Improved Fish Transport in Plastic Bags

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Most fish farms do not produce fry and fingerlings themselves but buy them from specialized traders. Some species cannot be produced and must be captured, such as milkfish fry and fingerlings. In both cases, fish must be transported.

Since the early 1950s, the so-called "plastic bag method" has become more and more common in fish transport. Its great advantage is that one needs nothing more than a plastic bag, a rubber band, pure oxygen and an isolating box. The boxes then can be shipped by van, railways or aeroplane. The method is shown in Fig. 1.

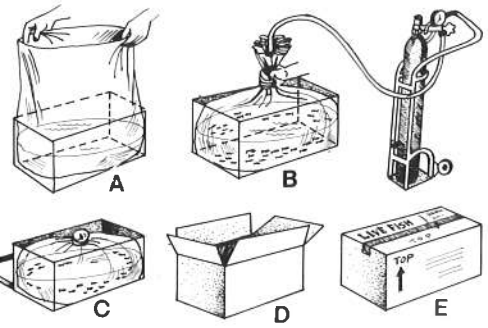

Fig. 1. Apparatus and sequence of packing fish by the plastic bag method.

To date, this method is accompanied by two major problems: mortalities are still too high and freight costs are continually increasing.

Experiments

Since the exporters of ornamental fish in Singapore certainly have the longest experience with this method in shipping fish all over the world, a detailed investigation was made on how they use the method. The ratio of fish weight, water volume and oxygen volume was determined. A complete analysis of transport water on arrival was made. Furthermore the metabolic rate of fish under transport conditions was determined. In addition, experiments on the influence of light and starvation on metabolic rate during transport were performed. Several ion exchangers were tested for their efficiency to remove ammonia from transport water.

Results

The results of the investigations led to the derivation of empirical relationships (see box).

The relationship between body weight of fish and fish density is closely connected to the relationship between body weight and oxygen consumption. Larger fish have a lower metabolic rate per unit weight than smaller fish. Thus larger fish can be packed at a higher density than smaller fish. Larger fish also have a slower rate of stomach evacuation. They need a longer period of starvation before transport to reduce the excretion of poisonous ammonia into the transport water. The formula for fish density given in the box applies to male siamese fighting fish *(Betta splendens)* packed individually with 30 ml water only as well as to milkfish fry packed 1,000 pieces/l and to grass carp of 12 cm length, packed at 15 pieces/l.

Very sensitive fish such as silver carp should be packed with 30% less density. For shorter transportation times, fish density can be raised by 30%.

The formula was developed on the basis of measurements on freshwater fish. It guarantees that after 48 hours there is still enough oxygen in the bag and that ammonia does not exceed a critical value, assuming that fish have been starved before transport as is suggested above.

Although marine fish have a very similar metabolic rate to freshwater fish, the formula should not be used for them without further investigation. Seawater, which normally has a pH of 8.3, also has a high buffering capacity for changes in pH. A higher pH means a higher percentage of poisonous ammonia. This may require a higher volume of transport water.

Eight days after arrival, the average mortality rate in shipments from Singapore to Europe was found to be 13%.

How to Use the Plastic Bag Method for Transporting Freshwater Fish (up to 48 hours)

- When several fish are packed in the same bag, the optimum fish quantity per unit water volume (Fq) can be calculated by the following formula:

$$Fq = 38 \cdot \sqrt{W} \quad (g/l)$$

W is the mean weight of the individual fishes in g.

- The necessary water volume (Wv) for individually packed fish can be estimated by

$$Wv = 27 \cdot \sqrt{W} \quad (ml)$$

- Plastic bags must be chosen so that the triple volume of oxygen can be filled in above the water volume.
- Fish fry and very small fish of less than 0.1 g should be starved for 24 hours before transport. Small fish up to 3 g should be starved for 2 days. Large fish should be starved for at least 3 days.
- Isolating boxes should be used for transport. Inside the boxes fish should be kept in darkness.
- An addition of common salt (NaCl) will improve transportation conditions. Depending on the salinity tolerance of the fish species shipped, 1 to 10 g/l should be added. Marine salt reduces the efficiency of the ion exchangers and should not be used together with them.
- Ammonia can be removed from transport water by acid ion exchangers loaded with Na^+ (e.g., Amberlite IR 120 or Dowex 50 X8). Fill a common tea bag with 20 g/l of ion exchanger and put into a plastic bag. This will reduce ammonia by 50%. Water volume then can be reduced by 20%.
- After transport, fish must be adapted very slowly to the water of their new environment. Small quantities of the new water should be poured into the plastic bag, until the water volume exceeds the initial quantity by two or three times. This procedure should last at least half an hour. The transport water must not be aerated.
- If possible, fish should be treated against external parasites, bacteria and fungi the day after arrival.

About 5% arrived dead in the bag. The main reasons for mortality seemed to be packing and handling errors. Half of the high mortalities observed (above 25%) could not be related to bad quality of fish or transport water on arrival and must be caused by insufficient adaptation of fish to their new environment, which often differs extremely from that in the transport bag.

On arrival, pH values in the bags ranged from 5.5 to 6.5. The average concentration of carbon dioxide amounted to 170 ppm. Mean oxygen index was 133%. These values are slowly built up during transport and fish usually can adapt to them.

A sudden transfer to water with carbon dioxide less than 1 ppm and pH above 7 will cause severe problems for the fish. Plasma pH rises rapidly. The mucus layer on the skin is often shed. Sensitive fish die after a few minutes. A continuous slow adaptation for at least half an hour is recommended. A simple device for doing this is shown in Fig. 2.

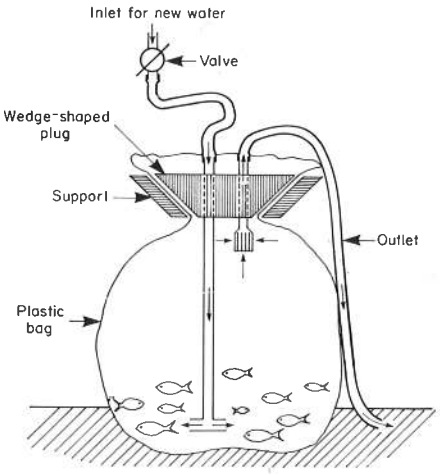

Fig. 2. A simple device to allow gradual changing of water in a transport bag after arrival. Failure to acclimatize fish in this way accounts for much mortality of transshipped fish.

The metabolic rate of fish under transport conditions is three times higher than the so-called routine metabolic rate. Sudden stimuli keep fish in an excited state and their oxygen consumption at a high level. Optical stimuli may be reduced by keeping the fish in darkness inside the boxes. Other stimuli such as sudden noise and bumps normally cannot be influenced.

During transport only ammonia reaches toxic concentrations with a mean value of 0.025 ppm on arrival. The long-term upper limit for non-sensitive fish is 0.020 ppm. Strong acid ion exchangers loaded with sodium (Na^+) are able to remove ammonium ($NH4^+$) from the water in exchange for Na^+. Amberlite IR 120 and Dowex 50 x 8 should be available all over the world. A common tea bag can be filled with the necessary quantity of ion exchanger, closed and put into the plastic bag. A quantity of 20 g/l will remove 50% of the ammonia. Such a tea bag with ion exchanger will cost less than US$0.10.

Fish density now can be raised by 20% or a given quantity of fish can be packed with 20% less water. As freight costs usually are calculated by the weight of a shipment and water makes 90% of the weight in fish transport, nearly 20% freight charge can be saved by this method. •

Asian Fisheries Forum Update

The First Asian Fisheries Forum to be held in Manila, 26-31 May 1986, is now likely to become the largest conference of its kind ever held in Asia.

By the end of October 1985, the deadline for submission of abstracts, there were 304 abstracts on hand. At that time the number of persons who had indicated they would attend the Forum was over 400.

Interest in the Forum has spread far beyond the region. Intending participants are from 45 countries of which 23 nations are outside Asia.

Aquatech '86

Interest is high in the Philippines, where 85 persons are planning to attend the Forum. The Philippine Center for International Trade and Exhibitions (PHILCITE) has decided to hold an exhibition on aquatic technology to coincide with the Forum. The exhibition, called "Aquatech '86", is aimed at attracting commercial interests to display products, publications, supplies for the industry and research, etc. This also is attracting international attention. The exhibition site is next to the Philippine International Convention Center, where the Forum will be held. For more information contact Aquatech '86 Secretariat, P.O. Box 598 Manila, Philippines (Telex 40496 Philcite PM).

Society Council Meets

Planning for the Forum is being undertaken by the Council of the Asian Fisheries Society. The Council met in Taiwan on 24-26 September 1985 mainly to discuss and finalize Forum plans. Council received reports from Councilor Dr. Rogelio Juliano, chairman of the 10-member Local Organizing Committee and from Ms. Narz Lim, whose company, Business Resource Center, is managing the Forum and providing the Forum secretariat.

First Society Branch Formed

The Taiwan Council meeting was sponsored by the Taiwanese Government and the Tungkang Marine Laboratory, led by Councilor Dr. I-C. Liao. A branch of the Asian Fisheries Society was formed in Taipei during the visit by Society Councilors, bringing the number of Taiwan members of the Society to fifty.

The private sector in Taiwan has shown keen interest in the Society. Several companies organized functions for Councilors to view fisheries and aquaculture products and to learn more about the activities of this sector in Taiwan.

Funding Agency Support

The International Development Research Centre of Canada recently provided CAN$10,000 to assist the Society to prepare for the 1986 Forum. The Australian and Swedish Governments have agreed to provide travel support for a limited number of participants, based on the quality of submitted Forum papers. Meanwhile, the Society is seeking other donors to help increase the number of qualified authors that can be assisted to attend the Forum.

It is not too late to plan attendance at the Forum. Address enquiries to the Secretariat, First Asian Fisheries Forum, P.O. Box 2273 MC, Makati, Metro Manila, Philippines.