Note on procedures for the large-scale transportation of juvenile fish

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Abstract

Procedures followed in the large-scale transportation of juvenile fish are reviewed and recommended. Attention is given to the steps taken prior to the packaging of fish, which include the disinfection of fish against parasites and the use of anaesthetics to minimise handling stress.

Introduction

The establishment of fish hatcheries in climatically suitable regions in a country where the large-scale spawning of fish is undertaken, necessitates the occasional mass transportation of fry and juvenile fish.

Long distance transport usually involves airfreighting the fish with a resultant cost increase. It follows that the most cost effective ways of packaging the fish have to be sought. In recent years, the general use of polythene bags for the mass transportation of fry and juvenile fish has contributed much towards the expansion and development of aquaculture in many countries.

In this paper various procedures for preparing fish for transportation (Hattingh *et al.*, 1975; Kruger, 1980; Woynarovich and Horváth, 1980; Ferreira *et al.*, 1984) are reviewed and ways and means are presented for the preparation and packaging of juvenile fish. According to the experience of the authors these procedures yielded the highest fish survival rate.

Treatment of pond fish against intestinal tapeworms before transfer to holding tanks

One of the main reasons why the authors specifically recommended the treatment of all juvenile fish produced at hatcheries in South Africa against infection by intestinal tapeworms is the occurrence in recent years of the tapeworm *Bothriocephalus acheilognathi*. The treatment is part of a series of procedures which precede the transportation of juvenile fish to other areas. Results show that this tapeworm specifically infests cyprinids (Brandt *et al.*, 1981; Van As *et al.*, 1981). Since 1981 this parasite has also been found in tilapia at fish farms and impoundments in various parts of the Transvaal. The authors consider that the prophylactic treatment of pond fish against internal and external parasites is essential in order to prevent the distribution of diseases from the hatcheries to fish farms. Experience, however, shows clearly that this procedure contributes towards a high survival rate of juvenile fish during transportation.

Prophylactic treatment of pond fish against intestinal parasites, prior to transportation, is done with the cestocide Lintex M (niclosamide: 2,5 — dichloro — 4' — nitrosalicylanilide). The fish are treated at a concentration of 1,33 g of Lintex M per kg of feed. This preparation can be blended with any available fish feed and even repelleted with a domestic mincer if relatively small numbers of fish are to be treated. The type of treatment followed is described in detail by Brandt *et al.* (1981). After the treatment period (which lasts approximately seven days), the juveniles are seined for further treatment against ectoparasites in holding tanks, prior to being transported elsewhere.

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Collection and transfer of fish to holding tanks

The collecting gear used may also play a role in mortalities which may occur amongst juvenile fish during the process of transfer of fish from the ponds to the treatment tanks. Depending on the size of the juveniles collected, the mesh size of the seine net selected for use is of considerable importance, as severe injury may be caused to fish juveniles attempting to escape. A few minutes before collecting, food is applied to one corner of the pond to be seined in order to attract the fish to that specific area. The authors found this procedure of collection of juveniles to be the best. The stirring up of mud from the bottom is reduced as the net is only used in one small portion of the pond. By encircling the fish in one corner, the juveniles accumulate in a small section of the net within the pond itself from where they are then transferred to containers. Buckets are used for transferring the juveniles to aerated containers filled with water. A quick estimate of the number of fish required for transfer can be obtained by using a sub sampler. This eliminates the undue handling and return of large numbers of juveniles to the ponds. Because of the high densities of fish usually handled in containers, there is a minimum delay between the time of collection at the ponds and the transfer of juveniles to holding tanks in the hatchery building.

Prophylactic treatment of fish in holding tanks

After transfer of juveniles to well aerated holding tanks, they are immediately treated against external parasites, according to procedures developed by Sarig (1971), Lahav and Sarig (1972) and Leteux and Meyer (1972). It was found that under local conditions the application of 40 $mg.\ell^{-1}$ formalin (Van As, *et al.*, 1984) and 0,05 $mg.\ell^{-1}$ malachite green applied simultaneously to the water in the holding tanks accommodating the fish yielded the best results. (Schoonbee, *et al.*, 1978). This treatment which lasts for a period of six hours, successfully removes external parasites present on the fish. Where considerable numbers of juveniles are required by fish farms, this treatment can also be applied directly to fish in the ponds (Sarig, 1971; Hepher and Pruginin, 1981). The authors, however, prefer the treatment of juveniles against parasites in containers, as this procedure allows for better control of treated fish.

After treatment, the holding tanks are drained and refilled with acclimated, well aerated water which is then circulated through a filter system for at least another 6 h period. During this time much of the faeces from the stomachs of the fish is removed. Only then are the fish ready for packaging.

Types of bags used for the transportation of fish

Bags made of nylon are recommended for the transportation of fish. Although more expensive than polythene types, they have proved to be more durable and allow for proper sealing.

Packaging of fish

Water used for the packaging of fish should preferably be acclimated by thorough aeration for a period of 2-3 days prior to use. Approximately 1 h before transfer of the fish to the plastic bags, the water in the holding tank as well as the acclimated water is cooled to 14-16°C with crushed ice. At this temperature, all warm-water fish, including cichlids belonging to the genera *Oreochromis* and *Tilapia*, will survive. At reduced temperatures the activity of the fish is suppressed. This reduces stress during transportation. The addition of the anaesthetic benzocaine-hydrochloride (Ferreira *et al.*, 1979, 1984) or MS222 (Sandoz) has been found to further relieve stress if used at a concentration of 10 $mg.\ell^{-1}$ (Ferreira, 1982; Ferreira *et al.*, 1984).

After treatment, the juveniles are transferred directly from the holding tanks to bags at 0,5 kg fish per ℓ. The bags are then filled with oxygen which is bubbled through the water during inflation. After inflation the bags are usually sealed with rubber bands, and to eliminate possible leakages of air and water they are placed into an opaque polythene bag, which in turn is also properly sealed. The fish are then transferred to suitable boxes for transportation.

Fish densities recommended for transportation

Following the above procedures, the fish can remain in the bags for as long as 24 h, with a low mortality rate. It was found that approximately 500 juveniles, ranging in mass from 2,5 g to 3,5 g, can easily be kept for 24 h in bags containing 3 ℓ of water. It is recommended that, where larger juveniles are transported, the numbers be reduced accordingly, so that the mass of fish package is approximately 0,5 $kg.\ell^{-1}$ water.

The direct transfer of fish from the ponds into bags for transportation is not recommended. An example of water quality deterioration and survival rates of fish treated prior to packaging, compared with fish transferred directly from the ponds to bags, is shown in Tables 1 and 2. It is evident that pH, ammonia and phosphate concentrations as well as conductivity of the water are markedly affected over a 24 h period. Whilst the oxygen concentrations in the water in both types of packaging remained sufficiently high throughout the 24 h period, a more rapid decline in oxygen levels occurred in those bags containing the untreated fish. This phenomenon is mainly ascribed to the presence of higher biochemical oxygen demand, possibly as a result of organic material and the presence of higher densities of bacteria in the water containing the untreated fish. The pH levels in both cases, however, showed a decline to below 7. A considerable accumulation of ammonia occurred, increasing from less than 0,150 $mg.\ell^{-1}$ to 29,541 $mg.\ell^{-1}$ (treated) and 40,41 $mg.\ell^{-1}$ (untreated) over the 24 h period. This phenomenon may be an important factor affecting the long term survival of juveniles in the bags. The deleterious effects of the discharge of excretory and other metabolic wastes on fish mortalities can clearly be seen amongst the untreated fish after 18 h (Table 1). At this stage, mortalities already increased from 11% to 30% within the following 6 h, compared to a 97% survival of fish subjected to the prescribed treatment.

Discussion

It is a well known fact that stress during the transportation of fish will result in mortalities. It has been shown that handl-

TABLE 1
OBSERVATIONS ON THE CHANGES IN THE WATER QUALITY OF PACKAGED FISH, TRANSFERRED DIRECTLY FROM PONDS, AFTER 6, 18 AND 24h, WITH NOTES ON FISH MORTALITIES WHICH OCCURRED DURING THIS PERIOD. (WATER ANALYSIS ACCORDING TO APHA, 1975)

Water analysis	Acclimated water used for packaging of fish	Water quality of packaged fish: After 6 hours 1	After 6 hours 2	After 18 hours 1	After 18 hours 2	After 24 hours 1	After 24 hours 2
Conductivity $\mu S.cm^{-1}$	260	868	730	1260	1145	1500	1445
Dissolved oxygen $mg.\ell^{-1}$	7,8	9,3	7,0	8,8	8,6	7,4	4,5
pH	7,81	6,58	6,45	6,49	6,46	6,50	6,40
Nitrate- N $mg.\ell^{-1}$	0,083	0,383	0,238	0,233	0,176	0,722	0,568
Ammonia-N $mg.\ell^{-1}$	0,123	15,480	18,050	27,574	26,574	39,893	40,410
Phosphate (PO_4) $mg.\ell^{-1}$	0,092	0,770	0,778	0,749	0,815	0,974	1,037
Number of fish per 3ℓ water		524	505	520	586	533	462
Number of dead fish		0	0	62	66	166	171
Mortality (%)		0	0	11,9	11,3	31,0	33,0

TABLE 2
OBSERVATIONS ON THE CHANGES IN THE WATER QUALITY OF PACKAGED FISH, TREATED PRIOR TO PACKAGING, AFTER 6, 18 AND 24 h, WITH NOTES ON FISH MORTALITIES WHICH OCCURRED DURING THIS PERIOD. (WATER ANALYSIS ACCORDING TO APHA, 1975)

Water analysis	Acclimated water used for packaging of fish	Water quality of packaged fish					
		After 6 hours		After 18 hours		After 24 hours	
		1	2	1	2	1	2
Conductivity $\mu S.cm^{-1}$	239	610	620	1170	1180	1510	1440
Dissolved oxygen $mg.\ell^{-1}$	8,2	6,8	9,4	13,1	12,9	10,8	9,6
pH	7,68	6,38	6,38	6,62	6,21	6,25	6,29
Nitrate-N $mg.\ell^{-1}$	0,066	0,163	0,176	0,128	0,216	0,229	0,229
Ammonia-N $mg.\ell^{-1}$	0,080	10,417	13,670	29,960	30,089	33,766	29,541
Phosphate (PO_4) $mg.\ell^{-1}$	0,012	0,697	0,713	0,818	0,870	0,953	0,991
Number of fish per 3ℓ water		634	480	553	549	505	552
Number of dead fish		0	0	1	4	15	19
Mortality (%)		0	0	0,2	0,7	3,0	3,0

ing stress on fish may induce changes in plasma composition and in certain erythrocyte parameters (Bouck and Ball, 1966). This is usually followed by an increase in the oxygen consumption of the affected fish (Chiltenden, 1973) and carbohydrate metabolism (Narasimhan and Sundararay, 1971). According to Hattingh and Van Pletzen (1974), and Hattingh *et al.*, 1975, the osmoregulatory induced stress after capture may be a major factor causing fish mortalities. The authors' experience has shown that higher mortalities occur amongst larger fish. Successful transportation of mature fish can however be facilitated by cooling the water to approximately 15°C and by using anaesthetics such as benzocaine hydrochloride or MS222 (Sandoz) at a concentration of 10 $mg.\ell^{-1}$ in the holding water. Ferreira *et al.* (1984) showed that the use of benzocaine-hydrochloride in the holding water may reduce the release of certain excretory wastes by fish during transportation. Woynarovich and Horváth (1980) also recommend Quinaldine as a possible anaesthetic during fish transportation. Hattingh *et al.* (1975), Rogers (1971) and Tripathi (1954) suggest the use of commercial NaCℓ at concentrations varying from 0,2% to 3% in the holding water, which they maintain assists in the reduction of fish mortalities during transportation.

The release of metabolic products, particularly excretory wastes, by fish into the holding water may be an important contributing factor inducing stress amongst fish and causing mortalities. By enabling fish intended for transportation to release as much of their gut contents as possible prior to packaging, and by reducing stress through light anaesthesia and cooling of the water, a significant reduction in mortalities can be obtained. Juvenile fish treated in this manner can be transported over prolonged periods for 18 to 24 h with minimum mortalities.

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