DIETARY HABITS AND SELF-PRODUCTION OF FOODS OF INDIVIDUALS PARTICIPATING IN THE FRENCH DIOXIN AND INCINERATORS STUDY

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Abstract
In order to interpret the serum levels of PCDDs, PCDFs and PCBs of 1030 adults participating in the French dioxin and incinerators study, quantitative information on dietary habits and self-production of foods was recorded. As animal fat is the main contributor to background dioxin exposure, a validated food frequency questionnaire for fat intake was used to characterize the influence of dietary habits on dioxin serum levels. The average quantities of total food eaten (purchased and home grown) were comparable to national data except for fruit and vegetables intakes which were higher. Another questionnaire was developed to quantify the consumption of home-grown or local foods (fruit and vegetables, eggs, poultry, meat, milk) for individuals both living or not in the impact area of the incinerator's plume. For those local food eaters, the proportion of locally grown foods in their total intake was relatively low, although the study regions were mainly rural areas. The local foods that were eaten in the largest proportion of the total intake were fruit and vegetables. The foods of animal origin like meat, dairy products and eggs were not frequently provided by the local production. Farmers were the group with the highest intake of local foods.

Introduction
Diet is the main contribution to dioxin background exposure. Foods of animal origins like dairy products, fishes and seafood, meat, poultry are the main contributors of background dioxin exposure [1]. However, it is not clear if it is always the case for individuals living in the vicinity of municipal solid waste incinerators (MSWI). When trying to correlate dioxin exposure to dioxin emissions from incinerators, it is necessary to record dietary habits and the origin of the foods consumed. In a recent study, dioxin serum levels of individuals living in the vicinity of MSWI have been positively correlated to the intake of locally produced animal fat [2]. The type and the quantity of locally produced and home-grown foods have to be estimated in a local dioxin exposure study. In France like in other countries such as in the USA, the consumption of home-grown foods is not very frequent and the most popular home grown foods are fruit and vegetables [3]. Detailed information on the quantities and origins of foods consumed has been produced by this study in order to interpret serum dioxin levels.

Materials and Methods
The French Dioxin and Incinerators Study has been carried out by the National Institute of Public Health Surveillance (InVS) in collaboration with the French Food Safety Agency (Afssa). 1030 adults (30-65 years) have been included between March and July 2005 in 8 different areas in France around municipal solid waste incinerators. In each of the 8 areas, about 130 peoples living for at least 10 years around the incinerator (5 years for recent ones) and who had no occupational exposure potential were studied. In each of the exposed or non-exposed study groups, the population studied was divided in two groups:
1) people eating home-grown or food produced locally (poultry, meat, eggs, milk, fruit and vegetables…),
2) people not eating home-grown or locally-produced food.

Two dietary questionnaires were asked to the participants. Total food intake was quantified by a validated food frequency questionnaire for the estimation of lipid intake [4]. This questionnaire used 109 different food items with a specific focus on possible dioxin exposure contributors: 21 dairy products, 11 meats and eggs, 6 fishes and

seafoods. Fruit and vegetables were also detailed for the analysis of heavy metals exposure: 13 vegetables and 6 fruit subgroups. The food frequencies ranged from more than twice a day to less than once a month and never for solid foods and from more than four times a day to less than one a month and never for beverages. The portion sizes for solid foods were recorded using photographs for the food vectors of animal lipids, which are also the food vectors of dioxins. Photographs of twelve types of foods were reproduced using three photos for each food type. For beverages, portion sizes were estimated by reproduced glasses or mugs. A second dietary questionnaire was asked for the measurement of the intake of locally-produced foods with the same information than for the questionnaire for total food intake (frequency of consumption, portion size, duration per year). Lipid content of foods was derived from the French National Food Composition database CIQUAL [5]. Food consumption was expressed in grams of food products or in grams of lipids of the food products for food from animal origin. Detailed information on the survey design has been given in another abstract [6].

Results and discussion

In comparison with the results of the national dietary survey [7], total food intake of the study participants were much higher in fruit and vegetables (674 $g.d^{-1}$ versus 421 $g.d^{-1}$), relatively high for dairy products and fish and comparable for meat, starchy foods and beverages. These intake differences may be linked to the use of distinct dietary survey methodologies: a food frequency questionnaire for this study instead of a 7 days record for the national dietary survey. However, the higher intake of fruit and vegetable may be explained by the over-representation of rural areas and of producers of home-grown fruit and vegetables.

Table 1. Food intakes of the study participants (quantities in $g.d^{-1}$)

Food group	Mean intake	CI 95% of mean
Meat	**164.6**	**[153.4-175.7]**
Beef + veal + mutton	60.3	[55.7 – 64.8]
Pork + pork products	56.5	[52.3 – 60.7]
Poultry (incl. Rabbit)	43.7	[39.0- 48.2]
Offals	5.0	[4.4- 5.6]
Eggs	**27.4**	[24.0- 30.7]
Fishes and seafood	**62.1**	[52.9 – 71.4]
Lean fishes	40.2	[33.4 – 47.0]
Fat fishes	8.3	[6.1- 10.5]
Crustaceans + molluscs	8.7	[7.8 – 9.6]
Dairy products	**360.0**	[340.8 – 379.3]
Milk	120.9	[106.9 – 135.0]
Yoghurts + fresh cheese	160.7	[149.9 – 171.7]
Cheese+ butter	79.9	[73.4 – 86.3]
Vegetables	**397.6**	[363.8 – 431.4]
Aerial vegetables	167.8	[153.1 – 182.5]
Root vegetables		[-]
Fruit	**276.1**	[252.7 – 299.6]
Starchy foods	**343.7**	[319.1 – 368.3]
Alcoholic drinks	**129.2**	[114.7 – 143.7]
Water	**1188.6**	[1148.9 – 1228.3]
Tap water	699.7	[660.6 – 738.7]
Mineral water	488.9	[466.2 – 511.6]

The mean total lipid intake was comparable to the national dietary survey data (106.6 $g.d^{-1}$ vs 91.1 $g.d^{-1}$). The contribution of animal fats to this total intake was relatively high, especially for dairy products but with a relatively low contribution from fishes and seafood. There is no clear evidence of a food pattern of the study population that may explain a specific background dioxin exposure (table 2).

Table 2. Lipid intakes of the study participants (quantities in $g.d^{-1}$)

Food group	Mean intake	IC95% of mean
Total Lipids	**106.6**	[101.0 – 112.3]
Lipids from animal origin	**67.9**	[64.0 – 71.7]
Lipids from meat	**22.7**	[21.1 – 24.3]
Lip beef + veal + mutton	6.9	[6.4 – 7.4]
Lip pork + pork products	10.9	[9.9 – 11.9]
Lip poultry + rabbit	4.2	[3.8 - 4.7]
Lip offals	0.8	[0.7 - 0.9]
Lipids from eggs	**3.5**	[3.1 – 3.9]
Lipids from fishes and seafood	**2.9**	[2.3 – 3.4]
Lipids from dairy products	**38.8**	[36.6 – 41.1]
Lip milk	2.4	[2.1 – 2.8]
Lip yoghurts + fresh chease	5.2	[4.8 – 5.5]
Lip cheese+ butter	31.4	[29.3 – 33.6]

Among the dairy products group, the cheeses and the butter contributes mainly to the mean lipid intake.

The most frequently home-grown and locally produced foods are fruit (701 consumers out of 1030 participants) vegetables (738 consumers) and eggs (366 consumers). Poultry is the most frequently locally produced meat. These figures show that the aim to focus on consumers of locally produced foods, an at risk population for dioxin exposure from MSWI, was actually reached (table 3).

For vegetables and fruit, the mean intakes of home grown and locally produced foods are important in comparison to the total mean intake. This result shows that having a self-production of fruit and vegetables may increase the total intake. In contrast, for the foods of animal origin which may be important contributors to the dioxin exposure, the mean quantities of home-grown and locally produced foods are relatively low but not negligible.

Table 3. Intake of home-grown and locally produced foods by the consumers of these products (in g.d^{-1})

Food	Number of consumers	Mean	IC95% of mean
Meat	**386**	**10,1**	**[8.6 – 11.6]**
Beef + veal + mutton	140	3.1	[2.5 – 3.7]
Pork + pork products	95	1.6	[1.2 – 2.1]
Poultry (incl. Rabbit)	303	4.7	[3.9 – 5.5]
Offals	121	0.5	[0.4 – 0.6]
Eggs	**366**	**7.2**	**[63 – 8.0]**
Fish and seafood	**85**	**1.2**	**[0.6 – 1.8]**
Dairy products	**127**	**12.6**	**[7.0 – 18.2]**
Milk	67	9.7	[4.3 – 15.1]
Yoghurts and fresh cheese	42	1.3	[0.7 – 1.8]
Cheese and butter	71	1.6	[1.1 – 2.2]
Vegetables	**738**	**81.5**	**[68.1 – 94.9]**
Aerial vegetables	735	37.9	[31.8 – 44.0]
Root vegetables	398	5.3	[4.3 – 6.2]
Fruit	**701**	**37.3**	**[30.8 – 43.8]**
Starchy foods	**490**	**22.8**	**[15.3 – 30.3]**
Lipids	**803**	**5.5**	**[4.7 – 6.4]**
Lipids of animal origin	**506**	**7.7**	**[6.6 – 8.9]**

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