Nuibrava

Aquaculture

WORLD

AQUACULTURE

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AQUACULTURE SAFARI '25

Aquaculture on the Rise

Innovating in the Aquaculture Sector in

Mozambique

Nuibrava AquaShow – 59th Maputo International Fair – FACIM 2024

AUGUST 2024

Nuibrava AquaShow – 59th Maputo International Fair – FACIM 2024

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1. AQUACULTURE

Aquaculture or **Aquaculture** is the science that studies and develops techniques for reproducing and cultivating aquatic organisms, such as fish, mollusks, algae, crustaceans, and even turtles or alligators.

This cultivation must be carried out in appropriate conditions, with control of lighting and water temperature, and can occur in fresh or saltwater environments (where it is called mariculture).

One of the main objectives of aquaculture is to ensure products for consumption with greater control and regularity.

The first aquaculture activities took place a long time ago, and there are records that the Chinese already knew about it several centuries before our era and that the Egyptians already raised Nile tilapia (Sarotherodon niloticus), 4000 years ago.

2. Types of Aquaculture

- Fish farming: fish farming, in freshwater, brackish water or seawater;
- Shrimp farming: shrimp and lobster farming;
- Rice farming: rice and shrimp cultivation;
- Mariculture: saltwater aquaculture;
- Malacoculture: breeding of mollusks (snails, cuttlefish, squid and octopus);
- Mussel farming: mussel farming;
- Oyster farming: oyster farming;
- Pectiniculture : scallop breeding;
- Algae farming: algae cultivation;
- Frog farming: frog breeding.

3. Phases in Fish Farming

Fish cultivation consists of three stages: **Nursery**, **Juvenile** and **fattening**.

Nursery refers to the production of **fry/fingerlings**, newborn fish. The phase in which these fry/fingerlings are subjected to a process so that they weigh about 30 g is the juvenile phase, which is followed by the phase in which the fish are fed, the fattening phase, until the time when they must be removed (the so-called harvesting) for sale, after processing.

4. Main water quality parameters

There are some parameters that can be analyzed to ensure better **water quality**. These differ between physicists and chemists:

4.1. Physical Parameters

- **Temperature** - One of the main factors that can affect **water quality**. In this sense, all the physiological activities of fish (respiration, digestion, reproduction, feeding, etc.) are closely linked to the temperature of the water. Thus, the temperature above or below the optimum can directly influence the way it reduces its growth and even causes mortality.
- **Color** - In general, bluish or blue-green colorations indicate good productivity and high water **quality**. For fish species such as carp and tilapia, the ideal is that they have a green color, as this demonstrates the existence of basic elements for the maintenance of aquatic life.
- **Turbidity** - The more turbid the water, the worse the quality. This is one of the biggest dangers for aquaculture, as turbidity prevents the penetration of sunlight and consequently the development of phytoplankton (microgreens that live in the water and give it green color).

- **Visibility and Transparency** - This **water quality parameter** indicates the ability to allow the passage of the sun's rays. The deeper the pond and the more opaque (due to the presence of dissolved clay) the water, the lower the incidence of light to the bottom. It is very important, as it is related to the existence of plankton in the nursery.

4.2. Chemical Parameters

- **pH** - Indicates the concentration of bases and acids in the water and should be observed at least once a week. It has a direct influence on productivity, since it receives interference from the chemical substances in the water.
- **Alkalinity** - It is the ability of water to neutralize acids, and is important to verify the buffering effect of water.
- **Hardness** - It can be defined as its ability to resist changes in pH during the course of the day. This parameter will change according to the presence of Calcium (Ca) and Magnesium (Mg) salts in the water.
- **Dissolved Oxygen** - This **water quality parameter** is one of the most important for fish farming. There are two sources of obtaining oxygen, the first being through contact and direct penetration of atmospheric air into the water.
- **Ammonia** – Ammonia, which should be monitored especially when adding fertilizers containing ammonium in their formulation to water. One of the main sources of ammonia in tank water is fish excretion and excess food that has not been eaten.

Table 1: Key parameters that should be monitored regularly

Parameter	**Measuring Equipment**	**Optimal value**	**Values tolerated by most species**	**Measurement frequency**
Temperature	Thermometer or oximeter	26º to 30º C	Most species have satisfactory results between 24º and 32º C	Daily
Dissolved oxygen	Oximeter	Above 4 mg/l	Up to 1.5 mg/l for short periods of time	Daily
ph	pH meter or analysis kit	6.5 to 8.5	5.0 to 10.5	Weekly
Transparency	Secchi Disc	Above 200 cm in case net tank	Above 60 cm	Biweekly
Total ammonia/toxic ammonia	Water quality kit	Below 0.1 mg/l (toxic ammonia)	Up to 0.3 mg/l	Weekly, when the amount of feed supplied per day is greater than 60 kg/ha

5. Basic Principles of Fish Farming

In the aquatic environment, in addition to fish, lives a large amount of microscopic algae, called phytoplankton, and a set of tiny types of animals, called zooplankton. Bacteria and fungi are also present in this environment and are important in the decomposition of organic matter. It is important that the environment is balanced so that the fish can grow and be healthy, as expected.

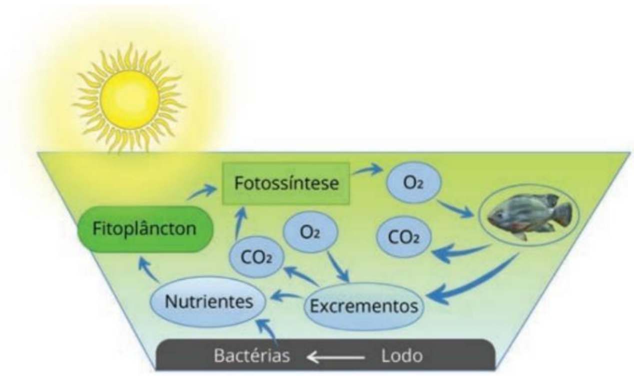


Fig. 1: Representation of the environment of a nursery with all its components

5.1. The importance of phytoplankton

Phytoplankton is the set of microscopic algae that give their greenish color to fish farming ponds and has important functions in the aquatic environment. Like land plants, phytoplankton also produce oxygen when exposed to sunlight, through photosynthesis. This is the main source of oxygen used for the respiration of fish and other organisms in fish farms. To do this, phytoplankton absorbs, as a nutrient, a good part of the waste (feces and other excretions) released by fish into the water after their decomposition. With these two actions, oxygen production and waste use, phytoplankton are important for pond water and their quantity must be balanced for greater benefit in production.

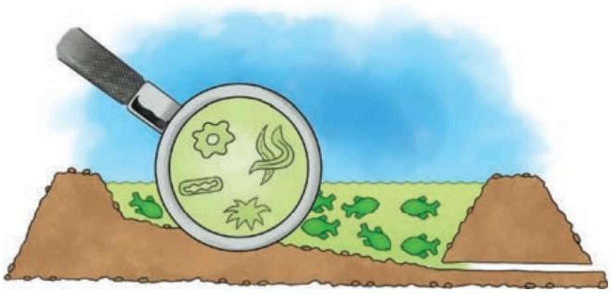


Fig. 2: Oxygen production and nutrient uptake by phytoplankton

5.2. Oxygen production by phytoplankton

During the day, in the presence of sunlight, phytoplankton absorb nutrients and carbon dioxide (CO2) present in the water and release oxygen in the process of photosynthesis. Therefore, the formation of phytoplankton in ponds is essential to maintain the supply of oxygen to the fish.

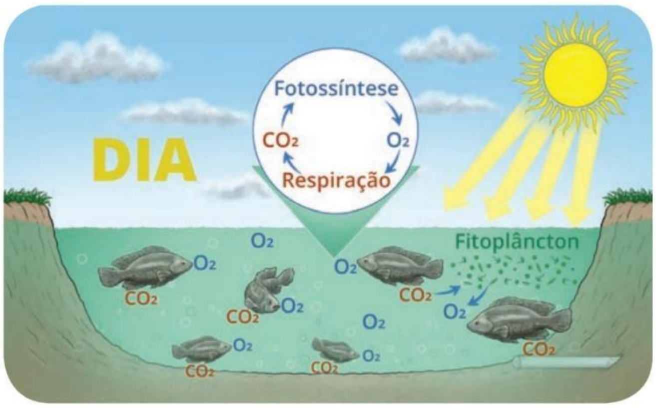


Fig. 3: Representation of the effects of phytoplankton during the day

At night, without sunlight, photosynthesis does not occur and phytoplankton stop producing oxygen, but continue to breathe, as do fish and other organisms, consuming oxygen and releasing carbon dioxide into the water. Thus, the oxygen level in the water usually increases during the day and decreases after sunset.

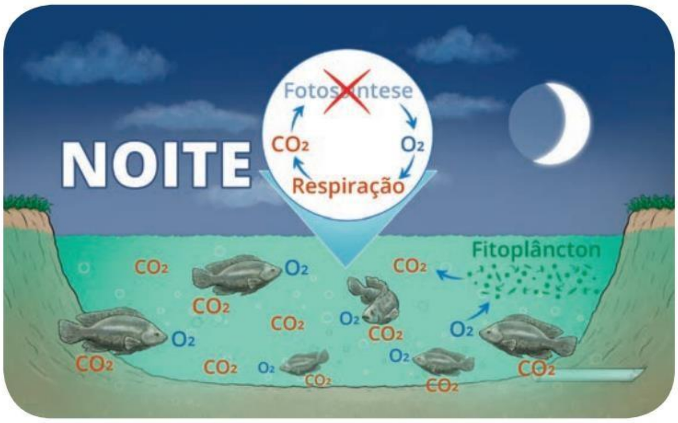


Fig. 4: Illustration showing the effects of phytoplankton at night

5.3. The variation of O2 and CO2 in water during the day

The higher the concentration of phytoplankton and the intensity of the light, the greater the production of oxygen during the day and consumption at night. In addition, as the concentration of carbon dioxide in the water acts in the opposite way to oxygen, with its reduction during the day, there is an increase in the pH of the water and, during the night, with the increase in carbon dioxide, there is a reduction in pH.

In summary, the dissolved oxygen concentration and pH rise during the day, while the carbon dioxide concentration decreases. During the night, the reverse occurs, when the concentration of oxygen drops, the pH decreases and carbon dioxide increases. And the greener the water, the greater the variation of these parameters, which can reach dangerous levels for fish.

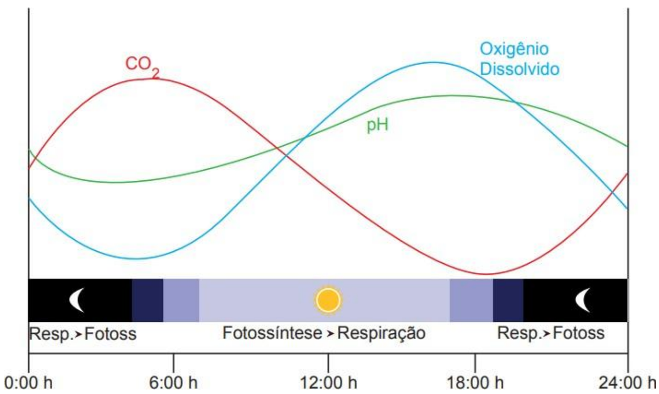


Fig. 5: The variation of oxygen and carbon dioxide in the water during the day and at night

6. The brine shrimp

Brine shrimp, known in the Macao region as "*Artemia salina*", is a species of microcrustacean brachiopod, belonging to the phylum Arthropoda and the order Anostraca. There are six species of brine shrimp spread around the world. Depending on the different physiological and biochemical parameters of the environment, brine shrimp populations can reproduce sexually or parthenogenetically, releasing **nauplii** or **cysts**. According to PEREIRA (2001) brine shrimp is adapted to major environmental changes, such as abrupt variations in salinity, temperature and dissolved oxygen.

Brine shrimps are rich in proteins, vitamins (carotene) and mineral salts, so they are an excellent diet for fingerlings, and especially shrimp farming for fish and crustaceans in the natural environment. For this reason, they prefer to inhabit places that are difficult for other species to survive, such as salt pans, which reach temperatures of up to 40ºC and salinity of up to 300 parts per thousand, because in these environments they are free of predators.

The production of the microcrustacean Brine shrimp. It is intended for use in the cultivation of crustacean larvae and fish, of high commercial value, being used alive, as nauplii or adults, as dry or frozen biomass.

According to CÂMARA (2004), in Brazil, about 250 tons of *A.franciscana* (**franciscana Brine shrimp**) biomass are collected annually, considering a maximum sustainable capacity of 0.2 tons per hectare/year, and the current production (250 tons) could be increased by up to 12 times (3,000 tons) in the 15,000 ha of evaporators available.

6.1. The Hatching of Brine shrimp

Kingdom: Animalia Phylum:Arthropoda

Subphylum: Crustacea

Class: Branchiopoda

Order: Anostraca

Family: Artemiidae

Genus: Artemia

Species: Artemia salina

Brine shrimp is a saltwater crustacean. The body is divided into the head, thorax and abdomen. The head consists of two fused segments that support two pedunculated eyes, a naupile eye, as well as the antinoles and antennae. The filiform antenulae are located in the dorsal part. The antennae of males are transformed into grasping organs and in females they are short and foliaceous.

Cysts: Average diameter of 0.2 to 0.3 mm, weighing between 2.8 and 4 mg.

Young Nauplius: Size of 0.45 mm long and 0.1 mm wide, weighing 0.01 mg.

Juvenile: With 5 to 6 mm, reaching, as an adult, up to 15 to 16 mm.

Environmental factors

Salinity: Between 3 and 300 parts per thousand.

Oxygen: At least 1 to 2 mg/l. Optimum around 4mg/l. It can survive low levels of oxygen (1 mg/litre) where it has a reddish colour (increased haemolymph).

Temperature: Withstands from 5ºC to 40ºC (optimal from 25ºC to 28ºC).

Light: Sensitive to light due to their compound eyes.

pH: The same as the lagoon, approximately 8.0.

Growth: Brine shrimp growth involves a series of molts, passing through egg stages until sexual maturity that is reached in two weeks and can produce about 200 nauplii every five days.

The life cycle of brine shrimp is 21 days.

Reproduction: Brine shrimp reproduces by parthenogenesis (production of offspring without fertilization of the eggs by sperm) or sexually. The eggs are divided into paired ovaries, which are located on either side of the digestive tract, behind the thoracopods. Once mature, the oocytes are transferred via oviducts into the uterus.

6.2. EXPERIMENT – HATCHING OF BRINE SHRIMP

Required material

- Container (bottle from water or tub)
- Air Pump (if available)
- Light Source 24h a day
- brine shrimp Eggs (brine shrimp cysts)

Reagents

- Brine shrimp cysts
- Seawater
- Freshwater
- Sodium Chloride
- Hydrochloric acid
- Sodium Hydroxide
- Baking Soda

Execution

- Place brine shrimp cysts in a container to hydrate for 1.5 to 2.0 hours at a concentration of 70 g cysts/l (1 g/14 ml) of fresh water;
- Seal the air intake into the incubator (or container) and let it sit for a few minutes. Remove the eggs that settle with a sieve, and those that float discard them.
- Transfer the brine shrimp to the pickling solution for a maximum of seven to ten minutes. Avoid raising the temperature above 35°C (when finished, the cyst becomes orange and transparent under the microscope).

NOTE: Brine shrimp cysts can be placed directly in the tanks without undergoing the decapsulation process. However, the hatching and number of nauplii will be smaller.

- Return the eggs to the colander and rinse them with tap water until they lose their chlorine smell (about ten minutes).
- Wash the cysts with 0.1N HCl (18~20 seconds).
- Return the brine shrimp to the sieve and rinse it with tap water for about five minutes.
- Place the cysts to hatch in the bottles filled with 15 liters of brackish water (5%) or "brine shrimp water". Keep aeration and lighting constant. The hatching time will take between 15 and 24 hours.

Note: To prepare 40 liters of brine shrimp water, dissolve 320 g of coarse salt and 80 g of baking soda separately in fresh water. The salinity of this water will be around 12%.

OBTAINING THE PICKLING SOLUTION

The pickling solution is composed of seawater, Sodium Hydroxide and Sodium Hypochlorite.

1. Decapsulating the volume of the solution

14 ml per gram of cyst (71.88 ml)

2. Amount of sodium hypochlorite (H.S.)

$= \frac{A \text{ por } 1000}{B}$ H.S. $= \frac{A \text{ por } 1000}{B}$ (10 g/68.12 ml)

H.S. (10g/68.12ml)

A = 0.5 per gram of cyst

B = 3000 by Hypochlorite Refractive Index - 4003

Amount of seawater

It is equal to the difference between the volume of the pickling solution minus the portion of Sodium Hypochlorite.

3. Amount of Sodium Hydroxide 0.15 g per g of cyst (1.5 g/10 g)

a) Cyst production

It is important to mention that at low salinities (100 g/l) there is high reproduction. This data should be considered, as it allows continuous recruitment and, from a small population, high production can be obtained in a few weeks. In very high salinities there is no recruitment, the production of cysts is generated, accompanied by the death of the adults.

The production of cysts is not only triggered by high salinities, but also by high temperature and desiccation, toxic levels of ions (K, Ca, etc.).

Brine shrimp is an osmoregulatory organism, so inside your body salinity is low and salts are constantly broken down.

b) Commercial Production

The world's largest producers of brine shrimp cysts are the United States, Russia and Bulgaria.

It is extremely difficult to establish a simple program to control the production and harvesting of brine shrimp in natural areas, due to all the factors mentioned, so it is recommended: 1) Periodic monitoring of the study populations.

2) Characterization of their life cycle throughout the year (number of organisms

adults, nauplii, cysts). 3) The above will allow us to know the concentration of suitable food and the ideal time to fertilize and establish the harvest.

In salt pans, the introduction of brine shrimp cultivation contributes to salt precipitation, since brine shrimp controls the algae population, reducing viscosity.

By introducing brine shrimp, one contributes to obtaining greater salt purity due to other compounds or particles (Sorgeloos, 1982).

4. Feeding

In the analyses of the contents of the digestive tract, everything from algae and debris to grains of sand were found, which shows that it is a non-selective filtering organism, so it can ingest contaminated materials. It ingests particles from 1.2 to 50µ. It feeds only on particles, not soluble foods. Brine shrimp does not regulate its diet (it feeds 24 hours a day). These factors should be considered for the appropriate selection of wild species and for the calculation of the concentration and diet suitable for aquaculture purposes.

In wild populations, it is difficult to determine the maximum sustainable yield (MSY) as it depends on environmental factors.

Hatching Technique Summary

- ✓ Initially, the cysts go through a 1-hour hydration process, immersed in fresh water.
- ✓ After this step, a decapsulation is performed with a bath in sodium hypochlorite solution lasting a maximum of 3 minutes, always observing the change in color, which goes from brown to slightly pink or orange when the process is completed. This step aims to partially dissolve the chorion (protective layer of the cyst) increasing the percentage of hatching.
- ✓ Once the decapsulation is completed, the cysts are placed in incubators with water with salinity of 25 g/l and oxygenated through aeration produced by an aquarium air compressor at a controlled temperature, around 26ºC.
- ✓ After a period of between 24 and 36 hours, hatching occurs and the first stages of larval development can be observed.

7. O Labdisc

"**The Laboratory in the Palm of Your Hand**"

Labdisc is a "Complete and all-in-one laboratory in the palm of your hand", which puts an advanced science laboratory in the hands of young scientists. It is the only science solution for the middle and pre-university level with up to 15 wireless sensors integrated into a single compact device – revolutionizing learning in terms of convenience, cost and portability.

7.1. State-of-the-art wireless technology

More than just a clean and safe working environment with no cables, a single wireless transmission from Labdisc to all integrated sensors reduces radio interference. This also eliminates the need for expensive transmitters integrated into each sensor.

7.2. Automatic sensor testing and calibration

The compact Labdisc features key features such as display, keyboard, memory, and battery, allowing data collection regardless of a computer's use.

This faculty keeps science economical and free from computer problems such as availability or even screens that are difficult to observe in direct sunlight on a field trip. Back in the classroom or lab, Labdisc can operate as a sensor interface, transmitting online measurements to the computer.

7.3. Natural Sciences Unit

Integrated sensors

Air pressure, ambient temperature, current, distance, GPS, light, microphone, pH, relative humidity, sound level, temperature, voltage, universal input.

7.4. Biology and Chemistry Unit

Integrated sensors

Air pressure, barometer, conductivity, pH, DO2, light, universal input, thermocouple, ambient temperature, heart rate, temperature, humidity, GPS, colorimeter, turbidity.

7.5. Environmental Sciences Unit

Integrated sensors

Ambient temperature, barometric pressure, colorimeter, GPS, IR temperature, pH, relative humidity, sound level, temperature, turbidity, UV.

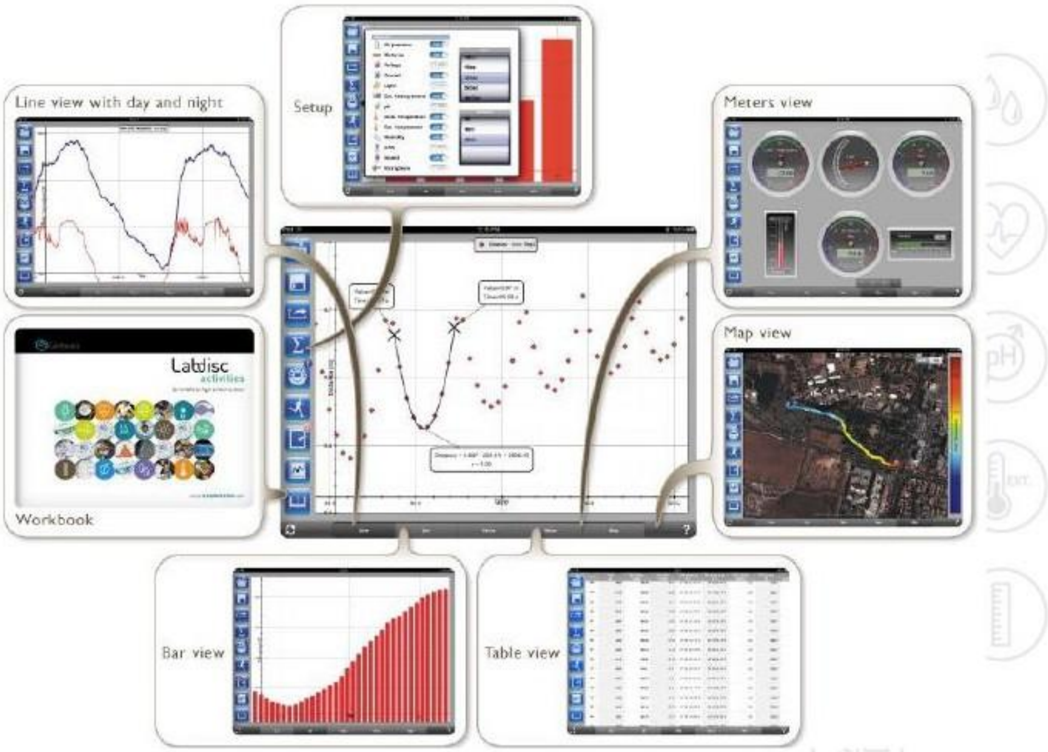
7.6. Physics Unit

Integrated sensors

Air pressure, voltage, low voltage, light, universal input, ambient temperature, temperature, current, distance, microphone, accelerometer.

7.7. Analysis Software

Easy to use, rich screen, compatible with all operating systems, accessible to all ages.



8. SELECTED EXPERIENCES

8.1. Experiment 1: Water Quality – Turbidity

Objective

The aim of this activity is to compare the turbidity of different natural and artificial water sources, evaluate a hypothesis and test it using the Labidsc turbidity sensor.

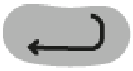
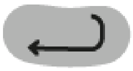
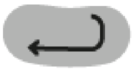
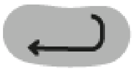
Material

- Labdisc Biology
- Turbidity sensor
- Three
- Glass Cups
- Three different water samples

Labdisc Configuration

To collect measurements with the turbidity sensor, Labdisc must be configured following these steps:

- Call the Labdisc by pressing 
- Press  and select "SETUP" Pressing 

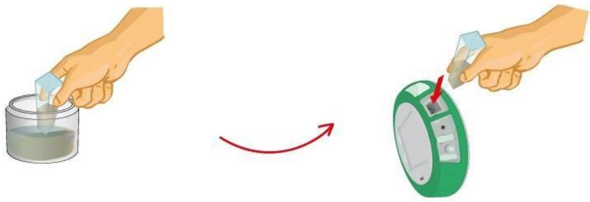
• Now select The option "SET SENSORS" with		and Choose "Turbidity". Then press				
• After Returns to the configuration Press		one time and Select "RATE FROM SAMPLING" with		Choice "MANUAL".		
• To return to Measurements Press		three times. Start the measure with		and Press		whenever Want register one datum.
• When end from measure, stop the Labdisc Pressing		See the instruction "Press the key SCROLL to STOP") and Press				

Accomplishment

- First, calibrate the turbidity sensor by introducing the bucket filled with drinking water into the sensor. Then, press and hold the turbidity key for

3 seconds until you hear a long beep.

- Select different natural water sources, such as ponds or lakes, around your local environment.
- Take some water samples from each location, including artificial water sources – i.e., artificial ponds – and drinking water. Label them and write down observations about the appearance of the water.



- Fill the cuvette to a volume of 75% with the samples and measure the turbidity, making sure the cuvette is dry on the outside.
- Under suitable conditions, you can measure directly in the field, following the previous suggestions.
- Select a bar chart  from the GlobiLab menu to show the results of the experiment.
- Then, label the bars indicating the name or zone where the samples were collected. Use the  Of tool of theGlobiLab software.
- Observe the data in the table by clicking  , if Want know precisely the values close between two or more samples.

Evaluation

1. Do you think there is a correlation between the appearance of the samples and the objective turbidity measurements?
2. Which water samples showed minimum or maximum turbidity values?
3. Considering your experimental results, is it possible to group the samples under any criteria? If so, are there large or small differences between the groups?
4. Were your expectations and initial hypothesis fulfilled? Explain.

8.2. Experiment 2: Measuring the pH of different substances

Objective

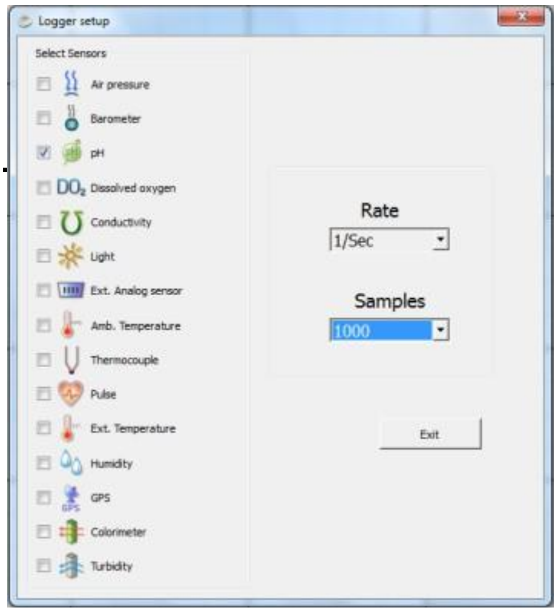
The purpose of this activity is to investigate the pH of different substances using the Labidsc pH meter sensor.

Material

- Labdisc of Biology and Chemistry
- A straw
- A glass
- pH Measurement Sensor
- Water

Labdisc Configuration

- Open the GlobiLab software and turn on Labdisc.
- Click on the Bluetooth icon in the bottom right corner of the GlobiLab screen.
- Select the Labdisc you are currently using. Once Labdisc has been recognized by the software, the icon will change from gray to blue  If you prefer a USB connection, follow the instructions previous click on the USB icon. You'll see the same color change when Labdisc is recognized .
- Click  to configure Labdisc. SealCcione pH in the "Logger Setup" window.
- Enter "1/Sec" for the Sample Rate and "1000" for Samples.
- Once you have finished setting up the sensor, start measuring by clicking .



- After finishing the measurement, turn off Labdisc by clicking  .

Accomplishment

- Put 50 ml of water in the gobelé
-
- Insert the pH sensor without touching the sides or bottom of the gobelé.
- Start the measurements and record the initial pH for a few seconds.
- Blow into the water with the straw for one minute.
- Continue to measure for one minute and then turn off Labdisc.

- Select a line graph  from the GlobiLab menu to show the results of the experiment.
- Then label parts of the curve according to the stages with the . 
- Next, show the pH values of the start and end states with the markers by clicking  on each section.

Evaluation

1. What was the effect caused by blowing into the water?
2. What happened to the pH change when it stopped blowing?

9. AGAR-AGAR

Agar-agar is a microalgae that has thickening, gelling and stabilizing properties that can be used in recipes to give greater consistency to desserts or in the preparation of vegetable gelatins, for example.

In addition, due to its properties and the fact that it is rich in fiber and minerals, such as phosphorus, potassium, iron, chlorine and iodine, cellulose and proteins, agar-agar can help in the process of weight loss and regulation of bowel function.

Agar-agar can be found in pharmacies, supermarkets or health food stores in the form of dried algae strips, powder or capsules, and should be used as directed by the doctor or nutritionist.