PCDD/PCDFs, PCBs and PBDEs in Wild and Farm-Raised Fish

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Introduction

Recent studies have shown that farm-raised fish contain higher levels of polychlorinated dioxins and furans (PCDD/PCDFs) and polychlorinated biphenyls (PCBs)(1) than wild fish. This has largely been attributed to the use of fish oils in feeds used for farm-raised fish. Previous work by Ferrario et. al.(2) shows that contamination may also come from feed additives such as ball clay. The ball clays show a very unique PCDD/PCDF isomer distribution pattern in which only PCDDs are present and OCDD is generally the highest concentration. Later work by Johnson and Petreas (3) reported that wild fish caught off the coast of California and in the San Francisco Bay contained elevated levels of brominated flame retardants (PBDEs). This study looks at concentrations of PCDD/PCDFs, PCBs and PBDEs in wild and farm-raised fish.

Table 2: PCDD/PCDF Analytical Results
(in pg/g, (ppt) wet wt.)

	WILD FISH				FARM-RAISED FISH		
Compound	SWORDFISH	SALMON	TILAPIA	SCALLOP	SALMON	CATFISH FILLET	CATFISH NUGGET
2,3,7,8-TCDD	ND(0.0840)	ND(0.0820)	ND(0.0733)	ND(0.0760)	ND(0.0655)	ND(0.0842)	**0.121**
1,2,3,7,8-PeCDD	ND(0.221)	ND(0.0515)	ND(0.0566)	ND(00504)	ND(0.0737)	ND(0.0634)	**0.761**
1,2,3,4,7,8-HxCDD	ND(0.185)	ND(0.0674)	ND(0.107)	ND(0.0125)	ND(0.110)	ND(0.0988)	**1.06**
1,2,3,6,7,8-HxCDD	ND(0.206)	ND(0.0728)	ND(0.113)	ND(0.145)	ND(0.119)	ND(0.116)	**1.42**
1,2,3,7,8,9-HxCDD	ND(0.195)	ND(0.0698)	ND(0.110)	ND(0.134)	ND(0.114)	ND(0.107)	**1.07**
1,2,3,4,6,7,8-HpCDD	ND(0.147)	ND(0.0869)	ND(0.121)	ND(0.0651)	ND(0.0750)	**0.436**	**9.40**
OCDD	ND(0.216)	ND(0.0217)	**0.487**	ND(0.151)	ND(0.230)	**4.57**	**43.4**
2,3,7,8-TCDF	**0.220**	ND(0.108)	ND(0.0760)	ND(0.0732)	**1.03**	ND(0.0740)	ND(0.0657)
1,2,3,7,8-PeCDF	ND(0.201)	ND(0.109)	ND(0.107)	ND(0.0782)	**0.120**	ND(0.0895)	ND(0.0845)
2,3,4,7,8-PeCDF	ND(0.198)	ND(0.106)	ND(0.103)	ND(0.0784)	**0.297**	ND(0.0819)	ND(0.0801)
1,2,3,4,7,8-HxCDF	ND(0.0499)	ND(0.0314)	ND(0.0537)	ND(0.0415)	ND(0.0541)	ND(0.0624)	ND(0.0464)
1,2,3,6,7,8-HxCDF	ND(0.0494)	ND(0.0325)	ND(0.0544)	ND(0.0422)	ND(0.0555)	ND(0.0583)	ND(0.0449)
2,3,4,6,7,8-HxCDF	ND(0.0633)	ND(0.0354)	ND(0.0606)	ND(0.0504)	ND(0.0625)	ND(0.0694)	ND(0.0523)
1,2,3,7,8,9-HxCDF	ND(0.0713)	ND(0.0451)	ND(0.0705)	ND(0.0558)	ND(0.0762)	ND(0.0816)	ND(0.0638)
1,2,3,4,6,7,8-HxCDF	ND(0.0543)	ND(0.0510)	ND(0.0533)	ND(0.0390)	ND(0.0441)	ND(0.0445)	ND(0.0374)
1,2,3,4,7,8,9-HpCDF	ND(0.0576)	ND(0.0435)	ND(0.0663)	ND(0.0462)	ND(0.0505)	ND(0.541)	ND(0.0414)
OCDF	ND(0.238)	ND(0.167)	ND(0.240)	ND(0.0190)	ND(0.160)	ND(0.192)	ND(0.155)
TEQ (WHO-97)	**0.0220**	**0**	**0.0000487**	**0**	**0.2575**	**0.004817**	**1.33534**

Conclusion

In general, the farm-raised fish had higher levels of PCDD/PCDFs, PCBs and PBDEs than the wild fish. The data are consistent with results reported in similar studies. However, some individual trends can be noted.

PCDD/PCDFs: The catfish nuggets had a PCDD pattern similar to that seen in fish exposed to dioxins found in ball clay, which may be used as an additive in fish feed. Ball clay is used in catfish food and can contain high levels of PCDDs. This unique pattern has PCDDs, but not PCDFs.

PCBs: As reported in other studies, the farm-raised salmon had the highest levels of PCBs. The swordfish and wild salmon had higher concentrations than the tilapia and sea scallops, which may be due to the age of the fish when harvested.

PBDEs: There are little data available about PBDEs in fish, but this study shows a trend for the concentration to be higher in the farm-raised fish than the wild fish. The farm-raised salmon had much higher levels than the wild salmon. The highest level of PBDE detected in all the samples was compound BDE-47, followed by BDE-101. PBDEs were detected in all of the fish tissue samples.

Table 1: PBDE Analytical Results
(in pg/g, (ppt) wet wt.)

	WILD FISH				FARM-RAISED FISH		
Compound	SWORDFISH	SALMON	TILAPIA	SCALLOP	SALMON	CATFISH FILLET	CATFISH NUGGET
BDE-1	ND	ND	ND	ND	ND	ND	ND
BDE-2	ND	ND	ND	ND	ND	ND	ND
BDE-3	ND	ND	ND	ND	ND	ND	ND
Total Mono-BDE	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**
BDE-10	ND	ND	ND	ND	ND	ND	ND
BDE-7	ND	ND	ND	ND	0.765	2.65	2.69
BDE-13	ND	ND	ND	ND	0.884	0.215	ND
BDE-15	ND	ND	ND	ND	1.66	2.13	0.763
Total Di-BDE	**ND**	**ND**	**ND**	**ND**	**4.26**	**5.00**	**3.46**
BDE-17	0.974	ND	ND	ND	9.71	3.71	3.08
BDE-25	ND	ND	ND	ND	16.1	ND	ND
BDE-28	3.25	3.08	ND	ND	59.7	4.41	3.78
BDE-35	ND	ND	ND	ND	ND	ND	ND
Total Tri-BDE	**4.23**	**3.08**	**ND**	**ND**	**99.8**	**9.73**	**8.69**
BDE-49	15.2	3.41	ND	ND	276	8.09	10.2
BDE-75	1.98	ND	ND	ND	2.07	1.47	1.26
BDE-47	58	17.4	11.1	5.49	1310	218	124
BDE-66	3.52	1.53	ND	ND	68.1	5.15	3.36
BDE-77	ND	ND	ND	ND	ND	ND	ND
Total Tetra-BDE	**78.7**	**24.3**	**11.1**	**5.49**	**1740**	**240**	**144**
BDE-100	14.5	3.1	2.59	1.75	279	57.1	35.6
BDE-99	24.1	7.81	8.25	6.7	243	395	151
BDE-85	ND	ND	ND	ND	ND	13.1	5.01
BDE-116	ND	ND	ND	ND	ND	ND	ND
BDE-126	ND	ND	ND	ND	3.28	ND	ND
Total Penta-BDE	**40.8**	**10.9**	**10.8**	**8.45**	**561**	**466**	**191**
BDE-155	7.63	0.795	ND	ND	46.5	ND	1.86
BDE-154	22.2	1.85	0.842	0.919	116	21.9	15.9
BDE-153	4.45	ND	1.55	ND	38.6	28.0	20.3
BDE-138	ND	ND	ND	ND	ND	2.68	1.95
BDE-156	ND	ND	ND	ND	ND	ND	ND
Total Hexa-BDE	**34.2**	**2.64**	**2.39**	**0.919**	**212**	**58.3**	**42**
BDE-183	1.23	2.11	15.3	ND	1.49	25.3	14.7
BDE-181	ND	ND	ND	ND	ND	ND	ND
Total Hepta-BDE	**1.23**	**2.11**	**15.3**	**ND**	**18.2**	**25.3**	**14.7**
BDE-197	ND	ND	ND	ND	ND	8.84	5.75
BDE-203	ND	ND	ND	ND	ND	ND	1.92
Total Octa-BDE	**ND**	**ND**	**ND**	**ND**	**ND**	**8.84**	**9.63**
BDE-207	14.8	8.57	ND	ND	12.2	17.0	ND
Total Nona-BDE	**14.8**	**8.57**	**ND**	**ND**	**17.1**	**17.0**	**3.08**
BDE-209	800	504	328	220	411	453	214

Analytical Method

Tissue samples were purchased from supermarkets in Sacramento and El Dorado Hills, CA. Three wild, ocean fish and one bivalve were selected—swordfish, salmon, tilapia and sea scallops—and three farm-raised fish—salmon, catfish fillets and catfish nuggets. All tissue samples were homogenized and extracted reflecting typical edible portions. The samples were analyzed using EPA Method 1613 for PCDD/PCDFs, EPA Method 1668 for PCBs, and draft EPA Method 1614 for PBDEs. In the tables presented, only coplanar/mono-ortho PCBs and PCB totals for each congener level are reported. Data for all 209 PCB congeners are available.

Table 3: PCB Analytical Results
(in pg/g, (ppt) wet wt.)

	WILD FISH				FARM RAISED FISH		
Compound:	SWORDFISH	SALMON	TILAPIA	SCALLOP	SALMON	CATFISH FILLET	CATFISH NUGGET
PCB-77	4.09	0	0.197	0.271	21.2	2.31	0.93
PCB-81	4.30	0	0	0	18.9	0	0
PCB-105	78.7	19.2	0.815	0.544	438	6.71	9.63
PCB-114	6.65	2.39	0	0	27	0	0.617
PCB-118/106	312	80.3	2.53	1.53	1590	17	35.9
PCB-123	7.53	1.85	0	0	18.7	0	0.707
PCB-126	5.57	1.08	0	0	9.46	0	0.29
PCB-156	57.3	4.07	0.29	0	151	0	3.49
PCB-157	11.9	1.99	0	0	41.8	0	1.09
PCB-167	52.5	3.45	0.22	0	110	1.29	2.53
PCB-169	6.15	0	0.151	0.177	0	0	0
PCB-189	5.75	0	0	0	16.7	0	0.535
Total Mono-PCB	0	6.03	0.597	0.165	0	0	0.968
Total Di-PCB	0	0	2.18	3.02	0	0	4.19
Total Tri-PCB	39.6	261	4.26	5.05	1210	93.3	43.1
Total Tetra-PCB	861	1310	7.96	8.84	10300	318	145
Total Penta-PCB	1680	700	13.2	8.73	8720	104	251
Total Hexa-PCB	3250	473	18.3	7.37	12000	92.8	302
Total Hepta-PCB	1520	106	7.69	1.51	3760	24.4	123
Total Octa-PCB	260	11.5	1.86	0.319	554	2.44	33.2
Total Nona-PCB	36.5	0.739	0.169	0	68.3	3.37	9.46
Total Deca-PCB	14.0	1.28	0.114	0	31.7	0.948	4.61
Total PCB	**7660**	**2870**	**56.3**	**35.0**	**36600**	**639**	**917**
TEQ	**0.698**	**0.122**	**0.00199**	**0.00198**	**1.26**	**0.00238**	**0.0363**

References

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