CHAPTER I

INTRODUCTION

1.1 Theoretical Background

Polycyclic aromatic hydrocarbons (PAH) are airborne pollutants. They consist of three or more fused benzene rings. Some of these PAH are considered to be possible or probable human carcinogens such as BaP, BaA, BbF, BkF, PYR (ATSDR, 1990). Especially in urban areas, since the vehicle exhaust appears to be one of the major generators of carcinogenic and mutagenic PAH in urban area, the ambient air near the roads with heavy traffic can be highly polluted with PAH (Somporn Chantara, 2000). In Thailand, Hathairatana et al. (2002) studied the average airborne PAH concentrations in Bangkok urban area, and found that total PAH concentrations were 19.48 ng/m^3 at the OEPP, which is a residentail and commercial area. While at the MOSTE was found to cantain total PAH concentrations of 42.95 ng/m^3. This site had heavy traffic volume (55,000 vehicles/day) and is located under an expressway. The average BaP levels in Europe were in the range of 1-20 ng/m^3 and about 1 ng/m^3 in the USA.(Hathairatana Garivait, 1999). Therefore, the monitoring of atmospheric PAH is necessary in order to reduce the risk.

The monitoring of atmospheric PAH by conventional method using high volume air sampler is very expensive. Moreover, the collected air sampler have to import from other countries. Recently, the monitoring of atmospheric PAH with bioindicators has emerged as an alternative way to the biological-based method. From this biomonitoring method, it would reduce the cost of the monitoring equipment by the use of local plants that have the possibility to adsorb the atmospheric PAH. So in this study, the experiment was conducted to test the possibility of *Murraya paniculata* (L.) Jack leave to monitor the atmospheric PAH. Various plants have been found to take up the atmospheric PAH (Nakajima et al., 1995) such as spruce needle to quantify PAH, PCB and PCDD/PCDF, pine needles for monitoring PCB (Kylin, Grimvall and Ostman, 1994). Komp and McLachlan cited in Bakker, Tolls and Kolloffel (2000) studied uptake of SOCs such as pesticides, PCB, chlorobenzenes and

PAH in difference plant species; azalea leaves for pesticides, PCB and chlorobenzenes; plantain for PCB, chlorobenzenes and PAH and ryegress for PCB. The aerial plant components of most importance are the leaves which have a relatively large surface area accessible to atmospheric chemicals facilitating the establishment of equilibrium conditions (Muller, Hawker and Connell, 1994). Leaves consist of various phases including intercellular air, water, lipids, structural carbohydrates, and proteins. Each of these phases has characteristic physicochemical properties, which, together with the physicochemical properties of the chemical itself, largely govern the partitioning, and distribution of the chemical (Muller et al., 1994).

Accumulation of PAH in plant can be explained by the partitioning theory (Simonich and Hites, 1994). Partitioning of hydrophobic organics within the plant or leaf is conceptually demonstrated. Under equilibrium conditions, the fugacity(F) of a hydrophobic chemical is identical in all of the phases,

$$F_P = F_L = F_A \text{ --------------(1.1)}$$

Where F_P, F_L and F_A are the fugacities in plant, leaf and air, respectively. The fugacity in each phase can be related to chemical concentration (C) and fugacity capacity (Z) by the Equation 1.2

$$F = C/Z \text{ --------------(1.2)}$$

In a biota, it is widely assumed that the partitioning medium for hydrophobic organics is lipid. In laboratory experiments, octanol is normally used as a convenient matrix considered equivalent to lipid. Hence, the octanol/water partitioning coefficient, K_{OW}, equals the ratio of the fugacity capacities in the organic and water phases reaching equilibrium:

$$C_O/C_W = Z_O/Z_W = K_{OW} \text{ ------(1.3)}$$

The same as leaf/water partition coefficient, K_{LW} and leaf/air partition coefficient, K_{LA} are equal the ratio of the fugacity capacities in the leaf and water and leaf and air at equilibrium, respectively. And can be expressed as follows:

$$K_{LW} = C_L/C_W = Z_L/Z_W \text{ ---(1.4)}$$

$$K_{LA} = C_L/C_A = Z_L/Z_A \text{ ---(1.5)}$$

Where C_L is the concentration in the aerial plant components and C_A is the concentration in the atmosphere at equilibrium. Due to difficulties in maintaining constant concentrations in the atmosphere of the exposure chamber, Equation 1.5 may be expanded by including the equilibrium concentration of the chemical in the aqueous phase

$$K_{LA} = (C_L/C_W)*(C_W/C_A) \text{ --------(1.6)}$$

Where C_A/C_W is Henry's law constant (H) and C_L/C_W is the portion of concentration in aerial plant components and concentration in water from the experiment (Muller et al., 1994). And from those theories, the concentration of PAH in the atmosphere could be obtained from the concentration of PAH in plant leaves as shown in Equation 1.7.

$$K_{LA} = (C_L/C_W)*1/H \text{ -------------(1.7)}$$

1.2 Objectives

1.2.1 To investigate the absorption of atmospheric PAH on orange jasmine leaves (*Murraya paniculata* (L.) Jack).

Strategy : Analyzing the PAH concentration in leaves, which were collected from four study sites.

1.2.2 To investigate the potential of orange jasmine leaves (*Murraya paniculata* (L.) Jack) to monitor atmospheric PAH.

Strategy : Evaluating the relationship of measured concentrations of atmospheric PAH and calculated atmospheric concentration PAH estimated from leaves.

1.3 Hypothesis

1.3.1 The atmospheric PAH can be absorbed by orange jasmine leaves *Murraya paniculata* (L.) Jack.

1.3.2 There is a relationship between measured concentrations of atmospheric PAH and calculated atmospheric concentration PAH estimated from the orange jasmine leaves *Murraya paniculata* (L.) Jack.

1.4 Scope of the study

1.4.1 Study on 16 PAH (NAP, ACY, ACE, FLU, ANT, PHE, FLA, PYR, BbF, IP, CHR, BkF, BaP, BPER, DbA and BaA), which are recommended by the U.S. EPA.

1.4.2 Four sampling sites were selected from Bangkok roadsides (Patumwan, Phongphet, Saphan Khwai and Kasemraj junction). They were reported to have difference traffic volumes. Background samples were collected at Asian Institute of Technology (AIT).

1.4.3 Study the orange jasmine leaves *Murraya paniculata* (L.) Jack found on four sampling sites.