

HEXABROMOCYCLODODECANE (HBCD) STEREOISOMERS IN U.S. FOOD

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Introduction

Hexabromocyclododecane (HBCD) is a brominated flame retardant used in polystyrene foam for thermal insulation in buildings, upholstery textiles, and electrical equipment¹. Three stereoisomers exist for HBCD; commercial mixtures of HBCD consist of the γ - stereoisomer (75 – 89%), followed by α - (10 – 13%) and β - (1 – 12%)². The α -HBCD stereoisomer predominates in biota³ and may be due to thermal rearrangement of γ -HBCD to the α -HBCD⁴. HBCD exposure has been associated with human immune system alterations⁵ and cancer promotion in laboratory animals⁶. HBCD may also cause neurotoxic effects in children, such as decreased fine manipulative abilities and lower attention⁷. We measured HBCD stereoisomer levels in U.S. food as food and dust contribute to significantly to human intake. To the best of our knowledge, we report HBCD stereoisomer levels in U.S. food for the first time.

Materials and methods

An assortment of fish, meat, and other foods were purchased in 2010 from Dallas, Texas supermarkets, frozen at -80°C, and sent on dry ice to Eurofins laboratory in Hamburg, Germany. Chemical analysis was performed using the isotope dilution method. ¹³C-labelled BPA and γ -HBCD were used as internal standards. Control of recovery using internal standards was followed by recalibration within each sequence of analyses. A minimum of one blank was used within each batch. Analysis of HBCD stereoisomer levels was by LC/MS-MS. Total HBCD levels were calculated by summing stereoisomer levels. The limits of detection ranged from 0.02 to 0.04 ng/g ww for HBCD stereoisomers.

Results and discussion:

Table 1 shows total and stereoisomer HBCD levels in U.S. food. Total detected levels of HBCD were calculated by summing stereoisomer levels and setting non detects to one half the limit of detection. Total HBCD levels ranged from 0.006 – 1.363 ng/g ww. Stereoisomer specific analysis revealed that α -HBCD was present in 13 of 36 foods (36%) and ranged from 0.006 – 1.307 ng/g ww; β -HBCD was present in 3 of 36 foods (8%) and ranged from 0.015 – 0.019 ng/g ww; and γ -HBCD was present in 8 of 36 foods (22%) and ranged from 0.017 – 0.143 ng/g ww.

Table 1. Total HBCD and HBCD stereoisomer levels in U.S. foods (ng/g ww)

Food	HBCD level			
	Total	α -HBCD	β -HBCD	γ -HBCD
Beach Cliff Sardines in Water	1.366	1.307	< 0.005	0.056
Butterball Turkey Smoked Sausages	0.518	0.479	< 0.005	0.036
Albertson's fresh salmon	0.446	0.327	< 0.005	0.116
Whole Foods fresh salmon	0.410	0.346	< 0.005	0.061
King Oscar Brisling Sardines	0.270	0.262	< 0.005	< 0.010
Whole Foods fresh catfish	0.162	0.115	0.016	0.031
Whole Foods fresh deli sliced turkey	0.155	0.135	< 0.005	0.017
Albertson's fresh tilapia	0.148	< 0.005	< 0.005	0.143
Albertsons Chili with Beans	0.105	< 0.005	< 0.005	0.100
Brunswick Sardines in Olive Oil	0.067	0.059	< 0.005	< 0.010

Kroger fresh deli sliced ham	0.051	0.027	0.019	< 0.010
Jennie-O Lean Turkey Sausages	0.049	0.029	0.015	< 0.010
Hillshire Farm Turkey Sausages	0.032	0.024	< 0.005	< 0.010
Albertson's fresh catfish	0.016	0.008	< 0.005	< 0.010
Kroger fresh catfish	0.014	0.006	< 0.005	< 0.010
Wolf Brand Chili with Beans	0.010	< 0.005	< 0.005	< 0.010
Hormel Chili with Beans	0.010	< 0.005	< 0.005	< 0.010
Hormel Black Label Bacon	0.010	< 0.005	< 0.005	< 0.010
Farmland Hickory Smoked Bacon	0.010	< 0.005	< 0.005	< 0.010
Tyson Smoked Center Cut Bacon	0.010	< 0.005	< 0.005	< 0.010
Albertson's Creamy Peanut Butter	0.030	< 0.020	< 0.020	< 0.040
Peter Pan Creamy Peanut Butter	0.030	< 0.020	< 0.020	< 0.040
TIF Creamy Peanut Butter	0.030	< 0.020	< 0.020	< 0.040
Kroger fresh deli sliced beef	0.010	< 0.005	< 0.005	< 0.010
Kroger fresh deli sliced turkey	0.010	< 0.005	< 0.005	< 0.010
Kroger fresh deli sliced chicken	0.010	< 0.005	< 0.005	< 0.010
Albertson's fresh deli sliced beef	0.010	< 0.005	< 0.005	< 0.010
Albertson's fresh deli sliced ham	0.010	< 0.005	< 0.005	< 0.010
Albertson's fresh deli sliced turkey	0.010	< 0.005	< 0.005	< 0.010
Whole Foods fresh deli sliced chicken	0.010	< 0.005	< 0.005	< 0.010
Kroger fresh tilapia	0.010	< 0.005	< 0.005	< 0.010
Van De Kamp's fish sticks	0.010	< 0.005	< 0.005	< 0.010
Fisher Boy fish sticks	0.010	< 0.005	< 0.005	< 0.010
Gorton's fish sticks	0.010	< 0.005	< 0.005	< 0.010
Whole Foods fresh tilapia	0.010	< 0.005	< 0.005	< 0.010
Whole Foods fresh deli sliced beef	0.010	< 0.005	< 0.005	< 0.010

α -HBCD dominated in these samples as seen in biota and the environment⁴ despite γ -HBCD being highest in commercial HBCD mixtures. However, health effects of chemical mixtures are unknown. As detectable levels of BPA and HBCD were found in many foods, further research is indicated to determine levels of BPA, HBCD, HBCD stereoisomers, and other endocrine-disrupting compounds in U.S. food and the health consequences of chemical mixtures.

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References:

1. Covaci A, Gerecke AC, Law RJ, Voorspoels S, Kohler M, Heeb NV, Leslie H, Allchin CR, de Boer J. (2006); *Environ Sci Technol.* 40(12): 3679-3688.
2. Heeb NV, Schweizer WB, Kohler M, Gerecke AC. (2005); *Chemosphere.* 61(1): 65-73.
3. Law RJ, Herzke D, Harrad S, Morris S, Bersuder P, Allchin CR. (2008); *Chemosphere.* 73(2): 223-241.
4. Heeb NV, Graf H, Schweizer WB, Lienemann P. (2010); *Chemosphere.* 80(7): 701-708.
5. Hinkson NC, Whalen MM. (2009); *J Appl Toxicol.* 29(8): 656-661.
6. Ronisz D, Finne EF, Karlsson H, Förlin L. (2004); *Aquat Toxicol.* 69(3): 229-245.
7. Roze E, Meijer L, Bakker A, Van Braeckel K, Sauer P, Bos AF. (2009); *Environ Health Perspect.* 117(12): 1953-1958.