Dioxins in Milk: A Case Study on Localised Contamination

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1. Introduction

Polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans, collectively known as 'dioxins', were the subject of a report published in 1989 by the United Kingdom (UK) Department of the Environment[1], which summarised the then available data on these chemicals in the UK environment. The report also included advice on the human health hazards of dioxins from the expert committee which advises the UK Government on the toxicity of chemicals in food and the environment. In its comments on the report, the committee recommended that the UK food supply should be monitored for dioxins as this appeared to be the principal route of exposure for the public.

The major route of exposure to dioxins for most people in the UK is likely to be from food and in particular milk and fatty foods such as milk products, meat and eggs. In 1988, the UK Ministry of Agriculture, Fisheries and Food (MAFF) started collecting samples of individual fatty foods for analysis for dioxins, as well as total diet samples[2]. These are composite samples representing the average diet consumed in the UK by the general population, but not including food consumed outside the home, alcoholic beverages or tap water[3]. In addition to estimating average dietary intakes of dioxins, a study on the influence of local sources of dioxins on the concentration of these chemicals in food was investigated by sampling cows milk obtained directly from bulk storage tanks on individual farms. Cows milk was chosen for investigation because milk is relatively easy to analyse for dioxins and cows graze relatively large areas and any dioxins present on herbage and soil eaten by the cows would concentrate in the fat content of the milk produced. Milk and milk products are also significant items in the normal UK diet.

2. Approach

Milk was obtained from farms in rural areas remote from potential sources of dioxins and also from farms close to urban/industrial areas. Samples taken from rural areas provide background concentrations of dioxins which can then be compared with results for samples taken from other areas (see Table 1).

Table 1: Concentrations of dioxins and furans (ng/kg TEQ fat) in cows' milk in *the United Kingdom*

	Mean (ng/kg TEQ fat)	Range (ng/kg TEQ fat)
Farms in rural areas	1.5	1.1 - 3.2
Farms in urban/industrial areas	5.0	3.0 - 7.1

11 farms in the Derbyshire area of central England were included in the exercise because of their proximity to relatively industrialised areas. At that time, there was no particular reason to expect that levels of dioxins in this area would differ from those found in the urban/industrial areas previously sampled [2]. Milk samples obtained from these 11 farms in Autumn 1990 were analysed in March 1991. The results showed that milk from 9 of the 11 farms contained concentrations of dioxins in the milk broadly within the range of 1.1 to 7.1 ng TEQ/kg (I-TEF system[4]) fat found elsewhere in England and Wales: the samples from the two remaining farms in the Bolsover area of Derbyshire showed concentrations of 42 and 40 ng TEQ/kg fat respectively. Following these initial findings, which were based on the single analysis of one sample from each farm, MAFF immediately undertook a further intensive programme in April 1991 to test milk from all dairy farms in the area around the two farms (a total of 27) in order both to confirm the early results and to establish the extent of any problems.

3. Results

The results of the follow up testing programme confirmed that the contamination problem was localised to the two farms first identified (Farms A and C in Table 2), with concentrations of 37 and 23 ng TEQ/kg fat respectively in the milk, which were greater than the Maximum Tolerable Concentration for dioxins (MTC) of 17.5 ng TEQ/kg fat set by MAFF and the UK Department of Health. This figure was calculated by scientific and medical experts at MAFF and the Department of Health on the basis of the Tolerable Daily Intake (TDI) for 2,3,7,8-TCDD of 0.01 ng/kg body weight per day set by the World Health Organization Regional Office for Europe at its meeting in 1990[5]. This can be regarded as 0.01 ng/kg body weight per day for 2,3,7,8-TCDD equivalents[4] for mixtures of dioxins. The MTC is defined as the amount of dioxins which could be present in milk and still ensure that upper-range (97.5%ile) consumers of milk would not exceed the TDI.

The milk from the two dairy farms was considered unsuitable for human consumption and consequently it was agreed that no further milk would be accepted into the food supply from these two affected farms until the concentrations of dioxins fell consistently below the MTC. However, the concentrations of dioxins in milk from dairies supplied by these farms and in retail samples bought in the area were in the range 1.8 - 3.1 ng TEQ/kg fat, comparable with those in milk from rural areas. There was therefore no risk to health for most consumers.

Further milk samples were obtained in July 1991 including a sample from a herd suckling calves on a farm adjacent to the two affected farms (Farm B), which had not been tested previously because it did not produce milk for human consumption. Milk from the suckler

herd produced a result of **56 ng TEQ/kg fat** for dioxins in whole milk, the highest level of dioxins found in milk samples tested by MAFF. Additional samples of milk have been taken at intervals over the period 1991 - 1993. The variation in levels in milk from 10 of the 27 farms, including Farms A, B and C, is given in Table 2. It is evident that the concentrations of dioxins had fallen considerably by August 1992 in milk samples from individual animals from Farms A and C, to the extent that the MTC was no longer exceeded.

Table 2: Variation with time of dioxins concentrations (ng/kg TEQ fat) in milk from individual farms in the Bolsover area

Farm	October 1990	April 1991	July 1991	October 1991	August 1992	October 1992	September 1993
A	42	37	13	-	7.4	4.9	4.1
B	-	-	56	-	48	50	25, <42*
C	40	23	22	-	5	8.4	-
D	-	4.6	-	5.6	-	-	-
E	-	5.9	-	4	-	-	-
F	-	12	3.8	7.8	2.8	-	2
G	6.7	13	3	4.7	2.7	-	1.5
H	-	7.4	3.5	7.8	3.2	-	2.5
I	-	2.9	-	4.1	-	-	-
S	-	2.1	-	3.4	-	-	-

* This milk sample had a very low fat content (0.41% fat) which caused analytical difficulties. The value quoted is the maximum concentration and the actual concentration will be lower.

As a result of these findings, further samples of milk were taken in October 1992 and September 1993. The concentrations found confirmed the findings of the August 1992 samples, that the concentrations of dioxins in milk from Farms A and C had fallen to levels comparable to those found in other urban/industrial areas of the UK. The concentration of dioxins in milk from Farm B, however, continued to exceed the MTC.

Other investigations undertaken by MAFF in the Bolsover area included:

- determination of the levels of dioxins in edible tissues from cattle on farms in the Bolsover area;
- investigations into the concentration of dioxins in soil and herbage from the three affected farms; and
- investigations into the rate of decrease in dioxin concentrations in milk and meat from animals on the affected farms when the animals were fed a "dioxin free" diet.

4. Conclusions

The concentrations of dioxins in milk from individual farms in the Bolsover area have fallen below the MTC of 17.5 ng TEQ/kg fat other than for one farm. It is of interest that the concentrations of dioxins in milk from the most affected farms decreased in a relatively short time. This indicates that the cause of the elevated levels probably ceased to be operative during the period of the investigations. While the safety of the food chain in the area was being investigated by MAFF, other UK Government departments were examining potential sources of dioxins in the area and action was taken where appropriate to minimise environmental pollution. These actions may have contributed to the reduction of dioxins concentrations in milk from the farms.

It is reassuring that, even in an area where locally produced foods have been found to be grossly contaminated, the levels of dioxins in such foods have fallen quickly after contaminating inputs were reduced. Further monitoring is being carried out by MAFF to ensure that food, and in particular milk, from the Bolsover area continues to remain safe for human consumption.

5. References

1) Department of the Environment (1989): Dioxins in the Environment, Pollution Paper No. **27**, publ. HMSO, United Kingdom.

2) Ministry of Agriculture, Fisheries and Food (1992): Dioxins in Food, Food Surveillance Paper No. **31**, publ. HMSO, United Kingdom.

3) Peattie, M.E., Buss, D.H., Lindsay, D.G. and Smart, G.A. (1983): Reorganisation of the British Total Diet Study for monitoring food constituents from 1981. Fd. Chem. Toxic. **21(4)**, 503-507.

4) NATO/Committee on the Challenges of Modern Society (1988): International Toxicity Equivalency Factor (I-TEF) method of risk assessment for complex mixtures of dioxins and related compounds. Pilot study on international information exchange on dioxins and related compounds. CCMS Report Number **176**, publ. Environmental Protection Agency, Washington D.C., USA.

5) World Health Organization, Regional Office for Europe (1991): Summary report. Consultation on Tolerable Daily Intake from food of PCDDs and PCDFs. Bilthoven, Netherlands, 4-7 December 1990. **EUR/ICP/PCS 030(S) 0369n**, publ. WHO Regional Office for Europe, Copenhagen.