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Occurrence of Thiaminase in Some Common Aquatic Animals of the United States and Canada

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By

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Occurrence of Thiaminase in Some Common Aquatic Animals of the United States and Canada

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ABSTRACT

Two tables are presented that survey the presence or absence of thiaminase in freshwater and marine fish and shellfish.

INTRODUCTION

The presence of thiaminase in fish that are routinely used raw in rations for animals can cause a dietary deficiency. The disease in mink is commonly called *Chastek paralysis* (Green, Evans, and Carlson, 1937). Knowledge about the presence or absence of thiaminase in aquatic animals is therefore important to mink ranchers and other animal feeders, scientific researchers, commercial fish vendors, and others.

Thiaminase is an enzyme that destroys thiamine (vitamin B_1) and, like many enzymes, its activity is greatly reduced or destroyed upon heating to moderate temperatures (50°-100° C). Thus, mink ranchers, for example, can cook the fish before feeding it to the animals to avoid a Chastek paralysis problem (Lee, 1948; Gnaedinger and Krzeczkowski, 1966). However, mink ranchers generally prefer to avoid cooking the fish because mink show a preference for raw fish and cooking adds to the operational costs. Knowledge whether fish do or do not contain thiaminase is therefore vitally important to animal feeders, particularly mink ranchers, for safety and economic reasons.

Also, scientific researchers at times need to consider whether or not an aquatic animal involved in their research contains thiaminase. For example, in biological research where fishes are held in aquaria for feeding studies or other research, the presence of thiaminase in the animals being fed to the fish could possibly cause a vitamin deficiency or other problems that could impede the research (Wolf, 1942).

Many species of aquatic organisms have been assayed for thiaminase activity in various laboratories throughout the world. Most of these assays, however, were made in conjunction with specific research programs that were designed to study a particular species native to the area of the research laboratory. As a result, the data on the occurrence of thiaminase in aquatic specimens is scattered throughout various research papers published over the years.

Deutsch and Hasler (1943) and Neilands (1947) determined the thiaminase activity of a great number of freshwater and aquatic animals. A number of important fishes and shellfish, however, were not examined by these researchers but were investigated by several other researchers. The purpose of this report, therefore, is to combine the listings of thiaminase activity in aquatic animals that have appeared in the literature and also some recent unpublished work at this laboratory into a comprehensive list of aquatic animals that have been assayed for thiaminase activity.

Explanation of the Tables

The list is presented in two tables: Table 1 presents the information for freshwater animals, and Table 2 presents the information for marine animals. The animals are listed alphabetically by common name. The scientific name is also shown for each animal; the names were taken from the publication(s) cited. The scientific names relating to the unpublished data of this laboratory are from the list published by the American Fisheries Society (1960).

The part of the animal that was analyzed for thiaminase is also shown in the tables. Whether the whole animal or, for example, just the viscera was analyzed is important; this point will be further discussed later. Where the source of the animal was given in the original reference, this information is also given in the tables.

DISCUSSION

In most cases, the whole animal was analyzed for the data presented in Tables 1 and 2. However, for some of the animals, only the viscera or flesh was analyzed. Thiaminase apparently concentrates in the viscera more than in any other part of the animal (Lee, 1948). Some researchers have found thiaminase to be present in the viscera of some aquatic animals but not in the flesh of that same animal. For example, Neilands (1947) found that viscera of lobster contained thiaminase, but the muscle did not. In over 30 marine and freshwater animals studied by Neilands, however, the lobster proved the only example of such a relationship. In other experiments by Neilands (1947) and by Stout, Oldfield, and Adair (1963), the observation was made that fish (yellow perch, white perch, and hake in these experiments) generally considered to be thiaminase-free could be found to contain thiaminase activity if the fish was captured at a time when the animal it fed on was not completely digested and this animal itself contained thiaminase.

These findings are significant for several reasons: (1) It is possible that some of the animals listed in Tables 1 and 2 were found to contain thiaminase because they were caught at a time when their stomachs contained undigested, thiaminase-containing feed. Also, the opposite could be true; that is, those species listed as not containing thiaminase could at times be found to contain thiaminase activity if captured with the undigested thiaminase-containing food in their stomachs. (2) The findings could help to explain apparent discrepancies that sometimes occur in regard to the reported thiaminase activity of a certain species. For example, burbot is listed in Table 1 as containing thiaminase when the animal came from the Great Lakes; whereas, burbot did not contain thiaminase when captured from Rainy Lake, Minn. It is possible that the burbot feeds on thiaminase-containing animals in the Great Lakes; whereas, the animals available for food in Rainy Lake are thiaminase-free. Another possibility is that the burbot from the Great Lakes was captured with undigested (thiaminase-containing) food in its viscera, and the burbot from Rainy Lake was captured with completely digested food in its viscera.

Additional precautions that have to be considered in using the data presented in the tables are: The data do not indicate which animals have the greatest concentration of thiaminase and which have lesser concentrations of the enzyme. In many respects this factor may not be too important, at least with present lack of knowledge about threshold concentrations in regard to the ability of thiaminase to impair physiological activity of thiamine. In other words, even a small amount of thiaminase in the animal could cause concern depending on the intended use of the animal. Thus, a mink rancher is not likely to feed raw, thiaminase-containing fish to mink even though it was shown that the fish contained a relatively low level of thiaminase activity. In this case, the mink rancher would cook the fish to be on the safe side. According to the results of research by Gnaedinger and Krzeczkowski (1966), it appears that fish with various concentrations of thiaminase activity all have to be heated to about the same temperature time relationship to give complete destruction of thiaminase activity. Therefore, a mink rancher probably should not give fish with "low" levels of thiaminase a milder heat treatment than fish with "high" levels of thiaminase.

Different analytic methods were used by the various researchers to obtain the data presented in the tables. That is, the presence or absence of thiaminase was observed through various chemical methodologies or biological feeding studies; it is possible that one method of detection could show the presence of thiaminase, whereas another method would show that the thiaminase was absent in the animal. Generally, the chemical methods for thiaminase activity are believed capable of detecting lower levels of thiaminase than the biological methods.

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Table 1.—Thiaminase presence in freshwater animals.

Common name	Part of fish analyzed	Scientific name	Source	Thiaminase presence or absence[1]	Reference
Alewife	Whole	*Pomolobus pseudoharengus*	Lake Michigan	+	4, 5, 11
Bass, largemouth	Whole	*Huro salmoides*	Great Lakes	—	3
Bass, smallmouth	Whole	*Micropterus d. dolomieu*	Great Lakes	—	3
Bluegill	Whole	*Lepomis m. macrochirus*	Great Lakes	—	3
Bowfin (dogfish)	Whole	*Amia calva*	Arkansas	+	5
Bowfin	Whole	*Amia calva*	Great Lakes	—	3
Buffalofish	Viscera	*Ictiobus cyprinellus*	Arkansas	+	[2]
Bullhead	Whole	*Ameirurus m. melas*	Great Lakes	+	3
Bullhead (mixture of black, brown, yellow)	Whole	*Ictalurus* ssp.	Arkansas	+	[2]
Burbot	Viscera	*Lota lota maculosa*	Great Lakes	+	3
Burbot	Whole	*Lota lota*	Lake Erie	+	[2]
Burbot	Whole	*Lota lota*	Rainy Lake	—	[2]
Carp	Whole	*Cyprinus carpio*	Great Lakes	+	[2]
Carp	Viscera	*Cyprinus carpio*	Great Lakes	+	3
Catfish (channel)	Whole	*Ictalurus punctatus*	Great Lakes	+	3
Chub (bloater)	Whole	*Coregonus hoyi*	Lake Michigan	—	3, 4
Clams (chowder, steamer, cherrystone	Not stated	Not stated	Not stated	+	10
Crappie	Whole	*Pomoxis nigromaculatus*	Great Lakes	—	3
Eel	Muscle	*Anguilla rostrata*	Not stated	—	11
Eel	Viscera	*Anguilla rostrata*	Not stated	—	11
Fathead minnow	Whole	*Pimephales p. promelas*	Great Lakes	+	3
Gar (n. longnose)	Whole	*Lepisosteus osseus oxyurus*	Unknown	—	3
Goldfish	Whole	*Carassius auratus*	Great Lakes	+	3, [2]
Lake herring	Whole	*Leucichthys artedi arcturus*	Lake Superior	—	3
Lamprey (adult)	Whole	*Petromyzon marinus*	Great Lakes	+	[2]
Mud minnow	Whole	*Umbra limi*	Great Lakes	+	3
Mussel (pigtoe)	Muscle	*Pleurobema cordatum*	Tennessee River	+	[2]
Pike (northern)	Whole	*Esox lucius*	Great Lakes	—	3
Pike (walleye)	Viscera	*Stizostedion v. vitreum*	Great Lakes	—	3
Pumpkinseed	Whole	*Lepomis gibbosus*	Great Lakes	—	3
Rock bass	Whole	*Ambloplites r. rupestris*	Great Lakes	—	3
Salmon	Muscle	*Salmo salar*	Not stated	—	11
Salmon	Viscera	*Salmo salar*	Not stated	—	11
Salmon (coho)	Whole	*Oncorhynchus kisutch*	Lake Michigan	—	[2]
Sauger	Viscera	*Stizostedion c. canadense*	Great Lakes	+	3
Sculpin	Whole	*Myoxocephalus quadricornis*	Lake Michigan	+	[2]
Shad (gizzard)	Whole	*Dorosoma cepedianum*	Lake Erie	+	5
Sheepshead (freshwater drum)	Whole	*Aplodinotus grunniens*	Lake Erie	—	[2]
Sheepshead (freshwater drum)	Viscera	*Aplodinotus grunniens*	Lake Erie	—	[2]
Shiner (spottail)	Whole	*Notropis hudsonius*	Lake Michigan	+	5
Smelt (American)	Whole	*Osmerus mordax*	Great Lakes	+	3, 4, 5, 11
Smelt (pond)	Not stated	*Hypomesus olidus*	Not stated	—	2
Stoneroller (central)	Whole	*Campostoma anomalum*	Lake Michigan	+	[2]
Sucker (common white)	Whole	*Catostomus commersoni*	Great Lakes	+	3, 11, [2]
Trout, brown	Whole	*Salmo trutta fario*	Great Lakes	—	3
Trout, lake	Viscera	*Cristivomer n. namaycush*	Great Lakes	—	3
Trout, rainbow	Whole	*Salmo gairdnerii irideus*	Great Lakes	—	3
White bass	Viscera	*Lepibema chrysops*	Great Lakes	+	3
Whitefish, Menomonee	Viscera	*Prosopium cylindraceum*	Great Lakes	+	3

Table 1.—Thiaminase presence in freshwater animals—Continued.

Common name	Part of fish analyzed	Scientific name	Source	Thiaminase presence or absence[1]	Reference
Whitefish	Dressed	*Coregonus clupeaformis*	Great Lakes	+	3
White perch	Muscle	*Morone americana*	Not stated	—	11
White perch	Viscera	*Morone americana*	Not stated	—	11
Yellow perch	Whole	*Perca flavescens*	Great Lakes	—	3, 11

[1] + indicates that thiaminase was found to be present; — indicates that it was not found to be present.

[2] Unpublished data. Analyses made at National Marine Fisheries Service, Ann Arbor Technological Laboratory, Ann Arbor, Mich. (Analyses performed by the chemical method of: Gnaedinger, 1965.)

Table 2.—Thiaminase presence in marine animals.

Common name	Part of fish analyzed	Scientific name	Source	Thiaminase presence or absence[1]	Reference
Anchovies	Whole	*Anchoa hepsetus*	Gulf of Mexico	+	7
Anchovies	Whole	*Engraulis mordax*	Not stated	+	12
Black backs	Whole	*Pseudopleuronectes americanus*	Atlantic Ocean	—	3, 11
Butterfish	Whole	*Poronotus triacanthus*	Gulf of Mexico	+	9
Cusk	Muscle	*Brosme brosme*	Atlantic Ocean	—	11
Cusk	Viscera	*Brosme brosme*	Atlantic Ocean	—	11
Clams	--	*Mya arenaria*	Atlantic Ocean	+	11, (²)
Cod	Fillets	*Gadus morhua*	Atlantic Ocean	—	3, 11
Cod	Viscera	*Gadus morhua*	Atlantic Ocean	—	11
Croaker	Whole	*Micropogon undulatus*	Gulf of Mexico	—	9, (²)
Cunner	Viscera	*Tautogolabrus adspersus*	Long Island Sound	—	8
Cutlassfish (silver eels)	Whole	*Trichiurus lepturus*	Gulf of Mexico	—	9, (²)
Dogfish	Muscle	*Squalus acanthias*	Atlantic Ocean	—	11
Dogfish	Viscera	*Squalus acanthias*	Atlantic Ocean	—	11
Eelpout	Muscle	*Zoarces anguillaris*	Atlantic Ocean	—	11
Eelpout	Viscera	*Zoarces anguillaris*	Atlantic Ocean	—	11
Goosefish	Muscle	*Lophius piscatorius*	Atlantic Ocean	—	11
Goosefish	Viscera	*Lophius piscatorius*	Atlantic Ocean	—	11
Haddock	Dressed	*Melanogrammus aeglefinus*	Atlantic Ocean	—	3, 11
Haddock	Viscera	*Melanogrammus aeglefinus*	Atlantic Ocean	—	11
Hake	Whole	*Urophycis* spp.	Gulf of Mexico	—	9
Halibut	Muscle	*Hippoglossus hippoglossus*	Atlantic Ocean	—	11
Halibut	Viscera	*Hippoglossus hippoglossus*	Atlantic Ocean	—	11
Herring	Whole	*Clupea harengus*	Atlantic Ocean	+	3, 11
King whiting (ground mullet)	Whole	*Menticirrhus americanus*	Gulf of Mexico	—	(²)
Lemon sole	Whole	*Pseudopleuronectes americanus dignabilis*	Not stated	—	3
Lizardfish	Whole	*Synodus foetens*	Gulf of Mexico	—	9
Lobster	Muscle	*Homarus americanus*	Atlantic Ocean	—	11
Lobster	Viscera	*Homarus americanus*	Atlantic Ocean	+	11
Lumpfish	Muscle	*Cyclopterus lumpus*	Atlantic Ocean	—	11
Lumpfish	Viscera	*Cyclopterus lumpus*	Atlantic Ocean	—	11
Mackerel	Whole	*Scomber scombrus*	Atlantic Ocean	—	3, 11
Mackerel	Whole	*Scomber japonicus*	Pacific Ocean	+	2
Menhaden	Whole	*Brevoortia tyrannus*	Chesapeake Bay	+	(²)
Menhaden (large scale)	Whole	*Brevoortia patronus*	Gulf of Mexico	+	7
Moray eel	Whole	*Gymnothorax ocellatus*	Gulf of Mexico	+	9
Mullet	Whole	*Mugil* sp.	Gulf of Mexico	—	(²)
Mussel	--	*Mytilus edulis*	Pacific Ocean	+	8, 11
Oyster	Muscle	*Ostrea edulis*	Atlantic Ocean	—	11
Periwinkle	Muscle	*Littorina litorea*	Atlantic Ocean	—	11
Plaice, Canadian	Muscle	*Hippoglossoides platessoides*	Atlantic Ocean	—	11
Plaice, Canadian	Viscera	*Hippoglossoides platessoides*	Atlantic Ocean	—	11
Pollock	Muscle	*Pollachius virens*	Atlantic Ocean	—	11
Pollock	Viscera	*Pollachius virens*	Atlantic Ocean	—	11
Porgy (scup)	Whole	*Stenotomus aculeatus*	Gulf of Mexico	—	9
Porgy (scup)	Whole	*Stenotomus chrysops*	Chesapeake Bay	—	(²)
Quahog, black or ocean	--	*Artica islandica*	Atlantic Ocean	+	8
Razor belly (scaled sardine)	Whole	*Harengula pensacolae*	Gulf of Mexico	+	9
Red fish	Whole	*Sebastes marinus*	Not stated	—	3
Seabass	Whole	*Centropristis striatas*	Chesapeake Bay	—	(²)
Sea catfish	Whole	*Galeichthys felis*	Gulf of Mexico	—	9
Sea raven	Muscle	*Hemitripterus americanus*	Atlantic Ocean	—	11
Sea raven	Muscle	*Hemitripterus americanus*	Atlantic Ocean	—	11
Sea robin	Viscera	*Prionotus* ssp.	Gulf of Mexico	—	9, (²)
Scallop	Muscle	*Placopecten grandis*	Atlantic Ocean	+	11

Table 2.—Thiaminase presence in marine animals—Continued.

Common name	Part of fish analyzed	Scientific name	Source	Thiaminase presence or absence[1]	Reference
Sculpin	Muscle	*Myoxocephalus octodecemspinosus*	Atlantic Ocean	—	11
Shrimp (brine)	Whole	*Artemia salina*	Lab grown	—	([2])
Skate	Muscle	*Raja senta*	Atlantic Ocean	—	11
Skate	Viscera	*Raja senta*	Atlantic Ocean	—	11
Spot	Whole	*Leiostomus xanthurus*	Gulf of Mexico	—	9, ([2])
Squid	Whole	*Loligo brevis*	Gulf of Mexico	—	9
Starfish	Whole	*Asterias vulgaris*	Atlantic Ocean	—	11
Tautog (blackfish)	Viscera	*Tautoga onitis*	Long Island Sound	—	8
White trout	Whole	*Cynoscion arenarius*	Gulf of Mexico	—	9
Whiting	Whole	*Merluccius bilinearis*	Atlantic Ocean	—	3
Witch flounder	Muscle	*Glyptocephalus cynoglossus*	Atlantic Ocean	—	11
Witch flounder	Viscera	*Glyptocephalus cynoglossus*	Atlantic Ocean	—	11
Yellow tails	Whole	*Limanda ferruginea*	Atlantic Ocean	—	3, 11

[1] + indicates that thiaminase was found to be present; — indicates that it was not found to be present.
[2] Unpublished data. Analyses made at National Marine Fisheries Service, Ann Arbor Technological Laboratory, Ann Arbor, Mich. (Analyses performed by the chemical method of: Gnaedinger, 1965.)

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