TRANSFER OF PCDD/Fs FROM THE ENVIRONMENT INTO COWS MILK

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Introduction

In 1991 cows' milk was found to be contaminated by PCDD/Fs at three farms in North Derbyshire, UK. Milk from the worst affected farm was found to have a concentration of 85 pg TEQ/g (milk fat), some 5 times higher than the UK threshold concentration (16.6 pg TEQ/g). The source (an incinerator used to destroy chlorinated phenols) and the extent of the contamination have been reported previously.[1,2]

Whilst the PCDD/F concentration in milk from the other two farms fell rapidly to a more typical concentration in the months following the discovery, milk from the worst affected farm has remained above the threshold value. The concentration of PCDD/Fs in this milk as reported by The U.K. Ministry of Agriculture, Fisheries and Food (MAFF) since 1991 is shown at Figure I.[3]

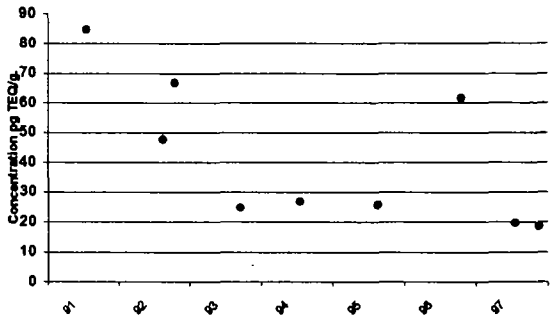

Figure I PCDD/F concentration in milk fat 1991 to 1997[3]

It was considered that the continued presence of PCDD/Fs in the milk at this farm (which is within 0.5 km of the point source of emission) was due to the persistence of PCDD/Fs in the soil ingested during grazing or the contamination of the grass from either continuing aerial deposition or from the soil.

Experimental

As part of a wider project investigating the fate of PCDD/Fs at this farm involving measuring concentrations in air, grass and soil, a cow from an uncontaminated rural area was introduced to the experimental field from which weekly milk samples were taken for as long as possible (6 months). The cow had calved one week earlier and was kept with the calf throughout the experiment to prolong the lactation period. Milk samples were taken by hand with no other milking apart from suckling taking place (i.e. consistent with a beef suckler herd).

Results

The PCDD/F concentration andcongener profile for air, grass and soil in the experimental field taken during the experiment are shown at Table I

	Air * fg/m^3	Grass** pg/g	Soil pg/g
2,3,7,8-TCDF	21	1.6	12
1,2,3,7,8-PeCDF	45	1.3	15
2,3,4,7,8-PeCDF	1	0.4	8.6
1,2,3,4,7,8-HxCDF	44	0.6	15
1,2,3,7,8,9-HxCDF	32	0.4	8.4
1,2,3,6,7,8-HxCDF	4	0.2	8.8
2,3,4,6,7,8-HxCDF	37	0.5	9.7
1,2,3,4,6,7,8-HpCDF	120	2.0	50
1,2,3,4,7,8,9-HpCDF	14	0.2	4.3
OCDF	67	3.1	68
2,3,7,8-TCDD	6	1.1	45
1,2,3,7,8-PeCDD	13	0.7	18
1,2,3,4,7,8-HxCDD	8	0.2	4.7
1,2,3,6,7,8-HxCDD	36	2.5	52
1,2,3,7,8,9-HxCDD	24	1.5	35
1,2,3,4,6,7,8-HpCDD	140	2.2	63
OCDD	360	8.8	145
I-TEQ	59	3	78
* mean of 12 samples	** mean of 7 samples		

Table I PCDD/F concentration in Air, Grass and Soil from the experimental field.

The concentration of PCDD/Fs in milk fat as TEQ values for the full sampling period is shown at Figure II and in detail for selected weeks throughout the sampling period in Table II.

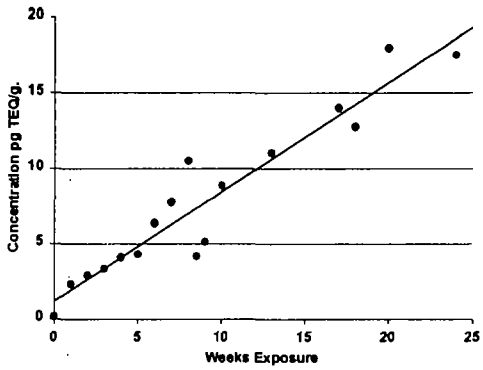

Figure II Plot of concentrations of PCDD/Fs as TEQ in milk fat.

	No of Weeks Exposure				
	0	1	4	10	24
	pg/g fat	pg/g fat	pg/g fat	pg/g fat	pg/g fat
2,3,7,8-TCDF	<0.08	0.31	0.28	0.32	0.61
1,2,3,7,8-PeCDF	0.03	<0.04	0.11	0.11	0.35
2,3,4,7,8-PeCDF	0.86	1.15	1.60	2.00	4.75
1,2,3,4,7,8-HxCDF	0.40	0.54	0.77	0.69	3.00
1,2,3,6,7,8-HxCDF	0.27	0.36	0.53	0.62	2.13
1,2,3,7,8,9-HxCDF	0.18	0.39	0.55	0.60	2.09
2,3,4,6,7,8-HxCDF	<0.2	<0.2	<0.2	<0.2	<0.2
1,2,3,4,6,7,8-HpCDF	0.18	0.46	<0.15	0.95	1.35
1,2,3,4,7,8,9-HpCDF	<0.02	<0.02	<0.02	0.06	0.09
OCDF	0.13	0.38	0.34	0.78	1.24
2,3,7,8-TCDD	<0.83	1.28	2.18	5.88	9.74
1,2,3,7,8-PeCDD	<0.90	1.24	2.13	3.35	7.64
1,2,3,4,7,8-HxCDD	0.20	<0.10	0.27	0.22	0.89
1,2,3,6,7,8-HxCDD	<1.46	1.88	3.30	6.31	18.95
1,2,3,7,8,9-HxCDD	<0.78	<0.78	1.40	2.34	7.48
1,2,3,4,6,7,8-HpCDD	0.50	0.71	0.50	1.07	2.08
OCDD	1.36	2.84	1.06	4.91	1.74
I-TEQ	0.17	2.3	4	9	18

Table II Concentration of PCDD/Fs in milk fat for selected weeks

A comparison of the PCDD/F congener profile in the milk from the cow at 0 weeks and 24 weeks exposure is shown at Figure III.

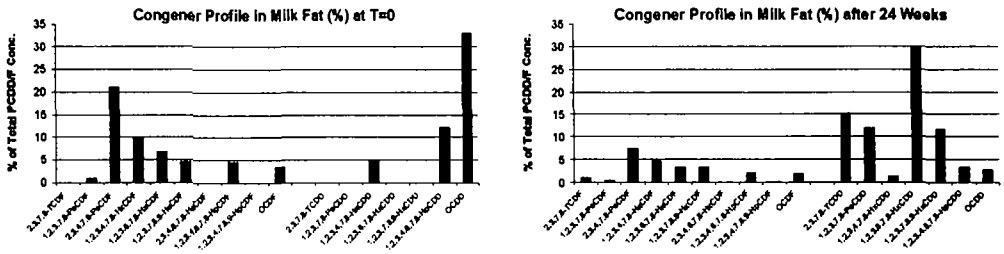

Figure III Congener Profile at 0 weeks and 24 weeks

Discussion

There is a good linear relationship between the change in PCDD/F concentration and the length of time that the cow grazed the contaminated field. Interms of TEQ values the increase was immediate, increasing from a starting concentration of 0.17 to 2.3 pg TEQ/g (milk fat) in the first week. This had increased by Week 4 to 4 pg TEQ/g, at Week 10 to 9 pg TEQ/g and by week 20 the concentration had reached 18 pg TEQ/g, which remained unchanged at Week 24.

It appears that the PCDD/F concentration had started to stabilise at around Week 20 as there was no change between that week and Week 24, both being 18 pg TEQ/g. This concentration is strikingly similar to those reported by MAFF which, except for an inexplicable anomaly in 1996, have remained consistently between 20 and 30 pg TEQ/g since 1993 and more recently 19 pg TEQ/g in 1997 as shown in Figure I.

The congener profile changed significantly during the exposure period. At Week 0 several congeners (particularly PCDDs) were virtually absent (<LOD) with PCDFs and OCDD dominating. At the end of the experiment the congener profile showed significant increases of 2,3,7,8-TCDD (from <1% - 15% of the total 2,3,7,8-substituted congeners), 1,2,3,7,8-PeCDD (<1% - 12%), 1,2,3,6,7,8-HxCDD (<1%-30%) and 1,2,3,7,8,9-HxCDD (<1%-12%).

The concentration of OCDD remained fairly constant throughout the experiment but compared to other congeners, particularly those referred to above, it fell proportionally from 33% of the 2,3,7,8-substituted congeners to 3%.

The congener profiles of the grass and soil are similar although the concentrations are much greater in the soil (Table I). Proportionally OCDD dominates in both grass (32%) and soil (26%) however it is not the dominant congener in the milk after 24 weeks exposure. It appears that the lower chlorinated PCDD congeners (TCDD- HxCDD) are being absorbed into the milk at a greater transfer rate than the other congeners.

Possible explanations for this are differences in the bio-availability and/or metabolism of the different congeners ingested during grazing.

Acknowledgements

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References

1. Holmes S.J., Jones K.C. and Miller C.E.(1995) Organohalogen Compounds 24, 373
2. Holmes S.J., Green N., Lohmann R. and Jones K.C.(1998) Organohalogen Compounds 39, 257
3. MAFF Joint Food Safety and Standards Group. Food Surveillance Paper 143, (1998)