

**Analysis of Dioxin-Furan, PCB and trace metal levels in  
farmed catfish, Escambia County, FL**

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by:

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## **Abstract**

Farm-raised catfish from Escambia County, Florida were analyzed for Dioxin-Furans, Polychlorinated biphenyls, and trace metals including total mercury. Results from the organic contaminants were very low, most in the range of the analytical blanks making them undetectable. Calculated toxic equivalent values based on a conservative approach, were all well below screening thresholds for occasional fish consumption. The only elevated value found was for abdominal fat deposits, which had significant levels of Dioxin-Furans, but not PCBs, suggesting that this material should not be recycled into fish foods by processors. As this material is not marketed for human consumption, it is of little direct concern. All toxic metal concentrations, including Mercury, were near or at analytical detection limits, indicating the fish flesh was relatively free of these compounds.

## **Introduction.**

Farm raised fish are becoming more available in the marketplace to meet demand unfulfilled from wild caught fishes taken from increasingly depleted stocks. The food quality of the farm raised fish relative to wild caught fish has been the subject of concern (Luksemburg et al., 2004), including concern that the benefit of fish oils in salmon being outweighed by the costs involved in toxic contamination with PCBs (Hites et al, 2004). Farm raised catfish have not be left out of this scrutiny. Past studies have documented high levels of PCBs and Dioxin-Furans in farm raised catfish, mainly as a result of contaminated feed stocks (Fiedler et al., 1998; Rappe et al., 1998).

This investigation was undertaken to evaluate the PCB, Dioxin-Furan, and trace metal content of farm raised catfish from Escambia County, FL.

## **Materials and Methods**

Catfish (*Ictalurus punctatus*) were recovered from an aquaculture pond at the farm of Steven Hiebert, Walnut Hill, FL. Hook and line, both baited and snag hook were used to capture fish. Fish were wrapped in aluminum foil and placed on ice in a cooler immediately after capture. Nine fish were selected for three groups of three similar sized individuals to make up three composite samples. Procedures followed those outlined in the US EPA guidance for assessing contaminants in fisheries (US EPA, 2000).

In the lab, fish processing was conducted on foil-covered benches with surgical gloves. All items contacting fish were cleaned in a series of warm soapy water, tap water, isopropyl alcohol, and 18mΩ purified water. Each fish was measured for total length and total weight and assigned an identity code. Fillets were removed with a clean stainless steel fillet knife cleaned between each fish. Skin was removed with the knife. Fillets were weighed, and equal proportions of fillet were combined from each of three fish in each composite. The combined fillets were homogenized in a Foss Tecator tissue homogenizer, with all parts cleaned between samples. Homogenized tissues were placed into certified pre-cleaned jars, labeled with the appropriate identity code and frozen prior to shipment.

Samples were shipped with ice packs in a cooler to Pace Laboratories, Minneapolis, MN, for analysis of dioxin-Furans (Method 1613), 209 PCB congeners (Method 1688A), and trace metals. Toxic equivalent quotients (TEQ) were calculated using the coefficients reported in van den Berg et al. (1998). Data were compiled in MS Excel spreadsheet files for reduction and reporting.

## **Results and Discussion.**

**Sample characteristics.** Data for individual fish combined into the three composite samples is listed in Table 1. Average characteristics of each composite are listed in Table 2. Fish length for each of the composites was significantly different ( $P = 0.006$ ), although there were no significant differences in weight ( $P = 0.547$ ). The overall average weight was 671 g or

approximately 1.5 lbs / fish. Since there were no significant differences in weight between composites, all further analyses represent a pooled analysis. The duplicate samples (080119A, 080119B) were averaged prior to calculating the average between composites.

Substantial abdominal fat deposits were found in each fish. This material was weighed and represented approximately 2.7% of total body weight for each fish. Although this material is not normally consumed by humans, all abdominal fat was combined into a sample for separate analysis, as organic contaminants are known to partition into fats, and the sample would represent an extremely sensitive measure of any contaminant exposure. Percent lipid was relatively high for all fillets ranging from 5.6 to 6.4% with an overall average of 6.23%, within the range of values reported in the literature, but on the high end of analysis of catfish fillets from North Carolina facilities (average 4.93%; Seo et al., 1995).

**Contaminant Analyses.** The analytical reports for these samples are attached as Appendix I. Dioxin-Furan (DF) content of the samples, as measured by toxic equivalent quotients (TEQ) for all congeners, were not greater than the analysis blanks, indicating very low levels of these contaminants in the fillet tissue (Table 3). All composites of fillets were well below the US EPA screening value for recreational (occasional) fish consumption (0.26 ppb). With the low levels recovered, the actual concentration of undetected individual congeners is unknown, and a conservative estimate of exposure substitutes one half of the detection limit for the zero values ( $ND = \frac{1}{2}$ ). Even with this conservative estimate, fillet values are not higher than the analytical blank, and well below the screening value (Table 3). Similar results were obtained for PCB analysis (Table 4). Total PCBs were also low, and well below the US EPA screening value of 20,000 ng/kg.

The abdominal fat sample did show accumulation of Dioxin-Furans, as reflected in the TEQ value at 0.54, above the US EPA screening value (0.26; Table 3), but it should be understood that these compounds will preferentially accumulate in this tissue, and it does not represent the edible portion of the fish. PCB content of the fat, in contrast, while higher than the amount in fillets, was not elevated to levels of concern (Table 4). The combination of a fast growing, high growth efficiency fish with such fat deposits to absorb organic contaminants may contribute to keeping the levels of these compounds low in the edible flesh.

**Metals.** Concentrations of Arsenic, Cadmium, Copper, Lead and Mercury were all very low in the catfish fillets (Table 5). Most results were near the limits of detection for the analysis, and in some cases, were somewhere below the detection limits. For the latter samples, the analytical detection limits were reported and are indicated in red in Table 5. Data from an average of 162 catfish samples from southeastern US fish farms had higher average concentrations than the presently analyzed samples with the exception of copper, which may be the result of use of this compound in the aquaculture setting. Despite the higher average values in Santerre et al. (2001), significant variation in their analysis was apparent and some of their samples were below the limits of detection: Cd 98%, Cu 17%, Pb 89%, As 96%, Hg 16%. Mercury is of particular concern in freshwater fishes, and the catfish pond sediments are potentially a source of methyl mercury. This form of the compound is bioaccumulated by

individuals and in trophic food webs, but these dynamics were not manifest in the farm pond, with very low levels of total mercury found in the catfish filets.

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Table 1. Composite sample identifications and characteristics.

DATE	ZONE	SPECIES	COMPOSITE	FISH NO	FORK LENGTH	TOTAL LENGTH	WEIGHT
19-Jan-08	Farm Pond	<i>Ictalurus punctatus</i>	080119A	1	365	400	630
19-Jan-08	Farm Pond	<i>Ictalurus punctatus</i>	080119A	2	382	433	730
19-Jan-08	Farm Pond	<i>Ictalurus punctatus</i>	080119A	3	354	399	560
19-Jan-08	Farm Pond	<i>Ictalurus punctatus</i>	080119C	1	384	430	720
19-Jan-08	Farm Pond	<i>Ictalurus punctatus</i>	080119C	2	381	425	690
19-Jan-08	Farm Pond	<i>Ictalurus punctatus</i>	080119C	3	367	411	650
19-Jan-08	Farm Pond	<i>Ictalurus punctatus</i>	080119D	1	330	374	720
19-Jan-08	Farm Pond	<i>Ictalurus punctatus</i>	080119D	2	329	364	690
19-Jan-08	Farm Pond	<i>Ictalurus punctatus</i>	080119D	3	327	370	650
19-Jan-08	Farm Pond	<i>Ictalurus punctatus</i>	080119B	08119A dup			

Table 2. Average characteristics for composites and analytical results for percent lipid in fillets.

SPECIES	COMPOSITE	FORK LENGTH	TOTAL LENGTH	WEIGHT	average ab fat* g	% lipid in fillet
<i>Ictalurus punctatus</i>	080119A	367	411	640	18.9	6.4
<i>Ictalurus punctatus</i>	080119B ("A" duplicate)					5.6
<i>Ictalurus punctatus</i>	080119C	377	422	687	18.6	6.3
<i>Ictalurus punctatus</i>	080119D	329	369	687	17.3	6.4
<b>Overall Average</b>		<b>358</b>	<b>401</b>	<b>671</b>	<b>18.3</b>	<b>6.23</b>
<b>Standard Deviation</b>		<b>25.6</b>	<b>27.7</b>	<b>26.9</b>	<b>0.843</b>	<b>0.386</b>
Analytical Blank						

\*Fat deposits removed from abdominal cavity

Table 3. . Dioxin-Furan (DF) TEQ values for composite fillet samples and composite abdominal fat. All values are ng/kg wet weight of tissue.

SPECIES	COMPOSITE	TEQ <sub>DF</sub> ND=0	TEQ <sub>DF</sub> ND=1/2
<i>I. punctatus</i> fillet	080119A	0.024	0.044
<i>I. punctatus</i> fillet	080119B	0.048	0.063
<i>I. punctatus</i> fillet	080119C	0.020	0.048
<i>I. punctatus</i> fillet	080119D	0.022	0.042
<b>Average</b>		<b>0.026</b>	<b>0.048</b>
<b>Standard Deviation</b>		<b>0.013102163</b>	<b>0.0095</b>
Abdominal fat	080119E	0.55	0.55
Analytical Blank		0.0377	0.045

Table 4. Total PCB content of composite fillet samples and composite abdominal fat. All values are ng / kg wet weight of tissue

SPECIES	COMPOSITE	Total PCBs
<i>I. punctatus</i> fillet	080119A	1310
<i>I. punctatus</i> fillet	080119B	1430
<i>I. punctatus</i> fillet	080119C	1520
<i>I. punctatus</i> fillet	080119D	1270
<b>Average</b>		1387
<b>Standard Deviation</b>		114
Abdominal fat	080119E	8680
Analytical Blank		1390

Table 5. Trace metals content of composite catfish fillets samples and composite abdominal fat. All values are mg / kg wet weight of tissue.

Parameter	Fillet composites				average	stdev	SE Average*
	080119A	080119B	080119C	080119D			
Arsenic	0.013	0.024	0.013	0.018	0.017	0.0052	0.075
Cadmium	0.009	0.0081	0.01	0.0081	0.0088	0.0009	0.483
Copper	0.4	0.23	0.23	0.32	0.295	0.0819	0.27
Lead	0.024	0.024	0.024	0.024	0.024	0	0.714
Mercury	0.0048	0.005	0.0047	0.0058	0.0051	0.0005	0.008

\*Santerre et al., 2001.