CHAPTER I

INTRODUCTION

In nature, mercury occurs in minerals mostly in the form of cinnabar (mercuric sulfide, HgS). Mercury compound, especially organomercuric compounds, are used in agriculture for seed dressing to prevent disease and protect the germination of seeds. In industries, mercury compounds are used in the electrolytic pro - duction of chlorine and caustic soda, as catalyst for the synthesis of acetaldehyde, vinyl chloride and dyestuff, in instruments such as thermometer and barometer. Apart from these it is used in paints for antifouling and prevention of deterioration, in dental preparation and as slimicides in pulp and paper industries. In former time, mercury compounds such as mercuric salicylate, mercuric succinimide had been used as antisyphilitic agents, but now, most of these compounds have been replaced by antibiotics.

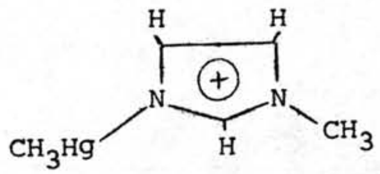
Metallic mercury and mercury compounds are normally present at low concentration in the environment. This concentration level could be increased by inappropriated release of industrial waste and the use of organic mercury as seed dressing. Mercury appears in industrial discharge in 5 forms, namely, inorganic divalent mercury (Hg^{2+}), metallic mercury (Hg^{o}), phenylmercury ($C_6H_5Hg^+$), alkoxyalkylmercury ($RORHg^+$) and alkylmercury (RHg^+) (1).

Metallic phenyl- and alkoxyalkyl-mercury can be converted to inorganic divalent mercury which can be subsequently converted to methylmercury (II) by some microorganism in anaerobic condi - tion. (1) Methylmercury is one of the most toxic forms of organomercuric compounds. The major from of mercury accumulated in the edible tissue of most fish and shellfish is methylmercury (II). (2) and not the less toxic inorganic form. Large scale outbreaks of methylmercury (II) poisoning have occured in various parts of the world. In Japan, poisoning in the Minamata Bay, Niigata areas resulted from consumption of methylmercury - contaminated fish. In Pakistan and Guatamala, massive poisonings have resulted from the consumption of wheat seed treated with methyl- and ethylmercury (II) fungicides. In view of the potential hazard of methylmercury (II) to human health, it is necessary to monitor the levels of methylmercury (II) in food, especially in the edible portion of fish and in cereal grains.

Methylmercury (II) has high affinity to deprotonated sulfhydryl group (-SH), as indicated by the formation constants shown in Table 1.1. Consequently, it is assumed that methylmercury (II) in foodstuffs, particularly in fish, is in the form of complex of cysteine-containing peptides and proteins. The behavior of methylmercury (II) in human is shown schematically in Figure 1.1. Once ingested, methylmercury (II) is very efficiently absorbed from gastrointestinal tract into the blood stream.

As the blood circulates through the brain, some of the methylmercury cross the blood-brain barrier. Methylmercury (II) causes irreversible damage on cells of the central nervous system. The first symptoms are loss of sensation at the extremities of the hands and feet. As the body burden increases, these symptoms are followed by loss of coordination in gait (ataxia), slurred speech (dysarthia), loss of hearing, blindness, coma

Table 1.1 Formation constants of methylmercury complexes (3,4)

Ligand	complex	log K_f
Acetylglycine	$CH_3CONHCH_2CO_2HgCH_3$	2.68
Methylamine	CH_3HgNCH_3	7.57
N-Methylimidazole		6.93
Glutathione	$HO_2C\underset{NH_2}{C}HCH_2CH_2CONH\underset{CH_2SHgCH_3}{C}HCONHCH_2CO_2H$	15.9
Chloride	CH_3HgCl	5.45
Bromide	CH_3HgBr	6.7
Iodide	CH_3HgI	8.7
Hydroxide	CH_3HgOH	9.5
Cysteine	$CH_3HgSCH_2\underset{NH_2}{C}HCO_2H$	15.7

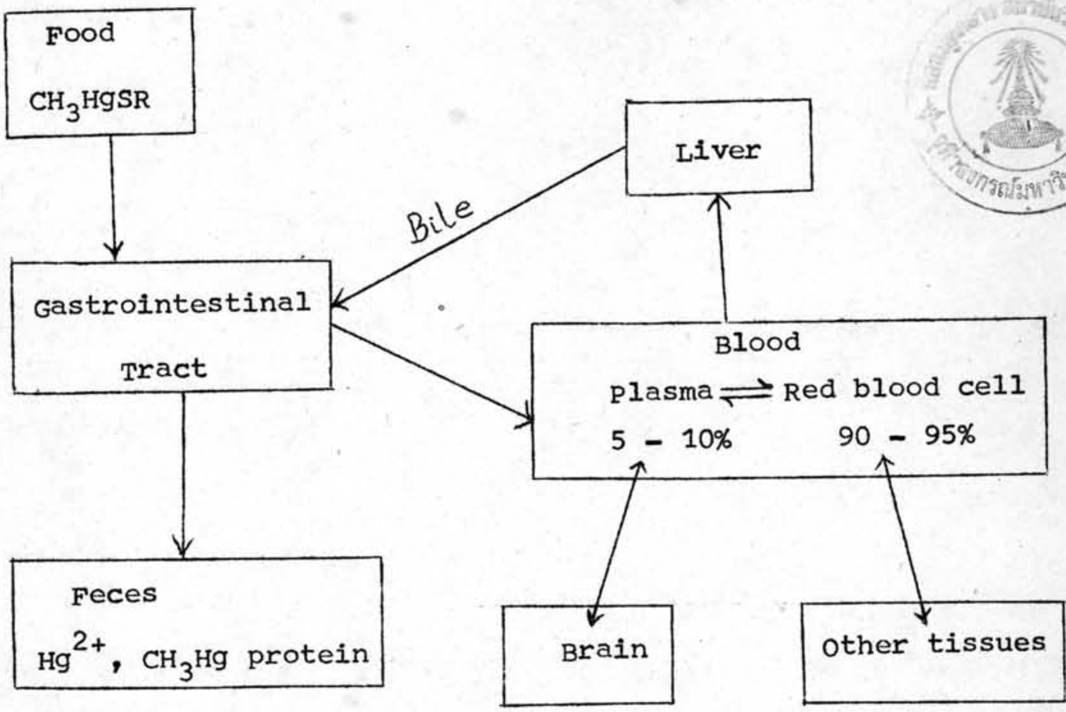


Figure 1.1 Schematic representation of the distribution of methylmercury in human(3).

and death. Estimates of the body burden at the onset of symp - toms of methylmercury (II) poisoning are given in Table 1.2

Table 1.2 Body burden at the onset of symptoms of methylmercury (II) poisoning

Symptom	Body burden (mg)
Paresthesia	25
Ataxia	55
Dysarthria	90
Deafness	180
Death	200

Methylmercury (II) is extracted from the blood through the liver. In the liver, a small amount undergoes biotransformation to mercury (II), which, together with the methylmercury (II), is secreted back into the gastrointestinal tract in the liver bile. Methylmercury (II) in the bile exists in two forms; i.e. the major fraction in the form of low molecular weight complexes and the remainder in the form of protein complex. The mercury (II) and a fraction of the protein-complexed methylmercury (II) are excreted in the feces. The remainder of the bile methylmercury(II) in the portein-complex and virtually all of that in low molecular weight complex, are reabsorbed into the blood stream.

The determination of low concentration of total mercury in biological and environmental samples has become routine with the development of the cold vapor atomic absorption spectrophotometric method (5). Methods to monitor the levels of methylmercury (II) is, however, essential for toxicological evaluation. Several authors have presented methods for the determination of organic mercury compounds (6, 7, 8). These methods either do not separate different compounds, e.g. methylmercury (II) from phenylmercury compound or are designed for mercury contents higher than those usually met in foods.

A sensitive, but complicated method for the quantitive analysis of methylmercury by flameless atomic absorption spectrometry has been developed. In this method, methylmercury (II) can be determined by firstly releasing organic and inorganic mercury (II) from the sample with tin (II) chloride-cadmium chloride, and then the inorganic mercury (II) from the sample with tin (II) chloride.

A selective method for the determination of methylmercury (II) in tissue sample and foodstuffs has been proposed by Westoo (8, 9, 10). The method based on the conversion of methylmercury (II) to methylmercury (II) chloride (CH_3HgCl) which is then extracted into benzene and measured its content by gas chromatography using a gas chromatograph equipped with an electron capture detector. Since this technique is rather sensitive, selective and not complicated, it has therefore been widely used for the determination of methylmercury (II) .

After a survey through the different local analytical laboratories, it appears that there is a great interest in monitoring the level of methylmercury in foodstuffs, but nothing explicit has been performed up to the present time. For this reason, the present work was initiated to investigate the instrumental conditions for the assay of nanogram to picogram concentration of methylmercury(II) chloride by gas-liquid chromatography using an electron capture detector. Furthermore it is a desire to develope method for the extraction of methylmercury(II)chloride from fish samples. The details of the instrumental conditions must be explicit and the extraction must be quantitative, so that the method can be recommended and applied for routine analysis in the future.