CHAPTER V

DISCUSSION

Both internal and external concentration of trace elements classified as bulk, essential, toxic and others in man's hair were shown in table 4.1 to 4.4 respectively. The external concentration of the elements was obtained from the difference between concentration in unwashed and washed sample. The internal concentration was the elemental concentration in washed sample. Table 4.5 indicated the concentration range, average and proposed baseline of determined elements in washed and unwashed samples.

With reference to table 4.1 to 4.4 , it could be seen that most of samples showed higher elemental concentration in unwashed hair more than in washed hair as it should except in some elements in small amount of sample indicated in vice versa, i.e.

Sample code no.	Group of element			
	bulk	essential	toxic	other
B-15	-	-	-	Ti
B-22	-	-	Hg	-
E-26	Mg	Zn	As	Ce
F-2	Ca	-	-	-
F-5	Ca, Mg	Br, Fe, Mn, Zn	-	Rb
F-11	Ca, Cl	Br, Fe, Mn, I Zn	Hg, Co, Sb, Se, V	Ti
E-29	-	Zn	Hg	Ce, Rb

This indicated that there was contamination during the sample preparation step, viz, cutting, washing, air-drying etc. It is to be noted also that the elements found were almost the same and sample numbers, F-5 and F-11, showed heavy contamination. In this connection, the possible conclusion of such contamination may be as follows :-

a) Ti from the scissors (cutting step)

b) Mg, Ca, Ce, Rb, I, Mn, Br, Fe, Zn, Co, Sb and V from the atmospheric input of air particulate in the sample preparation room (washing step)

c) Se, Hg, As, Br, Cl from the vapour of chemical reagents used by other scientists in the sample preparation room.

However, this is the evidence that the utilized technique is quite sensitive. Consequently, it is recommended that more care must be taken in sample handling and all sample preparation steps must be done entirely in clean glove-box or laminar flow fumehood.

Since baseline concentrations of trace elements in human hair in Thailand are not yet known at present, this results, for men only, could not be regarded as conclusive. However, in comparison with values reported by others cited in table 5.1 and 5.2, the results as indicated appear to be within that range except the elements As and Na which showed rather high value. With this regard, food contamination may be considered as the source.

Consequently, the extensive study should be done especially for the element As.

The purpose of grouping hair donors into five categories is aiming to evaluate, if possible the external contamination in relation to the donor's occupation, field of study or residence. Owing to the obtained data did not clearly indicate any significantly high concentration of determined elements and because of insufficient information needed, the definite conclusion can not be drawn for the time being. However, there were some interesting cases which should be brought into consideration, that is:

a) In sample numbers C-1 and C-2, who were brothers and lived in the same dormitory, studied the same subject, Pharmacology, but at different university and was about the same age, that is 20 and 22 years respectively, however no correlation of any elements between two donors both internal and external concentration was observed, except elements Ag and Au in which both cases indicated rather high external contamination. With this respect, it is believed that the possible contamination may come from either their residental area, e.g. a silver-goldsmith shop or their profession, e.g. pharmacist.

b) One interesting hair sample (F-26) clearly showed internal and external contamination of Al. Upon checking with his occupation, it was found that he has been working with aluminium and aluminium alloy in making a roof rack as well as a body of the car.

c) Sample no. F-6 showed high concentration of Se internally and externally. Since he had a long hair, the selenium contamination from shampoo may be the possibility. But for internal contamination, there was not enough information to make any suggestion.

In this study as many as 31 elements could be detected instrumentally as summarized in table 5.3, and the multi-elements determination could be done in a single run. Additionally, the reliability of the utilized technique was quite satisfactory as shown in table 5.4. The sensitivity was quite good as indicated in table 5.5. Since the irradiation time and the counting time of irradiated samples were not able to keep constantly and to be prolonged regarding the insufficient irradiation facilities, irradiation time as well as the malfunction of one out of two Ge(Li) detectors causing in minimizing the counting time the obtained limit of detection was quite variably as illustrated in table 5.5.

Although the washing procedure employed in this study was recommended by the IAEA and was used extensively with many researchers throughout the world with satisfaction. It is to be noted that many workers (61,64,66) found that there were some elements, e.g. Fe, Cr, Co, Hg, Na lost during the washing step.

It is necessary to mention that although the definite conclusion could not be drawn at present upon lacking of some

significant information ; it is beyond the objective of this study. However, it is believed that the introduction of the technique which is applicable, as an analytical tool, in our country may be very useful to those who are interested in this type of work.

Table 5.1 Reported levels (internal concentration) of toxic metals in human hair and tentative "normal" and toxic levels* (ppm):

Element	Reported Range	"Normal" Range	Threshold Effected	Acute or Chronic-Effects	Death
Antimony	0.03-47.0	0.03-9.0	Unknown		
Arsenic	0.0-1585.0	0.0-2.0	3.0	12.0	
Chromium	0.0-6.43	0.0-4.0	Unknown		
Cobalt	0.0-3.11	0.0-1.0	Unknown		
Copper	7.8-486.0	7.8-120.0	Unknown		
Mercury	0.01-2436	0.01-30.0	50.0-200.0	200.0-800.0	500.0
Selenium	0.3-30.0	0.3-13.0	8.0-30.0	8.0-30.0	
Vanadium	0.006-271	0.006-2.71	Unknown		

*Levels are tentative estimates from visual inspection of data only. Data are incomplete on toxic effect, and experts vary in interpretation.

Table 5.2 Summary of the average of some trace elements concentration in washed hair found by this study compared with the others.

Element	Concentration in ppm					
	Thailand	Ref	Japan	Ref	India	Ref
Ag	0.056± 0.071		0.21	35	0.68	66
Al	10.94 ± 14.32		13.7 ± 11.5	35	-	
As	1.591± 1.539		0.31	35	0.083	66
Au	0.0083± 0.008		0.013		0.66	
Ba	7.206± 6.948		-		-	
Br	0.977± 1.346		7.0 ± 5.9	35	2.30	66
Ca	668.65 ±464.48		946	35	568 ± 803	67
Ce	0.499± 0.305		-		-	
Cl	47.78 ± 51.60		720 ± 590	35	3190	66
Co	0.043± 0.056		1.6 ± 2.3	35	0.07	66
Cr	0.180± 0.175		0.32	35	0.46	66
	0.16 ± 0.04	58	-		-	
	0.241	57	-		-	
	0.16	58	-		-	
Cu	4.094± 2.718		13.1	62	-	
	12.9 ± 1.6	58	-		-	
	14.1 ± 1.4	58	-		-	
	20.0 ± 1.2	59	-		-	
Fe	13.84 ± 10.58		-		-	
	19.2 ± 3.3	58	-		-	
	28.7 ± 2.5	58	-		-	

Table 5.2 (contd.)

Element	Concentration in ppm					
	Thailand	Ref	Japan	Ref	India	Ref
Hg	1.156± 1.134		-		-	
	2.3	60	-		-	
I	0.382± 0.325		0.57± 0.80	35	3.77	66
La	0.035± 0.066		0.040	35	0.18	62
Mg	85.69 ± 52.35		83	35	-	
	69.0 ± 46.0	59	-		-	
Mn	4.113± 3.294		1.27	35	0.29± 0.03	58
	3.81 ± 0.75	58	-		-	
	2.61 ± 0.33	58	-		-	
Na	282.10 ±273.94		48.7	35	31.2	66
Rb	1.004± 2.144		-		1.25	66
Sb	0.109± 0.511		0.101	35	0.12	66
Se	3.117± 11.164		3.74	35	1.28	66
Sn	0.052± 0.043		60	35	-	
Ti	4.560± 2.416		5.35	35	-	
V	0.110± 0.084		0.086	35	-	
Zn	189.30 ±141.55		164	62	-	
	175 ± 16	66	-		-	
	164 ± 15	58	-		-	
	115 ± 60	59	-		-	

Remark The result from Thailand without reference was from this study

Table 5.3 The 31 trace elements found in human head hair

Bulk Element	Essential Element	Toxic Elemant	Other Elements
Ca	Br	As	Al
Cl	Co	Co	Ag
K	Cr	Cr	Au
Mg	Cu	Cu	Ba
Na	Fe	Hg	Ce
	I	Sb	Hf
	Mn	Se	La
	Se	V	Rb
	Sn		Sc
	V		Sm*
	Zn		Ti
			W*

* could not be determined quantitatively

_ classified as essential and toxic elements

Table 5.4 The reliability test for analysis method: Using IAEA Hair HH-1

Element	Concentration in ppm					
	Result of this work*		IAEA HH-1 value		Das et al. (65)	
	$\bar{X}$ ± SD		accepted range	$\bar{X}$ ± SD	$\bar{X}$ ±	(SD)
Ag	0.143	0.014	0.14 - 0.23	0.19	0.06	-
Al	5.776	0.663	2.60 - 10.78	5.50	2.58	-
As	0. 051	0.007	0.03 - 0.09	0.05	0.02	0.0565 0.0065
Au	0.029	0.001	0.02 - 0.05	0.03	0.01	0.0457 0.0030
Ba	1.493	0.128	0.22 - 4.73	1.83	2.52	-
Br	4.038	0.05	0.37 - 8.42	4.16	2.09	1.71 0.04
Ca	540.93	2.87	246.0 - 712.0	522.03	160.22	-
Cl	2443.24	46.97	1776.67 - 3140.00	2265.29	478.28	1803.33 89.63
Co	5.554	0.101	2.70 - 8.05	5.97	1.21	7.966 0.493
Cr	0.222	0.003	0.20 - 0.63	0.27	0.16	-
Cu	8.80	0.58	1.80 - 19.05	10.23	3.17	10.866 0.416
Fe	25.24	2.12	0.44 - 50.00	23.70	9.76	22.0 3.60
Hg	1.658	0.119	1.20 - 2.30	1.70	0.24	1.59 0.105
I	10.86	0.53	4.90 - 32.20	20.25	8.91	12.33 0.32

Table 5.4 (contd.)

Element	Concentration in ppm							
	Result of this work*		IAEA Hh-1 value				Das et al. (65)	
			accepted range					
	$\bar{X}$	± SD			$\bar{X}$	± SD	$\bar{X}$ ±	SD
La	0.024	0.003	0.01	0.02	0.01	0.01	-	
Mg	69.84	1.58	47.24	71.90	62.01	9.58	-	
Mn	0.792	0.085	0.32	1.30	0.85	0.25	0.6166	0.0058
Na	12.835	0.126	5.90	23.48	12.64	4.77	12.8	0.01
Sb	0.027	0.003	0.02	0.05	0.03	0.01	-	
Se	0.330	0.013	0.26	0.41	0.35	0.04	-	
Ti	5.671	0.557	0.55	11.10	5.31	5.51	-	
V	0.140	0.029	0.02	0.31	0.14	0.15	0.08	
Zn	173.67	1.28	91.00	265.33	174.08	31.51	166.0	2.0
Rb	0.908	0.124	0.88	1.00	0.94	0.09	-	

* determined at least three times

Table 5.5 Detection Limits of Trace Elements(in μg)

Condition I		Condition II		Condition III	
μg	element	μg	element	μg	element
$2.99-3.01 \times 10^{-5}$	I	$8.5-11.1 \times 10^{-7}$	Au	$1.9-2.3 \times 10^{-5}$	Cr,Sc
$2.72-3.01 \times 10^{-4}$	V	$7.9-12.2 \times 10^{-5}$	As	$3.5-4.3 \times 10^{-5}$	Hg
$1.95-2.04 \times 10^{-3}$	Cu	$0.9-1.2 \times 10^{-4}$	La	$4.7-5.7 \times 10^{-5}$	Hf
$2.85-3.15 \times 10^{-3}$	Al	$1.8-2.5 \times 10^{-4}$	Br	$1.4-1.6 \times 10^{-4}$	Se
$2.99-3.00 \times 10^{-3}$	Mn	$6.7-13.1 \times 10^{-3}$	Na	$1.7-2.0 \times 10^{-4}$	Sb
$1.18-1.22 \times 10^{-2}$	Ti	$1.4-1.7 \times 10^{-2}$	Sn	$3.7-4.6 \times 10^{-4}$	Rb
$8.40-8.60 \times 10^{-2}$	Mg	$0.9-1.7 \times 10^{-1}$	K*	$4.7-5.7 \times 10^{-4}$	Co
$1.49-1.50 \times 10^{-1}$	Cl			$3.7-4.9 \times 10^{-3}$	Ba
$0.99-1.01 \times$	Ca			$5.2-6.2 \times 10^{-3}$	Zn
				$4.9-6.1 \times 10^{-2}$	Ag
				$8.2-9.9 \times 10^{-2}$	Fe

	Condition I	Condition II	Condition III
irradiation time	2 min	68-82 hr	68-82 hr
decay time	1.83 - 2.17 min	5 d	20 d
counting time	2 min	800-1200 sec	2500-3500 sec
thermal neutron flux(n $cm^{-2}sec^{-1}$)	1.8×10^{12}	2×10^{12}	2×10^{12}

* Condition for potassium determination was:

irradiation time = 12 - 18 hr ,decay time = 40 hr

counting time = 600-900 sec

thermal neutron flux = 4.25×10^{11} n $cm^{-2}sec^{-1}$

Note All elements were counted with a 26 cm^3 Ge(Li) detector