

Influence of Polychlorinated Dibenzofurans (PCDFs) and Polychlorinated Biphenyls (PCBs) to Serum Protein Components in Rats

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Polychlorinated dibenzofurans(PCDFs) are known highly toxic substances(BAUER et al.,1961; HOFMANN,1958), as well as structurally related compound 2,3,7,8-tetrachlorodibenzo-p-dioxin(TCDD). The latter compound is known its high acute toxicity, strong teratogenicity and fetocidal action(SCHWETZ et al.,1973; SPARSCHU et al.,1970; COUTNEY and MOORE,1971; NEUBERT and DILLMANN,1972).

The presence of PCDFs in commercial polychlorinated biphenyls(PCBs) has been first shown by VOS et al.(1970). Subsequent researches revealed that PCDFs were contained in all commercial PCB preparations including American, French, German and Japanese preparations(BOWES et al.,1973,1975; ROACH and POMERANTZ, 1974; NAGAYAMA et al.,1976; MIYATA and KASHIMOTO,1976).

Feeding study of PCBs to chicks resulted in small spleens showing atrophy of lymphoid tissue(VOS and KOEMAN,1970; FLICK et al.,1965). Lymphopenia, Atrophy of the cortex of thymus and a reduction in the number of the germinal centers in the spleen and lymph nodes were found after dermal application of PCBs in rabbit (VOS and BEEMS,1971). Atrophy of thymus were also found after dietary administration of PCDFs in chicks (MCKINNEY et al.,1976). These results suggest that PCBs and PCDFs may affect humoral defence mechanism and serum globulin levels.

The purpose of the present study was undertaken to determine the effect of PCBs and PCDFs on serum protein components of rats.

MATERIALS AND METHODS

PCDFs used in this study was kindly supplied by Dr.M.MORITA(Tokyo Metropolitan Research Laboratory of Public Health). Its average chlorine number of aromatic ring substitution was 4.7. PCBs were obtained commercially(Kanechlor 500).

Sprague-Dawley derived male rats (Clea Japan Inc., Tokyo Japan), weighing 100-130g, were housed individually in aluminum cages. Controlled temperature (25°C), humidity (55%) and light-dark cycle were provided. Four groups of 10 rats each fed the diet containing 0 (controls), 1, 10ppm of PCDFs or 100ppm of PCBs in ground rat chow (CE-2, Clea Japan Inc.) ad libitum. After 27 days, the rats were sacrificed by decapitation and trunk blood was collected from individual animals. Leucocyte counts were determined with Coulter Counter Model S (Coulter Electronics Inc., Hialeah, FL.). Total protein in serum was determined by Biuret reaction (GORNALL et al., 1949). Electrophoretic separation was done on cellulose acetate strips (SEPARAX, Jookoo Sangyo Co., Ltd., Tokyo, Japan) in a Veronal Buffer (pH=8.6, $\mu=0.07$) at a constant current of 0.8mA/cm. The separation was finished after 90 minutes and the strips were colored with solution of 0.8% Ponceau 3R in trichloroacetic acid for 2 minutes. Then the strips were decolored with 3% solution of acetic acid. Each fraction of proteins was extracted with 2ml of 0.01N sodium hydroxide solution and measured the protein concentration with Gilford 300N spectrophotometer (Gilford Instrument Laboratories Inc., Oberlin, Ohio).

RESULTS AND DISCUSSION

The rats fed the diet containing both dose of PCDFs showed a significantly depression of growth rate. Slight depression of growth rate was recorded for the rats fed the diet containing 100ppm of PCBs.

TABLE 1

Effect of PCBs or PCDFs on Thymus Weight and Leucocyte Counts of Male Rats¹⁾

	Thymus Weight		Leucocyte Counts
	(g)	(g/100g)	($\times 10^3/\text{mm}^3$)
Controls	0.75 \pm 0.10	0.23 \pm 0.01	8.36 \pm 2.03
PCBs 100ppm	0.74 \pm 0.15	0.24 \pm 0.01	7.67 \pm 1.68
PCDFs 1ppm	0.43 \pm 0.09 ²⁾	0.16 \pm 0.03 ²⁾	8.26 \pm 2.11
PCDFs 10ppm	0.15 \pm 0.06 ²⁾	0.07 \pm 0.03 ²⁾	7.70 \pm 2.35

¹⁾ Mean Value \pm SD

²⁾ Significantly different from controls at $p < 0.001$

TABLE 2
Serum Protein Components of Male Rats Fed the Diet Containing PCBs or PCDFs for 27 Days¹⁾

	Total Protein (g/100ml)	Albumin ²⁾ (%)	α_1 -Globulin ²⁾ (%)	α_2 -Globulin ²⁾ (%)	β -Globulin ²⁾ (%)	γ -Globulin ²⁾ (%)	A/G ³⁾
Controls	5.77±0.16	56.8±3.5	19.2±2.9	6.2±1.5	4.8±1.3	13.8±1.0	1.32±0.20
PCBs 100ppm	6.05±0.28 ⁴⁾	55.2±2.7	16.2±1.4 ⁵⁾	5.9±1.2	6.4±0.6 ⁵⁾	15.5±1.6 ⁴⁾	1.24±0.13
PCDF 1ppm	5.66±0.24	55.6±2.2	16.4±1.9 ⁴⁾	6.9±1.6	6.2±0.8 ⁵⁾	14.5±2.1	1.26±0.11
PCDF 10ppm	5.47±0.34 ⁴⁾	54.6±3.5	14.6±1.7 ⁶⁾	6.9±0.9	6.0±0.9 ⁴⁾	18.1±1.8 ⁶⁾	1.21±1.72

¹⁾ Mean±SD

²⁾ Percentage of the total protein content

³⁾ Albumin/Globulin

⁴⁾ Significantly different from controls at p<0.05

⁵⁾ Significantly different from controls at p<0.01

⁶⁾ Significantly different from controls at p<0.001

Absolute and relative weights of thymus were significantly decreased in the rats fed the diet containing both dose of PCDFs (TABLE 1). The thymus atrophy caused by PCDFs was seen in chicks (MCKINNEY et al., 1976). TCDD, structurally similar to PCDFs, also caused severe atrophy of thymus on rats, mice and guinea pigs (VOS et al., 1973; BUU-HOI et al., 1972; HARRIS et al., 1973; GUPTA et al., 1973). While PCBs produced minimal effect on thymus weight in present study. Leucocyte counts did not differ between controls and PCB- or PCDF-fed groups (TABLE 1).

The results of electrophoresis are given in TABLE 2. Total protein concentration in serum was significantly decreased in the rats fed the diet containing 10ppm of PCDFs. α_1 -Globulin was significantly decreased in the rats fed the diet containing PCBs or PCDFs. β -Globulin was significantly increased in all treated groups. γ -Globulin was increased in the rats fed the diet containing 100ppm of PCBs or 10ppm of PCDFs. Albumin, α_2 -globulin and albumin-globulin ratio did not differ between controls and treated groups.

VOS and DE ROIJ (1972) reported that each component of serum proteins was not affected significantly in guinea pigs fed the diet containing 50ppm of PCBs for 8 weeks and VOS et al. (1974) showed that α -, β - and γ -globulin were decreased in the mice received weekly dose of 25 μ g/kg TCDD for 6 weeks.

These wide differences between Vos et al. and our results may be ascribed either to the use of different species or different chemicals. Furthermore, it may be explained that the increases of globulin in our study are attributed to liver injury.

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