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Effect of physico-chemical parameters on fish health

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Abstract
In many regions of the world, fish are an economical source of protein and an essential cash crop, and water provides physical support for their life processes, such as feeding, swimming, reproduction, digestion and excretion. So for survival and survival, good water quality is really important. The consistency of water is defined in terms of its chemical, physical and biological content. Temperature, pH, salinity, and dissolved oxygen are some essential physical and chemical parameters affecting the aquatic environment. Others are total solids suspended and dissolved, total alkalinity and contaminants of acidity and heavy metal. The restricting criteria for the reproduction of fish organisms (flora and fauna) are these parameters. Poor water quality can result in low benefit, poor quality of the liquid and possible risks to human health. Production is decreased if the water includes pollutants that may affect the cultivated species' development, growth, reproduction or even trigger mortality.

Keywords: Temperature, pH, salinity, and dissolved oxygen

1. Introduction

Fish is an affordable sources of protein and an essential cash crop in several regions of world and water is the physical support in which they carry out their life functions such as feeding, swimming, breeding, digestion and excretion [1]. After receiving different types of pollutants that alter water quality characteristics i.e. physical, chemical and biological), many workers have reported the status of water bodies. Dhawan and Kaur (2002) [2] have observed that feeding and fertilisation work together to increase fish production efficiently and effectively. Fish are grown in ponds (lentic waters) in most countries, but unfortunately, they are not so aware of the importance of water quality management in fisheries. If they are properly directed and informed of practises in water quality management, they can achieve optimum fish yield in their ponds to a greater degree by applying low input costs and achieving high fish yield production. The interactions of the chemical components influence the water quality in the fish ponds. Carbon dioxide, pH, alkalinity and hardness are interrelated and may have significant impacts on the fertility of the pond, the level of stress and fish wellbeing, the supply of oxygen and the toxicity of some metals as well as ammonia. Many water safety features are not constant. Concentrations of carbon dioxide and pH fluctuate or cycle regularly. The alkalinity and hardness are relatively stable but can change over time, depending on the pH or mineral content of the watershed, usually weeks to months [3]. Deterioration in the condition of water can result in stress and susceptibility of fish to disease. Since fish are cold-blooded organisms, their body temperature varies according to the environment, affecting their metabolism, physiology, and eventually influencing development. For aquaculture, the suggested pH range is 6.5 to 9.0. Pond pH varies due to respiration and photosynthesis during the day.

Dissolved oxygen (DO) concentrations decrease after sunset as photosynthesis ceases and oxygen (respiration) is absorbed by both plants and animals in the pond. Carbon dioxide (CO_2) in heavily stocked fish ponds.

As a consequence of respiration, concentrations may become high. During respiration, the free CO_2 released reacts with water, producing carbonic acid (H_2CO_3) and reducing the pH. For good pond productivity, a total alkalinity of 20 mg/L or more is required. Between 75 and 200 mg/L $CaCO_3$ is the desirable range of total alkalinity for fish cultivation [3]. The most significant water quality element in fish culture is known to be the dissolved oxygen concentration (DO). Low concentrations of dissolved oxygen can change all aspects of predator-prey interactions, including rates of encounter, attack rates, and successful capture [4-6]. The amount of oxygen absorbed by microorganisms during the decomposition of organic matter is determined by biochemical oxygen demand or BOD. However, the habitat of the pond can be controlled by manipulating the properties of the water for an optimal environment, resulting in high development of fish.

2. Water Temperature

Fish are poikilothermic species, that is, their body temperature is equal to the temperature of the water in which they live, or 0.5 to 1 °C above or below. The metabolic rate of fish is strongly associated with the temperature of the water: the higher the temperature of the water i.e. the closer the normal range to the optimal value), the higher the metabolism. This generalisation is especially true to warm-water fish. Cold-water fish, such as salmonids, whitefish or burbot fish, have a particular form of metabolism: their metabolic activity will begin at comparatively low temperatures, while they become less active and eat less food at high water temperatures, typically above 20 °C. The temperature of water also has a great effect on the initiation and course of a variety of diseases of fish. In most fish species, the immune system has optimal efficiency at water temperatures of about 15 °C. Fish are able to withstand seasonal changes in their natural habitat quickly. Temperatures, such as a fall in winter to 0 ° C and a rise in summer to 20-30 °C (depending on species) under Central European conditions. However these changes need not be abrupt; if the fish are forced into a new setting where the temperature is 12 °C colder or warmer (8 °C for salmonids) than the initial water, the temperature shock happens.

Under these circumstances, fish can die, exhibiting symptoms of paralysis. Muscles in the respiratory and heart system. Also if the temperature difference is as low as 1.5-3 °C, issues can occur with young fry. If fish are fed and then moved suddenly by 8 °C or more to cooler water, their digestive processes will slow down or cease. In the digestive tract, the food will remain undigested or half-digested and the gases created will cause the fish to become overweight, lose equilibrium, and ultimately die. A high-nitrogen feed (e.g. natural food or high-protein pellets) is provided to carp, sudden transition too much cooler water will greatly raise the amount of ammonia nitrogen in the blood serum because the metabolic rate lowers the ammonia diffusion from the gills. This will result in auto-intoxication and death from ammonia.

3. Water pH

For fish, the optimum pH range is from 6.5 to 8.5. Salmonids (e.g. brown and rainbow trout) can be impaired and killed by alkaline pH values above 9.2 and acidity below 4.8; and cyprinids (especially carp and tench) can be quickly lethal with pH values above 10.8 and below 5.0. Salmonids are therefore more susceptible to high pH and more resistant to low pH compared to cyprinids. The American char is highly resistant to acidic waters and can withstand pH levels as low as 4.5-5.0. During the spring, low water pH occurs more commonly, especially when acidified snow melts, and in peat bogs that drain water. High alkaline pH will occur in eutrophic reservoirs (ponds) where large quantities of CO_2 are taken up by green plants (blue-green algae and higher aquatic plants) during the day for intense photosynthetic action. This affects the water's buffering ability and if bicarbonate is adsorbed from waters with medium alkalinity, the pH will increase to 9-10.0 or even higher. When mineral acids and hydroxides, or other acidic or alkaline compounds, are discharged or leached into water courses, ponds or reservoirs, water pH may also be altered.

Fish can produce an increased amount of mucus on the skin and on the inner side of the gill covers as a protection against the impact of low or high water pH. Fish tissues, particularly gills, are destroyed by excessively high or low pH values, and haemorrhages can occur in the gills and in the lower part of the body. In post mortem examinations of the skin and gills, excess quantities of mucus, sometimes including blood, can be observed. The mucus is watery and dull-coloured. The poisonous action of a variety of other compounds (e.g. ammonia, hydrogen sulphide, cyanides, and heavy metals) on fish is also greatly impaired by water pH.

4. Dissolved oxygen

Oxygen diffuses from the air into the water especially where the surface is Turbulent, and even from marine plant photosynthesis. In the other hand, as described earlier, oxygen is extracted by the aerobic oxidation of organic compounds by bacteria and by the breathing of all the species present in the water. The dissolved oxygen content in water can be expressed as mg per litre, or as a percentage of the saturation value of the air. When the values in mg per litre are translated into percent saturation or vice versa, water temperature, ambient pressure and content of salts dissolved in water must be taken into account. Different species of fish have different criteria for the oxygen content dissolved in water. Salmonids have the most demanding oxygen needs in water; their optimal concentration is 8-10 mg per litre, and they begin to exhibit signs of suffocation if the level drops below 3 mg per litre. Cyprinids are less demanding; they can survive only when the oxygen concentration decreases to 1.5-2.0 mg per litre in water containing 6-8 mg per litre and display symptoms of suffocation.

A number of other factors often depend on the oxygen needs of fish. The temperature, pH and CO2 of the water and the fish's metabolic rate are included. Temperatures and average individual weight and total fish weight per unit volume of water are the key requirements for the oxygen requirement of the fish. The needs for oxygen rise with a higher temperature (e.g. an increase of water temperature from 10 °C to 20 C at least doubles the need for oxygen); a higher average fish weight per unit volume of water will contribute to increased movement and as a result of overcrowding, to increased respiration. With rising individual weight, oxygen needs per unit weight of fish decrease considerably. This decline can be reflected in the carp in the following proportions: yearling = 1, two-year-old carp = 0.5-0.7, marketable carp = 0.3-0.4. For various animals, major variations in oxygen demand are often found. The comparable values for several other species are as follows: trout 2.83, peled 2.20, pike perch 1.76, roach 1.51, sturgeon 1.50, perch 1.46, bream 1.41, pike 1.10, eel 0.83 and tench 0.83, using a coefficient of 1 to express the oxygen demand of common carp.

As mentioned, degradation by biodegradable organic substances (including waste water from agriculture, the food industry and public sewage) is the most commonly responsible cause for a substantial decrease in the oxygen concentration of water (oxygen deficiency 1). Bacteria that use oxygen from the water for this process decompose these compounds. In the absence of bacteria, a few compounds might be oxidised. The concentration of organic substances in water in terms of their capacity for taking oxygen from the water can be measured by means of the chemical oxygen demand (COD, which represents a theoretical maximum) and the biochemical oxygen demand within five days (BOD5, which represents the potential for bacterial degradation). The upper limit of COD, as determined by the Kubela method, for the optimal range for cyprinids in pond or river waters, is 20–30 mg O2 per litre and the corresponding BOD5 limit for cyprinids is 8–15 mg O2 per litre, depending on the intensity of the culture and the rates of reaeration. For salmonids the corresponding levels are up to 10 mg O2 per litre for COD and up to 5 mg O2 per litre for BOD.

Fish are usually destroyed by suffocation in contaminated holding ponds in winter, and this also occurs in high-temperature and low-flow polluted water courses in summer. Oxygen depletion also occurs early in the morning during the summer in severely eutrophicated ponds as a result of overnight oxygen intake by bacteria for the decomposition of organic compounds and the respiration of aquatic plants. Oxygen depletion can also be caused by unsustainable zooplankton production in heavily fertilised ponds (e.g. those used for the disposal of sewage) with a continuous inflow of degradable organic substances; zooplankton itself needs oxygen for respiration and in addition, its feeding pressure lowers the population of phytoplankton that produces oxygen during the day.

To sum up, oxygen levels in water depend on the equilibrium of air and plant inputs and the intake of all life forms. Air inputs rely on the air-water interface's turbulence and the water's oxygen deficiency. Plant inputs rely on photosynthetic activity that increases with temperature and sunlight; the atmosphere can lose excess oxygen. This equilibrium has to be adequately understood; no assurance that the levels will be sustained during the night is a satisfactory oxygen level reported during the day. On a wet, sunny afternoon, moderate levels reported in calm eutrophic waters will almost always suggest that extreme oxygen shortages will occur during the night. Also because of high CO_2 levels, lower than predicted daytime pH values can suggest high bacterial respiration levels that could contribute to low night-time oxygen levels.

5. Conclusion

In addition to their direct impacts on the ecosystems there, chemicals that contaminate the marine ecosystem may be toxic. It is well known that certain illnesses and developmental defects in fish living in a contaminated environment can occur more frequently. However, only a small amount of information is available on this relationship, which is largely tied to interactions with farmed or cultivated fish. Restricted environmental stressors, such as low dissolved oxygen, temperature and pH, and ammonia, are likely to be related to the position of fish farms in largely uncontaminated waters. The interrelationship between the contamination of surface water by a broad variety of contaminants and pathogens of natural fish stocks and the mechanisms involved must now be investigated in a real way. This is a significant although currently under-developed area of scientific study and management of fisheries.

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