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Increase in the Human Blood PCB Levels Promptly Following Ingestion of Fish Containing PCBs

K. Kuwabara, T. Yakushiji, I. Watanabe, S. Yoshida, K. Yoyama, and N. Kunita
Laboratory of Food Chemistry, Osaka Prefectural Institute of Public Health, Nakamichi, Higashinari-ku, Osaka, 537, Japan

Since 1966, it has been found that polychlorinated biphenyls (PCBs) are widely distributed in grobal ecosystems (RISEBROUGH *et al.* 1968, JENSEN *et al.* 1969). The PCB levels and their gas chromatographic patterns in human adipose tissue and blood have been demonstrated (JENSEN and SUNDSTRÖM 1974, MASUDA *et al.* 1974). In the present study, we examined the change of PCB levels and patterns in the human blood following intake of the fishes contaminated by PCBs.

EXPERIMENTAL

Analytical procedure was fundamentally the same one as that described in our previous study (KUWABARA *et al.* 1978). Quantitative analysis was carried out by gas chromatography using an electron capture detector (^{63}Ni) and employing a 2% OV-1 column (2 mm i.d. × 1.8 m) (UGAWA *et al.* 1973). Recovery rates of PCBs by this procedure were more than 90 %. Qualitative analysis for gas chromatographic patterns was by 2% Apiezon L grease purified column (2 mm i.d. × 5 m) (JENSEN and SUNDSTRÖM 1974, NAKAMURA and KASHIMOTO 1977).

The cutlass fish (*Trichiurus lepturus*) and the immature yellowtail (*Seriola quinqueradiata*) obtained at a market were found to be highly contaminated by PCBs, compared with many other fishes investigated (YAKUSHIJI *et al.* 1977). The former fish contained 0.90 ppm (mg/kg) and the latter, 0.40 ppm. At noon, they were ingested by two subjects (K, 26-year-old man; W, 27-year-old man). Their blood samples were obtained before and after the ingestion and in the following morning.

For the two kinds of control experiments by Subject K, rice was eaten at one time, and a large high fat content meal, i.e. 61g-margarine, 39g-pork and 184g-rice, was ingested at another time. All blood samples were obtained at the appropriate time.

RESULTS AND DISCUSSION

Time course of blood PCB levels: Subject K ingested a total of 181 μg of PCBs and Subject W, a total of 128 μg of PCBs by eating the cutlass fish and immature yellowtail. These PCB amounts are close to the maximum acceptable daily intake of

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PCBs, 5 μg/kg/day that has been determined by Ministry of Health and Welfare in Japan.

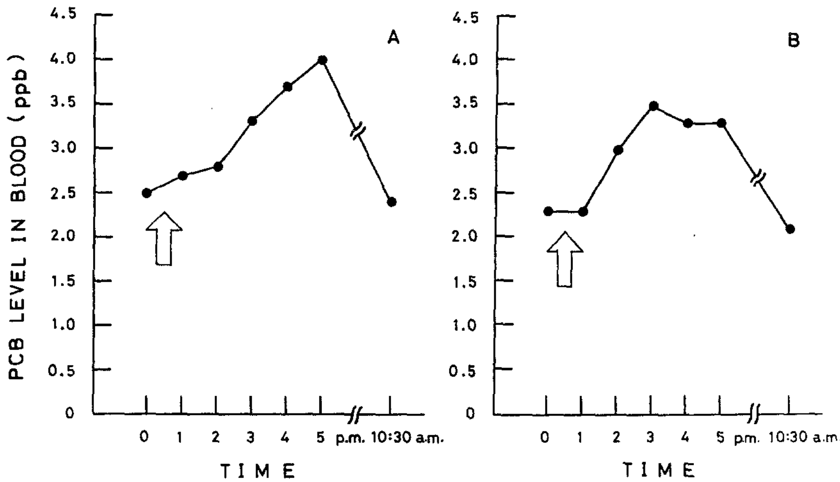

Fig.1. Time course of PCB levels in the blood of Subject K (panel A) and Subject W (panel B) after intake of the fishes contaminated by PCBs. Each arrow shows the time of ingestion.

Fig.1 shows the time course of blood PCB levels following the ingestion of these fishes. The PCB levels in the human blood were steadily increased from 2.5 ppb (μg/kg) to 4.0 ppb (1.6 times; Fig.1A) and from 2.3 ppb to 3.5 ppb (1.5 times; Fig.1B). However, in the next morning, each level came down to a lower level. In our previous study, even by 8 times repetition sampling at 10:30 a.m. over a period of 3 months, the blood PCB levels of Subject K were never as high as that in this investigation and were 2.2 ppb ± 0.2 ppb on the average (KUWABARA *et al.* 1977, unpublished).

RADOMSKI *et al.* (1971) reported that concentrations of organochlorine pesticides in plasma were remarkably consistent throughout a week, although they found minor increases in p,p'-DDE and p,p'-DDT concentrations promptly following the ingestion of the evening meal.

In the control experiments of this study, we found either no increase in the blood PCB levels after ingesting rice containing less than 0.5 μg of total PCBs (Fig. 2A), or a slight increase (from 2.4 ppb to 2.8 ppb) after ingesting a large high fat content meal containing 1.4 μg of total PCBs (Fig. 2B). This slight increase, however, was presumed not to be significant. Even if lipids in blood would temporarily increase, PCB concentration in whole blood may not be heightened.

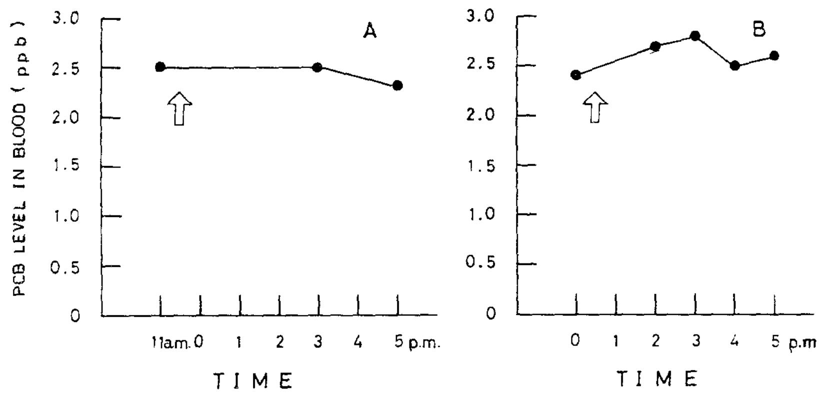

Fig.2. Time course of PCB levels in the blood of Subject K who ingests rice only (A), or who ingests margarine, pork and rice (B). Each arrow shows the time of ingestion.

Blood and fish PCB patterns: The gas chromatographic patterns of the cutlass fish and the immature yellowtail, which were very similar to each other, resembled a mixture of Kanechlor, a commercial brand of Japanese PCBs as shown in Fig.3. However, the pattern of blood of Subject K did not resemble that. Only a few kinds of low (3 and 4) chlorinated biphenyls (Peak k and Peak 9) and almost all kinds of high (from 5 to 8) chlorinated biphenyls (from Peak 25 to Peak 51) were detected in the blood of the man.

The chlorobiphenyl amounts of each peak of the gas chromatograms were calculated by the method using a mixture of exactly same concentrations of Kanechlor 300, 400, 500 and 600 as the standard (NAKAMURA and KASHIMOTO 1977). Then, the chlorobiphenyl amounts in each peak compared with that in Peak 32 were obtained. The result was shown in Fig.4.

As illustrated by the dotted line in Fig.4, the PCB pattern of the fish differed from the PCB patterns in the human blood. Surprisingly, the patterns of blood PCBs were remarkably consistent before and after the ingestion of these fishes highly contaminated by PCBs. Further, even if the blood PCB level became highest by the intake PCBs of the fishes, the change of the blood PCB patterns was not observed. There were also no changes of the blood PCB patterns in the present control experiments and our previous study that were carried out over a period of 3 months as mentioned earlier (KUWABARA *et al.* 1977, unpublished).

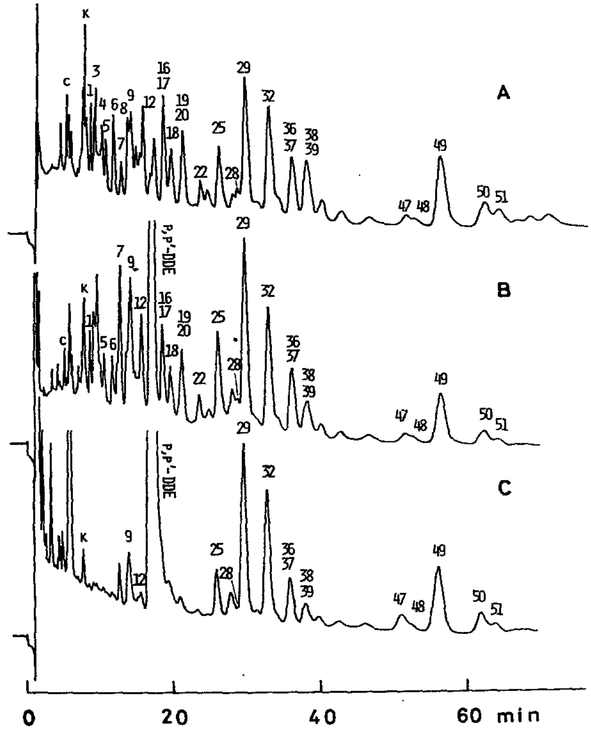

Fig.3. Gas chromatograms on the 2% Apiezon L column of PCBs. A: Kanechlor mixture (Kanechlor 300:400:500:600 = 1:1:1:1, w/w/w/w), B: the cutlass fish and C: the blood of Subject K after intake of this fish.

The reason why there was a consistency in the patterns of human blood PCBs was presumed that the liver or other organs might support only a certain structure(s) of PCBs among all kinds of PCBs absorbed after ingestion of the meal, and/or the hepatic enzymes could metabolize only that structure's PCBs very promptly. BUSH *et al.* (1974) presented an evidence that the biphenyl possessing chlorine atoms at 4 and 4' position tended to accumulate in the avian body. JENSEN and SUNDSTRÖM (1974) reported that the chlorobiphenyls which had 1 or 2 chlorine atoms at the "ortho" position of the biphenyl bridge were mainly retained in the human body. Each structure of PCB in Peak k, 9 (YAKUSHIJI *et al.* 1978), 25, 28, 29, 32, 47, 49 and 50 (JENSEN and SUNDSTRÖM 1974) which remained chiefly in the human blood in our present study satisfied that specific chemical structure described in those two reports. It is important to continue further pursuit of any reason for the fact that there is a facility and no facility of the accumulation in the human body according to the difference of chemical structure of PCBs.

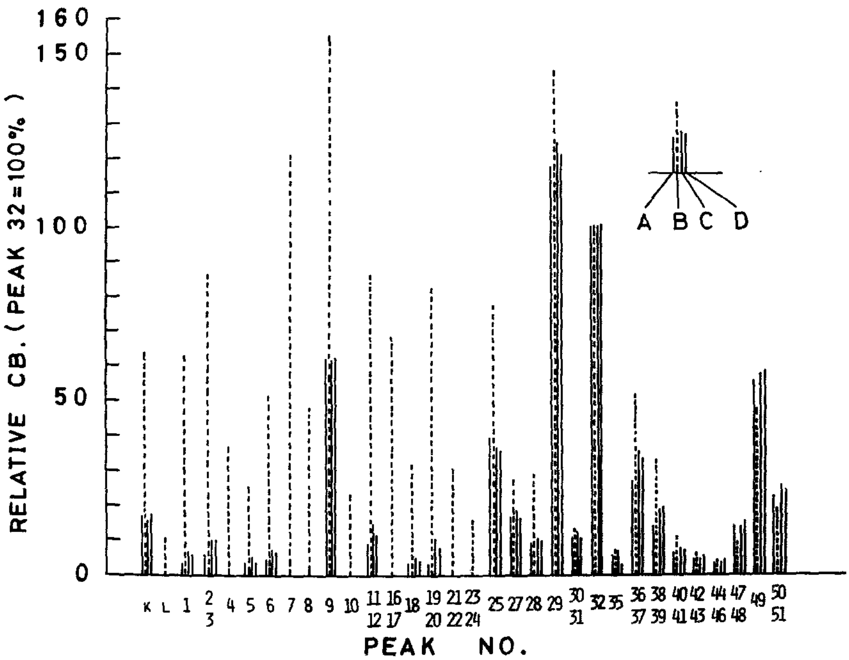

Fig.4. Relative chlorobiphenyl concentrations in each peak compared with Peak 32 on the 2% Apiezon L column in the cutlass fish and the blood of Subject K before and after the intake of this fish.
A: Blood, 0.5 hr before the intake of the fish.
B: Cutlass fish.
C: Blood, 4 hr after the intake of the fish at the time of maximum blood PCB level.
D: Blood, 22 hr after the intake of the fish.

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