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FA171

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Teach Aquaculture Curriculum: Chlorine--Friend or Foe?[1]

Carlos V. Martinez, Cortney L. Ohs, Brian E. Myers, Elisa J. Livengood, Craig S. Kasper, Amber L. Garr, R. Leroy Creswell, and Frank A. Chapman[2]

This is Activity 18 in a series of 24 in the Aquaculture Curriculum.

Abstract:

We are all familiar with the uses of chlorine—from making your "whites whiter," to disinfecting your sinks and countertops, to sanitizing your bathroom and keeping your swimming pool crystal clear—but what about our drinking water and the effects tap water can have on aquarium or aquaculture fish? The truth is that chlorine is a very effective sanitizing agent against algae, bacteria, fungi, and some viruses. And for fish and other aquatic life, even the slightest trace of chlorine can prove fatal. In the U.S., almost all public municipal water sources use chlorine to disinfectant their water, and many add ammonia as a secondary disinfectant. This mixture of chlorine and ammonia forms a compound known as chloramine, which is very toxic to fish and other aquatic organisms.

In this simple activity, students will be able to determine the amount of chlorine present—in parts per million (ppm)—in their tap water, as well as the amount of ammonia when chloramines are being used. Then they will use two methods to remove chlorine from water: (1) applying a dechlorinator (instantaneous), and (2) aerating for 24 hours to simply *de-gas* the chlorine. Methods will be tested in separate containers, and both methods will require the students to take a pre- and post-treatment chlorine concentration measurement. This will allow students to hypothesize, predict, and discuss the effectiveness of each treatment. They also will be able to discuss issues of disinfection, sanitation, human health, and fish and aquatic animal health. Mathematical skills will be utilized as well.

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2. Carlos V. Martinez, assistant in Extension, School of Forest Resources and Conservation, Program in Fisheries and Aquatic Sciences, Gainesville, Florida 32611; Cortney L. Ohs, assistant professor, School of Forest Resources and Conservation, Program in Fisheries and Aquatic Sciences, Indian River Research and Education Center, 2199 South Rock Road, Fort Pierce, Florida 34945; Brian E. Myers, associate professor, Department of Agricultural Education and Communication, Gainesville, Florida 32611; Elisa J. Livengood, graduate student, School of Forest Resources and Conservation, Gainesville, Florida 32611; Craig S. Kasper, aquaculture program manager, Hillsborough Community College, 10414 East Columbus Drive, Tampa, Florida, 33619; Amber L. Garr, research associate, Harbor Branch Oceanographic Institute at Florida Atlantic University Center for Aquaculture and Stock Enhancement, 5600 U.S. 1 North, Fort Pierce, Florida 34946; R. Leroy Creswell, marine Extension agent, St. Lucie County Cooperative Extension, Fort Pierce, Florida; and Frank A. Chapman, associate professor, School of Forest Resources and Conservation, Program in Fisheries and Aquatic Sciences, Gainesville, Florida 32611.

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Objectives:

Students will be able to:

1. Describe the effects of sanitizing agents on pathogens and aquatic life
2. Determine the types of disinfectants used in tap water
3. Measure concentrations of chlorine used in aquaculture
4. Describe some relationships between humans, aquaculture, and water

Grade Level:

5–12

Subject Area:

Water quality, chemistry, mathematics, health (human, fish/aquatic animal), disinfection, sanitation

Time:

First day: less than one hour

Second day: less than one hour

Student Performance Standards (Sunshine State Standards):

03.01 Employ scientific measurement skills (SC.912.E.7.8; SC.912.L.14.4; MA.912.S.3.1, 2; MA.912.S.4.2; MA.912.S.5.1, 2, 3, 4, 5)

03.02 Demonstrate safe and effective use of common laboratory equipment (LA.910.1.6.1, 2, 3, 4, 5; SC.912.L.14.6,SC.912.L.16.10; SC.912.L.17.12, 14, 15, 16; MA.912.A.2.1, 2)

03.06 Interpret, analyze, and report data (SC.912.L.16.1; SC.912.N.1.1, 2, 3, 4, 6, 7; SC.912.N.2.2, 5; SC.912.N.3.1; SC.912.N.4.1; MA.912.S.3.1, 2; MA.912.S.4.2; MA.912.S.5.1, 2, 3, 4, 5)

12.01 Recognize and observe safety practices necessary in carrying out aquaculture activities (LA.910.1.6.1, 2, 3, 4, 5).

13.01 Identify and describe the qualities water should possess for use in aquaculture (LA.910.1.6.1, 2, 3, 4, 5; SC.912.L.17.In.a).

13.02 Explain how changes in water affect aquatic life (LA.910.1.6.1, 2, 3, 4, 5; SC.912.L.17.2, 3, 7, 10).

Interest Approach:

Guide students through a discussion about what they know about chlorine. Discuss chlorine in water and the significance of its presence regarding people and animals. Discuss why chlorine is added to drinking water, and discuss examples of diseases, like cholera and typhoid fever, which can be spread through contaminated water. More information on cholera and typhoid fever can be found by searching the Internet.

Student Materials:

First Day

1. Access to municipal water (not well water)
2. One individual water sample each and one shared water sample
3. Sodium thiosulfate (enough to neutralize the chlorine in the volume of the container)
4. One stirring implement (e.g., plastic spoon)
5. Three chlorine–water quality test strips (Student Instructions 2 and 5)
6. Three ammonia–water quality test strips (optional)

Second Day

1. One chlorine–water quality test strip (Student Instructions 7)
2. One ammonia–water quality test strip (optional)

Teacher Materials--See Table 1

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Student Instructions:

1. Student will collect a tap-water sample (fresh, with little or no splashing) in each of two containers.

2. Student will use a chlorine–water quality test strip to test the amount of chlorine present in both containers (both water samples should be equal at this point).

3. Student will record the amount of chlorine present in parts per million (ppm) using the color chart supplied with the test kit.

4. Student will add the proper amount of sodium thiosulfate (S.T.: chlorine neutralizer) to container #1 and stir until dissolved (approximately 3–5 minutes).

5. Student will recheck the amount of chlorine in container #1, making sure that all S.T. has dissolved. The chlorine concentration should be 0.0 ppm. If not, recalculate step #4.

6. Student will add an air line with an airstone to container #2, allowing vigorous aeration to occur for 24 hours. This air line is connected to an aquarium air pump.

7. After 24 hours, the student will check the amount of chlorine in container #2. If not at 0.0 ppm, wait another 24 hrs, and remeasure.

Note: This activity can be performed by individual students, groups of students, by the teacher, or any combination. A suggestion is to allow individual students to complete steps 1 through 5 and have the teacher help with a single aeration example (steps 6 and 7). This will limit the need (cost) to one air pump, although a multiport gang valve could be used to allow one air pump to run multiple airstones.

Note: The above chlorine activity also can include an added ammonia–water quality test using similar test strips for ammonia and following the procedure outlined above. This will allow students to prove or disprove the presence of chloramines as their sanitizing agent.

Teacher Instructions:

Preparations:

1. Take a head count of all students participating in order to have the proper number of:

a. Individual containers (cups)

b. Chlorine test strips (50/kit)

c. Ammonia test strips (50/kit)

2. Prepare for the dechlorination by aeration test:

a. Large container (bucket or clear, plastic vase)

b. Aquarium air pump

c. Air line tubing (enough to reach from the bottom of the large container over to the air pump)

d. Air line gang valve if needed

e. Sodium thiosulfate (chlorine neutralizer)

3. The teacher should be prepared to familiarize the students about the different uses of chlorine in our everyday lives and then correlate them to the pros and cons of chlorine in aquaculture.

Activity:

Have students work individually or in groups. Make sure all the needed components are available for this activity. This also should include the sample water, as many classrooms do not have a tap-water source in them. Once all of the students have acquired their water samples, the teacher should help the students follow the student instructions. Even though the testing method is very simple (dipping a strip into the water), a color change will appear. The teacher should keep in mind that these changes can vary slightly, as well as each student's ability to read that color. If needed, the teacher should help the students compare the color of their strips with that of the supplied color chart. The teacher should make sure the aquarium air pump is in a location where it will not fall into the water and become a safety hazard.

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Table 1. Teacher Materials:

Material	*Store*	*Estimated Cost*
Tap water from a municipal source	NA	NA
Individual containers (plastic or paper cups)	Walmart; grocery store	$6 and up
Large container (used for 24-hour dechlorination, ~1 gallon or more; clear would allow observation of air lifting and circulating)	Walmart; grocery store	$10 and up
Aquarium air pump	Walmart; Aquatic Eco-Systems, Inc.; pet store	$10 and up
Air line (should reach from the air pump, into the container, and down to the bottom)	Walmart; Aquatic Eco-Systems, Inc.; pet store	$5 and up
Airstone (for each outlet of the air pump)	Walmart, Aquatic Eco-Systems, Inc.; pet store	$1 and up
Chlorine–water quality test strips 3/student—first day 1/test—second day	Aquatic Eco-Systems, Inc. (#H27450, 50 strips per kit)	$10 and up
Ammonia–water quality test strips 3/student—first day 1/test—second day	Aquatic Eco-Systems, Inc. (H#27553)	$16 and up
Sodium thiosulfate (4-pound jar treats ~65,000 gallons @ 1 ppm of chlorine)	Aquatic Eco-Systems, Inc. (#ST1A)	$18 and up
Zeolite—used to neutralize ammonia (1.5-pound jar treats ~500 gallons @ 1 ppm of ammonia)	Aquatic Eco-Systems, Inc. (#ZAR12)	$11 and up
AmQuel—neutralizes both chlorine and ammonia (16-ounce bottle treats ~2,400 gallons)	Aquatic Eco-Systems, Inc. (#AM16P)	$10 and up

Postwork/cleanup:

The cleanup for this activity is very simple. The teacher simply needs to either pour all of the water samples down the drain or use them to water some plants. The cups, along with the large container, can be dried, stacked, and stored until the next use. The aquarium pump, air line, airstone, and unused test strips can be stored for reuse.

Anticipated Results:

Sanitizing Agent: CHLORINE

1. ***First day***

a. All first-day samples should show some level of chlorine present.

b. All first-day samples should NOT show any levels of ammonia.

c. The water samples receiving chlorine neutralizer (sodium thiosulfate) should show NO measurable amount of chlorine present.

d. All the water samples should continue to show NO levels of ammonia present.

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2. *Second day*

a. After 24 hours, the water receiving vigorous aeration should show a greatly reduced amount of chlorine present, if not zero.

Sanitizing Agent: CHLORAMINE

1. First day

a. All first-day samples should show some level of chlorine.

b. All first-day samples should show some level of ammonia

c.The water samples receiving chlorine neutralizer (sodium thiosulfate) should show NO measurable amount of chlorine present.

d. All the water samples should continue to show measurable levels of ammonia.

2. *Second day*

a. All the samples should continue to show measurable levels of ammonia.

b. After 24 hours, the water receiving vigorous aeration should show a greatly reduced amount of chlorine present but will probably not be zero.

NOTE: The reason chlorine is combined with ammonia is to form the sanitizing agent known as chloramine. This mixture enables the chlorine to remain active and NOT de-gas as easily as chlorine alone.

NOTE: The above chlorine activity can also include an added ammonia–water quality test using similar test strips for ammonia that would allow the students to prove or disprove the presence of chloramines as their sanitizing agent.

NOTE: An ammonia neutralizer (zeolite) or an ammonia, chlorine and chloramine–combined neutralizer (AmQuel Plus) can be added to this activity in the same way that the chlorine neutralizer was added. This will allow the students to become familiar with BOTH types of sanitizing agents (chlorine and chloramine), their toxic effects on aquatic life, and methods that can be used to neutralize each agent.

NOTE: Water treated with AmQuel may interfere with the ammonia test.

Explanation of Concepts:

1. Measure the concentrations of various disinfectants added to municipal water
2. Understand the effects of sanitizing agents on unwanted pathogens (human health)
3. Understand the negative effects of sanitizing agents on aquatic life (pet fish, food fish, aquatic plants, etc.).
4. Understand how to neutralize chlorine contained in various water sources before using this water in an aquarium or for aquaculture