RIVM report 639102 022
Rijksinstituut voor Volksgezondheid en Milieu

RIKILT report 2001.003
Rijks-Kwaliteitsinstituut voor Land- en Tuinbouwproducten

Dioxins and dioxin-like PCBs in foodstuffs: Occurence and dietary intake in The Netherlands at the end of the 20th century

J.I. Freijer, R. Hoogerbrugge, J.D. van Klaveren,
W.A. Traag, L.A.P. Hoogenboom and A.K.D. Liem

2001

This investigation has been performed by order and for the account of the Inspectorate for Health Protection, Account Food, Ministry of Health, Welfare and Sports, within the framework of project 639102, Dioxins in food.

RIVM, P.O. Box 1, 3720 BA Bilthoven, telephone: 31-30-274 91 11; telefax: 31-30-2742971
RIKILT, P.O. Box 230, 6700 AE Wageningen, telephone: 31-317-475400; telefax: 31-317-417717

Abstract

Here a survey is presented of the most recent (1998/99) information on the occurrence of dioxins and dioxin-like PCBs in foodstuffs in the Netherlands. The data on occurrence collected during measurement programmes on occurrence were combined with food consumption data to assess the dietary intake of dioxins and dioxin-like PCBs in the general population. This yielded the following results. The estimated median lifelong-averaged intake of dioxins in the population is 0.65 pg WHO-TEQ/kg bw per day. The estimate for the sum of dioxins and dioxin-like PCBs is 1.2 pg WHO-TEQ per/kg bw per day. The 90th percentile of intake in the population is 1.6 times higher than the median intake. The contribution of different food groups to the total intake of TEQ (dioxins and dioxin-like PCBs) is fairly uniformly distributed over the foods consumed: meat products (23%), dairy products (27%), fish (16%), eggs (4%), vegetable products (13%), and industrial oils and fats (17%). A comparison was made between these results and those of the 1990/91 survey. After a correction was made for methodological differences, an average reduction in intake of 50% for dioxins (PCDDs and PCDFs) and 60% for non-ortho PCBs was estimated. This substantial reduction is related to the decrease in the concentrations of dioxins (PCDDs and PCDFs) and dioxin-like PCBs in the majority of foodstuffs. Nevertheless, 8% of the population is exposed to intake levels above the TDI (Tolerable Daily Intake) of 2 pg TEQ/kg bw per day, as recently derived by the Scientific Committe on Food (SCF) of the European Commission.

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Samenvatting

Dit rapport geeft een overzicht van de meest recente informatie die beschikbaar is over het voorkomen van dioxinen en dioxine-achtige PCB's in voedingsmiddelen die geconsumeerd of geproduceerd worden in Nederland. Deze gegevens zijn ontleend aan twee nationale meetprogramma's die door RIVM en RIKILT zijn uitgevoerd in 1998 en 1999. Binnen deze programma's werden concentraties gemeten van dioxinen (PCDD's en PCDF's) en dioxine-achtige PCB's (non-ortho PCB's en mono-ortho PCB's) in zowel mengmonsters van consumentenproducten (producten uit de winkel) als individuele Nederlandse primaire agrarische producten (uit het slachthuis en van agrarische bedrijven). De gegevens over het voorkomen van dioxinen en dioxine-achtige PCBs in consumentenproducten werden gecombineerd met voedselconsumptiegegevens voor een schatting van de inname van dioxinen en dioxine-achtige PCB's in de algemene populatie. Bij deze schatting werd rekening gehouden met variatie in voedingspatronen in de populatie (op basis van de Voedsel Consumptie Peiling van 1998) en de leeftijdsafhankelijkheid van de inname.

De resultaten zijn als volgt: De gemiddelde concentraties van dioxines gemeten in dierlijke vetten liggen tussen de 0,24-1,5 pg WHO-TEQ/g vet. Voor de som van dioxinen en dioxine-achtige PCB's liggen de concentraties 1-2,5 keer hoger dan voor dioxinen alleen (0,47-2,8 pg WHO-TEQ/g vet). In vis zijn op productbasis de concentraties van dioxinen en dioxine-achtige PCB's vaak hoger dan in vleesproducten. Voor vis werd het volgende concentratiebereik vastgesteld: dioxinen 100-920 pg WHO-TEQ /kg product, de som van dioxinen en dioxine-achtige PCBs 270-3300 pg WHO-TEQ /kg product. Concentraties in plantaardige producten (0-58 pg WHO-TEQ /kg product) zijn vergelijkbaar met de concentraties in dierlijke producten met een laag vet gehalte. De bijdrage van dioxine-achtige PCB's aan de totale TEQ concentratie in plantaardige producten is verwaarloosbaar t.o.v. de bijdrage van dioxinen.

De mediane lange termijn (levenslang-gemiddelde) inname van dioxinen in de populatie wordt geschat op 0,65 pg WHO-TEQ/kg lichaamsgewicht/ dag. De schatting voor de som van dioxinen en dioxine-achtige PCB's is 1,2 pg WHO-TEQ/kg lichaamsgewicht/ dag. Het 90ste percentiel van inname in de populatie is 1,6 keer hoger dan de mediane inname. De bijdrage van de verschillende groepen voedsel aan de gemiddelde inname van TEQ (dioxinen en dioxine-achtige PCB's) is redelijk uniform verspreid over ons voedselpakket: vleesproducten (23%), melkproducten (27%), vis (16%), eieren (4%), plantaardige producten (13%), en industriële oliën en vetten (17%).

Een vergelijking van de resultaten van de huidige studie met de resultaten van een studie die het RIVM in 1990/91 heeft uitgevoerd laat een daling zien van de inname. Na te hebben gecorrigeerd voor methodologische verschillen werd een gemiddelde daling van 50% voor dioxinen en van 60% voor non-ortho PCB's berekend. Deze aanzienlijke daling is gerelateerd aan de afname van concentraties van dioxinen en dioxine-achtige PCB's in een groot deel van de voedingsmiddelen. Een neerwaartse trend is over de afgelopen 10 jaar ook vastgesteld in een aantal andere Europese landen. Desalniettemin wordt een deel van de

Nederlandse bevolking blootgesteld aan innames boven de internationale gezondheids-doelstellingen. Recentelijk heeft de Scientific Committee on Food (SCF) van de Europese Commissie een nieuwe TDI afgeleid (Tolerable Daily Intake) van 2 pg WHO-TEQ/kg lichaamsgewicht/dag. Uit de berekende innamedistributie kan geconcludeerd worden dat de inname van 8% van de bevolking het inname niveau van 2 pg TEQ/kg bw/dag overschrijdt. Diverse limietwaarden, zoals voorgesteld om dierlijke producten met hoge dioxine concentraties van de markt te weren hebben een gering direct effect op de lange-termijn inname van dioxinen in de populatie. Het nut van dergelijke limietwaarden is vooral het reguleren van korte-termijn piekinnames bij incidentele vervuiling en besmetting van landbouwhuisdieren. Daarnaast wordt ook verwacht dat deze limietwaarden bijdragen aan een verminderde lange-termijn inname bij individuen met zeer specifieke eetpatronen, waarbij vooral producten worden gegeten met potentieel hoge concentraties van dioxinen en/of dioxine-achtige PCB's.

Summary

This report compiles the most recent information on the occurrence of dioxins and dioxin-like PCBs in foodstuffs in the Netherlands. The occurrence data were extracted from two measurement programmes carried out by RIVM and RIKILT in 1998/99, where concentrations of dioxins (PCDDs and PCDFs) and dioxin-like PCBs (non-ortho PCBs and mono-ortho PCBs) were measured in composite consumer food categories and in Dutch primary agricultural products. Concentrations measured in consumer foods were combined with food consumption data to assess the dietary intake of dioxins and dioxin-like PCBs in the general population. The dietary intake was estimated by also taking into account the food consumption patterns in the population (1998 food consumption survey), age dependency, short-term variations within the individual and variations between individuals in the general population.

Measured average concentrations of dioxins in animal fats were shown to range from 0.24-1.5 pg WHO-TEQ/g fat. In summing dioxins and dioxin-like PCBs, concentrations were found to be 1-2.5 times higher than for dioxins only (range of 0.47-2.8 pg WHO-TEQ/g fat). On a product basis, concentrations of dioxins and dioxin-like PCBs in fish were shown to be higher than in most meat products. The following range of average concentrations was found for fish: dioxins, 100-920 pg WHO-TEQ/kg product, sum of dioxins and dioxin-like PCBs, 270-3300 pg WHO-TEQ/kg product. Concentrations of dioxins in vegetable products (0-58 pg WHO-TEQ/ kg product) are comparable to those in low-fat animal products. The contribution of dioxin-like PCBs to the total TEQ concentration in vegetable products is negligible compared to that of dioxins.

The median lifelong-averaged intake of dioxins in the population is estimated at 0.65 pg WHO-TEQ/kg bw per day. The estimate for the sum of dioxins and dioxin-like PCBs is 1.2 pg WHO-TEQ /kg bw per day. The 90th percentile of intake in the population is 1.6 times higher than the median intake. The contribution of different food groups to the average intake of TEQ (dioxins and dioxin-like PCBs) is fairly evenly distributed over the foods consumed: meat products (23%), dairy products (27%), fish (16%), eggs (4%), vegetable products (13%), and industrial oils and fats (17%).

A comparison was made between the results of the current survey and the results of the 1990/91 survey. After corrections were made for methodological differences, an average reduction in intake of 50% for dioxins (PCDDs and PCDFs) and 60% for non-ortho PCBs was estimated. This considerable reduction is related to the decrease in the concentrations of dioxins (PCDDs and PCDFs) and dioxin-like PCBs in the majority of foodstuffs. A downward trend in intake and concentrations was also observed in other European countries during the last decade. Nevertheless, a large fraction of the population is exposed to intake levels exceeding international health safety objectives. The Scientific Committee on Food (SCF) of the European Commission has recently derived a TDI (Tolerable Daily Intake) of 2 pg TEQ/kg bw per day. From the calculated intake distribution it can be concluded that the intake of 8% of the population exceeds this TDI. Various limit values, proposed to exclude

animal products from the market, containing high levels of dioxins, have only a minor absolute effect on the average long-term dioxin intake by the population. These limit values would be mainly beneficial in regulating short-term high intake in the case of contamination incidents. It is also expected that these limits will lower the long-term intake for individuals with very specific feeding patterns, consisting mainly of products with high concentrations of dioxins and dioxin-like PCBs.

1: Introduction

AKD Liem[1], JI Freijer[2] and R Hoogerbrugge[2]

[1]Present address: SCF Secretariat, European Commission, SANCO/C/3 Brussels

[2] National Institute for Public Health and the Environment, Bilthoven

1 Introduction

1.1 Dietary exposure of the general population of The Netherlands to dioxins and dioxin-like PCBs

The dietary exposure of the general population of The Netherlands to polychlorinated dibenzo-*p*-dioxins (PCDDs) and dibenzofurans (PCDFs) has been subject of extensive investigations in the past ten years. The first exposure estimate was reported in 1989. A dietary intake was estimated of 115 picograms (pg) of dioxin (I-TEQ[1]) per person (60 kg) per day. This estimate was based on available literature data on concentrations in ambient media and foods, and average consumption figures for different groups as reported for The Netherlands (Theelen, 1989). At that time, no information was available on dioxin concentrations in commodities representative of the Dutch food supply.

The need to conduct a survey on levels in products from the Dutch food supply was strongly increased when elevated dioxin levels were reported for cow's milk collected near a large municipal waste incinerator in Rotterdam (Liem et al., 1989). Following that report, the Dutch government issued an emission guideline and proclaimed an upper limit for the dioxin level in milk and milk products of 6 pg I-TEQ/g milk fat (Staatscourant, 1989). This provisional standard was based on filling up the tolerable daily intake (TDI) of 240 pg TEQ for a 60 kg-person (Van der Heijden et al., 1982), an intake of 80 pg TEQ/day by consumption of food other than dairy products (Theelen, 1989) and an average daily consumption of 26 g of milk fat (VCP, 1988). As it was primarily based on literature data, uncertainty remained about the representativity of the occurrence and intake data for the Dutch situation. Therefore, an extensive survey was initiated to establish the concentration of dioxins and related compounds in foods consumed by the majority of the consumers in The Netherlands, and to assess the resulting dietary exposures for the general population. The results of this survey have been reported in 1991 (Liem et al., 1991).

The respective dietary exposure estimates (Liem et al., 1991) were based on results of chemical analysis of foods collected in 1990-1991 and food consumption data acquired during the first national dietary survey held in 1987-1988 (VCP, 1988; Hulshof and Van Staveren, 1991). The assessment revealed a dietary intake of PCDDs and PCDFs for the common Dutch person of approximately 1 pg I-TEQ/kg body weight (bw) per day. The intake was about twice as high if TEQ contributions of non-ortho PCBs 77, 126 and 169[2]

[1] I-TEQ: total concentration of 2,3,7,8-substituted PCDDs and PCDFs expressed in toxic equivalents of 2,3,7,8-TCDD (TEQ) using the International Toxic Equivalency Factors (I-TEF) as published by NATO/CCMS (1988). See Appendix 1 for an overview of TEF values.

[2] The TEQ contribution of the non-ortho PCB fraction was at that time calculated using TEF values as proposed by a Dutch Working Group (Van Zorge et al., 1989; Liem et al., 1991). If the TEQ contribution would be

were also taken into account. Converted to body weight, the intake appeared to be higher for children/adolescents up to 20 years of age, than for adults. The 95^{th} percentile of the intake for the general population was estimated to be approximately three times higher than the median intake. Milk fat and related food items such as cheese, butter, and beef contributed 50% to the total daily exposure of the general population. The food items provided by the food industry contributed 13 to 24%. The major source in the latter foods appeared to be fish oil (Liem et al., 1991; Liem and Theelen, 1997).

In 1996, new intake estimates were reported after completion of supplementary studies conducted in 1991-1995. The follow-up study resulted in new data on levels in consumer milk, fish oils (before and after refinery), cereals and game. The second assessment resulted in slightly lower (14%) intake estimates than in the assessment reported in 1991. The major part of this difference could be explained by a smaller contribution of fish oils (Liem et al., 1996).

The aforementioned intake estimate appeared to be in good agreement with an exposure assessment reported by Van Dooren-Flipsen et al. (1997). The former study differs from the latter in the way concentrations in specific food products are considered. In the study reported by Liem and co-workers, the intake contribution of products marketed by the food industry was estimated by assuming an average composition of oils and fats used by the food industry, and the chemical analysis of a limited number of different oils and fats (Liem and Theelen, 1997). Van Dooren-Flipsen et al. were instead able to link a larger number of specific food items with available measurement data for primary agricultural products by using a database (CPAP) with conversion factors to Dutch primary agricultural products for a larger number of food commodities. They thus improved the accuracy of the estimates of concentrations in specific food products. The overall result appeared to differ only slightly from previous estimates.

Van Dooren-Flipsen and colleagues also investigated time trends. In addition to the analytical data for foods with the majority reflecting the period 1990-1991 (Liem et al., 1996), they had access to monitoring data for primary agricultural products collected in 1994-1996 (Van Dooren-Flipsen et al. 1997). Besides, the results from the second Dutch National Food Consumption Survey were used to investigate the influence of developments in food consumption between the first (1987-1988) and second food consumption survey (1992). The trend study revealed an overall decrease of 55% in the mean dietary intake of the general population between 1990 and 1996. About 15% of this decline could be attributed to changes in food consumption and the remaining 40% to a decrease in concentrations of PCDDs and PCDFs between 1990 and 1996 (Van Dooren-Flipsen et al., 1997). These findings are in agreement with the declining intakes found in a duplicate diet study (Liem et al., 1997) and the decreasing levels in human milk (Liem et al., 1995). Similar observations have also been reported for Germany and the United Kingdom. The downward trend seems to be paralleled

calculated using the current TEF scheme as proposed by WHO (Van den Berg et al., 1998), the total TEQ contribution of these three congeners would almost remain the same, because the TEF value for PCB 126, responsible for the major part of the TEQ value, has not been changed.

by the general consciousness to abandon the use of PCBs and the measures taken by various European countries at the end of the 1980s to reduce the dioxin emissions and to lower their levels in the environment.

In the before mentioned studies, an important objective was also to provide information on the fraction of the population that was likely to exceed the tolerable daily intake (TDI) for dioxin related compounds. If the dietary intakes (situation 1990-1991) were compared to the TDI of 10 pg TEQ/kg bw as recommended by WHO in 1990 (Ahlborg et al., 1992), it was estimated that only a small fraction (1.5%) of the Dutch general population was exposed to amounts exceeding this TDI (including intake of PCDDs, PCDFs and non-ortho PCBs). However, the majority of the population (i.e. over 90%) of the Dutch population was exposed to amounts exceeding the public health based exposure limit of 1 pg TEQ/kg bw/day, as proposed by the Health Council of The Netherlands in 1996 (Liem and Theelen, 1997).

1.2 Developments in 1990-2000

In the period 1990-2000, the following developments can be noted in the field of exposure and risk assessment of dioxin related compounds.

- TRENDS IN EMISSIONS. In many European countries, much effort has been put in measures to control the release of dioxin-like compounds into air. European inventories (Quass et al., 1998) have indeed shown that the situation improved, due to the implementation of new technology in various industrial and incineration processes and various other measures to reduce the environmental load with dioxin-like compounds. For the Dutch situation the reduction in the emission of dioxins into air was estimated to be more than 90% (TNO, 1995ab; Cuijpers et al., 1998). As a result of this, the exposure of the general population has declined (EU-SCOOP, 2000).

- CONTRIBUTION OF OTHER DIOXIN-LIKE COMPOUNDS. Since 1990 the list of compounds with a 2,3,7,8-TCDD toxic equivalency factor has been the subject of international discussions. In most publications and reports the International TEFs are being used as issued by NATO/CCMS in 1988 for the seventeen 2,3,7,8-substuted PCDDs and PCDFs (I-TEFs). In 1993 a WHO working group reached consensus on TEF values for three non-ortho, eight mono-ortho and two di-ortho substituted PCBs (Ahlborg et al., 1994). In 1997, the TEFs for the selection of 2,3,7,8-substituted PCDDs and PCDFs, and the list of dioxin-like PCBs agreed upon in 1993 were re-evaluated again at a WHO consultation in Stockholm. This WHO consultation resulted in the current list of WHO-TEFs which is now being recommended to be used to express the toxicity of mixtures of PCDDs, PCDFs and PCBs in equivalents of 2,3,7,8-TCDD (WHO-TEQ; van den Berg et al., 1998). The contributions of the mono-ortho PCBs included in the list of WHO-TEFs were not yet taken into consideration in the previously described exposure estimates for the Dutch situation. These intake assessments were based on TEQ contributions of PCDDs, PCDFs and three non-ortho PCBs with IUPAC nos. 77, 126 and 169 only. It has been estimated for the Dutch situation that the total TEQ intake would have been 30-40% higher if the mono-ortho PCBs would also be taken into account. Consequently, the mean daily intake of dioxin and related compounds from food in The Netherlands in the early 1990s could have been as high as 3 pg TEQ/kg bw/day (Liem and Theelen, 1997).

- CONTRIBUTION OF OTHER FOODS. In the before mentioned assessments intake contributions through consumption of vegetable products were not taken into consideration, because the intake of dioxins was considered to result mainly from consumption of animal fats (Liem et al., 1991; Fürst et al., 1992). Relatively high contributions of vegetables have been reported for Southern European regions (Di Domenico, 1990; Schuhmacher et al., 1997). However, these assessments were based on estimated concentrations or a few measurements only. Furthermore, differences in food consumption habits were taken into account which are probably not representative for the Dutch situation. A preliminary estimate for the Dutch situation was based on results from a field survey on curly kale (Brassica oleracea var. acephala) (Liem et al., 1993). An additional dioxin intake through consumption of vegetables and fruits of 8 pg I-TEQ/day, corresponding to approximately 10% of the total dietary intake of PCDDs and PCDFs, was estimated for the common Dutch person. However, the latter estimate should be considered with caution, since various assumptions were made to extrapolate the measured concentrations in curly kale to an intake contribution of vegetables and fruits. The need to improve the estimates of the intake contribution of vegetables and fruits increased because of the international trend of diminishing concentrations of dioxins and dioxin-like PCBs in animal and dairy products.

- DEVELOPMENTS IN THE TOLERABLE INTAKE. In previous exposure assessments of PCDDs, PCDFs and dioxin-like PCBs for the general Dutch population (Liem et al., 1991), the estimated dietary intakes had been compared with a TDI of 10 pg TEQ/kg bw as recommended by WHO in 1990. This TDI has been derived assuming a threshold dose for the carcinogenic effect of 2,3,7,8-TCDD (Ahlborg et al., 1992). Since then, new toxicological, epidemiological and mechanistic data have emerged, in particular with respect to neurodevelopmental, reproductive and endocrine effects. Using the improved database, the Health Council of The Netherlands proposed a public health based recommended limit for dioxins and dioxin-like PCBs of 1 pg TEQ/kg bw in 1996 (HCN, 1996), a WHO Consultation agreed on a TDI of dioxins and dioxin-like PCBs in the range of 1-4 pg TEQ/kg bw in 1998 (WHO, 2000). The most recent assessment of the toxicity of dioxin related compounds was published by the Scientific Committee on Food (SCF) of the European Commission in November 2000 and May 2001 (SCF, 2000; SCF, 2001). The SCF used the WHO evaluation of 1998 as starting point and expanded the database with studies published since then. Because of the very long half-lives in the human body of 2,3,7,8-TCDD and related compounds, the SCF found it more appropriate to establish a tolerable weekly intake rather than a tolerable daily intake. The Committee arrived at a tolerable weekly intake (TWI) of 14 pg WHO-TEQ/kg bw for PCDDs, PCDFs and dioxin-like PCBs.

1.3 Objectives

The current study evaluates the levels of dioxins and related compounds in different food stuffs and assesses the dietary exposure of the Dutch population to these compounds.

The main objectives of this work are:
(a) to obtain representative data on levels of dioxins and related compounds in foods consumed by the general population in the Netherlands.
(b) to obtain representative data on levels of dioxin and related compounds in primary agricultural products produced in the Netherlands.
(c) to estimate dietary intake in the population and the relative importance of specific food groups to the total intake of dioxins and dioxin-like PCBs.
(d) to compare the results of the current survey with those of the 1991 survey.
(e) to estimate the fraction of the population for which intake exceeds the TDI.
(f) to evaluate the effects of limit values on the average intake and non-compliance of products.

1.4 This report

The research has been carried out by the National Institute of Public Health and the Environment (RIVM) and the State Institute for the Quality of Agricultural Products (RIKILT). The study was commissioned by the Dutch National Working Group on Dioxins in Food. The results are presented in this report.

2: Sampling strategies

R Hoogerbrugge[1], JD van Klaveren[2] and J de Vries[3]

with contributions of:

G Kleter[3]
AKD Liem[4]

[1] National Institute for Public Health and the Environment,
Bilthoven

[2] State Institute for the Quality of Agricultural Products,
Wageningen

[3] Inspectorate for Health Protection,
The Hague

[4]Present address: SCF Secretariat, European Commission, SANCO/C/3
Brussels

2 Sampling strategies

2.1 Consumer foodstuffs

2.1.1 Introduction

One of the principal aims of this study is to obtain representative data on levels of dioxin and related compounds in foods consumed by the general population in the Netherlands. For this objective a sampling programme was designed. The sampling strategy of consumer foodstuffs is based on the assumption that lipophilic components like dioxins and PCBs are almost entirely present in the fat fraction of the foodstuffs. Using the results of the Dutch National Food Consumption Survey 97/98 (DNFCS 3) 24 food categories were defined to cover most of the fat containing foodstuffs. In order to meet the needs to improve the estimate of the contribution of other foods one food category containing vegetables and three categories containing complex dishes and mixed products were recognised.

In co-operation with the Dutch Inspectorate for Health Protection and Veterinary Public Health (Regionale Keuringsdiensten van Waren) a sampling protocol was formulated. For the defined food categories relevant foods were purchased and pooled, to measure the contaminant levels in composite samples. The choice of food products in each category was based on their portion in the total (fat) intake of these products as derived from the DNFCS 3.

2.1.2 Materials and methods

Selection of foods

For the selection of foods, the database of the Dutch National Food Consumption Survey (DNFCS) was used. The survey has been described in detail elsewhere (Voedingscentrum, 1998; Kistemaker et al., 1998). Briefly, 2774 households participated resulting in a sample of 6250 subjects. Food consumption was assessed by a 2-day dietary record method, equally distributed over the seven days of the week and over a whole year. For each subject, data on age, sex, body weight and a series of other characteristics were available. The population ranged from 1 to 97 years in age. For each person, the quantities of various ingested food items over the day were recorded. This resulted in consumption data of 1209 different food products. Of each food product, a comprehensive description of the food items, including percentage total fat, was available from the Netherlands Nutrient databank. The descriptions in the Netherlands Nutrient databank (NEVO, 1996) were used to investigate the type(s) of fat or oil in the 1209 food products included in the DNFCS database. Food products not expected to contain dioxin related compounds were not considered in the selection procedure (Kistemaker, 1989). This screening procedure resulted in a reduction of 1209 to 807 food products ranked into food categories according to type of fat or oil (See Appendix 8). The database of the DNFCS was also consulted to perform a secondary screening. This screening aimed at identifying the food categories most significantly contributing to total fat consumption. This resulted in a selection of 18 food categories (Tables 2.1 and 2.2) with differing types of fats and oils. For each of these food categories, a set of food products was defined covering at least 95% of the total fat intake of the respective category.

For the category vegetables the fat based approach was assumed to be impractical. The 21 most popular vegetables were needed to cover 95% of the average intake of the vegetables by the Dutch population. Sampling of the following food categories was assumed to be not necessary or was abandoned in a later stage: (a) consumer milk since data from a monitoring programme were available; (b) the categories liver, game and horses because of their relatively small contribution to the average diet; (c) mixed categories like mixed products, complex dishes, pastries and sweets since these average levels can be calculated from other categories by the CPAP conversion programme (van Dooren et al., 1995). Summarising, 24 food categories were defined for which levels of dioxins and dioxin-like PCBs had to be established, either by direct chemical analysis or by use of the CPAP conversion programme. (Tables 2.1 and 2.2).

Collection and composition of samples

Samples were collected from all selected food products belonging to each food category. During sampling, possible differences between geographical areas and seasons and the proportional contributions of the various food products have been taken into account. To reduce the number of measurements, a general sampling scheme was followed as illustrated in Figure 2.1. The composition of the samples for chemical analysis was aimed at the highest attainable degree of national representativity for each of the selected food categories.

Almost all categories were sampled using a proportional technique. The samples were prepared from a mixture of different food products, with each item added in weight proportional to its average consumption, as determined in the Dutch National Food Consumption Survey. Tables 2.1 and 2.2 list the individual amounts of the food products combined to a (regional) representative sample for each of the respective food categories. The selection of food items to be mixed had to cover at least 95% of the fat intake of the respective category according to the DNFCS 3. All these composite samples held at least a total of 50 g of fat. For the category vegetables the fat based approach was not used. Instead, the 21 most popular vegetables were mixed to cover the required 95% of the average intake of the vegetables by the Dutch population. The vegetables were not washed or cleaned before adding them to the composite samples.

The items themselves were collected in five different regions in the Netherlands. In each region, two different inspectors of a Regional Inspectorate for Health Protection and Veterinary Public Health collected independently from each other the complete set of requested food items at stores of their own choice. A protocol containing general instructions and a detailed account of the amounts of each food product to be collected were provided to the respective inspectors. The samples were collected in March 1999. Then all samples were transported to the Inspectorate for Health Protection and Veterinary Public Health, (Keuringsdienst van Waren Oost) "East". The preparation of the regional and national composites (Figure 2.1) was carried out at the Laboratory of the Regional Inspectorate in

Nijmegen and at the Laboratory for Organic-analytical Chemistry of RIVM. All samples were stored frozen at –20C until chemical analysis.

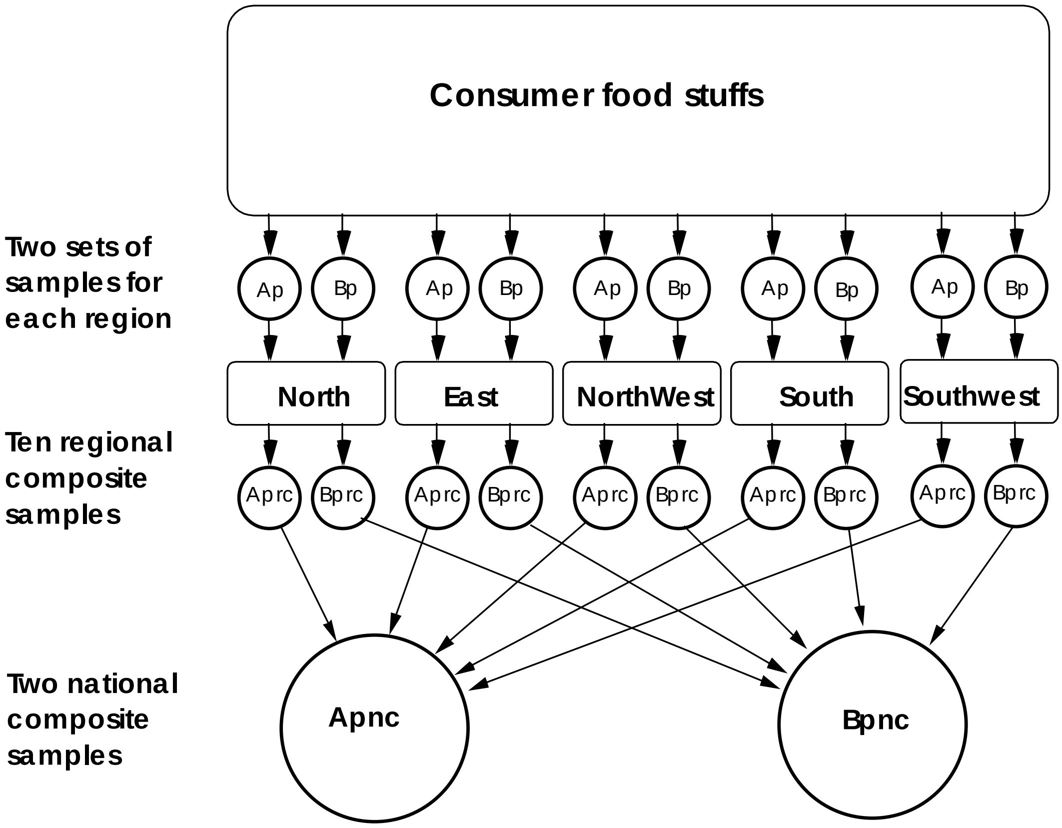


Figure 2.1 Schematic presentation of the applied strategy for sample collection and preparation of national representative composite samples to determine the levels of PCDDs, PCDFs and PCBs in almost all categories of food consumed in the Netherlands. In each of the five regions, two sets of samples ("Ap" and "Bp") were collected by two different inspectors independently, consisting of various food products. Next, regionally collected food items were mixed either proportionally, when composed of different types of food items (covering 95% of the fat intake of the respective food category), or by weight (vegetables). In preparing the regional composite samples ("Aprc" and "Bprc"), of each food product either the Ap or Bp sample was used. Next, national representative composite samples ("Apnc" and "Bpnc") were composed by mixing equal weights of five Aprc and Bprc mixtures, respectively. Note that the final composition of Apnc and Bpnc differs by applying this pooling scheme.

Table 2.1 Composition of the food categories. The composition of the food categories represents at least 95% of the fat intake of the respective category. However, for vegetables the composition represents at least 95% of the product intake of the respective category. See also the text.

Category	Foodstuff	Foodstuff (in Dutch)		Mass g	Contribution %
Animal products					
Beef	minced cows meat	gehakt runder-		211	59.1%
	hamburger	hamburger		64	17.9%
	braising steak	rundersucadelappen		43	12.0%
	stewing steak	runderriblappen		20	5.6%
	ground cows meat	rundertartaar		19	5.3%
			Σ	357	
Pig	pig sausage	varkensbraadworst		61	29.3%
	bacon (lean)	speklap, mager, zonder zwoerd		55	26.4%
	chop	varkenshals/schouderkarbonade		71	34.1%
	pork	spek vers, vet rauw		9	4.3%
	kromenski	slavink		12	5.8%
			Σ	208	
Poultry	chicken skinless	kip/bout zonder vel		335	31.3%
	chicken with skin	kip/bout met vel		147	13.7%
	chicken meat	kipfilet		547	51.1%
	turkey	kalkoen		31	2.9%
	chicken liver	kippelever		11	1.0%
			Σ	1071	
Dairy products					
Butter	butter unsalted	boter ongezouten		43	69.4%
	butter salted	boter gezouten		16	25.8%
	butter (half)	boter halfvolle kuip (Linera of ander		3	4.8%
			Σ	62	
Cheese	cheese Gouda	kaas Goudse 48+		136	84.0%
	cheese Edam	kaas Edammer 40+		15	9.3%
	cheese "Maaslander"	kaas Maaslander 48+		5	3.1%
	brie 50+	kaas Brie 50+		3	1.9%
	brie 60+	kaas Brie 60+		3	1.9%
			Σ	162	
Fish					
Lean fish	cod	kabeljauw		2337	66.4%
	plaice	schol		797	22.6%
	coal-fish	koolvis		385	10.9%
			Σ	3519	
Fatty fish	herring (salted)	haring gezouten		188	57.5%
	eel (smoked)	paling gerookt		34	10.4%
	mackerel (steamed/raw)	makreel gestoomd/rauw		34	10.4%
	mackerel (smoked)	makreelfilet gerookt		17	5.2%
	salmon (raw)	zalm rauw		28	8.6%
	herring (marinated)	haring gemarineerd		26	8.0%
			Σ	327	
Crustaceans	mussels	mosselen gekookt		627	34.7%
	schrimps	garnalen gepeld		1079	59.7%
	crab	krab		58	3.2%
	lobster	kreeft		44	2.4%
			Σ	1808	
Fish, prepared	fried fish filet	lekkerbekje gebakken		257	59.9%
	fish fingers	vissticks		172	40.1%
			Σ	429	

Table 2.1 continued

Category	Foodstuff	Foodstuff (in Dutch)		Mass g	Contribution %
Eggs					
Eggs	chicken eggs (cooked)	ei kippe- gekookt		472	100.0%
Vegetable products					
Nuts	peanut butter	pindakaas		33	30.8%
	peanuts (salted/unsalted)	noten pinda's gezouten/ongezouten		40	37.4%
	nuts (to go with cocktails)	noten borrel-		17	15.9%
	nuts mixture	noten gemengd gezouten		7	6.5%
	peanute sauce	saus saté- bereid		10	9.3%
			Σ	107	
Vegetable oil	margarine	margarine, kuipje/pak		34	41.0%
	low-fat margarine	halvarine		11	13.3%
	cooking-fat	vet bak- en braad-		4	4.8%
	potato crisps	chips		26	31.3%
	mayonnaise (80 % oil)	mayonaise 80% olie		8	9.6%
			Σ	83	
Vegetables	cauliflower	bloemkool		22	11.7%
	onion	ui		20	10.6%
	cucumber	komkommer		14	7.4%
	butter-bean	sperziebonen		14	7.4%
	carrot	wortelen		14	7.4%
	tomato	tomaat		12	6.4%
	chicory	witlof		12	6.4%
	leek	prei		10	5.3%
	Brussels sprouts	spruitjes		8	4.3%
	lettuce	sla		6	3.2%
	sauerkraut	zuurkool (k&k)		6	3.2%
	endive	andijvie		8	4.3%
	butter-bean (tin/glas)	sperziebonen uit blik/glas (k&k)		6	3.2%
	lettuce Iceberg	ijsbergsla		6	3.2%
	beetroot	bieten		4	2.1%
	French bean	snijbonen		4	2.1%
	mushrooms	champignons		6	3.2%
	tomato (cooked)	tomaat gekookt (k&k)		4	2.1%
	spinach (frozen)	spinazie diepvries (k&k)		4	2.1%
	spinace with cream (frozen)	spinazie à la creme (k&k)		4	2.1%
	broccoli	broccoli		4	2.1%
			Σ	188	
Industrial oils/fats					
Margarine	margarine	margarine, pakje		22	15.3%
	low-fat margarine	halvarine		11	7.6%
	cooking-fat	vet bak- en braad-		25	17.4%
	frying-fat	vet frituur-		4	2.8%
	French fries	frites bereid		82	56.9%
			Σ	144	
Fried snacks	minced meat hot dog	frikandel bereid		114	38.8%
	croquette	kroket bereid		98	33.3%
	sausage roll	broodje saucijze-		24	8.2%
	prawn crackers	kroepoek bereid		15	5.1%
	egg-roll (chinese)	loempia bereid		43	14.6%
			Σ	294	

Consumer milk

The milk that reaches the majority of consumers in The Netherlands is produced by only two major manufacturers that have factories distributed over the country. Milk produced by these factories (further referred to as 'consumer milk') represent pooled samples of milk produced by dairy farms evenly distributed over the country. From time to time, Dutch consumer milk may even comprise supplies from abroad. Only minor fractions are brought directly on the market by individual dairy farms. After the merging of some of the manufacturers, the sampling campaign was reduced to the Northern and Western region as of January 1999. Using this information a monitoring programme on consumer milk is active since October 1997. Each few days cartons of milk containing 1 litre each are bought at local stores in the areas south and west. By mixing equal weight amounts of the temporal samples, a monthly representative pooled sample was obtained. The results from the monthly samples of March 1999 were used as input in the intake calculations. The original study design of the monitoring programme consisted of chemical analysis of PCDDs and PCDFs only. In the framework of this dietary intake study, the regional composites from March 1999 were also analysed for contents of PCBs.

Table 2.2 Composition of the food categories that were recognised, but not sampled and/or not analysed. The composition represents at least 95% of the intake of the respective category.

Category	Foodstuff	Foodstuff (in Dutch)		Mass g	Contribution %
Mixed meat[1]	minced meat 50%pork/ 50%	gehakt half-om-half		107	50.0%
	smoked sausage	rookworst		57	26.6%
	minced meat loaf	gehaktbal half om half, bereid		35	16.4%
	frankfurter	knakworst		15	7.0%
			Σ	214	
Mutton[1]	sheep meat	schapevlees		125	56.8%
	lamb	lamsbout		48	21.8%
	lamb	lamskarbonade		25	11.4%
		lamszadel		13	5.9%
		lams- gehakt		9	4.1%
			Σ	220	
Wheat products[1]	wheat	tarwe		87	87.0%
	rice	rijst		7	7.0%
	rye	rogge		4	4.0%
	corn	maïs		2	2.0%
			Σ	100	
Meat Products[2]					
Liver[2]					
Milk[3]					
Complex dishes[2]					
Bakery products[2]					
Sweets[2]					

[1] Sampled, but not analysed; [2] Not sampled, neither analysed; [3] Milk monitoring programme, see text.

Remaining categories

Table 2.2 shows the composition of the remaining categories, including the categories mixed meat, mutton, wheat products, meat products, liver, complex dishes, sweets and bakery products. Although sampling and analysis of part of these categories (mixed meat, sheep and cereals) was planned, in a later stage this was abandoned due to changes in priorities in the analytical laboratory. Instead, concentrations in all the remaining categories were derived from their composition using the CPAP conversion model (Van Dooren et al., 1995). Basic data for this conversion were taken from the main sampling programme (Table 2.1) and data from earlier measurement programs (Liem et al., 1991; Liem et al, 1996). Comparable to the collection and composition of the categories listed in Table 2.1, for each category selection of food items included in the conversion had to cover at least 95% of the fat intake of the respective category according to the DNFCS 3.

2.2 Primary agricultural products

2.2.1 Introduction

The aim of this part of the project was to measure concentrations of dioxins and PCBs in enough samples of milk and eggs and animal fats of cattle, pigs, poultry and fish to obtain a general impression of the mean and variation in dioxin and non-ortho PCB levels within each type of animal fat or fish. At least ten samples for each type of animal fat were taken to obtain an impression of mean and variation.

The initial idea was to join these measurements in the monitoring program for residues in primary agricultural products. According to the execution of Council EU-Directive 96/23 each European Member State has to perform a national monitoring programme in which residues of certain substances are analysed in these products. The substances included in these programs are those for which residue limits have been set (e.g. pesticide act, EU-directives etc). At the time this project started there were no residue limits for dioxins in animal products (except milk) and therefore dioxin measurements in animal products are not a part of the Directive 96/23 obligations. However, in the Dutch National Programme fats of cattle, pigs, eggs and poultry are analysed for mono-ortho PCBs. This measurement package was extended with PCDDs and PCDFs in order to cover the TEQ contributing dioxins and mono-ortho PCBs.

2.2.2 Sampling of primary products for dioxin analyses

The sampling of the animal fats (Appendix 6) was comparable to the sampling of the composite samples of different food groups collected from supermarkets with respect to the timeframe and the location of sampling (section 2.1). Fat samples of pigs, cattle and poultry were taken from different slaughterhouses in different regions of the country (Amsterdam, Doetinchem, Assen, Apeldoorn, Almelo, Nijmegen, Weert, Breda). The fat samples of pigs and cattle originated from individual animals. For poultry this was not possible due to low fat levels per chicken. Therefore three chickens were pooled together to obtain enough fat for the dioxin analysis. Samples of beef fat were taken from both dairy cows (n=6) and cows destined for meat production (n=4) according to production figures. In the final results one of the bovine samples was excluded due to analytical failure.

Eggs and milk were sampled from four regions in The Netherlands. In total 12 egg samples were analysed. Each sample consisted of 10 individual eggs originating from one farm. In The Netherlands the dairy industry collects milk through a dairy driver, who collects milk from different individual farms. Milk for this project was collected from 12 different milk collections, each originating from four to six individual farms.

For fish in total 29 samples were collected of different types of fish and crustaceans such as cod, herring, mackerel, shrimp and mussels. The selection of the type of fish to sample was related to the consumption data of the second Dutch National Food Consumption Survey (DNFCS 2). Each type of fish was sampled two or three times. When different types of fish are categorised into lean or fatty fish, the number for each category was around ten. Of the crustaceans, including molluscs, only four samples were analysed. Salmon was not included in the analyses, because this type of fish is mainly imported. All fish samples were taken at fish trade centres just after the fish was landed.

With the exception of fish, all samples were taken in the period October 1998 until April 1999 with a two-monthly interval. Certain types of fish are not available in this period. Fish was therefore sampled in October 1998, March 1999 and June 1999. Although Directive 96/23 indicates that sampling strategies should be more focused on products containing higher levels, this was not the strategy applied when sampling for this project.

3: Concentrations of dioxins and PCBs in foodstuffs

R Hoogerbrugge[1], WA Traag[2], LAP Hoogenboom[2] and RA Baumann[1]

with contributions of:

AC den Boer[1]
GS Groenemeijer[1]
RS den Hartog[1]
WC Hijman[1]
I de Lange[1]
E Dijkman[1]
AC van Beuzekom[1]
GR van der Hoff[1]
HAG Heusinkveld[1]
G v.d. Weg[2]
C v.d. Kraats[2]
J Immerzeel[2]
C Onstenk[2]
L Portier[2]

[1] National Institute for Public Health and the Environment, Bilthoven

[2] State Institute for the Quality of Agricultural Products, Wageningen

3 Measurements of concentrations of dioxins and PCBs in foodstuffs

3.1 Consumer foodstuffs

3.1.1 General principle of the chemical analysis

The congener-specific determination of the PCDDs, PCDFs, non-ortho PCBs and mono-ortho PCBs has been performed by using methods consisting of isolation of the fat fraction by organic solvent(s) extraction, a purification and analyte enrichment scheme based on the use of Carbosphere activated carbon for fat removal and separation of the planar from the non-planar compounds, followed by subsequent steps to purify resulting eluates from other interfering compounds. Analysis was performed by injecting aliquots of two separate fractions containing the PCDDs/PCDFs and the planar PCBs, respectively, into a capillary gas chromatograph coupled to a high resolution mass spectrometer (GC/MS). For identification and quantitation, internal standards of $^{13}C_{12}$-labeled analogues were used that were added to the sample prior to extraction. The clean-up and instrumental methods have been described in more detail previously (Liem et al., 1990; Van der Velde et al., 1994). For the determination of the other PCBs, an aliquot of extracted fat was dissolved in hexane and purified on a silica chromatographic column in a normal phase LC system. The eluting fraction containing the compounds of interest was collected and concentrated. Analysis was performed by injecting aliquots of the concentrated eluates into a GC/MS system.

In the following sections, the various extraction steps and additional refinements applied in the analysis of the different food samples will be described.

Sample extraction

After homogenisation, an amount of sample was weighed for extraction. In Annex 2 the preparation/extraction procedures carried out for the different food items is given. To test portions, a solution of toluene containing $^{13}C_{12}$-labeled internal quantitation standards (Cambridge Isotope Laboratories, Woburn, MA, USA) of the 2,3,7,8-chlorine substituted PCDDs and PCDFs, and non-ortho PCBs 77, 126 and 169 was added at levels between 5 and 30 pg/g of (extracted) fat. $^{13}C_{12}$-labeled OCDF was excluded to avoid interference with OCDD analysis. After refluxing, all extracts were evaporated to dryness and the amount of (extracted) fat was weighed to determine the fat content of the original sample.

Clean-up

Extracted lipids were redissolved in a dichloromethane-hexane mixture (1:1, v/v; 5 ml/g of fat) and brought onto the top of a Carbosphere column. Next, the clean-up procedures were followed as described for milk samples in Liem et al. (1991).

All eluates were evaporated to dryness and redissolved in 50 µl of toluene containing an internal sensitivity standard (PCDD/F analysis: $^{13}C_6$-labeled 1,2,3,4-TeCDD; PCB analysis: $^{13}C_{12}$-labeled PCB 80) at a concentration of 2.5-5 ng/ml of toluene.

For the determination of the other PCBs, an aliquot of the extracted fat was dissolved in hexane at a concentration of 45 mg/ml, while 200 µl PCB $^{13}C_{12}$ labels were added. A volume of 400-600 µl of this extract was injected onto a normal phase HPLC system, equipped with a silica column. A fraction of 4 ml containing the compounds of interest was collected, evaporated to dryness and redissolved in 50 µl toluene containing $^{13}C_{12}$-labeled PCB 80 as internal sensitivity standard.

Gas chromatography - mass spectrometry

GC/MS analyses were performed on a VG70SQ or AutoSpec (Micromass, Manchester, UK) mass spectrometer coupled to a HP 5890 (Hewlett Packard, Palo Alto, MA, USA) gas chromatograph. GC separations were carried out on a non-polar column (60 m DB-5MS ; J&W Scientific, Folsom, USA; 0.25 mm ID, 0.10 µm film thickness) . The temperature programme for PCDD/F analysis consisted of an isothermal period (150°C, 1 min), a rise at 10°C/min to 200°C, then at 2.5°C/min to 290°C and finally a second isothermal period of 4 min at 290°C. The temperature programme for non-ortho PCB analysis consisted of an isothermal period (90°C, 1 min), a rise at 10°C/min to 290°C, and finally a second isothermal period of 10 min at 290°C. The temperature programme for the other PCB analysis consisted of an isothermal period (100°C, 1 min), a rise at 15°C/min to 175°C, then at 4°C/min to 290°C and finally a second isothermal period of 2 min at 290°C.

In all cases, helium was used as carrier gas at a linear velocity of 30 cm/s. Samples for PCDD/F analysis were injected by use of a solid all glass falling needle injector (Fa. Koppen, Best, The Netherlands). Samples for the non-ortho and other PCBs analysis were injected using a CTC-A200s (CTC-Analytics, Zwinger, CH) autosampler.

The GC/MS interface was maintained at 275°C in all cases. Ionization of samples was performed in the electron impact mode (EI) with 31 eV electrons. Instruments were operated at increased resolution. The resolving power (RP) was typically between (static) 3000 and 5000. Detection was performed by selected ion recording.

Quality Control Determination of TEQs

The reliability of the Carbosphere method for the determination of TEQ levels in biotic samples has been discussed extensively before (Liem et al., 1990; Van der Velde et al., 1994). The methods applied for the analyses of the various food products are basically the same as the method validated for milk samples. In the previous food study (Liem et al., 1991), it was shown that the accuracy and reproducibility of the analytical data for the various food samples are comparable with those found for cow's milk (low levels) and human milk (high levels).

In the study presented here, as is the case for more than ten years with most analyses of dioxins in food, analytical series are accompanied by a quality control sample of cow's milk. Accordingly, the *intra-laboratory* reproducibility can be established. The replicate analysis (n>100) of this sample, with an average level of 3 pg I-TEQ/ g milk fat shows an analytical RSD of 6% and negligible systematic variation in time. Therefore, levels found in this study are expected to have negligible (< 5%) systematic variation compared to previous studies carried out at the RIVM.

The results from *inter-laboratory* studies for dioxins and furans indicate that experienced laboratories usually have results with RSDs in the order of 10 -15% (De Jong et al., 1993; Horwitz and Albert, 1996). For dioxin-like PCBs the number of interlaboratory studies in food is much smaller. For these PCBs one would expect a *inter-laboratory* reproducibility which is similar to dioxins and furans since comparable methods are used (GC/MS with ^{13}C-labeled standards). Recent results for various foodstuffs agree with these assumption (http://www.folkehelsa.no/filer/pdf/food2000-2.pdf).

Determination of individual congeners

The congener-specific data resulting from the quality control samples of cow's milk and human milk have been discussed in Liem et. al (1990). Analytical variations appeared to be better than 20% for levels above 1 pg/g fat and less than 50% for levels between 0.1 and 1 pg/g fat. Below 0.1 pg/g fat, higher variations up to 60% should be taken into account. These variations were considered acceptable in view of the complex matrix and the extremely low levels at which some congeners have been detected.

Presentation of data

Measurement data will be given in more significant digits than usual to allow tractability of derived intakes. With the standard procedure for milk samples of 150 g, a method detection limit (signal to noise ratio >3) can be attained of 0.1-0.2 pg/g of fat for the PCDDs and PCDFs and of 0.2-1.0 pg/g of fat for the three non-ortho planar PCBs. The method detection limit for the other matrices depends on several factors, e.g., the original sample taken as test portion, the fat content, varying recoveries and the presence of other interfering substances. Therefore it is chosen to present measurement data in combination with estimated limits of detection (LODs) using the LODs for milk as reference and the respective matrices. A general practice is to report only those results that are higher than the limits of detection (LOD). Sometimes, however, analytical conditions appeared to be more favourable allowing quantitations below the estimated LODs. In these cases, measured concentrations have been included in the tables.

In expressing levels in TEQs, the WHO-TEFs (Appendix 1) have been used for the PCDDs, PCDFs and dioxin-like PCBs. In the presentation of the measurement data these TEQ values have been calculated assuming non-detects equal zero. It should be noticed that TEQ values may differ considerably when calculated assuming non-detects equal zero (lower bound estimates) or non-detects equal LOD (upper bound estimates). However, in agreement with the intake study reported in 1991 (Liem et al., 1991) it has been decided to use the lower bound estimates in this report.

3.1.2 Results and Discussion

The results of the analytical chemical analysis are summarised in Appendix 3 for each of the food categories. The congener specific information is shown in Appendix 5. In Appendix 3 the results from meat and dairy products are expressed as pg TEQ/g fat. The concentrations in fish and vegetable categories are expressed as pg TEQ/kg whole product. This difference is often made (EU-SCOOP, 2000) since the latter products might have very low or less informative fat contents.

For some of the categories comparison with other data is impossible since the composition of most of the samples is tailor made for an intake study of the Dutch population. For some products a comparison with the previous study can be made although there are some complications since the previous study used other TEF values and the number of PCBs analysed was more limited.

Average concentrations

The data in Appendix 3 present the average concentration in 16 food categories. In summary, the following may be observed:

(a) Meat, dairy products and eggs: Average concentrations of PCDDs, PCDFs in meat, dairy products are all well below 1.5 pg WHO-TEQ/ g fat. The highest values were measured in eggs (average: 1.52 pg WHO-TEQ/ g fat), the lowest in pork (average: 0.24 pg WHO-TEQ/ g fat). If the TEQ contribution of non-ortho PCBs and mono-ortho PCBs is also accounted for, average concentrations of total TEQ remain below 3 pg WHO-TEQ/ g fat. The highest level was found in poultry (2.78 pg WHO-TEQ/ g fat), the lowest value in pork (0.47 pg WHO-TEQ/ g fat).

(b) Fish: On a product basis, the average concentrations of PCDDs and PCDFs in fish are higher than in meat products. For fatty fish the highest average concentration was found, 921 pg WHO-TEQ/ kg product. The lowest value was found in the category ‘Fish, prepared’ (104 pg WHO-TEQ/ kg product). For the total TEQ concentration (including the dioxin like PCBs) the following was found: the highest value was found in fatty fish (3158 pg WHO-TEQ/ kg product, the lowest value in the category ‘Fish, prepared’ (267 pg WHO-TEQ/ kg product).

(c) Vegetable products: From the measurements carried out in the current study it appears that levels of PCDDs and PCDFs in most vegetable products (on a product basis) are comparable to, or lower than those in low-fat animal products (poultry, beef). In the category ‘Vegetables’ the average concentration was 58 pg WHO-TEQ/ kg product. The contribution of dioxin-like PCBs in all vegetable products is negligible compared to that of PCDDs and PCDFs.

Variation of measurement data

Appendix 3 shows the observed levels in each composite sample, as well as the average and the Relative Standard Deviation (RSD) between the two national composite samples. The RSD is the standard deviation of the two numbers divided by the average and multiplied by 100% to express the number as a percentage. From these individual RSDs a pooled RSD is calculated as the square root of the average of the squares of the RSDs. This pooled RSD, 34%, is much larger than the variance that is observed in multiple analyses of the same sample (e.g. the RSD of 6% of the quality control cow's milk sample). This suggests that the analytical variation is a minor part of the total variation indicating that the latter is dominated by the difference between the samples.

The pooled variation is larger than the 20% variation between the duplicate measurements of the previous study (Liem et al., 1991). A general cause for this difference might be the fact that in the previous study quite some food groups possessed a more homogeneous composition. For example the animal fats were divided into liver and other fats. In the study reported here the chicken livers were not separated from the other fats.

In contrast to most food categories, two categories show more pronounced differences between the two composite samples: (i) For the category vegetable oils/fats the larger difference is probably caused by the large number of congeners with concentrations below the detection limit in one of the samples while in the other samples the levels of various congeners are just above the detection limit. (ii) Also for eggs a more pronounced difference is found. This might be caused by the fact that the food category eggs consist only of one type of food (chicken eggs). To obtain sufficient sample material the inspectors were instructed to collect a box of eggs. The levels of dioxins of the eggs from one box are probably highly correlated, because they generally originate from one farm. Then the effective number of independent eggs in one national pooled sample is only 5 and therefore the random uncertainty might be much larger than for the other food groups because they consist of much more independent samples.

The initial analysis of the composite sample ‘Nuts’ indicated rather high levels (app. 1000 pg WHO-TEQ/kg product), which was suspicious, and could indicate a measurement error. Reanalysis of these composite samples both RIVM and RIKILT pointed at much lower levels. From these results the conclusion was drawn that the initial analysis suffered from a contamination. Therefore the initial result was rejected and replaced by the RIVM reanalysis results. Since the weight of the nuts composite sample was much smaller than the other samples, a different type of glassware was used, being the most likely source of contamination. In addition to this hypothesis, the maximum possible influence of the contamination pattern was calculated for all other samples in the same series of analysis. Based on this pattern, it could be concluded that the maximum influence was very limited (< 5 %) for most samples. However, for both the composite samples of vegetables and prepared fish a hypothetical contamination (up to 20-30 %) could not be excluded. To check the possible influence, the vegetable samples were reanalysed giving results that deviated from the original results, both in TEQ-level and in pattern. However, these measurements are all on very low concentration levels and therefore have a considerable analytical uncertainty. An additional complication for the vegetable samples is the fact that both homogeneity and stability can be assumed to be larger sources of uncertainty than for all other, more fatty, composite samples in this study. For these reasons a clear criterion for acceptation/rejection of data could not be formulated. Therefore the average of both the old and the new result was calculated for each of the national composite samples and incorporated in the intake calculations. For the sample ‘Vegetables B’ the no-PCBs were based on the initial analytical result only due to analytical problems in the reanalysis. For both samples the other PCB's were not reanalysed since they have hardly any influence on the intake. Concluding, the uncertainty in the WHO-TEQ of vegetable samples can be up to 50 %. The prepared fish samples were reanalysed at RIKILT. The difference between the initial RIVM and the new RIKILT results was acceptable on WHO-TEQ basis (20-30 %). This difference can partly be attributed to the same contamination as was found for the nuts. However, the influence of this difference on the intake calculations is very small, such that it could be ignored (<1%).

One of the main objectives of this study is to calculate the intake of dioxins based on the average levels in the food categories reported. For this purpose it is important to note that for the general population the intake is not dominated by a single food category but is due to contributions of many food items. In that case, the influence of the random uncertainties in the pooled samples will have a large tendency to level out.

Table 3.1 Interlaboratory comparison

Sample[1]	Concentration (pg /g fat)		Difference on fat basis		Difference on product basis	
	RIKILT	RIVM	Ratio	RSD (%)	Ratio	RSD (%)
PCDD/PCDF[2]						
1	3.88	3.00	1.29	18	1.18	12
2	15.74	13.95	1.13	9	1.03	2
3	5.68	5.24	1.08	6		
4	2.61	2.42	1.08	5		
non-ortho PCB[3]						
1	3.54	3.24	1.09	6	1.00	0
2	5.70	5.43	1.05	3	0.95	3
3	1.15	0.95	1.22	14		
4	2.79	2.41	1.16	10		
Average ratio			1.14		1.04	
Pooled RSD				10		4

[1]Identification of the samples is as follows: (1) The RIVM cow's milk QA sample, (2) The RIVM human milk QA sample, (3) The RIKILT DECO cow's fat QA sample, and (4) The RIKILT cow's fat QA sample.[2]I-TEQ, [3]WHO-TEQ

Interlaboratory comparison RIKILT/RIVM

Differences found in interlaboratory comparisons might have a systematic component. To study the existence of such a deviation between both laboratories that participated, the mutual quality control samples were cross-examined. Analysis included the dioxins/furans (I-TEQ) and the non-ortho PCBs (WHO-TEQ). The results are presented in Table 3.1. The QA samples were analysed in the regular way at the institute where the QA sample originated. At the other institute the same samples were analysed only once.

For the four samples, on a fat basis a relative standard deviation of 5-18% is found. Compared to the RSDs found in inter-laboratory comparisons such a difference is quite normal. Unfortunately, like in most inter-laboratory comparisons, a rather large part of the deviation between the two laboratories is systematic. Part of this systematic deviation can probably be explained by the fat extraction procedure, because on a product basis differences are less than on a fat basis.

Trends in concentrations

A number of composite samples in this study have a composition that is comparable with samples in the study carried out in 1990/91 (Liem et al., 1991) The levels of these samples are shown in Table 3.2. To enable a direct comparison the dioxins of this study are, like in 1991, expressed as I-TEQ. The table also shows the remainder which is defined as the recent level divided by the level in 1991. This remainder varies between 25% and 60% indicating a strong reduction of both dioxins, furans and non-ortho PCBs. These observations are on a parallel with the regulatory measures implemented during the last decade to reduce the dioxin emissions into the environment (Liem and Van Zorge, 1995). In many other European countries a comparable trend has been observed. The results of the SCOOP project on dioxins and related PCBs (EU-SCOOP, 2000) show that for countries in which trend data are available over a similar time span, concentrations also tend to decrease.

Table 3.2 Comparison of concentrations in pooled samples for 1991 (Liem et al., 1991) and 1999 (this report). Levels are all expressed as pg I-TEQ /g fat. TEF factors applicable in 1991 were used (See Appendix 1).

Food category	Dioxins[a] (I-TEQ)			non-ortho PCBs (WHO-TEQ)		
	1991	1999	Remainder %	1991	1999	Remainder %
Milk	1.5	0.5	33	1.3	0.6	44
Beef	1.8	0.7	41	2.4	1.0	41
Pig	0.4	0.2	49	0.2	0.1	61
Butter	1.8	0.6	33	2.1	0.8	38
Egg	2.0	1.2	59	2.3	0.6	24
Cheese	1.4	0.6	42	2.1	0.7	35

[a] PCDDs and PCDFs.

3.2 Primary products

3.2.1 General introduction

The chemical analysis of samples of primary products was identical to the procedure which was followed for the consumer products (section 3.1.1). Additionally, a number of samples was examined using the CALUX bioassay (Bovee et al., 1996; Hoogenboom et al., 1999).

Results of the chemical analyses for primary products are presented in Appendix 4 and Appendix 6. Appendix 4 summarises the data for each product category, whereas Appendix 6 focuses on individual samples. From Appendix 4 it appears that the variation in TEQ levels is higher than for the consumer products (Appendix 3). This can be explained by the sampling schemes discussed in Chapter 2. For consumer food stuffs composite samples were used in order to determine average levels. Accordingly, the natural variation in individual products is dampened. The variation obtained in the measurement programme of primary products reflects the relatively higher variation that can be expected in individual animals.

The average levels in most of the primary products are higher than in consumer products of the same origin. This difference can partly be explained by the systematic deviation that was found between the two laboratories. A possible mechanistic explanation is that the composite samples of consumer products include the effect of food processing, while the samples of the primary products were taken at slaughterhouses and farms. Food processing involves mixing of different types of fat, and processes that might degrade dioxins and PCBs. Finally, the difference might also be explained by the geographical origin of the products. The food commodities collected in shops and supermarkets include products from different parts of the world, while the primary products concern the animals processed in the Dutch slaughterhouses and farms.

3.2.2 Screening of bovine fat samples with the CALUX-bioassay

Examination of 9 bovine fat samples with GC/MS revealed that 3 samples contained relatively high levels of dioxins and non-ortho PCBs (5.44, 8.53 and 22.90 pg TEQ/g fat; see Appendix 6 and 7). Based on this it might be concluded that an important fraction of the cows used for meat production might contain levels exceeding a possible future MRL of 5 pg TEQ/g fat (See Section 5.4). Therefore 8 of these samples and an additional 31 samples from the same monitoring programme were tested in the CALUX-bioassay (Bovee et al., 1996; Hoogenboom et al., 1999). This assay is able to detect dioxins and planar PCBs based on their ability to bind to the Ah-receptor, followed by the increased synthesis of a number of cellular proteins. In the case of the cells used in the test, this includes the enzyme luciferase, which can subsequently be measured by a light emitting reaction..

As shown in Appendix 7, three samples showed an elevated response in the test, being the same three elevated samples detected by GC/MS. From this result it can be concluded that the fraction of cows with elevated levels is probably much lower (8%, n=39) than the fraction that could be deduced from the outcomes of the GC/MS analysis alone (33%, n=9). The probability of selecting all 3 positive samples in a set of 9 samples taken from 39 samples is less than 0.01. This might indicate some preference for contaminated animals in the sampling of bovine fat.

4: Dietary intake of dioxins and dioxin-like PCBs

JI Freijer[1], PE Boon[2] and DCM Fiolet[1]

with contributions of:

GM Steentjes[1]
JD van Klaveren[2]

[1] National Institute for Public Health and the Environment, Bilthoven

[2] State Institute for the Quality of Agricultural Products, Wageningen

4 Dietary intake of dioxins and dioxin-like PCBs

4.1 Introduction

This chapter addresses the assessment of the dietary intake of dioxins and dioxin-like PCBs. The distribution of actual dietary intake in the Dutch population is assessed using the most recent occurrence data (March 1999; chapters 2 and 3) and national representative food consumption data (1997-1998). This intake distribution can be compared to the TDI (Tolerable Daily Intake), in order to identify the fraction of the population with an intake above the TDI. Intake exceeding the TDI is discussed in the next chapter (Section 5.2).

4.2 Estimating dietary intake

4.2.1 Outline of methods

In the current study, human dietary intake of contaminants is estimated by combining data on concentrations of contaminants in different food products and the consumption of these products. Figure 4.1 displays the principal flow scheme which has been employed to analyse human dietary intake of contaminants in The Netherlands. The flow scheme shows the relationships between different submodels and databases.

In The Netherlands, food consumption patterns are studied in the Dutch National Food Consumption Survey (DNFCS; Kistemaker et al., 1998). This survey recognises two sources of variation in food consumption in the population, variation between individuals (6250 persons), and short-term variation within an individual (on a daily basis for a period of two consecutive days). The Dutch National Food Consumption Survey distinguishes between many different food products, defined in a list of standard products (NEVO products). Concentrations of dioxins and dioxin-like PCBs are available from the measurement programme. Obviously, the detailed classification of food products in the DNFCS does not match with the food categories recognised in this programme. In order to translate concentrations found in the measurement programme to those in NEVO products a conversion model is employed.

In calculating the human exposure to dioxins and dioxin-like PCBs we employ a two-step approach. First, modelled concentrations in NEVO products are combined with the food consumption data. This yields two estimates of daily personal intakes for all individuals included in the survey. These estimates contain the basic information for evaluating the intake distribution in the population with the statistical exposure model STEM (Slob, 1993a; Slob, 1993b).

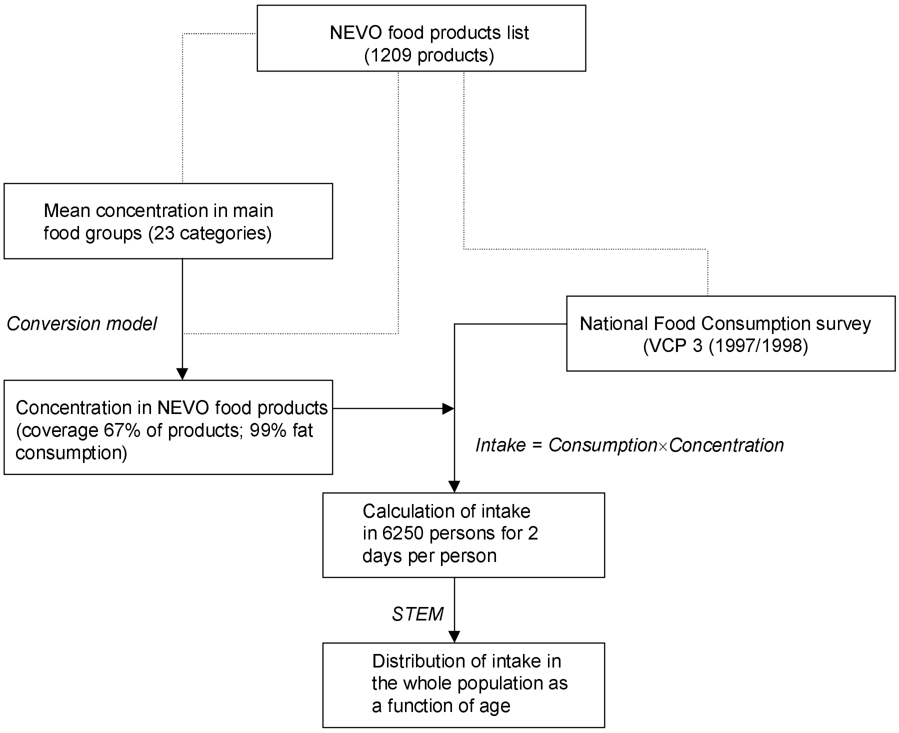


Figure 4.1 Overview of databases and submodels used in analysing human exposure to dioxins and dioxin-like PCBs.

4.2.2 The Dutch National Food Consumption Survey

The Dutch National Food Consumption Survey (DNFCS) makes use of a list of specific consumer foods, that are coded and described (nutrients, energy content, etc.) in the Dutch Nutrient Database (NEVO database; NEVO, 1996). The DNFCS provides data on the consumption of NEVO food-items. In 1997/1998 the Dutch National Food Consumption Survey (DNFCS 3) was performed for the third time. Earlier surveys were carried out in 1987/1988 and 1992. In the most recent survey, data were collected on the consumption habits of a stratified probability sample of households living in The Netherlands. The survey comprises a description of the daily consumption over two consecutive days and recording of age, sex and body weight (bw) for each individual within the sampled households. Data have been collected from April 1997 until April 1998. Collection of data was evenly spread over the weeks of the year and the days of the week. In total 6250 persons aged 1 to 97 participated, belonging to 2774 households (Kistemaker et al., 1998; Voedingscentrum, 1998).

4.2.3 Concentrations in food products

Chapters 2 and 3 describe the joint measurement programme of RIKILT and RIVM for dioxins and dioxin-like PCBs in food. In the joint monitoring program, Dutch primary agricultural products as well as consumer products were collected and analysed. For the intake calculations the data set on consumer products was used, as this data set represents a compilation of products that can be found in supermarkets and shops, also including imported products. The programme on consumer products yielded concentrations of composite samples of 24 food categories (Tables 2.1 and 2.2; Appendix 8). Usage of the DNFCS in calculating dietary intakes requires the concentration to be known in much more detail, i.e. at the level of NEVO products.

A conversion model was used to translate the concentrations found in the measurement programme for each food category to those in the NEVO products. Three different procedures were used to assign concentrations to NEVO products:

(a) Concentrations in main food categories measured on a weight basis (i.e. in pg TEQ/kg product) were directly assigned to each NEVO product belonging to that category.

(b) Concentrations in main food categories measured on a fat basis (in pg TEQ/g fat) were assigned to that NEVO product, using the fat content of the NEVO product considered to convert to a weight basis.

(c) The dioxin and dioxin-like PCB concentration of four main mixed categories were not measured in the measurement programme (See chapters 2 and 3). The concentrations of the NEVO-items belonging to these categories were estimated by perceiving them as a weighted sum of two or more of the other categories, of which concentration levels were measured. Weights were assigned by dieticians. This procedure is part of the CPAP conversion model for Primary Agricultural Products (Van Dooren et al., 1995)

The conversion covered 67% of the NEVO items that were recorded in the DNFCS 3. The fat consumption via the selected NEVO products includes 99% of the fat consumption summed over all recorded NEVO products. The selected NEVO items thus represent the largest part of the products that are relevant for dioxin and dioxin-like PCB intake.

4.2.4 Statistical Analyses

The concentrations of dioxins and dioxin-like PCBs in NEVO food products and the DNFCS food consumption patterns were stored in an ORACLE™ database, which enabled rapid calculation of daily intakes for all individuals that participated in the survey. For each individual the intake was computed for the two consecutive days considered in the survey. A frequency distribution of these intakes yields information on the variability of daily intakes in the population. Such a distribution shows the variation in short-term intake, but is unsuitable for an assessment of the long-term intake, which is required for a comparison with the TDI. A distribution of life-long averaged intakes would be considerably narrower than the distribution of daily intakes, because within-subject variations level out. Another drawback of looking at just the frequency distribution of daily averaged intakes of all individuals in the survey is that no insight is gained on the relationship between age and intake in individuals.

Slob (1993a; 1993b) developed a statistical model for the description of dietary intake of chemicals with long-term effects (like dioxins and PCBs) for the population: the STatistical Exposure Model (STEM). STEM is intended to model the mean dietary intake as a function of age. It combines regression analysis on age by fitting a polynomial curve to the data, and nested variance analysis to separate within-subject variance from between-subject variance. The within-subject variance is estimated by analysing the differences between the intake during the two consecutive days for each person. By subtraction of the within-subject variance from the total variance an estimate can be made of the long term between-subject variance. The basic assumptions of STEM are as follows:

(a) Intake in the population is lognormally distributed.
(b) The within-subject variance is homogeneous throughout the population.
(c) Intakes of the two consecutive days at which food consumption was recorded are not correlated.
(d) The integral of temporal variations in concentrations of contaminants in consumed foodstuffs approximates the average concentration in these products as measured in this study.

Further details on the procedure and an extensive evaluation of the assumptions can be found in Slob (1993a; 1993b). The above assumptions limit the use of STEM to contaminants that can be found throughout the diet of the general population. Many environmental contaminants comply to this condition.

4.2.5 Contribution of food groups to the total intake

In order to evaluate the contribution of different food groups to the dioxin and dioxin-like PCB exposure we estimated the contribution of the food groups to the total intake in the population. This estimate of the average contribution provides valuable information for regulators, as it enables them to take measures to reduce concentrations in specific foodstuffs. However, it should be stressed that these figures refer only to the population as a whole, and not to individuals in the population.

For a more robust evaluation of the contribution of food groups to the intake of individuals STEM should be applied for each specific food group. However, this procedure is laborious and several assumptions concerning the validity of the use of lognormal distributions might be violated. This can partly be solved by comparing the intake through all products with the intake that results when excluding the food group of interest (Liem et al., 1991).

4.3 Results and discussion

Figure 4.2 shows a frequency distribution of the calculated short-term total dioxin (PCDD/PCDFs and dioxin-like PCBs) intake, obtained by direct combination of concentration data and food consumption patterns. The distribution consists of 12496 values of daily intake of dioxins: 2 consecutive days for 6248 individuals selected from the DNFCS database. Figure 4.2 presents the short-term variation in the whole population. This variation has two components: a within-individual and a between-individual variance. The high values in the tail of the distribution (maximum daily intake 33 pg /kg bw/day, outside panel) should therefore be interpreted with caution, as they represent a one-day event for a person in the DNFCS survey. The short-term intake values in itself are not suitable for evaluating the variation in the population, because of the within-individual component.

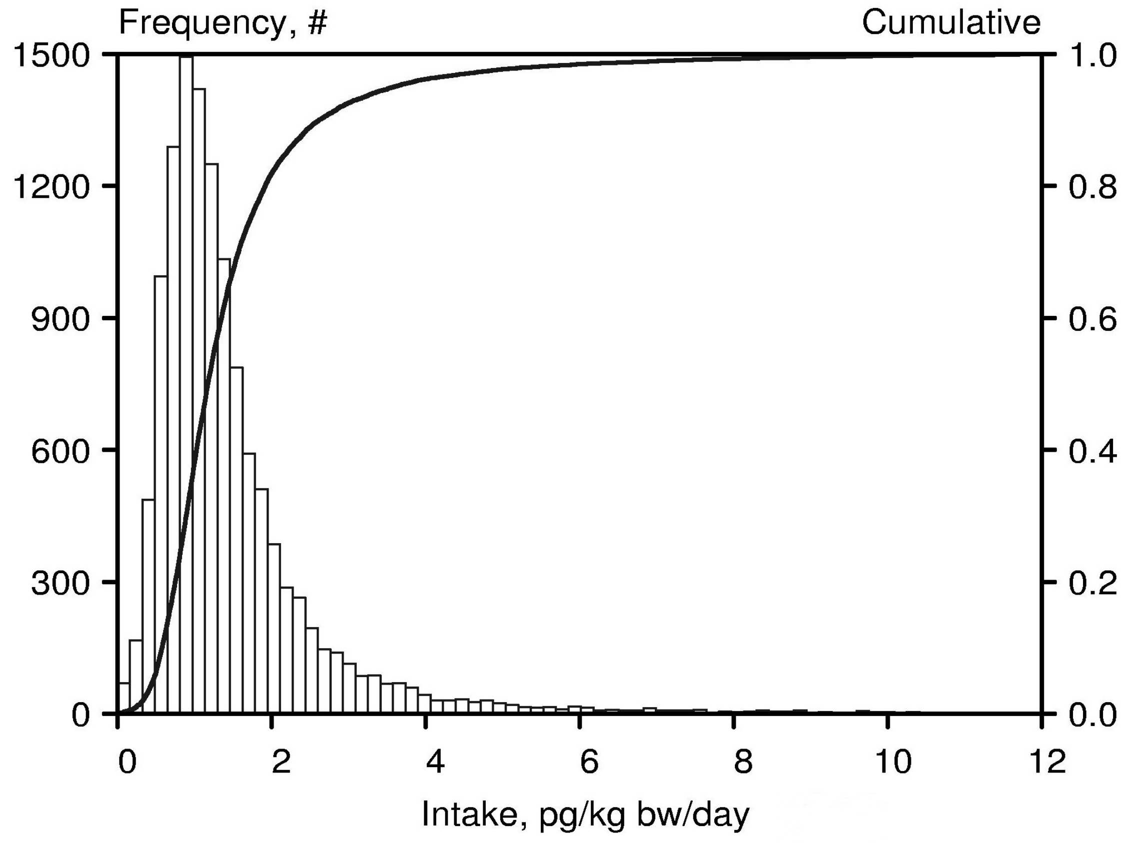
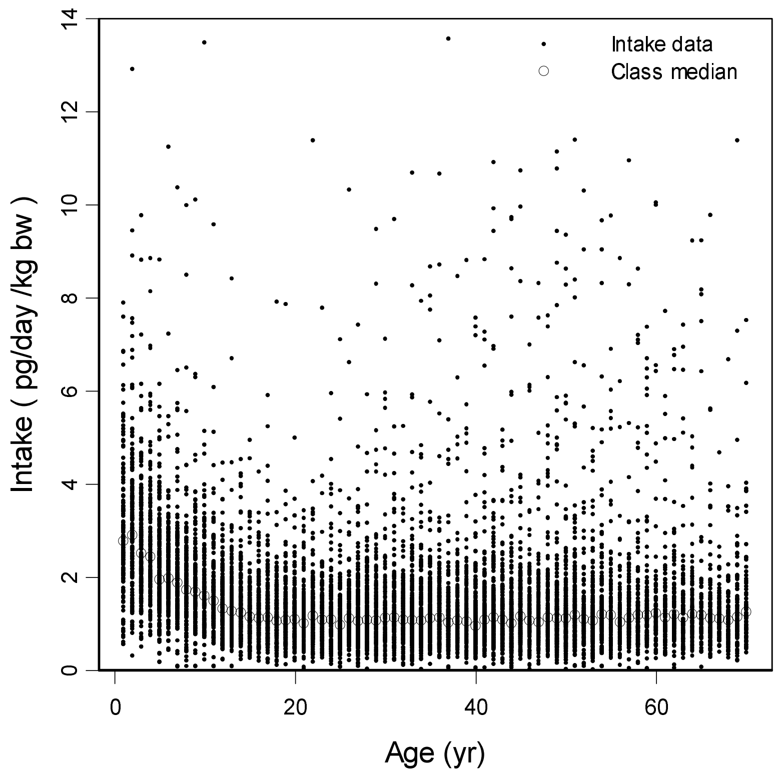
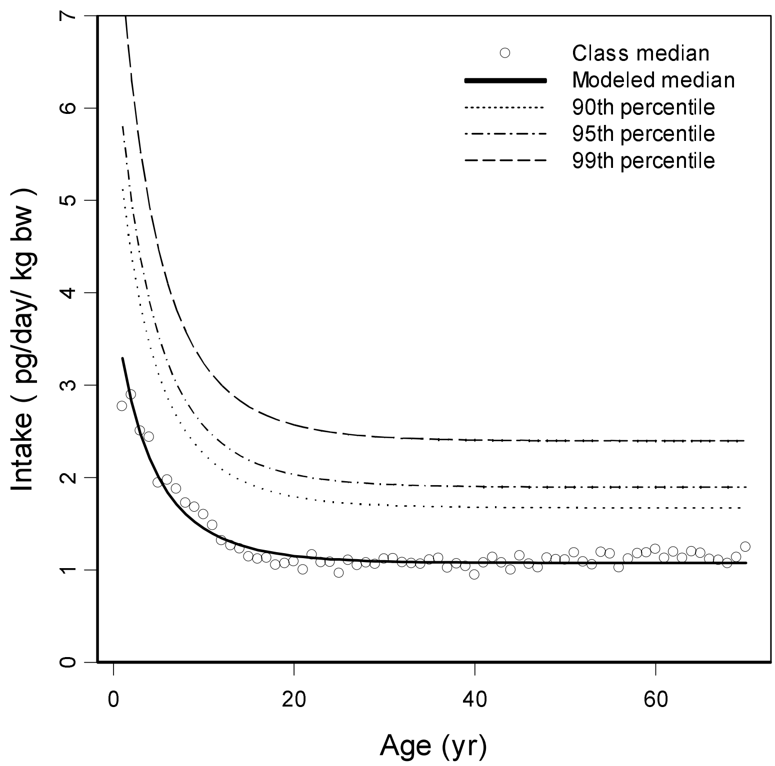


Figure 4.2 Frequency distribution of daily-averaged intake (in pg WHO-TEQ/kg bw/day) of total dioxins (PCDD/PCDFs and dioxin-like PCBs) in the Dutch population. Data represent 12496 days of 6248 persons.



a



b

Figure 4.3 Relationship between total dioxins (PCDD/PCDFs and dioxin-like PCBs) intake and age. (a) The upper panel shows all the raw data (see also Fig 4.2) and the calculated median intake for each age class. (b) The lower panel depicts the intake distribution for the population after performing regression and nested variance analysis (Slob, 1993a) on the data in the upper panel. Percentiles refer to the between-subject variation.

Processing of the intake data displayed in Fig. 4.2 with the statistical exposure model (STEM) yields the results presented in Fig. 4.3. This figure displays the relationship between intake and age. The upper panel (a) depicts the individual data points included in the frequency distribution of Fig. 4.2. Also, the median of each age class is indicated. These data are input to the STEM model, which estimates the median relationship with age. The regression line (heavy line in Fig. 4.3b) shows that the fitted relative intake corresponds to the median value for each age class. The percentiles in the lower panel (b) of Fig. 4.3 represent the variation within the population (between-subjects variance), which is obtained after subtracting the within-subject variance from the total variance. Accordingly, the variation indicated by the percentiles is much less than the variation in the raw data in the upper panel (Fig. 4.3a). From the lower panel (Fig. 4.3b) we can now deduce parametric intake distributions for each age class. Figure 4.4a-b displays two of these cross-sections for age 2 and 40 yrs. Obviously, as dictated by the regression result, the median for young children is higher than for adults.

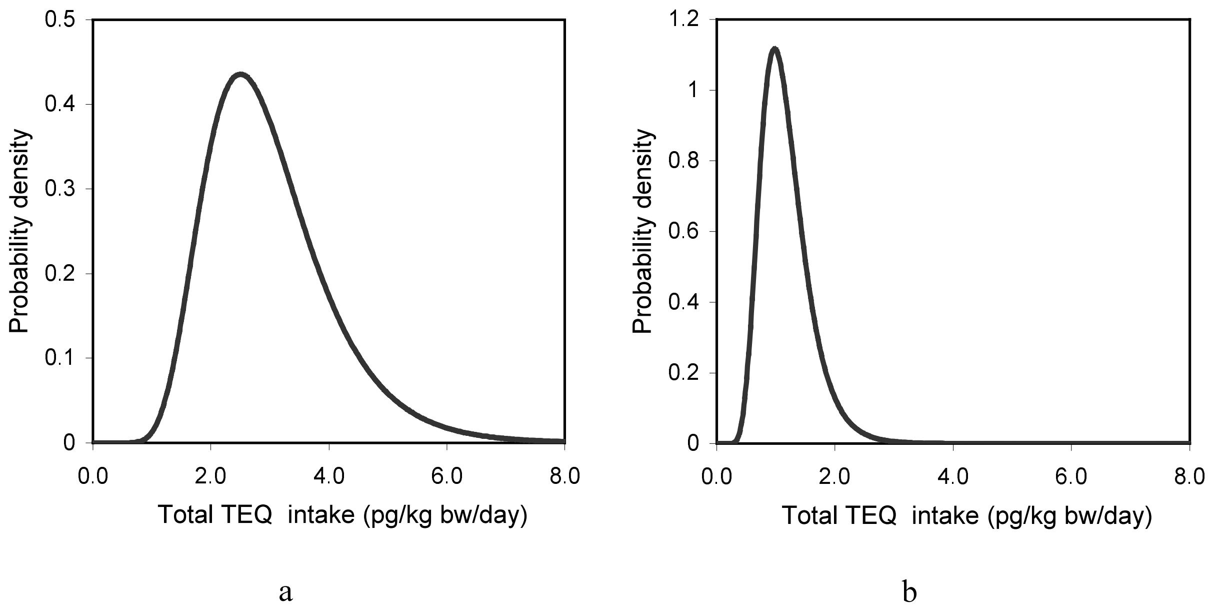


Figure 4.4 Modelled distribution of age-depending yearly-averaged intake (pg WHO-TEQ/kg bw/day) of total dioxins (PCDD/PCDFs and dioxin-like PCBs) in the population. Probability density refers to variation in each age class. (a) For age 2 yrs, (b) For age 40 yrs.

Table 4.1 Key statistics of the intake distributions calculated by STEM.

Contaminants	Median intake[a] (pg/kg bw/day)			Variance[b]		
	2 yrs	10 yrs	40 yrs	total	within-subject	between-subjects
dioxins[c]	1.5	0.75	0.56	0.05889	0.03802	0.02087
non-ortho PCBs	1.0	0.51	0.37	0.08783	0.06136	0.02647
mono-ortho PCBs	0.31	0.16	0.12	0.10633	0.07835	0.02798
Σ PCBs	1.3	0.68	0.50	0.08747	0.06142	0.02605
Σ dioxins[c], PCBs	2.8	1.5	1.1	0.06785	0.04543	0.02242

[a]WHO-TEQ, [b]10 Log transformed scale and for all age-classes, [c]PCDDs and PCDFs

The same procedure was followed for dioxins and the two sets of PCBs seperately. Results are summarised in Table 4.1. From the results in the table it can be concluded that the median intake of 2 yr old children is more than 2 times higher than that of adults. The higher intake of children is mainly due to the high intake of food relative to their bodyweight, and not to the concentrations of contaminants in the food products that children eat. The statistical parameters in Table 4.1 were used to calculate averages and specific percentiles in the distribution of age-specific intake. Table 4.2 displays the averages and 90th percentiles of these distributions.

The intake-age relationship established in the above described fashion is the starting point for the calculation of lifelong-averaged intake. The assessment of lifelong-averaged intake as well as its role in estimating the fraction of the population for which intake exceeds the TDI is discussed in section 5.2.2.

Table 4.2 Average and 90th percentile in age-specific intake distributions based on the between-subjects variance (see Table 4.1)

Contaminant	Average[a] (pg/kg bw/day)			90th percentile (pg/kg bw/day)		
	2 yrs	10 yrs	40 yrs	2 yrs	10 yrs	40 yrs
dioxins[b]	1.5	0.80	0.60	2.2	1.2	0.87
non-ortho PCBs	1.1	0.55	0.40	1.7	0.83	0.61
mono-ortho PCBs	0.33	0.17	0.13	0.51	0.26	0.19
Σ PCBs	1.4	0.73	0.53	2.2	1.10	0.81
Σ dioxins[b], PCBs	3.0	1.5	1.1	4.4	2.3	1.7

[a]WHO-TEQ, [b]PCDDs and PCDFs

Table 4.3 Estimated average contribution of food groups to the intake of dioxins (PCDDs and PCDFs) and dioxin-like PCBs in the Dutch population in 1998/99. Absolute values are expressed per person.

Food group	Contribution to total intake					
	Dioxins[b]		Σ PCBs		Σ dioxins[b], PCBs	
	pg/day[a]	%	pg/day[a]	%	pg/day[a]	%
Animal products	9.2	21	12	26	21	23
Dairy products	11	24	14	30	25	27
Fish	4.3	9.6	9.9	22	14	16
Eggs	2.2	4.9	1.3	2.8	3.5	3.9
Vegetable products	9.3	21	2.4	5.3	12	13
Industrial oils and fats	9.0	20	6.3	14	15	17
Total	45	100	46	100	90	100

[a]WHO-TEQ, [b]PCDDs and PCDFs

Table 4.3 shows an overview of the average contribution of different food groups to the intake of dioxins (PCDDs and PCDFs), dioxin-like PCBs and the total of dioxins and dioxin-like PCBs in the population. Some interesting differences between dioxins and dioxin-like PCBs appear from the table. The intake of dioxins is rather evenly distributed over the various food group, with vegetable products being an equally important route as the other food groups (21%). On the other hand, the intake of dioxin-like PCBs hardly occurs through products with vegetable origin (5.3%). A remarkable difference can also be seen for fish. While fish is an important route for dioxin-like PCBs (22%), for dioxins (PCDDs and PCDFs) fish modestly contributes to the total intake (9.6%). Figure 4.5 presents the overall contribution of the food groups for the total TEQ intake.

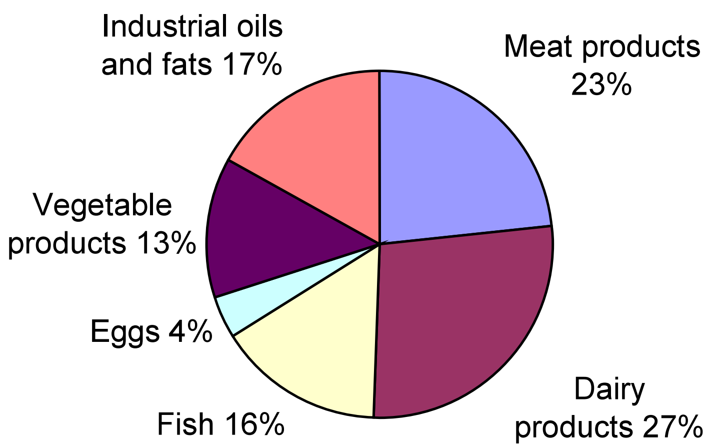


Figure 4.5 Estimated average contribution of food groups (%) to the intake of dioxins and dioxin-like PCBs in the Dutch population in 1998/99.

5: Implications, trends, limit values and uncertainties

R Hoogerbrugge[1], JD van Klaveren[2], PE Boon[2], MJ Zeilmaker[1], JI Freijer[1] and AKD Liem[3]

[1] National Institute for Public Health and the Environment, Bilthoven

[2] State Institute for the Quality of Agricultural Products, Wageningen

[3] Present address: SCF Secretariat, European Commission, SANCO/C/3 Brussels

5 Implications, trends, limit values and uncertainties

5.1 Introduction

In addition to the assessment of concentrations and dietary intake of dioxins and dioxin-like PCBs in the Dutch population the following issues need to be addressed:
(a) Comparison of the intake distribution in the population with the tolerable daily intake. This is discussed in section 5.2.
(b) Comparison of the present dietary intake calculations with those of the last nation wide survey (Liem et al., 1991). Section 5.3 discusses the trend in dioxin and non-ortho PCB intake from 1990/91 to 1998/99.
(c) The possible effects of regulatory measures on non-compliance of products and reduction of intake in the population. In section 5.4 the effects of different limit values proposed by the Ministry of Health, Welfare and Sports and the Ministry of Agriculture, Nature management and Fisheries to regulate food commodities are presented.
(d) For the above mentioned assessments an adequate estimate of uncertainties in the data and the methods is imperative. An overview of uncertainties that affect the results in this study is presented in Chapter 5.5.

5.2 Fraction of the population with intakes exceeding the tolerable daily intake (TDI)

5.2.1 Tolerable Daily Intake

In order to protect the general population against the adverse health effects of exposure to environmental contaminants, health safety objectives such as the TDI (Tolerably Daily Intake) have been derived. The TDI of a compound can be defined as the highest lifelong-averaged intake at which, with the present knowledge, no adverse health effects are to be expected. In the derivation of the TDI uncertainty factors for interspecies and intraspecies variation are applied.

For the majority of chemicals health safety objectives have been derived on the basis of the daily intake per kg body weight. However, in case of chemicals that accumulate in the body, the accumulated amount (body burden) rather than the daily intake relates to the occurrence of adverse health effects of the chemical. For PCDDs, PCDFs and dioxin-like PCBs this rationale has been used to establish the TDI. The following procedure was applied (WHO, 2000): First, in experimental animals the highest body burden of 2378-TCDD (the most toxic PCDD) associated with the absence of toxic effects was determined. Second, this body burden was extrapolated to humans by means of toxicokinetic modelling. Next the tolerable daily intake (TDI) leading to this body burden in humans was determined. The TDI thus represents a tolerable daily intake for life-long exposure. Short-term excursions above the TDI would have no health consequences provided that the average intake over long periods is not exceeded (WHO, 2000).

The results of these calculations is a TDI ranging from 1-4 pg WHO-TEQ /kg bw/day. The upper end of this range should be considered as a tolerable intake on a provisional basis. The ultimate goal is to reduce the human intake levels below 1 pg WHO-TEQ /kg bw/day. The Scientific Committee on Food (SCF) recommended to express the lower limit of the tolerable intake on a weekly rather than a daily basis, due to the very long half-lives of dioxins and dioxin-like PCBs in the human body. Therefore in November 2000 the Committee established a temporary tolerable weekly intake (TWI) of 7 pg WHO-TEQ/kg bw /week (SCF, 2000). Recently, an update was made as a result of new scientific information avialable since the adoption of the SCF opinion of November (SCF, 2001). Based on this information, the Committee concluded that 2 pg/kg bw/day should be considered as a tolerable intake. Accordingly, the tolerable weekly intake (TWI) for the sum of dioxins and dioxin-like PCBs established in May 2001 is 14 pg WHO-TEQ/ kg bw /week.

In concordance with previous intake calculations and to enable the evaluation of time trends (Liem et al., 1991, 1996), in the present study we have persevered in using the daily timeframe as the time-unit for lifelong intake calculations.

5.2.2 Fraction of the population with intakes exceeding the TDI

The best way to make an adequate comparison of the intake distribution and the TDI would be to use the distribution of lifelong-averaged daily intake. After all, the definition of the TDI necessitates the calculation of an exposure measure with a matching time-frame.

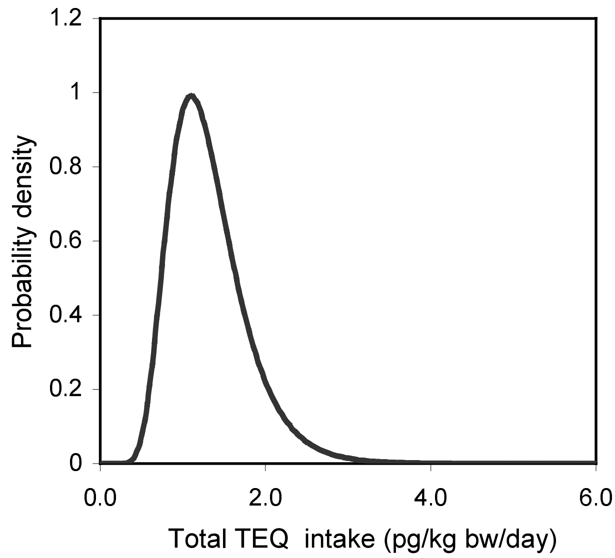


Figure 5.1 Modelled distribution of lifelong-averaged (1-70 yrs) intakes (pg WHO-TEQ/ kg bw/day) of total TEQ contributing PCDDs, PCDFs and dioxin-like PCBs in the Dutch population.

The lifelong-averaged intake can be derived from the intake-age relationship presented in Fig. 4.3b. For the median of the population, this is done by integrating the age dependent median intake from age 1 to 70 yrs, and expressing the result on a daily basis. As such, in this scenario it is assumed that exposure concentrations in food remain unchanged throughout one's life. Obviously, concentrations of dioxins and dioxin-like PCBs in food have changed considerably during the last century, which has influenced the intake of individuals as they grew older (Van der Molen, 1998). However, the present objective is to evaluate the potential effect of the current exposure conditions as if it would be effective on a lifelong period.

The same procedure can also be employed for other percentiles. It should be noted that for these percentiles it is then assumed that individual food consumption patterns are maintained throughout one's life. This means for example that a high intake during childhood remains high throughout one's life. Similarly, a low intake during childhood remains low throughout one's life, etc. Of course, with this assumption, the between-subject variation in the lifelong-averaged intake distribution is exaggerated (Slob 1993a and 1993b).

The above mentioned calculations were carried out for dioxins and dioxin-like PCBs separately as well as for total TEQ (Table 5.1). Figure 5.1 displays the lifelong-averaged (1-70 yr) intake distribution for the total TEQ. We can observe that the right-hand shoulder of the distribution approximately covers the range of the TDI (1-4 pg WHO-TEQ /kg bw/day).

Table 5.1 Estimated median, average and 90th percentile in the distribution of lifelong-averaged (1-70 yrs) intakes (pg WHO-TEQ/ kg bw/day) of dioxins (PCDDs and PCDFs) and dioxin-like PCBs.

Contaminant	Median[a] (pg/kg bw/day)	Average[a] (pg/kg bw/day)	90th percentile[a] (pg/kg bw/day)
dioxins[b]	0.65	0.69	1.0
non-ortho PCBs	0.43	0.47	0.70
mono-ortho PCBs	0.14	0.15	0.22
Σ PCBs	0.58	0.62	0.93
Σ dioxins[b], PCBs	1.2	1.3	1.9

[a]WHO-TEQ, [b]PCDDs and PCDFs.

Table 5.2 presents the calculated fraction of the population (in %) of which the lifelong-averaged daily intake exceeds different levels within the TDI range. The calculations show that the intake of a relatively small part (0.03%) of the population exceeds the upper end of the range in TDI as derived by the WHO (WHO, 2000). However, if the lower end of the range (1 pg WHO-TEQ /kg bw/day) is evaluated, then the majority of the population is exposed to intake levels above the TDI (74%). The most recently established tolerable intake level, as derived by the SCF (2 pg WHO-TEQ /kg bw/day) would imply that the intake of 8% of the population exceeds the TDI. These estimated percentages do not change when the corresponding TWI (SCF, 2000) is used.

Table 5.2 Estimated percentage of the population with a lifelong-averaged intake of total dioxins (Σ PCDDs, PCDFs and dioxin-like PCBs) exceeding various Tolerable Daily Intake levels (TDI)

TDI[a] (pg/kg bw/day)	Fraction of population exceeding the TDI %
1	74
2	8
3	0.5
4	0.03

[a]WHO-TEQ

5.3 Trends in dietary intake

The first extensive assessment of dietary intake of dioxins and dioxin-like PCBs (including PCDDs, PCDFs and non-ortho PCBs) in the Dutch population was carried out by RIVM one decade ago (Liem et al., 1991; 1996). The latter study is a fair reference-point to evaluate the trend in dietary intake of dioxins and non-ortho PCBs. However, an accurate comparison is impeded by differences in study design. The largest difference between the current study and the 1991 study is in the choice of sampled food categories used to establish a concentration database. In 1991 attention was mainly focused on fat-containing products, in which dioxins and PCBs are known to accumulate (Liem and Theelen, 1997). In the current study vegetables were added to the food categories. Considering the 1990/91 data it should also be noted that the current study uses an updated, somewhat different TEF system. Similarities between the two studies are: The food consumption patterns in the 1991 study were based on the DNFCS 1, that was recorded in 1987/1988 (VCP, 1988). The DNFCS 1 was carried out in the same way as the DNFCS 3, used in this study (Kistemaker et al., 1998). Methods employed to compute the intake distribution in the population in 1990/91 and in the current study are also similar (Slob, 1993a; 1993b).

After correction for above mentioned differences, the 1990/91 and 1998/99 intake distributions can be compared, taking notice of the following correction procedure: For the use of a different TEF system a correction factor was used on the 1990/91 intake data. Next, it was assumed that the absolute intake via vegetables in 1998/99 was equal to that in 1990/91 by adding this to the 1990/91 intake data. For all correction factors conservative values were chosen, i.e. the estimated reduction in intakes will be a lower bound estimate rather than an upper-bound estimate.

Figure 5.2 displays the estimated relationship between median intakes of dioxins and age in 1990/91 and 1998/99. The results indicate a considerable decrease of relative intake. Table 5.3 presents several statistical measures of the distribution of lifelong-averaged intake of dioxins in the population for the 1991 and 1999 exposure assessments. Table 5.3 shows a 46% decrease in the median and 48% decrease in the 90th percentile. This downward trend has also been observed in other European countries. The decrease in intake is mainly due to lower levels of dioxins rather than changes in food consumption (EU-SCOOP,2000).

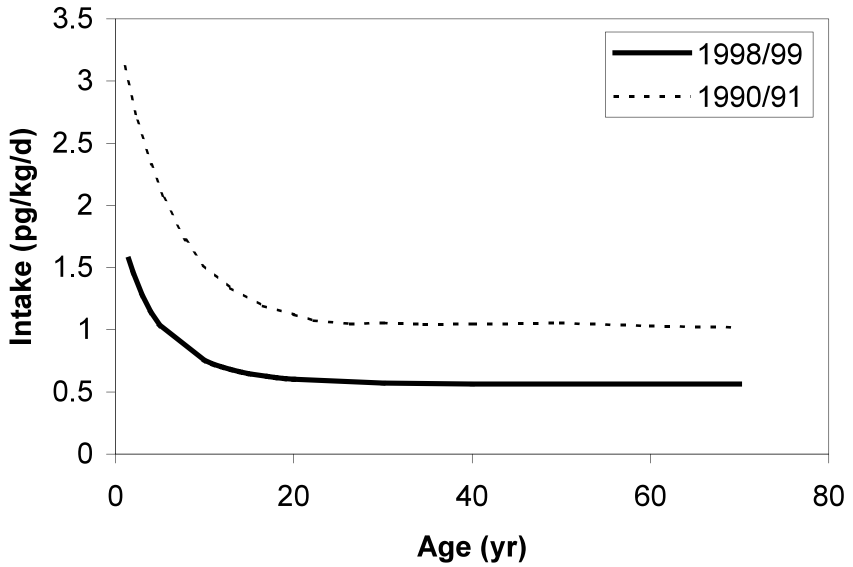


Figure 5.2 Median dioxin (PCDD and PCDF only) intake (pg WHO-TEQ/ kg bw/day) vs. age in the 1990/91 (Liem et al., 1991) and in the 1998/99 exposure assessments. The 1990/91 data were corrected for the use of new TEF values, recalculation in 1996 (Liem et al., 1996), and vegetable intake.

Table 5.3 Median, average and 90th percentile in lifelong-averaged (1-70 yrs) daily intake distributions of dioxins (PCDD and PCDF).

Statistics	Lifelong-averaged intake (pg WHO-TEQ/ kg bw/day)	
	1990/91	1998/99
Median	1.2	0.65
Average	1.2	0.69
90th percentile	1.9	1.0

The decrease in intake (Fig. 5.2) draws the attention to the contributions of different food categories to the intake of dioxins and dioxin-like PCBs. In order to evaluate what food products need consideration in abatement strategies a comparison is made between 1990/91 and 1998/99. Tables 5.4 to 5.5 report the contributions of different food categories to the total intake in 1990/91 and 1998/99. A correction was made for the 1990/91 data to account for vegetables.

For dioxins (Table 5.4) it can be observed that the intake in 1990/91 was dominated by animal and dairy products. This situation has changed considerably in 1998/99, where the relative contribution of these products decreased, while the relative contribution of vegetable products and industrial oils and fats increased. This can partly be explained by the fact that concentrations of dioxins in animals and cow milk have decreased during the last decade (Table 3.2). This trend was also observed in other European countries during the last decade (EU-SCOOP, 2000). The downward trend parallels the measures taken by various European countries at the end of the 1980s to reduce the dioxin emissions in order to lower their concentrations in the environment.

Table 5.4 Contribution of food groups to the total intake of dioxins (PCDDs and PCDFs) in the Dutch population in 1990/91 and 1999. The absolute average values are expressed per person (pg WHO-TEQ/day). The 1990/91 data were corrected for exclusion of vegetables.

Food group	Contribution to total intake (%)			
	1990/91		1998/99	
	pg /day	%	pg/day	%
Animal products	20	25	9.2	21
Dairy products	35	43	11	24
Fish	5.5	6.7	4.3	9.6
Eggs	3.5	4.4	2.2	4.9
Vegetable products	9.2	11	9.3	21
Industrial oils and fats	7.7	9.5	9.0	20
Total	81	100	45	100

Table 5.5 Contribution of main food groups to the intake of non-ortho PCBs in the Dutch population in 1990/91 and 1998/99. The absolute average values are expressed per person (pg WHO-TEQ/day). The 1990/91 data were corrected for exclusion of vegetables.

Food group	Contribution to total intake (%)			
	1990/91		1998/99	
	pg/day	%	pg/day	%
Animal products	16	18	7.7	23
Dairy products	39	44	11	34
Fish	11	13	7.1	21
Eggs	3.6	4.1	0.6	1.9
Vegetable products	5.4	6.1	1.9	5.6
Industrial oils and fats	13	15	5.1	15
Total	88	100	34	100

Table 5.5 shows that the trend for the non-ortho PCBs is somewhat different than for dioxins. The absolute intakes of non-ortho PCBs via all food groups have decreased dramatically, as is also illustrated in Table 3.2. The largest decrease occurred for dairy products and eggs. For fish the absolute decrease is much less than for the other food groups. Accordingly, an increase of the relative contribution of fish can be observed for the non-ortho PCBs. The intakes (in WHO-TEQ) of non-ortho PCBs via vegetable products were low in both the 1990/91 and 1998/99 surveys.

5.4 Effects of limit values in foodstuffs on non-compliance and intake reduction

5.4.1 Introduction

The effects of limit values of concentrations of PCDDs and PCDFs in foods of animal origin on non-compliance and on the intake of these compounds are presented in this section. The recent problems with feeds and foods contaminated with PCDDs, PCDFs and PCBs have increased the need to set limits for the concentration of these contaminants throughout the chain leading from feed to food. In this section, the theoretical effect of a range of possible limits on the average level in different kinds of food, as well as their effect on the intake of dioxins by the Dutch general population will be discussed. In addition, the percentage non-compliance has been estimated using available information on the distribution of concentrations of these compounds in the most relevant foods. Non-compliance is defined as the fraction of products that does not comply to a certain limit value. Because present enforcement of limit values in Dutch and European legislation considers dioxins (PCDDs and PCDFs), it was decided to focus on dioxins only. The reader should thus be aware that contributions of dioxin-like PCBs were not yet taken into account. All TEQ values that are presented in this chapter are TEQ contributions of PCDDs and PCDFs, unless otherwise stated. An extensive report of the exercises was presented to the Ministry of Heath, Welfare and Sports in July 2000 (Hoogerbrugge et al., 2000).

5.4.2 Method and data

The calculations are based on the two data sets of occurrence data of PCDDs and PCDFs available from the measurement programs:

Data set 1

Includes concentrations of PCDDs and PCDFs in primary agricultural products, i.e. meat samples from individual animals and samples of eggs and milk from individual farms. The animals have been sampled randomly in Dutch slaughter houses distributed over The Netherlands. The data are presented in Appendix 4. A summary is given in Table 5.6.

Table 5.6 Data set 1: Levels of dioxins (PCDDs and PCDFs) in animal fat expressed in pg WHO-TEQ/g fat.

Statistics	Individual animals			Individual farms	
	Poultry	Beef	Pig	Eggs	Milk
Average	0.72	1.6	0.53	2.0	0.64
n[a]	10	9	10	12	12
SD[b]	0.38	0.60	0.62	2.0	0.32
RSD[c]	53%	38%	115%	104%	51%

[a]number of samples [b]Standard deviation [c]Relative standard deviation

Table 5.7 Data set 2: Levels of dioxins (PCDDs and PCDFs) in animal fat expressed in pg WHO-TEQ/g fat.

Statistics	Dietary mixtures					
	Poultry	Beef	Pig	Eggs	Milk	Butter
Average	1.1	0.82	0.25	1.5	0.57	0.68
SD[a]	0.10	0.23	0.05	1.1	0.18	0.04
RSD[b]	9%	29%	20%	70%	32%	5%

[a]Standard deviation [b]Relative standard deviation

Data set 2

Refers to results from chemical analysis of PCDDs and PCDFs in national representative composites of different groups of foods collected in supermarkets in five different regions throughout the country (consumer foods). These composites have been compiled by combining a selection of food items in amounts reflecting their relative importance in the typical Dutch diet (Chapter 2). The results from these measurements are shown in Appendix 3 and Table 5.7.

Data set 1 is used to estimate non-compliance of products for various limits. Also, the decrease in average concentration is estimated as if non-complying products are fully intercepted. The calculated reduction in average concentrations is subsequently combined with data set 2 to estimate the reduction in dietary intake associated with a certain limit value. A schematic overview of this procedure is displayed in Figure 5.3.

The data in set 1 (Table 5.6) show that the relative standard deviations (RSD) for each type of animal food are quite high. The number of samples within each food type is rather limited, and therefore the estimates of the various RSDs for each food type will be inaccurate. Taking into account this inaccuracy, the RSDs of the food types are quite similar. Therefore a general RSD of 100% is assumed for all types of animal foods. In order to calculate the percentage of animals that are expected to have levels above a certain critical level we will also assume that the data are lognormally distributed. This distribution is often applied in the description of variation of biological variables. Using the normal distribution, a popular alternative, is rather illogical since an RSD of 100% would imply a considerable amount of negative concentrations.

5.4.3 Results

Effect of limit values on non-compliance

In Figure 5.3, the respective calculations are illustrated for dioxin levels in eggs. Similar calculations as shown in Figure 5.3 can be made for other types of food. The results for a number of limit values are shown in Table 5.8.

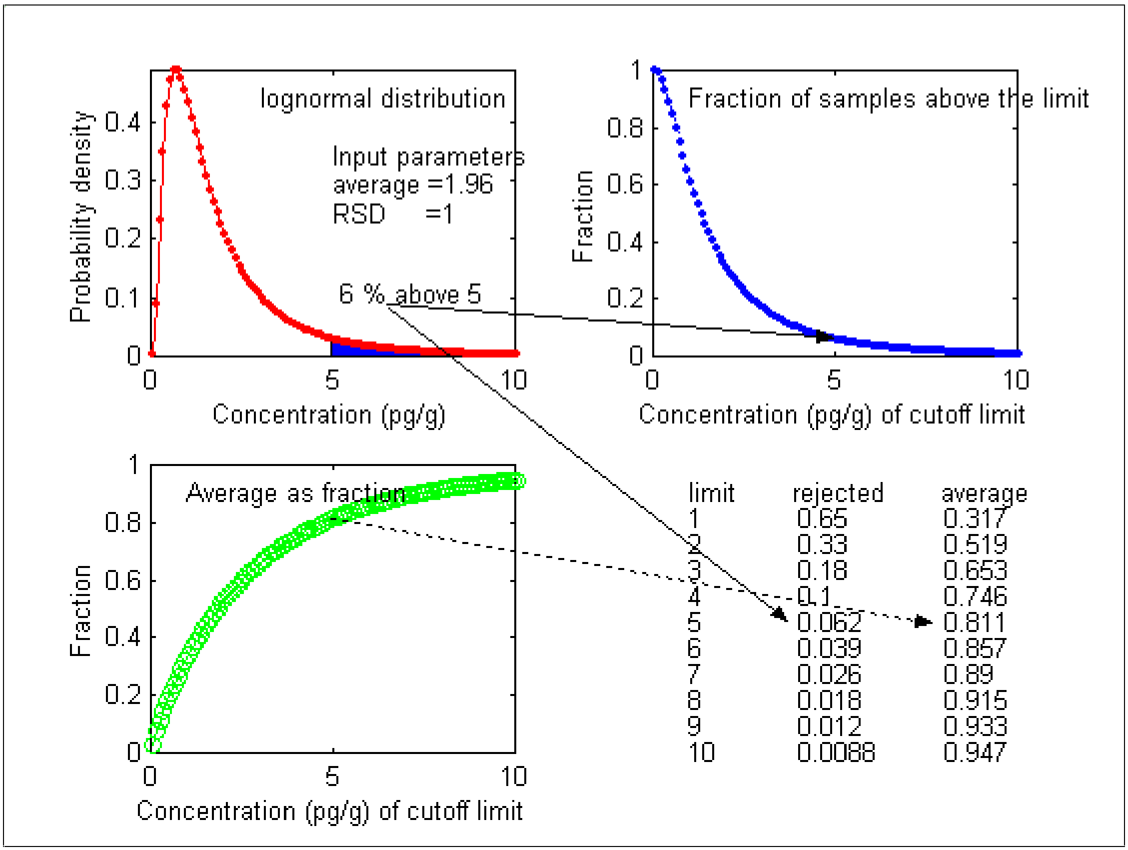


Figure 5.3 Calculation scheme. The upper left plot shows the calculated distribution of levels of dioxins in eggs from individual farms. The fraction of farms above a certain limit value is equal to the surface of the corresponding tail of this distribution. For each limit value such a tail can be calculated. The result is shown in the upper right plot. Assuming that the limit level is fully effective, the average concentration of the remaining part, relative to the average of all eggs, is shown in the lower left plot. The lower right square shows some tabulated values for the estimated fraction of rejected eggs and the average of the remaining fraction divided by the average of all eggs as function of the limit values.

Table 5.8 Percentage of non-compliance with certain limit values (using data set 1 and RSD=1).

Products	Average level (pg /g fat)	Scenario				
		Above 3[1]	Above 5[2]	Above 6[3]	Above 7.5[4]	Above 10[5]
Poultry	0.72	1.6	0.3	0.1	0.1	0.0
Beef	1.6	3.7	3.7	2.3	1.2	0.4
Pork	0.53	2.3	0.6	0.2	0.1	0.0
Eggs	2.0	6.2	6.2	3.9	2.1	0.9
Milk	0.64	1.1	0.2	0.1	0.0	0.0

[1]EU scenario: pork 2, beef 5, egg 5, [2]Belgium scenario: pork 3, [3]pork 4, [4]pork 5, [5]pork 6

Table 5.9 Reduction of the average level expressed in % of the original average and the resulting reduction (%) in the average dietary intake by the Dutch population for different limit values.

Parameter	Scenario				
	Above 3[1]	Above 5[2]	Above 6[3]	Above 7.5[4]	Above 10[5]
Reduction of average level					
Poultry	8	2	1	1	0
Beef	14	14	10	6	3
Pork	10	4	2	1	0
Eggs	19	19	14	10	5
Milk	6	2	1	0	0
Reduction of dietary intake	5	3	2	1	0.7

[1]EU scenario: pork 2, beef 5, egg 5, [2]Belgium scenario: pork 3, [3]pork 4, [4]pork 5, [5]pork 6

Belgium has recently notified national maximum levels (MLs) awaiting harmonised MLs on the European or CODEX level (Belgisch Staatsblad, 1999). These Belgium MLs are 3 pg TEQ/g fat for foodstuffs derived from pork and 5 pg TEQ/g fat for foodstuffs derived from poultry, beef, eggs and milk. The estimated percentages of samples above these limits are just a few percents, with a maximum of 6.2% for eggs. For limit values higher than 10 pg TEQ/g fat, all categories are expected to have less than 1% of non-compliance. The EU limit values represent a recent proposal by the European Union to regulate dioxin concentration in animal food products.

Effect of limit levels on average levels and dietary intakes

If the proposed limit values would be fully implemented, the average concentration of the remaining part of the distribution would be lower than the present average (See figure 5.3). However, a full implementation of limit values is in practice not feasible as it would largely exceed the currently available analytical capacity. Nevertheless, the theoretical effect of a certain limit value on the intake of dioxins by the Dutch population can be calculated. The basis for this calculation is that all products above the maximum level are intercepted and eliminated from the human food chain. These theoretical reductions of the average levels in animals in Dutch slaughterhouses are shown in Table 5.9. The effect of the calculated reductions in average levels on dietary intake is also displayed in Table 5.9. For example, when the full effect of the Belgium Maximum Levels is assumed, second column in Table 5.9, the average dietary intake of dioxins and furans by the Dutch population, which is 0.69 pg/kg bw/day (Table 5.1), will reduce with 3%.

5.4.4 Implications

If the limit values for dioxins in foodstuffs as recently notified by Belgium would be used in The Netherlands, a few percent non-compliance can be expected for Dutch cow's meat (3.7%) and for eggs (6.2%) using the concentrations in primary agricultural products sampled in the period October 1998 - April 1999. For foodstuffs derived from other types of animal fats, less than 1% non-compliance is to be expected. If the same Belgium limit values would be fully implemented and all non-compliant products would be taken from the market, the average concentrations in different types of animal fat are estimated to decrease 2 to 19%. Since the contribution of many different food types add up to the total intake of dioxins these reductions hardly influence the average long term intake in the population. The benefit of these limit values would mainly be to limit short-term high intake in case of contamination incidents. Also, it is expected that these limits will lower the long-term intake for individuals with very specific feeding patterns mainly consisting of products with high concentrations of dioxins and dioxin-like PCBs.

5.5 Uncertainties in data and methods

The intention of this section is to make the reader aware of uncertainties in data and methods and to point out how errors and uncertainties propagate in the process of the calculations presented in this report.

5.5.1 Uncertainties in analytical data and error propagation

The uncertainties in the sampling and the chemical analyses are fully discussed in chapter 3. Summarising the following was found: The differences between the concentrations between the two series of composite samples expressed as a pooled RSD is equal to 34%. The systematic deviation of analytical laboratories in general is 10-15% (RSD). This is relevant when comparing the results with third party intake studies. For trend analysis the uncertainty of 6% (RSD), found in the quality control programme of RIVM is important.

The sampling and analytical errors can propagate when performing the intake calculations (Chapter 4). In order to quantify these errors we performed these calculations for the two series of national representative composite samples separately. The results are presented in Table 5.10 as relative standard deviations. As can be observed in Table 5.10 the integrative nature of the intake calculations reduces the errors in the concentration data (<34%).

Table 5.10 Uncertainty in the intake estimate (in pg WHO-TEQ/kg bw/day) expressed as relative standard deviation (RSD), based on the two series of national representative composite samples.

	Contaminant				
	dioxins[a]	non-ortho PCBs	mono-ortho PCBs	Σ PCBs	dioxins[a] and Σ PCBs
RSD	11%	17%	19%	8%	10%

[a] PCDDs and PCDFs

Table 5.11 Uncertainty in percentage non-compliance with certain limit values (using data set 1, RSD=100%, and the average value of dioxins (PCDDs and PCDFs). Within parentheses the 95% one-sided confidence limits (minimum and maximum).

Product	Scenario				
	Above 3	Above 5	Above 6	Above 7.5	Above 10
Eggs	18 (8-33)	6 (2-14)	4 (1-10)	2 (0.6-6)	0.9 (0.2-3)

5.5.2 Uncertainties in the estimates of non-compliance

The estimates of non-compliance (Section 5.4) contain a number uncertainties: First, the small number of samples for each type of animal results in a relative standard error in the estimated averages in Dutch slaughterhouses in the order of 30%. This rather high value influences the accuracy of the estimated percentages above certain limit values that are shown in table 5.8. The one-sided 95% confidence limits for the percentages for eggs are shown in table 5.11 (see also Van der Voet, 2000). Second, the assumption of RSD=100% overestimates the actual RSD in most periods for most animals. If so, the percentage of samples above the critical level will also be overestimated. On the other hand, in case of contamination incidents both the average and the RSD will increase and the actual percentage of samples above the level might be larger than the estimated percentage. A third limitation in the interpretation of the results is that the sampling period not necessarily represents actual or future periods. The confidence intervals in Table 5.11 indicate that the estimated non-compliance should be interpreted with caution. If more accurate estimates are required, many more measurements should be performed.

5.5.3 Conversion model

In chapter 4, the concentrations in 24 composite samples are used to calculate the intake via 856 products. This requires a product assignment and conversion scheme (Chapters 2 and 4). Three different procedures were used to convert dioxin and dioxin-like PCB concentrations as measured in composite samples (section 4.2.3). The first two procedures are used for products that belong unambiguously into one main category, and involve a straightforward conversion using the fat content of the products. The third procedure (CPAP) is intended for the calculation of the dioxin and dioxin-like PCB concentrations in mixed food categories (e.g. meat products, wheat products, complex dishes, bakery products and sweets; Table 2.2).

These mixed categories consist of many different food products (appendix 8) that each, in turn, contain a mixture of different ingredients. Sampling of these products for concentration measurements would be laborious, due to the wide variety of food categories that make up their composition. More important, the chemical analysis of these food products would not be necessary, as the concentrations of the ingredients of these food items are already known. For example, 'ham and leek salad' (complex dishes) consists of the following ingredients relevant for dioxin and dioxin-like PCB exposure: egg (2%), vegetable oils and fats (24%), leek (35%) and pork (12%). The concentration of this product is calculated as the weighed sum of the concentrations in these separate constituents. In the

CPAP conversion model each food item, ranging from very simple to complex products, is defined in terms of its ingredients, that in turn are divided into a fat component, a fat-free component and a water component when relevant. This step is important because dioxin and dioxin-like PCBs are very lipophylic compounds. The amount and kind of each ingredient in a food product was assigned on expert-judgement using the best available knowledge. For more detailed information the reader is referred to van Dooren et al. (1995).

Due to the many different brands available per food product the amount and type of ingredients assigned to the different products are inevitably averages. The exact composition of a certain product as eaten on a certain day by a certain person may vary from the chosen values. For example, the food product 'pizza with vegetables frozen' was assumed to contain average amounts of the vegetables most likely to be present. Individual pizzas can deviate from this composition. However, the effect of these short term variations in composition on the total intake are extinguished when considering lifelong-intake.

Also, the percentage of fat per ingredient or food product, as recorded in the Dutch food composition table (NEVO 1996), is subject to variation. Because fat intake is important when considering dioxin and dioxin-like PCB exposure, we tested if the fat intake in the DNFCS differed when calculated with either CPAP or the fat content of products as recorded in the Dutch food composition table. The fat intake was only 1.8% lower when using CPAP, justifying the conclusion that as far as the conversion to fat intake is concerned CPAP is a valid conversion model.

5.5.4 Effect of variation in concentrations on intake estimates

In this study we aimed at an optimal approach to measure concentrations in composite samples of consumer food stuffs and in primary agricultural products (at an early stage of the food production chain, e.g. animal fats sampled at the slaughterhouse). In the measurement programme for consumer food stuffs all kinds of foods of different food groups were collected in March 1999. In most composite samples of food groups approximately five food items were selected to represent the 95% of the fat intake via that food group. These five food items were sampled by two independent persons at two different supermarkets in five different regions throughout the country. Consequently each national composite sample contained 50 individual food items.

Although the composite sample contained many different food items, there are some limitations regarding this approach. First, all samples were collected during one month, while dioxin and dioxin-like PCB levels may vary between seasons. The second limitation is that five sampled food items were assumed to be representative for most food groups. For homogenous food groups like beef this may be a good assumption, because the chosen five products contributed highly to the total intake of beef (Chapter 2). However, for more heterogeneous groups of products, this assumption may not be true (e.g. fried snacks). Another limitation is that several food groups were not analysed in the current programme, and instead data were used from the measurement programme conducted in 1991 (see chapter 2). In the programme focusing on primary agricultural products month to month variation was covered quite well, because samples were taken from October 1998 till April 1999 for milk and eggs and for animal fat of cattle, pork and poultry, and from October 1998 to June 1999 for fish. Bearing these limitations in mind we can conclude that the measurement programme of consumer food stuffs provides a relatively good impression of the average concentrations during winter 1999. The programme on primary agricultural products on the other hand offers an impression of the variation in concentrations in milk and eggs, fat of pork, cattle, poultry and fish.

This type of information can be combined in a probabilistic approach to study the possible range of dioxin and dioxin-like PCB exposure on a certain day of the average consumer in the population. To calculate the exposure via this approach we assumed that the dioxin and dioxin-like PCB levels of all primary agricultural products followed a lognormal distribution. We combined the variation found in the primary agricultural products with the average concentrations resulting from the programme on consumer food stuffs, to perform a Monte Carlo simulation, using 100,000 iterations. The results of the upper extremes of this distribution of daily-averaged dietary exposure to dioxins and dioxin-like PCBs in the total Dutch population are listed in Table 5.12. For an arbitrary Dutch consumer with an average dioxin and dioxin-like PCB intake of 1.8 pg WHO-TEQ kg^{-1} d^{-1}, a daily intake of 2.1 pg WHO-TEQ kg^{-1} d^{-1} can be found in one day out of ten days. One out of 100 days the average consumer will be exposed to 2.9 pg WHO-TEQ kg^{-1} d^{-1}. As long as all persons have an equal probability of consuming products with high or low concentrations, there is no concern that for specific individuals the long term averages will deviate from the distribution as calculated in section 5.2. However, if individuals or groups of consumers are chronically exposed to high concentrations, the extremes in the distribution of lifelong-averaged intake calculated in section 5.2 are not accurate enough. This may occur when the consumers eat contaminated products originating from a local market or his/her own farm.

Table 5.12 Simulated distribution of daily-averaged dietary intakes (pg WHO-TEQ/kg bw/day) of total dioxins (PCDDs, PCDFs and dioxin-like PCBs), considering 100,000 Monte Carlo realisations from a lognormal distribution of dioxin levels for milk and eggs, and fat of pork, cattle, poultry, and fish for an arbitrary Dutch consumer.

Statistics	Intake level[a] (pg/kg bw/day)
90^{th} percentile	2.1
95^{th} percentile	2.3
99^{th} percentile	2.9
Average	1.8

[a]WHO-TEQ

5.5.5 Effect of food consumption data on intake estimates

The DNFCS, which was the basis for food consumption data used in all intake calculations in Chapter 4 includes just two consecutive days of recording. For some specific product groups with high concentrations of dioxin and dioxin-like PCBs, this is inadequate to establish the consumption frequency of these products. For example, fish contributes significantly to a persons intake of dioxin and dioxin-like PCB on a day that fish has been consumed. For a consumer eating fish once a week, the probability that the fish will be eaten during the period of food recording is only 1/7.

The commission of the Dutch National Food Consumption Survey decided to collect more data on the daily variation of food consumption by adding a food frequency questionnaire (referred to as 'ANI'). This questionnaire was designed to measure usual food consumption and measures both the frequency of consumption as the average amount consumed. For example, questions were asked on how frequently (weekly or monthly) specific products were eaten (e.g. salmon) and if eaten, how much on average. The majority of questions were related to food items, which can contain a substantial amount of dioxins and dioxin-like PCBs. The food frequency questionnaire does not contain questions about the usual intake of fruits, vegetables and cereals, because measurement programmes in the past assumed that these products did not contain considerable amounts of dioxins and dioxin-like PCBs compared to animal products (van Dooren-Flipsen, 1998).

The usual dioxin and dioxin-like PCB intake for each respondent can be estimated by combining the information obtained by the food frequency questionnaire ANI with the dioxin and dioxin-like PCB levels found in this project as far as animal products were concerned. In addition a correction was applied for possible dioxin and dioxin-like PCB exposure as a consequence of consumption of products of plant origin (fruits, vegetables, cereals).

Tables 5.13 and 5.14 compare the results obtained with the food frequency questionnaire measuring usual or long-term intake with the intake estimated with the two-day food record method (2-days average) and the statistical model STEM (Slob, 1993a; Slob 1993b). The same respondent completed both the food frequency questionnaire (ANI) and the two days food recording. Tables 5.13 and 5.14 show that the estimated median values agree rather well. For the age classes 10-19 years and >20 years the difference between the median and the 90th percentile obtained with STEM and the food frequency method correspond quite well, while results for the method which calculates the two-days average from the DNFCS are somewhat higher. This is to be expected as the latter method overestimates the between-subject variance.

Table 5.13 Median dietary intake (pg WHO-TEQ/kg bw/day) of total dioxins (PCDDs, PCDFs and dioxin-like PCBs), according to the ANI food frequency questionnaire and the two days of recording food consumption (DNFCS).

Age group	Median (pg /kg bw/day) [a]		
	Two day average from DNFCS	STEM & DNFCS	Food frequency questionnaire
1-9 years old	2.2	2.1	2.2
10-19 years old	1.2	1.3	1.2
>20 yrs old	1.1	1.1	0.96

[a]WHO-TEQ

Table 5.14 The 90th percentile in distribution of dietary intake (pg WHO-TEQ/kg bw/day) of total dioxins (PCDDs, PCDFs and dioxin-like PCBs), according to the ANI food frequency questionnaire and the two days of recording consumption (Dutch National Food Consumption Survey).

Age group	90th percentile (pg /kg bw/day) [a]		
	Two day average from DNFCS	STEM & DNFCS	Food frequency questionnaire
1-9 years old	4.3	3.2	4.0
10-19 years old	2.2	2.0	2.1
>20 yrs old	2.5	1.7	1.7

[a]WHO-TEQ

We also studied whether the contribution of the different food groups to the dioxin and dioxin-like PCB intake in the higher intake categories differed between the two food consumption methods. For this we compared the contribution of food groups to the total intake of dioxin and dioxin-like as estimated from the two-day average of the DNFCS and the food frequency method PCBs for the individuals with intakes above the 90th percentile. The results are plotted in figure 5.4. The two-day record suggests that fish contributed largely to the dioxin and dioxin-like PCB intake in individuals exceeding the 90th percentile (34%). However, when the frequency of consumption is considered, the contribution of fish is just 20% (Figure 5.4). According to the food frequency questionnaire ANI 1.8% of all respondents consume fish once a week or more at breakfast or lunch. Corresponding percentages for fish consumption at dinner or as a snack are 12% and 2.8% respectively (van Dooren-Flipsen, 1999). Further data processing showed that 20% of the ANI respondents consumed fish once a week or more irrespective of the moment of the day.

It is evident from this example, that when food consumption of consumers with a high dietary exposure level (upper 10% of the distribution) is examined, one should be aware of the influence of the method used to measure food consumption on the outcome. The difference in the contribution of fish to the dioxin intake in this highly exposed group can be explained by the frequency of consumption, which is included in the food frequency method, but not in the two-day record.

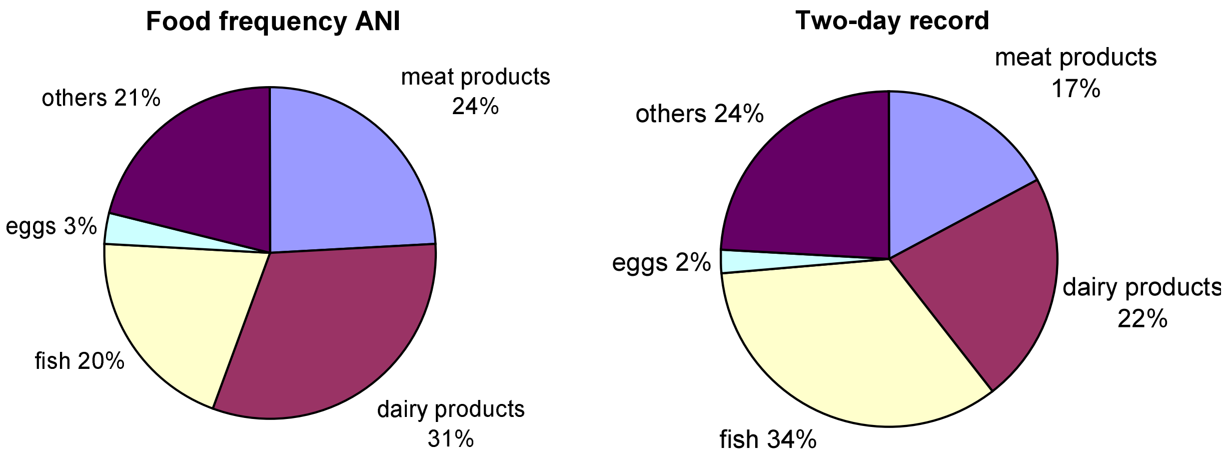


Figure 5.4 Different product groups contributing to the intake of those persons with a dioxin intake higher than 3 WHO-TEQ pg/kg body weight/d for both the food frequency questionnaire (right pie diagram) and the two days record method (left pie diagram).

6: Conclusions

JI Freijer[1], R Hoogerbrugge[1], JD van Klaveren[2],
WA Traag[2], L.A.P. Hoogenboom[2] and AKD Liem[3]

[1] National Institute for Public Health and the Environment, Bilthoven

[2] State Institute for the Quality of Agricultural Products, Wageningen

[3]Present address: SCF Secretariat, European Commission, SANCO/C/3 Brussels

6 Conclusions

Based on the work presented in this report the following conclusions were formulated:

Concentrations of dioxins and dioxin-like PCBs

- Meat, dairy products and eggs: Average concentrations of dioxins (PCDDs and PCDFs) in these food groups ranged from 0.24-1.5 pg WHO-TEQ /g fat. If the TEQ contribution of non-ortho PCBs and mono-ortho PCBs is also accounted for, average concentrations of total TEQ range from 0.47-2.8 pg WHO-TEQ /g fat.
- Fish: On a product basis, concentrations of dioxins and dioxin-like PCBs in fish are higher than in most meat products. The following range of average concentrations was found for fish: dioxins 100-920 pg WHO-TEQ /kg product, sum of dioxins and dioxin-like PCBs 270-3300 pg WHO-TEQ /kg product.
- Vegetable products: Concentrations of dioxins (PCDDs and PCDFs) in most vegetable products (0-58 pg WHO-TEQ /kg product) are comparable to, or lower than those in low-fat animal products (poultry, beef on a product basis). The contribution of dioxin-like PCBs to the total TEQ concentration in vegetable products is negligible compared to that of dioxins (PCDDs and PCDFs).
- Average concentrations in consumer products tend to be somewhat lower than those in primary products of similar origin.

Dietary intake of dioxins and dioxin-like PCBs

- Based on the 1998/99 concentration measurements and the 1998 food consumption survey we have estimated a median lifelong-averaged intake of dioxins (PCDDs and PCDFs) in the Dutch population of 0.65 pg WHO-TEQ /kg bw/day. The estimate for median total TEQ intake (dioxins and dioxin-like PCBs; lifelong-averaged) is 1.2 pg WHO-TEQ /kg bw/day. The 90th percentile of intake in the population is 1.6 times higher than the median intake.
- The contribution of the different food groups to the average intake of TEQ (PCDDs, PCDFs and dioxin-like PCBs) is rather evenly distributed: meat products (23%), dairy products (27%), fish (16%), eggs (4%), vegetable products (13%), and industrial oils and fats (17%).
- Two major differences occur between sources of PCDD/PCDFs and dioxin-like PCBs in the average diet: The contribution of vegetable products to the PCDD/PCDF intake is higher (21%) than to the dioxin-like PCBs (5%). On the other hand the contribution of fish to the PCDD/PCDF intake is lower (10%) than to the intake of dioxin-like PCBs (22%).
- Various possible limit values, proposed to exclude animal products with high levels of dioxins (PCDDs and PCDFs) from the market will have a minor absolute effect on the average long-term intake of dioxins in the population. The benefit of these limit values would mainly be to prevent short-term high intake in case of contamination incidents.

Additionally, it is expected that these limits will lower the long-term intake for individuals with very specific feeding patterns mainly consisting of products with high concentrations of dioxins (PCDDs and PCDFs).

Trends

- Meat and dairy products: A substantial decrease in concentration levels was observed in animal products during the last decade. For PCDDs and PCDFs a 33-66% decrease was found; for non-ortho PCBs the decrease ranged from 39-76%. This downward trend was also observed in some other European countries during the last decade.
- Fish: The decrease of concentrations in fish is less than in other animal products. Consequently, the relative contribution of fish to the intake of dioxins (PCDDs and PCDFs) and dioxin-like PCBs has increased.
- Vegetable products: The trend in vegetable products is largely unknown, because in previous surveys vegetable products were not fully examined. However, from the 1998/99 survey it appears that the contribution of vegetable products to the intake of dioxins (PCDDs and PCDFs) is substantial (21%).
- The dietary intake of dioxins and dioxin-like PCBs in the general population has decreased considerably. After correcting for methodological differences an average reduction in average intake of 50% for dioxins (PCDDs and PCDFs) and 60% for non-ortho PCBs was estimated. This is related to the decrease of the concentrations of dioxins (PCDDs and PCDFs) and dioxin-like PCBs in the majority of food stuffs during the last decade.

Intake compared to the TDI

- The Tolerable Daily Intake has been updated during the last decade. In 1991 a TDI of 10 pg I-TEQ/kg bw/day was operative, while in 2000 The World Health Organisation derived a TDI of 1-4 pg TEQ/kg bw/day. In May 2001, the Scientific Committee on Food established a TDI of 2 pg TEQ/kg bw/day. From the results in the present study we estimate that the intake of 8% of the population exceeds the level of 2 pg TEQ/kg bw/day.

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Acknowledgements

This report was carried out under the auspices of the working group ‘Dioxins in food’, which started its activities in 1989. The working group has the following members (December 2000):

J. de Boer[1], J.D. van Klaveren[2], P.E. Boon[2], W.A. Traag[2], L.A.P. Hoogenboom[2], G. Kleter[3], J.M. de Stoppelaar[3], H.M. Plate[3], J. de Vries[3], N.M.I. Scheidegger[4], A.L. de Kok[4], R.M.C. Theelen[5], J.H. van Wijnen[6], J.A. van Zorge[7], D. Houweling[8], R. Hoogerbrugge[8], R.A. Baumann[8], A.J. Baars[8], J.I. Freijer[8], M.J. Zeilmaker[8], C.E.J. Cuijpers[9].

The manuscript was reviewed by R.M.C. Theelen[5] , J.H. van Wijnen[6], and A.G.A.C. Knaap[8]. Their comments are gratefully acknowledged.

1 Netherlands Institute for Fisheries Research, IJmuiden
2 State Institute for the Quality of Agricultural Products,Wageningen
3 Ministry of Health, Welfare and Sports, The Hague
4 Ministry of Agriculture, Nature management and Fisheries, The Hague
5 present address Ministry of Agriculture, Nature management and Fisheries, The Hague
6 Municipal Health Service, Amsterdam
7 Ministry of Housing, Spatial Planning and Environment, Den Haag
8 National Institute for Public Health and the Environment, Bilthoven
9 present address Ministry of Health, Welfare and Sports, The Hague

Appendix 1 Toxic Equivalency Factors

Toxic Equivalency Factors to express the toxicity of mixtures of PCDDs, PCDFs and dioxin-like PCBs in toxic equivalents of 2,3,7,8-TCDD, as used in the 1991 study (Liem et al., 1991) and the current work (Van den Berg et al., 1998).

Structure	Liem et al. (1991) i-TEF 1991	Current work WHO-TEF 1998
PCDDs and PCDFs		
2,3,7,8-TCDD	1	1
1,2,3,7,8-PeCDD	0.5	1
1,2,3,4,7,8-HxCDD	0.1	0.1
1,2,3,6,7,8-HxCDD	0.1	0.1
1,2,3,7,8,9-HxCDD	0.1	0.1
1,2,3,4,6,7,8-HpCDD	0.01	0.01
OCDD	0.001	0.0001
2,3,7,8-TCDF	0.1	0.1
1,2,3,7,8-PeCDF	0.05	0.05
2,3,4,7,8-PeCDF	0.5	0.5
1,2,3,4,7,8-HxCDF	0.1	0.1
1,2,3,6,7,8-HxCDF	0.1	0.1
1,2,3,7,8,9-HxCDF	0.1	0.1
2,3,4,6,7,8-HxCDF	0.1	0.1
1,2,3,4,6,7,8-HpCDF	0.01	0.01
1,2,3,4,7,8,9-HpCDF	0.01	0.01
OCDF	0.001	0.0001
Non-ortho PCBs		
3,3',4,4'-CB(77)	0.01	0.0001
3,3',4,4',5-CB(126)	0.1	0.1
3,3',4,4',5,5'-CB(169)	0.005	0.01
Mono-ortho PCBs		
2,3,3',4,4'-CB(105)	-	0.0001
2,3,4,4',5-CB(114)	-	0.0005
2,3',4,4',5-CB(118)	-	0.0001
2,3,4,4',5-CB(123)	-	0.0001
2,3,3',4,4',5-CB(156)	-	0.0005
2,3,3',4,4',5'-CB(157)	-	0.0005
2,3',4,4',5,5'-CB(167)	-	0.00001
2,3,3',4,4',5,5'-CB(189)	-	0.0001

Appendix 2 Sample treatment

Treatment of samples for fat extraction and analysis of PCDDs, PCDFs and dioxin-like PCBs.

No	Category	Treatment
1	Poultry	amount: 100 g mix with sodiumsulfate (1:10) add 13C-mix reflux (16h) with dichloromethane evaporate to dryness determine fat content
2	Beef	amount: 100 g mix with sodiumsulfate (1:10) add 13C-mix reflux (16h) with dichloromethane evaporate to dryness determine fat content
3	Pork	amount: 100 g mix with sodiumsulfate (1:10) add 13C-mix reflux (16h) with dichloromethane evaporate to dryness determine fat content
4	Egg	amount: 100 g mix with sodiumsulfate (1:10) add 13C-mix reflux (16h) with dichloromethane evaporate to dryness determine fat content
5	Fried snacks	amount: 100 g mix with sodiumsulfate (1:10) add 13C-mix reflux (16h) with dichloromethane evaporate to dryness determine fat content
6	Cheese	amount: 30 g mix with sodiumsulfate (1:10) add 13C-mix reflux (16h) with dichloromethane evaporate to dryness determine fat content
7	Butter	amount: 15 g mix with sodiumsulfate (1:10) add 13C-mix reflux (16h) with dichloromethane evaporate to dryness determine fat content

Appendix 2 continued

Treatment of samples for fat extraction and analysis of PCDDs, PCDFs and dioxin-like PCBs.

No	Category	Treatment
8	Vegetable oils and fats	amount: 15 g mix with sodiumsulfate (1:10) add 13C-mix reflux (16h) with dichloromethane evaporate to dryness determine fat content
9	Margarine, low-fat margarine, frying fat and sauce	amount: 15 g mix with sodiumsulfate (1:10) add 13C-mix reflux (16h) with dichloromethane evaporate to dryness determine fat content
10	Vegetables	amount: 100 g freeze-dry for 48h add 13C-mix reflux (5h) with dichloromethane evaporate to dryness determine fat content
11	Nuts	amount: 10 g freeze-dry for 48h add 13C-mix reflux (5h) with dichloromethane evaporate to dryness determine fat content
12	Fish prepared	amount: 100 g freeze-dry for 48h add 13C-mix reflux (5h) with dichloromethane evaporate to dryness determine fat content
13	Fatty fish	amount: 70 g freeze-dry for 48h add 13C-mix reflux (5h) with dichloromethane evaporate to dryness determine fat content
14	Lean fish	amount: 500 g freeze-dry for 48h add 13C-mix reflux (5h) with dichloromethane evaporate to dryness determine fat content
15	Shellfish	amount: 350 g freeze-dry for 48h add 13C-mix reflux (5h) with dichloromethane evaporate to dryness determine fat content

Appendix 3 Levels in consumer food stuffs

Outline of levels of PCDDs, PCDFs and dioxin-like PCBs in consumer food stuffs.

Table A3.1
Total dioxins (PCDDs and PCDFs) expressed as WHO-TEQ in the two national representative composite samples of consumer food stuffs (non detect=0). See also Fig 2.1.

Food category	Units	Series A	Series B	Average	RSD (%)
Milk	pg/g fat	0.70	0.44	0.57	32
Beef	pg/g fat	0.98	0.65	0.82	28
Pig	pg/g fat	0.28	0.21	0.24	20
Poultry	pg/g fat	0.99	1.13	1.06	9
Butter	pg/g fat	0.70	0.65	0.68	5
Egg	pg/g fat	0.77	2.27	1.52	70
Fried snacks	pg/g fat	0.40	0.29	0.35	23
Veget. Oil	pg/g fat	0.15	0.04	0.09	82
Margerine	pg/g fat	0.07	0.17	0.12	59
Cheese	pg/g fat	0.70	0.65	0.67	5
Vegetables	pg/kg product	65	50	58	18
Nuts	pg/kg product	0	0	0	-
Fish, prepared	pg/kg product	130	78	104	35
Fish, fatty	pg/kg product	834	1007	921	13
Fish, lean	pg/kg product	118	244	181	49
Crustaceans	pg/kg product	443	516	479	11

Table A3.2
Non-ortho PCBs expressed as WHO-TEQ in the two national representative composite samples of consumer food stuffs (non detect=0). See also Fig 2.1.

Food category	Units	Series A	Series B	Average	RSD (%)
Milk	pg/g fat	0.71	0.43	0.57	35
Beef	pg/g fat	1.03	0.91	0.97	9
Pig	pg/g fat	0.10	0.09	0.09	7
Poultry	pg/g fat	0.53	0.64	0.58	13
Butter	pg/g fat	0.78	0.78	0.78	0
Egg	pg/g fat	0.34	0.54	0.44	32
Fried snacks	pg/g fat	0.22	0.20	0.21	7
Veget. Oil	pg/g fat	0.13	0.02	0.07	103
Margerine	pg/g fat	0.27	0.06	0.17	90
Cheese	pg/g fat	0.73	0.69	0.71	4
Vegetables	pg/kg product	3	2	2.5	28
Nuts	pg/kg product	0	0	0	-
Fish, prepared	pg/kg product	155	117	136	20
Fish, fatty	pg/kg product	1237	1811	1524	27
Fish, lean	pg/kg product	267	411	339	30
Crustaceans	pg/kg product	770	648	709	12

Table A3.3
Mono-ortho PCBs expressed as WHO-TEQ in the two national representative composite samples of consumer food stuffs (non detect=0). See also Fig 2.1.

Food category	Units	Series A	Series B	Average	RSD (%)
Milk	pg/g fat	0.17	0.06	0.12	68
Beef	pg/g fat	0.30	0.24	0.27	16
Pig	pg/g fat	0.13	0.14	0.14	5
Poultry	pg/g fat	0.96	1.33	1.14	23
Butter	pg/g fat	0.17	0.19	0.18	8
Egg	pg/g fat	0.14	0.72	0.43	95
Fried snacks	pg/g fat	0.04	0.03	0.04	20
Veget. Oil	pg/g fat	0.02	0.02	0.02	0
Margerine	pg/g fat	0.01	0.02	0.01	47
Cheese	pg/g fat	0.15	0.14	0.15	5
Vegetables	pg/kg product	0	0	0	-
Nuts	pg/kg product	12	14	13	11
Fish, prepared	pg/kg product	29	24	27	13
Fish, fatty	pg/kg product	237	1190	714	94
Fish, lean	pg/kg product	73	72	73	1
Crustaceans	pg/kg product	164	168	166	2

Table A3.4
Sum of total dioxins (PCDDs and PCDFs), non-ortho PCBs mono-ortho PCBs expressed as WHO-TEQ in the two national representative composite samples of consumer food stuffs (non detect=0). See also Fig 2.1.

Food category	Units	Series A	Series B	Average	RSD (%)
Milk	pg/g fat	1.58	0.94	1.26	36
Beef	pg/g fat	2.31	1.80	2.05	18
Pig	pg/g fat	0.50	0.44	0.47	9
Poultry	pg/g fat	2.47	3.09	2.78	16
Butter	pg/g fat	1.65	1.63	1.64	1
Egg	pg/g fat	1.25	3.52	2.39	67
Fried snacks	pg/g fat	0.66	0.53	0.59	15
Veget. Oil	pg/g fat	0.30	0.07	0.18	88
Margerine	pg/g fat	0.35	0.25	0.30	24
Cheese	pg/g fat	1.58	1.48	1.53	5
Vegetables	pg/kg product	68	52	60	19
Nuts	pg/kg product	12	14	13	11
Fish, prepared	pg/kg product	314	220	267	25
Fish, fatty	pg/kg product	2308	4008	3158	38
Fish, lean	pg/kg product	459	728	593	32
Crustaceans	pg/kg product	1377	1332	1354	2

Pooled RSD= 34%

Appendix 4 Levels in primary products

Average concentrations of PCDDs, PCDFs and non-ortho PCBs expressed as WHO-TEQ in primary products (non detect=0). Numbers in parenthesis indicate standard deviations.

Product	n[1]	PCDDs/PCDFs	non-ortho PCBs	Units
Egg	12	1.96 (2.04)	0.62 (0.14)	pg/g fat
Milk	12	0.64 (0.32)	0.87 (0.27)	pg/g fat
Poultry	10	0.72 (0.38)	0.75 (0.49)	pg/g fat
Beef	9	1.60 (0.60)	4.42 (6.61)	pg/g fat
Pig	10	0.53 (0.62)	0.83 (1.18)	pg/g fat
Fish and crustaceans	29	370 (410)	640 (780)	pg/kg product

[1] n = number of samples

Appendix 5 Levels in composite samples of consumer food stuffs

Description	Milk A (W)	Milk B (N)	Beef A	Beef B	Pig A	Pig B
RIVM sample code	99M1057	99M1058	99M1941	99M1942	99M1943	99M1944
Sample intake (g)	369.73	284.72	102.44	100.97	101.92	101.07
% extractable fat	3.4	3.5	11.4	14.9	24.4	21.9
PCDD/F-GC/MS-file	AS3100-1	AS3101-1	AS3123-1	AS3127-1	AS3124-1	AS3125-1
noPCB-GC/MS-file	VG0611-14	VG0611-15	VG0662-7	VG0663-3	VG0663-4	VG0663-5
PCB-GC/MS-file	VG0938-16	VG0938-17	VG0937-11	VG0937-12	VG0937-13	VG0937-14
PCDDs and PCDFs	pg/g fat	pg/g fat	pg/g fat	pg/g fat	pg/g fat	pg/g fat
2,3,7,8-TCDD	0.04	<0.05	0.12	0.07	0.08	0.05
1,2,3,7,8-PeCDD	0.17	0.11	0.25	0.16	0.09	0.07
1,2,3,4,7,8-HxCDD	0.13	0.07	0.15	0.13	0.13	0.10
1,2,3,6,7,8-HxCDD	0.31	0.21	0.41	0.33	0.15	0.12
1,2,3,7,8,9-HxCDD	0.13	0.09	0.13	0.16	0.08	0.05
1,2,3,4,6,7,8-HpCDD	0.59	0.50	0.92	0.73	1.18	0.91
OCDD	0.80	0.76	3.36	2.85	12.88	<0.05
2,3,7,8-TCDF	0.02	0.02	0.06	0.06	<0.02	<0.02
1,2,3,7,8-PeCDF	0.03	0.02	0.05	0.05	0.01	0.02
2,3,4,7,8-PeCDF	0.65	0.44	0.82	0.54	0.09	0.08
1,2,3,4,7,8-HxCDF	0.37	0.22	0.47	0.27	0.08	0.08
1,2,3,6,7,8-HxCDF	0.32	0.18	0.34	0.22	0.03	0.04
1,2,3,7,8,9-HxCDF	<0.04	<0.05	<0.04	0.05	<0.02	<0.02
2,3,4,6,7,8-HxCDF	0.32	0.20	0.33	0.24	0.03	0.03
1,2,3,4,6,7,8-HpCDF	0.27	0.17	0.43	0.33	0.22	0.19
1,2,3,4,7,8,9-HpCDF	0.02	0.02	0.07	0.06	0.02	0.02
OCDF	0.05	0.05	0.36	0.22	0.17	<0.02
Non-ortho PCBs	pg/g fat	pg/g fat	pg/g fat	pg/g fat	pg/g fat	pg/g fat
3,3',4,4'-CB(77)	1.08	1.26	2.4	1.8	0.5	0.7
3,3',4,4',5-CB(126)	7.07	4.30	10.3	9.1	1.0	0.9
3,3',4,4',5,5'-CB(169)	0.77	0.40	*	*	*	*
Other PCBs	ng/g fat	ng/g fat	ng/g fat	ng/g fat	ng/g fat	ng/g fat
2,2',5-CB(18)	<0.04	<0.04	0.18	0.14	0.16	0.32
2,4,4'-CB(28)	<0.04	<0.04	0.46	0.34	0.38	0.72
2,2',4,4'-CB(47)	0.13	0.06	0.10	0.06	0.06	0.16
2,2',4,5'-CB(49)	<0.04	<0.04	0.06	0.04	0.06	0.12
2,2',5,5'-CB(52)	<0.04	0.04	0.14	0.16	0.24	0.44
2,3,4,4'-CB(60)	<0.04	0.04	0.04	<0.04	0.04	0.04
2,3',4,4'-CB(66)	0.10	0.09	0.12	0.08	0.08	0.14
2,4,4',5-CB(74)	0.36	0.14	0.24	0.24	0.12	0.12
2,2',4,4',5-CB(99)	0.53	0.29	0.62	0.46	0.40	0.40
2,2',4,5,5'-CB(101)	<0.04	0.06	0.08	0.14	0.36	0.50
2,3,3',4,4'-CB(105)	0.17	0.10	0.16	0.20	0.08	0.12
2,3,4,4',5-CB(114)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
2,3',4,4',5-CB(118)	0.92	0.54	1.48	1.06	0.50	0.43
2,3,4,4',5-CB(123)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
2,2',3,3',4,4'-CB(128)	0.11	0.08	0.26	0.22	0.20	0.20
2,2',3,3',4,4'-CB(138)	1.24	0.94	3.36	1.92	1.54	1.50
2,2',4,4',5,5'-CB(153)	1.94	1.15	5.00	2.54	2.34	2.50
2,3,3',4,4',5-CB(156)	0.12	<0.04	0.22	0.22	0.14	0.18
2,3,3',4,4',5'-CB(157)	<0.04	<0.04	0.04	<0.04	<0.04	<0.04
2,3',4,4',5,5'-CB(167)	0.07	<0.04	0.10	0.08	<0.04	<0.04
2,2',3,3',4,4',5-CB(170)	0.32	0.17	1.26	0.34	0.46	0.56
2,2',3,4,4',5,5'-CB(180)	0.70	0.39	3.30	1.14	0.96	0.92
2,2',3,4,4',5',6-CB(183)	0.27	0.13	0.78	0.16	0.24	0.24
2,2',3,4',5,5',6-CB(187)	<0.04	0.04	0.08	0.06	0.42	0.40
2,3,3',4,4',5,5'-CB(189)	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
2,2',3,3',4,4',5,5'-CB(194)	<0.08	<0.08	0.36	0.20	<0.08	<0.08
Total WHO-TEQ - nd=0	1.58	0.94	2.31	1.80	0.50	0.44
Total WHO-TEQ - nd=LOD	1.64	1.07	2.35	1.86	0.57	0.51

* Not determined because of interference

Appendix 5 continued

Levels in composite samples of consumer food stuffs.

Description	Chicken A	Chicken B	Butter A	Butter B	Egg A	Egg B
RIVM sample code	99M1945	99M1946	99M1947	99M1948	99M1949	99M1950
Sample intake (g)	100.65	100.62	15.6	15.44	100.64	101.17
% extractable fat	6.6	5.7	89.7	93.8	11.8	12.5
PCDD/F-GC/MS-file	AS3126-1	as3132-1	as3133-1	as3148-1	as3135-1	as3136-1
noPCB-GC/MS-file	VG0663-6	VG0663-7	VG0663-11	VG0663-12	VG0663-13	VG0663-14
PCB-GC/MS-file	VG0937-15	VG0937-16	VG0937-20	VG0937-21	VG0937-22	VG0937-23
PCDDs and PCDFs	pg/g fat	pg/g fat	pg/g fat	pg/g fat	pg/g fat	pg/g fat
2,3,7,8-TCDD	0.13	0.10	0.07	0.10	0.14	0.66
1,2,3,7,8-PeCDD	0.34	0.40	0.18	0.17	0.34	0.99
1,2,3,4,7,8-HxCDD	0.13	0.13	0.12	0.10	0.13	0.37
1,2,3,6,7,8-HxCDD	0.28	0.23	0.27	0.24	0.29	0.72
1,2,3,7,8,9-HxCDD	0.22	0.18	0.11	0.10	0.30	1.03
1,2,3,4,6,7,8-HpCDD	1.27	1.32	0.52	0.36	2.76	2.37
OCDD	7.43	7.11	1.58	0.77	21.65	14.43
2,3,7,8-TCDF	<0.08	<0.09	0.07	0.04	0.23	0.32
1,2,3,7,8-PeCDF	0.21	0.24	0.08	0.04	0.10	0.15
2,3,4,7,8-PeCDF	0.64	0.91	0.62	0.53	0.23	0.55
1,2,3,4,7,8-HxCDF	0.55	0.53	0.29	0.25	0.15	0.42
1,2,3,6,7,8-HxCDF	0.21	0.15	0.24	0.20	0.08	0.12
1,2,3,7,8,9-HxCDF	<0.08	<0.09	<0.04	<0.03	0.04	<0.04
2,3,4,6,7,8-HxCDF	0.20	0.17	0.22	0.22	0.10	0.14
1,2,3,4,6,7,8-HpCDF	0.56	0.41	0.21	0.15	0.50	0.23
1,2,3,4,7,8,9-HpCDF	0.22	0.12	0.03	0.02	0.05	0.06
OCDF	0.68	0.56	0.09	0.08	0.32	0.21
Non-ortho PCBs	pg/g fat	pg/g fat	pg/g fat	pg/g fat	pg/g fat	pg/g fat
3,3',4,4'-CB(77)	13.2	14.4	1.5	1.2	9.5	13.7
3,3',4,4',5-CB(126)	5.3	6.3	7.8	7.8	3.3	5.3
3,3',4,4',5,5'-CB(169)	*	*	*	*	*	*
Other PCBs	ng/g fat	ng/g fat	ng/g fat	ng/g fat	ng/g fat	ng/g fat
2,2',5-CB(18)	0.18	0.16	0.20	<0.04	0.18	0.26
2,4,4'-CB(28)	0.64	0.54	0.48	0.38	0.56	0.80
2,2',4,4'-CB(47)	0.16	0.16	0.18	0.14	0.10	0.16
2,2',4,5'-CB(49)	0.12	0.08	0.08	0.06	0.08	0.14
2,2',5,5'-CB(52)	0.44	0.32	0.18	0.30	0.18	0.38
2,3,4,4'-CB(60)	0.20	0.22	0.08	0.06	0.08	0.10
2,3',4,4'-CB(66)	0.64	0.74	0.16	0.18	0.26	0.42
2,4,4',5-CB(74)	0.42	0.60	0.44	0.24	0.16	0.34
2,2',4,4',5-CB(99)	1.42	1.98	0.44	0.52	0.50	0.94
2,2',4,5,5'-CB(101)	0.88	0.90	0.10	0.34	0.18	0.76
2,3,3',4,4'-CB(105)	1.32	1.84	0.20	0.26	0.24	0.72
2,3,4,4',5-CB(114)	0.06	0.08	<0.05	<0.05	<0.05	<0.05
2,3',4,4',5-CB(118)	3.44	5.12	0.86	0.98	0.80	2.36
2,3,4,4',5-CB(123)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
2,2',3,3',4,4'-CB(128)	1.24	1.64	0.18	0.14	0.22	1.20
2,2',3,3',4,4'-CB(138)	7.76	11.50	1.26	1.46	1.76	5.96
2,2',4,4',5,5'-CB(153)	8.90	12.60	1.88	1.92	2.26	7.88
2,3,3',4,4',5-CB(156)	0.74	1.04	0.12	0.14	0.08	0.68
2,3,3',4,4',5'-CB(157)	0.14	0.10	<0.04	<0.04	<0.04	0.10
2,3',4,4',5,5'-CB(167)	0.34	0.52	0.04	<0.04	0.08	0.30
2,2',3,3',4,4',5-CB(170)	2.84	3.82	0.40	0.20	0.54	3.36
2,2',3,4,4',5,5'-CB(180)	4.56	6.88	0.60	0.78	1.36	6.14
2,2',3,4,4',5',6-CB(183)	1.24	1.66	0.22	0.20	0.28	1.24
2,2',3,4',5,5',6-CB(187)	2.08	2.66	0.07	<0.04	0.44	2.10
2,3,3',4,4',5,5'-CB(189)	0.08	0.16	<0.08	<0.08	<0.08	0.14
2,2',3,3',4,4',5,5'-CB(194)	0.50	0.82	<0.08	<0.08	0.20	1.02
Total WHO-TEQ - nd=0	2.47	3.09	1.65	1.63	1.25	3.52
Total WHO-TEQ - nd=LOD	2.50	3.12	1.72	1.69	1.31	3.56

* Not determined because of interference

Appendix 5 continued

Levels in composite samples of consumer food stuffs.

Description	Fried snacks A	Fried snacks B	Veget. Oil A	Veget. Oil B	Margarine A	Margarine B
RIVM sample code	99M1951	99M1952	99M1953	99M1954	99M1955	99M1956
Sample intake (g)	50.26	50.44	15.56	15.36	15.09	15.88
% extractable fat	18.8	18.8	61.6	62.1	42.5	41.3
PCDD/F-GC/MS-file	as3137-1	as3138-1	as3142-1	as3143-1	as3144-1	as3145-1
noPCB-GC/MS-file	VG0663-15	VG0663-16	VG0663-20	VG0663-21	VG0664-1	VG0663-23
PCB-GC/MS-file	VG0937-24	VG0937-25	VG0937-29	VG0937-30	VG0937-31	VG0937-32
PCDDs and PCDFs	pg/g fat	pg/g fat	pg/g fat	pg/g fat	pg/g fat	pg/g fat
2,3,7,8-TCDD	0.05	0.04	0.03	<0.05	<0.08	0.03
1,2,3,7,8-PeCDD	0.11	0.09	0.05	<0.05	<0.08	0.05
1,2,3,4,7,8-HxCDD	0.11	0.10	0.03	<0.05	0.03	0.06
1,2,3,6,7,8-HxCDD	0.26	0.16	0.06	0.03	0.06	0.09
1,2,3,7,8,9-HxCDD	0.21	0.11	0.05	0.03	0.06	0.08
1,2,3,4,6,7,8-HpCDD	1.57	1.37	0.80	0.42	0.74	0.98
OCDD	11.58	11.00	18.22	13.29	11.45	14.62
2,3,7,8-TCDF	0.17	0.09	0.08	0.04	0.03	0.05
1,2,3,7,8-PeCDF	0.11	0.05	0.03	0.03	0.06	0.05
2,3,4,7,8-PeCDF	0.22	0.14	0.04	0.02	0.04	0.06
1,2,3,4,7,8-HxCDF	0.12	0.12	0.03	0.03	0.05	0.06
1,2,3,6,7,8-HxCDF	0.09	0.08	0.02	0.01	0.02	0.03
1,2,3,7,8,9-HxCDF	<0.05	<0.05	<0.05	<0.05	0.03	<0.08
2,3,4,6,7,8-HxCDF	0.09	0.07	0.04	0.04	0.05	0.07
1,2,3,4,6,7,8-HpCDF	0.32	0.26	0.09	0.08	0.11	0.16
1,2,3,4,7,8,9-HpCDF	0.05	0.04	0.02	<0.05	<0.08	0.03
OCDF	0.40	0.50	0.20	0.18	0.22	0.32
Non-ortho PCBs	pg/g fat	pg/g fat	pg/g fat	pg/g fat	pg/g fat	pg/g fat
3,3',4,4'-CB(77)	3.2	3.0	5.2	1.2	2.6	9.6
3,3',4,4',5-CB(126)	2.2	2.0	1.3	0.2	2.7	0.6
3,3',4,4',5,5'-CB(169)	*	*	*	*	*	*
Other PCBs	ng/g fat	ng/g fat	ng/g fat	ng/g fat	ng/g fat	ng/g fat
2,2',5-CB(18)	0.06	<0.04	0.10	0.12	0.16	1.46
2,4,4'-CB(28)	0.20	0.22	0.32	0.24	0.26	2.40
2,2',4,4'-CB(47)	<0.04	0.08	0.04	0.04	<0.04	0.30
2,2',4,5'-CB(49)	<0.04	0.04	0.04	0.04	<0.04	0.32
2,2',5,5'-CB(52)	0.08	0.10	0.04	0.06	0.08	0.76
2,3,4,4'-CB(60)	<0.04	<0.04	0.08	<0.04	<0.04	0.08
2,3',4,4'-CB(66)	0.06	0.08	0.08	<0.04	0.06	0.30
2,4,4',5-CB(74)	0.06	0.08	<0.04	<0.04	0.04	0.22
2,2',4,4',5-CB(99)	0.20	0.24	0.06	<0.05	<0.05	0.06
2,2',4,5,5'-CB(101)	0.10	0.16	0.18	0.08	0.04	0.34
2,3,3',4,4'-CB(105)	0.10	0.06	<0.05	<0.05	<0.05	<0.05
2,3,4,4',5-CB(114)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
2,3',4,4',5-CB(118)	0.34	0.25	0.22	0.16	0.10	0.16
2,3,4,4',5-CB(123)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
2,2',3,3',4,4'-CB(128)	<0.04	0.12	0.04	<0.04	<0.04	<0.04
2,2',3,3',4,4'-CB(138)	0.68	0.86	0.24	0.10	<0.1	0.26
2,2',4,4',5,5'-CB(153)	1.00	1.20	0.58	0.16	0.12	0.26
2,3,3',4,4',5-CB(156)	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
2,3,3',4,4',5'-CB(157)	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
2,3',4,4',5,5'-CB(167)	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
2,2',3,3',4,4',5-CB(170)	<0.04	0.20	0.14	<0.04	<0.04	<0.04
2,2',3,4,4',5,5'-CB(180)	0.40	0.52	0.20	<0.04	0.06	0.08
2,2',3,4,4',5',6-CB(183)	0.08	0.12	0.08	<0.04	<0.04	<0.04
2,2',3,4',5,5',6-CB(187)	0.12	0.15	0.19	<0.04	<0.04	<0.04
2,3,3',4,4',5,5'-CB(189)	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
2,2',3,3',4,4',5,5'-CB(194)	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Total WHO-TEQ - nd=0	0.66	0.53	0.30	0.07	0.35	0.25
Total WHO-TEQ - nd=LOD	0.75	0.62	0.39	0.27	0.59	0.34

* Not determined because of interference

Appendix 5 continued

Levels in composite samples of consumer food stuffs.

Description	Cheese A	Cheese B	Vegetables A	Vegetables B	Nuts A	Nuts B
RIVM sample code	99M1957	99M1958	99M2150	99M2151	99M2203	99M2204
Sample intake (g)	30.13	30.57	100.00	100.00	10.00	10.00
% extractable fat	32.7	31.7	1.28	0.19	42.20	44.30
PCDD/F-GC/MS-file	as3146-1	as3147-1	AS3497-1	AS3498-1	AS3499-1	AS3500-1
noPCB-GC/MS-file	VG0663-24	VG0663-25	VG0673-14	VG0673-15	VG0673-16	VG0673-17
PCB-GC/MS-file	VG0937-33	VG0937-34	VG0937-6	VG0937-7	VG0938-3	VG0938-4
PCDDs and PCDFs	pg/g fat	pg/g fat	pg/kg product	pg/kg product	pg/kg product	pg/kg product
2,3,7,8-TCDD	0.11	0.07	<5	<5	<50	<50
1,2,3,7,8-PeCDD	0.19	0.17	12	11	<50	<50
1,2,3,4,7,8-HxCDD	0.10	0.10	14	15	<50	<50
1,2,3,6,7,8-HxCDD	0.25	0.26	17	14	<50	<50
1,2,3,7,8,9-HxCDD	0.11	0.10	14	10	<50	<50
1,2,3,4,6,7,8-HpCDD	0.57	0.51	132	85	<50	<50
OCDD	2.48	1.94	758	535	1000	1200
2,3,7,8-TCDF	0.05	0.05	10	7	<50	<50
1,2,3,7,8-PeCDF	0.05	0.05	20	16	<50	<50
2,3,4,7,8-PeCDF	0.53	0.55	47	34	<50	<50
1,2,3,4,7,8-HxCDF	0.30	0.26	65	46	<60	<50
1,2,3,6,7,8-HxCDF	0.22	0.21	50	34	<50	<50
1,2,3,7,8,9-HxCDF	<0.05	<0.05	35	26	<50	<50
2,3,4,6,7,8-HxCDF	0.25	0.23	56	40	<50	<50
1,2,3,4,6,7,8-HpCDF	0.22	0.20	162	114	<100	<100
1,2,3,4,7,8,9-HpCDF	0.03	0.02	41	30	<50	<50
OCDF	0.18	0.06	265	94	251	247
Non-ortho PCBs	pg/g fat	pg/g fat	pg/kg product	pg/kg product	pg/kg product	pg/kg product
3,3',4,4'-CB(77)	1.5	1.3	214	133	<500	<500
3,3',4,4',5-CB(126)	7.3	6.9	27	20	<200	<200
3,3',4,4',5,5'-CB(169)	*	*	<40	<40	<400	<400
Other PCBs	ng/g fat	ng/g fat	ng/kg product	ng/kg product	ng/kg product	ng/kg product
2,2',5-CB(18)	0.04	0.06	3	2	51	151
2,4,4'-CB(28)	0.16	0.14	6	5	84	408
2,2',4,4'-CB(47)	0.10	0.10	1	1	17	62
2,2',4,5'-CB(49)	0.04	<0.04	1	1	<40	53
2,2',5,5'-CB(52)	0.10	0.06	3	2	34	89
2,3,4,4'-CB(60)	0.04	<0.04	1	0	42	44
2,3',4,4'-CB(66)	0.12	0.08	1	1	42	89
2,4,4',5-CB(74)	0.20	0.20	1	1	17	35
2,2',4,4',5-CB(99)	0.52	0.40	1	1	<50	35
2,2',4,5,5'-CB(101)	0.08	<0.04	3	2	68	115
2,3,3',4,4'-CB(105)	0.16	0.18	2	2	25	35
2,3,4,4',5-CB(114)	<0.05	<0.05	<1	<1	<50	<50
2,3',4,4',5-CB(118)	0.94	0.84	3	2	91	102
2,3,4,4',5-CB(123)	<0.05	<0.05	<1	<1	<50	<50
2,2',3,3',4,4'-CB(128)	0.18	0.08	1	<1	<40	27
2,2',3,3',4,4'-CB(138)	1.28	1.20	2	3	59	195
2,2',4,4',5,5'-CB(153)	1.80	1.50	5	5	152	239
2,3,3',4,4',5-CB(156)	0.08	0.08	<1	<1	<40	<40
2,3,3',4,4',5'-CB(157)	<0.04	<0.04	<1	<1	<40	<40
2,3',4,4',5,5'-CB(167)	0.08	<0.04	<1	<1	<40	<40
2,2',3,3',4,4',5-CB(170)	0.26	0.20	<1	1	<40	<40
2,2',3,4,4',5,5'-CB(180)	0.64	0.70	1	1	<40	80
2,2',3,4,4',5',6-CB(183)	0.14	0.14	<1	<1	<40	<40
2,2',3,4',5,5',6-CB(187)	0.07	<0.04	0	1	<40	<40
2,3,3',4,4',5,5'-CB(189)	<0.08	<0.08	<2	<2	<80	<80
2,2',3,3',4,4',5,5'-CB(194)	<0.08	<0.08	<2	<2	<80	<80
Total WHO-TEQ - nd=0	1.58	1.48	68	52	12	14
Total WHO-TEQ - nd=LOD	1.65	1.55	74	59	285	286

* Not determined because of interference

Appendix 5 continued

Levels in composite samples of consumer food stuffs.

Description	Fish, prepared A	Fish, prepared B	Fish, fatty A	Fish, fatty B
RIVM sample code	99M2205	99M2206	99M2207	99M2208
Sample intake (g)	100.00	100.00	70.00	70.00
% extractable fat	9.63	10.40	14.34	14.31
PCDD/F-GC/MS-file	AS3501-1	AS3505-1	AS3506-1	AS3507-1
noPCB-GC/MS-file	VG0673-21	VG0673-22	VG0673-23	VG0673-24
PCB-GC/MS-file	VG0938-5	VG0938-6	VG0938-7	VG0938-8
PCDDs and PCDFs	pg/kg product	pg/kg product	pg/kg product	pg/kg product
2,3,7,8-TCDD	20	16	65	179
1,2,3,7,8-PeCDD	10	5	173	233
1,2,3,4,7,8-HxCDD	11	5	38	47
1,2,3,6,7,8-HxCDD	33	23	133	175
1,2,3,7,8,9-HxCDD	22	14	44	33
1,2,3,4,6,7,8-HpCDD	132	127	713	149
OCDD	1039	1168	5694	2061
2,3,7,8-TCDF	71	66	1115	903
1,2,3,7,8-PeCDF	47	36	166	141
2,3,4,7,8-PeCDF	82	44	828	861
1,2,3,4,7,8-HxCDF	119	56	92	154
1,2,3,6,7,8-HxCDF	92	50	88	100
1,2,3,7,8,9-HxCDF	62	31	26	20
2,3,4,6,7,8-HxCDF	111	56	106	112
1,2,3,4,6,7,8-HpCDF	301	131	154	119
1,2,3,4,7,8,9-HpCDF	88	36	32	27
OCDF	142	84	64	47
Non-ortho PCBs	pg/kg product	pg/kg product	pg/kg product	pg/kg product
3,3',4,4'-CB(77)	2282	1481	22173	16176
3,3',4,4',5-CB(126)	1504	1153	12136	17791
3,3',4,4',5,5'-CB(169)	422	191	2103	3011
Other PCBs	ng/kg product	ng/kg product	ng/kg product	ng/kg product
2,2',5-CB(18)	15	<4	75	143
2,4,4'-CB(28)	35	23	430	778
2,2',4,4'-CB(47)	17	10	166	1420
2,2',4,5'-CB(49)	13	15	169	684
2,2',5,5'-CB(52)	33	31	657	4064
2,3,4,4'-CB(60)	10	12	129	372
2,3',4,4'-CB(66)	35	29	430	1749
2,4,4',5-CB(74)	17	23	247	813
2,2',4,4',5-CB(99)	96	75	769	4536
2,2',4,5,5'-CB(101)	77	100	1540	5295
2,3,3',4,4'-CB(105)	44	50	396	1325
2,3,4,4',5-CB(114)	<5	<5	<7	82
2,3',4,4',5-CB(118)	146	139	1205	5547
2,3,4,4',5-CB(123)	<5	<5	<7	<7
2,2',3,3',4,4'-CB(128)	42	42	347	1720
2,2',3,3',4,4'-CB(138)	289	256	2280	11666
2,2',4,4',5,5'-CB(153)	389	383	3232	21027
2,3,3',4,4',5-CB(156)	19	10	118	741
2,3,3',4,4',5'-CB(157)	<4	<4	34	160
2,3',4,4',5,5'-CB(167)	12	8	80	521
2,2',3,3',4,4',5-CB(170)	31	23	232	2192
2,2',3,4,4',5,5'-CB(180)	94	79	717	5132
2,2',3,4,4',5',6-CB(183)	15	17	206	1674
2,2',3,4',5,5',6-CB(187)	71	92	826	4960
2,3,3',4,4',5,5'-CB(189)	<8	<8	<11	63
2,2',3,3',4,4',5,5'-CB(194)	<8	<8	66	303
Total WHO-TEQ - nd=0	314	220	2308	4008
Total WHO-TEQ - nd=LOD	320	226	2313	4009

* Not determined because of interference

Appendix 5 continued

Levels in composite samples of consumer food stuffs.

Description	Fish, lean A	Fish, lean B	Crustaceans A	Crustaceans B
RIVM sample code	99M2209	99M2210	99M2211	99M2212
Sample intake (g)	500.00	500.00	350.00	350.00
% extractable fat	0.43	0.57	1.36	2.13
PCDD/F-GC/MS-file	AS3458-1	AS3459-1	AS3510-1	AS3511-1
noPCB-GC/MS-file	VG0774-3	VG0774-4	VG0673-30	VG0673-31
PCB-GC/MS-file	VG0938-12	VG0938-13	VG0938-14	VG0938-15
PCDDs and PCDFs	pg/kg product	pg/kg product	pg/kg product	pg/kg product
2,3,7,8-TCDD	25	50	90	104
1,2,3,7,8-PeCDD	20	43	71	88
1,2,3,4,7,8-HxCDD	3	5	38	42
1,2,3,6,7,8-HxCDD	26	39	76	91
1,2,3,7,8,9-HxCDD	8	9	51	57
1,2,3,4,6,7,8-HpCDD	28	34	516	533
OCDD	135	113	1668	1890
2,3,7,8-TCDF	259	468	881	946
1,2,3,7,8-PeCDF	54	75	65	124
2,3,4,7,8-PeCDF	72	173	286	324
1,2,3,4,7,8-HxCDF	13	26	83	116
1,2,3,6,7,8-HxCDF	16	25	43	72
1,2,3,7,8,9-HxCDF	1	2	14	31
2,3,4,6,7,8-HxCDF	18	32	84	112
1,2,3,4,6,7,8-HpCDF	16	30	240	290
1,2,3,4,7,8,9-HpCDF	3	6	24	3
OCDF	13	23	440	385
Non-ortho PCBs	pg/kg product	pg/kg product	pg/kg product	pg/kg product
3,3',4,4'-CB(77)	6459	11059	29986	23602
3,3',4,4',5-CB(126)	2630	4040	7618	6421
3,3',4,4',5,5'-CB(169)	371	621	559	352
Other PCBs	ng/kg product	ng/kg product	ng/kg product	ng/kg product
2,2',5-CB(18)	9	11	29	31
2,4,4'-CB(28)	46	63	117	125
2,2',4,4'-CB(47)	32	35	92	93
2,2',4,5'-CB(49)	41	44	144	141
2,2',5,5'-CB(52)	84	88	230	226
2,3,4,4'-CB(60)	21	20	37	50
2,3',4,4'-CB(66)	95	102	250	293
2,4,4',5-CB(74)	47	55	103	121
2,2',4,4',5-CB(99)	207	225	728	677
2,2',4,5,5'-CB(101)	249	251	1103	1066
2,3,3',4,4'-CB(105)	130	106	195	190
2,3,4,4',5-CB(114)	4	5	6	7
2,3',4,4',5-CB(118)	334	350	809	860
2,3,4,4',5-CB(123)	<0	<0	<1	<1
2,2',3,3',4,4'-CB(128)	112	88	282	275
2,2',3,3',4,4'-CB(138)	590	628	2097	2071
2,2',4,4',5,5'-CB(153)	858	977	3758	3842
2,3,3',4,4',5-CB(156)	37	38	90	89
2,3,3',4,4',5'-CB(157)	10	9	27	25
2,3',4,4',5,5'-CB(167)	25	27	93	98
2,2',3,3',4,4',5-CB(170)	90	85	57	39
2,2',3,4,4',5,5'-CB(180)	180	198	169	200
2,2',3,4,4',5',6-CB(183)	43	42	265	279
2,2',3,4',5,5',6-CB(187)	172	189	1181	1405
2,3,3',4,4',5,5'-CB(189)	4	5	10	14
2,2',3,3',4,4',5,5'-CB(194)	22	24	7	8
Total WHO-TEQ - nd=0	459	728	1377	1332
Total WHO-TEQ - nd=LOD	459	728	1377	1332

* Not determined because of interference

Appendix 6 Levels in samples of primary products

Results from measurements of PCDDs, PCDFs and dioxin-like PCBs in primary agricultural products. Concentrations are expressed in pg WHO-TEQ /g fat (non detect=0).

Product	Date	Location	PCDDs/PCDFs	non-ortho PCBs
egg	Nov 98	East	1.46	0.62
		West	1.12	0.59
		North	2.47	0.41
		South	0.54	0.90
	Jan 99	East	3.63	0.45
		West	2.56	0.52
		North	7.59	0.58
		South	0.59	0.70
	Apr 99	East	0.30	0.58
		West	0.44	0.61
		North	1.78	0.66
		South	1.02	0.86
milk	Oct 98	Lochem	0.85	0.80
		Woerden	1.06	1.07
		Leeuwarden	0.77	0.73
		Tilburg	0.73	1.23
	Dec 98	Lochem	0.67	0.62
		Woerden	1.06	0.63
		Leeuwarden	0.77	0.69
		Tilburg	0.13	0.79
	Feb 99	Lochem	0.52	0.73
		Woerden	0.40	1.51
		Leeuwarden	0.65	0.69
		Tilburg	0.02	0.96
poultry	Oct 98	Nijmegen	0.53	0.99
	Nov 98	Nijmegen	0.90	1.95
		Apeldoorn	0.33	0.91
	Dec 98	Amsterdam	0.48	0.43
	Jan 99	Doetinchem	0.63	0.95
		Assen	1.44	0.36
	Mar 99	Apeldoorn	1.03	0.58
		Apeldoorn	1.10	0.59
		Assen	0.37	0.36
		Weert	0.34	0.42
beef	Oct 98	Amsterdam	1.80	6.73
		Breda	1.51	21.39
	Nov 98	Assen	1.12	2.57
	Jan 99	Nijmegen	2.93	2.51
		Assen	0.82	0.92
	Mar 99	Almelo	1.96	1.15
		Amsterdam	1.57	1.62
		Assen	1.28	1.06
		Weert	1.42	1.85

Appendix 6 continued

Results from measurements of PCDDs, PCDFs and dioxin-like PCBs in primary agricultural products. Concentrations are expressed in pg WHO-TEQ /g fat (non detect=0). For fish and crustaceans concentrations are expressed in pg WHO-TEQ/g product.

Product	Date	Location	PCDDs/PCDFs	non-ortho PCBs
pig	Oct 98	Doetinchem	0.50	3.92
		Doetinchem	0.01	0.43
		Amsterdam	0.20	0.85
		Breda	0.48	0.16
	Nov 98	Assen	0.22	0.14
	Jan 99	Doetinchem	0.06	0.08
		Amsterdam	0.41	0.31
	Mar 99	Amsterdam	2.15	1.66
		Assen	0.54	0.33
		Breda	0.77	0.46
fish and crustaceans				
cod	Nov 98	Dutch coast	0.03	0.10
	Mar 99	Dutch coast	0.08	0.41
	Jun 99	N-North sea	0.05	0.20
eel	Nov 98	Lake IJssel	1.63	3.23
	Mar 99	Lake IJssel	0.51	2.06
haddock	Nov 98	S-North sea	0.08	0.15
	Mar 99	Norwegian coast	0.05	0.09
	Jun 99	N-North sea	0.04	0.08
herring	Nov 98	Dutch coast	0.70	0.69
	Mar 99	S-North sea	1.14	0.98
	Jun 99	Central North sea	0.49	0.61
mackerel	Nov 98	S-North sea	1.27	2.85
	Mar 99	S-W Ireland	0.22	0.91
	Jun 99	Central North sea	0.40	0.96
mussel	Nov 98	-	0.81	0.89
	Mar 99	-	0.54	0.55
plaice	Nov 98	'Doggersbank'	0.19	0.19
	Mar 99	Dutch coast	0.21	0.24
	Jun 99	S-North sea	0.19	0.16
pollack	Nov 98	Northern coast	0.05	0.14
	Mar 99	Northern coast	0.10	0.27
shrimps	Nov 98	-	0.52	0.40
	Mar 99	Terschelling	0.61	0.54
sole	Nov 98	Central North sea	0.08	0.13
	Mar 99	Dutch coast	0.29	0.55
	Jun 99	S-North sea	0.10	0.18
whiting	Nov 98	Dutch coast	0.15	0.29
	Mar 99	Dutch coast	0.16	0.35
	Jun 99	S-North Sea	0.13	0.32

Appendix 7 Results of CALUX-bioassay

Sample code RIKILT	Matrix	Bioassay result[1]	Level (GC/MS) PCDD, PCDF, and non-ortho PCB pg WHO-TEQ/g fat
2800	bovine fat	negative	
3973	bovine fat	*suspected*	5.44
4012	bovine fat	negative	1.74
4094	bovine fat	negative	
4098	bovine fat	negative	
4100	bovine fat	negative	
4102	bovine fat	negative	
4112	bovine fat	negative	
5533	bovine fat	negative	
5536	bovine fat	negative	
5539	bovine fat	negative	
8439	bovine fat	negative	3.27
8450	bovine fat	negative	3.11
8456	bovine fat	negative	2.34
8526	bovine fat	negative	
11324	bovine fat	negative	
14197	bovine fat	negative	
17367	bovine fat	*suspected*	22.90
17386	bovine fat	*suspected*	8.53
18204	bovine fat	negative	
18210	bovine fat	negative	
18217	bovine fat	negative	
18222	bovine fat	negative	
19246	bovine fat	negative	3.69
19992	bovine fat	negative	
19999	bovine fat	negative	
20004	bovine fat	negative	
22694	bovine fat	negative	
22699	bovine fat	negative	
22711	bovine fat	negative	
25564	bovine fat	negative	
25573	bovine fat	negative	
25574	bovine fat	negative	
25575	bovine fat	negative	
27995	bovine fat	negative	
27996	bovine fat	negative	
32803	bovine fat	negative	
32807	bovine fat	negative	
32811	bovine fat	negative	

[1]The sample is declared negative when the response in the test is lower than that of a reference sample butter fat, shown to contain 2.7 pg TEQ dioxins per gram and 2.3 pg TEQ non-ortho PCBs per gram by the GC/MS reference method.

Appendix 8 Food category system (in Dutch)

Food category system with coded items (NEVO, 1996), used to group dioxins and dioxin-like PCB containing food products. Product names are in Dutch to enable unambiguous identification.

A. Animal products

1. Beef
105 Kalfshersenen rauw
315 Vet rund- uitgesmolten
338 Pekelvlees
698 Rundvlees gezouten rauw
1400 Runderbiefstuk rauw
1401 Runderbiefstuk van de haas rauw
1402 Runderentrectte rauw
1404 Runder bak- en braadlappen rauw
1405 Gehakt runder- rauw
1406 Runderklapstuk rauw
1408 Runderpoulet rauw
1409 Runderlenderollade rauw
1410 Runderrosbief rauw
1411 Runderschenkel rauw
1412 Runderriblappen rauw
1413 Runder doorregen lappen rauw
1414 Rundersucadelappen rauw
1415 Rundertartaar rauw
1416 Rundertong rauw
1435 Hamburger rauw
1437 Vink blinde kalfs- rauw
1438 Kalfsfricandeau rauw
1663 Rundvlees <5 g vet rauw
1664 Rundvlees >5 g vet rauw
1673 Kalfsvlees <5 g vet rauw
1674 Kalfsvlees >5 g vet rauw
1536 Runderbiefstuk bereid
1538 Runderentrecotte bereid
1539 Runderbaklappen bereid
1540 Gehakt runder- rul bereid
1543 Runderpoulet bereid
1544 Runderrollade bereid
1545 Runderrosbief bereid
1546 Runderschenkel bereid
1547 Runderriblappen bereid
1548 Runder doorregen lappen bereid
1549 Rundersucadelappen bereid
1550 Rundertartaar bereid
1569 Hamburger bereid
1570 Kalfsentrectte bereid
1571 Vink blinde kalfs- bereid
1572 Kalfsfricandeau bereid
1601 Gehakt runder- z ei bereid
1665 Rundvlees <10 g vet bereid
1666 Rundvlees >10 g vet bereid

2. Pork
343 Spek vers vet rauw
1417 Varkensbraadworst rauw
1418 Varkensfiletlappen rauw
1419 Varkensfricandeau rauw
1420 Varkenshamlappen rauw
1421 Gehakt varkens- rauw
1422 Varkenshaas rauw
1423 Varkenshamschijf rauw
1424 Varkenshaaskarbonade rauw
1425 Varkensschouder-/halskarbonade rauw
1427 Varkenskrabbetjes rauw
1428 Varkensnasivlees rauw
1429 Varkensoester rauw
1430 Varkensschouderlappen rauw
1431 Vink sla- rauw
1432 Speklap zonder zwoerd rauw
1667 Varkensvlees <5 g vet rauw
1668 Varkensvlees 5-14 g vet onbereid
1669 Varkensvlees >15 g vet rauw
1788 Varkensribkarbonade rauw
1790 Varkensschnitzel ongepaneerd rauw
314 Vet varkens- uitgesmolten
1297 Spek vers bereid
1391 Spek mager bereid
1551 Varkensbraadworst bereid
1552 Varkensfiletlappen bereid
1553 Varkensfricandeau bereid
1554 Varkenshamlappen bereid
1555 Gehakt varkens- bereid
1556 Varkenshaas bereid
1558 Varkenshaaskarbonade bereid
1559 Varkensschouderkarbonade bereid
1561 Varkenskrabbetjes bereid
1562 Varkensnasivlees bereid
1564 Varkensschouderlappen bereid
1565 Vink sla- bereid
1566 Speklap zonder zwoerd bereid
1567 Speklap met zwoerd bereid
1646 Varkenslappen bereid
1647 Varkensribkarbonade bereid
1670 Varkensvlees <10 g vet bereid
1671 Varkensvlees 10-19 g vet bereid
1672 Varkensvlees >19 g vet bereid
1772 Varkensfricandeau gebraden
1789 Varkensschnitzel ongepaneerd bereid

3. Poultry
108 Kip met vel rauw
330 Kalkoen rauw
475 Kippelever rauw
1305 Kip zonder vel rauw
1306 Kip soep- met vel rauw
1317 Kip/bout zonder vel gegrild
1634 Kipfilet rauw
1642 Kiprollade rauw
1392 Kipfilet bereid
1633 Kip met vel bereid
1635 Kip zonder vel bereid
1641 Kiprollade bereid
1644 Kip nuggets bereid in frituurvet
1645 Kipburger gepaneerd bereid

4. Meat products
319 Corned beef
328 Ham rauwe
335 Pastei lever-
336 Luncheon meat blik
340 Runderrookvlees
344 Vleeswaren gem
567 Worst boterham-
568 Worst bloed-
638 Worst cervelaat-
639 Spek ontbijt-
640 Worst lever-
641 Bacon
642 Pbti
643 Casselerrib gerookt/gekookt
701 Worst cervelaat- Surinaams

782 Worst thee-
783 Worst paling-
784 Ham achter-
785 Ham schouder-
796 Worstsoorten gem
810 Filet amiricain
908 Soepballetjes blik
1152 Worst salami
1155 Gehakt gebraden
1162 Worst gekookte
1171 Vleeswaren 20-30 g vet
1172 Vleeswaren 10-20 g vet
1211 Vleeswaren <10 g vet
1238 Worst lever- hausmacher
1239 Worst smeerlever-
1367 Suguk droge worst Turks
1368 Salam droge worst Turks
1660 Vleeswaren Na- 20-30 g vet
1771 Leverkaas/Berliner
1773 Zult zure
1774 Worst tonge-
1775 Spek ontbijt- gegrild
1776 Ham achter- gegrild
1777 Ham been-

5. Mixed meats
324 Worst rook- gekookt
566 Worst knak- blik
1434 Gehakt hoh rauw
1326 Gehakt hoh rul gebakken
1375 Köfte rundergehakt Turks bereid
1376 Köfte schapegehakt Turks bereid
1390 Gehaktbal- runder met ei bereid
1568 Gehaktbal hoh bereid

6. Mutton
99 Schapevlees rauw
1443 Lamsbout rauw
1444 Gehakt lams- rauw
1445 Lamskarbonade rauw
1447 Lamsschouder rauw
1575 Lamsbout bereid
1576 Gehakt lams- bereid
1577 Lamskarbonade bereid
1578 Lamszadel bereid
1579 Lamsschouder bereid
1675 Lamsvlees gemiddeld rauw

7. Liver
333 Runderlever gekookt
334 Varkenslever gekookt
1407 Runderlever rauw
1426 Varkenslever rauw
1560 Varkenslever bereid

B. Dairy products

8. Butter
310 Boter ongezouten
879 Boter gezouten
1530 Boter halfvolle

9. Cheese
304 Kaas strooi- Zwitserse pak
511 Kaas Edammer 40+
512 Kaas 40+ korstloze
513 Kaas Goudse 48+
514 Kaas 20+ Leidse/Friese nagel-
515 Kaas smeer- volvet 48+ pak/kuip
516 Kaas smeer- 40+ pak/kuip
517 Kaas smeer- 20+ pak/kuip
556 Kaas Camembert 45+
593 Kaas Brie 50+
654 Kaas cottage cheese kuip
714 Kaas Roquefort
715 Kaas room- 60+
716 Kaas Saint Paulin
718 Kaas Parmezaanse
719 Kaas room- zachte pak
721 Kaas Limburgse
722 Kaas Gruyhre
724 Kaas Emmenthaler
725 Kaas Cheddar
726 Kaas Bluefort
728 Kaas room- zachte pak
804 Kaas schape-
881 Kaas 48+ minder zout
882 Kaas Kernhemmer 60+
883 Kaas Amsterdammer 48+
927 Kaas 20+ Na-
928 Kaas 40+ Na-
1103 Kaas smeer- 30+
1104 Kaas rook-
1108 Kaas rambol
1109 Kaas smeer-
1110 Kaas Stilton
1112 Kaas rauwe melkse 48+
1113 Kaas 48+ Na-
1302 Kaas room- zachte pak
1362 Kaas schape- vet Turks
1363 Kaas schape- mager Turks
1382 Kaas 30+
1385 Kaasprodukt m plantaardige olie kuipje
1487 Kaas Brie 60+
1489 Kaas verse light 8% vet
1650 Kaas geite- verse naturel pakje
1723 Kaas 20+
1724 Kaas 50+
1725 Kaas Maasdam 45+
1726 Kaas 40+ Leidse/Friese nagel-
1727 Kaas 20+ korstloze
1809 Kaas 45+
9644 Kaas smeer- Mister Cheez Frico

10. Milk
241 Brood wit- melk
270 Melk rauwe
272 Melk chocolade- volle pak/fles
273 Melk chocolade- magere pak/fles
276 Vla chocolade- volle pak/fles
278 Yoghurt volle pak/fles
279 Melk volle pak/fles
280 Melk koffie- volle pak/fles
282 Vla vanille- volle pak/fles
283 Room half- fles
284 Yoghurt magere met vruchten pak/fles
285 Melk koffie- halfvolle pak/fles
286 Melk halfvolle pak/fles
287 Hangop
288 Pap havermout-
289 Melk karne- pak/fles
290 Pap karnemelkse-
293 Room koffie- fles
294 Melk magere pak/fles
295 Melkpoeder magere pak
296 Melkpoeder volle pak
298 Pap rijste-
299 Room slag- onbereid pak
300 Yoghurt volle Bulgaarse pak/kuip
301 Yoghurt magere pak/fles
303 IJs room-
305 Kwark magere pak/kuip
306 Kwark halfvolle pak/kuip
307 Kwark volle pak/kuip
477 Vla vanille- magere pak
478 Vla chocolade- magere pak
479 Melk karne- met vruchten
485 IJs Conotop
532 Pudding chocolade- pak/beker

657 Yoghurtdrank
720 Kwark magere met vruchten pak/kuip
736 Pudding vanille- kuip
767 Mousse chocolade- kuip
786 Pudding chipolata- kuip
812 Room zure pak
862 Milkshake
863 Yoghurt volle met vruchten pak
912 Pudding frambozen- met bessensaus kuip
915 Pudding chocolade- met roomsaus kuip
916 Yoghurt Bulgaarse magere pak
917 Kwark vruchten- halfvolle kuip
926 IJs room- z suiker pak
931 Kwark vruchten- magere kuip
933 Pudding caramel- kuip
938 Pudding griesmeel- met rode bessensap
940 Pudding vanille- met aardbeiensaus kuip
996 IJs room- z suiker pak
1002 IJs consumptie- Delight Line
1008 Toetje met room kuip
1085 Melkpoeder halfvolle instant blik
1313 Umer kuip
1336 Zuivelhapje met fruit Olvarit 8 mnd
1464 Melk chocolade- halfvolle
1469 Room banketbakkers-
1472 Crème au beurre
1502 Yoghurt halfvolle
1503 Room garde- 25% vet onbereid
1504 Dessert yoghurt- light met zoetstof
1681 Dieetopvolgmelk Nutrilon pepti plus poeder
1719 Melk Calcium plus
1720 Vla volle overige smaken
1721 Yoghurt vanille- halfvolle
1722 Pap griesmeel-
1757 Melk lactose-arm Nutrilose per 100 ml
1791 Spuitroom bus
1808 Crème fraiche
1813 Yakult drank
1829 Yoghurt Vifit volle naturel
1830 Yoghurt Vifit met vruchten
1831 Yoghurtdrank Vifit halfvolle naturel
1832 Yoghurtdrank Vifit met vruchtensap
1834 Yoghurtdrank met vruchtensap z suiker m zoetstof
9654 IJs Multivit Eismann
9660 Milk Crazy Coberco

C. Fish

11. Lean fish
114 Vis mager 0-2 g vet rauw
115 Vis matig vet >2-10 g vet rauw
813 Schol rauw
819 Kabeljauw gekookt
820 Kabeljauw rauw
919 Koolvis gekookt
1098 Inktvis rauw
1590 Tonijn naturel in water blik
1613 Kabeljauw vers/diepvries bereid in magnetron
1615 Koolvis vers/diepvries bereid in magnetron
1617 Schol vers/diepvries bereid in magnetron
1619 Tong bereid in magnetron

12. Fatty fish
112 Paling vers
113 Haring pan- rauw
116 Vis vet >10 g vet rauw
347 Bokking gerookt
349 Haringfilet in tomatensaus blik
350 Haring gezouten
355 Sardines blik
602 Zalm blik
603 Paling gerookt
604 Makreel gestoomd
822 Bokking bak- gebakken
1096 Zalm gerookt
1100 Haring gemarineerd
1255 Makreel naturel blik
1585 Heilbot gerookt
1586 Makreelfilet gerookt
1587 Zalm rauw
1605 Bokking gestoomd
1606 Haring gerookt
1610 Zalm bereid in magnetron
1611 Forel bereid in magnetron

13. Crustaceans
111 Mosselen gekookt
348 Garnalen gepeld
351 Krab
352 Kreeft gekookt
354 Oesters
702 Garnalen gezouten gedroogd
704 Garnalenpasta trassie
1630 Mosselen in zuur glas
1631 Garnalen naturel blik

14. Fish, prepared
814 Vissticks gebakken
815 Vissticks onbereid
817 Schol gebakken
818 Lekkerbekje gebakken
1310 Scholfilet bereid
1315 Kabeljauwfilet gebakken/gestoofd
1583 Mosselen gebakken/gefrituurd
1584 Inktvisringen gefrituurd
1588 Ansjovis in olie blik
1589 Tonijn in olie blik
1609 Makreel in olie blik

D. Eggs

15. Eggs
83 Ei kippe- rauw
84 Ei kippe- gekookt
85 Eidooier kippe- rauw
86 Eidooier kippe- gekookt
87 Eipoeder gedroogd
382 Advokaat
1314 Ei kippe- gebakken

E. Vegetable products

16. Wheat products
209 Cornflakes pak
213 Mout haver- pak
225 Ontbijtprodukt pak
229 Knäckebröt gemiddeld
236 Brood tarwe-
240 Koek ontbijt-
242 Brood rogge- donker
243 Brood rogge- licht
246 Brood volkoren-
248 Brood wit- water
249 Brood mout-
530 Meel pannekoek- pak
565 Brood geroosterd toast pak
596 Knäckebröt goudbruin
656 Muesli z suiker pak/zak
659 Macaroni gekookt z zout
811 Macaroni volkoren onbereid pak
887 Muesli met suiker pak/zak
1014 Rijst zilvervlies- gekookt
1017 Brood tarwerogge volkoren
1312 Toast naturel Cracottes pak
1395 Brood rogge-
1481 Wafel rijst- met zout
1779 Knäckebröt volkoren

1802 Knäckebröt sandwich

17. Nuts

198 Noten amandelen gepeld
199 Noten cashew-
200 Noten hazel-
201 Kastanjes
202 Kokosnootvlees
203 Noten para-
204 Noten pinda's ongezouten
205 Studentenhaver
206 Noten wal-
207 Noten gemengd ongezouten
455 Pindakaas
541 Pindakaas met stukjes noot
546 Noten borrel- special mix
550 Saus saté- onbereid
616 Saus saté- bereid
790 Amandelspijs met ei
809 Melk kokos- santen vast
872 Zonnebloempitten
876 Noten pinda's gezouten
1256 Marsepein

18. Vegetable oils and fats

122 Chips
267 Stokjes zoute
271 Melk koffie- volle mov verrijkt fles
274 Creamer koffie- Completa
275 Melk koffie- halfvolle linolzuurverrijkt fles
308 Olie arachide-
312 Olie mais-
313 Olie soja-
317 Olie zonnebloem-
318 Margarine >40-60 g linolzuur
430 Cacaopoeder pak
437 Saus cocktail- 25% olie
449 Kokosbrood
451 Mayonaise 80% olie
458 Saus sla- 25% olie
465 Saus frites- 25% olie
466 Saus frites- 35% olie
535 Cacaopoeder gezoet pot
549 Saus kerrie-ananas 25% olie
552 Saus sla- slank 5% olie
553 Dressing 40% olie
554 Creamer koffie- pot
555 Topping met suiker opgeklopt
574 Spread komkommer-
575 Spread sandwich-
601 Olie olijf-
606 Olie Becel-
607 Olie saffloer-
608 Olie maiskiem-
612 Saus frikandel- 15% olie
617 Ringlings
618 Nibbits
619 Wokkels
620 Frites sticks
631 Margarine 0-20 g linolzuur
632 Margarine >20-40 g linolzuur
687 Tahoe sojakaas pak
688 Tempeh sojaprodukt pak
729 Saus sla- 40% olie
732 Vet bak- en braad- >40-60 g linolzuur
838 Sesamzaad
852 Salade selderij-
867 Lijnzaad
870 Melk soja- gem vloeibaar
946 Aardappel driekantjes ber in zonnebloemolie
1094 Pasta plantaardig blik
1379 Vet frituur- vloeibaar >40 g linolzuur
1384 Dressing 20% olie
1386 Kaasprodukt m plantaardige olie snijdbaar
1490 Kaasprodukt m plantaardige olie 48+ snijdbaar
1505 Chips light
1511 Hamburger vegetarisch onbereid
1512 Schnitzel vegetarisch onbereid
1525 Vet bak- en braad- pak
1527 Halvarineprodukt >20-<40% vet
1529 Margarineprodukt <80% vet >40-60 linolz
1580 Margarineprodukt <80% vet 0-20 g linolz
1600 Saus sla- 10% olie light
1801 Vet bak- en braad- vloeibaar
9646 Halvarine Blue Band met Ca+
9665 Dessert soja choco/vanille/caramel V p 100 ml

19. Vegetables

7 Andijvie rauw
8 Andijvie gekookt z zout
11 Aubergine gekookt z zout
13 Selderij bleek- gekookt z zout
14 Kool bloem- rauw
15 Kool bloem- gekookt z zout
16 Kool boeren- gekookt z zout
17 Cantharellen rauw
18 Cantharellen gekookt z zout
19 Champignons rauw
20 Champignons gekookt z zout
21 Kool Chinese rauw
22 Kool Chinese gekookt z zout
24 Kool groene rauw
25 Kool groene gekookt z zout
26 Selderij knol- gekookt z zout
27 Komkommer rauw
28 Komkommer gekookt z zout
29 Koolraap gekookt z zout
30 Koolrabi gekookt z zout
31 Paprika groene rauw
32 Paprika groene gekookt z zout
34 Groenten winter- gem gekookt z zout
36 Postelein gekookt z zout
37 Prei gekookt z zout
38 Raapstelen rauw
39 Raapstelen gekookt z zout
40 Rabarber rauw
41 Kool rode rauw
42 Kool rode gekookt z zout
43 Kool savooie- rauw
44 Kool savooie- gekookt z zout
46 Sla rauw
47 Sla gekookt z zout
48 Snijbiet gekookt z zout
50 Bonen sperzie- rauw
51 Spinazie rauw
52 Spinazie gekookt z zout
53 Kool spits- rauw
54 Kool spits- gekookt z zout
55 Spruitjes gekookt z zout
57 Mais suiker- gekookt z zout
58 Taugé rauw
59 Taugé gekookt z zout
60 Tomaat rauw
61 Tomaat gekookt z zout
63 Ui rauw
64 Ui gekookt z zout
65 Sla veld- rauw
66 Sla veld- gekookt z zout
67 Witlof rauw
68 Witlof gekookt z zout
69 Kool witte rauw
70 Kool witte gekookt z zout
71 Wortelen rauw
72 Wortelen gekookt z zout
73 Kool zuur- rauw
74 Kool zuur- gekookt z zout
75 Groenten soep- rauw
77 Groenten zomer- gem rauw
124 Radijs rauw

125 Ramenas rauw
126 Sterkers rauw
127 Rauwkost gem
130 Asperges blik/glas
131 Augurken tafelzuur glas
132 Augurken zoetzuur glas
133 Champignons blik/glas
134 Doperwten middelfijn blik/glas
135 Doperwten zeer fijn blik/glas
136 Doperwten met wortelen blik/glas
137 Olijven blik/glas
138 Bonen snij- blik/glas
139 Bonen sperzie- blik/glas
140 Spinazie blik/glas
141 Puree tomaten- geconcentreerd blik
142 Bonen tuin- blik/glas
143 Wortelen blik/glas
144 Uien zilver- zoetzuur glas
145 Kool rode blik/glas
146 Spinazie diepvries
197 Bonen witte in tomatensaus blik/glas
341 Groenten zomer- gem gekookt z zout
538 Rabarbermoes glas
557 Selderij bleek- rauw
558 Selderij knol- rauw
560 Koolrabi rauw
561 Postelein rauw
562 Prei rauw
650 Kool rode met appeltjes diepvries
660 Bonen bruine blik/glas
682 Pompoen rijp
849 Venkel rauw
850 Groenten zoetzuur atjar tjampoer glas
851 Paprika zoetzuur glas
884 Paprika rode rauw
885 Paprika rode gekookt
920 Broccoli gekookt z zout
921 Broccoli rauw
922 Courgette rauw
951 Bonen sperzie- gekookt z zout
952 Kool boeren- diepvries gekookt
953 Doperwten diepvries gekookt
954 Bonen sperzie- diepvries gekookt
957 Asperges gekookt z zout
958 Bieten gekookt z zout
961 Bonen snij- gekookt z zout
962 Bonen tuin- gekookt z zout
963 Doperwten gekookt z zout
964 Peultjes gekookt z zout
965 Groenten winter- gem rauw
966 Courgette gekookt z zout
967 Venkel gekookt z zout
968 Bonen witte/bruine gekookt
1021 Artisjok rauw
1118 Bieten Na- blik/glas
1119 Doperwten extra fijn Na- blik/glas
1136 Andijvie diepvries
1139 Doperwten met wortelen diepvries
1141 Groentemix Mexico diepvries
1142 Groentemix poesta diepvries
1143 Bonen snij- Hollandse diepvries
1144 Groenten soep- diepvries
1146 Spinazie gesneden diepvries
1147 Spruitjes diepvries
1148 Bonen tuin- diepvries
1153 Augurken Na- glas
1154 Kool zuur- Na- blik/glas
1158 Uien zilver- zoetzuur Na- glas
1159 Uien zilver- zoetzuur z suiker glas
1161 Komkommerschijven zoetzuur glas
1187 Bamboespruiten blik/glas
1370 Druiveblad glas
1372 Puree tomaten- Turks geconcentreerd blik
1393 Ui gebakken
1394 Champignons gebakken met zout
1396 Rabarbermoes huishoudelijk bereid m suiker
1397 Tomaat gestoofd
1398 Kool boeren- met zout glas
1399 Sla ijsberg-
1454 Bieten rode zoetzuur glas
1484 Uitjes gefrituurd zak
1811 Kouseband gekookt z zout

F. Industrial oils and fats

20 Industrial oils and fats
121 Aardappelpuree bereid
123 Frites ongezouten bereid
265 Korstgebak zout
302 IJs consumptie-
309 Vet bak- en braad- 0-20 g linolzuur
316 Halvarine <20 g linolz 25-150 mg chol
325 Margarine 0-20 g linolz 0-300 mg chol pakje
856 Rösti onbereid
877 Frites gezouten bereid
880 Smeltjus onbereid pak
886 Frites oven- bereid
905 Vet frituur- 0-40 linolz 50-300 chol
907 Vet frituur- 0-40 g linolzuur
909 Halvarine 0-20 g linolzuur
945 Aardappel driekantjes bereid in diamantvet
948 Rösti bereid z vet
1150 Aardappelschijfjes diepvries onbereid
1260 Saus yoghurtbasis 25% olie
1456 Frites voorgebakken
1457 Aardappelen gebakken
1492 Jus gemiddeld vet
1501 Kruidenmix met groente zakje
1515 Saus op basis roux bereid
1517 Saus op basis pakje <3% vet bereid
1518 Saus op basis pakje >3% vet bereid
1524 Saus tomaten- kant en klaar glas
1526 Vet frituur- dierlijk en plantaardig vet
1678 Aardappelschijven bereid
1679 Frites oven- diepvries bereid
1680 Aardappelkroketten diepvries bereid
1797 Halvarineprodukt 0-5% vet
1798 Halvarineprodukt >5-20% vet
1799 Elmer halfvol
1800 Vet bak- en braad- >20-40 g linolzuur

21. Bakery products
227 Beschuit pak
228 Cracker cream- pak
230 Broodje luxe witte
232 Broodje koffie-
233 Brood krente-
234 Voedingsbiscuit peuter
235 Voedingsbiscuit kleuter
244 Brood rozijnen-
250 Broodje amandel-
251 Taart appel-
252 Biscuit
253 Cake eenvoudige
254 Koek eier-
255 Taart slagroom-
256 Taart crème au beurre-
257 Koek gevulde
258 Koekje
259 Kokosmakronen
261 Speculaas
262 Spritsstukken
263 Biscuit volkoren-
264 Biscuit zoute
468 Tompouce
474 Oliebol bereid in sojaolie
480 Chocoprince
481 Koek Bastogne
486 Vlaai vruchten-
489 Vlaai rijste-

518 Biscuit volkoren- goudgraantje
633 Bokkepootje
634 Koek kokos- klapper
635 Krakeling
636 Koek muesli-
655 Beschuit volkoren pak
713 Wafel stroop-
746 Puddingpoeder pak
789 Koek boter-
833 Appelcarri
835 Taart kwark-
836 Taart zand-
854 Taart vruchten-
855 Speculaas gevulde
873 Voedingsbiscuit Evergreen krenten
878 Croissants bereid blik
898 Pasteibakje roomboter
899 Pasteibakje
975 Knäckebröt sesam
1013 Paneermeel pak
1319 Voedingsbiscuit Switch overige smaken
1321 Voedingsbiscuit Switch appel/bosvruchten
1339 Koekjes bere- Bambix
1356 Voedingsbiscuit Evergreen overige smaken
1365 Baklava noten-honing gebak Turks
1459 Brood krente- volkoren
1460 Koek ontbijt- met vruchtenvulsel
1471 Biscuit chocolade-
1473 Doughnuts ongevuld
1475 Soes slagroom-
1476 Taart schuim- met crème au beurre
1477 Koekje voor diabetici
1478 Vlaai kruimel- gem
1479 Taart Mon Chou-
1480 Cake Pimm's
1506 Soesje kaas-
1507 Borstplaat room-
1699 Koekje kaas- gemiddeld

22. Snacks
266 Broodje saucijze-
269 Kroepoek bereid
322 Frikandel bereid
326 Kroket bereid
369 Loempia bereid
609 Nasibal diepvries bereid
610 Bamibal bereid
943 Bitterbal bereid in oven
1643 Kip nuggets bereid in oven

23. Complex dishes
368 Bami goreng blik
370 Macaroni met ham en kaassaus blik
371 Nasi goreng blik/diepvries
467 Pannekoek bereid
469 Babi pangang
470 Bami goreng zonder ei
471 Nasi goreng met ei
472 Tjap tjoi
473 Foe jung hai
577 Salade huzaren-
614 Slaatje huzaren-
627 Stamppot boerenkool bereid
646 Spaghetti Bolognaise diepvries
647 Stamppot boerenkool met worst diepvries
651 Spinazie á la crème diepvries
757 Soep heldere met vermicelli en groenten
758 Soep heldere met vlees
759 Soep heldere met groenten
760 Soep heldere met vermicelli en vlees
761 Soep heldere met vlees en groenten
762 Soep heldere m vlees/vermicelli/groenten
763 Soep gebonden met groenten
764 Soep gebonden met vlees
766 Soep met peulvruchten met vlees
787 Ragout met vlees
792 Soep gebonden met vlees en groenten
797 Soep op groentebasis bereid pak
798 Soep op vleesbasis bereid pak
800 Soep op groentebasis bereid blik
801 Soep op vleesbasis bereid blik
802 Soep op peulvruchtenbasis bereid blik
803 Soep maaltijd- bereid blik
806 Pizza met kaas en tomaat
843 Broodje worste- diepvries
853 Gado gado z rijst en z ei
865 Saté kip- met saus bereid
892 Pizza mini diepvries
893 Saté varkens- met saus
901 Broodje worste-
944 Kroket bereid in oven
1191 Stamppot zuurkool met worst diepvries
1279 Maaltijd Olvarit 15 mnd
1377 Groenteschotel met vlees Turks bereid
1378 Dolma patliga gevulde aubergine Turks bereid
1483 Stamppot boerenkool zonder vlees bereid
1485 Stamppot wortel/ui zonder vlees bereid
1488 Kaassouffli onbereid
1491 Lasagna koelverse maaltijd met saus en vlees
1493 Taart hartige op basis pak m groente/kaas/ham
1494 Pizza met vlees diepvries
1495 Pizza met groente diepvries
1496 Salade vis-
1497 Salade ham-prei-
1498 Salade kip-kerrie-
1499 Salade ei-
1533 Taart hartige bladerdeeg met groente/kaas/ham
1534 Pizza met crossabodem diepvries
1582 Soep luxe bereid pakje
1595 Chili con carne bereid
1770 Maaltijd sprookjesmenu Olvarit 15 mnd
1815 Bami goreng koelverse maaltijd
1818 Andijvie koelverse maaltijd met vlees
1820 Kip-kerrie koelverse maaltijd
1822 Chili con carne koelverse maaltijd
1824 Lasagne diepvriesmaaltijd
9620 Maaltijd Kip Tandoori Cocos-rijst Struik
9626 Maaltijd Hacheeschotel Struik
9627 Maaltijd Goulashschotel Struik

24. Sweets
431 Chocolade melk-
432 Chocolade pure
433 Vlokken chocolade- melk
434 Boter chocolade-
435 Vlokken chocolade- puur
436 Pasta hazelnoot-
444 Pasta chocolade- puur
461 Toffee
487 Mars
524 Chocolade M&M's
525 Milky way
526 Bounty
528 Snickers
570 Nuts
621 Chocolade M&M's met pinda's
717 Chocolade met noten
727 Bonbon met likeur
845 Twix
929 Chocolade melk- zonder suiker
1311 Hagelslag chocolade- gem
1508 Bonbon
1509 Reep muesli- met chocolade

G. Not categorized

25. Not categorized
5 Rijst geslepen onbereid pak
33 Rozijnen gedroogd pak
78 Meel gries- poeder pak/zak

80	Bloem rijste- pak
82	Vermicelli onbereid pak
94	Nier rauw
95	Paardevlees rauw
106	Eend rauw
107	Haas rauw
109	Konijn tam rauw
118	Erwten groene gedroogd pak
147	Appel z schil
148	Aardbeien
149	Abrikozen
150	Ananas
151	Banaan
152	Bessen blauwe
153	Bessen rode
154	Bessen zwarte
155	Bessen bos-
156	Bessen vosse-
157	Bramen
158	Citroen
159	Cranberries vers
160	Druiven witte/blauwe m schil
161	Frambozen
162	Grapefruit
163	Kersen
165	Mandarijn
166	Meloen net-
167	Morellen
168	Peer
169	Perzik
170	Pruimen m schil
171	Sinaasappel
172	Fruit citrus- gem
173	Fruit gem zonder citrusfruit
174	Aardbeien op siroop blik/glas
175	Abrikozen gedroogd
176	Abrikozen op siroop blik/glas
177	Ananas op siroop blik/glas
178	Appeltjes gedroogd
179	Appelmoes blik/glas
181	Dadels geconfijt
183	Fruitcocktail op siroop blik/glas
184	Kersen op siroop blik/glas
185	Krenten gedroogd pak
186	Mandarijnen op siroop blik/glas
188	Peren op siroop blik/glas
189	Perziken op siroop blik/glas
190	Pruimen gedroogd
191	Pruimen op siroop blik/glas
192	Tutti-frutti gedroogd
193	Vijgen gedroogd
194	Vruchten op siroop blik/glas
195	Fruit Olvarit 8 mnd
196	Kapucijners blik/glas
208	Meel boekweite- pak
210	Custard poeder pak
212	Gort parel- gortebloem pak
215	Maizena poeder pak
216	Puddingpoeder pak
220	Bloem tarwe- patent pak/zak
222	Meel tarwe- pak/zak
223	Bindmiddel gemiddeld
226	Meel aardappel- pak
231	Kiemen tarwe- pak
238	Cracker tea- matses pak
245	Voedingsbiscuit Sanovite
260	Lange vingers
297	Melk moeder-
320	Fazant rauw
339	Ree wild rauw
358	Eiwit kippeki rauw
372	Maaltijd Olvarit 8 mnd
373	Spaghetti met kaas en tomatensaus blik
374	Suiker basterd- bruine
375	Suiker basterd- witte
376	Stroop huishoud-
377	Suiker kristal-
378	Stroop keuken-
379	Stroop melasse-
381	Stroop suiker-
383	Sap appel-
385	Vruchtendrank rode bessen
386	Jenever bessen-
387	Vruchtendrank zwarte bessen
388	Sap besse-
389	Bier oud bruin
390	Bier pils
391	Brandewijn
392	Campari
393	Jenever citroen-
394	Cognac
395	Frisdrank cola
396	Sap druive-
398	Bronwater Evian
399	Vruchtendrank frambozen
400	Frisdrank
401	Jenever jonge
402	Jenever oude
403	Likeur 15-25% alc
406	Bronwater Perrier
407	Port
408	Rum
409	Sherry
410	Sap sinaasappel-
411	Bronwater Spa
412	Wijn Spaanse zoete
413	Sap tomaten-
414	Frisdrank tonic
415	Vermouth zoete
416	Vieux
417	Limonade vruchten-
419	Bronwater Victoria
420	Bronwater Vittel
421	Whisky
422	Wijn rode
423	Wijn witte
424	Weidrank Rivella rood
425	Weidrank Rivella light
427	Stroop appel-
428	Saus barbecue-
429	Bouillonblokje per gram pak
439	Gelatine pak
440	Gember op siroop glas
441	Gistextract
442	Hagelslag vruchten-
443	Honing
445	Jam huishoud-
446	Kauwgom
447	Kauwgom z suiker
450	Zuurtjes
453	Pepermunt
454	Piccalilly
457	Jam rozebottel-
462	Ketchup tomaten-
463	Siroop vruchtenlimonade- fles
482	Spekkie
484	Jam halfzoet halvajam
488	Puddingpoeder chocolade pak
497	Siroop rozebottel- Roosvicee diverse smaken
498	Siroop rozebottel- Roosvicee ferro
499	Siroop rozebottel- Roosvicee glucose
500	Siroop rozebottel- Roosvicee laxo
501	Siroop rozebottel- Roosvicee stop
519	Drop topdrop
520	Drop zoute
521	Drop dubbelzoute
522	Drop zoete
523	Stophoest
531	Meel poffertjesmix pak
536	Vruchtendrank eendrank

539	Dessertsaus vruchten-
540	Dessertsaus chocolade-
548	Saus schaschlik-
569	Toffee crisp
583	Ketchup hot
584	Ketchup curry-
590	Zemelen tarwe- pak
595	Cacaoprodukt poeder
599	Water 50-100 mg calcium per liter
605	Watergruwel Bessola
611	Lihanboutje bereid
622	Puddingpoeder overige smaken pak
630	Popcorn gepoft
644	Koffie bereid
645	Thee bereid
653	Rice Krispies gepoft pak
658	Rijst witte gekookt z zout
664	Sap grapefruit-
671	Bataat zoete rauw
686	Erwten splitpesie Surinaams gedroogd
689	Avocado
691	Lemmetje
692	Mango
693	Papaja rijp
694	Tamarinde
696	Meel mais-
733	Spread groente-
737	Aardappelpuree instant bereid
738	Siroop rozebottel- Roosvicee dieet
745	Stroop huishoud- gem
747	Bronwater
749	Vlaaivulling blik
750	Marsh mellows
751	Drop Engelse
752	Winegums
756	Biscuit ontbijt-
765	Soep met peulvruchten z vlees
791	Soep heldere met vermicelli
799	Soep op peulvruchtenbasis bereid pak
805	Jägermeister
807	Jam zonder suiker
837	Koek haver-
842	Bouillonpoeder per gram glas
844	Dressing naturel zonder olie Slafris
847	Gierst onbereid pak
857	Madeira
858	Juspoeder per gram
859	Aroma vloeibaar per gram glas
860	Aroma strooi- per gram
866	Vruchtenkoekjes
871	Sojapasta miso pot/pak
875	Appel met schil
923	Sap pere-
925	Koek ontbijt- volkoren
930	Wijn pleegzusterbloed-
947	Aardappel driekantjes bereid in oven
955	Rijst parboiled gekookt
969	Kapucijners gekookt
970	Linzen gekookt
971	Bonen soja- gekookt z zout
972	Erwten groene gekookt z zout
976	Knäckebröt lichtgewicht
980	Sportvoeding Isostar energiereep
981	Sportvoeding isotone drank Isostar poeder
982	Aardappelen gekookt
992	Puddingpoeder griesmeel z suiker pak
994	Puddingpoeder chocolade z suiker pak
1012	Voedingsbiscuit Na-
1015	Tarwe gebroken bulgur gedroogd pak
1019	Grutten boekweite- pak
1020	Meel bak- zelfrijzend pak
1022	Beschuit Na- pak
1023	Bloem rijste- instant pak
1025	Gist gedroogd
1029	Polymere sondevoeding Nutrison Energy per 100 ml
1030	Polymere sondevoeding Nutrison standard per 100 ml
1048	Polymere drinkvoeding Fortimel per 100 ml
1052	Polymere drinkvoeding E+ Kh+ Citrotene poeder
1054	Modulair eiwitconcentraat poeder
1056	Kiwi fruit
1057	Kaki
1059	Maaltijdvervangend produkt Modifast poeder
1062	Modulair Kh+ preparaat Fantomalt
1065	Preparaat glucose poeder
1074	Passievrucht
1088	Zoetstof Natrena tablet
1089	Zoetstof Natrena vloeibaar per druppel
1090	Lychee
1092	Zoetstof Sionon poeder
1095	Erwten kikker- gekookt
1097	Kaviaar/cod roe
1105	Meloen water-
1106	Meloen suiker-
1114	Banaan bak- rauw
1127	Citroensap vers
1131	Bronwater Chaudfontaine
1132	Sap tomaten-groente blik
1134	Berenburg
1135	Siroop limonade- z suiker
1137	Sap appel- bereid
1145	Vruchtendrank tweedrank
1182	Puree appel- z suiker blik/glas
1213	Ketjap zout
1214	Ketjap zoet Na-
1215	Ketjap zoet
1217	Puree frambozen-bessen- blik/glas
1219	Puree bananen- blik/glas
1222	Gistextract Na- glas
1237	Algenkondiment
1242	Vruchten op eigen sap blik/glas
1244	Vruchten op water blik/glas
1246	Polymere drinkvoeding Nutridrink per 100 ml
1253	Knäckebröt vezelrijk
1278	Maaltijd Olvarit 6 mnd
1283	Dieetzuigelingenvoeding Nutrilon laag lactose poeder
1294	Weidrank
1318	Voedingsbiscuit babyvoeding
1322	Cracker volkoren Cracottes pak
1325	Biscuit glutenvrij
1330	Opvolgmelk Nutrilon soya plus poeder
1331	Opvolgmelk Nutrilon soya plus per 100 ml
1343	Sportvoeding Extran hypotone dorstlesser citron p 100 ml
1344	Sportvoeding Extran koolhydraten per 100 ml
1350	Bakmix wit glutenvrij Glutafin
1351	Bakmix bruin glutenvrij Glutafin
1353	Biscuit glutenvrij Glutafin
1355	Ontbijtprodukt volkoren Nutrigran
1361	Brood wit- Turks
1366	Tulumba tatligi gebak Turks
1369	Leblebi kekererwten Turks geroosterd
1381	Melk soja- naturel per 100 ml
1389	Drop
1450	Chocolade pure z suiker
1451	Chocolade melk- met hazelnoten z suiker
1455	Aardappelpureepoeder
1458	Seitan
1461	Pasta sesam- tahin
1462	Sap ananas-
1463	Dubbeldrank
1465	Likeur <15 vol% alc Likoret
1466	Likeur >25 vol% alc
1467	Vocht van vruchtenconserven blik/glas
1468	Bier zwaar >7 vol% alc
1470	Berliner bol
1474	IJs water- op vruchtenbasis
1486	Stamppot zuurkool zonder vlees bereid
1500	Kruidenmix blok
1510	Melk soja- Ca+
1514	Mix vegetarische onbereid
1516	Saus op basis groentenat/melk bereid z vet

1519 Bier alcoholvrij <0,5 vol% alcohol fles/blik
1520 Bier alcoholarm 0,5-1,5 vol% alcohol fles/blik
1521 Limonade vruchten- light met koolzuur fles
1522 Frisdrank light z cafeone fles/blik
1523 Frisdrank light met cafeone fles/blik
1528 Bouillon van blokje bereid
1531 Stamppot rauwe andijvie zonder vlees bereid
1581 Vruchtendrank met zoetstof
1591 Zoetstof op aspartaambasis tablet
1592 Zoetstof op sacharinebasis tablet
1593 Zoetstof aspartaam en acesulfaam tablet
1594 Zoetstof sacharine en cyclamaat tablet
1596 Zoetstof op aspartaambasis poeder
1597 Zoetstof aspartaam en acesulfaam poeder
1598 Zoetstof op saccharinebasis poeder
1599 Fructosepoeder
1627 Kuit/hom gebakken
1637 Dieetzuigelingenvoeding Nutrilon pepti per 100 ml
1638 Dieetzuigelingenvoeding Nutrilon pepti poeder
1652 Stroop maismout- glas
1653 Stroop rijstmout- glas
1654 Diksap appel- geconcentreerd fles
1655 Diksap peren- geconcentreerd fles
1662 Siroop vruchtenlimonade- citroen/sinaasappel blik
1700 Polymere sondevoeding Nutrison Paediatric Energy p 100 m
1706 Sportvoeding Extran citron/orange per 100 ml
1708 Voedingsbiscuit Switch noten
1709 Voedingsbiscuit Evergreen choco
1711 Koekjes kinder- Circusvriendjes aardbei/banaan
1764 Fruit compote Olvarit 12 mnd
1765 Voedingsbiscuit start- Bambix
1766 Kinderbiscuit Bambix
1768 Verdikkingsmiddel Nutilis instant poeder
1769 Muesli krokante Nutrigran
1778 Knäckebröt maanzaad
1780 Knäckebröt muesli
1784 Dieetzuigelingenvoeding Nutramigen per 100 ml
1785 Dieetzuigelingenvoeding Nutramigen poeder
1787 Dieetkindervoeding Flexical poeder
1792 Maaltijdvervangend produkt Modifast muesli
1803 Saus oosterse kant en klaar glas
1804 Ontbijtprodukt 7-granen-energie ontbijt
1805 Ontbijtprodukt tarwegries met honing
1806 Ontbijtprodukt tarwebloem instant
1807 Siroop vruchtenlimonade- overige smaken blik
1810 Siroop vruchtenlimonade- alle smaken blik
1812 Nectarine
1825 Yoghurt Fysiq magere naturel pak
1826 Yoghurt Fysiq magere met vruchten
1827 Yoghurtdrank Fysiq magere naturel
1828 Yoghurtdrank Fysiq magere met vruchten
1833 Yoghurt magere met vruchten z suiker m zoetstof
4000 -
4001 -
4002 -
4003 -
4004 -
4005 -
4006 -
4007 -
4008 -
4009 -
9600 Quorn
9601 Melkdrank Milk & Fruit Sinaasappel
9603 Fris & Fit Yoghurt
9604 Ontbijtproduct Wake-up Brinta
9605 Ontbijtproduct Rice Krispies Kellogg's
9606 Ontbijtproduct Choco pops Kellogg's
9607 Ontbijtproduct Honey nut loops
9608 Ontbijtproduct Frosties Kellogg's
9609 Ontbijtproduct Smacks Kellogg's
9611 Ontbijtproduct All Bran Kellogg's
9612 Ontbijtproduct Fruit & Fiber Kellogg's
9613 Ontbijtproduct Special K Kellogg's
9615 Ontbijtproduct Boerenmuesli Kellogg's
9616 Ontbijtproduct Cornflakes Kellogg's
9634 Siroop vruchten- Multivit Roosvicee
9635 AA drink Multi Nine Sportdrank Raak
9636 Sap sinaasappel-Extra Del Monte
9637 Sportdrank Isostar Sandoz Nutrition
9638 Limonade Kindersinas Raak
9639 Vruchtendrank Multivit Punica
9640 Broodbeleg Kinder- Yammie
9642 Hoestbonbon vit C Pastilles Vicks
9645 Drink Energy Red Devil
9647 Sap appel- met toegevoegd vit C AH
9648 Yoghurtdrank Fruitpower met 6 vitamines
9650 Frisdrank Spa Citron met Vit. C
9651 Drank- zuivel Fruitality Campina
9652 Vruchtendrank Orange plus Ca Punica
9655 Ontbijtproduct 8 granen appel-honing
9656 Limonade vruchten- Sisi met vit C
9657 Ontbijtproduct Honey hitters
9658 Fruchte tee met vitamines
9661 Ballenmix Telekids
9662 Ontbijtprodukt groei-ontbijt Bambix V
9663 Ontbijtprodukt gemengde granen Nutrix V
9664 Ontbijtprodukt volkoren Bambix V
9666 Melk soja- choco/aardbei Soya drink V p 100 ml pak

Appendix 9 Mailing list

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