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Levels of Organochlorine Pesticides Residues in Milk of Urban Mothers in Kenya

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Previous use of certain organochlorine compounds (ocps) for pest control has caused serious problems due to their persistence in the environment and potential toxicity. Studies show that ocps accumulate in fatty tissues of living organisms reaching higher levels in animals higher in the food chain. Because of these factors, many countries have banned or restricted the use of ocps. In Kenya, there was widespread use of DDT to control pests, especially in the mosquito infested areas (Kanja et al, 1986). Use of DDT is now restricted to mosquito control (Pest Control Products Board Records, 1986).

Contamination of human milk by organochlorine and other related compounds has been reported throughout the world (Jensen, 1983). Many of these studies have been carried out in the industrialized countries, and only few investigations have been reported from developing countries. This is a major concern, because it is in the developing countries that organochlorine pesticides have been used indiscriminately and continue to be used in some countries. In Africa recent studies on ocps in human milk have been reported from Uganda, (Ejobi et al, 1996) and Zimbabwe Chikuni et al, 1997). In an earlier study carried out in rural Kenya, Kanja et al, (1986) revealed high levels of pesticides in human milk especially in areas that DDT had been widely used in the past. No other studies have been reported since then. This study was therefore initiated to investigate the levels of organochlorine pesticides in an urban area in Kenya. The present study also compares levels of ocps in human milk from the previous study in the rural areas of Kenya. Finally the study will serve as a means of assessment of the environmental contamination in an urban area and evaluate the toxicological significance to the breastfeeding infants.

MATERIALS AND METHODS

A total of 216 milk samples were collected from mothers who were in maternity wards in hospitals or attending post natal clinics in selected areas in Nairobi in 1991. All the mothers involved in this study were nursing their first or second

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child, were aged between 18 and 30 years, and had lived in Nairobi for at least 5 years prior to the date of sampling.

Samples were collected from mothers who were up to four weeks post partum. A questionnaire was completed by each mother giving information on the mothers weight, dietary habits, age, occupation, income, smoking habits and use of pesticides. About 10 ml of milk was collected from each mother, by expressing directly into precleaned bottles with teflon caps. The milk was transported to the laboratory, and stored at -20 °C until analysis was done.

Extraction, clean up and analysis of milk was done according to a method previously described by Skaare et al, (1988) with slight modifications. Briefly the method was as follows: 10 ml of the sample was extracted with 20 ml n-hexane and 15 ml acetone by ultrasonic disintegration. The extraction was repeated using 10 ml n-hexane and 5 ml acetone. The hexane was evaporated to dryness and the fat content determined. The fat was redissolved in hexane (0.005 fat/ml hexane). Two aliquots of the hexane extracts were treated with either concentrated sulfuric acid or methanolic sodium hydroxide. Analysis of the final hexane extract was done using a GLC with the following instrument parameters, ^{63}Ni electron capture detector, columns 1.5 m x 2mm I.D packed with either 1.5 % SP- 2250 / 1.95 SP on 100/120 sulpelcoport (analytical) and 4 % SE 30/6 % SP - 2401 on 100/120 Sulpelcoport (confirmation). Column, detector and injection port temperatures were set at 210°, 250° , 230° C respectively. Carrier gas was nitrogen 99% pure at 60 ml/min and the injection volume was 2-5 µl. An equivalent volume of a chlorinated pesticide mixture (CPM) standard was injected for identification and quantitation. The average recoveries of this method varied from 87 % for lindane to 105 % for p,p'DDT in high spiking and 77 % for β-BHC to 96 % for low spiking in cow milk. The quantification limits were set to 0.001 mg/kg wet weight for all residues. The results reported are not corrected for recoveries.

RESULTS AND DISCUSSION

Samples were collected from mothers who satisfied the criteria for the study. A total of 216 samples were analyzed for presence of ocp residues. There was no difference in the levels of pesticides in mothers from the different sampling areas within Nairobi therefore all the results were pooled (Table 1). The means, range and standard error of the mean (SEM) are presented on both fat weight basis and wet weight basis.

Nine organochlorine pesticides were detected with p,p'DDT and p,p'DDE being the most frequently encountered contaminants in all the milk samples analyzed. p,p'DDE was detected in 99.5% and p,p'DDT in 78.2% of all samples analyzed. Other residues detected were dieldrin (27%), β-HCH (18.5%), lindane (12%), α-HCH (8.8%). Also, metabolites of DDT such as *o,p'*-DDT and p,p'-DDD were detected in few of the samples analyzed and were considered in sum DDT (p,pDDT + o,p'DDT + 1.11 (p,p'DDE + p,p'DD). The levels of sum DDT ranged from 0.004 to 6.321 mg/kg fat. The mean ratio of p,p'DDT to p,p'DDE was 0.585. Mean levels (mg/kg milk fat) of α-HCH, β-HCH, lindane and dieldrin were 0.013, 0.083, 0.018 and 0.019 respectively (Table 1). The mean percent extractable fat was 3.76.

Previously only one study was carried out on levels of ocps in human milk in Kenya (Kanja et al, 1986). We compared the mean of Sum DDT observed in this study with that observed in the earlier study. The means sum DDT in this study, (0.47 mg/kg milk fat) was lower than the lowest mean level (0.69 mg/kg milk fat) observed in an earlier study carried out on mothers living in the rural areas of Kenya (Kanja et al, 1986) (Table 2). The criteria for selection of mothers in this study was the same as used in that previous study. Kanja et al, (1986) found that mothers in the rural areas were exposed to these chemicals during agricultural practices and through consumption of contaminated foods. A similar trend has been observed elsewhere in the developing countries. Warnez et al, (1983) found levels of Sum DDT were higher in the rural areas as compared to the urban areas of Rwanda. The mean Sum DDT was lower than means reported from a few other African countries like Zimabwe (Chikuni et al, 1997), South Africa (Bouwman et al, 1990) and Uganda (Ejobi et al, 1996). The higher levels in some of these countries are attributed to continued use of DDT (Chikuni et al, 1997). We attributed the low levels of the concentration of DDT in mothers' milk observed in this study to the restriction of DDT use in Kenya and the fact that samples were collected from an urban area where there is no known exposure to DDT since mosquitoes are not rampant as in some of the rural areas of Kenya. However, the presence of DDT in this study reflects a continued use of this chemical and its' presence in the environment

p,p'DDE a major metabolite of DDT, was observed to be a major contaminant. With restriction or total ban of the use of DDT, levels of P,P'DDT in foods of plant origin fall rapidly but exposure of human's to p,p'DDE still occurs through consumption of foods of animal origin. The mean level was lower than the lowest mean observed in earlier studies in Kenya (Table 2). Levels of p,p'DDT followed a similar trend, with the mean level (0.15 mg/kg fat) in this study being lower in the urban are than in the rural areas (Table 2).

We also evaluated the ratio of p,p'DDT to p,p'DDE. This ratio is usually higher in countries where DDT is still being used. In countries like Norway where use of DDT was banned in 1970 (Skaare, 1981) the ratio of p,p'DDT to p,p'DDE decreased over the years from 0.32 in 1970 to 0.15 in 1979. Evaluation of this ratio is valuable in detecting the source of contamination and assessing recent or previous exposure and direct or indirect exposure through the food chain. The ratio in this study (0.584) was much lower than the ratio obtained in earlier studies in other regions of Kenya when DDT was still widely used (Table 2). This reflects less exposure of the urban mothers to the parent compound DDT as compared to the metabolite, DDE.

We detected low levels of HCH residues in some of the samples analyzed in this study. The commercial insecticide HCH is a mixture of different isomers mainly *a*, β, and γ, HCH. γ-HCH (lindane) is the most important isomer that is used as an insecticide and is the most toxic. β-HCH, the most symmetric and stable isomer, is also the most persistent in nature, thus it is usually found in highest concentrations in human adipose tissues and milk. In addition, the α and γ isomers may isomerise into β-isomer in living organisms. This observation may explain the higher level of β-HCH and the frequent occurrence of this isomer as compared to the other two isomers. Kanja et al, (1986) found low levels of α, β, and γ HCH in a few of the samples analyzed. They attributed this to direct contact of the mothers with the technical insecticide, which was easily available from agro chemical shops. Presently, the use of lindane is restricted, products with lindane as a component are available for pest control on vegetables and this may be a major contributor of the compound in the human body. The levels of HCH isomers in this study were lower than the maximum residue limits set by WHO (0.2 for lindane and 0.5 mg/kg fat for other isomers).

Apart from the compounds in the DDT group, dieldrin was the other major contaminant in the mothers milk. The mean level of dieldrin in this study (0.02 mg/kg fat) was comparable to that observed in samples from Embu in an earlier study (Table 2). The mean level in this study was lower than the extraneous residue limit (0.15 mg/kg fat) set by WHO/FAO.

To evaluate the toxicological significance to the infants, we applied the acceptable daily intake (ADI) established for adults. The ADIs set by the WHO/FAO (µg/kg body weight) for some chlorinated pesticides are as follows, lindane 2.5, dieldrin 0.1 and sum DDT 20 (Ejobi et al, 1996). We assumed that the child consumed 130 g mothers milk per day, that milk contained 3.5 % (w/w) fat and that the mean weight of the infant was 5 kg as used by Slorach and Vaz (1983). The calculated intakes for infants in this study ranged from 0.022 to 28 µg/kg for sum DDT. Infants whose mothers had the highest levels of lindane, and dieldrin would have an intake of 0.61 and 1.2 µg/kg respectively. These results indicate that some infants in this study would exceed the ADI of sum DDT and dieldrin. Although this may be so, it is uncertain what effects these high levels may have on the infants since the AD1 is calculated based on a life time exposure and the infant is exposed to pesticides through mothers milk only for short time. Thus breast feeding should not be discouraged using these results because of it's well recognized advantage.

Table 1. Mean levels (mg/kg) of pesticides residues in milk samples of mothers living in Nairobi.

	Mean levels of residues mg/kg	
Compound	Mean ± S.E.M [a] (Range) % positive	Mean ± S.E.M [b] (Range) % positive
p,p'DDT	0.152±0.026 0.002-2.58 78.2%	0.045±0.007 0.001-0.67
p,p'DDE	0.306±0.041 0.003-4.818 99.5%	0.09±0.015 0.001-2.422
o,p'DDD[c]	0.273	0.125
o,p'DDT	0.075±0.021 0.002-0.443 11.6%	0.032±0.011 0.001-0.204
p,p'DDD	0.029±0.010 0.003-0.209 9.3%	0.011±0.005 0.001-0.096
Sum DDT	0.473±0.059 0.004-6.321	0.131±0.02 0.002-2.811
p,p'DDT/p,p'DDE	0.585±0.077 0.013-11.991	
α-HCH	0.013±0.002 0.002-0.038 8.8%	0.006±0.001 0.001-0.019
β-HCH	0.083±0.026 0.003-0.6 18.5%	0.024±0.009 0.001-0.282
Lindane	0.018±0.005 0.002-0.134 12%	0.008±0.002 0.001-0.062
Dieldrin	0.019±0.003 0.004-0.273 27%	0.008±0.002 0.001-0.075

a- Milk fat basis b- Fresh weight basis
c- only one sample had detectable levels,

Table 2: A comparison between levels of pesticides (mg/kg milk fat) in samples from the rural areas (Kanja, 1988) and an urban area (Nairobi) in Kenya (present study).

Area/year of collection	p,p'DDT	p,p'DDE	Sum DDT	p,p'DDT/p,p'DDE	Dieldrin
Turkana 83	7.38	2.17	7.79	4.4	0.687
Karatina 83	1.59	1.72	3.51	0.7	0.059
Loitoktok 84	0.47	0.43	1.69	1.7	2.445
Nanyuki 84/85	2.47	1.52	4.32	2.0	0.657
Rusinga Island 84/85	9.60	7.61	18.73	1.3	0.255
Embu 85	3.60	5.23	9.76	0.8	0.01
Homa bay 85	4.08	8.48	7.94	1.3	<0.05
Meru 85	0.65	1.41	2.20	0.6	0.465
All areas	3.70	2.95	6.99	1.6	0.370
Nairobi 1991[a]	0.15	0.31	0.47	0.6	0.022

a- present study

Results from this study further show that mothers living in Nairobi have low levels of organochlorines in their breast milk in comparison to those living in the rural areas. These low levels could be attributed to the restriction of the use of these pesticides. The presence of ocps in human milk shows continued exposure of these compounds from the environment through contact with contaminated material or through the diet. Steps should be taken to educate people on safe use of pesticides in order to reduce contamination. More studies should be carried out especially in the rural areas where high levels of ocps were previously detected In addition there should be a follow up on the compounds banned or restricted to ensure that they are not availed.

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