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Toxicity of Polychlorinated Biphenyls in Poultry

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SUMMARY

Polychlorinated biphenyls (PCB) used as a heat-exchange fluid in pasteurizing equipment used to destroy salmonella in fish meal leaked into 16,000 tons of Peruvian fish meal. Some of the fish meal was incorporated into feed and produced toxic effects in chickens and residue problems in their meat and eggs.

Significant findings in affected chickens were accumulation of fluid and damage to the liver. The toxicosis resembled chick edema disease. Toxic effects and accumulation in fat of specific PCB compounds apparently depends on the percentage of chlorine in the compound.

ON JUNE 9, 1971, a condition in 2-week-old broiler chickens, with signs similar to chick edema disease,[10,11] was seen. Gasping and incoordination of the head and neck occurred just prior to death. The most severely affected chickens emitted a squeaking sound. About 50% of the affected chickens died and the remainder were destroyed because of stunting. The condition occurred in several broiler flocks and from several poultry companies.

Necropsy revealed an accumulation of fluid around the heart and in the peritoneal cavity of most affected chickens. A greenish yellow gelatinous fluid was under the skin of some chickens. The liver had varying degrees of degeneration, with a mottled to roughened appearance resembling cirrhosis. The kidneys were swollen and pale with small hemorrhages. The spleen was small. Some chickens had white caseous material covering the heart and liver. Extensive hemorrhage was found in muscles of some chickens. There was inflammation of the intestinal tract and it was usually empty.

Because of the sporadic nature of the condition and its resemblance to chick edema disease or crotalaria poisoning, a toxic substance in the feed or water was suspected. Feed and water from houses with affected chickens were collected for analysis and a feeding experiment.

Sixty 1-day-old chicks from the same parent flock were allotted to 3 groups in a battery brooder. Twenty were given free access to the suspect feed, 20 were offered a known nontoxic feed, and 20 were offered known nontoxic feed and suspect water. Each group was observed daily for appearance and feed and water consumption.

At day 10, the chicks offered suspect feed were not active, would huddle close to the source of heat, and were gasping. At day 14, one-half of chickens offered suspect feed had stopped eating and would not move. On day 15, 10 chickens died and the remainder were gasping. The chickens offered control feed and suspect water were normal.

All chickens were necropsied. Those offered suspect feed had lesions typical of those seen previously in the commercial flocks, viz., hydropericardium, hydroperitoneum, pale swollen kidneys, splenic atrophy, roughened bronze liver, and muscle hemorrhage.

A sample of suspect feed was analyzed

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TABLE 1—Analysis of Suspect Feed

Contaminant	Amount (p.p.m.)
DDE (degradation product of DDT)	1.30
DDD (1,1,dichloro, 2,2,bis-p--chlorophenyl ethane)	1.42
DDT (1,1,1,trichloro, 2,2,bis-p--chlorophenyl ethane)	0.34
PCB (polychlorinated biphenyl)	148
BHC (benzene hexachloride)	8.8
CEF (chick edema factor)	None
Crotalaria seed	None

for chick edema factor, chlorinated hydrocarbon pesticides, crotalaria seed, and PCB, inasmuch as PCB has been reported[1,2] to cause signs and lesions similar to those we had observed. Results of feed analysis are given (Table 1).

The principal toxic ingredient in the feed was considered to be PCB 1242; results were reported to the poultry companies involved in the problem and to regulatory agencies.[3]

It was later determined that the only common ingredient being fed to poultry by the feed mills involved with the problem was Peruvian fish meal shipped from Wilmington, N. Car. It was found that thermonol-FR-1 (aroclor-1242), used as a heat exchange fluid in the pasteurization of fish meal, was leaking.[3]

The Food and Drug Administration tested the processed fish meal and found it to be contaminated with PCB. Investigations indicated the leak began on April 30, 1971, and continued through July 16, 1971.[3] Approximately 16,000 tons of fish meal had been shipped to the United States during this period.

Toxicity of PCB to Poultry—Experimental

In the accidental contamination of fish meal, the PCB designated 1242 was found, but many others are in use. It was therefore decided to test 2 others that are generally used in commerce, 1254 and 1260, as well as PCB 1242.

Weighed amounts of PCB 1242,[4] 1254, and 1260 were dissolved in acetone and mixed into 0.5 lb. (0.23 kg.) of feed that was held in an open container until all odor of acetone was gone. This premix was added to feed and fed ad libitum to chickens. One-day-old broiler chickens were weighed and wing banded. Forty were allotted to each of 12 groups and placed in an electrically heated battery brooder. A sample of fat was collected from representative chickens in each group for analysis for PCB with a gas chromatograph. Results are given (Table 2).

Discussion

Polychlorinated biphenyls have been used since 1929 as plasticizers, heat-transfer agents, in epoxy paints, printing inks, and carbonless carbon paper.[4] They are distributed worldwide in the environment, and residues have been found in fish and wild birds and in the oceans[2,5,6,8] One of the earliest findings of PCB in food occurred in 1969[7] when they were found in 5 of 12 milk samples in West Virginia. During the investi-

[4] Aroclor, Monsanto Chemical Company, St. Louis, Mo.

TABLE 2—Toxicity of PCB and Transfer to Fat in Chickens

No. chickens	PCB in feed (p.p.m.)	Mortality (%)		Residue in fat (composite) (p.p.m.)
		3 weeks	4 weeks	
		PCB 1242		
40	0	0	0	0
40	100	0	0	283
40	200	0	40	427
40	400	80	100	1,686
		PCB 1254		
40	0	0	0	0
40	100	0	0	515
40	200	0	20	783
40	400	50	60	1,557
		PCB 1260		
40	0	0	0	0
40	100	0	0	482
40	200	0	0	1,427
40	400	0	0	2,151

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gation, it was learned that PCB is commonly used as a heat-transfer agent in electrical capacitors. Further investigation indicated that an electrical company had allowed a right-of-way sprayer to use discarded transformer oil for defoliant spraying. Vegetation collected from the power line right-of-way yielded PCB. The drift of the spray to an adjacent dairy pasture caused the residue in the milk. Feeding of silage from silos painted inside with paint containing PCB also results in PCB residues in milk.[4]

Polychlorinated biphenyls are distinguished by numbers, of which the first 2 digits specify the PCB and the last 2 digits the approximate percentage of chlorine in the mixture.

In our study, PCB 1242 was more toxic to chickens than was PCB 1254 or 1260. As the chlorine content in the PCB decreases, toxicity apparently increases. Chickens fed PCB with the highest percentage of chlorine stored a greater amount of the material in their body fat. There was a difference in the lesions of chickens fed suspect feed and chickens fed feed containing PCB. Although there was accumulation of fluid in all chickens, those fed suspect feed had extensive hemorrhages in their breast muscle. This might have been due to other toxic chemicals such as benzene hexachloride.

Poultry are exposed to chlorinated hydrocarbons, including PCB, either via ingestion of contaminated feed or via use of these chemicals in the environment. A continuous residue problem can result in the food chain or in the recycling of rendered animal tissue. An example of this would be:

Animal Feed

Corn, soybeans, fishmeal, animal fat, meat and bone meal, bermuda grass, and alfalfa

↓

Fed to animals

Immediate toxic effects due to high-level contamination

Low-level effects from contaminated ingredients

↓

Residue develops in meat, milk, and eggs

↙ ↘

Human hazard

Buildup of tissue residue in animals

↓

Rendered animal by-products recycled into animal feed

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