

LEVELS OF POLYCHLORINATED DIBENZO-p-DIOXINS AND DIBENZOFURANS IN SELECTED
NORWEGIAN FOOD

A. Biseth and M. Oehme

Norwegian Institute for Air Research, P.O. Box 64, N-2001 Lillestrøm, Norway

K. Færden

Norwegian Food Control Authority, P.O. Box 8187 Dep., N-0034 Oslo 1, Norway

ABSTRACT

As a first part of a surveillance study of the PCDD/PCDF-level in Norwegian food, fish, margarine on marine fat basis and butter have been analyzed. The results so far indicate a weekly intake of 300-450 pg 2,3,7,8-TCDD-equivalents (TEQ) from these foods.

INTRODUCTION

It is generally agreed that the main route of exposure of human to PCDD and PCDF is intake through the diet [1]. The analysis of a representative food basket is therefore a crucial element in the estimation of the PCDD/PCDF-exposure of a population.

Therefore, in 1989, the Norwegian Food Control Authority initiated a surveillance programme of PCDD/PCDF in Norwegian food to answer the following questions: First, which type of food contributes significantly to the total intake, second, how high is the average intake, third, what are the exposure levels of persons belonging to assumed high risk groups and fourth, what actions should be taken by the government to assure an as low as reasonably achievable intake?

Similar studies in other countries [1-3] have identified fish, dairy products and meat as the main PCDD/PCDF sources in the diet. PCDD/PCDF are especially enriched in fat food. The Norwegian diet includes a relatively large intake of fish. Therefore, as a first step fat fish such as herring, mackerel and farmed salmon as well as cod and cod liver were analyzed. Approximately half

the Norwegian margarine consumption is produced from marine oils and, consequently, this type of margarine was included. Butter was analyzed as an indicator for the PCDD/PCDF levels in dairy products.

EXPERIMENTAL

Samples of mackerel and herring from the North Sea and the Norwegian coast as well as cod from the Arctic Sea were collected by the Norwegian Directorate of Fisheries. Farmed salmon was supplied by the fish farmers organization. Butter and margarine were bought in different retail shops by local food inspectors. Pooled samples were prepared from 10 individual fat or fish samples. The sampling sites are shown in Figure 1. The applied sample preparation technique and analytical method is described in [4]. Recovery values of the added ^{13}C -marked PCDD/PCDF congeners were in the order of 70-90%.

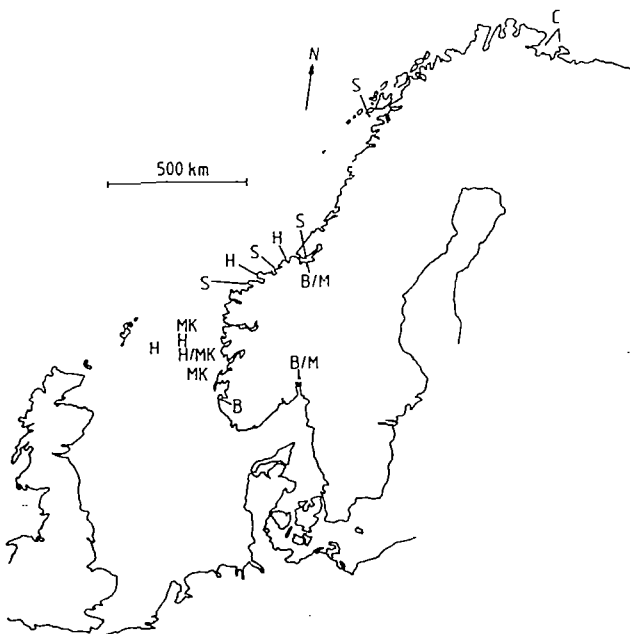


Figure 1: Sample collection sites for fish, margarine and butter.
B: butter, M: margarine, H: herring, MK: mackerel, S: farmed salmon, C: cod

Table 1: Levels of 2,3,7,8-substituted PCDF/PCDD in butter and margarine produced on marine fat basis in Norway, as well as in fish from the North Sea(1), the Norwegian coast(2) and the Arctic Ocean(3). Either single results or average values with the concentration range in parenthesis are given as pg/g fresh weight. Detection limits were calculated at a signal-to-noise ratio of 3:1.

Congener (pg/g)	Butter n=3	Margarine n=4	Herring(1)(2) n=6
2,3,7,8-TCDF	<0.2/0.45/0.67	1.5(0.95-1.8)	4.4(2.9-6.8)
1,2,3,7,8-PeCDF	0.17/0.21/0.24	0.24(0.14-0.33)	0.77(0.56-1.0)
2,3,4,7,8-PeCDF	0.67/0.48/0.98	0.47(0.33-0.54)	2.5(1.3-3.2)
1,2,3,4,7,8-HxCDF	0.27/0.11/0.31	0.12(<0.08-0.17)	0.28(0.18-0.54)
1,2,3,6,7,8-HxCDF	0.43/0.11/0.29	0.08(0.06-0.13)	0.20(<0.04-0.3)
1,2,3,7,8,9-HxCDF	0.18/<0.1	<0.1	<0.1
2,3,4,6,7,8-HxCDF	0.42/<0.05/0.17	<0.08	0.19(<0.04-0.24)
1,2,3,4,6,7,8-HpCDF	0.86/0.13/0.19	0.19(0.12-0.26)	0.29(<0.04-0.91)
1,2,3,4,7,8,9-HpCDF	<0.04	<0.04	<0.1
OCDF	0.81/0.32/0.21	0.28(<0.2-0.56)	<0.2
2,3,7,8-TCDD	<0.5	<0.9	<0.5
1,2,3,7,8-PeCDD	0.35/<0.2	<0.2	<0.15/0.9
1,2,3,4,7,8-HxCDD	0.26/<0.13	<0.2	<0.1
1,2,3,6,7,8-HxCDD	1.1/<0.13/0.89	<0.2	<0.1
1,2,3,7,8,9-HxCDD	0.2/<0.13/0.62	<0.2	<0.3
1,2,3,4,6,7,8-HpCDD	1.3/0.53/1.2	1.3(0.7-2.0)	<0.3/0.4
OCDD	2.6/4.7/6.4	18(6.1-32.9)	2.4(2.1-8.8)
2,3,7,8-TEQ ¹⁾	1.0 (0.75)	0.97 (0.44)	2.15(1.84)
Fat content [%]	-	-	13.9(11.1-20.2)
Congener (pg/g)	Farmed Salmon(2) n=4	Mackerel(1) n=3	Cod(3) n=2
2,3,7,8-TCDF	3.0(0.94-4.0)	2.5/2.0/2.4	0.23/0.18
1,2,3,7,8-PeCDF	0.19(0.10-0.31)	<0.04	0.064/<0.03
2,3,4,7,8-PeCDF	0.58(0.28-1.0)	<0.04/0.38/0.51	0.034/<0.03
1,2,3,4,7,8-HxCDF	0.05(<0.03-0.08)	<0.04	0.028/<0.02
1,2,3,6,7,8-HxCDF	0.035(<0.03-0.08)	<0.04	0.027/<0.02
1,2,3,7,8,9-HxCDF	<0.05	<0.1	<0.03
2,3,4,6,7,8-HxCDF	<0.03	<0.04	<0.02
1,2,3,4,6,7,8-HpCDF	<0.03/0.4/0.5	<0.08/0.3/<0.08	0.030/<0.02
1,2,3,4,7,8,9-HpCDF	<0.03	<0.08	<0.02
OCDF	<0.1	<0.15	0.06/<0.05
2,3,7,8-TCDD	<0.2/<0.4	<0.5	<0.1
1,2,3,7,8-PeCDD	<0.1	<0.15	<0.06
1,2,3,4,7,8-HxCDD	<0.08	<0.1	<0.05
1,2,3,6,7,8-HxCDD	<0.08	<0.1	<0.05
1,2,3,7,8,9-HxCDD	<0.2	<0.3	<0.1
1,2,3,4,6,7,8-HpCDD	<0.1/0.24/0.45	<0.3	<0.1
OCDD	2.7(<0.5-6.4)	7.6/6.7/1.5	0.91/1.5
2,3,7,8-TCDD-EQ ¹⁾	0.81(0.61)	0.71(0.40)	0.12(0.03)
Fat content [%]	2.1(1.0-3.7)	31.9(29-33.6)	0.34/0.3

1) Nordic model [5], half the values of the detection limits included (in parenthesis with zero contribution from not detected congeners)

RESULTS AND DISCUSSION

The average weekly consumption of fish in Norway is in the order of 280 g. Lean fish such as cod represents about 2/3 of the uptake. The remaining third consists mainly of the three analyzed species of fat fish in roughly equivalent amounts. The found PCDD/PCDF levels were comparable with those reported in a British study [3].

The consumption of hard margarine containing marine fat and of dairy fat is in the order of 100 g and 210 g respectively. The total uptake by the analyzed food was estimated in the following way. A maximum level was assessed by including half the values of the detection limits in the calculations of the 2,3,7,8-TEQ. A minimum level was calculated by excluding all not detected isomers and is given in parenthesis. Furthermore, it was assumed that butter was representative for the dairy fat uptake and cod for lean fish.

The weekly uptake per person expressed as 2,3,7,8-TEQ was assessed to be from fish ca. 135 (90) pg, from dairy fat ca. 210 (160) pg and from margarine 95 (45) pg resulting in a total exposure of 440 (295) pg. This corresponds to about a 1/5 (1/7) of the tolerable weekly intake set by the Nordic dioxin expert group (35 pg 2,3,7,8-TEQ/kg body weight and week)[5]. However, published and preliminary results from other studies indicate that the fat-related levels found in butter are 2-5 times lower than those found in other dairy products such as milk, cheese and yoghurt. Therefore, our estimation of the intake is probably too low. The preliminary figures given above will be revised after further analysis of milk, meat and other marine organisms.

REFERENCES

- [1] Codex Alimentarius Commission of the Food and Agriculture Organization of the United Nations and WHO, Report CX/FAC 90/20, March 1990.
- [2] Beck, H., Eckhard, K., Mathar, W. and Wittkowski, R. *Chemosphere* **18**, 417-424 (1989).
- [3] Startin, J.R., Rose, M., Wright, C., Parker, I. and Gilbert, J. *Chemosphere*, in press.
- [4] Oehme, M., Manø, S., Brevik, E. M. and Knutzen, J. *Fresenius Z. Anal. Chem.*, **335**, 987 (1989).
- [5] Ahlborg, U. G., Håkonsson, H., Waern, F. and Hanberg, A. (1988) Nordisk dioxinriskbedömning (with English summary). Nordic Council of Ministers, Miljörapport 1988:7, NORD 49:5-111, Copenhagen.