BASELINE RISK STUDY OF POTENTIAL CHEMICAL CONTAMINANTS IN ONTARIO FARM-RAISED RAINBOW TROUT

Mike Cassidy, Ana Matu and Gavin Downing.
Food Safety Policy Branch
Ontario Ministry of Agriculture and Food (OMAF), 1 Stone Road West, Guelph, Ontario N1G 4Y2.

Ontario

Abstract

Despite generally recognized health benefits of eating fish rich in omega-3 fatty acids, recent attention has focussed on the safety of farm-raised fish as a food source. Chemical contaminants could be introduced into aquaculture-raised product through veterinary therapeutics, contaminated fish oil-rich diets, and the environment. As part of its ongoing review and development of a comprehensive food safety program, the Ontario Ministry of Agriculture and Food (OMAF) conducted a baseline study of potential chemical contaminants in farm-raised trout.

Tissue samples of Ontario farm-raised rainbow trout (*Oncorhynchus mykiss*) were analysed for 10 veterinary drugs, 5 metals, 56 organochlorine/ organophosphate pesticides, and dioxins, furans, and dioxin-like polychlorinated biphenyls (PCB congeners), as per CFIA/US EPA guidelines. Veterinary drugs were analyzed on an individual fish basis; other analyses were performed on pooled samples consisting of three lots of fish.

Residues of 62 analytes were not detectable in any samples. Analyses showed the presence of oxytetracycline (n = 127, 1 detectable residue: 0.062 μg/g), and florfenicol (n = 127, 9 residues: range 0.1-0.3 ng/g) in market-ready fish.

Analyses also showed the presence of mercury (n = 59, 18 residues: 0.01-0.07 μg/g), lead (n = 59, 1 residue: 0.1 μg/g), selenium (n = 59, 58 residues: 0.2-0.8 μg/g), and arsenic (n = 59, 58 residues, 0.27-1.55 μg/g).

Dioxin (2,3,7,8-TCDD) was not detectable in any pooled sample (n = 63). Mean total PCB concentration was 0.024 μg/g (n = 63). Congener-specific analysis for dioxins, furans, and dioxin-like PCBs showed a total Toxic Equivalency Quotient (TEQ) ranging from 0.55-4.32 pg TEQ/g wet weight, with a median value of 1.44 pg TEQ/ g wet weight. Strong correlation was made between TEQ and fish size, independent of producer strata.

These results indicate levels of all chemicals tested in market-ready farmed trout are below current Health Canada Maximum Residue Limits (MRLs). This information will be used to develop appropriate science-based risk management programs for Ontario aquaculture to ensure public health and safety, while maintaining industry competitiveness.

Introduction

A prerequisite for the development of boat-to-throat, science-based food fish safety programs for Ontario is to conduct baseline studies to determine the prevalence of microbiological, physical and chemical hazards. The data from these studies will be used to assess and manage the risks associated with particular fish products, and to develop programming, including regulatory and non-regulatory options.

In 2001, the Ontario aquaculture industry produced approximately 4500 tonnes of farmed fish with a farm-gate value in excess of $16 million and an economic contribution of $65 million. Currently rainbow trout accounts for over 90% of the production output from Ontario aquaculture, and represents more than two thirds of Canada's farmed trout production. In addition to trout, there is small-scale food fish culture in Ontario of perch, walleye, sturgeon, Arctic charr, and tilapia.

Farm-raised fish may reach the Ontario consumer's plate through CFIA-registered processors, non-federally registered processors, farm-gate sales of fresh and smoked fish, farmers' markets and fee-fishing establishments

As part of its ongoing review and development of a comprehensive food safety program, the Ontario Ministry of Agriculture and Food (OMAF) conducted a baseline study of potential chemical contaminants in farm-raised trout.

Table 1. Residues of chemical contaminants detected in Ontario farm-raised rainbow trout.

Analyte	No. of Samples*	MDL (ppm)	No. of Residues	Range (ppm)	MRL (ppm)
Veterinary Drugs					
Oxytetracycline	**127**	**0.05**	**1**	**0.062**	**0.1**
Florfenicol	**127**	**0.1 ppb**	**9**	**0.1-0.3 ppb**	**0.8 ppm**
Metals					
Mercury	**59**	**0.02**	**18**	**0.01-0.07**	**0.5**
Lead	**59**	**0.1**	**1**	**0.1**	**0.5**
Selenium	**59**	**0.1**	**58**	**0.2-0.8**	**2.0**
Arsenic	**59**	**0.01**	**58**	**0.27-1.55**	**3.5**

***Vet drug results only for market-ready fish. Number of pooled samples for Metals.**
MDL = Minimum Detectable Level; MRL = Health Canada Maximum Residue Limit

Materials and Methods

Samples of fresh, whole market-sized rainbow trout (*Oncorhynchus mykiss*) were collected between October and December 2002 from individual lots supplied by large lake-based cage producers and medium and small land-based producers in Ontario. A total of 171 samples from individual lots were collected (65 producers). Samples were identified as market-ready if they were intended for immediate consumption (127 samples), or not market-ready if they were to be over-wintered for Spring harvest.

A sampling plan was developed proportional to volume within production stratum, with 58 samples collected from the large stratum (7 producers), 59 samples from the medium stratum (22 producers), and another 54 samples from the small stratum (36 producers).

Fish size was ranked as large (> 900 g), medium (600-900 g), or small (< 600 g).

Homogenates of skin-on, boneless edible tissue were prepared according to AOAC Official Method 937.07 “Fish and Marine Products, Treatment and Preparation of Sample, Procedure”. Individual market-ready samples were analysed for tetracyclines (HPLC), sulfonamides (TLC/Densitometry), and amphenicols (GC/MS). All samples (market-ready and not) were pooled in lots of three by fish size, and analysed for organochlorine (GC/ECD) and organophosphate (GC/NPD) pesticides, metals (ICPMS/CVAA), dioxins/ furans/ dioxin-like PCBs HRGC/HRMS).

Results

Residues of 62 analytes, including all 56 organochlorine/ organophosphate pesticides tested, were not detectable in any samples. Analyses showed a low incidence of veterinary drugs in market-ready fish, and a low incidence of mercury and lead (Table 1).

Dioxin (2,3,7,8-TCDD) was not detectable in any pooled sample (n = 63). Mean total PCB concentration was 0.024 μg/g (n = 63). Congener-specific analysis for dioxins, furans, and dioxin-like PCBs showed a total Toxic Equivalency (TEQ) ranging from 0.55-4.32 pg TEQ/g wet weight, with a median value of 1.44 pg TEQ/g wet weight (Figure 1).

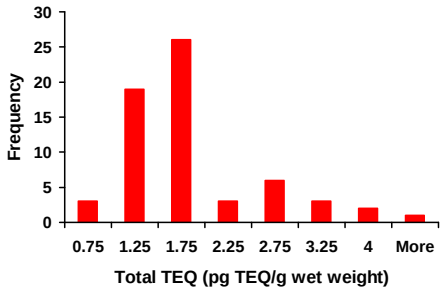

Figure 1. Frequency distribution of total dioxin/ furan/ dioxin-like PCB Toxic Equivalents (pg TEQ/ g wet weight) in pooled tissue samples of Ontario farm-raised rainbow trout.

Median total TEQ was 1.55, 1.49, and 1.15 pg TEQ/ g wet weight for large, medium, and small fish, respectively. Mean total TEQ was significantly correlated with fish size, independent of producer strata ($P < 0.05$, nested ANOVA).

Discussion

These results indicate that levels of all chemicals tested in market-ready Ontario farmed rainbow trout are below current Health Canada Maximum Residue Limits (MRLs).

Improvements in husbandry and animal health protocols, a strong veterinarian-client relationship, and adherence to prescribed dosage and withdrawal times may all contribute to minimizing the incidence of veterinary drug residues in Ontario aquaculture. Impacts from environmental contamination may be minimized as a consequence of relatively short exposure times from the accelerated farm production cycle.

Based on the median total TEQ, the number of portions of Ontario farm-raised rainbow trout that can be consumed before exceeding current Tolerable Daily Intake (TDI) guidelines for dioxins/ furans/ dioxin-like PCBs is shown (Figure 2).

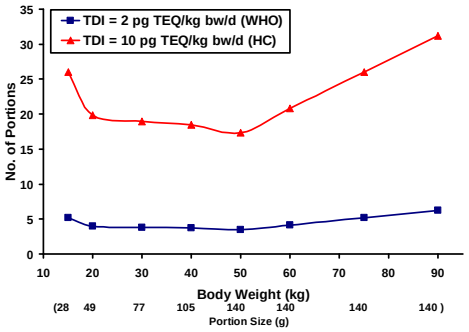

Figure 2. Upper- (Health Canada, HC) and lower-bound (World Health Organization, WHO) for the number of portions of Ontario farm-raised rainbow trout that can be consumed weekly without exceeding Tolerable Daily Intake (TDI) for dioxins/ furans/ dioxin-like PCBs. Tissue concentration assumed to be at 1.44 pg TEQ/g wet weight. Portion size adjusted for body weight.

The correlation between total TEQ and fish size may be indicative of a correlation to husbandry practices, e.g. increased feeding for larger fish. Further reductions in total TEQ may therefore be possible through the feed industry continuing to source low contaminated ingredients, e.g. minerals, fish meal and oil.

This information will be used to develop appropriate science-based risk management programs, including regulatory and non-regulatory options, for Ontario aquaculture to ensure public health and safety, while maintaining industry competitiveness.

Acknowledgements

Successful implementation of this project involved cooperation between the Public Health Branch of the Ministry of Health and Long-Term Care (MOHLTC), the Ministry of Natural Resources (MNR), the Canadian Food Inspection Agency (CFIA), and the Livestock Technology, Food Inspection and Food Safety Policy Branches of the Ontario Ministry of Agriculture and Food (OMAF).