

THE INTERACTION OF DIET, WATER CHEMISTRY, AND DISEASE STATE ON THE HEALTH OF CAPTIVE ORNAMENTAL FISH

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Abstract

Nutrition is an important modulator of immune function and can often tip the balance between health and disease.² In order to maintain fish in aquaria, sound nutrition and adequate feeding are essential to fish health as clinical disease often ensues when nutritional needs are not met. Diets that are adequate with respect to essential nutrients can hasten recovery from infection, slow the progress of an idiopathic disease, or help individuals overcome environmental stress.¹ Understanding the proper nutrient needs for aquaria fish is complicated by the fact that fish can accumulate trace minerals both directly from their aqueous environment and from the diet they ingest. Minerals accumulated through these two routes can have different physiological effects and fates. Many trace elements interact with each other or with particles in the water column, compounding the problem of understanding their bioavailability to fish. Despite decades of research on fish nutrition little information exists on the dietary and nutrient requirements of many captive ornamental fish species,⁴ as the goal in aquaria is longevity versus accelerated growth in aquaculture. The goal of this study was to evaluate the interaction of diet, water chemistry and disease state in captive ornamental fishes in order to improve overall fish health.

Necropsy and collection of tissues for histopathology are routinely performed on fish that have died from Disney's collection. For this project, livers in good condition (no autolysis) were dissected and kept frozen until they were sent to Michigan State University's (MSU) Diagnostic Center for Population and Animal Health (DCPAH) for analysis of selected vitamins (A and E) and minerals (iron, copper, zinc, cobalt, molybdenum, selenium, manganese). Because reference values for vitamin and mineral composition are not available for many of these captive fish species, we have partnered with Florida Fish and Wildlife Conservation Commission to provide us with livers from wild-caught fish of interest for comparison to species held in Disney's collection. Livers from these free-ranging species were collected by state biologists and held frozen until similarly sampled for vitamin and mineral analysis by MSU. Water samples were taken biannually from the main tank exhibit at Disney and analyzed for minerals (boron, bromide, calcium, cadmium, cerium, chlorine, copper, fluorine, iron, iodine, lanthanum, lead, lithium, magnesium, manganese, mercury, nickel, phosphorus, potassium, molybdenum, sodium, selenium, strontium, zinc, sulfate, bromate) by ENC Laboratories. Diet composition was

determined by analysis of individual diet items (MSU DCPAH and Dairy One Laboratories) and Zootrition software.

Preliminary results from this on-going project suggest a high degree of variability in vitamin and mineral levels within and between captive fish species, likely as a result of age and/or disease state. Comparisons between captive and free-ranging species suggest that significantly ($P < 0.05$) higher levels of copper (Cu), zinc (Zn), cobalt (Co), selenium (Se) and molybdenum (Mo) were present in the liver tissue of captive fish. Similarly, high levels of Zn, Co, Se and Mo were detected in the exhibit seawater as compared with levels in natural seawater. While there is little information on the nutritional needs of ornamental fish, the composition of the diet shows trace mineral levels within the range of those reported by the NRC³ and Watanabe et al.⁵ for aquaculture species (Table 1). It is unclear at this point what effects these high trace mineral levels are having on captive fish and whether excess mineral uptake/storage is occurring via the diet or water column. Sample sizes at this point in the project remain small. As the project continues we hope to be able to better understand the role of diet and water chemistry on the availability of minerals in order to provide optimal care to captive fish.

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Table 1. Vitamin and trace mineral composition of the diet fed to ornamental fishes in the main tank at Disney’s The Seas with Nemo and Friends (EPCOT). Values are compared with vitamin and nutrient diet recommendations for various aquaculture species.

	Units	Main Tank Diet	Aquaculture Requirements ^a
Vitamin A	IU/g	7	1-20
Vitamin E	mg/kg	64	25-120
Iron	mg/kg	387	30-150
Zinc	mg/kg	147	20-30
Copper	mg/kg	11	3-5
Selenium	mg/kg	1.1	0.3
Cobalt	mg/kg	1.24	1.05-1.00
Molybdenum	mg/kg	1.55	--
Manganese	mg/kg	63	13

^aSources: NRC³ and Watanabe et al.⁵