PCB AND PCDD/DF concentrations in egg and poultry meat samples from urban and rural areas in Wales and England

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1. Introduction

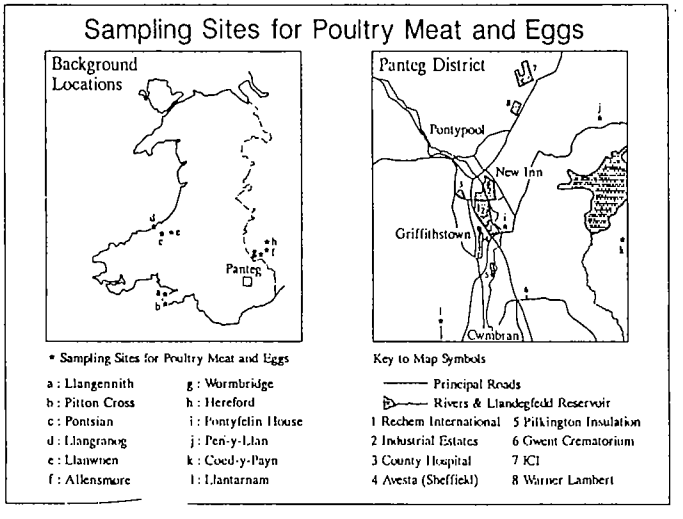
Between 1991 and 1995 an extensive investigation of environmental concentrations of PCBs and PCDD/DFs was undertaken in the Panteg district of south Wales[1)]. The study was primarily initiated as a result of public concern regarding the operations of a chemical waste incinerator, located to the south of the town of Pontypool and owned by Rechem International Ltd[2)]. Results from the main phase of the survey clearly indicated that the operations of the incinerator had produced elevated PCB and PCDD/DF soil and air concentrations in a strip of land some 200 metres wide around the eastern boundary of the plant. The data also implied that this contamination originated from one or more common sources and suggested that fugitive, rather than stack gas, emissions were responsible for the elevated soil and air concentrations observed in the vicinity of the plant[1,3)].

Given these findings, a particular objective of subsequent research was to assess the extent to which foodstuffs from the area were contaminated with PCBs and PCDD/DFs. Levels in locally grown fruit and vegetables were found to be low and generally in accord with data from elsewhere[4)]. This paper describes the survey of PCB and PCDD/DF concentrations in poultry meat and eggs. These foodstuffs tend to have a substantially greater lipid content than fruit or vegetables and consequently, in view of the liphophilic nature of PCBs and PCDD/DFs, can be expected to display higher levels of contamination. Moreover, previous sampling exercises in the Panteg district had indicated that PCB and PCDD/DF levels in duck eggs from Pontyfelin House (a smallholding situated some 70 metres from the eastern boundary of the incinerator) were often appreciably greater than those recorded elsewhere[1,2)]. As a consequence, the inhabitants of Ponyfelin House had been advised not to eat any of the duck eggs. Further interpretation of these results, however, was hindered by limited UK data on typical contamination levels in different environments; a situation reflecting previous reliance on samples from retail outlets.

The survey discussed below was therefore based on egg and poultry meat samples from precisely known locations. In particular, the research sought to compare PCB and PCDD/DF concentrations in these foodstuffs from urban and rural sites, and to assess the implications for human exposure of consuming such local produce. All concentrations presented in the paper are quoted on a fresh mass basis.

2. Methods

Samples of duck meat and eggs (bantam, chicken and duck) were collected between September 1993 and February 1994 from four smallholdings in the Panteg district and eight similar sites in three rural areas; namely the Gower peninsula (south Wales), Ceredigion (mid Wales) and south Herefordshire. These rural sources were in areas devoted to arable farming or fruit and vegetable production. At each egg sampling site a minimum of six eggs of each available type were collected. The locations of the sampling sites are shown below.



Sample preparation was carried out centrally at the University of East Anglia using standard procedures. Representative sub-samples were distributed to the three laboratories involved in the analysis programme. Following a recent review of PCB toxicology, the UK Department of Health recommended that the range of congeners determined in foodstuffs should not only include non-ortho, mono-ortho and di-ortho PCBs, but also those considered to have toxicological effects mediated by mechanisms other than Ah-receptor activity[5]. As a consequence, the following 46 PCB congeners were determined in the poultry meat and egg samples (4, 18, 28, 31, 33, 37, 41, 44, 47, 49, 51, 52, 60, 66, 74, 77, 81, 87, 99, 101, 105, 110, 114, 118, 123, 126, 138, 141, 151, 153, 156, 157, 167, 169, 180, 183, 185, 187, 189, 191, 193, 194, 201, 203, 206 and 209). The samples were also analysed for the seventeen 2,3,7,8 substituted PCDD/DFs.

The performance of each participating laboratory was assessed through an extensive inter-laboratory quality control programme[6]. Each laboratory was required to abide by the acceptance criteria and quality control procedures for PCDD/DFs[7] and to similar standards for PCBs[1]. Egg and duck meat samples from a number of sites were analysed by more than one laboratory as an integral part of the monitoring programme. For PCBs, there were 32 samples, eight of which (25%) were duplicates. The degree of inter-laboratory overlap for the 32 egg and duck meat samples analysed for PCDD/DFs was identical to that for the PCBs. One laboratory responsible for a small number of samples reported levels of the 46 PCB congeners which were often at variance (either lower or higher) with those detected by other analysts. After further investigation it was concluded that the data from this laboratory did not meet the necessary quality control standards and they were excluded from further consideration.

3. Results

PCB and PCDD/DF concentrations in eggs and duck meat from Pontyfelin House, other sites in the Panteg district, and the three rural areas are summarised in Tables 1 and 2.

Table 1: Median concentrations (ug/kg fresh mass) of sum of 46 PCB congeners.

	Eggs			Meat
Sampling Site Category	Duck	Chicken	Bantam	Duck
Rural	14 (7)	15 (7)	22 (5)	25 (6)
Panteg District	24 (2)	14 (3)	-	-
Pontyfelin House	191 (4)	-	341 (4)	43 (2)

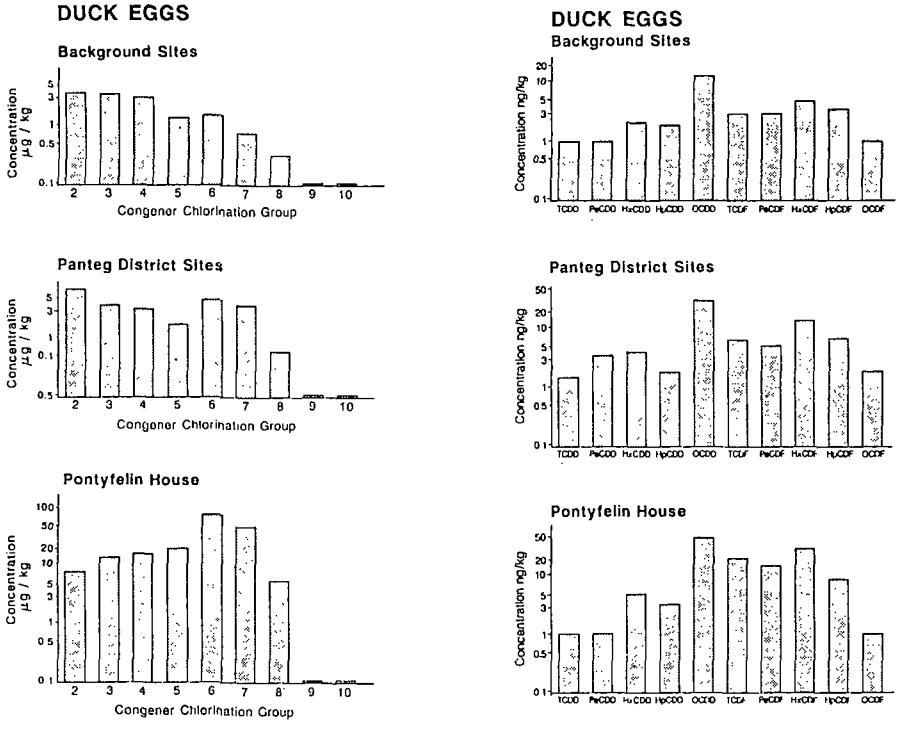
Note: figures in parentheses represent numbers of samples.

Table 2: Median PCDD/DF concentrations (ngTEQ/kg fresh mass).

	Eggs			Meat
Sampling Site Category	Duck	Chicken	Bantam	Duck
Rural	0.7 (7)	1.2 (7)	0.6 (5)	0.4 (6)
Panteg District	1.0 (2)	1.0 (3)	-	-
Pontyfelin House	3.8 (4)	-	12.0 (4)	1.0 (2)

Note: figures in parentheses represent numbers of samples.

Examination of these statistics suggests that there were considerable similarities in the concentrations found at sites in the rural and Panteg district categories. Higher levels were recorded at Pontyfelin House, although the contrast was less marked for duck meat than eggs. These differences were not due to variations in lipid content[6] and were also associated with changes in congener composition. This point is illustrated using the data for duck eggs in the graphs below. In these bar charts the 46 PCB congeners have been combined into nine groups on the basis of their number of chlorine atoms and the graphics indicate that the Pontyfelin House samples were characterised by greater proportions of the more chlorinated PCBs and certain furans (eg. TCDF and PeCDF).



4. Discussion

Comparison of the concentrations described above with values previously described in the literature requires some caution. This is partly due to the influence of factors such as lipid content, but also because many published results are based on retail samples that have been processed in some manner (eg. cooked) prior to analysis. Other complications include the various ways in which concentrations below the detection limit are treated, the preponderance of data on total PCBs rather than individual congeners, and the virtual absence of any information for poultry species other than chickens.

Notwithstanding these caveats, there would appear to be reasonable agreement between the concentrations found in samples from the rural and Panteg district sites, and those reported in the literature as background values[6]. PCDD/DF levels in eggs were perhaps slightly higher than anticipated (0.6-1.2 ngTEQ/kg compared to 0.1-0.3 ngTEQ/kg), but such differences could easily reflect one or more of the factors mentioned above.

Median PCB concentrations in duck and bantam eggs from Pontyfelin House (191 ug/kg and 341 ug/kg respectively) were substantially above background levels for chicken eggs (typically 10-20 ug/kg). To our knowledge, no previous information on PCBs in eggs from known contaminated sites has been published and consequently it is impossible to determine whether the elevated concentrations are typical of such situations. Rather more data exists for PCDD/DFs, and the Pontyfelin results are similar to levels reported in eggs from chickens foraging on land

contaminated with such substances[8,9]. In contrast, however, the median PCDD/DF concentration in duck meat from Pontyfelin (1.0 ngTEQ/kg) was well within the range of background values published in the literature[6].

Given these results, it is pertinent to consider the extent to which consumption of eggs and poultry meat from urban locations near the incinerator would result in residents of the area being exposed to higher levels of PCBs and PCDD/DFs than consumers of similar local poultry produce from rural sites.

Using mean consumption rates for duck eggs, bantam eggs and duck meat of 0.027, 0.017 and 0.017 kg/person/day[10], and the median PCB concentrations from Table 1, the dietary intake from the ingestion of poultry produce from Pontyfelin House would be 5.2, 5.8 and 0.7 ug/day respectively. For rural background areas the corresponding intake is 0.4 ug/kg from each type of foodstuff. Therefore, taking 10 ug/day as the average daily intake of total PCBs from all sources[11], the additional ingestion of PCBs (ie. differences of 4.8, 5.4 and 0.3 ug/day) resulting from consumption of Pontyfelin House poultry products would constitute 48%, 54% and 3% of the normal dietary intake of PCBs.

Similar calculations for PCDD/DFs using I-TEQs and the data in Table 2 indicate differences in in intakes of 84 pgTEQ/day for duck eggs, 194 pgTEQ/day for bantam eggs and 10 pg/TEQ/day for duck meat. These values are, respectively, equivalent to about 14%, 32% and 2% of the World Health Organisation TDI[12].

5. Conclusions

The results of this study have confirmed that PCB and PCDD/DF levels in egg samples from Pontyfelin House were substantially higher than those found elsewhere in the Panteg district or at rural locations. For duck meat the contrast was much less marked, but all the types of poultry produce displayed noticeable variations in congener composition when samples were grouped according to geographical origin. These results support the view that the environment in which poultry live does influence the PCB and PCDD/DF characteristics of their products. Exposure calculations indicate that consumption of bantam or duck eggs from Pontyfelin House would constitute a substantial proportion of recommended daily intakes for such contaminants and at the present time these products are still not being eaten.

Acknowledgements

The authors are grateful to the organisations who have assisted with information and the many people who helped with the provision of samples. Thanks are due to the laboratories that carried out the analyses and to P.Judge for the preparation of diagrams. The work was funded by the Welsh Office, UK. The views expressed in this paper are those of the authors alone.

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