DIOXIN INTAKE FROM U.S. FOOD: RESULTS FROM A NEW NATIONWIDE FOOD SURVEY

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ABSTRACT: We previously estimated daily intake of dioxins from U.S. food based on 20 measurements of individual food samples purchased from a New York State supermarket. We reported an adult average daily dioxin intake range of approximately 0.3 to 3.0 pg TEQ/kg bw/day based on PCDD and PCDF levels. The current food survey is based on approximately 100 food samples collected from supermarkets across the United States. Samples were pooled by food type prior to dioxin analysis. This study also extends our previous study by adding analysis of dioxin-like coplanar PCBs as well as by the use of more recent U.S. adult food consumption values for calculating average daily intake. For PCDDs and PCDFs, we calculate an intake of 0.52 to 2.57 pg TEQ/kg bw/day. If PCBs are included, the values are 1.16 to 3.57 pg TEQ /kg bw/day.

INTRODUCTION: There are relatively few surveys of dioxin levels in U.S. food despite the increasing number of studies reporting dioxin measurements in food from other countries, including Germany, England, Vietnam, Canada, Holland and Russia.[1-9] The few studies which estimate intake of dioxins from U.S. food are based on a modest number of samples.[10-13] We previously reported US food dioxin levels for approximately 20 food samples and calculated daily intake for Americans based on these measurements. Average food consumption rates were taken from national food survey data available at that time. Since then, the United States Department of Agriculture (USDA) has updated its National Food Consumption Survey (NFCS) and provides new consumption patterns for Americans.[14,15] Further, including a larger sample size from different regions of the United States, makes this food survey more representative of the U.S. general population. For these reasons, as well as reports of a decrease in levels of dioxins in food in some European countries, we collected over 100 food samples from across the US for analysis of PCDDs, PCDFs, and also some of the

dioxin-like PCBs.

METHODS: A wide variety of food samples were purchased in supermarkets in Binghamton, New York; Chicago, Illinois; Louisville, Kentucky; Atlanta, Georgia; and San Diego, California. Specimens were frozen and shipped to the dioxin laboratory for analysis. Aliquots of equal weight were combined by type, e.g., beef, eggs, pork, chicken, freshwater or ocean fish, from the geographical locations. The pooled samples were analyzed by methods previously described in detail by a World Health Organization "certified" laboratory for analysis of dioxins in biological specimens.[11]

RESULTS: Table 1 summarizes the foods analyzed in this survey. Table 2 provides a summary of the previously used US Department of Agriculture (USDA) consumption levels (1977-78)[14] and the newer USDA intake levels (1987-88).[15] In addition, the previous and newer estimates of adult daily dioxin TEQ intake are presented. For 1995, dioxin intake ranges from 0.52 to 2.57 compared to the 1991-2 value of 0.28 to 3.0 pg TEQ/kg bw/day. The new findings, which include PCBs where TEF values are available[16], provide an estimate of daily TEQ intake range to 1.16 to 3.57 pg TEQ/kg bw/day. Our analysis of the simulated vegan diet contained 0.06 pg/g TEQ, the lowest level of the twelve pooled samples.

DISCUSSION: The older estimated daily intake values for adults, based on fewer samples collected from one geographical area (New York) only, were 0.28 to 2.96 pg TEQ per kg bw per day. The new values for PCDD/Fs only are 0.52 to 2.57 pg/kg bw per day using updated estimated average consumption values. When PCBs are considered as well, the values range from 1.16 to 3.57 pg TEQ/kg bw per day. The new and the older values are similar, providing confidence in these estimates. The increase in TEQ when PCBs are included should be noted. However, since most measurable PCBs do not have dioxin toxic equivalency values (TEFs) at this time, our calculations may underestimate total dioxin-like toxicity. Further study with larger and more representative sampling seems indicated. Our findings of relatively low dioxin content in fruits and vegetables is consistent with previous publications. Measurement of dioxin levels in cooked food may be a better approach to characterization of dioxin intake from food. These findings differ from some recent European data suggesting a decrease in dioxin TEQs in food and also in humans, the latter primarily from dioxin contaminated food.

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Table I. Pooled Food Samples for Dioxin Analyses Collected in 1995 from Different Geographical Areas in the United States

Food Category	Food Homogenized for Analysis	City of Purchase
FISH		
Fresh-water fish	Catfish steak, rainbow trout	San Diego, CA
	Rainbow trout, lemon pepper catfish	Louisville, KY
	Rainbow trout, catfish fillets	Atlanta, GA
	Perch fillets, Lake Superior white fish	Chicago, IL
	Boneless rainbow trout, fresh salmon steak	Binghamton, NY
Ocean fish	True cod fillets, fresh salmon steaks, king salmon steak	San Diego, CA
	Tiger prawns, sea bass	San Diego, CA
	Ocean perch fillets	Louisville, KY
	Halibut, ocean perch, salmon steak	Atlanta, GA
	Ocean perch fillets, fresh scrod/cod, fresh/frozen cod fillet	Binghamton, NY
DAIRY		
Cheese	American cheese slices, brie, hot pepper cheese food,	San Diego, CA
	American cheese slices, swiss cheese slices, cracker barrel, sharp	San Diego, CA
	American cheese food	Louisville, KY
	Processed cheese food, natural muenster, pasteurized cheese food	Atlanta, GA
	Cheese variety pack, processed cheese food	Binghamton, NY
Butter	Butter, unsalted butter	San Diego, CA
	Sweet cream butter (salted)	Atlanta, GA
Ice cream	Chocolate-chocolate chip	San Diego, CA
	Chocolate-chocolate chip	Louisville,KY
	Chocolate-chocolate chip	Atlanta, GA
	Chocolate-chocolate chip	Chicago, IL
	Chocolate-chocolate chip	Binghamton, NY
Milk	Whole milk	San Diego, CA
	Vitamin D milk	Louisville, KY
	Homogenized milk	Atlanta, GA
	Whole milk	Chicago, IL
	Homogenized whole milk	Binghamton, NY
MEAT		
Beef	Lean ground beef, ground beef 75% lean	San Diego, CA
	Ground beef	Louisville, KY
	Cubed beefsteak, ground beef	Atlanta, GA
	Bone in hind beefsteak, ground beef (choice), round stew beef	Binghamton, NY
	Beef rib steak (USDA choice)	Binghamton, NY
Poultry	Boneless chicken thigh, boneless chicken breast	San Diego, CA
	Chicken drumstick	Louisville, KY
	Chicken thigh	Atlanta, GA
	Split chicken breast, chicken thighs, chicken fryer split	Binghamton, NY
Pork	Boneless pork loin chops, pork link sausage	San Diego, CA
	Pork loin thin sliced	Louisville, KY
	Pork loin	Atlanta, GA
	Thin boneless pork chop	Chicago, IL
	Pork sausage, boneless center cut pork chop	Binghamton, NY
Hot dog/bologna	Sliced bologna, hot dogs	San Diego, CA
	Oscar Meyer bologna	unknown
EGGS	Hard boiled large eggs	San Diego, CA
	Hard boiled eggs	Atlanta, GA
	Hard boiled eggs	Binghamton, NY
VEGAN*	Vegetables, grains, and fruit included in analysis (no animal products)	Binghamton, NY

Table 2. Range of Daily Adult Dioxin TEQ Intake from US Food: Comparison Between Total PCDD/Fs TEQ Consumption Data from 1995 (n = 90) vs. 1991-92 (n = 18) (wet weight, pg/g)

Sample	Average Adult Consumption (g/day)		Previous Estimates		New Estimates			
			1991-2 Daily TEQ Intake (pg/kg bw/day)(3) PCDD/Fs		1995 Daily TEQ Intake (pg/kg bw/day) PCDD/Fs		1995 Daily TEQ Intake (pg/kg bw/day) (4) PCDD/F/PCBs	
	1991- 2(1)	1995(2)	Low	High	Low	High	Low	High
Beef	88	44	0.05	2.03	0.08	0.25	0.12	0.40
Pork	28	19	0.01	0.13	0.02	0.11	0.02	0.17
Poultry	31	25	0.01	0.01	0.03	0.08	0.06	0.16
Fish (5)	18	15	0.01	0.04	0.14	0.18	0.20	0.34
Milk	254	202	0.16	0.16	0.00	0.68	0.00	0.74
Other Dairy Products	55	73	0.03	0.59	0.25	1.26	0.76	1.77
Total	**474**	**378**	**0.28**	**2.96**	**0.52**	**2.57**	**1.16**	**3.57**

(1) Reference 14
(2) Reference 15
(3) Reference 10
(4) Reference 16
(5) Fish total = average of ocean and fresh water fish samples
Body weight (bw) assumes an average 65 kg adult > 20 years of age.
Low = a zero value was used for the non-detect congeners in TEQ analysis of food.
High = a value of 1/2 the levels of detection was used for non-detect congeners in the TEQ analysis of food.
1991-2 food survey N = 18 (plus milk and soy formula) samples pooled for dioxin analysis; 1995 food survey N = 90 samples (plus one vegetarian) pooled for dioxin analysis