



STUDIES IN THE PHILIPPINES ON INGESTION AND ORGAN CONTENT OF TRACE ELEMENTS OF IMPORTANCE TO RADIOLOGICAL PROTECTION

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ABSTRACT

The first Coordinated Research Program on Reference Asian Man (RAM) was conducted for a period of six years. The study dealt with the collection of data in four areas namely: (1) anthropometric measurements, (2) organ mass measurements, (3) nutritional and dietary intake, and (4) pulmonary and water balance studies. Based on the research needs with reference to radiation protection, dietary intake and tissue analysis appear to be important aspects of the RAM. Information to be generated from the elemental analysis of food and tissue would be used to characterize the intake, retention and release of radioactive elements coming from different population groups. This study also aims to establish the elemental composition profile of the average Filipino using simple and accurate methods of measurements.

This report will present the protocol which is based to the extent possible on prescribed procedures required for the study. A standardized protocol to be used in the study is important since stable elements are present only in trace quantities in biological samples of interest. The procedures presented in this document include: collection of one day diet samples and tissue samples (lung, liver, skeletal muscle, thyroid, bone and kidney) from average healthy adult Filipino. The sample treatment and preparation, analytical measurements, data evaluation and reporting will complete said protocol.

The elements that are of importance to radiation protection are iodine, cesium, strontium, thorium and uranium. The essential minor elements are calcium, potassium and sodium. Trace elements like copper, manganese, iron, selenium and zinc will also be included in the analysis. Concentrations of common toxic elements such as mercury, cadmium and lead may likewise be reported in this study.

I. INTRODUCTION

The determination of the stable elements present in the human body has gained importance in assessing man's exposure to toxic substances like chemicals and radiation. Documented studies have shown that enhanced concentrations of these elements have a direct correlation to human diseases⁽¹⁾. Deficient or an excessive intake of an element often results to an impairment of a physiological function. Likewise in the calculation of radiation dose, it has been suggested that stable elements play an important role in the intake, retention and excretion of radioactive substances in the human body⁽¹⁾.

The elements which are of importance to radiation protection are cesium, iodine, strontium, uranium and thorium. Essential minor elements such as calcium, potassium, sodium and magnesium; trace elements like copper, iron, selenium, manganese and zinc as well as toxic trace elements such as mercury, lead and cadmium are also important to consider since these appear to have some influence on the behavior of radionuclides inside the body.

The major sources of elements in the human body are food eaten and water intake. Varying pattern of food intake and composition due to socio-economic, cultural and geographic reasons result to differences in the concentrations of elements in food eaten by different populations. Hence, it is necessary to establish the elemental composition profile of different population groups.

To date, there is little information available from the Asian Pacific regions on the occurrence and the significance of essential, minor and trace elements in biological samples. In the internal dose computation, it is necessary to consider these elements for it is believed that the path taken by the radionuclides inside the human body is regulated by the concentration of these elements. Based on research needs with reference to the Phase 1 of the project on Reference Asian Man, the elemental analysis of food and tissue appear to be a significant aspect of the previous study. Hence a second phase of the study was initiated to validate existing data and to generate additional data on the elemental composition of foods and tissues coming from the Asian member countries.

The Philippine Nuclear Research Institute (PNRI) participated in the first phase of the Reference Asian Man Studies. In the final report submitted, data on the concentrations of essential, minor and trace elements coming from typical Filipino diets using food composition table and the regional surveys conducted by PNRI, have been reported. Several diet samples have also been analyzed for the concentrations of the abovementioned elements⁽²⁾. Likewise methods for quantitation of these elements in selected tissues from various organs was discussed in the Formulation Meeting of the CRP held in Nakaminato, Japan last March, 1995⁽³⁾.

It is expected that the a study on the elemental composition profile of food eaten by the average Filipino and the corresponding body composition will establish a relationship between dietary intake of elements and its deposition. Furthermore, this study will generate information on the trace elemental needs and the tolerances of Filipinos which will be applied not only for radiation protection purposes, but also in health, medicine and nutrition.

II. PROTOCOL

A. SAMPLING

Representative sampling is defined as securing a sample of a population that exhibit average properties. Hence the selection of study groups is important in securing samples for this study.

1. FOOD

The study groups to be used in this research will be classified based on ethnic, socio-economic, and geographical factors. In securing the food samples, the Philippine Nuclear Research Institute (PNRI) will collaborate with the Food and Nutrition Research Institute (FNRI), using the 4th nationwide food consumption survey conducted in Feb-May, 1993⁽⁴⁾. This survey was conducted in 4,050 households, involving more than 24,000 household members from 84 provinces of the 13 regions of the country (Table 1). In each province, two (2) urban and two (2) rural barangays were sampled, using a systematic random sampling.

The 1993 food consumption survey indicated some kind of further deterioration in the average Filipino diet as compared with past findings. The summary of the findings in the 1993 nationwide nutrition survey with reference to this study is hereby presented⁽⁴⁾.

a) The 1993 Food Basket of the Average Filipino

The 1993 food basket of the average Filipino is a combination of rice, vegetable and fish and he spends a daily amount of P16.11 (\$0.55). His daily consumption of rice and its products is 282 grams (Table 2). For his viand, he eats fish and fish products in the amount of 99 grams which is 35% of 803 grams of the daily total food consumption. His meat consumption with poultry is at almost half the amount of fish he consumes, 48 grams. His vegetable consumption is 106 grams (30 grams of green leafy and yellow vegetables, 76 grams

of other vegetables). Fruit form part of his food basket in the amount of 77 grams. The rest of the basket contains dried beans, nuts and seed (10 grams), fats and oil (12 grams), starchy roots and tubers (1 gram) and sugars (19 grams). Milk and products are hardly taken by the average Filipino, only 1/4 of a cup (44 grams) per day. Beverages, condiments and other miscellaneous foods add 19 grams to the total weight (803 grams) of the food basket .

In the abovementioned survey, the urban population was heavy consumers of meat and poultry as well milk and milk products. The amount of these food items in urban areas were two times greater than in rural areas (Table 3)⁽⁴⁾.

b) Cultural and Geographic Differences in Food Consumption⁽⁴⁾

The National Capital Region (NCR) has the least amount of rice consumption (252 grams per capita per day). But heavy consumption of costly food items like bread and other cereal products, meat and products, poultry, eggs, milk, vitamin C rich foods and beverages was observed.

The Ilocos and Cagayan Valley, located in the northern part of the country, were the top consumers of rice registering at 344 grams per capita per day. Also both regions with Cagayan Autonomous Region (CAR) recorded heaviest consumption than the rest of the regions.

Visayas which occupies the central portion of the 7,100 islands, (except Western part) and Mindanao which is located at the southern part of the country (except Autonomous Region of Muslim Mindanao or ARMM) remained as corn eating regions as shown by their remarkably high consumption of this item⁽⁴⁾.

All regions of Visayas and Mindanao except Central Mindanao indicated per capita per day consumption quantity of fish and products at 100 grams and above which are heavier than consumption of Luzon regions except Bicol. In Luzon, fish was supplemented by comparatively greater amount of meat than Visayas and Mindanao.

c. Socio-economic Differences ⁽⁴⁾

The average Filipino household consists of 6 members. The largest size is 9 and above. Consumption amounts for the majority of food groups were recorded in households with fewer members and were subsequently reduced with membership of seven or more (Table 4).

The occupational groups like professionals, Overseas Contract Workers, administrative, executive, managers and large entrepreneurs have a diverse and better diet compared with other occupational groups. The disadvantaged other household with limited choices and provisions of food are fishermen, related workers and the unemployed.

Households are nutritionally at risk with food peso value of less than ten (10) pesos. The all urban Metro Manila recorded the highest average cost of food at P23.49 (\$0.90) while the rural areas reveal the lowest food cost of P13.18 (\$0.50). The wide gap of consumption is clearly indicated between the lowest and highest per capita income groups and per capita food peso value. Cheap foods are corn and products, green leafy and yellow vegetable, and starchy roots and tubers (Table 5).

d. Comparison with the Past Surveys⁽⁴⁾

Results of 1993 survey showed a general decrease in the food consumption. In 1987 the average food consumption was 869 grams per capita per day. This decreased in 1993 to 803 gram per capita per day, the lowest since the 1978 survey. The reason being is that the food supply declined during the 1990-91 period by 6.1%⁽⁴⁾. The decline ranging from 7.3 to 28 % were observed in rice & products, other vegetables, fruits, fish, starchy roots & tubers, sugars, fats, meat and other foods. However, increased consumption in poultry, corn and products, other cereal products and eggs were observed. Consumption for milk and milk products, nuts and seeds, dried beans and green leafy and yellow vegetables remained unchanged.

e. Food Sampling

Duplicate one day diet samples will be prepared from market "basket" samples. Test meals will consist of breakfast, lunch, dinner and two snacks based on the cost, availability of food items, and ease of preparation. The said test meals will be chosen from the commonly eaten meals per region prepared by the FNRI⁽⁵⁾ (Table 3). All the food that will be prepared for one whole day consumption including snacks taken in between meals and the late night snacks to be taken before retiring for the day, will be weighed and processed for analysis. Food served and eaten raw, processed foodstuff served directly on the dining table, perishable food items, condiments, and all types of beverages and drinks will also be included.

In support of the food weights taken, related data such as income grouping, food cost, meal pattern, cultural and other dietary practices (*i.e.*, leftovers) will be taken into account in the collection of samples.

Average typical meals of Filipino adult (20-40 years old) from 13 regions (10 samples per region) of the country will be analyzed. Collection period will be one year although food is plentiful during the summer months (Feb- May).

2. TISSUE

Representative autopsy samples from male and female adult populace coming from 12 regions (10 samples per region) will be taken for analysis through the cooperation of the Philippine Constabulary Crime Laboratory. The period of collection will depend on the number of accidental deaths that will be reported by the cooperating agency. Sample type will be thyroid, liver, skeletal muscle, lung, kidney and rib or long bone. Medical and autopsy record of the source of the tissue sample will be taken. Such data will include sex, age, cause and time of death.

Fresh normal looking tissue samples of approximately 300-400 grams for large organs, will be considered for this study with the total weight recorded. For the smaller organs like the thyroid, whole organ will be collected. With the use of stainless steel surgical forceps and scissors, the tissues will be divided into representative subsections and will be placed in clean polyethylene bags using unpowdered rubber laboratory gloves. The sample will be immediately placed in a portable ice cooler and will be transferred to a freezer with temperature of -20°C .

C. ANALYSIS OF ELEMENTS IN DIET AND TISSUE SAMPLES

1. PRE-TREATMENT

Each test meal or tissue sample will be homogenized using stainless steel or titanium tools and vessels (to avoid artificial external contamination) into a creamy consistency before ashing. The ordinary ashing apparatus will be used with caution to avoid contamination from the external walls of the muffle furnace. Temperature will be raised slowly to 450°C for the diet and soft tissue samples. Wet digestion method for bone tissue will be applied, using borosilicate glass beakers with watch glass for cover to avoid contamination from the laboratory environment. Closed system such as the PTF Pressure vessel and metal jacket for acid decomposition is the priority method to be applied in this study.

In the dissolution procedure, care will be observed to recover elements from the ash by applying proper acid leaching or treatment in the PTF vessel with hydrofluoric acid (HF) after decomposing organic substances. Clear looking solutions with out precipitate will be used for determination.

Table 7 shows the analytical technique which will be used to determine the high priority elements in this study.

The Philippine Nuclear Research Institute is presently establishing its own analytical facilities. Hence the analytical measurements in connection with this research had been initially requested to be performed at the National Institute of Radiological Sciences in Nakaminato, Japan. The said request was done during the formulation meeting held in March, 1995 at NIRS, Nakaminato, Japan. Diet and tissue samples will be prepared at the PNRI laboratory and will be then sent to NIRS for analysis.

Table 7. Analytical Technique for Each Element

SAMPLE	ELEMENT				
	Cs	I	Sr	Th	U
Bone	AAS/ICPAES		AAS/ICPAES	AAS/ICPAES	ICPMS
Diet	AAS/ICPAES	ICPMS	AAS/ICPAES	AAS/ICPAES	ICPMS
Kidney	ICPMS				ICPMS
Liver	AAS/ICPAES			AAS/ICPAES	ICPMS
Lung					
Muscle	AAS/ICPAES		AAS/ICPAES	AAS/ICPAES	
Thyroid		ICPMS			

NOTES: ICPMS Inductively Coupled Plasma Mass Spectrometry
 AAS Atomic Absorption Spectrometry
 ICP-AES Inductively Coupled Plasmaatomic Emission Spectrometry

III. RADIONUCLIDES AND TRACE ELEMENTS

The Health Physics Research Section of the PNRI published information on the Cesium 137 levels in local fish and shellfish found in the local Filipino diet⁽⁶⁾. Cesium is present in the marine environment as a result of atmospheric nuclear weapons testing and nuclear accidents abroad. The mean activity concentration of Cs 137 in 13 fish species which are commonly eaten by Filipinos was 0.53 ± 0.47 Bq per Kg of the wet edible fraction. In mollusks, the mean activity concentration was measured as $0.24 \pm .20$ Bq per Kg of the wet edible fraction. A similar value of 0.23 ± 0.12 Bq per kg of the edible fraction was observed in crustaceans⁽⁶⁾.

The PNRI has recently set up a Total Reflection x-ray Fluorescence (TXRF), an analytical tool for trace element analysis. Water from different sources have been analyzed using the equipment. The type of water samples analyzed were deep well water and tap water ⁽⁷⁾. The elements presented in this study which will be useful for the CRP on Reference Asian Man are: K, Ca, Fe, Cu, Zn, Sr and Pb. Table 8 shows the range of values obtained in this published information.

The Metropolitan Waterworks and Sewerage Authority is a government institution mandated to deliver clean and safe drinking water to the National Capital Region and nearby provinces. Hence to ensure the quality of drinking water, samples taken as tap water are routinely analyzed at their Central Laboratory. In addition, bottled mineral water and water from deepwell coming from different areas of the Philippines are also analyzed. A guest lecturer from the said agency will present the information with reference to the RAM Project on concentrations of trace elements in drinking water.

REFERENCES

1. Mckenzie, H. A. and Smythe, L. A. (1988) Quantitative Trace Analysis of Biological Materials. Elsevier Science Publishers B V. (Biomedical Division) p.20 - 37.
2. Natera, E.S. et. al. Paper presented on IAEA RCA- RCM on: Compilation of Anatomical, Physiological and Metabolic Characteristics For A Reference Asian Man. Oct 25-29,1993, Tianjin, China.
3. Natera, E.S. Paper presented on IAEA RCA - Project Formulation Meeting on: Ingestion and Organ Content of Trace Elements of Importance in Radiological Protection. 27 February - 3 March, 1995. Hitachinaka City, Japan.
4. Fourth National Nutrition Survey Philippines, 1993. Food Consumption Survey (Abstract and Background Information). Food and Nutrition Research Institute, Department of Science and Technology, Bicutan, Metro Manila. August, 1995.
5. Trinidad, P.T. et. al. 1989. Iron Absorption From adequate Filipino Meals. The Nucleus, Vol.XXVII : p. 29 - 47.
6. Duran, E.B. et.al. 1996. Cesium - 137 Levels in Fish and Shellfish in the Filipino Diet. The Nucleus, Vol.XXXII : p. 13 - 16.
7. Africa, L.B. and Calix, V.S. 1996. Total Reflection X - ray Flourescence Spectrometry: Theory, Instrumentation and Applications. The Nucleus, Vol. XXXII: p. 24 - 30.

**TABLE 1. NUMBER OF HOUSEHOLD BY URBAN / RURAL SECTOR
AND BY REGION: PHILIPPINES, 1993**

AREA	TOTAL	URBAN	RURAL
PHILIPPINES	4050	2208	1842
National Capital Region	384	384	-
I. Ilocos Region	192	96	96
CAR	240	120	120
II. Cagayan Valley	240	120	120
III. Central Luzon	288	144	144
IV. Southern Tagalog	528	264	264
V. Bicol Region	288	144	144
VI. Western Visayas	288	144	144
VII. Central Visayas	192	96	96
VIII. Eastern Visayas	288	144	144
IX. Western Mindanao	144	72	72
X. Northern Mindanao	336	168	168
XI. Southern Mindanao	288	144	144
XII. Central Mindanao	144	72	72
ARMM	210	96	114

DOST Fourth National Nutrition Survey: Philippines, 1993

TABLE 2. MEAN ONE-DAY PER CAPITA FOOD CONSUMPTION: PHILIPPINES, 1993

FOOD GROUPS/SUBGROUPS	CONSUMPTION		Percent of Total Food Intake
	Raw as purchased, In grams ⁽¹⁾		
	kg/year	g/day	
Cereals and Cereal Products	124	340	42.3
Rice and Products	103	282	35.1
Corn and Products	13	36	4.5
Other Cereals and Products	8	22	2.7
Starchy Roots and Tubers	6	17	2.1
Sugars and Syrups	7	19	2.4
Fats and Oils	4	12	1.5
Fish, Meat and Poultry	53	147	18.2
Fish and Product	36	99	12.3
Meat and Product	12	34	4.2
Poultry	5	14	1.7
Eggs	4	12	1.5
Milk and Milk Products	16	44	5.5
Whole Milk	13	35	4.4
Milk Products	3	9	1.1
Dried Beans, Nuts and Seeds	4	10	1.2
Vegetables	39	106	13.2
Green Leafy and Yellow Vegetables	11	30	3.7
Other Vegetables	28	76	9.5
Fruits	28	77	9.6
Vitamin C-Rich Fruits	8	21	2.6
Other Fruits	20	56	7.0
Miscellaneous	7	20	2.5
Beverages	3	9	1.1
Condiments and Others	4	11	1.4

NOTES:

(1) - As available in the kitchen including inedible and edible wastage

FNRI, DOST Fourth National Nutrition Survey : Philippines, 1993

TABLE 3. MEAN ONE-DAY PER CAPITA FOOD CONSUMPTION BY URBANIZATION: PHILIPPINES, 1993

FOOD GROUP/SUBGROUP	PHILIPPINES		ALL URBAN		METRO MANILA		OTHER URBAN		RURAL	
	CONSUMPTION (Raw, As Purchased), in grams ⁽¹⁾									
	kg/yr	g/day	kg/yr	g/day	kg/yr	g/day	kg/yr	g/day	kg/yr	g/day
Cereals and Cereal Products	124	340	116	318	107	293	120	328	132	361
Rice and Products	103	282	100	273	92	252	103	281	106	290
Corn and Products	13	36	6	17	n	1	8	23	20	55
Other Cereals and Products	8	22	10	28	15	40	9	24	6	16
Starchy Roots and Tubers	6	17	5	13	4	12	5	13	8	21
Sugars and Syrups	7	19	7	20	8	23	7	19	6	17
Fats and Oils	4	12	5	14	5	14	5	14	4	10
Fish, Meat and Poultry	53	147	59	161	66	181	56	154	47	132
Fish and Product	36	99	36	98	35	95	36	100	36	100
Meat and Product	12	34	16	44	23	63	14	37	8	23
Poultry	5	14	7	19	8	23	6	17	3	9
Eggs	4	12	6	15	6	16	6	15	3	9
Milk and Milk Products	16	44	24	64	31	85	21	56	9	24
Whole Milk	13	35	18	48	24	66	15	41	8	22
Milk Products	3	9	6	16	7	19	6	15	1	2
Dried Beans, Nuts and Seeds	4	10	4	11	4	10	4	11	3	8
Vegetables	39	106	36	98	32	87	37	102	41	113
Green Leafy and Yellow Vegetables	11	30	9	25	7	18	10	28	12	34
Other Vegetables	28	76	27	73	25	69	27	74	29	79
Fruits	28	77	30	82	28	78	31	83	27	73
Vitamin C-Rich Fruits	8	21	10	27	12	34	9	24	6	15
Other Fruits	20	56	20	55	16	44	22	59	21	58
Miscellaneous	7	20	8	23	11	29	7	20	6	16
Beverages	3	9	4	12	7	18	3	9	2	6
Condiments and Others	4	11	4	11	4	11	4	11	4	10

NOTES:

(1) - As available in the kitchen inedible and edible wastage

n - negligible less than 0.5 gram

**TABLE 4. MEAN ONE-DAY PER CAPITA FOOD CONSUMPTION
BY HOUSEHOLD SIZE: PHILIPPINES, 1993**

FOOD GROUPS/SUBGROUPS	HOUSEHOLD SIZE				
	1 - 2	3 - 4	5 - 6	7 - 8	9 & above
	CONSUMPTION (Raw, As Purchased), in grams ⁽¹⁾				
Cereals and Cereal Products	452	376	342	330	319
Rice and Products	360	312	283	269	271
Corn and Products	73	40	34	40	30
Other Cereals and Products	19	24	25	21	18
Starchy Roots and Tubers	13	17	18	17	16
Sugars and Syrups	22	20	20	17	17
Fats and Oils	15	15	13	11	9
Fish, Meat and Poultry	186	182	151	131	132
Fish and Product	128	121	100	92	91
Meat and Product	44	43	37	25	31
Poultry	14	18	14	14	10
Eggs	20	16	14	10	10
Milk and Milk Products	34	55	46	35	43
Whole Milk	33	43	35	29	35
Milk Products	1	12	11	6	8
Dried Beans, Nuts and Seeds	18	12	10	8	8
Vegetables	173	124	107	99	96
Green Leafy and Yellow Vegetables	41	33	31	30	26
Other Vegetables	132	91	76	69	70
Fruits	94	91	82	72	66
Vitamin C-Rich Fruits	26	24	22	18	20
Other Fruits	68	67	60	54	46
Miscellaneous	27	23	21	18	16
Beverages	14	10	9	8	8
Condiments and Others	13	13	12	10	8

NOTES:

(1) - As available in the kitchen including inedible and edible wastage

FNRI, DOST Fourth National Nutrition Survey : Philippines, 1993

**TABLE 5. MEAN ONE-DAY PER CAPITA FOOD CONSUMPTION
BY FOOD PESO VALUE: PHILIPPINES, 1993**

FOOD GROUPS/SUBGROUPS	FOOD PESO VALUE						
	< 10.01	10.01- 15.00	15.01- 20.00	20.01- 25.00	25.01- 30.00	30.01- 35.00	35.01 & over
	CONSUMPTION (Raw, As Purchased), in grams ⁽¹⁾						
DISTRIBUTION OF HOUSEHOLDS (%)	28.0	25.4	17.9	11.8	7.1	3.5	6.3
Cereals and Cereal Products	318	345	352	350	362	327	370
Rice and Products	229	296	316	308	321	285	309
Corn and Products	79	31	9	12	4	5	6
Other Cereals and Products	10	18	27	31	36	37	55
Starchy Roots and Tubers		14		20	15	13	21
Sugars and Syrups		17		23	28	30	35
Fats and Oils		12		16	18	16	27
Fish, Meat and Poultry	85	127	158	194	222	252	324
Fish and Product	81	103	114	107	111	126	93
Meat and Product	3	17	32	64	73	82	163
Poultry	1	7	12	24	38	44	67
Eggs	4	12	14	19	20	20	29
Milk and Milk Products	9	27	56	67	75	113	165
Whole Milk	8	24	51	57	59	75	88
Milk Products	1	2	5	10	16	38	77
Dried Beans, Nuts and Seeds	6	9	11	13	12	11	19
Vegetables	88	106	117	107	125	118	143
Green Leafy and Yellow Vegetables	32	33	31	21	25	22	25
Other Vegetables	55	73	86	86	100	96	119
Fruits	39	64	79	116	110	170	191
Vitamin C-Rich Fruits	7	13	21	32	35	79	72
Other Fruits	32	51	58	83	74	91	119
Miscellaneous	11	16	20	23	34	26	56
Beverages	3	5	10	10	21	15	41
Condiments and Others	8	11	11	13	14	12	15
Mean One Day Per Capita Food Peso Value	7.46	12.4	17.23	22.24	27.17	32.17	47.86

NOTES:

(1) - As available in the kitchen including inedible and edible wastage

FNRI, DOST Fourth National Nutrition Survey : Philippines, 1993

TABLE 6. COMPOSITION AND INTAKE OF MEALS IN THREE MAJOR REGIONS OF THE PHILIPPINES

REGION	SUBJECT	BREAKFAST	LUNCH	DINNER
NATIONAL CAPITAL REGION (NCR)	Male	fried egg small shrimps w/tomato boiled rice coffee & milk	boiled rice beef sinigang papaya	pork adobo sauteed mungbean boiled rice papaya
	Female	fried egg small shrimps w/tomato boiled rice coffee & milk	boiled rice beef sinigang papaya	pork adobo sauteed mungbean boiled rice papaya
CENTRAL VISAYAS	Male	papaya inun-unan (boiled fish) rice coffee w/ milk	mungbean w/ coconut boiled rice sweetened ube	fried dried fish apan-apan boiled rice sweetened sweet potatoes
	Female	papaya inun-unan (boiled fish) rice molasses	mungbean w/ coconut boiled rice sweetened ube	fried dried fish apan-apan boiled rice sweetened sweet potatoes
SOUTHERN MINDANAO	Male	boiled rice mudfish w/ tomato sauce papaya coffee w/ milk	boiled rice paklay banana pineapple juice	boiled rice inun-un mackarel sweetened banana (saba)
	Female	boiled rice mudfish w/ tomato sauce papaya coffee w/ milk or molasses	boiled rice paklay banana	boiled rice inun-un mackarel fried banana (saba) molasses

Source: Reference No. 5

TABLE 8. RESULTS OF TXRF ANALYSIS OF DRINKING WATER

ELEMENT	DEEPWELL			TAP WATER
	Quezon City ppm	Cavite ppm	Paranaque ppm	Marikina ppm
K	24.5	13.47	13.91	0.889
Ca	32.97	22.02	28.68	15.82
Fe	0.661	0.148	0.105	0.545
Cu	-	-	0.627	-
Zn	<0.22	0.087	<0.052	<0.036
Sr	<0.279	0.011	0.164	<0.051
Pb	-	-	-	<0.059

Source: Reference No. 7