

ASSESSMENT OF DIOXIN IN SELECTED FOOD ITEMS AND MOTHER MILK FROM COMMUNITIES NEAR AGENT ORANGE HOT SPOT IN DA NANG AIRBASE AND SUGGESTION TO REDUCE DIOXIN EXPOSURE

Tam TN^{1*}, Hue NTM², Thuong NV², Minh NH², Hanh TTT³, Rinh NV¹, Truong P¹, Ngoc-Phuong TN¹

¹Vietnam Association of Victims of the Agent Orange (VAVA), Nr.35 Me Tri Lake St, Thanh Xuan district, Hanoi, Vietnam

²Center for Environmental monitoring, Vietnam Environment Administration, Nr. 556 Nguyen Van Cu St, Long Bien district, Hanoi, Vietnam

³Hanoi School of Public Health, 138 Giang Vo, Ba Dinh district, Hanoi, Vietnam

Introduction

Dioxin contamination from Agent Orange (AO) in Vietnam has received much attention for the past decades^{1,2}. Da Nang former airbases were bulk storages for Agent Orange during the Vietnam War and currently is one of the most severe dioxin hot spots. This area has received much attention from national and international scientists due to high dioxin contamination caused by Agent Orange during Operation Ranch Hand and Pacer Ivy Operation^{1,3}. In recent years, samples of soil, sediment, some food samples, breast milk and blood samples of local residents at Da Nang in site and surrounding area have been reported to have elevated levels of dioxin^{2,4,9}.

In this study, Da Nang airbase has been used as a case study for examination exposure of dioxin and furans in selected food items and mother milk. Food items and mother milks were collected from surrounding four wards of Da Nang airbase in order to assess human exposure and bioaccumulation of dioxins in local communities. Daily intake of dioxin for local resident who consume local high risk food was estimated.

This study has implemented when dioxin remediation activities are currently being carried out in site of Da Nang airbase. Therefore, obtained data will not only point out status of dioxin contamination in the sites but also provide database for the further study. This study aimed to assess the current levels of dioxin in foods and estimate the dioxin daily intake for local residents under different scenarios. Recommendations for further risk reduction activities at the Da Nang hot spot were provided.

Materials and methods

Sample collection

Food items and breast milk were collected in four wards surrounding Da Nang airbase in order to assess human exposure and bioaccumulation of dioxins in local communities. Forty-six pooled food samples were collected from households living in An Khe, Hoa Khe, Chinh Gian and Thanh Khe Tay wards in Da Nang City, local markets and surrounding the airbases in 2013-2014. Pooled samples were formed by combining 5-15 individual samples. Each individual sample was collected from one household, a local pond or a retailer at a local market, and weighed at least 200g.

Twenty-seven breast milk samples were collected from primiparae who have lived over five years in Chinh Gian, An Khe, Khue Trung, Hoa Thuan Tay wards which are located near Da Nang airbase. The participants in the study were 21–42 years of age, non-smokers and importantly, had lived in the respective areas for at least 5 years.

Chemical analyses

Pooled food and mother breast milk has been transported to the Dioxin Laboratory in Hanoi and stored at -20°C until analysis. Chemical analysis of PCDD/Fs was carried out by following the method 1613B (U.S EPA, 1994) using High resolution Gas chromatography coupled with High resolution Mass spectrometer (HRGC/HRMS)⁶. Seventeen 2,3,7,8-substituted PCDD/Fs congeners was carried out by isotope dilution method using Micromass Autospec Ultima system (Waters, UK) with Agilent 7890A gas chromatograph (GC) and DB-5MS capillary

column (60 m × 250 µm i.d × 0.25 µm film thickness, J&W Scientific Inc., Folsom, CA). The procedure for sample preparation and equipment operation have described by our previous study^{4,7}.

The Toxic Equivalency Factors (TEFs) scheme by World Health Organization (WHO, 2005) was used for the calculation of TEQ in this study. Based on the TEQ concentrations of the investigated samples, the health risk of dioxin exposure were identified and warned to community surrounding of Da Nang airport.

Estimated daily intake

The estimated daily intakes were calculated using the following formula: Estimated daily intake from each type of food (pg/day) = dioxin concentration in food (TEQ pg/g) × daily food consumption level (g/day).

The maximum intake value was calculated by the equation: EDI (pg/g bw/day) = (800 × L × TEQ)/5.8; where: L is the mean lipid content of breast milk sample and assumed that infant's daily consumption of breast milk is 800 ml for 5.8 kg of infant weight.

Results and discussion

Dioxin level in food samples and estimated daily intake

Table 1 showed elevated levels of dioxin in potentially high risk local foods, including free range chicken meat (4.6 pg/g TEQ to 95 pg/g TEQ), fresh water fish (14.4 pg/g TEQ to 86.6 pg/g TEQ), fresh water snail (53.6 pg/g TEQ), free range duck meat (8.2 pg/g TEQ to 19.6 pg/g TEQ), free range chicken eggs (7.3 to 29.7 pg/g TEQ), free range duck eggs (15.7 pg/g TEQ) and beef (3.8 pg/g TEQ to 24.6 pg/g TEQ).

Table 1: TEQ concentrations of dioxin in food samples collected surrounding Da Nang Airbase, and estimated level of exposure

No.	Types of food samples	2,3,7,8 TCDD (pg/g)	TEQ (pg/g)	Daily food consumption level (g)	Lowest dioxin intake TEQ pg/day	Highest dioxin intake-TEQ pg/day	Lowest daily intake (pg/kg/day)	Highest daily intake (pg/kg/day)
		A	B	C	D*=BxC	E*=BxC	F=D/49.9	G=E/49.9
1	Free ranged chicken at households (3 pooled samples)	1.3-6.7	4.6-18.4	13.2	61.0	242.0	1.2	4.9
	Caged chicken bought at local markets (2 pooled samples)	0.01-0.6	0.1-6.1		1.5	80.0	0.03	1.6
	Duck meat bought at local markets	0.4	1.0		13.7	13.7	0.3	0.3
2	Chicken eggs, free ranged (2 pooled samples)	1.5-2.6	9.3-9.8	10.9	101.6	106.9	2.0	2.1
	Duck eggs at local market, from other areas (Bien Hoa)	0.2	0.6		9.7	9.7	0.2	0.2
3	Fresh water fish caught at local ponds (4 pooled samples)	6.7-15.3	14.4-86.6	78.6	1131.8	6806.8	22.7	136.5
	Seafood (3 pooled fish samples, local markets)	1.3-1.5	2.1-6.7	7.5	15.5	50.5	0.3	1.0
4	Beef at local markets (2 pooled samples)	0.3-3.3	3.8-24.6	6.1	23.3	150.6	0.5	3.0
5	Pork at local markets (2 pooled samples)	0.06-0.08	0.3-1.0	37.4	12.1	36.7	0.2	0.7
6	Fruit vegetables at households	0.03	0.05	23.7	1.1	1.1	0.02	0.02
7	Leafy vegetables at households: 3 pooled samples	0.02-0.07	0.07-0.2	139.3	9.7	28.7	0.2	0.6

8	Mixed rice sample bought at Trung Dung market	0.03	0.04	309	13.0	13.0	0.2	0.2
TOTAL highest dioxin exposure (TEQ) level if people consume local foods: free ranged chicken, duck, free ranged eggs, fresh water fish and snail							27.0	148.0
TOTAL dioxin exposure (TEQ) if people do not consume locally produced high risk foods							1.2	4.3

Estimated daily intake of dioxin for local residents if they did not consume locally produced foods (low risk scenario) ranged from 1.2 to 4.3 pg/kg bw/day (in Da Nang). However, if local residents consumed locally produced foods (high risk scenario), then the estimated daily intake for local people in Da Nang was from 27.0 to 148.0 pg/kg bw/day, which was exceeding the TDI level of 1-4pg/kg bw/day recommended by WHO¹⁰.

These data showed that local residents living surrounding Da Nang airbase was at high risk of exposure to dioxin if they consume local foods such as fresh water fish, snail, free-ranging chicken, chicken meat, and free-ranging duck and duck eggs being raised at or in the vicinities of the airbases. If local residents consume foods that originate from other areas, their estimated daily intakes were much lower, and fall within the range recommended by Health Canada (10 pg/kg bw/day) and were just slightly higher than the range recommended by WHO (1-4 pg/kg bw/day)¹¹.

Dioxin level in mother breast milk and estimated daily infant intake

The mean TEQ concentrations in mother milk samples collected from four wards ranged from 8.1 to 26 pg/g lipid. Observed trend of TEQ concentration was slightly different compared with those of the PCDD/Fs mass concentration, showing Khue Trung < Hoa Thuan Tay < Chinh Gian < An Khe. The mean estimated daily intakes of TEQ (EDI-TEQ) for the local breast-fed infants were showed in figure 1. The lowest EDI-TEQ value was found in Khue Trung, Cam Le district (48.0 pg TEQ/kg bw/day), while the highest value observed in An Khe, Thanh Khe district (155.6 pg TEQ/kg bw/day). The EDI-TEQ values in this study compared to Kim Bang non-contaminated site previous report (24.5 pg TEQ/kg bw/day)¹⁰.

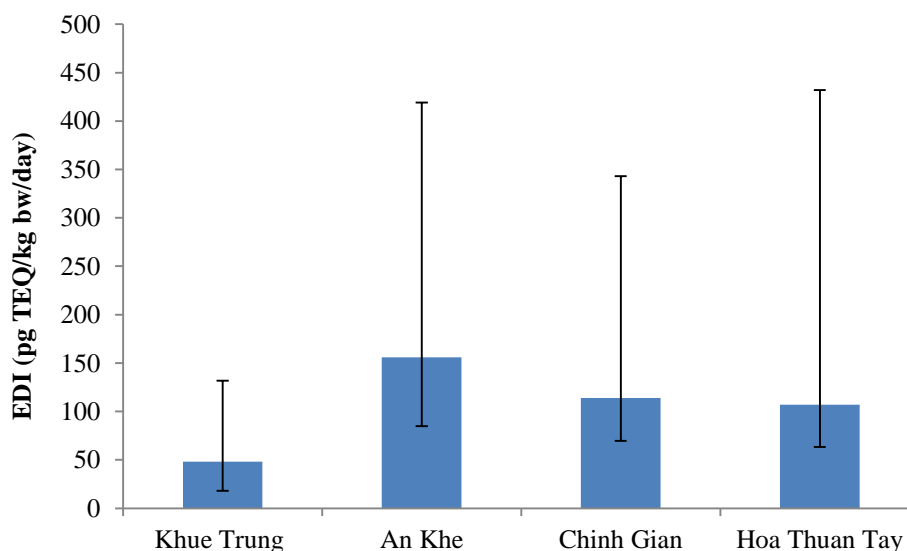


Figure 1: Estimated daily intake of TEQ for local breast-fed infants (pg TEQ/kg bw/day)

The potential risk of exposure to dioxin for Da Nang local residential with local food and infant-fed were estimated and considered in this study. Remediation projects is currently being implemented at Da Nang airbases, dioxin contaminated soil and sediment will be treated to safety level. However, dioxin pollution has already transported to areas surrounding the airbases during past decades. Therefore, the safety regulations for

harvesting, consuming food and mother milk which high-risk dioxin contamination in the Da Nang must be strictly implemented as soon as possible.

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