Pentachlorophenol as a Source of Dioxins and Furans

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Introduction

Pentachlorophenol treated wood used in feeding facilities was identified as the likely source of higher chlorinated dioxin congeners in animals from a feeding study (8 dioxins and 4 furans were fed) at Carrington, ND[1)], and from animals in production research facilities at Oregon State University and Pennsylvania State University.[2)] Pentachlorophenol treated wood fed to four dairy cows resulted in greater amounts of hepta and octa chlorodioxins being excreted than fed.[3)] A balance study in humans showed greater amounts of several higher chlorinated dioxins being excreted than consumed.[4)] The biological conversion of pentachlorophenol to dioxins would explain these findings. Alternatively, metabolic conversion of predioxins (chlorinated phenoxyphenols) could also account for the findings. The presence of predioxins in the feed or food would not be detected during dioxin analyses since they would be destroyed during sample preparation. We have fed pentachlorophenol at three degrees of purity to rats to determine the source of dioxins or the degree of conversion of pentachlorophenol to dioxins.

Experimental

Pentachlorophenol used in wood treatment (Dowicide 7, lot # 09115-2566) was dissolved in water and acidified with hydrochloric acid to convert all phenolic components to their respective phenols. The phenols were extracted with methylene chloride and dried over magnesium sulfate. The methylene chloride was evaporated and the residue was used as dose material without any purification. A reagent grade pentachlorophenol (J. T. Baker, reported melting point 190-191°C) was used without purification. Reagent grade pentachlorophenol was purified by reversed phase chromatography [2 tandem 25x100mm C18 Delta-Pak columns (Waters Corporation, Milford, MA) 20 ml/min, water-acetonitrile gradient, 60-100% over 20 min, 100% acetonitrile for 20 min]. Pre and post pentachlorophenol peak eluates were collected, reacted with diazomethane and analyzed by GCMS. Post peak eluates clearly showed the presence of octachlorodibenzodioxin and predioxins that would lead to hepta and octa dioxins. The pentachlorophenol collected from preparative HPLC was dissolved in methanol, passed through a Carbograph Extract-Clean column (Alltech Associates, Deerfield, IL), and crystallized from methanol/water as needles. A microscope hot stage melting point showed that the needles sublimed above 150°C to form plates that melted sharply at 190°C. Prior to the experiment the rats were trained to eat 10.5 g of ground feed in one hour (the ground feed had 0.20 ml of peanut oil placed on it). Twenty rats were randomly divided into four groups. One group received feed containing only peanut oil, while other groups received feed containing 0.10 mg of the respective pentachlorophenol samples in 0.20 ml of peanut oil. The feeding regime was continued for fourteen days. The rats were then euthanized with CO_2, the livers were removed and pooled for each group, and analyzed by EPA method 1613.

Results and Discussion

The results of the experiment are shown in Table 1. Both control animals and animals dosed with purified pentachlorophenol show similar concentrations of hepta and octa chlorodioxins. The reagent grade pentachlorophenol dosed animals yielded concentrations that are 5.5 and 2.6 times greater, respectively, for the hepta and octa congeners while, the technical grade pentachlorophenol concentrations were 979 and 1042 times greater. These data prove that pentachlorophenol is not converted to octachloro-p-dibenzodioxin in vivo in rats. The large concentrations of the hepta and octa chlorodioxins are thus due to absorption of the dioxins present in the feed, and in vivo conversion of predioxins to dioxins. Based on the results of our rat experiment, the excretion of larger quantities of hepta and octa congeners than present in diets of cows and humans likely is due to absorption of hepta and octa dioxin precursors and their subsequent conversion to dioxins.

Acknowledgments

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Literature Cited

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Table 1. Concentrations of Dioxins and Furans in Rat Liver (ppt)

Congeners	Controls	Purified PCP	Reagent PCP	Technical PCP
2378-TCDF	1.100	1.070	1.210	1.200
2378-TCDD	3.740	2.570	1.260	0.690
12378-PeCDF	0.200	0.318	0.180	0.364
23478-PeCDF	1.880	1.590	1.550	1.770
12378-PeCDD	33.000	26.600	13.500	1.930
123478-HxCDF	0.853	0.625	0.692	7.420
123678-HxCDF	0.681	0.525	0.695	2.230
123789-HxCDF	0.501	0.342	0.491	1.110
234678-HxCDF	0.110	0.090	0.070	0.070
123478-HxCDD	0.200	0.170	0.380	3.280
123678-HxCDD	1.150	0.710	1.940	278.000
123789-HxCDD	0.110	0.160	0.150	129.000
1234678-HpCDF	0.760	0.600	4.260	404.000
1234789-HpCDF	0.560	0.180	1.900	57.300
1234678-HpCDD	4.200	3.290	23.000	4112.000
OCDF	0.310	0.766	7.330	2042.000
OCDD	13.000	12.100	33.800	13552.000