Bioaccumulation and Distribution of PCBs in Hens and Chickens

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Introduction

Food is the main source of PCDD/F and PCBs exposure for humans, accounting for 98% of the total intake[1]. Chicken meat and eggs are important foods which have been thoroughly controlled after 1999 Belgium dioxin crisis[2]. Recently, studies of PCDD/Fs and PCBs accumulation and tissue distribution in chicken were carried out[3,4,5]. We investigated toxic and bioactive properties of PCBs on chickens which were being fed by spiked feed. Our study included clinical observations of PCBs toxic action, study of PCBs accumulation in different tissues, and investigations of PCBs influence on immunity of chickens vaccinated by Newcastle disease. This presentation shows some of the results on accumulation and distribution of PCBs in hens and chickens.

Methods and Materials

Solvents used were pesticides or PCB grade. $^{13}C_{12}$-labelled and calibration standards were purchased from Wellington Laboratories (Ontario, Canada).
GC-LRMS measurements were conducted on Finnigan Polaris Q; column DB-5ms, 30 m, 0.25 mm i.d., 0.25 μm film thickness; constant flow of carrier gas (helium) 1 ml/min. Full scan at m/z range – 41-550. The GC temperature was programmed as follows: 100°C isothermal for 2 min, heating to 220°C at the rate of 10°C/min, then to 280°C at the rate of 5°C/min. 1ml of the sample was injected in splitless mode with 0.1 min delaying of injector flowing.
GC-HRMS analyses were performed on mass spectrometer Finnigan MAT 95XL at resolution 10000 equipped with Hewlett Packard HP 6890 Plus gas chromatograph; column DB-5MS, J&W Scientific (20 m length, 0.18 mm id, 0,18 μm film thickness); splitless mode; oven temperature, 140◦C for 1 min, 14◦C/min ramp to 240◦C, followed by second ramp of 20◦C/min to 270◦C for 15 min hold; injector temperature, 280◦C; constant flow of carrier gas (He), 0,8 ml/min. Congeners identity was confirmed from the isotope ratio of the registered ion.
Investigation was carried out on young chickens (6 month old) and on hens (3 days old). 45 hens were divided into three groups (3x15). The control group consumed unspiked feed. Two others groups daily consumed feed spiked with PCBs mixture Sovtol (Russian analog of Aroclor-1254 with addition of 10% trichlorobenzene)[7]: 2.0 and 20.0 mg per kilogram of feed. Experiment duration was 40 days.
24 chickens were also divided into three groups (3x8) and fed in the manner described for hens.

The feed ratio was *formula feed:boneflour:fish oil* = 96%:3%:1%.

Chicken tissue samples and feeding components were extracted by salting-out method[6] and then treated according to EPA Method 8082A. Procedural blank samples were included for quality control.

Results and discussion

PCDD/Fs and WHO PCBs were analysed in Sovtol and results presented in table 1.

Table 1.PCDD/Fs congeners and WHO PCBs in Sovtol.

	I-TEQ, pg/g		TEQ, ng/g
2,3,7,8-TCDD	n.d.	PCB-81	196.13
1,2,3,7,8-PeCDD	n.d.	PCB-77	169.34
1,2,3,4,7,8-HxCDD	n.d.	PCB-123	753.06
1,2,3,6,7,8-HxCDD	n.d.	PCB-118	32653.1
1,2,3,7,8,9-HxCDD	n.d.	PCB-114	6195.48
1,2,3,4,6,7,8-HpCDD	n.d.	PCB-105	14498.8
OCDD	n.d.	PCB-126	25611.7
2,3,7,8-TCDF	16176.91	PCB-167	380.52
1,2,3,7,8-PeCDF	28897.69	PCB-156	10818.2
2,3,4,7,8-PeCDF	810893.59	PCB-157	2745.37

1,2,3,4,7,8-HxCDF	182781.13	PCB-169	0
1,2,3,6,7,8-HxCDF	59143.78	PCB-189	30.26
1,2,3,7,8,9-HxCDF	44406.19	**Σ WHO-TEQ, ng/g**	**94052.0**
2,3,4,6,7,8-HxCDF	57264.72		
1,2,3,4,6,7,8-HpCDF	3054.89		
1,2,3,4,7,8,9-HpCDF	3392.48		
OCDF	66.88		
Σ I-TEQ, pg/g	**1206078.2**		
Σ WHO-TEQ, pg/g	**1206018.1**		

Total PCBs levels and estimated PCDD/Fs and WHO-PCBs levels in liver, eggs, breast and leg muscles of chickens and hens are shown in table 2. Feeding components were analyzed as well (see table 2). Changing of PCBs levels in tissues are presented in fig.1.

We found a good correlation with our previous results on PCBs accumulation in chicken tissues[8].

Tissues of hens from the control group appeared to be quite highly contaminated with PCBs. It was found that fish oil used as a feeding component was contaminated by PCBs (table 2). The fish oil (for veterinary use) was produced by Murmansk fish plant, and bottled by “Agroservis” company (Voronezh, Russia).

It is obvious that PCBs levels in chicken groups are significantly lower than those in hens groups. This may be a result of removal of some PCBs from the chicken bodies via eggs.

Conclusions

1. Under the same feeding conditions, hens appeared to be more PCBs contaminated than eggs giving chickens. The estimated levels of WHO-TEQ_{PCB} and PCDD/Fs in lipids increased from 0,08 and 0.001 ng/g for control animals to 2,42 and 0.031 ng/g, respectively, for animals treated with Sovtol. WHO-PCB concentrations in hens tissues ranged from 1.2 to 24.45 ng/g lipids

2. Consumption of PCBs contaminated feed components makes chicken eggs and meat a significant source of human PCBs exposure.

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Table 2.

PCBs concentrations in liver, eggs, breast and leg muscles of chickens and hens and in feed components.

	PCBs dietary intake	Tissue type	Sample code	Total PCBs, µg/g wet weight	Total PCBs, µg/g lipids	Estimated WHO-TEQ_{PCB} levels, ng/g lipids	Estimated WHO-$TEQ_{PCDD/F}$ levels, ng/g lipids
Chicken	Control group (no Sovtol)	liver	**PK1**	0.12	2.59	0.24	0.003
		eggs	**PK2**	0.05	1.21	0.11	0.001
		breast muscles	**PK3**	0.05	3.08	0.29	0.004
		leg muscles	**PK4**	0.01	0.83	0.08	0.001
	Sovtol, 2 mg/kg of feed	liver	**PK11**	0.14	2.31	0.22	0.003
		eggs	**PK12**	0.13	1.87	0.18	0.002
		breast muscles	**PK13**	0.09	3.27	0.31	0.004
		leg muscles	**PK14**	0.14	2.40	0.23	0.003
	Sovtol, 20 mg/kg	liver	**PK21**	1.66	25.70	2.42	0.031
		eggs	**PK22**	1.61	24.41	2.30	0.029
		breast muscles	**PK23**	0.24	9.50	0.89	0.011

	of feed	leg muscles	**PK24**	0.30	7.99	0.75	0.010
Hen	Control group (no Sovtol)	liver	**PK30**	0.49	12.76	1.20	0.015
		breast muscles	**PK31**	0.27	15.60	1.47	0.019
		leg muscles	**PK32**	1.57	40.27	3.79	0.049
	Sovtol, 2 mg/kg of feed	liver	**PK33**	2.07	52.16	4.91	0.063
		breast muscles	**PK34**	1.40	62.49	5.88	0.075
		leg muscles	**PK35**	7.43	110.13	10.36	0.133
	Sovtol, 20 mg/kg of feed	liver	**PK38**	5.91	91.73	8.63	0.111
		breast muscles	**PK36**	4.68	138.67	13.04	0.167
		leg muscles	**PK37**	27.36	260.00	24.45	0.314
Feed components		bone flour	**PK-41**	0.07	2.12	0.20	0.003
		formula feed	**PK-42**	0.01	0.09	0.01	0.000
		fish oil	**PK-43**	4.87	4.87	0.46	0.006

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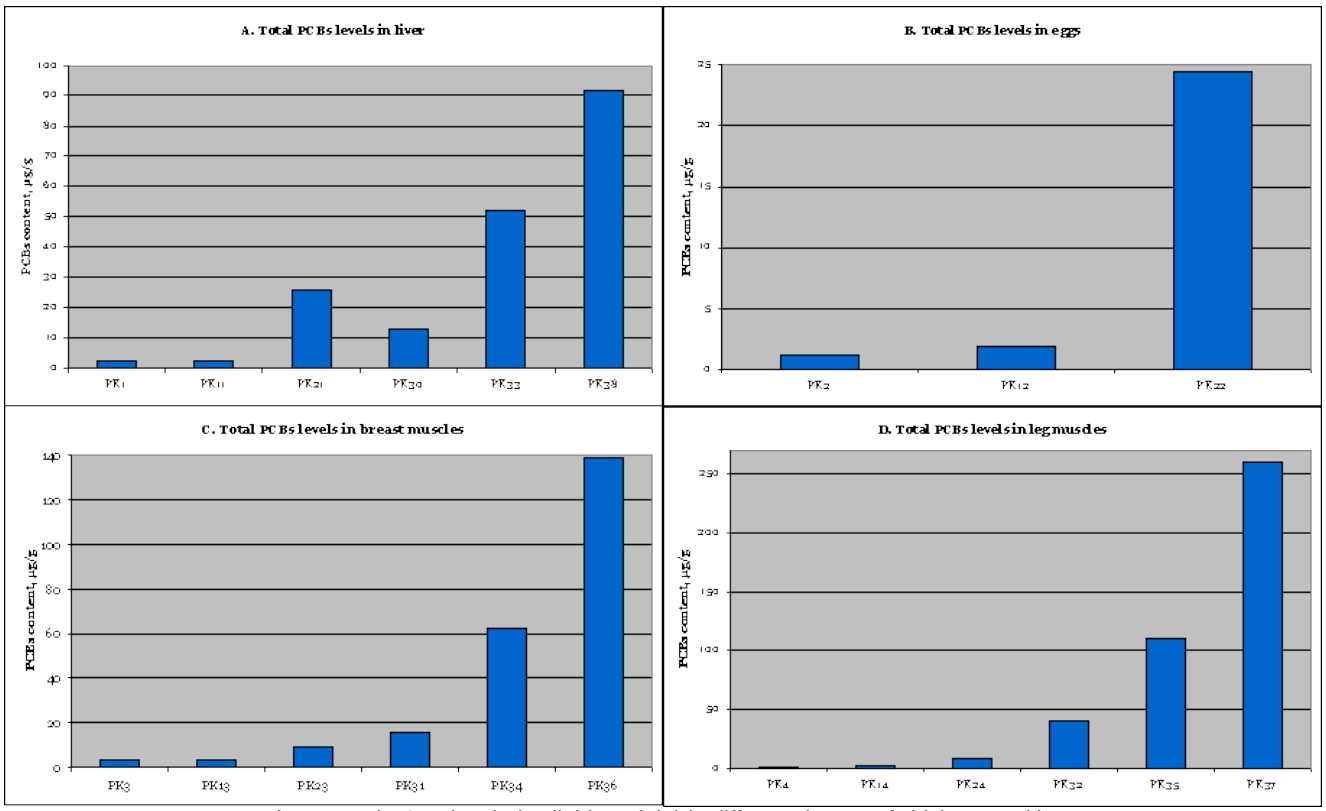

Fig. 1. Total PCBs levels (on lipids weight) in different tissues of chickens and hens.