Chapter 6

PTS contamination of indigenous residencies and domestic food

6.1. General overview

Results obtained from a survey targetting the residencies of selected indigenous families, reveal that the indoor environment, including home-processed, stored, and ready-to-eat foodstuffs, is widely contaminated by POPs (Tables 6.1 and 6.2). A high frequency of contaminated foodstuffs in the home environment seems to be consistent with the likelihood of residents showing increased blood concentrations of PCBs congeners and DDT metabolites. The occurrence of persistent organochlorines at detectable concentrations, in both local and imported foodstuffs sampled in indigenous communities, is much higher than that found in national averages obtained from nationwide food safety monitoring programmes (Table 6.3). 8.6% of local foodstuffs were contaminated by heptachlor at concentrations exceeding 0.10 µg/kg (Table 6.4), whilst according to national food safety standards, this toxicant should not be present in any foodstuff. Across the nation as a whole, only 0.1% to 0.4% of monitored foodstuffs contained pesticide residues at concentrations exceeding food safety limits.

DDT and HCH appear to be the pesticides most frequently detected in food consumed by indigenous families. At present, however, their concentrations are generally below guideline levels provided by food safety limits (Tables 6.5–6.8). For native communities of the lower Pechora river basin, the highest PCB concentrations were measured in local freshwater fish and duck fat, whereas on the Taymir Peninsula, the highest concentrations were found in smoked fish and reindeer meat.

A comparison of POPs concentrations in local foods samples from indigenous residencies, with those measured in fish species and reindeer meat sampled in the natural environment, clearly indicates that both the occurrence and level of contamination may well be increased as a result of home storage, processing, and preparation of foodstuffs. Hence, the mean concentration of the sum of PCBs measured in samples of reindeer meat after a period of indoor storage, was three times higher than that measured in fresh reindeer muscle sampled in the natural environment. For the sum of DDTs, there was a 1.6-fold increase in concentrations in samples of reindeer meat that had been stored and processed in the home compared to the fresh environmental samples.

Sample type	PCB contamination	DDT contamination	HCH contamination
Indoor wash-outs	100.0	100.0	100.0
Local foods:			
Meat	93.3	80.0	26.7
Fish	100.0	62.5	50.0
Berries	100.0	100.0	0
Imported foodstuffs	80.0	60.0	0
Human blood:			
Mother	100.0	100.0	100.0
Children	100.0	100.0	57.1
Other family members	100.0	100.0	92.8

Table 6.1. Pechora River Basin household survey. Percentage of specimens contaminated by selected POPs at detectable levels.

Sample type	PCB contamination	DDT contamination	HCH contamination
Indoor wash-outs	100.0	100.0	83.3
Local foods:			
Meat	100.0	66.7	16.7
Fish	60.0	100.0	100.0
Berries			
Imported foodstuffs	100.0	100.0	0
Human blood:			
Mother	100.0	100.0	100.0
Children	100.0	100.0	100.0
Other family members	100.0	100.0	90.0

Table 6.2. Taymir Peninsula household survey. Percentage of specimens contaminated by selected POPs at detectable levels.

Study area	Number of samples analyzed	Foodstuffs contaminated by Heptachlor		Heptachlor, concentration range
		n	%	µg/kg
Chukotka	26	3 (2 of whale meat[1]; 1 of mantak[2])	11.5	0.10 - 0.17
Taymir	18	2 (fish[2] and sunflower oil)	11.1	0.12 - 0.48
Pechora River Basin	26	1 (fish[2])	3.8	0.29
Total	70	6	8.6 (average)	0.10 - 0.48

Table 6.4. Heptachlor occurrence in local and imported foods at detectable levels.
[1] Cooked by boiling for 2hrs.
[2] Prepared for cooking (trimmed and sliced in the kitchen).

Monitored foodstuffs	Percentage of foodstuffs measured having detectable amount of organochlorine pesticides			Percentage of foodstuffs measured having organochlorine pesticides at levels exceeding national limits		
	2000	2001	2002	2000	2001	2002
Vegetables	6.0	6.0	7.2	0.2	0.2	0.4
Fruits and berries	7.2	7.5	11.6	0.6	0.5	0.4
Dairy and milk products	5.7	4.8	5.6	0.4	0.3	0.2
Meat and poultry	9.0	6.0	9.9	0.3	0.1	0.1
Processed sea and freshwater fish	15.7	10.9	16.1	0.4	0.5	0.2
Fresh frozen fish	10.3	5.0	16.3	0.3	0	0.2

Table 6.3. Pesticide monitoring of market food in Russia. Results for 2000-2002.*
* Data courtesy of the Federal Center for Sanitary and Epidemiological Surveillance. Russian Ministry of Health (unpublished data).

Foods	n	ΣPCB	*p,p'*-DDT	*p,p'*-DDE	ΣDDT	ΣHCH	HCB
Local foodstuffs:							
Reindeer meat [1]	3	0.49	0	0	0	0.049	
Reindeer liver [1]	2	1.19	0.14	0.12	0.27	0.61	
Reindeer fat	1	2.24	1.52	0.68	2.2	0	
Duck fat [1]	1	56.4	15.1	87.8	107.2	0	
Frozen fresh fish [1]	1	0.58	0.05	0.10	0.322	0	0.46
Salted fish [2]	5	1.95	0.18	0.56	1.23	0	0.90
Imported foodstuffs:							
Cooking oil	3	1.66	0.3	0	0.3	0	
Millet	1	0.28	0	0.06	0.06	0	
Dried milk powder	1	0	0	0	0.06	0	
Beef [1]	1	0.69	0.253	0.067	0.449	0.054	
National limit values					100 (fish and sea products)	200	10 (cereals)

Table 6.5. Concentrations of POPs (μg/kg wet wt) in foodstuffs sampled in the region of the lower Pechora River Basin.
[1] prepared for cooking (trimmed and sliced in the kitchen);
[2] ready-to-eat food.

Foods	n	ΣPCB	*p,p'*-DDT	*p,p'*-DDE	ΣDDT	ΣHCH
Local foodstuffs:						
Reindeer meet	3	1.27	0	0	0	0.75
Reindeer liver	2	33	1.95	3.2	7.56	16.53
Reindeer fat	1	2.45	0	0.67	0.67	0
Duck fat	1	54.0	15.7	91.7	112	0
Salted and fresh fish	6	124.76	6.41	25.88	54.1	0
Imported foodstuffs:						
Oil	3	1.67	0.3	0	0.3	0
Millet	1	0.28	0.06	0	0.06	0
Dried milk	1	0	0	0	0.06	0
Beef	1	92.8	34.2	9.05	60.7	7.3

Table 6.6. Concentrations of POPs (μg/kg lipid wt) in foodstuffs sampled in the region of the lower Pechora River Basin.

Foods	n	Σ PCB	p,p'-DDT	p,p'-DDE	Σ DDT	Σ HCH	HCB
Local foodstuffs:							
Reindeer meat [1] (fresh)	5	4.07	0.051	0.014	0.065	0	0
Reindeer meat [2] (dry-cured)	1	3.86	0	0	0	0	0
Freshwater fish [1]	2	1.61	0.14	0.415	0.654	0.279	0.22
Smoked freshwater fish [2]	1	7.58	1.05	1.46	3.14	1.38	1.57
Smoked herring [2]	1	0.96	1.63	0.51	2.5	0.108	5.03
Frozen fish mixture [2]	1	1.17	0.38	0.41	0.79	0.321	1.53
Imported foodstuffs:							
Wheat flour prepared for pastry	1	0.21	0	0.22	0.22	0	0
National limit values					100 (fish and sea products)	200	10 (cereals)

Table 6.7. Concentrations of POPs (μg/kg wet wt) in foodstuffs sampled on the Taymir Peninsula.
[1] prepared for cooking (trimmed and sliced in the kitchen); [2] ready-to-eat food.

Foods	n	Σ PCB	p,p'-DDT	p,p'-DDE	Σ DDT	Σ HCH	HCB
Local foods:							
Reindeer meat (fresh)	5	121.89	2.16	1.27	2.42	4.76	
Reindeer meat (dry-cured)	1	92.0	0	0	0	0	
Fish	2	70.2	0	14.98	16.88	3.88	
Smoked freshwater salmon	1	0	15.71	108.0	171.0	102.0	
Smoked herrings	1	0	63.5	16.5	91.6	3.48	
Smoked freshwater fish	2	0	39.61	62.25	131.3	52.74	
Sliced frozen fish	1	1.17	6.93	16.5	91.6	3.48	
Imported food:							
Wheat flour prepared for pastry	1	0.21	0	0.22	0.22	0	

Table 6.8. Concentrations of POPs (μg/kg lipid wt) in foodstuffs sampled on the Taymir Peninsula.

6.2. Effects of cooking on PTS food contamination

6.2.1. Boiling of meat

The contamination levels of POPs in local food can be significantly affected by the choice of cooking method. As seen from the data presented in Table 6.9, boiling meat for a period of at least 2 hours causes a significant reduction in both PCB and pesticide contamination of food. Concentrations of POPs in boiled food are 2.2 to 5 times lower than those measured in the uncooked meat of sea mammals. However, microbially-mediated fermentation in ground pits, and also fermentation by long-term immersion in salt water were found to increase POP concentrations in food.

6.2.2. Fermentation of marine mammal meat

Many native communities still do not benefit from high standards of environmental protection and often do not have access to good sanitation arrangements. Because of these circumstances and also due to economic reasons, home-fermentation of local produce is frequently undertaken in situations that may contribute to their contamination. Examples are the uncontrolled use of discarded plastic containers, which may have contained a range of chemical substances, as well as the use of ground pits which are not properly sealed from waste water drainage or may be sited in potentially contaminated soils.

Fermented walrus meat, known as 'kopalchen', was sampled during targeted surveys in the Chukotka region in 2003. It was found to have the highest level of PCB contamination of all ready-to-eat foodstuffs collected from the selected families (Table 6.10).

Food	State of food	Concentrations of selected POPs			
		ΣPCB	HCB	ΣHCH	ΣDDT
Bearded seal, meat	Fresh	9.42	0.24	0.55	4.0
	Boiled	1.89	0.25	0.25	0.91
Whale, mantak	Fresh	22.63	0.71	2.29	7.50
	Boiled	10.03	n.d	0.58	3.29
Walrus, meat	Fresh	3.1	0.20	0.17	0.30
	Fermented	623	0.16	0.73	7.76
Ringed seal, meat	Fresh	14.6	0.39	0.77	3.19
	Boiled	6.85	0.13	0.12	1.01
Arctic char	Fresh	9.79	0.12	1.00	0.99
	Marinated	3.83	0.13	n.d	0.80
	Dry salted	20.12	0.52	2.43	1.68

Table 6.9. Mean concentrations of POPs (µg/kg wet wt) in fresh (frozen) and cooked local foods.
n.d. - not determined (below the detection limit).

Contaminant	Fresh walrus	Walrus 'kopalchen'
	n=2	n=1
ΣPCB	2.9 - 3.2	623
ΣHCB	0.1 - 0.3	0.16
HCH	0.16 - 0.19	0.73
p,p'-DDE	0.17 - 0.23	6.71
p,p'-DD	0.13	0.09
ΣDDT	0.17 - 0.42	7.76

Table 6.10. Concentrations of POPs (µg/kg wet wt) in fresh walrus meat, and walrus meat fermented for 4 months by traditional methods in a ground pit ('kopalchen').

Kopalchen consists of the eviscerated unsalted flesh of walrus or other sea mammals and includes the skin and adjacent fat and meat tissue, which has been subjected to a period of natural microbial fermentation lasting up to several months, in a ground pit covered by soil. Generally, such pits are situated within residential areas, close to houses and are not properly protected from waste and drainage water incursion. Once dug, these pits are used on a long-term basis.

Ground pits or soil, where kopalchen fermentation takes place, appear to be heavily contaminated by PCBs (as indicated by a 200-fold increase in PCB concentration in kopalchen compared to fresh walrus meat) and also by DDT (20-fold increase in concentration).

6.2.3. Home-made alcoholic beverages

Among the indigenous communities of the western part of the Russian Arctic (for example the Kola Peninsula), where the social and economic status of indigenous people is relatively high, home-made alcohol is not widely consumed. In contrast, in regions such as the Chukotka Peninsula, where marketed alcoholic drinks are very costly, and therefore of limited availability to most indigenous people, moonshining and the making of alcoholic mash "braga"' is common, albeit illegal. Of the two, 'braga' production is throught to be more popular than moonshining due to its lower cost. According to the dietary questionnaire study that was undertaken, 'braga' consumption in northeastern Chukotka ranges from 30-50 litres per adult per year. A significant reduction in concentrations of POPs in the final product is achieved if "braga" is distilled to moonshine ("samogon") (Table 6.11).

Sample	ΣPCB	HCB	β-HCH	HCH	*p,p'*-DDE	*p,p'*-DDT	ΣDTT
Moonshine ('samogon')	82.0	3.3	12.7	33.0	39.0	44.0	86.0
Alcoholic mash('braga')	249.0	12.2	3.3	60.0	458.0	23.0	587.0

Table 6.11. Concentrations of POPs (ng/L) in alcoholic mash 'braga' and moonshine "samogon" sampled in the northeastern area of the Chukchi AO.

Analysis of 'braga' and 'samogon' showed higher PCB, HCH and DDT levels in 'braga', with significantly lower levels in 'samogon'. As found for kopalchen, *p,p'*-DDE is the major contributer to overall DDT metabolite concentrations in 'braga', whereas *p,p'*-DDT concentrations are relatively insignificant, suggesting that DDT contamination may be occuring through the use of waste chemical containers during the production of 'braga'.

The health impacts and importance of secondary contamination of local food can be illustrated by the elevated PCB serum concentrations found in families living in houses where higher levels of contaminantion of local food as a result of storage and processing were found (Table 6.12). Families living in houses where home-processed fish was found to be more highly contaminated (the same fish species being analyzed in each case) had, on average, a 16-fold increase in the relative risk factor of elevated PCB serum concentrations.

Secondary contamination of reindeer meat was not so great as that of fish, probably due to the simpler processing methods used for reindeer, involving more limited contact with waste materials and other contaminanted media.

Table 6.12. Comparison of PCB concentrations measured in foodstuffs sampled in selected households with levels in blood of adults from the same households, and the relative risk values associated with the foodstuffs.

	Households where adults had PCB serum concentrations greater than 1000 ng/g lipid (n=5)		Households where adults had PCB serum concentrations less than1000 ng/g lipid (n=5)	
	median	range	median	range
PCB concentrations measured in reindeer meat (n= 12)	86.17	1.05 - 446.0	40.87	2.48 - 87.10
Relative risk value	**2.9**		1.0	
PCB concentrations measured in freshwater fish (n= 9)	143.95	34.30 - 358.0	8.81	1.17 - 23.40
Relative risk value	**16.3**		1.0	

Table 6.13.
Linear correlation coefficients between blood POP levels among relatives of high-dose and low-dose groups and POP concentrations in wash-outs from the walls of their dwellings.

	High-dose groups			Low-dose groups		
	Levels in blood of family members (ng/g lipid, geometric mean)	Levels in wash-outs from the walls of dwellings (μg/m²)	Correlation coefficient	Levels in blood of family members (ng/g lipid, geometric mean)	Levels in wash-outs from the walls of dwellings (μg/m²)	Correlation coefficient
ΣPCB	1522	1.48	-0.04	788	1.66	0.25
	1275	2.87		99	2.23	
	827	3.24		711	3.11	
	1435	2.28		815	3.13	
	1869	1.86				
ΣDDT	939	0.9	0.43	716	36.8	0.84
	1414	0.86		437	1.4	
	634	10.1		600	2.12	
	729	7.85		936	4501	
	1352	73.58				

Due to significant individual variation in concentrations of the major PTSs found in maternal and cord blood of sampled indigenous people residing the same communities, it was considered of particular importance that contaminant sources and exposure pathways associated with some private and occupational activities involving PTS contaminated materials should be evaluated, even if only approximately. Clear relationships between contamination of dwellings by particular substances (as shown by contamination of water from the wash-outs of the walls of dwellings) and and levels of those same contaminants in the blood of inhabitants was found (Table 6.13).

Although such a restricted (case) study is of limited use (i.e., the resulting data have low statistical power and are generally inconclusive), the information on POPs exposure at the individual indigenous family level, involving the identification of risks associated with the use of specific chemicals in the household, and in occupational settings, may provide some insight into exposure sources and pathways. Generally, such sources of PTS exposure have not yet been adequately evaluated or documented for the types of situation that exist in the Arctic, especially with respect to some of the more vulnerable groups of indigenous people.