HANDLING AND TRANSPORTATION OF LIVE FISH FOR CONSUMPTION PURPOSES (A REVIEW)

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ABSTRACT

Live fish transportation is an act of moving live fish from one place to another in which measures are given to keep the fish's graduation rate high until it reaches its destination. Live fish to be transported are required to be in good health and not disabled to reduce the chance of dying during stunning and transportation. Live fish is the best and most flexible commodity for all kinds of purposes, especially for consumption purposes and various purposes in the fishery product processing industry. Fish provided for sale alive will have a higher selling value than fish sold dead. Several studies have been conducted to reduce stress on live fish during transportation, including the addition of calcium. There are several important factors that affect the transportation of live fish. These factors are fish quality; oxygen; pH, carbon dioxide, and ammonia; temperature; density and activity in transportation; and changes in fish biochemistry.

Keyword: *Live fish, Transportation, Fish consumption, Calcium salt*

1. INTRODUCTION

Live fish is the best and most flexible commodity for all kinds of needs, both for cultivation, consumption and for various purposes in the fishery product processing industry. However, not all areas can get fish in a live condition due to differences in the potential of their aquatic resources. Based on this, it is necessary to make an effort so that fish can be distributed evenly to various regions. Efforts that can be made for the even distribution of fish are by creating a good transportation method.

Live fish transportation is an act of moving live fish from one place to another in which measures are given to keep the fish's graduation rate high until it reaches its destination. The technique or method used in the trans portation process will be largely determined by the purpose of the transportation itself. Transportation of live fish is generally intended for cultivation purposes (transportation of brood stock, transportation of fish fry), ornamental fish, maintenance or care, and for consumption purposes.

A common method of transport for live fish is loading fish in plastic bags filled with water and oxygen. The loading and transport of fish is associated with a source of stress, which must be considered to prevent damage to the fish [1]. Fish transport procedures can cause stress to fish. The procedure consists of several activities, such as loading before transport, packing and oxygen delivery during fishing, loading fish into bags and determining fish density. The irregular movement of plastic bags during the transportation process, increased production of ammonia and metabolites in water will also affect the stress in fish transportation [2].

Various studies have been conducted to reduce stress during fish transportation. Stress conditions on fish during transportation can be reduced by the addition of calcium [3]. The addition of additives such as calcium salts [4], CaSO4 was tested to determine its effect on the physiological response of matrinxa˜ *Brycon amazonicus* fish [5] and sodium salts [6] have been tested for use in fish transportation.

2. LIVE FISH TRANSPORT

Transport of live fish is an act of moving live fish from one place to another in which measures are given to maintain a high degree of survival of fish to the destination. Based on this statement, the transportation of live fish is basically forced to place fish in an environment that is different from their original environment accompanied by sudden changes in environmental characteristics [7]. Live fish to be transported are required to be in good health and not disabled to reduce the chance of dying during stunning and transportation.

According to [8], most fish species are transported for local and international market needs every day. Transportation to the market can occur starting from a short distance of 1 hour or as long as 30 hours from the cultivation site. Transport of live fish under these conditions causes stress, which often results in high mortality rates or very weak fish.

The transportation of live fish is divided into two ways, namely the wet system and the dry system. The wet transportation system demands the same media as the previous fish habitat, namely water and sufficient oxygen [9]. Wet system transportation can be done in a closed or open way. In a closed way, fish are transported in a closed container with all the necessities of life for the fish in the transport package. The container used can be a plastic bag or other tightly closed packaging. In the open way, fish are transported in open containers and a continuous supply of oxygen is provided throughout the journey [10]. The dry system is the transportation of live fish using non-water media [11]. In this system, fish are conditioned in conditions of low metabolism, respiration and activity [9]. Based on this, it is necessary to stun the fish so that their metabolic rate is at a basal level.

Protein metabolism usually occurs during fish transport resulting in high ammonia excretion. Plasma ammonia in matrinxa was duplicated in the freshwater group. Ammonia excretion is a factor associated with decreased water quality during fish transport which can result in high mortality rates of fish species sensitive to ammonia. In contrast, tropical warm water fish such as matrinxa can survive extreme concentrations of ammonia [12]. Furthermore, matrinxa loading and transport requires a large amount of energy, which is associated with protein and carbohydrate catabolism [13].

3. CALCIUM SULFATE

Calcium sulfate is a material that is used for analysis in the laboratory and chemical industry. In the -anhydrite form (near anhydrous form) calcium sulfate is used as a preservative. In addition, it is also used as a coagulant in products such as tofu. In its natural state, crude calcium sulfate is a translucent white rock crystal. The anhydrous form occurs naturally as -anhydrite. Depending on the method of calcination of calcium sulfate dihydrate, specific semihydrates are sometimes known as: alpha-hemihydrate and beta-hemihydrate. Shown by the difference only in the size of the Crystal. Alpha-hemihydrate crystals are more prismatic than beta-hemihydrate crystals and, when mixed with water, form a stronger and harder superstructure. Calcium sulfate is a common component of gross deposits in the heat exchange industry. This is related to its solubility which decreases with increasing temperature.

Calcium sulfate occurs as an odorless white powder or as slightly colorless crystals. It has a melting point at 2,642^{o}F (1,450^{o}C) and is only slightly soluble in water. When heated, the hydrated form of calcium sulfate releases 1.5 molecules in water and the hemihydrate form, CaSO4.1/2 H_2O, is commonly known as Paris gypsum. When water is added, Paris gypsum forms a hard mass which is used in the manufacture of plaster molds, cement moldings, wall plaster and wallboard, as well as art objects (http://science.jrank.org/pages/1124/Calcium-Sulfate.html).

Among the many other uses of calcium sulfate is that it can be used as an additive in the transportation of live fish. Calcium sulfate (CaSO4) has been used by Brazilian farmers in live fish to reduce the negative effects of transportation, although it does affect salt content. Based on the research results of [4], calcium salts can be used in

fish transportation. The addition of calcium to the water is recommended to reduce stress during fish transportation. Furthermore, the effect of stress during fish transport can be reduced by using calcium as an additive [3].

4. STRESS DURING FISH TRANSPORT

Packaging and transportation of fish can also cause stress that causes death and will reduce yields [14]. Transport stress is one of the factors that play an important role in the incidence of fish disease and fish mortality. Many factors affect the survival of fish during transportation. Water exchange is carried out for oxygen supply, respiration and the movement of toxic metabolites such as carbon dioxide and ammonia is minimized during transportation. Fish are fasted before packaging to minimize metabolism [6], water temperature is also reduced to minimize metabolism. Fish are concentrated for more efficient transportation. Handling, density and low water quality determine some of the stress on fish.

The exercise of fish transport can cause plasma chocholamines and cortisol to increase and many other physiological stress responses to be initiated, such as producing high cortisol and activating several biochemical processes. Furthermore, the ion balance is disturbed as a result of increased catecholamines and cortisol.

Fish biologists have studied stress in recent years. Many practical aspects of intensive cultivation are directly related to metabolic and physiological stress responses. Furthermore, fish stress was investigated to improve fish conditions in reducing mortality and economic losses in the transportation process.
The defense of fish health that remains good during transportation is influenced by a number of factors or a combination of several factors. According to [15], these factors are:

a. Fish quality
The quality of the transported fish is a very decisive criterion. Transported fish must be healthy and in good condition. Weak individuals must be removed from shipment, most of which occur at high temperatures during preparation prior to transport. When fish is of low quality, even if the density of fish in transport containers is greatly reduced, it is still difficult to prevent fish loss. Weak fish die faster than fish that are in good condition on longer transport times.

Fish also require adaptation to lower temperatures prior to transportation. Ice is used to cool water, ice from carbonic acid should be avoided. As a comparison, 25 kg of ice will cool 1,000 liters of water in 2^{o}C water. If the water contains fish during the cooling process, the temperature will drop no faster than 5^{o}C per hour. Direct contact of fish with ice must be prevented at the same time. The temperature difference should not exceed 12-15^{o}C, depending on the species and age of the fish (FRG recommendation 1979).

Fish before being transported must be fasted for at least one day, except for the size of the larvae. If the fish's digestive tract is not completely clean, digestion of food will take place during transportation. Fish with a full digestive tract also require more oxygen, so they are more susceptible to stress, and will produce excretions that carry a lot of oxygen in the water.

b. Oxygen
The most important major factor in transportation is the availability of an adequate level of dissolved oxygen. However, the abundance of oxygen in the tank does not necessarily indicate that the fish are in good condition. The ability of fish to use oxygen depends on their tolerance to stress, water temperature, pH and concentration of carbon dioxide and metabolic products such as ammonia.

Important factors under oxygen consumption by fish in relation to oxygen metabolism during transport are weight and water temperature. The weight of the fish and its transportation in warmer water require more oxygen. For example, if the temperature of the water increases by 10^{o}C (for example from 10 to 20^{o}C), the oxygen consumption is about doubled. Accordingly, for each 0.5^{o}C increase in temperature, the loading of fish should be reduced by about 5.6%, on the other hand, for each 0.5^{o}C decrease in temperature, the loading can be increased by about 5.6%.

Fish at rest will consume oxygen in small amounts even though the amount of oxygen in the water is not limited. In fish transport systems, fish will need more than the minimum amount because the fish are not at rest. Furthermore, if

it moves a lot at the time of loading and is disturbed during its transportation it can consume close to the maximum amount. The amount of oxygen consumption in fish also depends on the amount of oxygen available. At high levels, fish will consume at a steady rate. When oxygen levels in the water are low, fish consume less oxygen than when oxygen levels are high. Fish transportation systems often contain water with insufficient oxygen levels to meet the fish's body needs. Contrary to predictions, fish will change their metabolism to use oxygen from their bodies.

The first time after loading is the most critical time for fish in their oxygen demand. Fish are stimulated and require large amounts of oxygen with a short time to adjust. Fish size is also an important factor. Large fish consume less oxygen per unit weight than smaller fish. The oxygen level of the water for fish living in warm water should be above 5 mg/l for normal conditions. This level prevents oxygen from being a major stress factor.

Transport of fish in a closed system with atmospheric oxygen pressure, the oxygen content in the water is usually not a limiting factor because there is sufficient oxygen pressure in a closed bag. Oxygen deprivation can occur in exceptional cases when the density of fish is too high or transport is longer than the survival of the fish. Dead fish compete with living fish for oxygen use, dead fish will increase the multiplication of bacteria that require a lot of oxygen, and this multiplication can then produce toxic metabolites. The manure produced by fish is another substrate for the growth of bacteria which reduces the oxygen content in the water, this process is intensive because the water temperature is higher.

In a closed system, a slight shaking of the bag will help the penetration of atmospheric oxygen into the water. Long transportation trips without any movement of the packaging bag can cause fish death even though high oxygen levels are still available in the bag.

c. pH, carbon dioxide and ammonia
Water quality is a function of loading of fish concentration and length of time for fish to be transported. Water sources used during transportation should be tested before shipping fish. The pH level of the water is a control factor because the proportion of toxic ammonia and carbon dioxide content is directly related to the pH function.

The increase in transportation time associated with the production of carbon dioxide through fish respiration can change the pH of the water to become acidic. The pH level of the water around 7-8 is optimum. The speed with which the pH changes causes stress to the fish, but buffers can be used to stabilize the pH of the water during fish transport. Trishydroxylmethylaminomethane organic buffer is effective in fresh and salt water. High solubility, stable and easy to apply.

Increased concentrations of carbon dioxide can affect fish and can be a limiting factor in fish transportation. A product of fish and bacterial respiration, carbon dioxide causes water in transportation to become acidic. Although it reduces the percentage of un-ionized ammonia in the water, it also reduces the increased oxygen capacity in fish blood.

Fish transported in tanks show a gradual increase in carbon dioxide concentration, unless aeration is sufficient. The increase in carbon dioxide can be tolerated if the precursor rate is slow.
Another important factor is the concentration of chlorine in the water, although like carbon dioxide, chlorine can also be removed from water by aeration. Concentrations of 0.5 mg/l are dangerous, although lower chlorine levels, for example 0.2 mg/l, will interfere with the respiratory mechanism of fish.

Ammonia (NH_3) increases in the transport water due to the protein metabolism of fish and bacteria acting on the effluent. Reduces metabolic rate in fish by lowering water temperature, and reduces fish activity, reducing NH_3 production. The production of NH_3 by the action of bacteria can be reduced by sending fish only after eating, so that their stomach and digestive contents are empty. The temperature and time of the last meal are important factors in regulating ammonia excretion.

d. Temperature
Water temperature is an important factor. Lower water temperatures will result in a higher pH and lower fish metabolism. In general, the optimum temperature area that can be applied to fish transportation is 6-8^{o}C for cold-

water fish and 10-12^{o}C for warm-water fish in summer, 3-5^{o}C for cold-water fish and 5-6^{o}C for warm-water fish in spring. and autumn, and 1-2^{o}C for winter.

e. Density and activity in fish transportation
The factor of space availability is also a factor that must be considered in fish transportation. Small fish have a ratio of the volume of fish transported to transport water should not exceed 1:3. Heavier individuals, brood fish can be transported in fish-to-water ratios from 1:2 to 1:3, but with smaller organisms this ratio decreases at 1:100 to 1:200.

Fish transportation conditions are also affected by excessive excretion and fatigue in fish. When a fish is placed in a transport container, it usually releases a certain amount of muscle activity. When active muscles are used, there is not enough blood to supply their needs. Alternatively the system is moved to use the energy supplied to add normal amounts of oxygen. The accumulation of lactic acid in the muscles and blood causes the blood pH to drop. Oxygen consumption is reduced by lowering the blood pH. Following some time from the strength of muscle activity, the accumulation of lactic acid cannot be reduced for 24 hours. Oxygen flow can be reduced to a normal level of 6 mg/l after the acclimatization time, as fish become calm and oxygen consumption stabilizes.

f. Changes in fish biochemistry
Preparation conditions also affect the composition of fish blood and blood serum biochemical parameters. An increase in temperature and a lower ratio of fish weight to water concentration means a higher erythrocyte count and a higher hemoglobin concentration in fish blood. There was no change at lower temperatures and the proportion of fish was lower in relation to water volume. The haematological condition is also altered by transportation. During transport of high-density fish, plasma corticoid and glucose levels increase and remain constant when transport stops. Although the mortality rate as a direct result of transport is low, a second effect of stress is responsible for the delay in death, caused by the consequences of osmoregulator dysfunction and disease.

The release of fish at their destination can be a very critical step in the transportation process. Fish are under some degree of stress in the transport unit and suddenly exhibiting different water characteristics or poor water quality will accelerate stress on the fish. Low water quality can mean fresh pumped groundwater with low oxygen or high carbon dioxide content. The difference in water characteristics often means that the pH, temperature or pure oxygen differs between the transport unit and the water at the destination of transportation.

Based on the factors described above, it can be suggested that the specific conditions of transport should be considered in each case and to change the number of baselines if a change shows importance after a brief test. It is also recommended to use the density of fish at the time of transportation can be extended at least 1.5 times to prevent the consequences of possible delays during transportation. When the fish to be transported are acclimatized, transporting dangerous fish, the stock density should be lower. The economic aspect in transportation cannot be ignored, if the transportation costs are high and the value of the fish transported is low, the stock density in the transportation unit can be increased even though the losses on the fish obtained are higher.

According to [16], changes in plasma cortisol, blood glucose, plasma chloride and liver glycogen were investigated in matrinxa (*Brycon cephalus*) for arrest and various clustering times. Water temperature, pH, dissolved oxygen, alkalinity, ammonia and nitrite levels should always be maintained to acceptable levels for matrinxa. Low but not marked increases were described in plasma cortisol and blood glucose levels, as were decreases in plasma chloride and liver glycogen levels. The results show that matrinxa is highly tolerant of the full catch and short-term procedure.

5. CONCLUSION

Transport of live fish is an act of moving live fish from one place to another in which measures are given to maintain a high degree of survival of fish to the destination. There are several important factors that affect the transportation of live fish. These factors are fish quality; oxygen; pH, carbon dioxide, and ammonia; temperature; density and activity in transportation; and changes in fish biochemistry. Calcium sulfate can be used as an additive in the process of transporting live fish.

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