POSTMORTEM ON THE PCB DISASTER

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The Peruvian fish meal that was accidently contaminated with Polychlorinated Biphenyls (PCB's) at Wilmington, North Carolina, and moved into the feed trade this past year cost the poultry industry millions of dollars in reduced prices and condemned meat and eggs. Before this incident, PCB's were almost completely unknown to feed manufacturers and poultrymen. However, PCB's have been studied since 1881 and have been in wide industrial usage since 1930. Several companies in the United States and five foreign countries manufacture PCB's for various industrial uses (Gustafson, 1970). The wide spread contamination of the global ecosystem was reported by Risebrough et al. (1968). Monsanto Chemical Company in the United States is the largest manufacturer and uses the trade name Aroclor. The commercially available Aroclors are designated by numbers. The first two digits represent molecular type: 12-chlorinated biphenyls: 25 and 44-blends of chlorinated biphenyls and chlorinated-terphenyls (75% biphenyl and 60% biphenyl, respectively): 54-chlorinated terphenyls. The last two digits give the weight percent of chlorine. Thus, Aroclor 1242 is a chlorinated biphenyl containing 42% chlorine. The PCB's commercially available from Monsanto range from 21% to 68% chlorine. Mass spectographic studies of Aroclor 1260 show the presence of 11 isomers: five containing seven chlorine atoms and one containing eight. It has been calculated that of the 210 possible combinations, 102 are probable (Peakall et al, 1970).

The chemical properties which make PCB's desirable industrial materials are their excellent thermal stability, strong resistance to both acidic and basic conditions, their resistance to oxidation and their general inertness which makes them very stable or relatively inactive compounds.

The most important physical properties of the PCB's are low vapor pressure, low water solubility and a high dielectric constant.

The largest single use of the PCB's is related to their electrical properties as coolant-insulation fluids in transformers. They are used in ballast for flourescent fixtures and plasticizers in electric wire and cables. Due to their thermal properties and fire resistance, they are used in high pressure hydraulic fluids, specialized lubricants, gasket sealers and machine tool cutting oils. Other miscellaneous uses include: binders in epoxy paints, toughening agents in varnishes and waxes, adhesives and carbonless carbon paper (Hubbard, 1964). The PCB property which brought about the crisis this past year was its heat transfer usage. The fish meal was being pasturized because of Salommella contamination.

McCume et al. (1962), reported that (Aroclor 1242) PCB's were moderately toxic when fed at a level of 0.02% and cause high mortality and extensive pathology within four weeks at a dietary level of 0.04%. Gross pathology included hydropericardium, enlarged heart, liver and kidneys, and hemorrhage of internal organs. Microscopically the kidneys showed marked tubular dilation and numerous casts.

Rehfeld et al. (1971), reported the maximum tolerance of (Aroclor 1248) PCB's in the chick was approximately 50 ppm. Symptoms observed in the chicks fed PCB's included depressed weight gain, edema, gasping for breath, hydropericardium, internal hemorrhaging, depression of secondary sexual characteristics and an increase in liver as a percentage of body weight. Several of these symptoms were present when levels of more than 20 ppm of PCB's were fed.

Scott et al. (1971), reported that PCB's (Aroclor 1248) were transferred to the adipose tissue and eggs of Single Comb White Leghorns (SCWL) hens at an increasing rate as the concentration was increased in the feed (Table 1).

TABLE 1. Transfer of PCB[a] from the laying diet to the adipose tissues and eggs of hens.

Diet No.	PCB in Diet	PCB in Adipose Tissue			PCB in Eggs				
		1 wk	4 wks	8 wks	1 wk	4 wks	6 wks	7 wks	8 wks
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
1	0	0	0	0	0	0	0	0	0
2	0.5	1.54	2.16	3.10	0.10	0.16	0.21	0.20	0.22
3	1.0	2.21	4.41	6.62	0.19	0.33	0.42	0.45	0.41
4	10.0	10.4	22.7	37.1	1.05	2.21	2.83	3.11	3.06
5	20.0	16.3	54.7	82.7	2.19	4.31	5.37	5.72	7.04

[a]Aroclor 1248, M. L. Scott '71

After eight weeks of feeding 1 ppm PCB's in the feed the hen contained 6.62 ppm in the adipose tissue and 0.41 ppm in the eggs. Feeding 20 ppm resulted in 82.7 ppm in the adipose tissue, 7.04 ppm in the egg and about a 13% reduction in egg production. Breaking strength of egg shells from hens receiving graded levels of PCB's was not affected. Hatchability was 72% of normal when the egg contained 2.2 ppm. Hatchability was about 56% of normal when the PCB concentration in the egg reached 4.5 ppm. Higher levels of PCB's in the egg virtually eliminated hatchability. Depletion of PCB's from the adipose tissue or eggs was not enhanced by feeding a low energy diet compared to that of feeding a standard diet.

Dahlgren and Linder, (1971), reported that (Aroclor 1254) PCB's fed to pheasants at 25 mg per week for seventeen weeks significantly depressed egg production and increased the number of pips. Even though weekly weight changes of hens, fertility and hatchability of eggs, mortality of adults and egg shell thickness did not appear to be affected by PCB's, total reproductive success was depressed. Mortality of chicks from hatching to six weeks of age was highly significantly greater in the offspring from hens fed 50 mg PCB's weekly.

Data collected from commercial Single Comb White Leghorn (SCWL) breeders by Shutze et al. (1971) on two different poultry farms under field conditions indicate that hatchability was less than 0.5% when the (Aroclor

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1243) PCB's were above 2.3 ppm. Adipose tissue contained 36.0 ppm, eggs 2.6 ppm and the complete feed contained 27.0 ppm PCB's from Flock A (Table 2). The fish meal sample obtained apparently was different from that used in making the feed since it contained only 16.3 ppm PCB's. When the PCB concentration in the eggs from flock A decreased to 1.6 ppm about a 20% hatch was obtained. In Flocks B and C, adipose tissue and egg samples were 20.4 and 2.5 ppm respectively (Table 3). Flock B (approximately 25,000 hens) was subjected to fourteen days of starvation to determine

TABLE 2. PCB Concentration ppm (Flock A)

PCB Concentration ppm (Flock A)	
Fish meal	16.3
Body Fat	36.0
Egg	2.6
Liver	12.0
Serum	0.6
Complete Feed	27.5

TABLE 3. PCB Concentration in the Adipose Tissue, Eggs and Percentage hatchability (Flock C)

Weeks	Adipose Tissue	Eggs	% Hatch
0	20.4	2.50	0
2	14.4	1.30	85.0
4	13.3	1.10	92.0
6	11.9	0.89	92.5
8	9.5	0.83	91.4
10	8.6	0.72	89.3

the influence of forced molting on the depletion rate of PCB's from the adipose tissue. The PCB concentration of the adipose from 20.4 ppm to 38.4 ppm during this perios. The hens were destroyed and buried at this time. Flock C (approximately 26,000 hens) was maintained on the standard breeder ration and monitored weekly for sixteen weeks. These data are presented in Table 3. The first eggs were set when the PCB concentration was 1.3 ppm and a hatchability of 85% was obtained. When the PCB concentration dropped to 1.1 ppm in the eggs, hatchability increased to 92%. As the PCB concentration decreased the hatchability was maintained between 89 - 92 %.

In Flock D (young pullets) the PCB concentration was 11.2 ppm at ten weeks of age and decreased to 2.8 ppm at 19 weeks of age. Mortality, growth rate and appearance appeared to be normal throughout the growing period.

The variation in laboratory results from the same lot of fish meal on one farm indicates a wide range in the contamination and possible sampling error. Results obtained from four laboratories were 165, 200, 657, and 1675 ppm PCB. The existing laboratory procedures leave much to be desired when split samples are submitted to either the same or different laboratories.

The PCB incident demonstrates the vulnerability of an entire industry and how it could be bankrupt. A feed quality control program is certainly desirable but how many analyses can be economically and practically run on a given feed sample?

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