

A COMPARISON OF DIOXINS AND DIBENZOFURANS IN COOKED AND UNCOOKED FOOD

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ABSTRACT: Intake of dioxins and dibenzofurans in the general population is almost exclusively from food, specifically meat, fish, and dairy products. Data on these levels are primarily from uncooked food. In an attempt to determine possible changes in the amount of dioxin in food as consumed, we present congener-specific dioxin and dibenzofuran data in several types of food, ground beef, bacon, and catfish, in the raw and cooked (broiled) state. Results from the cooked (broiled) hamburger samples suggest an approximate 50% decrease in total dioxin TEQ (wet weight basis) per hamburger under the conditions of this study. The decrease in total TEQ appears to be directly related to the decrease in wet weight associated with cooking.

INTRODUCTION: A growing amount of data exist on dioxin levels in food from several countries, including the U.S., Germany, Holland, England, Vietnam and Russia.⁽¹⁻⁶⁾ There is very little data available on how cooking affects the amount of dioxins in food.⁽⁷⁾ To determine possible changes in dioxin/furan (PCDD/PCDF) congeners and total dioxin toxic equivalents (TEQ) following cooking, we organized a study involving six foods. To date we have measured dioxins in cooked (broiled) and uncooked ground beef (hamburger); farm grown catfish; and bacon; purchased at a typical New York supermarket. In this extended abstract, only the ground beef data are presented.

METHODS:

Sample collection and preparation: Regular (75% lean) ground beef was purchased from a typical supermarket in Binghamton, New York, located 180 miles northwest of New York City. Each type of meat or fish was divided into 8 samples, approximately 200 g each. We shipped four samples cooked by broiling thoroughly in an electric oven and four uncooked as controls. Weights were obtained for uncooked and cooked samples. Samples were then labelled, frozen, and shipped to ERGO Laboratory on dry ice for dioxin analyses. The laboratory has been certified by the World Health Organization in several interlaboratory

validation studies for PCDD/F analyses of biological specimens.

Chemical Analysis: Samples for analysis were prepared for freeze-drying by cutting, followed by homogenizing in a blender. They were then freeze-dried during a 48-60 hour period, beginning at -25 degrees Celsius and ending at room temperature. Seventeen labelled internal PCDD/F standards were added. Samples were mixed with dichloromethane/cyclohexane (1:1), followed by 30 minutes of ultrasonic treatment followed by further solvent treatment for 20 hours, after which the samples were transferred into a column and eluted with fresh solvent. This was followed by evaporation of solvent from combined eluates. Lipid determination was by gravimetric means. Cleanup of lipids was performed by use of a combined column system including Carbpac on Celite.⁽⁸⁾

RESULTS: Data for ground beef, bacon, and catfish weights before and after cooking are provided in Table 1. Table 2 presents the PCDD/F congeners and total TEQ for ground beef on a pg/kg (ppq) wet weight basis. Total measured PCDD/Fs and total TEQs for uncooked and cooked hamburger samples range from 5790-6560 ppq and 127.6-133.5 ppq TEQ (uncooked), and from 6140-7826 ppq and 116-145 ppq TEQ (cooked), respectively. Cooking had little or no effect on the concentration of PCDDs and PCDFs in ground beef. The decrease in weight due to the loss of fat and water after cooking needs to be considered, and this is done for ground beef in Table 3. Also presented in Table 3 are the TEQs per ground meat or hamburger sample as it would be eaten. The mean TEQ per 200 g (uncooked) and 106 g (cooked) ground beef sample is 26 TEQ and 14 TEQ, respectively.

DISCUSSION: In this study cooking produced a 42 to 49 percent (average 47%) reduction in TEQ per hamburger. This decrease is identical to the decrease in weight due to cooking. Therefore, the reduction in TEQ per serving in cooked ground beef is apparently the result of loss of fat and water from cooking under these conditions. The samples analyzed are believed to be typical of ordinary ground beef or hamburger commonly sold in US supermarkets. Broiling, as the cooking method employed, is a common way to prepare meat. However, conditions may vary and other cooking methods may provide different results. In this study we note a significant reduction in dioxin content, but less than one order of magnitude change. The ground beef analyses presented here are the first of three series of completed analyses (ground beef, catfish fillets and bacon) in a planned series of 6 foods.

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TABLE 1. Descriptive Data for Uncooked and Cooked Food Samples

Food Type	Sample #	Weight (g)		% of Weight Lost
		Uncooked	Cooked	
Hamburger (uncooked)	1A	200.51	--	
	2A	200.78	--	
	3A	200.29	--	
	4A	200.26	--	
Hamburger (cooked)	1B	200.33	96.14	52.01
	2B	200.05	103.12	48.45
	3B	200.32	110.60	44.79
	4B	200.60	112.36	43.99
Bacon (uncooked)	1A	231.46	--	
	2A	198.77	--	
	3A	216.82	--	
	4A	211.57	--	
Bacon (cooked)	1B	221.58	43.24	80.49
	2B	230.75	47.26	79.52
	3B	230.47	66.57	71.12
	4B	244.91	71.93	70.63
Catfish (uncooked)	1A	193.49	--	
	2A	228.88	--	
	3A	230.81	--	
	4A	226.10	--	
Catfish (cooked)	1B	213.20	139.41	34.61
	2B	235.15	151.60	35.53
	3B	256.94	164.68	35.91
	4B	214.51	130.98	38.94

TABLE 2. Dioxins, Dibenzofurans, and Dioxin Toxic Equivalents in Cooked and Uncooked Hamburger (Ground Beef), wet weight, (pg/kg), ppq

Congener	TEF	Hamburger Uncooked				Hamburger Cooked			
		1A	2A	3A	4A	1B	2B	3B	4B
DIOXINS									
2378 TCDD	1	< 13.3	< 13.2	< 14.1	< 13.0	14.4	< 14.9	< 15.4	< 13.6
12378 PeCDD	0.5	37.3	37.5	37.6	35.9	36.4	31.6	34.9	31.6
123478 HxCDD	0.1	72.4	75.5	78.8	65.8	85.8	68.9	69.5	69.7
123678 HxCDD	0.1	295.1	314.6	294.6	314.9	306.0	281.4	314.4	270.9
123789 HxCDD	0.1	66.9	79.0	73.1	70.4	70.0	63.2	70.2	56.8
1234678 HpCDD	0.01	1602	1654	1632	1558	1611	1706	1804	1503
12346789 OCDD	0.001	3668	3489	3239	2956	4113	4791	4353	3450
Total Dioxins		5748	5656	5362	5007	6237	6950	6654	5389
DIBENZOFURANS									
2378 TCDF	0.1	33.4(M)	28.7 (M)	35.4 (M)	31.8 (M)	53.9 (M)	41.8(M)	37.9 (M)	30.5(M)
12378 PeCDF	0.05	< 13.3	< 13.2	< 14.1	< 13.0	14.4	< 14.9	< 15.4	< 13.6
23478 PeCDF	0.5	29.2	28.8	28.8	27.2	33.9	27.7	30.3	22.9
123478 HxCDF	0.1	89.5	88.1	91.1	87.9	92.0	91.9	100.1	80.9
123678 HxCDF	0.1	51.9	55.5	48.9	47.5	53.6	49.1	47.8	44.1
234678 HxCDF	0.1	ND(13.3)	ND(13.2)	ND(14.1)	ND(13)	ND(14.4)	ND(14.9)	ND(15.4)	ND(13.6)
123789 HxCDF	0.1	48.9	51.3	46.3	50.0	48.3	49.8	54.2	43.3
1234678 HpCDF	0.01	332.4	367.7	313.4	329.9	320.3	352.0	377.3	312.4
1234789 HpCDF	0.01	31.0	28.0	25.4	34.0	29.2	29.3	29.6	34.0
12346789 OCDF	0.001	188.7	174.5	158.1	167.6	181.8	227.4	228.6	176.5
Total Dibenzofurans		811.5	829.1	754.4	782.4	827.3	876.4	913.4	751.4
Total Dioxins and Dibenzofurans		6559	6485	6116	5790	7064	7826	7567	6140
Total TEQ		129.5	133.5	130.5	127.6	145.1	128.0	136.8	116.1

ND = not detected; detection limit in (); ND values contribute 0% to total PCDD/F and TEQ.

< = contribute 50%, one-half the value used in calculation of TEQ

M = Maximum value, contains possibly outside contamination, whole value used in calculation of TEQ

TABLE 3. Weight and Dioxin Toxic Equivalents in Uncooked and Cooked (Broiled) U.S. Hamburgers (Ground Beef), (wet weight basis, pg/kg,ppq) 1996

Sample	Weight (g)		TEQ (pg/kg (ppq))		% Decrease Weight per sample	% Decrease pg TEQ per sample	pg TEQ /sample	
	Before Cooking	After Cooking	Before Cooking	After Cooking			Before Cooking	After Cooking
Uncooked								
1A	200.5	--	130	--	--	--	26	--
2A	200.8	--	134	--	--	--	27	--
3A	200.3	--	131	--	--	--	26	--
4A	200.3	--	128	--	--	--	26	--
Mean	200	--	130*	--	--	--	26	--
Cooked								
1B	200.3	96	[130]	145	52	47	[26]	14
2B	200.1	103	[130]	128	48	49	[26]	13
3B	200.3	111	[130]	137	45	42	[26]	15
4B	200.6	112	[130]	116	44	49	[26]	13
Mean	200	106	[130]	131	47	47	[26]	14

* and [] = Mean non-cooked TEQ value used as 'Before' TEQ in cooked samples