A GLOBAL SURVEY OF PCBs AND ORGANOCHLORINE PESTICIDES IN BUTTER

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Introduction

PCBs and organochlorine pesticides are persistent organic pollutants (POPs) with relatively low water solubilities, which often lead to their bioaccumulation in fatty tissues[1]. It has been suggested that POPs are subject to global fractionation[2]. Highly volatile compounds will migrate faster and will have a tendency to stay in the atmosphere, whereas less volatile POPs will tend to condense and partition into the grass, soil, water, snow or ice. In this study butter samples from around the world were analyzed for levels of PCBs and organochlorine pesticides (HCHs, HCB, DDT, DDE, DDD and chlordane) to assess worldwide scale pollution and relate levels to usage and the global fractionation hypothesis. In addition, this paper aims to test whether butter is a suitable matrix to monitor the global atmospheric distribution of POPs. Butter concentrations will reflect grass concentrations, which in turn will reflect air concentrations. Butter can also be considered to 'integrate' persistent pollutant concentrations on a regional or distinct scale, since it is usually produced in factories taking milk from a large number of farms within a moderate distance.

Materials and methods

Butter samples from 22 different countries were collected throughout the latter part of 1998 and early 1999 from shops in the respective country of origin and delivered frozen to Lancaster University. The countries where the samples were taken from and the number of samples analyzed from each country are: Austria (1), Australia (5), Brazil (4), Canada (6), China (1), Czech Rep. (1), Denmark (2), Germany (1), India (1), Israel (1), Italy (1), Japan (1), Mexico (3), Philippines (3), S. Africa (2), Spain (3), Sweden (3), Thailand (1), Netherlands (1), New Zealand (1), Tunisia (1), UK (2) and USA (18). The samples were stored at –20°C until their analysis.

The extraction method used is described elsewhere[3]. The second stage of the clean-up procedure was altered to allow for the concurrent analysis of organochlorine pesticides. A silica fractionation column (9 mm id) was packed with 3 g of silica (activated at 350°C) and eluted with 33 ml of hexane (for PCBs) and 15 ml of hexane:DCM (1:1) (for OC pesticides).

Results and discussion

Mean total PCB, DDT, HCH, HCB and chlordane levels are shown in Table 1. The PCB congeners most commonly found in the butter samples are 138, 153, 180 and 118, followed by 170, 99, 74, 52 and 183 (in order of abundance). This distribution is similar to the findings of others[4,5,6]. Butter from the Czech Republic had the highest PCB levels, followed by Tunisia. In the Czech Republic, before 1968, PCB production was about 500 tonnes[7], and it is believed that these products are still in use. The production of PCBs stopped in Slovakia in 1984 but their use in the former Czechoslovakia continued for several years[8] (which could explain the high levels found in this study). The high concentrations found in some countries may therefore indicate that PCB-

containing equipment is still in use (despite PCB bans imposed in many countries) persist in the environment. The relationship between PCB homologue concentrations and latitude shows lower levels in the S. Hemisphere, and higher in the N. Hemisphere. Highest levels were found between 30 and 50°N, in agreement with measurements in soil by Ockenden (personal communication, unpublished data). This correlates well with PCB usage around the world. Comparing all the homologues, the tetra-chlorinated PCBs tend to be more uniform in distribution. This could indicate transport around the world, and consequently evidence for global fractionation.

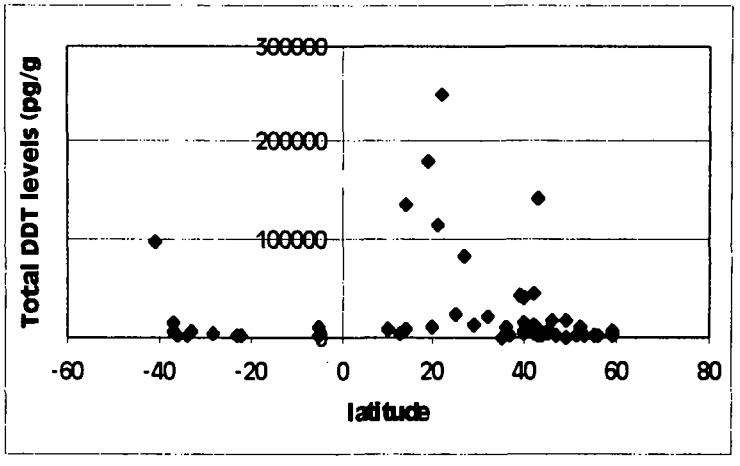
Table 1 – Mean PCB, DDT, HCH, chlordane and HCB levels (in pg/g fat)

Country	ΣPCB	ΣDDT	ΣHCH	ΣCHL	HCB
Austria	6800	1500	3400	20	5100
Australia	740	6000	300	nd	600
Brazil	1100	4300	2300	20	500
Canada	1700	2500	560	20	980
China	1800	41000	36000	nd	6200
Czech Republic	14000	17000	1800	nd	6200
Denmark	3100	2400	1400	20	2900
Germany	8700	1700	nd	nd	3300
India	4500	250000	220000	20	600
Israel	3600	21000	3600	60	1000
Italy	7700	5100	nd	nd	4100
Japan	600	3000	2800	40	1700
Mexico	1200	100000	2900	10	1100
Phillipines	520	71000	910	20	900
S. Africa	4200	4000	2500	20	700
Spain	5500	4900	19000	10	2600
Sweden	3600	3600	1600	10	1400
Thailand	1200	4000	2500	40	800
Netherlands	5600	11000	4000	50	3200
New Zealand	230	98000	600	nd	600
Tunisia	12000	7800	6400	20	2300
UK	6700	2400	3900	20	2100
USA	2300	25000	1300	40	900

nd = not detected

India had the highest DDT levels, despite the fact that its use has been restricted. The continuous and heavy usage in the first half of this century may have led to the accumulation of DDT in grass and surface soil. When latitude is plotted against the total DDT levels in different countries, northern latitudes show higher levels and southern latitudes lower DDT levels (Figure 1).

Figure 1 – Relationship between total DDT levels in butter (in pg/g fat) and latitude



The results for DDT are in accord with the global fractionation hypothesis. Having a relatively low mobility, DDT cannot be transported very far in the atmosphere and it therefore reflects the current use pattern in different countries.

HCH levels were very high for India and China (almost 10 times higher than any other country in the survey). Annual technical HCH (consisting of α- and γ-HCH) usage in both India and China is higher than most other countries[9]. The high α-HCH to γ-HCH ratios found in samples from India and China show that technical HCH is still in use in these countries or that present concentrations are being influenced by past use of technical HCH. The rest of the countries show considerably lower levels, in accordance with their use of lindane (pure γ-HCH) rather than technical HCH (wherever usage data was available).

HCB is the only POP that shows an inverse gradient with temperature, in agreement with previous work[10]. HCB also appears to have an inverted gradient with latitude in the N. Hemisphere.

The results obtained for most POPs were well below the FAO/WHO tolerance limits for foodstuffs

Following the UNECE/UNEP restrictions of several POPs it is useful to have a monitoring tool to reflect spatial differences of POPs. A relationship has previously been established between air and milk/butter fat concentrations[11]. This study suggests that butter can be rapidly and easily screened to provide data reflecting the ambient global distribution of POPs and usage patterns.

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