DETERMINATION OF MERCURY AND METHYLMERCURY IN VIETNAMESE PREGNANT WOMAN HEAD HAIR

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1. INTRODUCTION

As a participant to the Coordinated Research Program (CRP) on the Assessment of Environmental Exposure to Mercury in Selected Human Populations as Studied by Nuclear and Other Techniques since 1 July 1992, we started to carry out work on project "Determination of Mercury and Methylmercury in Vietnamese Pregnant Woman Head Hair".

This study is aimed at making a concrete survey of hair mercury levels in groups of women as monitored continuously from early pregnancy to post-natal period. The obtained data could be of great usefulness for further investigation on potential health risks in pregnant women and their babies as related to degree of mercury pollution in the environment.

1.1. SCIENTIFIC BACKGROUND OF PROJECT

Because prenatal life is more sensitive to the toxic effects of mercury than adult life, resulting in inhibition of early childhood development and mental ability of children whose mother were exposed to mercury during pregnancy, it is of primordial importance to carry out investigation on this problem. Since the degree of mercury contamination in the body is faithfully reflected in the mercury content of the human hair, pregnant women's head hair samples are selected for the purpose.

2. EXPERIMENTAL

2.1. COLLECTION OF SAMPLES

Ho-Chi-Minh and Nha-Trang Cities have been selected as two typical places representing common characteristics related to mercury contamination problem. The first area is an industrial region with many chemical plants that were suspected of discharging an appreciable amount of mercury into the environment. The second area is a coastal city where fish and sea products are the main foodstuff for the population. So, the potential health risks of mercury pollution through the diet constitute a serious social problem.

2.2. SAMPLE PREPARATION

The scalp hair samples (cut about 10 cm from the root of scalp hair) after washing with pure distilled water, were dried at 50°C and then dipped into an acetone/alcohol solution with volume ratio 50:50 for 3 hours and finally dried at 50°C for 5 hours.

The tuna fish samples have been collected from the market. They are divided into three parts: muscle, kidney and liver. The samples were dry frozen and then pulverized.

2.3. ANALYTICAL TECHNIQUES TO BE USED

INAA, RNAA and HPCL (High Performance Liquid Chromatography).

Hair and fish samples (100-200 mg), together with standard samples of Human hair (NIES-CRM-5), Horse Kidney (IAEA-H-8) and Fish Flesh (IAEA-M-A-2) were sealed in polyethylene ampoules and irradiated for 10 hours at thermal neutron flux about 2.5×10^{12} $n \cdot cm^{-2} \cdot s^{-1}$ in the core of Dalat Nuclear Reactor. After a decay period of 3-5 days, the separation of Hg in fish samples was performed.

The samples and standards were counted in fixed geometries with a HP-GE detector coupled to a computer-based Multi-channel Analyzer.

Tables 1 and 2 illustrate some typical results showing the dependence of mercury concentration in human scalp hair on geographic, sex and age conditions. Table 3 shows the mercury concentration in the various tuna fish organs. Figure 1 shows globally the frequency distribution of mercury concentration in Vietnamese hair.

2.3.1. Instrumental neutron activation analysis (INAA)

Using a planar HP-GE detector with FWHM about 500 eV at 122 key of ^{57}Co, X rays Au 67.0 and 68.8 key are resolved from one another, X ray Au 77.9 key and gamma ray ^{197}Hg 77.3 keV can be added together. So, a computer program should be used in order to fit the overlapping peaks. Figure 2 shows a typical spectrum of hair sample as measured on the planar HP-GE detector.

Using a coaxial HP-GE detector with FWHM about 2.0 keV at 1332 key of ^{60}Co, gamma ray 279 keV of 46.9-day ^{203}Hg is measured.

Table 4 shows the comparative results of mercury determination based on the two different above-mentioned measurements.

2.3.2. Radiochemical neutron activation analysis (RNAA)

2.3.2.1. Reagents

Mercury standard, IAEA Reference Materials, mercury carrier solution, nitric acid, sulphuric acid and sodium carbonate.

2.3.2.2. Apparatus

Teflon bomb, stirrer and vacuum bomb connected with filter.

2.3.2.3. Chemical procedure

Irradiated samples were mineralized in the teflon bomb with a solution of 6 Ml concentrated nitric acid and 2 Ml of concentrated sulphuric acid; addition of 20 mg of non-radioactive mercury and heating for 6 hours in dry furnace at 120°C. The samples were then left to cool down.

The sample solution was neutralized with sodium carbonate and ammonium hydroxide to pH = 6, added with KSCN, $ZnCl_2$ and stirred to form $HgZn(SCN)_4$. The precipitation was then washed with the thiocyanate washing solution and with alcohol. The precipitate was at last dried under infrared lamp. The reference and standard samples were also carried out the same way.

2.3.2.4. Chemical yield

By the gravimetric method, the chemical yield was determined to be 96.4%.

2.4. ANALYTICAL QUALITY CONTROL EXERCISE (AQCE)

We have carried out six determinations on total mercury content of two samples from IAEA in the intercomparison programme. Determination of methylmercury has not been performed yet. Table 5 shows the total mercury concentration of two samples in AQCE from IAEA.

3. RESULTS

Table 7 shows some primary results of determination of total mercury in the Vietnamese pregnant women head hair samples.

4. OTHER RELATED WORKS PERFORMED AT THE INSTITUTE

4.1. RESEARCH PROGRAM ON THE MARINE ENVIRONMENT

In recent years, we have carried out the determination of metallic elements in the marine environmental samples such as Ag, As, Co, Cr, Cu, Fe, Hg, Mn, Sb, Se, V and Zn. Table 6 shows some of the results in the determination of metallic elements in marine sediment (all results are to be reported on a dry weight).

Table 1: *Mercury Content in ppm of Human Scalp Hair Samples. (Population in southern Viecnam, age 18-60)*

Sex	Number of Measured Samples	Arithmetic Mean	Standard Deviation
Male	44	2.22	0.74
Female	67	2.72	0.91

Table 2: *Mercury Content of Human Scalp Hair samples in ppm. (Population in northern Vietnam, age 18-32)*

Sex	Number of Measured Samples	Arithmetic Mean	Standard Deviation
Male	2.	0.25	0.11
Female	28	0.29	0.14

Table 3: *Mercury Content in Tuna Fish Parts, in ppm. (The coast from Nha-Trang to Phan-Rang)*

Sample	Muscle	Liver	Kidney
1	0.23 +- 0.05	0.34 +- 0.05	0.61 +- 0.07
2	0.19 +- 0.06	0.41 +- 0.04	0.58 +- 0.04
3	0.20 +- 0.05	0.28 +- 0.05	0.35 +- 0.06

Table 4: *Mercury Content in ppm Based on Two Measurements.*

Sample	77.3 keV on planar det.	279 keV on coaxial det.	Ratio of Values
Hair	3.25 +- 0.07	3.16 +- 0.15	1.03
Fish	0.23 +- 0.02	0.21 +- 0.12	1.09

Table 5: *Mercury Content in ppm of Two Samples from IAEA.*

Sample	Number of Determinations	Arithmetic Mean	Standard Deviation
# 1	6	0.39	0.02
# 2	6	0.59	0.01

Table 6: *Concentration of Elements in Marine Sediment Samples, in ppm.*

Element	Number of Measured Samples	Arithmetic Mean	Standard Deviation
Ag	6	1.6	0.3
As	50	42	4
Co	50	5.7	0.4
Cr	50	85	6
Cu	50	33	4
Fe	100	27500	45
Hg	100	0.35	0.05
Mn	100	660	30
Sb	50	2.1	0.3
Se	50	2.7	0.3
V	6	95	7
Zn	50	155	15

Table 7: *Mercury Content in ppm of Pregnant Woman Hair according to months of pregnancy.*

Sample	Fourth	Fifth	Seventh
1	2.11 +- 0.06	2.08 +- 0.06	2.05 +- 0.06
2	2.18 +- 0.07	2.13 +- 0.07	2.12 +- 0.07

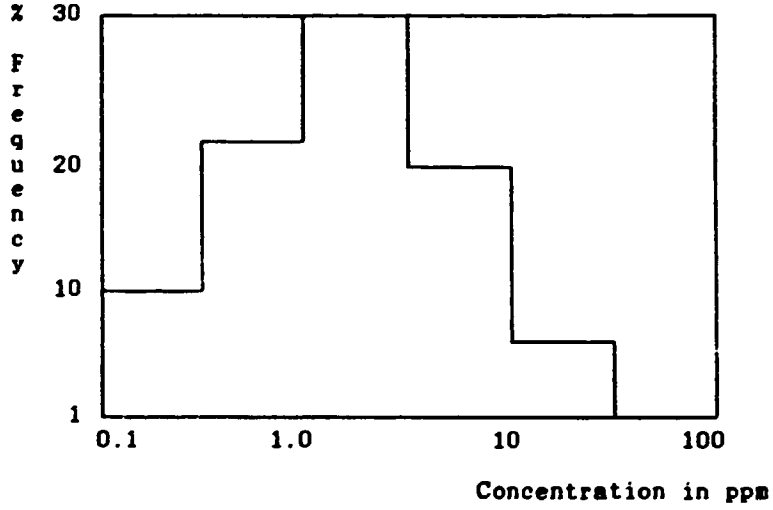

Figure 1: *Frequency Distribution of Mercury Concentration in Vietnamese Hair.*

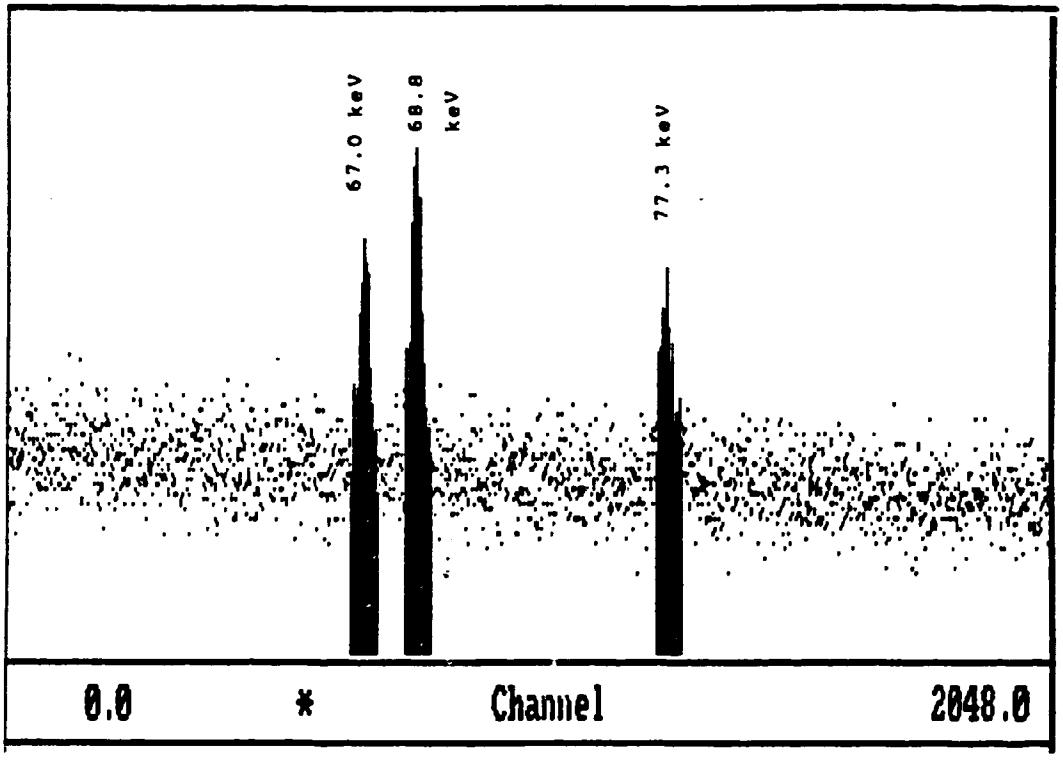

Figure 2: *A Typical spectrum of hair sample was measured on Planar HP-GE Detector (Ti=10h, Td=5d, Tc=3600s).*