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Body Weights, Food Intakes, and Water Intakes in Rats During Daily Administration of Closely Controlled Doses of Polychlorinated Biphenyls

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Polychlorinated biphenyls (PCBs) are persistant environmental contaminants which are widely distributed and tend to accumulate in the global food chains (PEAKALL & LINCER 1970, RISENBROUGH & DELAPPE 1972). In addition humans have been exposed to PCBs either through accidental contamination of foodstuffs by quantities large enough to elicit toxic symptons (KURSATSUNE et al. 1972), or through PCB residues in everyday foods YOBBS 1972). A number of diverse investigations of the toxological and biological effects of PCB in experimental animals have been published (BRUCKNER et al. 1974, ALLEN et al. 1975, OISHI et al. 1978). Although reports of weight loss have been included in several investigations (BRUCKNER et al. 1972, SANDERS et al. 1977), little is known of the time course of this basic parameter, or its relation to voluntary food and water intake. By following closely the kinetics of these changes with time it might be possible to better relate them to decreased appetite or derangements in energy metabolism. The present study was conducted to determine the effect of different doses of PCBs upon body weight, feed intake and water intake when administered orally in carefully controlled known doses on a daily basis.

MATERIALS AND METHODS

Aroclor 1254, dissolved in mineral oil, was administered daily to two groups of 6 Sprague Dawley rats by oral intubation. The dose levels of PCB were 0.05 g/kg body weight and 0.5 g/kg body weight. A third group also consisted of 6 Sprague Dawley rats and formed the control group. This group was treated the same as the experimental groups except for the administration of PCB. All groups consisted of males at the young adult stage of approximately 7 weeks and weighed about 200-250 g each. The animals were housed individually in polypropylene cages with ample bedding material. Body weights were taken daily. Each animal was initially supplied with 350 g of feed in the form of Purina Laboratory Chow and 425 mL of water. These formed an ad libitum source for the animals to draw

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upon and were always replaced before they were completely exhausted. The remaining food and water were weighed daily and the intakes calculated by differences. Each of the three groups consisted of an initial number of 6 rats each and was observed daily for a period of 3 weeks. Only on regularly recurring cleaning and maintenance days were data not gathered for each particular group.

RESULTS

In PCB treated rats of both doses there were significant decreases in body weight, feed intake, and water intake. In rats treated at a dose of 0.05 g/kg body weight there was a loss of weight at the rate of 0.84 g/day from an initial average weight of 247.2 to a final weight at the twenty-first day of 235.0 g. This weight loss pattern commenced on the ninth day of PCB administration. In rats treated at a dose of 0.5 g/kg there was a loss of weight at the rate of 2.74 g/day from an initial average weight of 232.0 g to a final weight at the twenty-first day of 178.5 g. This weight loss pattern began after only four days of PCB administration. The control animals by contrast showed the weight gain pattern of normal growth. These animals showed an increase in weight at the rate of 3.34 g/day from an initial average weight of 198.3 g to a final weight at the beginning of the twenty-first day of 292.3 g. This pattern of normal growth began immediately and continued throughout the experiment at a rate of 3.34 g/day. This is shown in Table 1.

In animals treated with PCB at a dose of 0.05 g/kg there was a decrease in food intake at the rate of 0.39 g/day from an initial average daily intake of 17.2 g to a final intake at the twenty-first day of 11.7 g. This decrease began on the ninth day of PCB administration. In animals treated at a dose of 0.5 g/kg there was a decrease in food intake at the rate of 0.44 g/day from an initial average daily intake of 22.9 g to a final intake at the seventh day of 7.5 g. This decrease began on the seventh day of PCB administration. The control pattern of feed intake was one of constancy at an average value of 22.63 g of steady feed intake each day. These results are shown in Table 2.

In rats treated with PCB at a dose of 0.05 g/kg there was a decrease in water intake at the rate of 0.75 mL/day from an initial average daily intake of 23.5 mL to a final intake at the twenty-first day of 11.7 mL. This decrease began on the sixteenth day. In rats treated at a dose of 0.5 g/kg there was a decrease in water intake at the rate of 0.55 mL/day from an initial average daily intake of 41.2 mL to a final intake at the twenty-first day of 20.0 mL. This decrease began on the tenth day.

TABLE 1

Effect of daily doses of PCB upon increase in body weight in rats. The data are expressed as the means in g ± S E of 6 rats weighed each day.

Day	Control		PCB at 0.05 g/kg		PCB at 0.5 g/kg	
1	198.3 ± 12.4		247.2 ± 13.2		232.0 ± 3.8	
2	229.9 ± 12.1		258.0 ± 8.7		- ± -	
3	241.2 ± 8.2		253.8 ± 10.3		236.7 ± 3.9	
4	249.0 ± 7.5		256.0 ± 9.7		237.3 ± 3.1	
5	250.2 ± 7.2		261.0 ± 9.1	*	225.3 ± 3.3	
6	256.2 ± 5.6		- ± -	*	221.9 ± 3.7	
7	- ± -		247.0 ± 9.4		214.9 ± 4.9	
8	257.0 ± 11.5		260.2 ± 6.7		- ± -	
9	281.3 ± 4.2		265.3 ± 6.6	*	188.1 ± 5.2	
10	278.3 ± 6.3		258.4 ± 5.7	*	196.8 ± 4.8	
11	280.7 ± 2.0	*	257.4 ± 5.7	*	190.3 ± 5.2	
12	287.0 ± 3.5	*	261.6 ± 5.5	*	182.4 ± 5.8	
13	289.3 ± 4.2		- ± -	*	180.1 ± 6.0	
14	- ± -		254.4 ± 5.5		183.4 ± 7.1	
15	293.3 ± 4.3	*	258.5 ± 4.5		- ± -	
16	300.0 ± 4.5	*	249.5 ± 11.5	*	167.9 ± 6.9	
17	297.3 ± 4.5	*	242.0 ± 5.0	*	175.4 ± 7.5	
18	299.3 ± 4.3	*	235.5 ± 6.5	*	173.2 ± 10.2	
19	296.3 ± 3.5	*	243.5 ± 7.5	*	176.2 ± 12.9	
20	292.3 ± 1.8		- ± -	*	183.5 ± 18.5	
21	- ± -		235.0 ± 19.0		178.5 ± 22.5	

* Significant difference from control at the $p < 0.05$ level.

The control pattern of water intake was consistant about an average value of 40 mL of water intake each day. These results are shown in Table 3.

DISCUSSION

There is a marked tendency for body weight to decrease in rats treated with PCB. Although this effect holds for both doses with their ten-fold difference, the lower dose effected a lower rate of weight loss with a more delayed onset. The weight gain for the controls showed a constant and normal daily increase. It seems reasonable that during this period of latency for both doses, the normal tendency for rats to gain weight with growth was being overwhelmed by the accumulating effect of the daily PCB administrations. Decreases in body weight

TABLE 2

Effect of daily doses of PCB upon feed intake in rats. The data are expressed as the means in g ± S E of rats as measured each day.

Day	Control	PCB at 0.05 g/kg	PCB at 0.5 g/kg
1	- ± -	17.2 ± 3.8	22.9 ± 0.3
2	20.2 ± 2.9	25.8 ± 0.9	- ± -
3	22.4 ± 1.8	20.6 ± 1.2	17.5 ± 0.3
4	27.1 ± 1.8	* 20.4 ± 2.1	* 20.0 ± 1.9
5	24.9 ± 1.9	21.2 ± 3.1	* 9.5 ± 1.5
6	24.5 ± 1.8	- ± -	* 11.9 ± 1.6
7	- ± -	17.9 ± 2.4	27.3 ± 3.9
8	23.6 ± 2.6	18.4 ± 2.4	- ± -
9	24.0 ± 1.5	21.4 ± 1.2	18.0 ± 2.5
10	26.0 ± 1.5	* 16.2 ± 0.7	* 6.7 ± 1.2
11	23.3 ± 2.0	* 15.0 ± 1.1	* 12.3 ± 1.5
12	23.7 ± 1.7	19.4 ± 1.7	* 9.0 ± 2.1
13	17.0 ± 3.8	- ± -	11.9 ± 2.7
14	- ± -	17.1 ± 2.7	13.4 ± 0.8
15	24.0 ± 1.2	19.5 ± 1.5	- ± -
16	27.7 ± 1.4	* 15.0 ± 2.0	* 11.9 ± 1.5
17	20.0 ± 1.7	14.0 ± 2.0	* 12.7 ± 2.1
18	19.0 ± 1.0	* 11.0 ± 1.6	* 9.0 ± 1.8
19	17.0 ± 0.6	19.0 ± 1.2	* 9.0 ± 2.1
20	20.3 ± 1.2	- ± -	* 16.0 ± 1.0
21	- ± -	11.7 ± 9.7	7.5 ± 1.5

* Significant difference from control at the $p < 0.05$ level.

have been reported (BRUCKNER et al. 1973) but only at very high acute single doses of 2.5 g and 6.0 g of PCB/kg body weight. Also, the animals were sacrificed after only 24 hrs. This is in a range ten-fold higher than our highest dose. This investigation also showed no effect upon body weight after 3 weeks with a dose of 0.10 g/kg which is twice as high as our low dose. However we used Aroclor 1254 instead of 1242 which would mean that our rats were subjected to a PCB mixture containing a higher percentage of biphenyls highly substituted with chlorine. In another investigation (SANDERS et al. 1976) it was found that PCB feeding did not affect the final body weights. However in this case mice were used and the dosage of PCB actually ingested by the animals is unclear.

It is worthy to note that there is also a consistant decrease in feed intake in animals treated with PCB. Again this effect holds for both the low and the

TABLE 3

Effect of daily doses of PCB upon water intake in rats. The data are expressed as the means in g ± S E of 6 rats as measured each day.

Day	Control		PCB at 0.05 g/kg		PCB at 0.5 g/kg
1	60.8 ± 6.6		23.5 ± 5.4	*	41.2 ± 2.2
2	28.1 ± 8.2		50.6 ± 7.1		- ± -
3	34.9 ± 4.1		22.0 ± 4.3		24.6 ± 4.0
4	52.1 ± 5.1		28.6 ± 4.4		43.0 ± 4.6
5	39.3 ± 6.8		30.6 ± 3.6	*	21.3 ± 2.9
6	50.6 ± 4.2		- ± -		32.1 ± 4.7
7	- ± -		19.2 ± 4.0		72.0 ± 9.9
8	38.9 ± 5.2		34.6 ± 6.0		- ± -
9	35.7 ± 2.7		36.2 ± 2.0	*	10.5 ± 3.2
10	34.0 ± 1.0		42.8 ± 5.9		43.8 ± 6.7
11	30.0 ± 7.5		54.2 ± 4.1		28.5 ± 3.7
12	32.7 ± 1.4		43.7 ± 2.9	*	15.3 ± 5.2
13	31.3 ± 0.7		- ± -	*	26.7 ± 3.9
14	- ± -		34.5 ± 7.9		25.6 ± 4.1
15	39.5 ± 4.1		34.5 ± 5.5		- ± -
16	39.3 ± 3.3		31.0 ± 4.0	*	17.9 ± 4.1
17	32.3 ± 1.9	*	6.5 ± 1.5		34.9 ± 2.5
18	52.3 ± 4.1	*	21.0 ± 3.7	*	19.6 ± 2.0
19	51.0 ± 4.5	*	27.0 ± 4.0	*	30.0 ± 3.3
20	49.7 ± 4.3		- ± -	*	29.5 ± 3.9
21	- ± -		11.7 ± 7.7		20.0 ± 3.0

* Significant difference from control at the $p < 0.05$ level.

high dose, but here the rate of the decreasing feed intake is only somewhat lower with the lower dose and the onset is only delayed by 2 days. However in both cases the onset is considerably ahead of the onset of the weight loss patterns. This would support the conclusion that a decrease in feed consumption must precede the loss of weight and is to some degree dependent upon it. The feed intake for the controls showed a constant daily level throughout the twenty-one days of the experiment and an overall efficiency of feed conversion to body weight gain of 19.5%. The efficiencies of feed conversion were - 3.2% in the case of the rats given the dose at 0.05 g/kg and - 17.25% in the case of the rats given the higher dose of 0.5 g/kg. This tends to indicate that there are factors operating in the loss of weight other than a diminished intake of food. These might include altered energy metabolism or decreased feed absorption.

The intake of water by rats treated with PCB also decreases with the onset of this decrease starting later for the lower dose. While the pattern is similar, both of these onsets start later than do those of the feed intakes. However the rate of decrease in water uptake in the animals given the lower dose of PCB is somewhat higher than those given the higher dose. The reason for this is not clear. There has been direct evidence that PCB has a dehydrating effect but only with acute high doses of 2.5 - 6.0 g/kg (BUCHNER et al. 1973). It is possible that this disproportionate loss in water is contributing to the weight loss in this manner. The water intake for the control animals showed a constant daily value with no discernable pattern of change throughout the experiment.

These findings suggest that even moderate doses, when administered each day in known amounts, produce detailed and readily identifiable patterns of day to day changes in basic physiological parameters. Further work is necessary to elucidate the underlying mechanisms responsible.

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