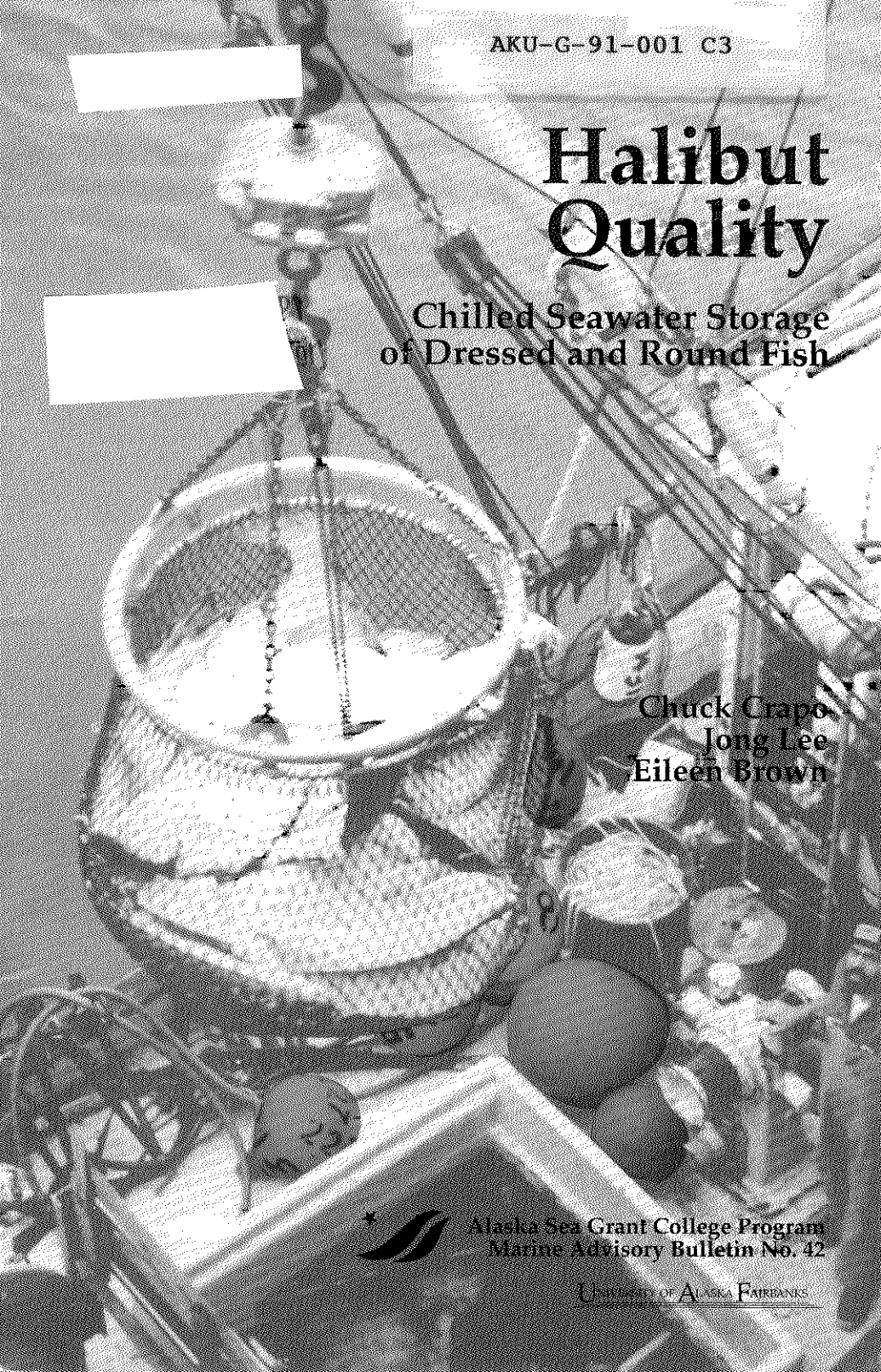
Halibut Quality

Chilled Seawater Storage of Dressed and Round Fish



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Alaska Sea Grant College Program
Marine Advisory Bulletin No. 42

University of Alaska Fairbanks

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MAB-42 1991 Price: $2.00

Elmer E. Rasmuson Library Cataloging-in-Publication Data.

Crapo, Chuck.
Halibut quality : chilled seawater storage of dressed and round fish.

(MAB-42)

1. Halibut fisheries—Alaska—Quality control. 2. Fishery products—Preservation. 3. Fishery processing. I. Lee, Jong S. II. Brown, Eileen. III. Alaska Sea Grant College Program. IV. Title. V. Series: Marine advisory bulletin ; 42.

SH351.H2C73 1991

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About This Publication

Cover photo is by Kurt Byers, cover design is by Karen Lundquist, editing is by Sue Keller, and text formatting is by Lisa Sporleder. This booklet was produced by the Alaska Sea Grant College Program, which is cooperatively supported by the University of Alaska with state funds and by the U.S. Department of Commerce, NOAA Office of Sea Grant and Extramural Programs, under grant no. NA90AA-D-SG066, project no. A/71-01 and A/75-01.

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Introduction

The Alaska halibut fishery has changed drastically in the past several years. Once a six month fishing season, the halibut season now has been reduced to four or five days. A fisherman can catch 100,000 pounds of halibut in 24 hours. This is sometimes more fish than fisherman and processor can properly handle, resulting in quality problems and complaints from the market.

Traditional on-board handling of halibut has been to dress and thoroughly ice each fish. This was essential during the long trips of the 1960s and 1970s. With much shorter fishing periods, proper dressing and icing is frequently delayed so the crew can continue fishing. Round fish may lie on deck or in the hold many hours before they are dressed. Frequently, the unchilled fish rapidly loses its fresh quality.

Many processors have strict policies, accepting only dressed halibut. To accommodate this, some fishermen dress their catch while waiting to unload. This usually involves bringing the halibut up from the hold, dressing, and then re-icing. The extra handling may cause additional quality loss.

Much controversy exists about the handling and storage of round halibut. There is a general perception that halibut stored in the round lose quality very fast. Since seasons are so short, is it preferable to chill the round fish quickly or follow traditional methods of dressing and icing? Are there quality differences between short-term storage of round and dressed halibut? This publication reports on an investigation of the quality changes in round and dressed halibut held in chilled seawater systems.

The Experiment

Twenty-eight halibut (18 round and 10 dressed) were caught by an International Pacific Halibut Commission (IPHC) charter vessel, bled, chilled to 32°F in ice and delivered within 15 hours. The fish were transferred to three chilled seawater systems. Dressed fish were held at 32°F and round fish at 32°F and 40°F for up to 12 days.

At periods of two, four, six, and eight days, two halibut were removed from each system for examination. Fish quality was measured by visual examination, Torrymeter (an instrument that measures relative fish quality), chemical analysis, and microbial count. Samples for the chemical tests were taken from flesh near the sweetmeats and gonads, areas expected to deteriorate quickly. Microbial samples were taken by swabbing the belly flap. Round halibut stored at 40°F were held for 12 days to observe long-term temperature abuse conditions.

After examination, fletches were cut from each fish, plate frozen at -40°F, and held for six months at 0°F for taste panel assessment.

Two dressed halibut were used as control fish (0 days storage). Initial Torrymeter values, microbial counts, and trimethylamine (TMA) levels were from samples taken as the fish were unloaded. Fletches from these fish were frozen for taste panel assessment.

Results and Discussion

Visual Changes

Visual inspection determined quality changes occurring during the storage period (Table 1). Changes in poke odor and decomposition (belly burn), flesh odor and firmness, condition of the eyes and gills, and meat discoloration were recorded. No differences existed among the three treatments after two days storage, although the halibut held at 40°F had slightly sunken eyes and bleached gills. All fish had firm flesh with no odor and a neutral gut smell.

By the fourth day of storage, round and dressed halibut held at 32°F showed slight flesh softness. Round halibut also had a slight gut odor. The fish at 40°F was deteriorating with slight belly burn and acidic flesh odor, buildup of slime on gills, and reddening eyes.

At day six, more differences appeared between dressed and round fish held at 32°F. The round halibut had a slight acidic flesh odor, belly burn, and gut odor. The dressed fish showed no flesh odor although the gut cavity had a slight odor. Those held at 40°F were showing moderate softness, odor, and belly burn. Meat was slightly discolored near the gonads.

After eight days, noticeable differences existed between treatments. The dressed halibut held at 32°F retained the best quality, with slightly soft flesh and odor in the gut cavity. The flesh was still free of any odor. The round fish held at 32°F had moderate belly burn and softness, slight flesh odor, and meat discoloration near the gonads. The 40°F halibut was in the poorest condition with soft flesh, moderate acidic odor, severe gut odor, and belly burn.

At 12 days storage, the fish held at 40°F were severely belly burned and the flesh was very sour (acid and sulfide smells) and soft. At this point, the fish was spoiled.

Table 1. Visual quality changes in halibut held in CSW at 32°F and 40°F.

Storage time (days)	Treatment	
	Dressed (32°F)	Round (32°F)
2	no gut odor firm flesh cloudy eyes no flesh odor	no gut odor firm flesh cloudy eyes no flesh odor
4	no gut odor slight flesh softness dull eyes no flesh odor	slight gut odor slight flesh softness dull eyes no flesh odor
6	slight gut odor slight flesh softness dull eyes no flesh odor	slight gut odor/belly burn slight flesh softness reddening eyes slight acid odor in flesh
8	slight gut odor slight flesh softness sunken, cloudy eyes no flesh odor	moderate gut odor/belly burn moderate flesh softness sunken, cloudy eyes slight sulfide odor in flesh meat discolored near gonads
12	–	–

Table 1. (cont.) Visual quality changes in halibut held in CSW at 32°F and 40°F.

Storage time (days)	Treatment Round (40°F)
2	no gut odor firm flesh slight sunken eyes no flesh odor
4	moderate gut odor/slight belly burn slight flesh softness reddening eyes slight acid odor in flesh
6	moderate gut odor/belly burn moderate flesh softness red, sunken eyes moderate acid odor in flesh meat discolored near gonads
8	severe gut odor/belly burn severe flesh softness red, sunken eyes moderate sulfide odor in flesh meat discolored near gonads
12	severe gut odor/belly burn severe flesh softness brown, sunken eyes severe sulfide odor in flesh meat discolored throughout belly

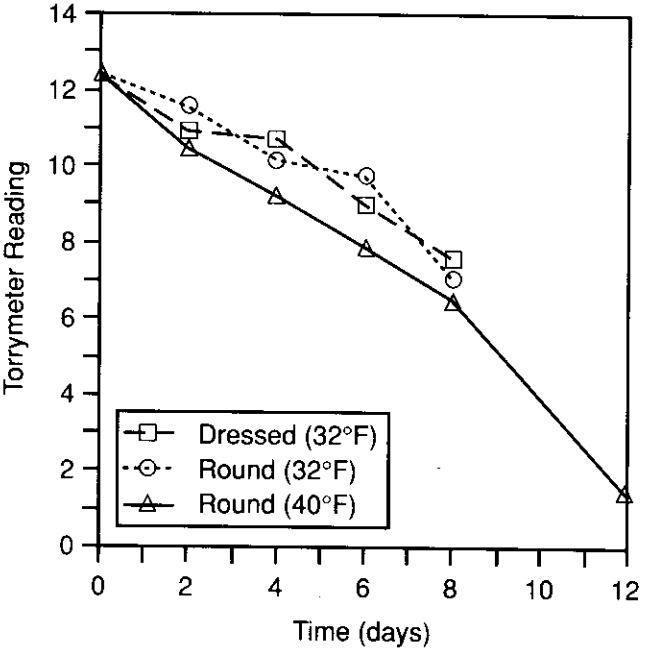

Figure 1. Quality loss measured by Torrymeter.

Torrymeter Results

The Torrymeter, a device that measures electrical resistance of fish skin, was used to determine relative quality. As fish deteriorate, electrical resistance of the skin is reduced and the Torrymeter readings become smaller. Values can range between 0 and 16. Eight Torrymeter readings were taken on each fish as it was visually inspected. The average values are given in Figure 1.

There were slight quality differences between round and dressed fish held at 32°F. After eight days of storage, dressed fish showed slightly better quality. Round halibut held at 40°F had the lowest Torrymeter readings, indicating a faster rate of quality loss. Significant quality loss had occurred in these fish between 8 and 12 days.

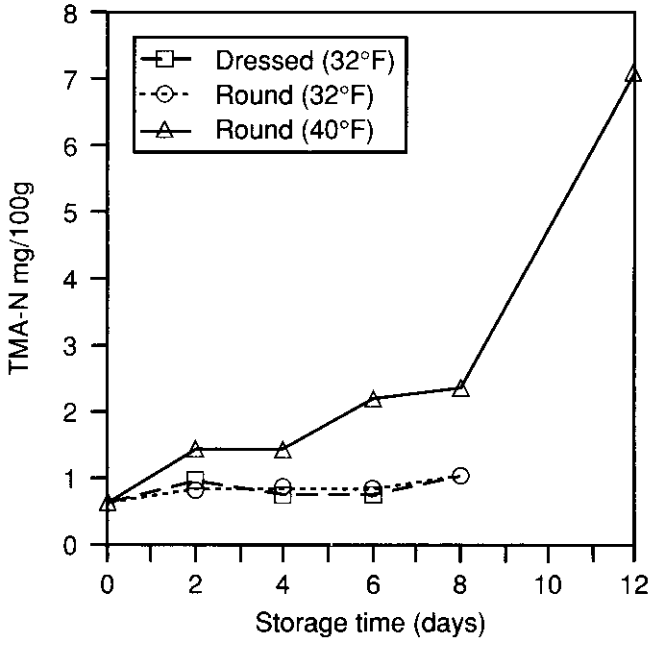

Figure 2. TMA content of halibut muscle.

Chemical Indices of Quality

One of the measurements of fish quality is the trimethylamine level found in the flesh. TMA is a chemical produced by bacterial action on non-protein nitrogen compounds (Hebard et al. 1982). As bacteria multiply, TMA levels increase. The quantity of TMA is usually expressed as the amount of trimethylamine nitrogen (TMA-N) found in a sample. TMA-N levels above 6 mg per 100 g will change the odor and flavor of fish flesh (Brockelsby and Riddell 1937). TMA also reacts with fats to produce an odor common to old, stale fish.

Round and dressed halibut stored at 32°F showed low TMA production during the eight-day storage period (Figure 2). Values

Table 2. Aerobic plate counts of chilled seawater at 32°F and 40°F.

Storage time (days)	Bacteria per ml	
	32°F*	40°F
Control	805,000	130,000
2	310,000	3,240,000
4	2,230,000	17,500,000
6	2,040,000	33,000,000
8	3,080,000	30,500,000
12	–	58,000,000

*Samples taken from the dressed halibut system.

ranged from 0.65 to 1.04 mg TMA-N per 100 g of flesh. This was judged insufficient to affect the flavor and odor of the flesh.

The round halibut held at 40°F had significantly higher levels of TMA. After eight days storage, the TMA level was 2.35 mg TMA-N per 100 g of flesh. While this amount of TMA did not affect flavor or odor of the flesh, it was more than twice the amount found in 32°F fish. TMA increased to 7.04 mg TMA-N per 100 g after 12 days storage, which exceeded the 6 mg per 100 g threshold.

Microbial Growth

Bacterial levels in the chilled seawater (CSW) and halibut were monitored throughout the storage period. The microbial counts obtained from the seawater are shown in Table 2. CSW held at 32°F had 310,000 bacteria per ml after two days that slowly increased to 3.08 million after eight days, a tenfold increase. By contrast, microbial counts of the 40°F CSW multiplied almost 450 times from an initial load of 130,000 to 58,000,000 bacteria per ml

Table 3. Aerobic plate counts of halibut held in CSW at 32°F and 40°F.

Storage time (days)	Bacteria per cm^2		
	Dressed (32°F)	Round (32°F)	Round (40°F)
Control	2,750	2,750	2,750
2	27,000	193	3,720
4	170,000	605	6,450
6	810,000	1,525	20,775
8	3,900,000	1,680	56,325
12	–	–	105,775

after 12 days. This comparison dramatically illustrates the effect of temperature on bacterial growth.

The microbiological counts obtained from the fish during the storage period are shown in Table 3. The initial bacterial counts for the control (0-day storage) halibut were 2,750 per cm^2. The dressed halibut at 32°F exhibited the fastest microbial growth rate increasing to 3.9 million bacteria per cm^2 after eight days. This was probably the result of contamination of the poke from the CSW system as well as bacteria being released from the gut during the dressing process and rapidly multiplying on the belly flap. However, the high bacteria count did not adversely affect visual or chemical quality of the flesh. There was no odor in the gut and TMA levels remained low.

Bacterial growth in the round halibut held at 32°F showed the slowest rate. It initially decreased to 163 bacteria per cm^2 and then gradually increased to 1,680 per cm^2. TMA levels remained low and slight flesh odors developed after six days storage. It appears that the bacteria were confined to the gut and were unable to contaminate the flesh. Bacteria from the CSW were unable to

contaminate the round fish as there was no exposed flesh. The low storage temperature also contributed to the slow growth rate.

The round halibut held at 40°F showed a steady increase in microbial count with 106,000 bacteria per cm^2 at the end of 12 days. This was more that 60 times the number found on the round halibut held at 32°F. At the higher storage temperature, bacterial growth was so rapid that it was not confined to the viscera and contaminated the flesh in the belly cavity. The high numbers of bacteria present in the CSW also may have contributed to the higher microbial counts in the flesh. TMA levels were twice that of the fish held at 32°F. The higher the temperature, the faster the bacterial growth and production of TMA.

Taste Panel Results

In a blind test, taste panelists evaluated halibut fletches after six months of frozen storage. The samples were rated for off-odor, off-flavor, saltiness, moistness, tenderness, and desirability. Overall, all samples had similar scores for saltiness, moistness, and tenderness. Slight off-odors and off-flavors were detected between treatments. These scores revealed that fish held at 40°F had more off-odors and off-flavors than fish held at 32°F.

The best indicators of change between treatments were the scores for desirability (Table 4). The scores showed a clear separation between the fish held at two and four days and those held for six and eight days, regardless of storage temperature. Fish held up to four days were clearly more desirable than those held longer. Little difference existed between the round and dressed fish held at 32°F, while fish stored at 40°F quickly lost desirability after four days storage.

Table 4. Desirability scores for halibut held in CSW at 32°F and 40°F.

Storage time	Desirability score*		
(days)	Dressed (32°F)	Round (32°F)	Round (40°F)
Control	3.15	3.15	3.15
2	2.86	3.15	3.00
4	3.57	3.00	3.15
6	4.29	4.51	5.00
8	5.85	5.71	6.57

12-day fish spoiled and were not evaluated.
*Lower scores indicate a more desirable sample.

Conclusions

No significant quality difference existed between dressed and round halibut held at 32°F. The slight deterioration that occurred during the eight-day storage period did not translate to significant quality differences as measured by TMA or taste panel assessment. The overall eating quality of the 32°F fish was judged to be the same.

Visual quality differences between the dressed and round halibut held at 32°F were noticeable. After four days storage, slight odors were present in the round fish. While this did not affect the other quality measures, it influenced perceived quality. Round fish were visually inferior to the dressed fish.

Holding round halibut at 40°F showed a rapid deterioration with noticeable visual changes within four days after catch. The high bacterial counts in the CSW and fish, and TMA levels confirmed decreased quality and desirability.

Quickly reducing the internal temperature of halibut is more critical to its quality than dressing the fish. From this experiment, we

conclude that it is acceptable to hold halibut in the round as long as its core temperature is quickly reduced to 32°F and it is processed within four days after catch. If quick chilling, temperature requirements, or time limit cannot be met, then dressing and proper chilled storage is the only option. Proper chilled storage not only includes good temperature control, but also a high level of sanitation for the CSW system to operate effectively.

This investigation focused only on holding halibut in chilled seawater systems. For many fishermen, processors, and marketers, proper iced storage is the only acceptable method for chilling halibut. A quality comparison between iced and CSW-held halibut cannot be made from this experiment. Additional studies are being planned to compare quality of iced and CSW-stored fish.

Acknowledgments

The authors wish to thank the International Pacific Halibut Commission, Seattle and King Crab, Inc., Kodiak for their cooperation and assistance in obtaining the halibut for this project.

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