TRACE ELEMENTS IN AIR, WATER AND FOOD IN THE PHILIPPINES

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INTRODUCTION

Trace elements like lead, mercury, chromium and cadmium have since time immemorial been implicated in the production of illnesses due to their inherent toxicity. While there are efforts to get substitutes that are less toxic, they have not diminished in their popularity on account of their industrial usefulness. Lead has many uses, but the most important source of lead exposure are from the making of storage batteries, paints and the blending of gasoline with tetraethyl lead. There are around 17 storage battery plants, 30 paint establishments and 3 oil refineries processing lead in the country (Jose, 1972). Water and air pollution with lead are usually due to these industries as well as users of gasoline like motor vehicle and motor boats. In the case of mercury, we have a company mining and exporting it as well as an establishment using large quantities of the material for the production of chlorine by electrolysis of brine. Chromium is mined in the Zambales area and this is exported abroad. Locally, it is used mainly in the electroplating industry. Cadmium is a hazard in foundries, steel mill and machine shops where alloys of the metal are processed. Eating in cadmium plated utensils also have been reported to cause cadmium poisoning.

Industries processing lead, mercury, chromium and cadmium discharge their waste into the surrounding atmosphere, rivers, stream draining into the Manila Bay. Potentially they could contaminate water resources and marine life in the Bay such as fish, shrimps, shellfish and oysters. Japanese investigators have reported poisoning with mercury(Hunter, 1969), and cadmium (WHO, 1972), among inhabitants of Tokyo Bay area who have eaten fish and shellfish caught in the bay due to pollution with mercury and cadmium by industries in the area.

It would therefore be of interest to study and evaluate the extent and degree of pollution of our water and food resources to enable us contribute in a small way for the proper recognition and control of this hazard. Apparently, information in this area is inadequate. For lead some data are available (Dizon, *et al.*, 1960; Jose, 1972).

MATERIALS AND METHODS

Samples of air containing lead were collected at different sites of a steel mill by means of a midget impinger, while in a chlorine plant samples of air were collected by the same equipment to determine mercury content. Water samples were collected at the Pasig River, Luneta and in a rural area in Bulacan for analysis of lead, mercury and cadmium. These was followed by obtaining food items in the market and then analyzed for the same minerals plus chromium. Urine samples were collected among workers in the chlorine plant and mercury was determined.

Chromium determination was based on the method suggested by Public Health Service (Publ. No. 192), cadmium by standard methods (APHA, 1971), lead by the USPHS method (1963), and mercury by the dithizone

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method of the Department of Physiological Hygiene, School of Hygiene, University of Toronto. It was observed that in a comparison between atomic absorption and the dithizone method in the analysis of lead in blood, results were very close to each other (Slavia, 1965).

RESULTS

Table 1 shows the concentration of lead in air in a steel mill. It would be observed that they are below the threshold level of 0.15 mg/cubic meter of air. Table 2 shows the levels of mercury in the work areas in a chlorine plant. The threshold limit of 0.1 mg per cubic meter of air is exceeded in two locations, namely: Cell Room 1 and Cell Room 2. In Table 3 are shown the mean levels of lead, mercury and cadmium in water collected from several sources. They are within normal limits of 0.1 mg per litre in the case of lead and 5 μg per litre in the case of mercury. But in the case of cadmium, the maximum allowable limit of 10 mg per litre was exceeded by the water collected in the Pasig River sample I and in a rural area of Bulacan. Table 4 shows the trace metal content of some Philippine foods. Based on foreign levels (Vostal and Clarkson, 1973) the mercury content of fish varies from 0.75 mg/kilogram in tuna up to 1.3 mg/kilograms for swordfish. This study levels are within this normal range. The figures for lead, chromium and cadmium are within normal limits. In Table 5 are shown mercury levels in the urine of workers of the chlorine plant. The threshold level of mercury in the urine is 0.1 mg/litre. This concentration was exceeded by only two individuals, which have been exposed occupationally to mercury vapor.

Table 1

Mean concentration of lead in air (mg/cu meter) at different sites in a foundary/steel mill.

Location	Concentration (mg/cu meter)
I	0.02
II	0.009
III	0.02
IV	0.02

Table 2

Average level of mercury in the air of a chlorine plant.

Site	(mg/cu meter)
I (cell room 1)	0.17
II Clinic	0.005
III (cell room 2)	0.13
IV Warehouse	0.05
V Loading	0.04

DISCUSSION

This study data shows that the levels of mercury, lead, chromium and cadmium in some Philippine foods are still within normal limits inspite of industrial waste and other sources dumped in the soil and water resources. In the case of mercury, it has been observed that plant foods as well as meat are poor in mercury. Fish is a special problem. Since the tragic incident at Minamata and Niigata, Japan in which a considerable number of inhabitants were poisoned due to eating of marine foods caught at Minamata Bay which was polluted with mercury, it has been given special attention. Thus, mercury poisoning by ingestion is limited to fish eaters.

In Niigata, Japan (WHO, 1973) patients with symptoms of mercury poisoning have whole blood levels of 0.2 mg/gm of mercury corresponding to 0.4 mg/gm of mercury in blood cells. This value is 100 times higher than the blood mercury content of non-fish eaters. Mercury in fish is in the form of

Table 3

Mean concentrations of lead, mercury and cadmium in water based on location.

Location	Lead (mg/1)	Hg (μg/1)	Cd (μg/1)
Pasing River I	0.09	3.5	24.8
Pasing River II	0.07	4.6	0
Pasing River III	0.10	4.60	0
Luneta I	0.05	-	0
Luneta II	.09	-	0.0
Hagonoy, Bulacan	.08	0.8	91.8

Table 4

Mean concentration of mercury, lead, chromium and cadmium in foodstuffs (μg/100 gm).

	Mercury	Lead	Chromium	Cadmium
Galunggong (round scad)	116.0	13.5	90.0	30.5
Alegasin (mullet)	208.0	2.5	218.0	68.80
Salaysalay	0	112.0	97.5	33.1
Bangus (milkfish)	100.0	0.0	130.0	0
Hipon (shrimps)	0.0	112.0	160.0	16.5
Hito (catfish)	75.0	56.0	260.0	17.8
Alumahan	89.0	40.0	240.0	6.9
Hasahasa (chub mackerel)	14.7	44.0	300.0	37.1
Sapsap (slip mouth)	141.4	4.3	136.0	0
Dalagang bukid	41.2	5.7	168.0	81.4
Bisugo (nemipterid)	102.7	4.8	120.0	21.5
Tilapia	17.8	8.3	168.0	81.4
Malunggay	0	-	.31	0
Kangkong (water chestnut)	0	32.6	0	34.4
Rice	113.5	13.9	0	0

Table 5

Mean concentration of mercury in urine of 32 workers (μg/litre).

1.	26.35	12.	8.4	23.	90.7
2.	12.7	13.	15.3	24.	49.9
3.	2.1	14.	2.7	25.	0
4.	8.7	15.	1.5	26.	29.8
5.	27.7	16.	0	27.	0
6.	15.8	17.	2.0	28.	18.6
7.	20.9	18.	4.2	29.	23.4
8.	20.8	19.	390.2	30.	25.9
9.	0	20.	168.5	31.	25.8
10.	3.0	21.	28.2		
11.	16.2	22.	0		

methyl mercury, an organic form of mercury. Apparently, fish get this from planktons and microorganisms which have the ability to methylate inorganic mercury to methyl mercury. Bigger fish has a higher mercury content than smaller ones.

Lead, another pollutant of our air, water and foods comes mainly from agriculture in the use of lead arsenate to control insects and fungi, indoor use of lead paints, water pipes and inadequately fired glasses or porcelain, motor vehicles and motor boats used for transportation and fishing. The average intake per day is around 200-300 μg (WHO,

1972) and the same amounts seems to be the range of lead concentrations in food.

Cadmium content of our foods and waters are within normal limits except water samples collected at a rural area in Bulacan. Possibly, this could come from the fertilizers extensively used to promote growth of planktons in fishponds in the area. Fertilizers may contain 15-21 μg/gm of cadmium. In the case of acid pH, intake of cadmium by plants could be considerable. Soft drinking water may be an important source of cadmium. Cadmium containing plastics used for pipe or food containers may be a potential source of cadmium in food.

Cadmium is a non-essential trace element. It is accumulated with age and the body burden comes from water, food and environmental sources. In Japan, it has been reported to cause "itai-itai" disease (WHO, 1972) manifested by damage to the kidneys, hypercalciuria, osteomalacia and pseudofracture. It was seen in multiparous women past 50 years and living mainly on a rice diet with high cadmium content. The Philippine rice samples are poor in cadmium.

Chromium is usually present in two forms, the hexavalent and trivalent forms. The hexavalent chromium is toxic and is encountered in occupational exposures like in mining chromates and electroplating. The trivalent form is present in food and is considered an essential nutrient. Conversion of trivalent chromium to hexavalent form does not occur in the living body. In animal foods chromium is found in large quantities, in plant foods the level varies from 20-50 mg/kg. Usual diets give 5 μg/day. Assessment of chromium nutrition in man is difficult because of the small number of cases studied and the lack of knowledge concerning the chemical nature of chromium in foods.

SUMMARY

A study was conducted to determine the levels of trace metals like lead, mercury, chromium and cadmium in air, water and foods by colorimetric means. It was observed that their levels are within normal limit with minor exceptions which was mentioned already.

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