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Organochlorine Insecticides in Trout, *Salmo trutta fario* L., Taken from Four Rivers in León, Spain

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The ubiquity and persistence of chlorinated pesticides in aquatic organisms has been well studied over the last 40 years.

These compounds possess high chemical stability and strong lipophilic properties. Aquatic systems, ans fish in particular, can accumulate organochlorine residues directly from water through their respiratory processes, and also from food.

High concentrations of these compounds can have lethal effects in organisms, but ecologically more important are the sub-lethal effects that prolonged exposure to lower concentrations may have on their biological processes.

The survey reported in this paper was carried out in 1986 to determine the levels of the ten organochlorine insecticides in brain, liver, muscle and kidney samples of trout (Salmo trutta fario, L.).

METHODS AND MATERIALS

In 1985 22 trout (Salmo trutta fario, L.) were taken from four rivers in León. Trout numbers for each river were as follows: Bernesga river (La Gotera): 11 trout; Curueño river (La Vecilla): 3 trout; Curueño river (Valdepiélago): 2 trout; Sil river (Palacios del Sil): 3 trout; Orbigo river (Rioseco de Tapia): 3 trout.

Extracts were obtained from each specimen of muscle, liver, kidney and brain for individual insecticide analysis. All tissue samples were stored at -20°C until they were analyzed.

Extraction of organochlorine pesticides and cleaned-up hexane extracts were made according to methods described by Sthar 1977.

Cleaned-up hexane extracts of tissues were completely evaporated under a gentle stream of nitrogen. 3 ml of hexane was added for

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TABLE 1.- Mean, range (in ppm/wet weight) and incidence percent of organochlorine pesticides in trout.

	α-HCH	Lindane	Heptachlor Epoxide	Aldrin	Dieldrin	Endrin
Liver						
Mean	0.394	0.013	0.016	0.113	0.070	0.104
Range	0.394	0.002-0.034	0.001-0.045	0.002-1.380	0.070	0.003-0.306
Incidence	4.54%	13.64%	72.73%	90.91%	4.54%	13.64%
Brain						
Mean	0.129	0.105	0.035	0.305	0.685	0.123
Range	0.073-0.173	0.032-0.180	0.009-0.189	0.102-0.929	0.010-4.630	0.123
Incidence	18.18%	27.27%	68.18%	100%	54.54%	4.54%
Kidney						
Mean	0.066	0.054	0.018	0.057	0.035	0.157
Range	0.066	0.004-0.814	0.001-0.050	0.007-0.215	0.003-0.067	0.003-0.636
Incidence	4.54%	31.82%	63.64%	59.09%	9.09%	22.73%
Muscle						
Mean	———	0.008	0.007	0.018	0.010	0.157
Range	———	0.004-0.017	0.003-0.015	0.007-0.037	0.003-0.021	0.003-0.311
Incidence	———	22.73%	95.45%	40.91%	22.72%	9.09%

TABLE 2.- Mean, range (in ppm/wet weight) and incidence percent of organochlorine pesticides in trout

	o,p'-TDE	p,p'-TDE	p,p'-DDE	p,p'-DDT	Σ DDT
Liver					
Mean	0.047	0.093	0.092	0.675	0.666
Range	0.047	0.023-0.300	0.007-0.289	0.011-8.336	0.025-8.675
Incidence	4.54%	50.00%	72.73%	77.27%	95.45%
Brain					
Mean	0.150	0.160	0.444	1.160	1.285
Range	0.150	0.053-1.034	0.018-1.383	0.049-6.185	0.053-6.185
Incidence	4.54%	22.73%	18.18%	90.90%	100%
Kidney					
Mean	0.413	1.166	0.168	1.148	1.261
Range	0.022-1.038	0.003-3.243	0.014-0.773	0.116-6.163	0.052-6.163
Incidence	13.64%	22.73%	50.00%	54.54%	81.81%
Muscle					
Mean	—	1.467	0.028	0.821	0.673
Range	—	1.467	0.007-0.055	0.029-6.517	0.007-6.517
Incidence	—	4.54%	45.45%	50.00%	72.73%

the reconstitution.

Identification and quantification of organochlorine residues were carried out by gas-chromatography using a gas chromatograph Hewlett Packard mod. 5830A fitted with a Ni^{63} electron capture detector and a computer.

Operating parameters were as follows: columns were of glass 6' x 1/4'' packed with a) 1.95% QF-1/1.5% OV-17 on 80/100 Chromosorb W (AW/DMCS) and b) 3.8% SE-30 on 80/100 Chromosorb W (AW/DMCS). Temperatures were as follows: detector 300°C, injection block 250°C, and oven 200°C for QF-1/OV-17 and 180°C for SE-30. The carrier gas was 5% argon-methane at a flow rate of 25 ml/min.

Quantitative measurement of the insecticide residues was by comparison of peak heights from the standard solution: α-HCH, lindane, heptachlor-epoxide, aldrin, dieldrin, endrin, o,p'-TDE, p,p'-TDE, p,p'-DDE and p,p'-DDT.

RESULTS AND DISCUSSION

Data on quantitative analysis are summarized in tables 1 and 2. In these tables both the mean residue levels and ranges of organochlorine pesticides in parts per million (ppm) on a fresh tissue basis are reflected. Is also summarized in the same tables the incidence per cent of organochlorine pesticides. Σ DDT refers to the sum of the individual residues of o,p'-TDE, p,p'-TDE, p,p'-DDE and p,p'-DDT present in the sample.

The highest incidence percentage of the ten insecticides researched in all samples was for Σ DDT. This percentage was as follows: 100% in brain, 95.45% in liver, 81.81% in kidney and 72.72% in muscle.

Concentrations we detected for Σ DDT generally higher than those reported by others authors on freshwater species of fish.

Solly and Shanks (1969) report a great concentration in trout (*Salmo gardneri*) liver samples from three North Island lakes of 1.91 ppm which is 4.5 times lower than our data. Kelso *et al.*, 1970, detected in carp liver (*Cyprinus carpio*) from the Grand river Ontario a great concentration of 4.71 ppm. This amount was also lower than our concentration. In this same species Carrasco *et al.*, 1972, found low levels, 361.5 times lower than our data.

Several authors also found concentrations lower than those detected by us in muscle of several species of freshwater fish. Thus Solly and Shanks 1969, obtained from the raimbow trout concentrations of the range of 0.45-0.92 ppm. In this same species, Solly and Harrison (1972) found concentrations of 0.04-0.12 ppm.

However, Johnson and Lew 1970, found a great concentration of 23.2 ppm in the liver of several species of freshwater fish. In muscle of these same species, these authors detected a great

concentration of 187.5 ppm. These amounts are higher than those reported by us.

In brain, the mean concentration detected for ΣDDT was similar to that reported by others authors. Merino (1978), in carp brain, found a mean concentration of 1.160 ppm.

In relation to residue levels of ΣDDT in kidney we have not found any reports on it in freshwater fish.

The accumulation of ΣDDT in all samples was higher than the other pesticide residues found, the p,p'-DDT fraction being the major contributing factor to the level of contamination of this group of pollutants (except in muscle that was the p,p'-TDE fraction).

These results can be partially explained because these insecticides group present a high persistence in soils (Nash and Wolson 1967 and Holden 1975). This fact favours their introduction into living beings, where it remains for a long time in the contaminated biotopes without undergoing any important transformations. Aquatic vertebrates also have a low DDT biotransformation ability and similar compounds, and in this way they will remain accumulated in fats for a long time due to their high liposolubility (Walker, 1975).

Of the other organochlorine pesticides, only aldrin was most frecuently found pesticide with exception of ΣDDT in samples of brain and liver 100% and 90.91% respectively. The incidence of this insecticide was also very high in kidney (59.09%) and muscle (40.91%).

Addison 1976, reports that aldrin is quickly epoxidized to dieldrin in the "Salmonidae". However the incidence found by us of dieldrin was low in all samples examined. This fact may be attributed to a recent source of contamination with aldrin. This theory was rejected given that the legislation valid in Spain prohibits the use of this group of insecticides by private individuals and because the organochlorine insecticides analyzed by us has not been used in León province over de last 10 years (Almanza, 1986).

Basing ourselves on the data adduced by Nash and Woolson (1967), we think that the occurrence of aldrin in our samples is due to the high persistence in soils. This fact favours its passage to waters by wind-borne dusts and rain (Moriarty 1975 and Haines 1983).

According to fix Albrigh et al. 1980, the elimination of the heptachlor is very slow in cutthroat trout. This would explain the high incidence which we have seem in all samples of trout for this insecticide.

From the observation of the accumulation rate of all organochlorine pollutants in the tissues studied, it can be seem that residues are mainly accumulated in brain and at a lower rate in the kidney.

TABLE 3.- Total organochlorine pesticide load of trout according to the river (ppm/wet weight).

	BERNESGA	CURUEÑO	ORBIGO	SIL
Average	3.200	7.256	5.291	4.040
Range	1.027-7.480	0.766-12.373	2.799-9.135	2.192-7.200

In table 3 the whole load of organochlorine pesticides of trout grouped according to the river from which they were taken is summarized. From summarized data one suggestion appears to be obvious; since there is no chemical industry and/or pesticides for pest control in areas studied by us, the contamination appears to be significant in these fishes.

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