

DETERMINATION OF TRACE METAL CONCENTRATIONS IN MONKFISH

(*LOPHIUS AMERICANUS*)

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ABSTRACT

Once considered a 'trash fish', monkfish (*Lophius americanus*) currently ranks as the fourth largest commercial finfish in the U.S. with tails, livers, and whole fish being consumed. As bottom dwellers, monkfish are often in direct contact with sediments which may contain elemental (trace metal) contaminants. Through bioaccumulation, these trace elements may pose potential health risks to humans and may have adverse effects on the organism's reproductive capacity. Therefore, this study aimed to determine the concentrations of a suite of these metals in monkfish muscle, liver, and gonads and examine the potential risks posed by these contaminants to humans. Monkfish were collected using gill nets from three sites in the northwest Atlantic Ocean during the spring of 2007. Muscle, liver, and gonads were collected from each fish and analyzed for arsenic, cadmium, lead, selenium, zinc, and total mercury. Significant differences were found in accumulation patterns for the elements as well as the organs among the sites. All trace metals and total mercury concentrations were within the maximum permissible limit for human consumption, with the exception of hepatic and gonadal mean selenium. The results from this study will serve as an important tool in the assessment of essential fish habitat for monkfish and the risk related to consumption of this commercial fish species.

INTRODUCTION

The monkfish, *Lophius americanus*, is the most important commercial finfish in the northeastern United States with whole fish, tails, and livers being consumed. As bottom dwellers, monkfish are often in direct contact with sediments and accumulate the elemental contaminants that are enriched in the benthic community. Bioaccumulation of these contaminants in fish tissue may have adverse effects on their reproductive capabilities and result in pathological alterations of the liver, kidney, spleen and gonads (Hamilton, 2004). Though a commercially important fish, very little information is available on metal concentrations in monkfish tissue from the U.S. The purpose of this study was to determine trace metal (arsenic, cadmium, lead, selenium and zinc) and total mercury concentrations in monkfish muscle, liver, and gonadal tissues collected from three sites off the east coast of the U.S.



Fig. 1. Map showing the three sampling locations in the northwest Atlantic Ocean.

Objectives:

1. To compare concentrations of trace metals (arsenic, cadmium, lead, selenium, zinc) and total mercury among the three sites.
2. To determine the potential risk posed by these contaminants to humans.

MATERIALS AND METHODS

FIELD COLLECTION

Monkfish ranging from 88 to 100 cm total length (TL) were caught with gill nets from three sites: East of Cape Cod, Massachusetts (42°00'00"N, 69°15'00"W), Mud Hole, New Jersey (40°04'00"N, 73°30'00"W) and Finger's Hole, Maryland (38°03'21"N, 74°49'56"W) in the northwest Atlantic Ocean (Fig. 1) from February to May, 2007. Ten fish were collected from Mud Hole and Finger's Hole sites and twelve from the East of Cape Cod site. Muscle, liver and gonads were analyzed for several trace metals [arsenic (As), cadmium (Cd), lead (Pb), selenium (Se), zinc (Zn)] and total mercury (Hg).

Sample sizes for each site were: Finger's Hole (n=10), Mud Hole (n=10) and East of Cape Cod (n=12).

MATERIALS AND METHODS

Trace metal analysis

Approximately 2 g of homogenized muscle, liver, and gonads were analyzed for trace metals (As, Cd, Pb, Se, Zn) using microwave digestion techniques and inductively coupled plasma mass spectrometry.

Mercury analysis

Total mercury was determined by thermal combustion amalgamation atomic absorption using a direct Hg analyzer (Milestone DMA-80).



RESULTS AND DISCUSSION

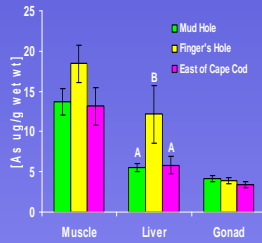


Fig. 2. Mean arsenic concentrations (± S.E.). Arsenic concentrations were significantly higher in livers collected from Finger's Hole than Mud Hole and East of Cape Cod sites ($P < 0.05$). Identical letters represent statistical non-significance among sites for each tissue type.

- Arsenic and total mercury concentrations did not exceed the ranges (76 μg/g and 1.0 μg/g respectively) known to produce deleterious effects in humans (FDA, 2001).

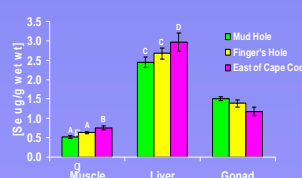


Fig. 4. Mean selenium concentrations (± S.E.). Selenium was highest in the muscle and liver samples collected East of Cape Cod compared to the other two sites. Identical letters represent statistical non-significance among sites for each tissue type.

- Hepatic and gonadal selenium concentrations exceeded the maximum permitted concentration of 1.0 μg/g.
- Elevated levels of selenium may result in reproductive failure in fish and reduce the survival of embryos and larvae (Coyle *et al.*, 1993).

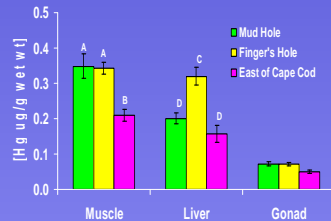


Fig. 3. Mean total mercury concentrations (± S.E.) for monkfish. Total mercury concentrations were significantly higher in muscle samples collected from Mud Hole and Finger's Hole than Cape Cod. Hepatic total mercury levels were significantly different and higher for Finger's Hole compared to the other two sites. Identical letters represent statistical non-significance among sites for each tissue type.

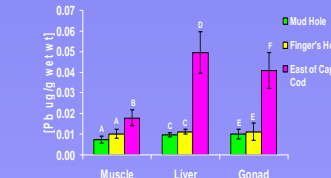


Fig. 5. Mean concentrations of lead (± S.E.). The highest concentrations of lead were found in all tissue samples collected East of Cape Cod. Identical letters represent statistical non-significance among sites for each tissue type.

- Lead concentrations were within the permissible limit (1.5 μg/g; FDA, 2001).
- High lead concentrations in the muscle, liver and gonads of monkfish from East of Cape Cod may be attributed to the dumping of toxic chemicals in that area.

RESULTS & DISCUSSION

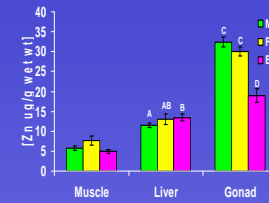


Fig. 6. Mean concentrations of zinc (± S.E.). Accumulation of zinc was highest in the gonads of fish from all three sites. Zinc levels in the gonads were significantly higher for fish collected from Finger's Hole and Mud Hole sites than those collected East of Cape Cod. Identical letters represent statistical non-significance among sites for each tissue type.

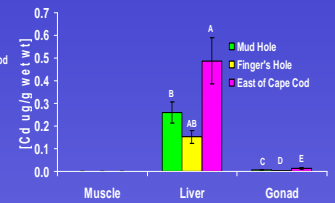


Fig. 7. Mean concentrations of cadmium (± S.E.). Cadmium concentrations were highest in the liver than in the muscle and gonads and highest in liver samples collected from East of Cape Cod. Gonadal cadmium concentrations were significantly different among the sites. Identical letters represent statistical non-significance among sites for each tissue type.

- East of Cape Cod site had the highest hepatic cadmium concentration compared to the other two sites.
- Both mean zinc and cadmium concentrations were below the permitted levels (50 μg/g for zinc and 3.0 μg/g respectively; FDA, 2001).
- Zinc accumulation in the gonads may reflect the essential role of the element as cofactor involved in biochemical processes during reproduction and metallothionein induction. Metal ions including cadmium may alter the immune function of fish and stimulate ovarian growth and estrogen synthesis (Zelikoff *et al.*, 1995).

CONCLUSION

- Site and tissue specific differences were found in As, Hg, Se, Pb, Zn and Cd levels.
- Bioaccumulation of selenium in monkfish liver and gonads.
- Elevated lead and cadmium levels in monkfish caught off Cape Cod, MA suggest that this site may be more contaminated than the other two sites.

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