Preferred session: Human exposure – POPs in the diet
Submission: poster

DIOXINS AND PCBS IN EGGS AND VEGETABLES FROM PRIVATE GARDENS: REASONS FOR CONCERN?

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Introduction
In more rural areas, growing vegetables in the own garden or in an allotment is a common practice. Chickens are often held for their eggs. Reasons for growing own vegetables and keeping chicken can be economical or as a hobby. Besides, people are often convinced that products from their own garden are more healthy as they have control on products used and can provide more space and less stress to the chickens. However, are these food products as healthy as commercially produced food from a perspective of the content of undesirable chemicals? An evaluation of biomonitoring results in Flanders (Belgium) showed an association between egg consumption and increased levels of chlorinated compounds in rural regions. In preparation of an action plan on exposure of private gardeners to chlorinated compounds, eggs and vegetables were sampled from 15, respectively 8 gardens. The samples were analyzed for their dioxin and PCB content and interpreted with regard to levels, sources and influencing factors, exposure and risk.

Materials and methods
We selected 15 households for participation in the study. Selection criteria were the availability of chickens, held for egg production and of a vegetable garden (8 of the 15 participants), being able to provide samples for potatoes, carrots, courgette and lettuce. Seven participants were recruited from the adolescent biomonitoring in Flanders (2009) providing serum concentrations of dioxins and dioxin-like PCB measured by the Calux method and of indicator PCB.
For each chicken run, 10-15 eggs were collected and 5 soil samples were combined for analysis. For each vegetable garden, a sufficient number of vegetables was provided, a composite soil sample (5 subsamples) was taken and a deposit dust gauge (Bergerhoff type) was placed for a period of 1 month to collect atmospheric deposition. A questionnaire was provided to collect information on gardening practices, chicken feeding practices and egg consumption. Vegetable samples were washed with cold water and (except for lettuce) thean the samples were subdivided in two subsamples, one of which was peeled before analysis. All samples were analyzed for dioxins (PCDD/F), dioxin-like PCB and indicator PCB content according to standard analytical methods.

Concentrations were compared to available legal standards for first interpretation. Graphical representation was used to investigate the relation between measured concentrations in eggs and influencing factors. A correlation and regression analysis was used to investigate the relation between measured concentrations in eggs and vegetables and the concentration in soil and atmospheric deposition (the latter only for vegetables). Contribution to exposure was calculated based on reported consumption and compared with tolerable intake values.

Results and discussion:

The concentrations in eggs are given in Table 1. The concentrations PCDD/F and dioxin-like PCB are much higher than the concentrations measured in commercial eggs on the Belgian market[i] (average concentrations of 0.41 – 0.66 pg TEQ 1998/g fat for PCDD/F and 0.48 – 0.79 pg TEQ 1998/g fat for dioxin-like PCB), depending upon origin). Based on a collection of European data from official controls, the indicator PCB (6 congeners) content in eggs averages 16.7 ng/g fat[ii], which is lower than the average measured in our study. Almost all samples exceeded the European action levels for PCDD/F and dioxin-like PCB. The maximum level was exceeded in 10 samples. One egg sample exceeded the Belgian maximum level for indicator PCBs (200 ng/g fat) which was set as a consequence of the Belgian dioxin crisis in 1999. These results are consistent with a previous study in Belgium[iii], where also higher concentrations were found in eggs from home grown chickens compared

to commercially available eggs.

Table 1: Measured concentrations in eggs

	PCDD/F (pg TEQ 1998/g fat)	DL-PCB (pg TEQ 1998/g fat)	indicator-PCB (7)* (ng/g fat)
mean	6.7	14.6	105
median	4.2	3.5	32.9
min	1.6	1.9	12.0
max	21	138	1023
P90	15	20.1	134

*: PCB 28, 52, 101, 118, 138, 153, 180; PCB 118 belongs also to the dioxinlike PCBs and is excluded when the 6 indicator PCBs are reported (as is done by EFSA)

Concentrations in eggs are influenced by environmental and gardening factors. Box plots indicate that concentrations in eggs tend to be higher when material (paper, wood, …) is burned in the garden and when a stove or hearth is used during the cold season. Grass covering and throwing mown grass in the chicken run lowers the concentration in eggs, whereas throwing garden weeds in the chicken run is unfavourable with regard to concentrations. Concentrations in eggs were significantly correlated with concentrations in soil. The regression equations (after log transformation) are given in Table 2.

Table 2: Regression equations for concentration in eggs (per gram fat) versus concentration in soil (per gram dry matter)

	regression equation	R^2	p
PCDD/F's (pg TEQ 1998)	log egg = 0.33 + 0.645 * log bodem	0.357	0.019
dl-PCB's (pg TEQ 1998)	log egg = 0.85 + 0.819 * log bodem	0.635	< 0.000
merker-PCB's (ng)	log egg = 0.75 + 1.129 * log bodem	0.848	< 0.000

Concentrations of dioxins and PCBs in vegetables are highly variable and no significant differences between vegetables could be seen. This is probably caused by the small number of samples per vegetable (8) and the low levels, being often close to or below the quantification limit. There is a significant impact of peeling on the dioxin and PCB content of the vegetables, as show in Table 3. The impact is most clear for dl-PCB and indicator-PCB.

Table 3: Average concentrations of PCDD/F, dl-PCB and indicator-PCB in unpeeled and peeled vegetables (medium bound)

		PCDD/F (pg TEQ 1998/kg)	DL-PCB (pg TEQ 1998/kg)	indicator-PCB (7) (ng/kg)
potatoes	unpeeled	20.3	2.2	29.1
	peeled	20.4	1.2	10.3
carrots	unpeeled	10.0	5.3	56.7
	peeled	15.0	2.5	18.4
courgette	unpeeled	17.4	8.3	81.0
	peeled	12.3	2.9	49.8
lettuce	n.a.	8.0	3.8	31.9

Concentrations measured in vegetables are in the range of those reported at the European level[2,iv].

The results of the exposure assessment are given in Figure 1and Figure 2. For eggs, reported consumption data were used. For potatoes and vegetables average Belgian consumption data in consumers were used. Intake in the Belgian population[1,v] are given for reference. Intakes were calculated from median concentrations and for maximum concentrations (P90 for eggs) and compared with the Tolerable Weekly Intake of 14 pg/kg body weight per week, published by EFSA for sum of PCDD/F and dl-PCB[vi] and with the MRL of 140 pg/kg body

weight and per week, published by ATSDR[vii] for indicator PCBs.

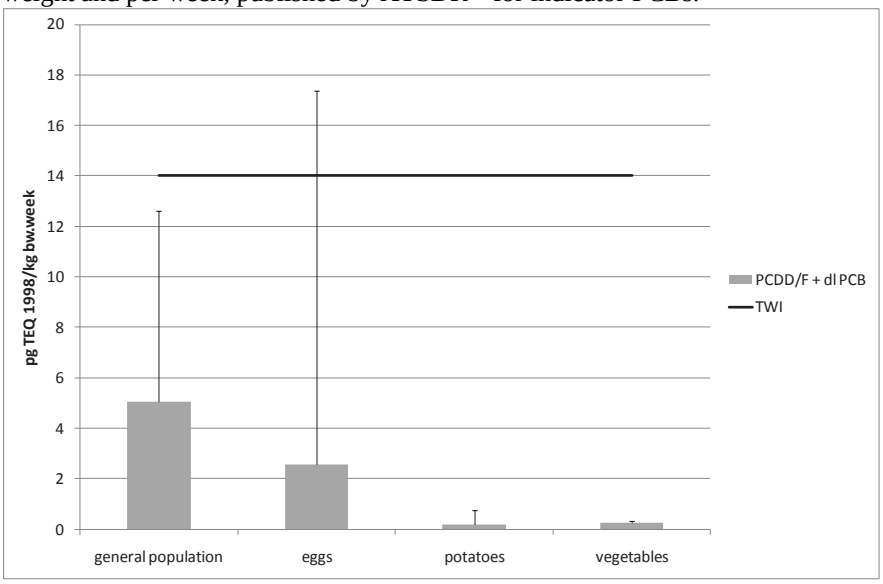

Figure 1: Exposure assessment for PCDD/F and dl PCB

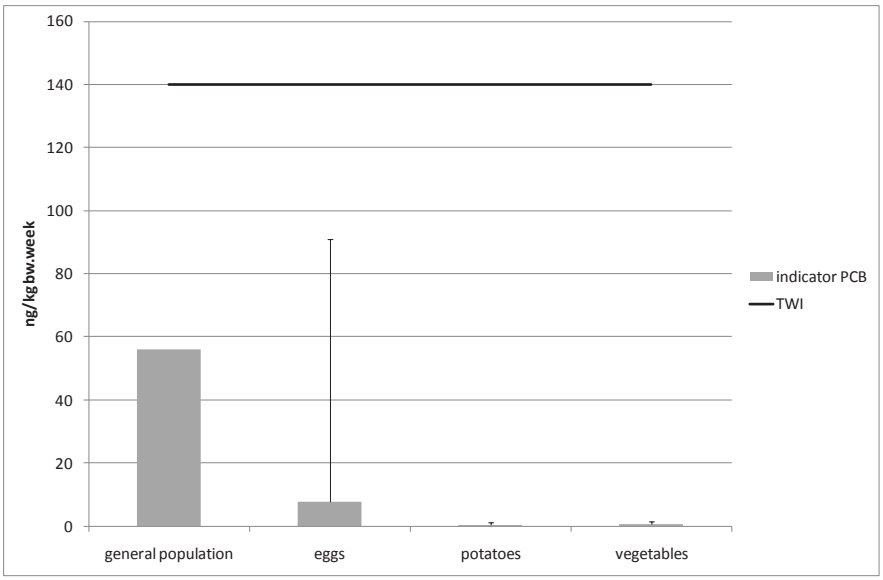

Figure 2: Exposure assessment for indicator PCB

Intake of dioxins and PCBs contributes less than 2 % to the total intake of these compounds in the general population, when it is assumed that egss are from commercial origin. In case of consumption of eggs from own chicken, eggs increase the exposure by about 50 %, based on median concentrations of PCDD/F and dl-PCB. In some gardens, the intake from eggs alone results in an exceedance of the Tolerable Weekly Intake (TWI). For indicator PCBs, the intake from eggs can be significant and even higher than average background intake, but the tolerable intake is only exceeded for one participant family. Intake from vegetable consumption constitutes only a small percentage of total intake of dioxins and PCBs.

We saw a clear correlation between the levels of indicator PCB in eggs and in the serum of the adolescents available for 7 of the participating families (Figure 3). We did not see a correlation for PCDD/F, nor for

dl-PCB, which could be caused by comparison of chemical measurements in eggs with biological measurements in serum and the small number of data points (6).

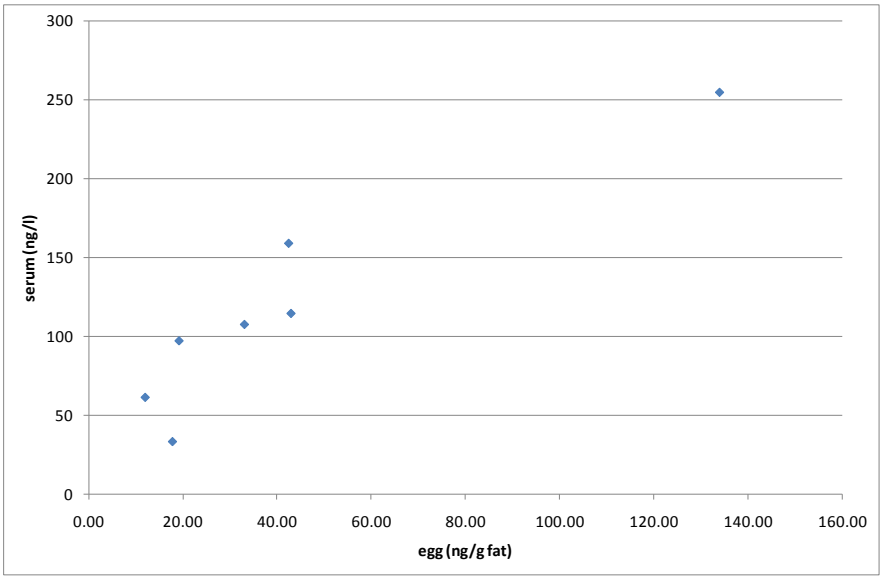

Figure 3: Relation between indicator PCB in egg and in serum of adolescents

The findings from the current study, integrated with results from other studies, will be used to formulate an advice to the general population with regard to consumption of food from the own garden.

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