INFLUENCE OF GEOGRAPHICAL AND WEATHER PATTERNS ON ENVIRONMENTAL POLLUTION BY DDT AND ITS METABOLITES IN ZIMBABWE

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Introduction

The actual usage of DDT in Zimbawe is related to vector control in areas effected by tsetse flies (Glossina morsitans) and malaria, and this organochlorine compound has entered the environment in all places where spraying programmes are taking place (1,2,3). But DDT and other organochlorines can contaminate areas far away from the actual sources. Particle-bound long distance air transport and deposition in colder regions of organochlorines depending on weather conditions and the situation of low and high pressure systems in the atmosphere is well documented (4). In a study from 1993-1995 high levels of DDT were found in human milk from Nyanga, a fruit-growing district in the Eastern Highlands of Zimbabwe (5). In this area no DDT is used, whereas pest control on the commercial fruit farms only includes usage of HCH. The Mudzi area which is situated 100-150 km north of Nyanga is located in the low veld, in the north-eastern part of Zimbabwe, and is malaria endemic. There an intensive spraying programme is going on during the rainy season. During this season winds will drift from the north to the south where condensation takes place in the colder mountain areas of Nyanga. Situated in the middle of the Inter-tropic Convergence Zone (ITCZ), the Eastern Highlands are contaminated by air-borne organochlorine compounds during the summer (2). The objectives of this study were to determine the influence of weather and geographical conditions on the environmental pollution of HCB (hexachlorobenzene), HCHs (hexachlorocyclohexanes), and DDT with its metabolites in the areas of Nyanga and Mudzi.

Materials and Methods

***Collection of samples**:* During the rainy season in 1997-1998 16 human milk samples were collected from mothers living in the Mudzi area and 28 from mothers living in the Nyanga area. Both areas are situated in the eastern part of Zimbabwe. The average age of the mothers was 22 years in both sampling sites, whereas the average age of the breast fed children at the time of sampling was 8 months in Mudzi and 5.5 months in Nyanga. Both mothers with their first and second child participated in this study. The diet of the mothers which is based on *sadza* (thick maize-meal porridge) combined with vegetables and animal products is quite similar in the studied areas, with a slightly higher usage of fish in Nyanga.

Sample extraction, clean-up, and GC analysis: All the analyses were performed by the author at the laboratory of environmental toxicology at the Norwegian School of Veterinary Science in Oslo, Norway. The milk samples were extracted with cyclohexane and acetone and the fat extract was cleaned-up with sulphuric acid according to a method described earlier (6,7), slightly modified. The milk fat content was determined gravimetrically. As internal standards the PCBs 29, 112 and 207 were used. The analyses of the organochlorines were performed on two separate GCs, Carlo-Erba, HRGC 5300 Mega Series (Carlo-Erba Instrumentation, Milano, Italy) equipped with ECD ^{63}Ni detectors and with 60 m SPB-5 and SPB-1701 capillary columns (Supelco, Inc., Bellafonte, Pa). Details of the GC-method and tests of quality control are described by the authors elsewhere (5,8). The laboratory was accredited on April 11, 1996, by the Norwegian Accreditation as a testing laboratory according to the requirements of NS.EN 45001 (1989) and ISO/EC Guide 25 (1990).

Results and Discussion

HCB: Compared to industrialised countries (8,9) very low levels of HCB were measured in the human milk samples from Mudzi and Nyanga, as shown in table 1. They can be considered as a background level for the global distribution of this persistent chemical.

HCH: The Nyanga area is a commercialised fruit growing area and human milk samples from this area showed a relatively high contamination of sum-HCH (consisting of α-, β-, and γ-HCH) and are a result of this agricultural activity. The mean level of HCH in Nyanga was 10 times higher than the corresponding levels in Norway today (Polder, pers. com.), where HCH only was used in small scale until 1992.(7,9), but 2-10 times lower than corresponding levels in countries where HCH still is used heavily in agricultural activities like Russia and the former Soviet Union (8,10,11). The sum-HCH level in Nyanga was 14 times higher compared to the corresponding level in the Mudzi area with a range of 25 to 3979 μg/kg fat weight in Nyanga and a range of 2 to 75 μg/kg fat weight in Mudzi. The mean level of sum-HCH in Mudzi was 2 times lower than the corresponding level in Norway today (Polder, pers. com.). In both sites the β-HCH was the predominant isomer which contributed with 93 % to the sum-HCH in Nyanga and with 53 % in Mudzi. Only small scale farming is common in the area of Mudzi and the population is rather poor. Usage of HCH in this area is not documented. This indicates a possibility that HCH is deposited here as an air-borne contaminant from other parts of the country or from other parts of the world (4).

DDT and its metabolites: High levels of sum-DDT were determined in human milk samples from Nyanga (8810 μg/kg fat weight) and Mudzi (16838 μg/kg fat weight) with the persistent pp-DDE as the main contributor to the sum-DDT with 77% in Nyanga and with 82 % in Mudzi. The ratio pp-DDT/pp-DDE was 0.17 in Nyanga and 0.18 in Mudzi. The levels of pp-DDE ranged from 450 to 44916 µg/kg fat weight in Nyanga and from 1662 to 50242 µg/kg fat weight in Mudzi. The high DDT residues in the human milk from Mudzi can be explained because this area has a ground spraying program during the rainy season (2). Also earlier studies in other areas in Zimbabwe with vector control programmes have shown an extremely high contamination of DDT in human milk (5,12), concluding that these levels are among the highest reported in the world. The DDT levels in these areas are 30-70 times higher than corresponding levels in Norway (9) where DDT was banned in 1980, and about 10 times higher than corresponding levels in human milk samples from the northern part of Russia (8). In samples collected in 1993-1995 (5), a mean level of 10060 µg/kg fat weight of sum-DDT was reported in human milk from Nyanga, with a ratio pp-DDT/pp-DDE of 0.28. This might indicate a slowly decreasing trend. Still it is alarming that this area with absolutely no history of ground spraying is contaminated with such high levels of DDT. It is suggested that during the rainy season the moist winds from the north carry the DDT particles southwards to Nyanga where they are deposited in the valleys, the Eastern Highlands serving as wind breakers. The cool climate in Nyanga also assists in the condensation of drifting DDT particles, and in this way the DDT and its metabolites will accumulate in the local food chain. Even if DDT is known to be skin permeable contaminant the main contribution to the contamination in humans in Zimbabwe is supposed to be through the daily intake of contaminated foodstuff (Chikuni, not published).

Table 1. Residues (ppb, ug/kg fat) of organochlorines in human milk from Nyanga and Mudzi

	Nyanga	(N 28)	Mudzi	(N 16)
	Mean	S.D.	Mean	S.D.
fat %	3.38	1.33	5.10	3.03
HCB	3.91	4.02	1.75	1.73
sum-HCH	399	784	27.7	22.6
pp-DDE	6868	9181	13784	12382
sum-DDT	8810	11018	16839	15407
ratio DDT/DDE	0.17	0.10	0.18	0.06

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