

Environmental Levels (Air and Soil) of Other Organohalogenes and Dioxins

PENTACHLOROPHENOL LEVELS IN BEEF ADIPOSE TISSUE AS AN INDICATOR OF TREATED-WOOD EXPOSURE

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Introduction

Pentachlorophenol (PCP)-treated wood has been used extensively in livestock facilities (1), and many treated-wood structures still exist on farms and at research stations. Because PCP formulations contain dioxin and furan impurities, these treated structures are a potential source of food animal exposure to polychlorinated dibenzo-*p*-dioxins and furans (PCDD/Fs). Recently we have reported that control steers used in a feeding experiment were contaminated by PCP-treated wooden pens at the Carrington Research Extension Center, Carrington, ND (2). The contamination pattern consisted of high levels of 1,2,3,6,7,8-HxCDD, 1,2,3,4,6,7,8-HpCDD, OCDD, and 1,2,3,4,6,7,8-HpCDF, and no detectable levels of tetra- or penta-chlorinated dioxins or furans.

Cattle with higher than average levels of PCDD/Fs were also identified at several experiment station sites during a nation-wide survey of PCDD/Fs in beef (3). The congener profile in these animals was similar to the PCP-contaminated steers at Carrington with high levels of 1,2,3,6,7,8-HxCDD, 1,2,3,4,6,7,8-HpCDD, and OCDD. PCP-treated wood was found at each of these facilities. In order to further verify that PCP-treated wood may be the source of these observed contaminations, we have analyzed adipose tissue from these animals for PCP levels.

Materials and Methods

Adipose tissue samples were stored at -60 °C until thawed for analysis. One gram of perirenal adipose tissue was dissolved in ethyl acetate and spiked with a known amount of ¹³C₆-pentachlorophenol (99% isotopic enrichment, 98% chemical purity, Cambridge Isotope Laboratories, Andover, MA, USA). The solution was filtered and applied to a Woelm basic alumina column. Matrix impurities were eluted with methylene chloride and ethyl acetate washes and PCP was eluted with acetone:methanol (1:1). PCP was derivatized to pentachloroanisole (PCA) with diazomethane and further purified on a column of acidic and neutral silica gels. ¹³C₆-Hexachlorobenzene (99% isotopic enrichment, 98% chemical purity, Cambridge Isotope Laboratories, Andover, MA, USA) was added as a recovery standard and the solution was analyzed by HRGC-HRMS at a resolution of 15,000 in a multiple ion monitoring mode.

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Results and Discussion

Table 1 shows results from 18 cattle previously surveyed for PCDD/F levels (2, 3) and the levels of PCP found from this study. The first four animals listed are from Carrington, ND, where exposure was known to be due solely to PCP-treated wood at the facility. The remaining animals were part of a nationwide survey, and so exposures were not as thoroughly known or controlled. These data are presented in order of decreasing I-TEQ (4). Trends in the levels of 1,2,3,6,7,8-HxCDD, 1,2,3,4,6,7,8-HpCDD, and OCDD followed the decrease in I-TEQ with the exception of animal #29 which had relatively low levels of these three dioxin congeners compared to the total I-TEQ.

Table 1. Levels of PCP, specific PCDD congeners, and I-TEQ in cattle. Values are given in pg/g lipid (ppt). (-) represents negative values after subtraction of the blank levels.

| <u>Animal #</u> | <u>Total I-TEQ</u> | <u>123678- HxCDD</u> | <u>1234678- HpCDD</u> | <u>OCDD</u> | <u>PCP</u> |
|-----------------|------------------------|--------------------------|---------------------------|-------------|------------|
| C-321 | 57.1 | 272 | 766 | 920 | 13,653 |
| C-345 | 44.2 | 192 | 515 | 1042 | 6,724 |
| C-355 | 38.7 | 171 | 487 | 768 | 8,025 |
| C-489 | 28.7 | 116 | 326 | 422 | 5,378 |
| 115 | 44.3 | 157 | 358 | 562 | 8,973 |
| 114 | 42.8 | 196 | 282 | 639 | 1,263 |
| 116 | 26.5 | 99 | 154 | 390 | 445,280 |
| 144 | 19.4 | 66 | 274 | 179 | 5,643 |
| 29 | 13.7 | 7 | 13 | 39 | 2,714 |
| 218 | 5.5 | 32 | 35 | 105 | 542 |
| 76 | 5.1 | 19 | 28 | 91 | 833 |
| 23 | 3.2 | 5 | 11 | 13 | 1,581,331 |
| 217 | 2.8 | 14 | 20 | 33 | 852 |
| 32 | 2.8 | 8 | 16 | 40 | 972 |
| 101 | 1.8 | 7 | 20 | 39 | 1,339 |
| 214 | 0.9 | 3 | 5 | 1.7 | 806 |
| 45 | 0.6 | 0.8 | 1.3 | - | 1,049 |
| 31 | 0.5 | 0.7 | 0.6 | 0.7 | 734 |

In general the levels of PCP found in the perirenal adipose tissue do not show a correlation to the total I-TEQ levels. The animals from Carrington, ND, showed elevated levels of PCP and dioxins, as expected, because they had been raised in a controlled setting which contained PCP-treated wood. Fries et al. have shown a relationship between cattle TEQ levels and the levels of pentachlorophenol in their environments (5).

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However, factors such as absorption, metabolism, and excretion, which are quite different for PCP and PCDD/Fs, will affect the bioconcentration in animals. PCP is rapidly eliminated having a half-life of a few days in lactating cows (6). Most PCDD/Fs, on the other hand, have half-lives of 30-50 days in lactating cows (6, 7) and even longer in nonlactating cattle (8). Cattle which have been exposed to treated-wood and then moved to a "clean" facility would quickly rid themselves of PCP but not PCDD/F stores which would have accumulated. Alternatively, PCDD/Fs are selectively absorbed with more highly chlorinated congeners having poor bioavailability (9). A brief exposure to PCP-treated wood immediately before sampling would render high PCP levels in an animal, but levels of PCDD/Fs could remain low due to the relatively low contamination levels in PCP formulations. This may be the case for animals 116 and 23 which have extremely high PCP levels compared to I-TEQ.

The levels of PCP found in this study indicate a background concentration of several hundred ppt in beef cattle. The levels do not correlate with PCDD/F levels in most cases. When environmental exposure was controlled (as in the case of the Carrington, ND, animals), PCP levels were more indicative of the levels of PCDD/Fs found in the animals. This suggests that under controlled exposure conditions PCP levels could be used as a screening device to reflect PCDD/F contamination levels.

References

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