ORGANOCHLORINES IN CHICKEN'S EGGS AND MEAT FROM THE IRTKUTSK REGION, RUSSIA

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Introduction

Previous investigations found elevated levels of PCBs and PCDD/Fs in the environment of the Irkutsk region. The main source of emissions was localized to the Usol'e-Sibirskoe area, a major centre of the organochlorine industry in the Soviet Union[1]. This source was found to influence organochlorine levels in cow's milk produced at farms located both close to and distant from the town[2]. In addition, organochlorine pesticides were used widely in agriculture in the Irkutsk Region before 1980-1990[3]. They accounted for 35-38 % of the total employment of pesticide in the region[3]. Chickens are one species of domestic animals that can indicate contamination of the environment, especially soil[4]. Chickens are known to consume some quantity of soil and small grits to assist in digestion of food so they can have a particularly high exposure to contaminants associated with soil[4].

The aims of the work presented here were to investigate the dependence of the levels of organochlorine compounds (PCBs, DDTs and HCHs) in chicken egg and meat samples produced in private households and in big chicken farms on soil contamination with these chemicals, and to assess the intake of PCBs, DDTs and α- and γ-HCH for people consuming chicken eggs and meat produced in the Irkutsk Region.

Materials and methods

In 2001-2005, chicken eggs and meat samples were collected in six private households, one small farm, and 3 big poultry farms in the Irkutsk region (Table 1, Fig. 1). The chickens in the small farm and the private households were free ranging, while the chickens from the poultry farms were raised in cages. Two of the investigated poultry farms were located within 30-40 km of Usol'e-Sibirskoe. The third poultry farm was located near Sayansk (another town with organochlorine industry). The private households were located both in Usol'e-Sibirskoe and in background areas.

All samples were transported to the Institute of Geochemistry in Irkutsk and stored at -30°C until analysis. Each sample consisted of at least 5-8 eggs or chips of red and white meat. Analyses were made in the laboratory of the Institute of Geochemistry in Irkutsk. Samples were mixed, freeze-dried and Soxhlet extracted. The analitical method is described elsewhere[2]. The samples were analyzed for 128 PCBs, *p,p'*-DDT, *p,p'*-DDD, *p,p'*-DDE, α-HCH and γ-HCH. Daily intake and carcinogenic risk were calculated in accordance with [5,6].

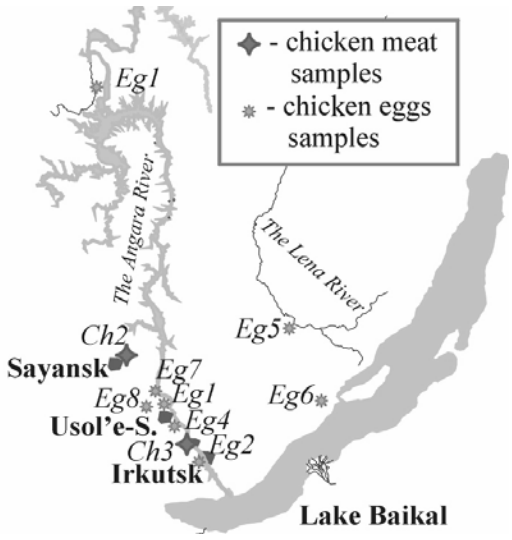

Fig. 1. Site of sampling chicken eggs and meat.

Results and Discussion

HCHs, DDTs. The sum of α- and γ-HCH in chicken meat and eggs ranged from 0.85 to 1.33 and from 0.32 to 39.2 ng/g lipids, respectively (Fig. 2,3). The sums of DDT and its metabolites (*pp'*-DDD and *pp'*-DDE) were 0.52 – 0.73 and 1.32 - 57 ng/g lipids in chicken meat and eggs, respectively. The lowest levels of HCHs and

DDTs were found in eggs from the Belorechenskoe poultry farm. The highest HCH and DDT levels were measured in eggs from private households in the agricultural areas of Buret', Elantsy and Kachug. In no case did the HCHs and DDTs levels exceed Russian sanitary standards. The ratio α-HCH/γ-HCH in chicken meat and eggs changed from 0.48 till 6.9, which suggests that technical HCH (dominated by α-HCH) and lindane (γ-HCH) have both been used, but to a different extent in different areas. The ratios *pp'*-DDE/*pp'*-DDT in eggs ranged from 1.17–87. Low values of the ratio suggest relatively recent usage of DDT in some private households, even though the pesticide was officially banned in the beginning of 1970s in Russia.

Table 1. Description of samples of chicken eggs and meat collected in the Irkutsk Region.

Sample	#	Habitation	Status of habitation	Household	Year of sampling	Lipids, %
Chicken eggs	eg1	Usol'e-Sibirskoe	Industrial town	Private	September, 2003	6.4
Chicken eggs	eg2	Irkutsk	Regional center	Private	August, 2001	11.6
Chicken eggs	eg3	Bratsk	Industrial town	Farm	November, 2002	10.8
Chicken eggs	eg4	Tel'ma	Agricultural habitation	Private	January, 2003	10.3
Chicken eggs	eg5	Kachug	Agricultural habitation	Private	September, 2003	9.1
Chicken eggs	eg6	Elantsy	Agricultural habitation	Private	May, 2005	13.5
Chicken eggs	eg7	Buret'	Agricultural habitation	Private	September, 2003	8.8
Chicken eggs	eg8	Belorechenskoe	Agricultural habitation	Poultry farm	September, 2003	8.3
Chicken meat	Ch2	Angarsk	Industrial town	Poultry farm	November, 2005	11.9
Chicken meat	Ch3	Sayansk	Industrial town	Poultry farm	November, 2005	10.6

PCBs. The sum of PCBs in chicken meat produced in poultry farms amounted to 3.4-5.7 ng/g lipids, including 1.03-1.38 ng/g lipids of the six indicator PCBs. It should be noted that PCB levels in meat from the Angarsk poultry farm decreased by 4 times between 1997 and 2005.

The sum of PCBs in chicken eggs ranged from 10 to 380 ng/g lipids (Fig. 4). The lowest levels were found in samples from the Belorechenskoe poultry farm and private households in Irkutsk. The highest levels were found in samples from a private household in the settlement Tel'ma located just downwind of Usol'e-Sibirskoe. In most samples PCB levels did not exceed Belgium guidelines for admissible levels in food.

PCBs 28, 74, 95/66, 99, 118, 153, 105, and 138 contributed most to the sum of PCBs (up to 67 %). The PCB homologue pattern in chicken meat and eggs were similar to the PCB homologous pattern in Sovol or Arochlor1254 [7] with the exception of the chicken eggs from Tel'ma (Fig. 5). This sample was characterized by a higher fraction of lower chlorinated PCBs that can result from another technical mixture of PCB (Trichlobyphenyls)[7] or significant atmospheric transport of the congeners in direction to the settlement.

Relationship between PCB and pesticide levels in chicken eggs. A significant, strong correlation was found between HCHs and DDTs. A weak correlation was found between total PCB and HCHs, and between total PCB and DDTs. This indicates that the organochlorine pesticides have a common source of contamination and transport to the hens, while the PCBs have an independent source.

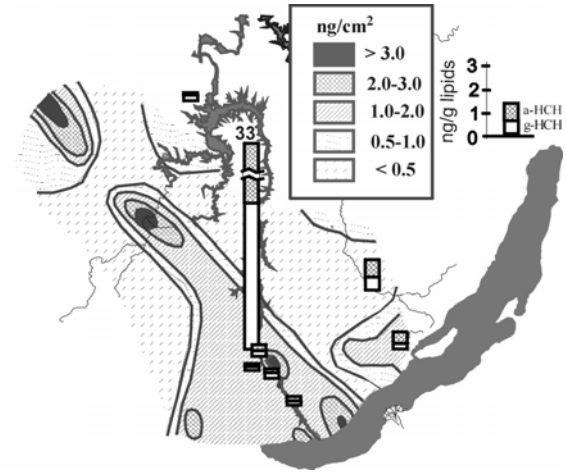

Fig. 2. HCHs levels in soil[8] (ng/cm^2) and chicken eggs (ng/g lipids).

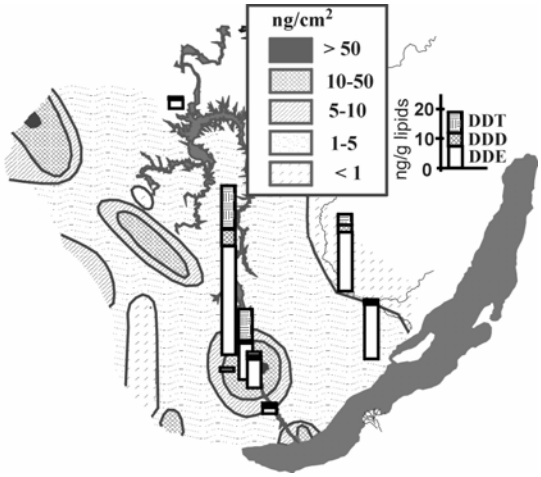

Fig. 3. DDTs levels in soil[8] (ng/cm^2) and chicken eggs (ng/g lipids).

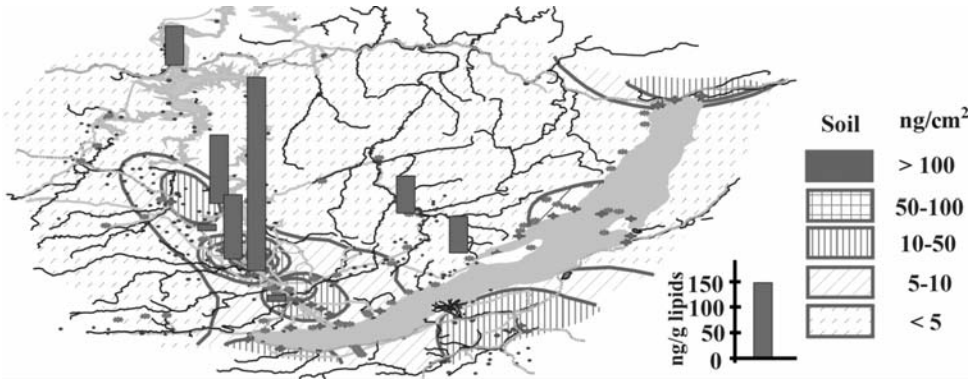

Fig. 4. PCB levels in soil[8] (ng/cm^2) and chicken eggs (ng/g lipids).

Relationship between PCB and pesticide levels in chicken eggs and soil. The levels of PCBs and pesticides in the soil of the region were investigated previously[8]. The correlation between organochlorine compound levels in eggs and soil was tested, excluding the data for the Belorechenskoe poultry farm because the hens there were raised in cages where soil ingestion was limited. The pesticide levels in eggs and soil were correlated only weakly or not at all, suggesting that feed and not soil was the major source of exposure. On the other hand, average or strong correlation were obtained for total PCBs and some PCB congeners. For the lower chlorinated PCBs the correlation was significant ($p < 0.05$). This indicates that soil ingestion is the major vector of PCBs to the eggs, and affirms the importance of the PCB source in Usol'e-Sibirskoe for contamination of both the terrestrial ecosystem and locally produced food.

Intake of PCBs, HCHs and DDTs with chicken meat and eggs by people. The main part of population of the Irkutsk Region consume chicken meat and eggs produced on big poultry farms rather than in private households. Under such conditions the chicken meat and eggs contribute approximately equal quantities of the investigated organochlorines to the diet. The daily intake amounts to 53 ng of total PCBs including 26.4 ng of indicator PCBs, 6 ng of total DDTs including 4 ng of DDE, and 5.5 ng of HCHs (3.5 ng of α-HCH and 2 ng of γ-HCH).

The values correspond to 4.5% of the total daily intake of total PCBs, 2 % of total DDTs, and 0.1 % of HCHs in the Irkutsk region. Such daily intake can result in 1.9 cases of cancer in during a life among 1 million population, including 1.5, 0.03 and 0.34 cases due to intake of PCBs, DDTs, and HCHs, accordingly.

However, if a person consumes chicken meat and eggs produced in a private household, the values become considerably higher. For example, consumption of chicken eggs produced in the settlement Tel'ma will result in an increase of the daily intake of only indicator PCBs up to 430 ng/day or 6 ng/kg in a day, which equals 1/3 of the reference dose of total PCB intake from all food items (0.02 µg/kg in a day)[5].

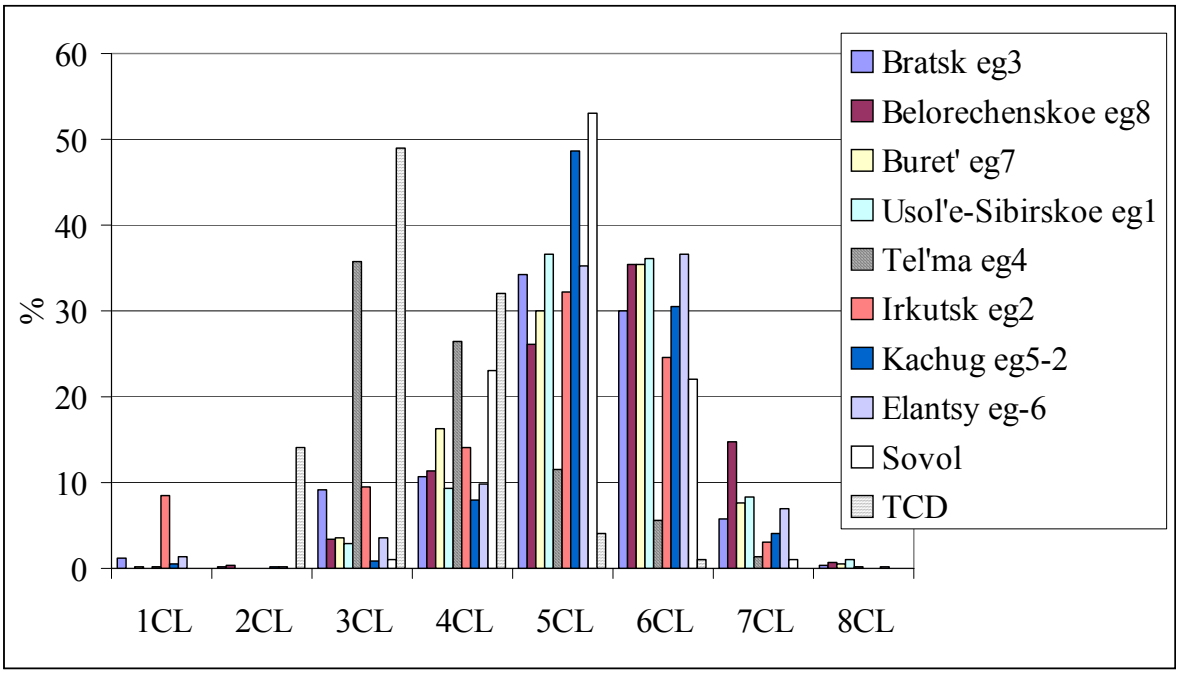

Figure 5. Homologous pattern in Sovol and Trichlodiphenyl (TCD)[7] and in chicken eggs (%).

Acknowledgments

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