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Minimum dissolved oxygen tolerance of four different sizes of milkfish

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Milkfish, *Chanos chanos*, is perhaps one of the most hardy species amenable to culture in brackishwater ponds. Lin (1969) reported that the juveniles are euryhaline, can withstand salinities up to 108.6 ± 7.8 ppt and can live in temperatures between 8.5 and 42.7°C. Few, if any, of the other fishes that manage to enter brackishwater ponds and grow to marketable size together with milkfish have these characteristics. However, extensive fish kills still occur in milkfish ponds in the Philippines during the months of May and June. During this period the days are extremely calm, especially in the early morning hours, strongly suggesting that the kills are triggered off by dissolved oxygen depletion.

In ponds where two or more size groups of milkfish are present it has been observed that the bigger fish generally show manifestation of stress earlier than the smaller ones. Stress is manifested by frenzied swimming, breaking off of water surface and gasping. Dead fish shows darkened body coloration along the dorsal region. The same manifestations have been associated with stress caused by extreme salinity changes (Anonymous, 1972). On the other hand, Job (1957) reported that there was no "size effect" on asphyxial levels for 0.7 and 11.0 g milkfish with mean values of 1.05 mL/L at 20°C and 0.78 mL/L at 25°C for both size groups. He cautioned, however, against regarding these values as absolute indexes.

Four size groups of milkfish were tested, namely, 4-18 g, 20-34 g, 35-95 g and 200-300 g to determine the minimum dissolved oxygen tolerance of four different size groups of milkfish under simulated conditions. A number of fish from each group was placed separately in identical 1.2 m² wooden tanks containing seawater filled up to 30 cm depth. The aggregate weight of fish per size group was approximately 1 kg. The fish were held for 72 hours, fed with lab-lab and provided with continuous aeration to allow recovery from stress during transport and handling.

After the recovery period, aeration was stopped and 200 g of fine rice bran spread over the water in each tank creating a film of bran particles on the water surface. This was designed to speed up depletion of dissolved oxygen considering the combined effects of the screening-off of sunlight, the reduction of air-water interface and the breakdown of the bran particles.

Water quality was monitored initially and every hour thereafter until the fish showed signs of stress, then at median lethal concentration (TL/50) time and finally when all the fish were dead (TL/100). Four runs were conducted from July through September, 1977.

A YSI model 57 D.O. meter was used to measure dissolved oxygen down to about 1 ppm level, switching to titration at the lower levels following the standard Winkler method described in Strickland and Parsons (1972) procedures. Free carbon dioxide, ammonia-nitrogen and nitrite-nitrogen were monitored following the procedures in the above-mentioned reference. A Shimadzu Spectrophotometer UV-100-02 at 640 nm and 510 nm was used for ammonia-nitrogen and nitrite-nitrogen respectively.

Initial dissolved oxygen ranged from 7.2 to 8.0 ppm at the start of the experiment. Tolerance of the four size groups of milkfish to decreasing levels are shown in Table 1.

The first sign of anoxia characterized by frenzied swimming and gasping was observed at 1.36 ± 0.06 ppm for the 200-300 g size group compared to 0.96 ± 0.06 ppm for the 4-18 g size group. Similarly, TL/50 was observed at higher dissolved oxygen levels for the bigger size group

compared to the smaller size group with values of 0.40 ± 0.02 ppm and 0.12 ± 0.01 ppm for the 200-300 g and 4-18 g size group, respectively. TL/100 was observed in 11-15 minutes from the first sign of stress for all size groups. In general, tolerance to decreasing dissolved oxygen level showed that bigger size groups were affected earlier than the smaller size groups.

Salinity ranged from 20 to 30 ppt in all tanks and in all trials. Water quality measurements are presented in Tables 2-5.

There was no marked variation in the physico-chemical parameters among the different size groups from the initial readings until the end of each trial. Dissection of dead milkfish showed neither clogging of the gills nor obstruction of the stomach and intestines. All indications therefore, strongly suggested that death was mainly due to anoxia.

Based on the results obtained in this study, it is probable that stress on milkfish in brackishwater ponds could start when oxygen level drops to about 1.4 ppm. A further decrease to 0.04 ppm could produce a total kill of all specimens above 4 grams with marketable size and bigger size fish dying first.

Table 1. Tolerance of four size groups of milkfish to decreasing dissolved oxygen levels.

Size group of milkfish	200-30 g	35-95 g	20-34 g	4-18 g
Reaction	Dissolved oxygen level in ppm			
1st symptom of anoxia	1.36 ± 0.06	0.18 ± 0.02	1.00 ± 0.07	0.96 ± 0.06
Initial lethal concentration	0.50 ± 0.02	0.40 ± 0.03	0.34 ± 0.03	0.32 ± 0.02
Median lethal concentration (TL/50)	0.40 ± 0.02	0.24 ± 0.03	0.18 ± 0.03	0.12 ± 0.01
Total fish kill (TL/100)	0.27 ± 0.04	-0.17 ± 0.02	0.12 ± 0.04	0.04 ± 0.01

Table 2. Mean range of water quality measurements for size group 200-300 g

Parameters	Initial	1st symptom of anoxia	TL/50	TL/100
Temperature ($^{\circ}$ C)	31-33.2	32-34	32-34	32-34
pH	6.4-6.8	6.3-6.7	6.3-6.6	6.3-6.6
Free CO ₂ (ppm)	29-44	30-46	30-46	30-46
Ammonia-N (ppm)	0.10-0.58	0.11-0.58	0.11-0.58	0.11-0.60
Nitrite-N (ppm)	0.00-0.08	0.00-0.08	0.00-0.10	0.00-0.10

Table 3. Mean range of water quality measurements for size group 35-95 g.

Parameters	Initial	1st symptom of anoxia	T/L 50	TL/100
Temperature (°C)	31-33.2	31-34	32-34	32-34
pH	6.3-6.7	6.3-6.6	6.3-6.7	6.3-6.6
Free CO ₂ (ppm)	30-43	32-43	34-46	30-44
Ammonia-N (ppm)	0.00-0.58	0.11-0.58	0.12-0.60	0.11-0.60
Nitrite-N (ppm)	0.00-0.08	0.00-0.08	0.00-0.08	0.00-0.09

Table 4. Mean range of water quality measurements for size group 20-34 g.

Parameters	Initial	1st symptom of anoxia	TL/50	TL/100
Temperature (°C)	31-33.1	31.8-34.1	32-34.2	<u>32-34.2</u>
pH	6.3-6.8	6.3-6.7	6.3-6.6	6.3-6.6
Free CO ₂ (ppm)	32-42	<u>34-46</u>	<u>35-46</u>	<u>36-44</u>
Ammonia-N (ppm)	0.11-0.60	0.10-0.55	0.11-0.55	0.11-0.55
Nitrite-N (ppm)	0.00-0.08	0.00-0.08	0.00-0.10	0.00-0.10

Table 5. Mean range of water quality measurements for size group 4-18 g.

Parameters	Initial	1st symptom of anoxia	TL/50	TL/100
Temperature (°C)	31-33.3	32-34	32.2-34.2	32.2-34.2
pH	6.4-6.8	6.3-6.6	6.3-6.6	6.3-6.6
Free CO _x (ppm)	<u>31-43</u>	32-44	36-44	36-46
Ammonia-N (ppm)	0.10-0.56	0.10-0.57	0.11-0.60	0.11-0.60
Nitrite-N (ppm)	0.00-0.09	0.00-0.09	0.00-0.10	0.00-0.10

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