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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

Weight Loss of Pond-Raised Channel Catfish (*Ictalurus punctatus*) During Holding in Processing Plant Vats

DONALD C. GREENLAND and ROBERT L. GILL

SEATTLE, WA.
December 1971

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Weight Loss of Pond-Raised Channel Catfish (*Ictalurus punctatus*) During Holding in Processing Plant Vats

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ABSTRACT

Information on weight loss and mortality was obtained for samples of channel catfish (*Ictalurus punctatus*) held for processing at a catfish processing plant located at Dumas, Ark. Weight losses were determined for several different holding situations by daily weighings of samples held in wire containers. Mortality was recorded at 24-hr intervals. Test results showed peak weight loss during the test period for all holding situations averaged 55 kg per metric ton (5.5 lb. per cwt), 82.0% of which occurred during the first 48 hr of holding. There was no difference in weight loss of fish held at densities of 320.3 kg per cubic meter (20.0 lb. per cu ft) and 640.6 kg per cubic meter (40.0 lb. per cu ft) of water ranging from 21.1° to 22.2° C (70.0° to 72.0° F). However, at the heavier loading there was twice the mortality, 8.0% compared to 4.5%. Fish held in a pond with temperatures from 8.9° to 15.0° C (48.0° to 59.0° F) fared the best of any of the test groups. These fish had a peak weight loss of 2.0% and suffered no mortality. Similar groups of fish held in vats at 21.1° C (71.0° F) aerated with agitators and compressed air had peak weight losses of 4.2% and 6.9% and suffered mortalities of 34.0% and 15.0% respectively.

INTRODUCTION

Most of the catfish processing plants located in Alabama, Arkansas, and Mississippi utilize live fish delivered to their plants to insure a high-quality finished product. These catfish are held in large concrete vats at the plants. As needed, fish are removed from the vats, killed, and run directly onto the processing line. Processors have often mentioned to us that the weight of fish being held for processing "shrinks" from pond-side weighings and that weight deductions for scrap fish and removal of dead catfish account for only a portion of the difference. These weight discrepancies have caused misunderstandings between farmers and processors. Without accurate "shrink" data, processors have been reluctant to consider changing plant facilities to try to reduce weight loss. Our assistance was requested to obtain data that would be helpful to processing plant managers in deciding whether fish weight losses were indeed a problem. During the winter of 1970-71, a study to determine this was conducted at the Southern Catfish Processors, Inc. in Dumas, Ark., by National Marine Fisheries Service personnel.

TEST PROCEDURES

Samples of channel catfish (*Ictalurus punctatus*) coming into the processing plant located at Dumas, Ark., were weighed and placed in wire-mesh containers located in the plant holding vats. These containers were weighed at approximately 24-hr intervals (Fig. 1 and 2) and the weight change was determined by comparing the daily reading with that of the previous day. If mortality had occurred in the interim, the dead fish were removed and weighed, and these data were used to establish the beginning weight for the following day.

The fish used in this study came from several farms. All were harvested by seining and had been held in the net for periods ranging from a couple of hours to 2 days. These fish were delivered to the plant in Dumas, Ark., in haul trucks equipped with agitators and had spent from 2 to 4 hr in transit.

Three series of tests were conducted over a 3-month period. During this time, water temperatures in the holding vats ranged from 21.0° to 22.0° C (70.0° to 72.0° F). The ponds from which the test populations came had water temperatures of 8.9° C (48.0° F), 10.0° C (50.0° F), and 13.9° C (57.0° F) for Tests "A", "B", and "C".

Test "A" consisted of measuring weight changes in four pots: the first two contained 90.7 kg (200.0 lb.) of channel catfish each, and the second two, 181.4 kg (400.0 lb.) of fish each. Fish densities were 320.3 kg (20.0 lb.) and 640.6 kg (40.0 lb.) per cubic meter (cu ft) of water. These pots were set in line near the

Figure 1.—Weighing container of channel catfish held in pond to determine weight change.

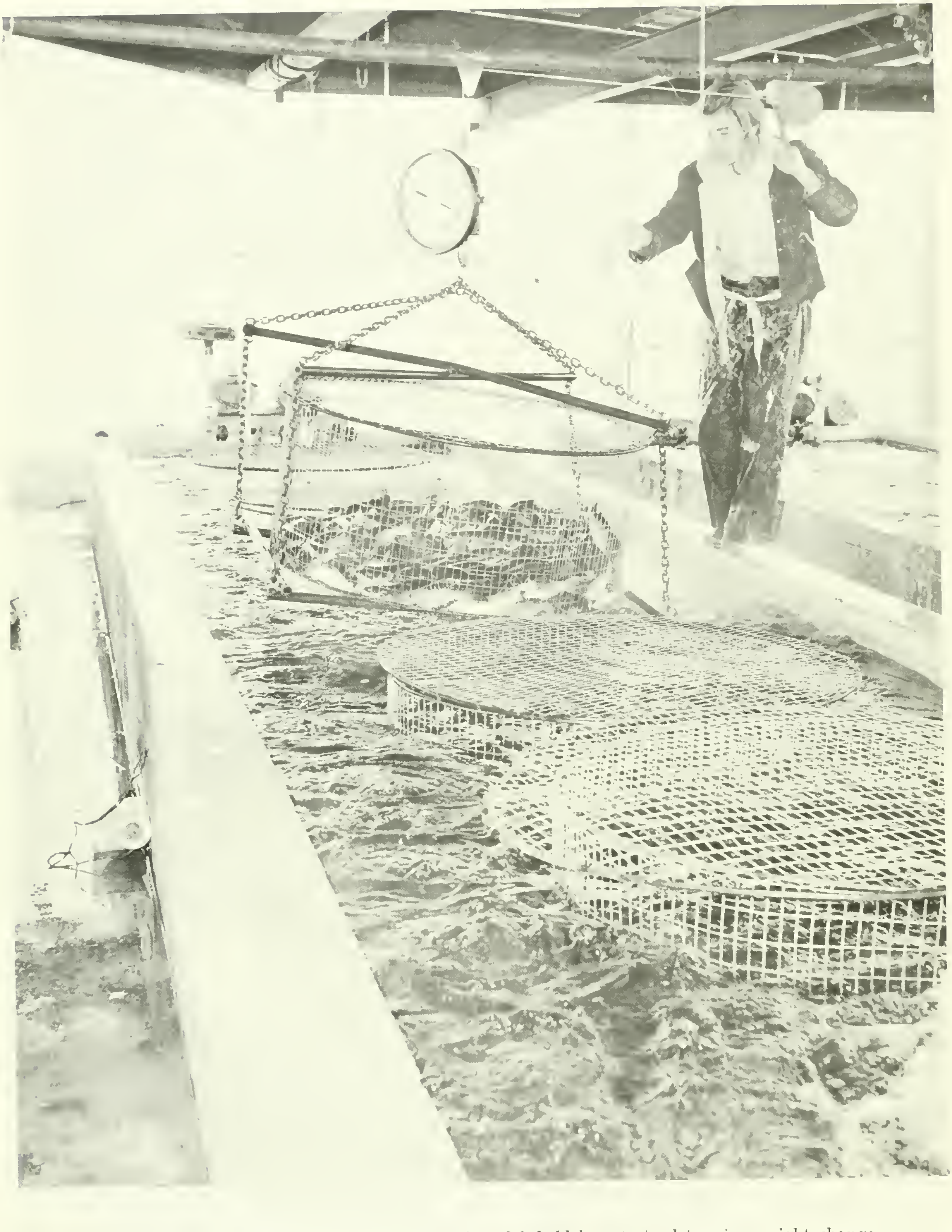

Figure 2.—Weighing container of channel catfish held in vats to determine weight change.

head of a holding vat being aerated by compressed air delivered through three perforated plastic hoses fastened to the vat bottom. A clearance of about 0.46 m (1.5 ft) was allowed between pots. Fish being held for the plant were present in this vat and circulated freely around the pots.

Test "B" was similar to "A" except that two additional pots were used as controls to determine if the daily disturbance of weighing caused undue weight loss or mortality. These two pots, one containing 90.7 kg (200.0 lb.) of fish and the other 181.4 kg (400.0 lb.) were weighed only at the start and at the termination of Test "B".

After the results of Tests "A" and "B" were examined, additional tests were run to determine if different holding conditions would alter experimental results. Six pots, each containing 136.1 kg (300.0 lb.) of catfish, were used. Two were placed in a vat which was aerated with agitators, two were positioned in vats aerated with compressed air, and the last two were put in a small, dirt, holding pond located adjacent to the plant. Water temperatures were 21.1° C (71° F) in both vats and ranged from 8.9° to 15.0° C (48.0° to 59.0° F) in the pond during testing. As in the previous experiments, all the pots were weighed at approximately 24-hr intervals, using the same set of scales and the same procedures.

TEST RESULTS

All groups of test fish lost weight during the 7-day holding period (Table 1). In all tests the bulk of this weight loss occurred during the first 3 days. Figure 3 shows the results

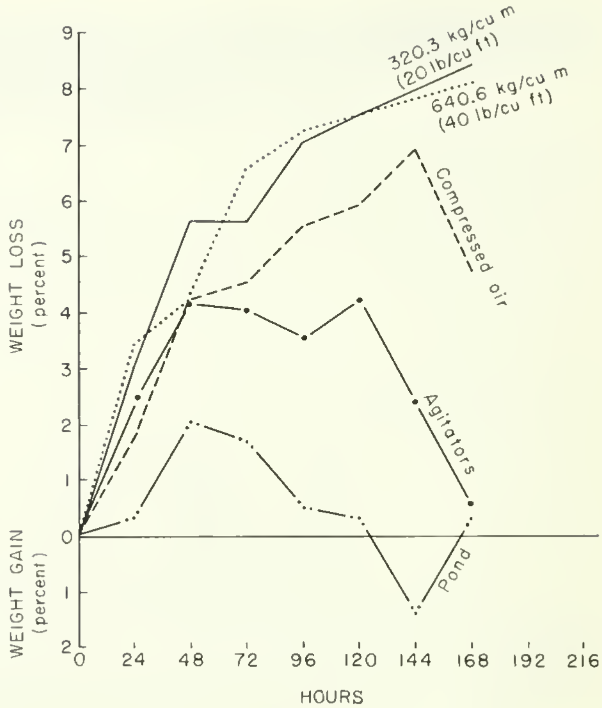

Figure 3.—Cumulative weight loss in percent for channel catfish held at different concentrations and in different water conditions.

of tests comparing concentrations of 320.3 and 640.6 kg of fish per cubic meter (20.0 and 40.0 lb. of fish per cu ft) of water, for fish held in vats having different aeration systems, and for fish held in cooler pond water. In all cases, the most rapid rate of weight loss occurred during the first 48 hr. Surprisingly, the weights were static for almost all of the test groups between the third and fourth weighings (48 to 72 hr). After passing this plateau, the

Table 1.—Weight change in percent for individual samples.

Day	Test "A"				Test "B"						Test "C"					
	Pot:				Pot:						Pot:					
	1	2	3	4	1	2	3	4	5	6	1	2	3	4	5	6
1-2	−4.9	−2.9	−3.2	−4.2	−1.9	−2.2	−1.9	C	−3.9	C	−1.7	−2.0	−2.4	−2.1	−0.3	−0.3
2-3	−1.0	−3.0	−1.8	−1.0	−3.3	−3.2	−2.2	O	−2.0	O	−2.6	−2.0	−1.4	−2.2	−1.3	−2.0
3-4	−1.0	+0.5	−2.1	−2.1	+0.8	−0.1	−0.1	N	−1.4	N	−0.6	0.0	+0.1	0.0	+0.3	+0.3
4-5	0.0	−1.5	−0.5	−1.1	−2.6	−1.5	−1.0	T	−0.5	T	+0.6	−2.5	+0.1	+0.8	+1.0	+1.3
5-6	--	--	--	--	−1.7	−1.5	−0.6	R	+0.2	R	−0.6	−0.1	−0.4	−1.0	−0.0	+0.3
6-7	--	--	--	--	−0.5	−0.3	−0.9	O	+0.3	O	−1.7	−0.3	+2.4	+1.4	+1.6	+0.7
7-8	0.0	0.0	−0.3	−0.3	+0.1	−0.8	0.0	L	−0.5	L	+3.0	+1.4	+2.5	+3.0	−1.6	−0.7
Total	−6.9	−6.9	−7.9	−8.7	−9.1	−9.6	−6.7	−9.4	−7.8	−9.2	−3.6	−5.5	+0.9	−0.1	−0.3	−0.4

Table 2.—Mortality in kilograms for individual samples.

Hours	Test "A"				Test "B"						Test "C"					
	Pot:				Pot:						Pot:					
	1	2	3	4	1	2	3	4	5	6	1	2	3	4	5	6
24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	12.3	0.0	0.0	6.8	0.0	0.0
48	0.0	0.0	0.5	0.0	5.3	8.0	18.4	0.0	0.8	0.0	0.2	0.0	0.5	0.0	0.0	0.0
72	0.0	0.0	0.4	0.0	0.0	0.0	3.9	0.0	0.0	0.0	2.0	1.5	1.1	1.0	0.0	0.0
96	0.5	0.4	2.1	1.3	0.8	0.0	0.0	0.0	1.0	0.0	3.9	2.1	2.2	5.1	0.0	0.0
120	--	--	--	--	0.0	0.6	0.0	0.0	3.7	0.9	2.3	3.2	6.9	6.5	0.0	0.0
144	--	--	--	--	1.0	1.1	0.0	0.0	3.8	0.0	2.2	1.3	15.5	8.5	0.0	0.0
168	1.2	1.8	12.3	16.1	1.4	0.0	2.5	0.0	3.3	0.3	5.5	4.2	19.1	19.8	0.0	0.0
Total	1.7	2.2	15.3	17.4	8.5	9.7	24.8	0.0	12.6	1.6	28.4	12.3	44.9	47.7	0.0	0.0

curves showing weight loss for Tests "A" and "B" continued at a much reduced level for the last 96 hr. The Test "C" curves started a similar trend, but during the final days of the test period these curves started downward, indicating the fish were possibly regaining some weight.

Daily mortality was tabulated in kilograms (Table 2). The greatest mortality, 34.0%, occurred to Test "C" fish held in the vats aerated by agitators. Test "C" catfish held in the vats supplied with compressed air suffered 15.0% mortality. Mortality for the 320.3 and 640.6 kg (20.0 and 40.0 lb.) loadings of fish in Tests "A" and "B" averaged 4.5% and 8.0%, respectively. Almost no mortality occurred to fish held in the two control pots in Test "B" and none occurred to the Test "C" fish held in the cool pond water.

The effect of the daily handling on weight loss and mortality was checked with two control groups in Test "B". These two containers, one with a fish density of 320.3 kg per cubic meter (20.0 lb. per cu ft) of water and the other with a fish density of 640 kg (40.0 lb.), were weighed every 24 hr. The weight loss for the controls averaged 9.3%; for the pots weighed every 24 hr, the loss was 8.4%. It appears that daily weighing did not contribute to weight loss. The daily handling during weighing did cause mortality. In the containers handled every 24 hr, 8.0% of the fish held at the higher density died and 4.5% of the fish held at the lower density succumbed. None of the 320.3 kg (20.0 lb.) control group died and only 0.9% of the fish expired at the heavier loading of 640.6 kg (40.0 lb.).

The test results comparing weight losses of fish held at concentrations of 320.3 kg and 640.6 kg per cubic meter (20.0 and 40.0 lb. per cu ft) of water indicated that at these loadings density had little effect. At the end of 168 hr, containers with 320.3 kg (20.0 lb.) of fish incurred an average weight loss of 8.4% and those with 640.6 kg (40.0 lb.) of fish lost 8.1%. Even though density did not appear to affect weight loss, it did contribute to higher mortality. At the end of the test period, containers with the heavier loadings sustained twice the mortality of those with 320.3 kg (20.0 lb.) of fish: 8.0% compared to 4.5%.

The results of the tests comparing weight losses in vats aerated by compressed air and by agitators indicated the peak weight loss was slightly greater in the compressed air situation than with agitators (6.9% compared to 4.2%). However, a substantially greater mortality occurred in the vat with agitators (34.0% compared to 15.0%).

The two containers of fish held in the cool pond water fared the best of any of the test groups. The peak weight loss for those fish averaged 2.0%. No mortality was recorded.

The test results for all groups of fish held in the plant vats indicated weight losses were fairly similar at the end of 48 hr (Fig. 3). The average loss during this period of 45 kg per metric ton (4.5 lb. per cwt) constitutes 82.0% of the peak weight loss of 55 kg per metric ton (5.5 lb. per cwt) for these groups. The maximum weight losses for each test situation show the containers with 329.3 and 640.6 kg (20 and 40 lb.) of fish lost 84.0 and 81.0 kg per metric ton (8.4 and 8.1 lb. per cwt). Fish held in vats aerated by compressed air and by agitators lost 69.0 and 42.0 kg per metric ton (6.9 and 4.2 lb. per cwt), respectively; those in the cooler pond water incurred a 20.0 kg per metric ton (2.0 lb. per cwt) loss.

DISCUSSION

All groups lost weight during the test period. However, during the last few days of the test some positive weight change readings were obtained, indicating some of the groups, particularly those in Test "C", were regaining weight. This seemed highly unlikely as none of the fish were being fed and all were under stress because of the holding situation. We surmised that these positive weight changes were caused either by the test gear or procedure and were not the result of fish growth.

Perhaps some of these positive observations could be attributed to misreading the weighing scales; and, as the scale was calibrated prior to each day's weighing, there could have been some misadjustment. Another possibility was that the scale itself was inaccurate. However, this unit had been sent to the manufacturer prior to the beginning of these tests for cleaning and reconditioning. It has since been checked against other scales and found to be accurate. It is doubtful any of these factors would account for the large percentage (23.0%) of positive daily observations observed.

We speculated that wind blowing on certain days might have affected the suspended scale. The weighing operations were conducted in an open shed, and perhaps wind pressure on the lift cable might be biasing the test results. However, examination of meteorological observations for the general area does not support this.

One of the most reasonable explanations for the positive weight gains was the possibility that the fish became infected with hemorrhagic septicemia, a bacterial infection which can impair kidney function and cause water retention and which would result in a weight gain. As each test progressed, the condition of the test population deteriorated and some of the fish in all the test groups exhibited outward signs of bacterial infection. However, none of these fish was examined by anyone qualified to make a positive diagnosis of hemorrhagic septicemia, nor was it determined that kidney damage occurred. One other consideration that lends support to a disease-caused weight increase was that positive weights did not occur until the third day of holding in any of the tests, indicating a build-up time was required, as would be expected in a bacterial disease.

One known factor that biased our figures was the presence of dead fish in the containers at the time of weighing. We determined that dead fish held in the plant's holding vats gained weight. Samples of fish that averaged 764.0 g (26.9 oz) were sacrificed, and, over a 24-hr period, gained an average of 62.5 g (2.2 oz). This weight increase amounted to 8.2% of the beginning weight. A complication in utilizing this information to adjust data when dead fish were present was the fact that it was not known when individual fish succumbed nor how long they had been dead. Without this information, appropriate weight adjustments for mortality could not be allocated.

Two additional factors that could affect weight changes have been suggested for our consideration; the time of last feeding and the state of sexual maturity. During the period the weight loss study was conducted, mid-December to late March, the influence of both these factors would be minimal. However, at other seasons of the year, particularly in late spring, both these variables would have to be accounted for in studying weight changes during holding.

Regardless of the cause, weight losses, particularly in the last days of Test "C", were masked by unknown factors and losses would probably have been greater than shown. We are suspicious of the figures showing slightly more weight loss in vats with compressed air than those having agitators, and would like further verification of this before accepting this as fact.

This study did not determine whether the weight losses that occurred during holding were evident in the finished product, the dressed fish. This point and other factors encountered, such as the effect of fish density on mortality, the damage caused by handling, and the possibility of using cool water to reduce mortality and weight loss would be worthwhile research projects for future programs.

CONCLUSIONS

Based on the test results, the following conclusions were made concerning catfish weight loss and mortality during holding:

1. Channel catfish lose weight during holding. Most of the loss occurs during the first 48 hr and the test results showed 82.0% of the maximum average weight loss of 55 kg per metric ton (5.5 lb. per cwt) occurred during this period.

2. Weight loss was similar for fish held at densities of 320.3 and 640.6 kg per cubic meter (20.0 and 40.0 lb. per cu ft) of water but mortality was twice as much, 8.0%, for the higher concentrations of fish.

3. Handling the fish every 24 hr to weigh them did not contribute to weight loss but did cause mortalities of 4.5% and 8.0% to occur in containers with loadings of 320.3 and 640.6 kg of fish per cubic meter (20 and 40 lb. per cu ft) of water.

4. Our data showed fish held in vats with agitators suffered slightly less weight loss than those held in vats supplied with compressed air. Mortalities, however, were 34.0% with agitators and 15.0% with compressed air. Because of this large mortality, and a number of positive weight readings during the final days of this test, we are hesitant of accepting these results. Additional studies should be conducted before judging the merits of aerating vats with agitators or compressed air.

5. Fish held best in cool pond water of 8.9° to 15.0° C (48.0° to 59.0° F): they suffered no mortality and had a maximum weight loss of 2.0%. Similar fish held in vats with 21.7° C (71° F) water incurred twice the weight loss and had mortalities averaging 15.0% and 34.0%.

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