POPs IN DEVELOPING COUNTRIES: HUMAN MILK ANALYSIS AT PACIFIC REFERENCE LABORATORY IN FIJI ISLANDS

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Introduction

The Stockholm Convention, a global treaty on elimination of persistent organic pollutants (POPs), came into force in May 2004. Fiji was the second country after Canada to ratify the Stockholm Convention, thereby agreeing to formulate a national implementation plan to monitor and control the release of POPs in the country. POPs are hazardous chemicals that are persistent, bioaccumulate in food chains and have the potential to impact at all levels of the trophic system. Fiji is an archipelago of more than 300 islands which lies between 15 ^{o}- 22.5^{o} S latitude and 174^{o} E - 177^{o} W longitude, spread over a total area of 709,700km^{2} of which 97% is ocean[2]. The current population of Fiji is estimated at about 837,231[8]. The larger islands in Fiji are quite mountainous, but also contain significant flat plains; it is on these flat plains that most agricultural and commercial activities are located and where pollution problems are most likely to occur[2]. Fiji, like many developing countries in the world, has limited or no monitoring data on POPs concentration in the environment and on the exposure of wildlife and humans to these chemicals[1,7]. Only a few studies on pesticide levels have been carried out in the South Pacific region, including Fiji, and relatively little is known on the occurrence of organochlorine chemicals[2,3,4]. Fiji has been part of two World Health Organization (WHO) studies on POPs in human milk. Composite milk samples sent to WHO reference laboratory in Germany indicated the presence of a range of PCDD/Fs and organochlorine pesticides and PCBs[6]. A United Nations Environment Programme (UNEP) and Global Environment Facility (GEF) funded capacity building project has provided specific training and support at the Analytical laboratory of the Institute of Applied Sciences at University of the South Pacific. The training and support from partner laboratories assisted the Pacific Reference Laboratory meet international standards for basic POP analysis. In this paper we report concentration data for basic POP chemicals (organochlorine pesticides and polychlorinated biphenyls (PCBs) in human breast milk samples taken from Kadavu in the Fiji Islands and analyzed at the Pacific Reference Laboratory in Fiji.

Material and methods

Approximately 5 – 6 g of composite human breast milk samples from new mothers in Kadavu (n = 11) were soxhlet extracted for a minimum of 16 hours using 175 mL of hexane; acetone (3:1 v/v). For each gram of wet sample, 3 g of anhydrous sodium sulphate was added to dry the sample. Clean-up for samples was done on an alumina column, while fractionation was done over silica column. Analysis for organochlorine pesticides and PCBs was carried out at the Institute of Applied Sciences (IAS), an ISO17025 accredited laboratory using methods adopted from the Institute for Environmental Studies (IVM) analytical methods for UNEP Chemicals POPs Training Project (i.e Internal standard technique and quantification using a high resolution gas chromatograph with a micro-ECD)[5]. Analytes of interest targeted in this study included the organochlorine pesticides (including DDTs, HCHs and Drins) and indicator PCBs. Recoveries of the internal standard (PCB 103 and PCB 198) were calculated for all samples and was used as a measure of QCQA to assess the methodology. A laboratory blank was included as well.

Results and Discussions

The internal standards for spiking to calculate recovery were used for quality control and quality assurance purpose. The recoveries of the internal standards were between 72 – 104 %. A number of contaminants including DDTs, HCHs, Heptachlor Epoxide and indicator PCBs (28, 52, 101, 118, 153, 138, 180) were detected. The concentrations of ΣDDTs (total of o,p'DDT, p,p'DDT, o,p'DDD, p,p'DDD, o,p'DDE, p,p'DDE) found in the human milk samples from Kadavu in Fiji Islands are summarized in Table 1. The concentration range for ΣDDTs detected in the human milk samples was 3430 to 4450 pg g^{-1} (SD = 526; median = 4180) wet weight. The current study on human milk from Kadavu indicates that p,p'DDE is found as the dominant contributor towards ΣDDTs. The p,p'DDE concentrations contributed 69 – 87 % towards ΣDDTs present in the human milk sample. It is noteworthy that DDE/DDT ratio in human milk sample was 24 to 88 (SD = 36; median = 56). This indicates that there has been no

recent exposure from DDT in this population. One study highlights that DDT concentrations in human milk have declined in most areas of the world, consistent with restrictions on its use[9]. The concentrations for ΣHCHs (total for a-HCH, b-HCH, g-HCH, d-HCH) found in the human milk from Kadavu are summarized in table 1. The concentration range for ΣHCHs detected in the milk samples was 600 to 860 pg g^{-1} (SD = 139; median = 640) wet weight. The results indicate that b-HCH concentrations contribute 82 – 83 % towards ΣHCHs present in the human milk sample. The concentrations for ΣDrins (total of Aldrin, Dieldrin, Telodrin) found in the human milk samples are summarized in table 1. The concentration range for ΣDrins detected in the milk samples was 2310 to 4250 pg g^{-1} (SD = 1082; median = 2460) wet weight. The results indicate that dieldrin concentrations contribute 96 – 97 % towards ΣDrins. The concentrations for $\Sigma PCBs_7$ found in the human milk samples are summarized in table 1. The concentration range for $\Sigma PCBs_7$ detected in the milk samples was 2520 to 4540 pg g^{-1} (SD = 874; median = 2540) wet weight. The results indicate that PCB 52 concentrations contribute 82 – 91 % towards $\Sigma PCBs_7$.
Generally it can be seen that ΣDDTs are still the dominant POP chemical found in human milk in this population with highest contribution by p,p'DDE towards ΣDDTs (Figure 1). Further, ΣDDTs from Kadavu human milk samples in a WHO study was reported as 573.5 ng g^{-1} fat[6]. Overall, concentrations for POP chemicals in this study are low in comparison to human milk data from countries outside the Pacific Island Region[9].

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Table 1: Summary of concentrations (pg g^{-1} wet weight) for ΣDDTs, ΣHCHs, $\Sigma PCBs_7$ and other basic POPs detected in composite human milk samples from Kadavu, Fiji Islands

Sample	CompM1	CompM2	CompM3	Blank
ΣDDTs	4180	3430	4550	200
ΣHCHs	600	860	640	10
ΣDrins	2310	4250	2460	100
$\Sigma PCBs_7$	2520	4040	2540	100
PCB 52	2090	3690	2090	100
Dieldrin	2220	4140	2360	100
p,p' DDE	3660	2380	3890	100
b-HCH	490	700	530	10
HCB	10	10	20	5
a-Endosulfan	660	510	700	10
PentaCB	20	10	20	5
HCBD	410	220	430	10
cis-HeptEpox	30	20	30	5
trans-HeptEpox	20	10	20	5

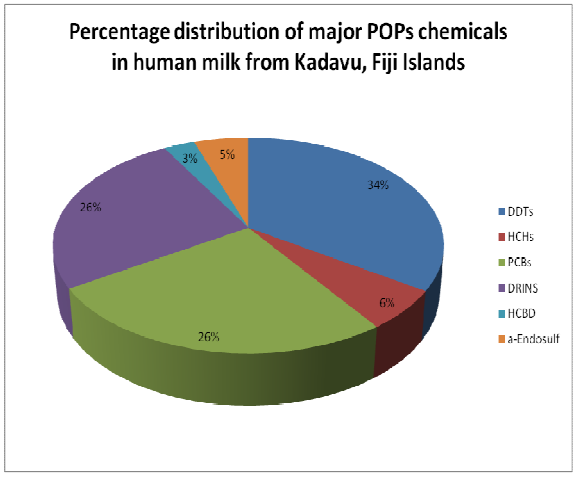

Figure 1. Percentage (%) distribution of major POP chemicals in human milk samples from Kadavu, Fiji.