Nitrite Poisoning or "Brown Blood" Disease- A Preventable Problem

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Introduction

Nitrite poisoning commonly called "brown blood" disease is an environmental condition that affects a number of fish species cultured for food today including channel catfish. Its cause is elevated levels of nitrite in the pond or culture system water. The presence of nitrite at abnormally high levels, over the years, has resulted in loss of millions of pounds of catfish and a sub-lethal stress of millions more.

Nitrite, a product of the breakdown of ammonia by bacteria, is a compound that can enter the circulatory system of fish through the gills. Its presence at elevated levels can cause the fish blood to take on a dark brownish color, thus the name "brown blood." Chemically, nitrite can oxidize hemoglobin in the fish red blood cells and convert it into another compound called methemoglobin. Methemoglobin does not transport oxygen as is the function of normal hemoglobin and, as a result, affected fish show signs of low oxygen stress even in the presence of saturated levels of dissolved oxygen. The fish are actually suffocating because their blood cannot take up oxygen as is the case normally. Even if the fish do not die from the immediate stress, they are affected just like fish which are stressed from classical low dissolved oxygen levels.

The intensity of the condition can be evaluated by the color of the fish blood. Slightly affected fish have reddish-brown blood, whereas more acutely affected fish have chocolate brown colored blood. The percentage of hemoglobin in the fish blood that has been converted to methemoglobin combined with the dissolved oxygen concentration present in the water will decide the number of fish that will survive or suffocate and die. For example, fish which moderately affected with nitrite poisoning in a pond with a dissolved oxygen level of 7 ppm should survive but, if the same fish is placed in a pond with a dissolved oxygen level of 2.0 ppm likely will not.

Sources of Nitrite in Ponds

Nitrite is an intermediate fish waste compound that is formed when ammonia is broken down through bacterial activity. Particular groups of bacteria use ammonia as their food source. The ammonia decomposing bacteria then produce a waste product called nitrite. Still other groups of bacteria use nitrite as a food resource and produce nitrate as waste. Nitrate is a compound that is not toxic to fish at concentrations typically found in ponds. Another alternate route of ammonia decomposition and uptake in commercial catfish ponds is through direct utilization by phytoplankton (microscopic plants).

While most trouble from elevated nitrite presence arises during the cooler months, it can occur any time of year. More commonly, when abnormally large amounts of ammonia build up during cooler water temperatures caused by reduced phytoplankton and bacterial activity, similar but rapid build up of nitrite will sometimes follow. To add to the dilemma, the bacteria that consume ammonia produce nitrite work faster than the bacteria that convert nitrite to non-toxic nitrate in cool water. The outcome of this situation is that significantly elevated nitrite levels can build-up and possibly result nitrite poisoning. It is important to be aware that lethal concentrations of nitrite can develop in cool water that has elevated levels of ammonia within 24 hours.

Prevention and Treatment

Nitrite toxicity is easily preventable does not have to be a significant problem in catfish pond production. The solution is using salt (NaCl) as an amendment to water. More explicitly, the chloride (Cl), which is found in common salt, is the fraction of salt that is responsible for the prevention and can affect treatment of nitrite poisoning in fish. The chloride competes with nitrite at the fish gill surface for absorption. If a concentration ratio of 9 to 1 of chloride to nitrite is maintained in water, many more chloride ions are absorbed than are the nitrite molecules therefore; nitrite poisoning or “brown blood” disease does not develop. Farmers who routinely maintain a minimum of 60-150 ppm of chloride in water at all times seldom experience losses from nitrite build-up and effectively prevent nitrite poisoning. Prevention is far more economically desirable than trying to treat fish already stressed and dying. Although salt and freight prices have risen significantly in recent months, it’s still the best management practice to use salt preventatively. It is a prudent business practice to retain as much salt as possible by retaining as much water as practical. Setting standpipe elevation to capture rainfall and reduce dilution by excessive rainfall should be a conscious goal. As a management task, pond water should be monitored for chloride levels several times each year. Often, ponds will receive more rain or well water during the course of the year than is realized and chloride levels will become reduced. It is typically an effective strategy to be sure to enter the fall season with a minimum of 60-100 ppm chlorides. Most effective managers monitor chloride levels at least 2-3 times per month through the winter and spring to maintain a minimum of 60 ppm chlorides. The economic consequences of not practicing a nitrite management strategy can be severe. Both the direct loss of fish from nitrite poisoning as well as indirect losses brought about by stress induced losses from bacterial and parasitic disease more than justify the cost of salt. If salt costs $100 per ton, it takes only 133 pounds of fish sold at 75 cents per pound to cover its cost. Some areas of Alabama have the good fortune of having access to salty well water. Although this water doesn’t have the same chemical make-up as seawater, it is still of great value to most freshwater fish species. Most traditional agricultural water users do not find the saline water valuable but it can be of great value to those growing fish or crustaceans. Farms having access to this type of saline water seldom see problems with nitrite induced mortality.

Calculations

Salt (NaCl) is currently the cheapest source of chloride for most producers. Addition of 4.5 lbs of salt per 1 acre-foot of water increases the chloride level 1 ppm. Some practical examples are presented below to illustrate how a farmer can manage to effectively eliminate nitrite induced losses of stock.

FIRST: Measure the chloride level in the existing pond or water source. This is typically done using an inexpensive and simple water quality kit or test strip.

SECOND: Calculate how much salt by weight is necessary to bring the chloride level to 60 ppm or higher. For example:

Problem 1

– The pond has 60 ppm chlorides
– Need 100 ppm chlorides
– Must increase 40 ppm chlorides
– Pond is 12 acres with 4 feet average depth

* 4.5 lbs. of salt X 40 ppm chlorides needed = 180.0 lbs. of salt/acre-foot
*180.0 lbs. of salt/acre-foot X 48 acre feet = 8640 lbs.
* 8640 lbs. ÷ 2000 lbs. = 4.32tons => Add 4.5 Tons of Salt

OR

Problem 2

– Nitrite 8 ppm
– Chloride 60 ppm
– Pond 15 acres with 4.0 foot average depth

* 8 ppm nitrite X 9 = 72 ppm chloride required for protection
* 72 ppm chloride needed - 60 ppm chloride present = 12 ppm chloride to add
* 12 ppm chloride X 4.5 lbs. salt/acre-foot = 54 lbs. salt/acre-foot
* 54 lbs. salt/acre-foot X 60 acre-feet in pond = 3240 lbs.
* 3240 lbs ÷ 2000 lbs = 1.62 tons => Add 2 Tons of Salt

****<u>Refer to Chloride/Nitrite table below for additional information on salt requirements for protection against Nitrite Poisoning.</u>**

Custom delivery trucks are available for large quantities of salt delivered in Alabama. These trucks can haul and dispense up to 18 tons per load. Prices will vary between $90 and $100 per ton delivered (2008 prices). Incorporate into ponds using paddlewheel aeration equipment. Broadcast evenly across pond if stressed fish are being treated for nitrite poisoning. Generally, 24 hours are required for full incorporation.

Remember

* Prevention is the key and is much less expensive than correcting an existing problem.
* Maintain a minimum of 60 ppm chlorides at all times in commercial catfish ponds.
* Always maintain at least a 9 to 1 chloride to nitrite ratio. Many use a 10:1 ratio.

Salt Addition Reference Table for Prevention of Nitrite Poisoning

To use this table: First, measure chloride and nitrite levels in the pond. Then, find the corresponding nitrite row and chloride column on the table. At the intersection of the row and column is the number of pounds of **salt needed per acre/foot to provide minimal protection.**

Nitrite Level	Chloride Level																					
	0	**5**	**10**	**15**	**20**	**25**	**30**	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**105**	**110**
1	41	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	81	59	36	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	122	99	77	54	32	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	162	140	117	95	72	50	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	203	180	158	135	112	90	68	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	243	221	198	176	153	131	108	63	41	18	0	0	0	0	0	0	0	0	0	0	0	0
7*	284	261	239	216	193	171	149	104	81	59	36	14	0	0	0	0	0	0	0	0	0	0
8	324	302	279	257	234	212	189	144	122	99	77	54	32	9	0	0	0	0	0	0	0	0
9	365	342	320	297	274	252	230	185	162	140	117	95	72	50	27	0	0	0	0	0	0	0
10	405	383	360	338	315	293	270	225	203	180	158	135	113	90	68	45	23	0	0	0	0	0
11	446	423	401	378	355	333	311	266	243	221	198	176	153	131	108	86	63	41	18	0	0	0
12	486	464	441	419	396	374	351	306	284	261	239	216	194	171	149	126	104	81	59	36	14	0
13	527	504	482	459	436	414	392	347	324	302	279	257	234	212	189	167	144	122	99	77	54	32
14	567	545	522	500	477	455	432	387	365	342	320	297	275	252	230	207	185	162	140	117	95	72
15	608	585	563	540	517	495	473	428	405	383	360	338	315	293	270	248	225	203	180	158	135	113
16	648	626	603	581	558	536	513	468	446	423	401	378	356	333	311	288	266	243	221	198	176	153
17	689	666	644	621	598	576	554	509	486	464	441	419	396	374	351	329	306	284	261	239	216	194
18	729	707	684	662	639	617	594	549	527	504	482	459	437	414	392	369	347	324	302	279	257	234
19	770	747	725	702	679	657	635	590	567	545	522	500	477	455	432	410	387	365	342	320	297	275
20	810	788	765	743	720	698	675	630	608	585	563	540	518	495	473	450	428	405	383	360	338	315

Additional Recommended Reading

Durburrow, R.M., D. M. Crosby and M.W. Brunson. 1997. Nitrite in Fish Ponds. SRAC Publication No. 462

Hargreaves, J. A. and C. S. Tucker. 2004. Managing Ammonia in fish Ponds. 2004. SRAC Publication No. 4603.

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FSA9000-2M-5-97RV.