS foods and targeted foods, the DLC congeners are summed and presented as Toxicity Equivalents. Finally dietary exposure estimates are derived using the most recent National Health and Nutrition Examination Survey (NHANES).

Material and Method

Analytical method The FDA uses two methods to identify and quantify DLCs in foods. The first method is high resolution mass spectroscopy (HRMS), which is the preferred method for high consumption-rate foods with very low or no expected DLC levels. HRMS is also the preferred method for TDS samples, given that TDS is used for estimating DLC exposure and these estimates may depend on the level of detection of the analytical methodology. The second method FDA uses is ion trap mass spectroscopy (ITMS) which is the preferred method for lower consumption-rate foods with higher expected DLC levels. Both ITMS and HRMS provide congener-specific estimates of concentration. ITMS method detection levels are often 3 to 10 fold higher than HRMS method detection levels depending on the congener and/or given food. ITMS uses less expensive and more easily maintained equipment, resulting in lower cost per sample and a higher total sample throughput compared to HRMS.

TDS Methodology: FDA's TDS is an ongoing monitoring program in which about 280 foods and beverages representing all major components of the average American diet are collected and analyzed for various pesticides, industrial contaminants and nutrients. TDS samples are collected four times each year; with samples from one collection period each year analyzed for DLC. For each collection period, samples are collected from grocery stores and fast food restaurants in three different cities. The foods are prepared table-ready (i.e., as they would be consumed) and the three samples of each TDS food are then composited before analysis. In the case of DLC analysis, these foods are analyzed specifically for polychlorinated dibenzo-*p*-dioxin (PCDD), polychlorinated dibenzofuran (PCDF), and dioxin-like polychlorinated biphenyls (PCB) congeners. The congener concentration for each sample are summed by its respective Toxic Equivalency Factor and presented as a DLC Toxicity Equivalent[1]. Dietary exposure estimates for DLCs are derived from a probabilistic analysis using the TEQ congener concentrations and consumption records from the NHANES 2005-2006 Dietary Interview[2] (2005-06 NHANES) for 14 age-sex subgroups and the total US population.

Targeted Sampling Methodology: The FDA targeted sampling program calls for the collection and analyzes of foods suspected of having higher levels of DLCs and more variability in those levels than other foods annually. This sampling and analysis provides additional analytical results for foods that demonstrate higher levels of DLCs from the TDS analysis. In addition these results can be used to aid in the investigation of potential sources and pathways for DLC contamination in the food supply. These foods are analyzed for polychlorinated dibenzo-*p*-dioxin (PCDD), polychlorinated dibenzofuran (PCDF), and dioxin-like polychlorinated biphenyls (PCB) congeners. The congener concentration for each sample are summed by its respective Toxic Equivalency Factor and presented as Toxicity Equivalent[1]. Dietary exposure estimate for DLCs are derived from a probabilistic analysis using the TEQ congener concentrations and consumption records from the NHANES 2005-2006 Dietary Interview[2] (2005-06 NHANES) for eaters-only of each targeted foods for the US population.

Results and Discussion

TDS Dietary exposure estimates: In 2010, FDA completed its most recent exposure assessment of DLC in the TDS from 2004 – 2007. The analysis provided estimates for the mean and 90th percentile for the 14 age – gender groups. The mean TDS DLC exposure for the 14 age – gender subgroups range from 13.4 to 56.6 pg WHO-TEQ/kg bw/ month. The 90th percentile TDS DLCs exposure by the 14 age – gender subgroups range from 20.1 to 91 pg WHO-TEQ/kg bw/month. The mean DLCs exposure showed good agreement with the 2001 – 2004 TDS exposure assessment. The 2001-2004 results are found at http://www.fda.gov/Food/FoodSafety/FoodContaminantsAdulteration/ChemicalContaminants/DioxinsPCBs/ucm077498.htm .

Table 1. Estimated DLC Exposure for TDS

Age-gender groups	Mean (pg WHO-TEQ/kg bw/month)	90th percentile (pg WHO-TEQ/kg bw/month)
M/F 6-11 months	43.1	77.2
M/F 2 yrs	56.6	91.0
M/F 6 yrs	38.6	56.3
M/F 10 yrs	33.5	51.3
F 14-16 yrs	17.0	25.8
M 14-16 yrs	22.9	37.6
F 25-30 yrs	16.3	25.9
M 25-30 yrs	18.7	29.3
F 40-45 yrs	15.2	26.8
M 40-45 yrs	16.1	26.0
F 60-65 yrs	13.4	20.1
M 60-65 yrs	15.8	25.7
F 70+ yrs	15.3	26.2
M 70+ yrs	15.1	23.0

Dietary exposure estimate for targeted samples: In 2010, FDA also completed an exposure assessment for targeted samples from 2004 – 2006. The analysis provided dietary exposure estimates for eaters – only for 21 targeted finfish samples. The general conclusion for the mean dietary exposure estimates of DLC via the consumption of finfish ranged from 0.5 to 97.3 pg WHO-TEQ/kg bw/month with most of the means below 10 pg WHO-TEQ/kg bw/month. Finally the consumption of finfish represents a small percentage of the populations with most species being consumed by less than 1% of the US population.

Table 2. Estimated DLCs Dietary Exposure for Eaters - only from Finfish Targeted Samples

Fish name	% Eaters	Mean (pg WHO-TEQ/kg bw/month)	90th percentile (pg WHO-TEQ/kg bw/month)
Basa	1	2.9	8.6
Bluefish	0.1	7.2	14.6
Catfish	1	23.0	56.0
Cod	1.6	0.5	1.2
Croaker	0.1	4.0	9.0
Flounder	3	6.1	16.8
Halibut	3	3.2	7.6
Ocean Perch	0.1	4.8	11.8
Orange Roughy	0.1	7.9	17.6
Pollock	2	1.2	3.3
Porgy	0.1	97.3	263.8
Salmon	4	14.0	37.2
Sardines	0.4	12.1	34.0
Sole	3	1.0	2.4
Stripped Bass	0.1	32.9	77.1
Swordfish	0.1	10.8	21.5
Tilapia	0.5	6.3	14.5
Trout	0.3	17.3	38.0
Tuna, canned	7.4	1.3	3.3
Tuna, not canned	0.30	3.3	8.3
Weakfish (Seatrout)	0.10	8.4	20.5

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References

1. Toxicity Equivalents were calculated using Toxic Equivalency Factors established in 2006 by the World Health Organization (WHO) (van den Berg M, Birnbaum L, Denison M, De Vito M, Farland W, Feeley M, Fiedler H, Hakansson H, Hanberg A, Haws L, Rose M, Safe S, Schrenk D, Tohyama C, Tritscher A, Tuomisto J, Tysklind M, Walker N, Peterson RE. 2006. The 2005 World Health Organization reevaluation of human and mammalian toxic equivalency factors for dioxins and dioxin-like compounds. Toxicol Sci 93: 223-241).

2. U.S. Department of Agriculture, Agricultural Research Service, Beltsville Human Nutrition Research Center, Food Surveys Research Group (Beltsville, MD) and U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics (Hyattsville, MD). *What We Eat in America, NHANES 2005-2006 Documentation: Dietary Interview - Individual Foods -- Days One and Two (DR1IFF_D & DR2IFF_D).* (July 2008). Available from: http://www.cdc.gov/nchs/nhanes/nhanes2005-2006/exam05_06.htm [accessed 03/16/10].