Thesis Title Animal Study on Pulmonary Toxicity of Fly Ash Emitted From Mae Moh Electric Plant

Name Nantaporn Buthbumrung

Degree Master of Science (Toxicology)

Thesis Supervisory Committee

Krongtong Yoovathaworn, B.Sc.(Pharm), Ph.D.

Chompusakdi Pulket, Ph.D.

Punya Temchroen, D.V.M., M.S.

Pipat Cherdrungsri, M.S.

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ABSTRACT

The pulmonary toxicity of respirable coal fly ash was studied in adult male Wistar rats which were exposed 6 hr per day for 1 day or for 5 consecutive days to fly ash particles collected from an electrostatic precipitator of Mae Moh electric plant, Lampang Province. The emission rates of fly ash into the inhalation chamber (0.17 m^3) were 0.8, 8, and 80 g/hr, respectively, to obtain the corresponding concentrations of fly ash at the breathing zone of the animal about 5 (low), 50 (medium) and 500 (high) mg/m^3 with the percent variation of 6.44, 4.87 and 2.86, respectively. The mass median aerodynamic diameter of fly ash was 7.7 μm with geometric standard deviation of 1.93 μm. The elements observed in the fly ash samples include organic and inorganic components. The oxides of iron, silica, aluminum and calcium were the most abundant compounds. To assess the effect of coal fly ash on the pulmonary system after acute and repeated exposure, functional, biochemical, cytological and morphological changes were evaluated. There were no significant differences in the respiratory rate between pre- and post-exposure in any exposure groups except those

exposed to high concentration of fly ash. The depth of breath was significantly decreased in animals exposed to the high concentration for 1 day and in those exposed to medium concentration for 5 days.

Bronchoalveolar lavage (BAL) fluid from animals exposed to fly ash at the medium and high concentrations for 1 day and the medium concentration for 5 consecutive days showed increases in lactate dehydrogenase (LDH), acid phosphatase (ACP), alkaline phosphatase (AKP) activities and the amount of total protein in a dose-related manner. Inhalation of fly ash also produced a dose-dependent increase in the numbers of recovered cells in BAL fluid. The average cellular composition of the pooled lavage fluid was about 95% macrophages and 5% lymphocytes. The mean total cell count was increased to 2 and 2.5 times after exposure to the medium and high concentrations of fly ash for 1 day, respectively, and 1.5 times when exposed to the medium concentration for 5 consecutive days. Increasing numbers of dusty and foamy macrophages were found in BAL fluid of rats exposed to fly ash in a dose-dependent manner.

When the animals were exposed to fly ash at the high concentration the particles were seen in the alveolar cells. Numerous fly ash laden macrophages were observed around the bronchioles and inside the septa. There were no fibrotic lesions in the lungs of treated rats even in the repeated exposure group. The histopathological changes of rat lung in both of single and repeated groups did not clearly relate to an exposure concentration. The results of the present study thus demonstrated the dose-dependent cytotoxicity and inflammatory reactions in the lung caused by respirable coal fly ash after a short period of exposure as shown by numerous biomarkers, i.e. lavage fluid chemistry, cytology and histopathology of the lung. Repeated exposure caused more intense inflammatory response than a single exposure at the same concentration.