A Rapid Method to Improve the Indiana Fish Consumption Advisory

J.A. Lasrado[1]; C.R. Santerre[1]; J.R. Stahl[2]; T. Noltemeyer[3]; D.C. Deardorff[4]

[1]Foods and Nutrition, Purdue University; [2]Indiana Department of Environmental Management; [3]En Chem, Inc.; [4]Strategic Diagnostics, Inc.

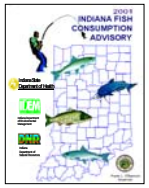
ABSTRACT

Polychlorinated biphenyls (PCBs) in fish tissue were analyzed using enzyme-linked immunosorbent assay (ELISA) and gas chromatography/electron capture detection (GC/ECD) methods. Fish samples were collected in 2000-2001 during an Indiana fish survey. For fish tissue from 0.05 to 5.0 ppm, ELISA was not significantly different from GC/ECD ($p<0.05$). This research has demonstrated the effectiveness of using ELISA for analyzing fish samples. With this rapid assay State agencies will be able to expand their monitoring programs and improve fish consumption advisories.

INTRODUCTION

PCBs are a cause for concern because they can pass via the placenta to the fetus and through breast milk to the infant (EPA, 1992). Consumption of PCB-contaminated fish serves as the main route of human exposure to PCBs (EPA, 1993).

Total PCB content is a function of the lipid content of a fish. With age, fish accumulate more lipid, increase in length, and can have greater exposure to PCBs. In 2000, 38 States issued fish consumption advisories for PCBs. However, the limitation of the Indiana fish consumption advisory is two-fold.



i. Compliance with fish consumption advisories can be poor (<62%), which may be due to the complexity of the advisory.
i. The translation of residue data to an advisory has not been statistically validated.

Since analytical methods are costly, time consuming, and require sophisticated instruments (Safe 1990), the number of data points that are used to create the advisory are limited and may be statistically inadequate. A low cost, rapid assay may facilitate the proper collection of data for advisory development.

OBJECTIVES

1. To demonstrate that an ELISA method is as precise as a GC method for the measurement of total PCB in fish tissue (PART A).
2. To simplify the Indiana fish consumption advisory using regression analysis (PART B).

PART A

METHODS

Forty (0.05 to 0.5 ppm) and twelve (0.5 to 0.5 ppm) contaminated wild fish samples collected by the Indiana Department of Environmental Management (2000 –2001) were analyzed by a standard GC/ECD method and ELISA.

GC/ECD analyses were carried out by En Chem, Inc. (Madison, Wis.) using SW-846 Methods (EPA 1992, 1996). ELISA was performed using a commercial kit (Strategic Diagnostics, Inc.)

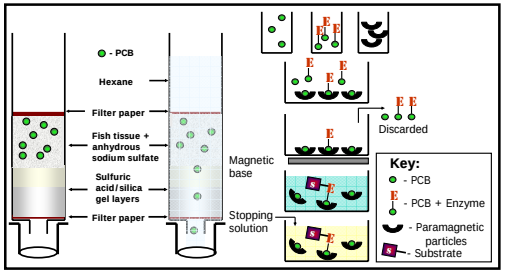


Figure 1. Illustration of the clean-up, extraction and ELISA

Equation used to calculate PCB concentration (450 nm):

$$\text{Logit } B/B_o = \text{Slope} * \text{Ln [PCBs]} + \text{Intercept}$$

Where: B = Sample absorbance
B_o = Blank absorbance

RESULTS

The statistical comparison of total PCB concentrations for fish samples from 0.05 to 5.0 ppm, indicated that there was no significant difference between ELISA and GC/ECD ($p<0.05$).

The ratio of ELISA-determined to GC-determined total PCB values is on average 1.12 (Figure 2).

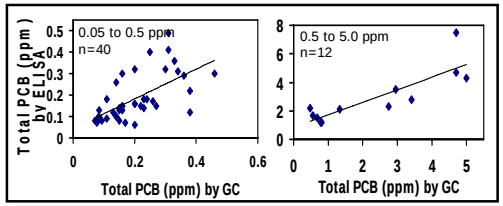


Figure 2. Comparison of total PCB concentrations determined by ELISA and GC for fish tissue.

PART B

METHODS

Total PCB values for carp samples (n =430) collected from 1987 to 1999 for locations across Indiana were divided into 5 groups (Table 1). The data obtained was statistically reduced to obtain a regression model to predict total PCB.

Table 1. Location groups and consumption frequencies

Location Group	Total PCB (ppm)	General Consumption	At-Risk Consumption*
1	<0.05	Unrestricted	1 meal/week
2	0.05 - 0.22	1 meal/week	1 meal/month
3	0.22 - 0.93	1 meal/month	DO NOT EAT
4	0.93 - 1.89	1 meal/2months	DO NOT EAT
5	>1.89	DO NOT EAT	DO NOT EAT

*At-Risk Consumption includes recommended intakes for pregnant and lactating women, women of childbearing age and children under 17 years of age.

Parameters to determine the best predictor for total PCB included: Location, Length (inch), Weight (g), Length/Weight Ratio, Lipid content (g.

Table 2. 2001 Indiana Fish Consumption Advisory uses length as a predictor for total PCB.

County Name / River, Stream, Lake, or Reservoir Name	Fish Species	Fish Length (inches)	Contaminant ■ = PCBs ❍ = Mercury	Group (1– 5)
Kosciusko County				
All Indiana Rivers and Streams	Carp	15-20	■ ❍	3
		20-25	■ ❍	4
		25+	■ ❍	5
Barrel and a Half Lake	Largemouth bass	5-13	■ ❍	2
		13+	■ ❍	3

Statistical analysis was carried out using SAS. Data were normalized and the analysis of variance was carried with progressive removal of insignificant parameters.

RESULTS

Regression equation for the prediction of total PCB (on a lipid basis) in carp ($\alpha = 0.05$):

$$\text{Log [PCB]} = 8.05 + \beta_1 * (\text{Ratio}) + \beta_2 * (\text{Location})$$

Where: Ratio = Weight (g)/Length (inch)
Location = Sampling location group

CONCLUSIONS

ELISA was not significantly different ($p<0.05$) from GC/ECD for the analysis of total PCB in fish samples from 0.05 to 5.0 ppm.

This research provides a rapid alternative for the determination of total PCBs, which could increase the number of fish samples analyzed during the development of fish consumption advisories.

A simplified 'residue calculator' that can predict PCB residues based upon location, carp length and weight was developed. With increased sample sizes 'simplified calculators' can be developed for other species. Therefore, fish advisories can be more accurate and user-friendly.

REFERENCES

Angling Indiana, 2001. fn.cfs.purdue.edu/anglingindiana/
EPA, 1992. EPA-1.17-846/final 1/99.
EPA, 1993. EPA/823-R-93-003.
EPA, 1996. EP 1.17/Update No.3/Final.
ISDH, 2001. www.in.gov/isdh/dataandstats/fish/ fish_adv_index.htm
Safe et al., 1990. Critical Reviews of Toxicology 21: 51-88

ACKNOWLEDGMENTS

We are grateful to the Illinois-Indiana Sea Grant Program and Purdue University Research Foundation for partially funding this research. This research was supported through a cooperative agreement with the Agricultural Research Service of the United States Department of Agriculture project number 1935-42000-035. We would also like to thank Strategic Diagnostic, Inc. for providing ELISA kits and Cheryl Schaul and Soon-Mi Shim for their assistance.