Water quality management

In fish culture, water quality is the degree of how conducive the water is for fish growth and the environmental conditions that affect it. It starts with selecting a site where the available water is of good quality. As the water directly affects fish health and, therefore, growth performance, maintaining water quality is absolutely essential. Fish farmers need to have sufficient knowledge of water quality parameters, the required ranges and the treatments to apply when the water becomes suboptimal for fish growth.

There are two types of water quality parameters: physical and chemical. Physical parameters are the properties of the water that can be sensed, such as color, temperature, odor and turbidity. Chemical parameters refer to the chemical elements of the water, such as dissolved oxygen (DO), pH and ammonia.

Water temperature

Water temperature is one of the most important physical parameters that influence fish survival and growth. If the tolerance and optimal range of the water temperature is exceeded, this affects the behavior, appetite, growth, activity, and reproduction of the fish. For Nile tilapia, specifically, the optimal water temperature for survival is between 27°C and 30°C.

Effects of temperature on tilapia cage culture

If the water temperature is too low, fish will eat less feed, leading to decreased growth. If the water temperature is too high, the level of dissolved oxygen (DO) in the water drops, leading to very high mortalities. High water temperature also leads to rapid decomposition of nutrients, causing ammonia and nitrate levels to rise which, in turn, increase the growth of algae in the cage.

How to measure water temperature

- Use a simple water thermometer to measure the temperature of the water in a cage.
- Measure the water at different points to get an accurate result.
- To measure the temperature directly, attach the thermometer to a weighted rope and insert the thermometer into the cage.
- Lower the device into the cage and leave it suspended there for few seconds to take the reading correctly.
- If possible, measure the temperature from at least four points within the cage to get an accurate reading.

Plate 1. Measuring the water temperature.

Dissolved oxygen (DO)

DO is the amount of atmospheric oxygen saturated in the water. Water gets oxygen from the atmosphere and through photosynthesis by aquatic plants that live in and around the water.

Just like other terrestrial animals, fish need oxygen to survive, so DO is an essential water parameter to culture fish successfully. To maintain adequate levels, the DO concentration should be higher than 5 mg/L and no lower than 2 mg/L in the early morning. If DO levels drop too low, the fish will begin to move erratically, gasp for air at the surface of the water and eat less feed. Mortalities will be high.

How to measure DO

- To determine the DO level in a water sample, use a DO meter, which is a handy instrument and easy to use on a fish farm.
- Measure the DO early, at around 04:00, as DO levels tend to be low in the morning. Measure again three more times, around 10:00, 14:00 and 18:00, to get an idea of how much the DO is fluctuating during the day in the water. Measure again, at the same times, on random days.
- Measure the DO on cloudy and rainy days, as the levels in water tend to be lower.
- Connect the probe to the meter and clean it thoroughly with an electrolyte solution.
- After connecting the probe to the meter, calibrate the meter using a standard solution.
- Perform a 0% calibration and a 100% water saturation by mixing the two reagents that come in the box.
- Insert the probe into the solution and wait until the meter reads zero.
- Remove the probe and rinse it well with ionized or distilled water.
- Insert the tip of the probe into the water to take the reading.
- The DO level will be shown on the meter.

Range	Interpretation	Remarks
1–1.99 mg/L	Extremely low	Toxic to fish
2–4.99 mg/L	Moderately suitable	Low survival rate
5–7.99 mg/L	Suitable	Moderate survival rate
8–9 mg/L	Suitable	High survival rate
above 9 mg/L	Extremely high	Bubbles appear on surface

Table 1. Characteristics of dissolved oxygen.

Plate 2. Measuring the DO level.

Water pH

The pH is the level of acidity or alkalinity in the water. Generally, the pH scale ranges from 0 to 14, with 7 indicating that the water is neutral. A pH lower than 7 is acidic while a pH higher than 7 is alkaline.

Extremely high or low pH can lead to high mortalities among tilapia, so it is important maintain the acidity and alkalinity of the pond at favorable levels. For tilapia, a pH of 6.5–8.5 is ideal for growth and survival. High pH can damage the gills, eyes and skin of fish and make it difficult for them to dispose of metabolic wastes. High pH can also increase the toxicity of ammonia in the water.

How to measure water pH

- pH paper is a universal indicator for measuring pH. However, an electronic pH meter is a more accurate and faster method.
- Before the meter is used, calibrate the probe with a known pH solution, such as distilled or deionized water.
- Use a clean bowl to collect the water sample from the cage, as a dirty bowl can have impurities that will affect the pH reading.
- Insert the probe into the water sample to take the reading.
- If using pH paper, collect the water using a clean bowl and insert the pH paper into the water. Compare the change in color on the pH paper with the indicator.
- Measure the pH in the water twice a day, around 10:00 and 15:00. The pH level should stay within a suitable range of no more than 0.5 units, as greater fluctuations throughout the day are not ideal, especially for fry. For example, if the pH reading at 10:00 is 7.2 and at 15:00 is 8.3, the overall fluctuation within the day would be 1.1 units. Although both measurements are within range, the daily fluctuation would be too high and, thus, harmful for fry.

Range	Interpretation	Remarks
1–2	Extremely acidic	Toxic to fish
2–6	Moderately acidic	Low productivity
6–9	Suitable H+ ion	Desirable for fish
9–11	Moderately alkaline	Low productivity
11–14	Extremely alkaline	Toxic to fish

Table 2. Characteristics of water pH.

Plate 3. An electronic pH meter (top) and pH paper (bottom).

Turbidity and transparency

This refers to the level of clarity or cloudiness in the water. Turbid water is considered cloudy water. Suspended solid particles or too much plankton results in water turbidity, which prevents light from penetrating the water and so reduces the rate of photosynthesis. High turbidity is caused by mud, algae bloom, excess plankton and plant debris. For tilapia, cage culture requires a water transparency of 30–40 cm.

How to measure turbidity

- To measure water turbidity, use a calibrated Secchi disk. This instrument is a circular disk suspended with a calibrated rope that has alternating black and white quadrants used to measure the transparency or turbidity in water.
- Measuring water transparency requires being able to distinguish between transparency levels caused by (1) suspended solid particles or (2) plankton. This is important as the latter is an indication of the level of productivity of water, not turbidity.
- To measure turbidity, lower the Secchi disk into the water until it disappears. The depth of disappearance is called the Secchi depth. It is a measure of the transparency of the water.
- Turbidity can also be measured using specialized optical equipment in a laboratory or in the field.

Effects of water turbidity

High turbidity prevents light from penetrating the water, and sediments and dissolved particles can clog the gills of the fish, eventually causing death. Suspended particles in the water absorb heat from the sun, which increases the water temperature and decreases the photosynthetic activity of plants and algae. The result in both cases is lower concentrations of DO in the water.

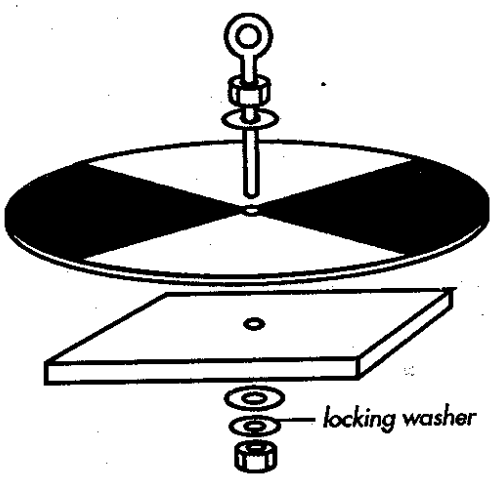

Figure 1. Secchi disk.

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