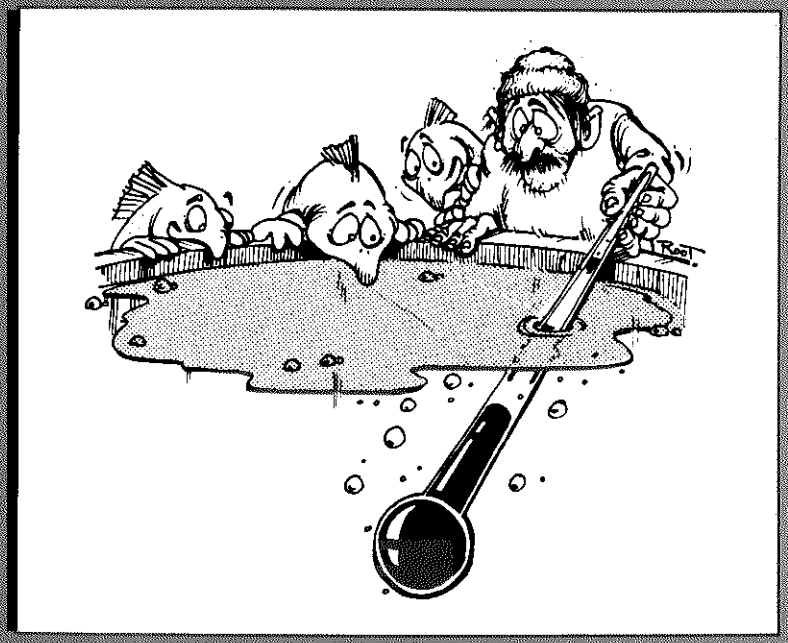
SALMON QUALITY
THE EFFECTS OF DELAYED CHILLING



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INTRODUCTION

Producing good quality salmon begins with the fisherman, who determines the quality of fish the with which the processor will work. With the record salmon catches of recent years and intense competition in the markets, quality has become much more important. This has required that processors be more critical of their purchases and emphasized the necessity for fishermen to deliver good quality fish.

There are three critical elements in producing good quality salmon: cleanliness, care and cooling. A clean hold and clean working surfaces help prevent bacterial contamination. Proper care minimizes bruising and other physical abuse of the salmon. Finally, cooling slows bacterial growth and enzyme activity.

Proper cooling of the catch is the most important action that a fisherman can take. Chilling reduces the two most frequent causes of quality loss: bacterial spoilage and enzyme activity. Each of these are responsible for a considerable loss of salmon each year. Two factors make chilling effective: the temperature of the fish must be reduced to 32^{o} F and the chilling must be done quickly.

However, the process of "quick" chilling differs widely in Alaska's salmon fisheries. Physical constraints in some salmon harvesting areas make it impossible to chill fish until they are picked up by a tender or landed at the processor's dock eight to 24 hours after they are caught. In other areas, chilling starts as soon as the fish is brought aboard the fishing vessel. These different chilling practices cause wide variation in salmon quality.

This paper reports on an investigation of the quality changes that occur when chilling is delayed 0, 12, 24, and 48 hours. It also provides the basis for recommendations on how quickly fish should be cooled.

THE EXPERIMENT

Sixty-four fresh coho salmon were obtained from a seiner on the fishing grounds and were immediately dressed and cleaned. Sixteen fish were immediately iced in a tote, and called the 0-delay fish. The remaining fish were held at ambient temperature, approximately 50°F. At intervals of 12, 24 and 48 hours, a batch of 16 of these fish were iced in a plastic tote. All fish were held for eight days in the iced totes. Ice was added to the totes as needed to maintain the fish at 32°F.

After eight days, the fish were assessed visually and by a taste panel. The taste panel evaluated odor and flavor using a ten-point desirability scale as the criteria for quality. The scale ranged from a highest value of 10 to a lowest value of one. Any score lower than four meant the fish was unacceptable.

The Torrymeter, a device used to measure the relative quality of iced fish, was also used to determine the condition of the fish. The Torrymeter values range from 16, meaning excellent quality, to 0, meaning very poor quality.

RESULTS

VISUAL EXAMINATION

By visual examination, the 0-delay fish were in the best condition. These fish retained most of their scales and were firm. They were odorless and their eyes were bright. There was no drying on any surface of the fish.

Fish held for 12 hours before chilling had a slight odor and the eyes were dull, however the flesh was still firm and moist. There was also little scale loss in these fish.

With a 24-hour delay in chilling, the visual changes were dramatic. These salmon were noticeably soft with a strong fishy odor. The skin was dry and cracked from moisture loss. Their eyes were dull and sunken into the head.

The 48-hour delay fish were in the poorest condition, with considerable softness, strong odor, sunken red eyes and dried skin. Both the 24 hour and the 48 hour fish had lost a substantial number of scales during storage. These results are summarized in Table 1.

Table 1. Results of visual examination of fresh salmon held in ice for eight days after various periods of delay

Treatment (Hours of delay)	Condition
0 hours	firm flesh no odor bright, clear eyes no scale loss moist skin
12 hours	firm flesh slight fishy odor dull eyes 10 percent scale loss moist skin
24 hours	soft flesh strong fishy odor sunken, cloudy eyes 40 percent scale loss dry patches on skin
48 hours	very soft skin strong fishy odor sunken, red eyes 60 percent scale loss dry skin

TORRYMETER RESULTS

The Torrymeter, by measuring electrical resistance of the fish's skin, confirmed the visual examination. As the electrical resistance is reduced, the Torrymeter numbers become smaller and indicate a loss of quality in the fish. Table 2 shows the Torrymeter values for the fish from this experiment.

Table 2. Mean Torrymeter values for fresh salmon held in ice for eight days after various periods of delay

Treatment (Hours of delay)	Condition
0 hours	5.60
12 hours	3.10
24 hours	1.13
48 hours	0.09

There were significant differences among the four groups of fish. The longer the chill delay, the lower the Torrymeter value and fish quality. The loss of quality during the storage period is shown in Figure 1. For each delay period, the rate of quality loss was different. There was a faster quality loss with 24 and 48 hour delays in chilling than there was with no delay. In research on cod, a Torrymeter value of four or less indicates poor quality fish.

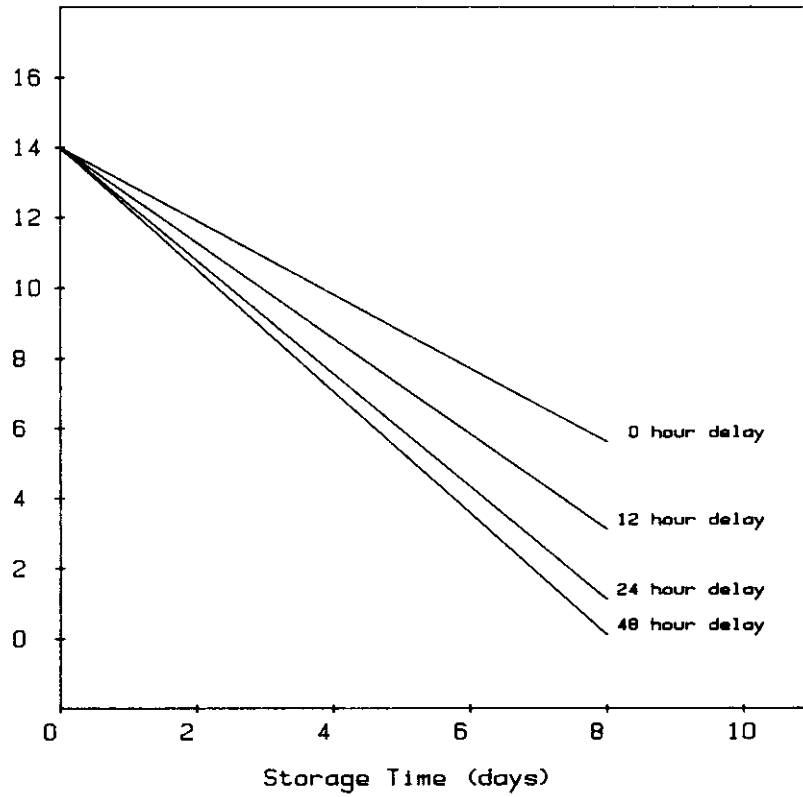

Figure 1. Loss of quality during the storage period.

TASTE PANEL RESULTS

The results of the taste panels are shown in Table 3. The flavor of the samples revealed a significant difference between the 48 hour delay and other samples. There was no significant statistical difference among the 0, 12 and the 24 hour delay samples, although the 0-hour delay fish received the highest flavor scores.

Table 3. Mean flavor and odor scores for fresh salmon held in ice for eight days after various periods of delay[1]

Treatment (Hours of delay)	Flavor	Odor
0 hours	6.65[a]	6.48[a]
12 hours	6.50[a]	6.41[a]
24 hours	6.55[a]	6.41[a]
48 hours	5.98[b]	5.95[b]
Controls (frozen)	6.58[a]	6.31[ab]

[1] Mean values in a column with the same exponent did not vary significantly (p=.05) from one another.

The values for odor showed a similar pattern. There was a significant difference between the 48 hour samples and all others, with the 48 hour samples rated the lowest. There was

no significant statistical difference among the 0, 12 and 24 hour samples, although the 0-hour sample was rated as having the least odor.

The taste panel evaluations revealed that the longer the chill delay, the poorer the flavor and odor of the fish, and that holding the fish 48 hours before chilling produced significantly poorer flavor and odor than when fish were chilled sooner.

CONCLUSION

The experiment demonstrated that it is important to chill fish as soon as possible. The 0-hour fish, those cooled without delay, had the best appearance, the highest Torrymeter values and the highest taste panel scores. The 12 and 24 hour-delay fish were slightly lower in all categories indicating that there was some measurable quality loss. The 48-hour delay fish were the worst samples, rated lowest in all categories.

The recommendation from this experiment is to chill the fish immediately after catching them. This will minimize the loss of quality caused by bacterial spoilage and enzyme acactivity. Immediate icing, along with careful physical handling will allow the fisherman to deliver the best quality product possible. Fish held longer than 24 hours without chilling will suffer significant quality loss.