BRINE DIPPING OF HADDOCK FILLETS

By J. Holston* and S. R. Pottinger**

ABSTRACT

Fillets dipped in water or in various strengths of brine increased in weight. Major factors affecting degree of increase were (1) immersion times, (2) available surface area per unit of weight, and (3) brine strength. Salt uptake was directly related to the strength of the brine; it was affected by the available surface area per unit of weight, by the brine temperature, and the immersion time. Free drip from thawed frozen fillets is reduced to a practical minimum when from 0.8 to 1.2 percent of salt is incorporated into the fillet. Press drip is reduced only when the salt content of the fillet is 1.5 percent or greater. Tests of the effect of increasing quantities of salt in the fillet upon saline palatability indicated that the optimum salinity was approximately 1.0 percent. The following immersion periods and brine strengths caused the uptake of approximately 1.0 percent of salt in the fillet and were found to be the most satisfactory in the preparation of fillets for freezing:

Large haddock fillets: 20 seconds; 15 percent by weight of salt in brine.
Scrod haddock fillets: 20 seconds; 10 percent by weight of salt in brine.
Fillets of brine-frozen scrod haddock: 20 seconds; 6 to 8 percent by weight of salt in brine.

INTRODUCTION

The fishing industry has long practiced the custom of lightly brining fish fillets by dipping them in a salt solution for a short period of time prior to freezing. The process has a threefold purpose: (1) to wash the fillets, (2) to decrease free drip from thawed fillets, and (3) to give the fillets a pleasing saline flavor. The concentration of the salt in the solution and the length of the immersion period have been left largely to the experience of the processor. In some instances, however, the brining process has been based on recommendations of various investigators (Birdseye 1929; Pattison 1930; Tressler and Murray 1932; Taylor 1933; Tarr and Sunderland 1940; Lemon 1940; Tarr 1941; and Stansby and Harrison 1942). A wide range of brine concentrations and of dipping times have been suggested for fillets from different species of fish and even for fillets from the same species.

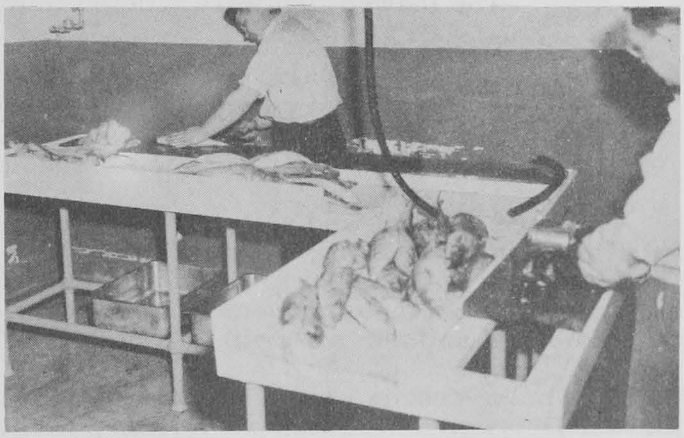

Fig. 1 - Scaling and filleting scrod haddock for brine-dipping experiments.

Many of the questions of industry as to the effects of brine dipping upon fillets from iced fish could not be answered in the light of available knowledge. To answer such questions and, in particular, to study the effects of brine dipping upon fillets prepared from fish brine-frozen at sea (Puncochar and Pottinger 1953), the Service's Boston Fishery Technological Laboratory began a study of this phase of commercial processing. The work was restricted to studies on fillets of haddock and scrod haddock. The specific objectives were:

1. Determine the factors affecting weight change and salt uptake by fillets during the brine-dipping process.
2. Determine the effect of brine dipping upon free drip and press drip of fillets.
3. Determine the salt content producing the most nearly optimum saline palatability of the fillets.

* Chemist, ** Chief } Fishery Technological Laboratory, Branch of Commercial Fisheries, U. S. Fish and Wildlife Service, East Boston, Mass.

4. Determine the effect of brine dipping on the quality and the palatability of the fillets prepared from brine-frozen round fish.

5. Prepare recommendations for brine-dipping procedures for use in the commercial production of fillets from iced fish and from fish frozen in-the-round at sea.

EXPERIMENTAL PROCEDURES

PREPARATION OF SAMPLES: The fillets used in this study were prepared from the following:

A. Iced eviscerated haddock and scrod haddock:

1. Haddock stored in ice for less than 1 day.
2. Scrod haddock stored in ice for less than 1 day.
3. Scrod haddock stored in ice for 1 day.,
4. Scrod haddock stored in ice for 5 days.
5. Scrod haddock stored in ice for 10 days.

B. Brine-frozen scrod haddock:

1. Whole scrod haddock, brine-frozen immediately after capture at sea, stored for 1 week in a refrigerated (0° to 5° F.) trawler hold and then thawed in running water (60° F.) for 120 minutes. The thawed fish were filleted immediately.

2. Whole scrod haddock, similarly brine-frozen, stored for 1 week in a refrigerated (0° to 5° F.) trawler hold followed by storage 18 weeks in a commercial cold-storage (-10° to 0° F.) warehouse. The fish were thawed in running water (60° F.) for 120 minutes and were filleted immediately.

The iced haddock and scrod were procured from local inshore trawlers. At the request of the laboratory, the fish were eviscerated immediately after capture and then carefully iced in canvas baskets to prevent them from being bruised by pressure of other fish or by movement of the boat en route to port. All were as nearly as possible of uniform size within each classification.

The brine-frozen whole fish were prepared at sea aboard the Service's research trawler *Delaware*. The fish were frozen in the refrigerated brine at a temperature between 5° and 8° F.; immersion time was approximately 90 minutes.

DIPPING AND PACKAGING FILLETS: To study the effects of the dipping process on the fillets, tap water and salt solutions of differing concentrations (0.8, 5, 10, 15, 20, and 26 percent salt by weight) were used. The salt used in preparing the solutions was of the highest industrial grade (99.64 percent sodium chloride and only very small amounts of calcium and magnesium salts). The temperatures of the dipping solutions used for some of the studies on haddock and scrod haddock held in ice for less than one day were maintained at $45^{\circ} \pm 5^{\circ}$ F. All other studies were made with the temperatures of the various dipping solutions at $65^{\circ} \pm 5^{\circ}$ F. No attempts were made to adjust or to buffer the degree of acidity (pH) of the brines, since the study was designed to simulate the usual commercial procedures.

The length of time (immersion time) that the fillets were held in the dipping liquids was very carefully regulated. For studies on the effect of variations in immersion time, the fillets were dipped for 5, 10, 30, 60, and 120 seconds. In all other studies designed to show the effects of other factors such as brine concentration, freezing, freezing and storage, and of storage in ice, the fillets were immersed for 20 seconds. The 20-second immersion period was chosen because it was believed to represent roughly the average of immersion periods used in industry.

The dipping process was carried out as follows: Ten pounds of fillets were placed in a large-mesh screen basket and the basket and contents were immersed in the brine. The brine was agitated manually in order to permit uniform wetting of the fillets. The fillets were then allowed to drain, skin side up, for two minutes on a wide-mesh screen. They were removed and weighed again. All weighings were made to the nearest one-fifth of an ounce. Two or more replicate dipping tests were made for each solution for each experimental factor under consideration.

Table 1 - Summary of Characteristics of Brine-Dipped 1/ Haddock and Scrod-Haddock Fillets

Description of Samples	Concentration of Salt in Brine Dip	Weight Increase	Salt Content 2/	Free Drip	Press Drip	Total Solids in Press Drip	Texture Rating 3/	Organoleptic Rating 4/	Saline Palatability Rating
	(Percent)						Lbs.	Score	
Large Haddock 6/ (iced less than 1 day)	5/0.0	2.6	0.14	4.2	26.0	4.9	32.2	83	Bland
	0.8	2.6	0.25	5.4	28.7	4.8	31.3	82	Bland
	5	2.9	0.44	3.7	28.3	5.3	32.6	86	Bland
	10	3.0	0.72	2.0	28.4	7.2	32.3	82	Optimum
	15	3.1	0.93	2.1	22.6	6.9	31.6	81	Optimum
	20	2.9	1.08	1.6	18.8	6.1	29.3	82	Optimum
	26	2.3	1.23	0.9	18.6	6.4	27.0	83	Slightly to salty
Scrod haddock 6/ (iced less than 1 day)	5/0.0	3.9	0.14	4.4	30.3	3.9	25.0	82	Bland
	0.8	3.9	0.20	5.8	26.5	5.0	25.0	83	Bland
	5	4.4	0.45	4.5	27.1	5.1	24.3	83	Insufficient salt
	10	4.5	0.91	1.7	26.9	4.6	24.7	86	Optimum
	15	4.9	1.21	1.2	28.4	4.3	24.6	84	Optimum
	20	4.8	1.58	0.5	20.8	5.2	25.3	87	Excessively salty
	26	4.0	1.86	0.6	21.3	5.3	25.3	88	Excessively salty
Scrod haddock 7/ (iced for 1 day)	5/0.0	2.7	0.19	4.1	24.0	-	25.2	81	Bland
	0.8	4.1	0.25	3.2	25.8	5.2	25.2	76	Bland
	5	3.8	0.50	3.7	32.0	4.8	26.2	83	Insufficient salt
	10	3.5	0.79	1.5	21.3	5.0	24.5	84	Optimum
	15	4.3	1.33	1.8	14.4	6.3	24.0	69	Optimum
	20	4.5	1.91	1.5	14.8	6.3	23.8	71	Excessively salty
	26	4.5	2.15	1.2	15.0	6.3	23.7	70	Excessively salty
Scrod haddock 7/ (iced for 5 days)	5/0.0	3.4	0.20	5.2	31.0	4.9	24.2	76	Bland
	0.8	3.9	0.24	6.5	32.4	3.9	23.0	68	Bland
	5	4.9	0.58	3.3	30.7	4.8	26.2	69	Insufficient salt
	10	5.8	0.92	2.3	25.9	4.6	24.5	76	Optimum
	15	5.8	1.23	1.1	24.9	5.2	25.0	76	Optimum
	20	5.6	2.03	1.5	15.6	6.3	16.5	69	Excessively salty
	26	5.9	2.78	1.4	14.7	5.6	16.7	65	Excessively salty
Scrod haddock 7/ (iced for 10 days)	5/0.0	3.2	0.19	1.3	29.7	3.5	25.2	59	Bland
	0.8	3.1	0.23	1.2	27.1	3.9	25.7	72	Bland
	5	3.8	0.59	1.0	30.6	3.7	24.0	72	Insufficient salt
	10	4.8	0.95	0.83	25.7	4.2	26.3	69	Optimum
	15	4.8	1.37	0.31	20.3	4.7	22.0	67	Optimum
	20	5.1	1.84	0.37	18.7	5.0	25.3	68	Excessively salty
	26	4.9	2.33	0.29	16.6	5.7	24.2	63	Excessively salty
Brine-frozen Scrod haddock 7/ (stored 1 week at 0° F.)	5/0.0	2.1	0.44	5.8	-	-	24.1	75	Bland
	0.8	2.2	0.45	5.4	-	-	26.3	85	Bland
	5	3.5	0.75	4.4	-	-	24.7	87	Insufficient salt
	10	3.5	1.16	3.5	-	-	25.2	84	Optimum
	15	3.9	1.55	1.3	-	-	23.8	78	Slightly too salty
	20	3.8	2.04	0.7	-	-	26.1	81	Excessively salty
	26	2.7	2.62	0.9	-	-	24.9	63	Excessively salty
Brine-frozen Scrod haddock 7/ (stored 18 weeks at 0° F.)	5/0.0	2.7	0.64	2.8	28.8	5.1	25.3	72	Bland
	0.8	2.9	0.65	2.4	28.8	5.0	24.6	89	Insufficient salt
	5	3.6	0.84	2.2	26.6	5.6	26.2	82	Optimum
	10	4.4	1.40	1.6	27.4	5.4	26.0	61	Optimum
	15	6.0	1.98	1.9	27.5	5.1	24.6	66	-
	20	5.6	2.45	1.6	27.1	5.3	24.8	53	Excessively salty
	26	5.0	2.87	1.2	24.3	5.9	24.0	51	Excessively salty

1/ 20-second immersion.
2/ Salt content of undipped fillets varies between 0.14 and 0.20 percent.
3/ Expressed as force (in pounds) required to shear. Increased values indicate decreased tenderness.
4/ Averaged rating of panel. Optimum rating: 100; Good: 80; Fair: 50.
5/ Tap water.
6/ Brine-dip temperature: 45 ± 5° F.
7/ Brine-dip temperature: 65 ± 5° F.

The weighed fillets were wrapped in moisture-vaporproof cellophane, boxed in 5-pound waxed cartons, and frozen in a plate freezer (-20° F. ambient temperature). The samples were held in frozen storage (-2° to 0° F.) for three weeks before the analysis was started.

TEST METHODS: The physical, chemical, and organoleptic methods used were, in the main, those reported by Magnusson, Pottinger, and Hartshorne (1952). The following factors were studied:

(1) Weight increase.
(2) Salt uptake.
(3) Free drip.
(4) Press drip.
(5) Press-drip solids.
(6) Texture.
(7) Organoleptic palatability.
(8) Optimal levels of salt for palatability in fillets.

Salt Determinations: The salt content of the fish fillets was determined by the use of the rapid official A.O.A.C. (1950) titration method for salt in fishery products. Each reported figure for salt content is an average of six determinations. The analyses were performed on six 10-gram portions of fish drawn from 3 minced homogeneous masses of meat, each mass being composed of the meat of 6 previously skinned fillets. Other work had shown that the salt content of undipped fillets varies between 0.14 and 0.20 percent.

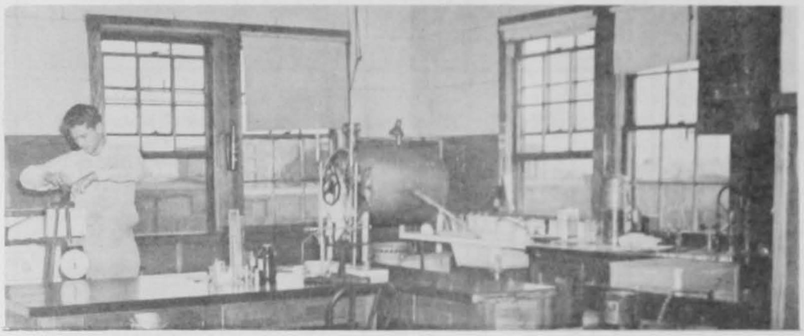

Fig. 2 - Testing fillets in the laboratory

Free-Drip Determination: The determination of free drip (liquid exuded from a thawing fillet without application of pressure) was made by taking 4 weighed frozen fillets (from each of the 8 experimental dipping liquids) and for $3\frac{1}{2}$ hours exposing them to room temperature (75° F.) and allowing them to thaw and drain.

Table 2 - Effects of Extended Immersion of Scrod-Haddock 1/ Fillets in Sodium-Chloride (10-percent) Brine 2/

Immersion Time	Weight Increase	Salt Content 3/ (as NaCl)	Free Drip	Press Drip	Press-Drip Solids	Texture 4/	Organoleptic Rating	Saline Palatability Rating
Seconds	(Percent)					Lbs.	Score	
5	2.8	0.73	4.6	24.1	6.1	15.4	81	Insufficient salt
10 6/	3.0	0.85	3.0	28.9	5.1	21.6	78	Insufficient salt
20 6/	3.8	0.91	1.7	24.2	4.8	24.7	85	Optimum
30	4.2	1.21	2.2	31.8	4.5	25.7	81	Optimum
60	6.1	1.44	2.8	31.0	4.7	19.2	75	Slightly to salty
120	7.3	1.62	2.1	36.0	4.6	21.3	73	Excessively salty

1/ Scrod haddock, iced less than 1 day.
2/ Brine temperature: 65° ± 5° F.
3/ Salt content of undipped fillets varies between 0.14 and 0.20 percent.
4/ Expressed as force (in pounds) required to shear. Increased values indicate decreased tenderness.
5/ Averaged ratings of panel. Optimum rating 100; Good: 80; Fair: 50.
6/ The data reported for this immersion-time interval were taken from other studies of the effects of brining upon fillets. They are added here to round out the immersion-time studies.

The thawed fillets were then weighed again. The observed weight loss divided by the original weight and multiplied by 100 gave the percentage of free drip. These tests were performed three times for each factor under investigation.

Press-Drip Determination: The determination of press drip (liquid expressed from a thawing portion of a fillet under pressure) was made by subjecting weighed, uniform, frozen cores of fish cut from fillets to a pressure of 10 pounds per square inch for a period of 15 minutes at a temperature of approximately 75° F. The fish thawed during this period. The liquid expressed from the fish core was drained off. The plug of fish was then weighed again. The weight difference (press drip) was expressed as a percentage of the original weight of the frozen core. Three tests were performed for each factor under consideration. Press-drip solids were determined by drying the weighed press drip liquid to a constant weight. The latter weight was expressed in terms of a percentage of the former weight as the percentage of solids in press drip.

Organoleptic Testing: Organoleptic testing was performed by a panel of staff members accustomed to tasting fish. The thawed fillets were wrapped in aluminum foil and baked for 20 minutes in a preheated oven maintained at 400° F. The panel graded the fish on a scale from 1 (inedible) to 10 (excellent) for each of the factors of appearance, flavor, and texture, with double weight being given to the factor of flavor. Organoleptic tests on the fish were repeated three times for each experimental factor under consideration. The texture (considered as tenderness or toughness) of the fillets was determined by subjecting carefully prepared portions of tempered (meat temperature: 25° to 30° F.) meat to the shearing action of interlocking steel plates. The uniform portions of meat were prepared in such a way that the muscular striations were perpendicular to the plates. The force (in pounds) necessary to shear the fish fillet portions was determined by a spring scale and indicator. Six determinations were performed for each sample under investigation.

Saline-Palatability Testing: Saline palatability of the samples was assessed by serving 7 portions of cooked fillets, each containing different, but known, concentrations of salt, to each member of a taste panel accustomed to eating fish. Their judgments as to relative desirability of the salt flavor incorporated into a fillet by a particular experimental dipping procedure were expressed in terms of the most satisfactory salt concentrations. A rating of "bland" indicated that no salt flavor was discernible. A rating of "optimum" indicated that the salt flavor of the particular sample was at a level considered to be most appetizing by the majority of the panel. A sample that was rated as "excessively salty" was, at best, displeasing and, at worst, almost inedible.

DISCUSSION OF RESULTS

WEIGHT OF FILLETS: An increase in the weight of the fillets was observed following immersion in the various dipping solutions (table 1). The increase, caused by absorption of salt and/or water, occurred under all experimental conditions, whether the fillets were dipped in water or in a saturated salt solution. An increase occurred regardless of whether the fillets were prepared from small or from large fish, from fish held in ice for periods of from 1 to 10 days, or from fish frozen and cold-stored for 1 or for 18 weeks.

Effect of Immersion Time: A major factor in determining the degree of weight increase was observed to be the length of the immersion period (table 2). Samples (10 pounds of fillets per sample) that were immersed for 5 seconds in a 10-percent salt solution increased 2.8 percent in weight or to 10.28 pounds. After 120 seconds, the weight increases in the dipped fillets were observed to average 7.8 percent (0.78 pounds).

Effect of Fillet Volume: A second factor determining the degree of weight increase in dipped fillets seemed to be the ratio of cut-surface area to the weight of the fillet. Fillets prepared from scrod haddock have a much greater surface area in proportion to their weight than does an equal weight of haddock fillets. From 15 to 20 scrod-haddock fillets were required for a 10-pound sample. Only 5 or 6 haddock fillets were required to attain the same weight. Concomitantly, the observed weight increases of dipped scrod-haddock fillets were consistently 70 to 100 percent greater than those observed with haddock fillets (table 1).

The effects of periods of storage of fish in ice, of brine-dip concentration, and of brine temperature on the weight increases of dipped fillets were comparatively minor. No significant, consistent differences in weight increase were found after dipping fillets of fish stored in ice for 1, 5, and 10 days. The slight variations that were observed were not consistent and could not, on the basis of present knowledge, be ascribed to the time of storage in ice.

Effect of Brine Concentration and Temperature: Differences in brine concentration appeared to cause a slight but significant variation in the weight gain of dipped fillets. Intermediately strong brines (8 to 16 percent) appeared to cause the largest increases in fillet weight. The effect of brine temperature, in the range of 45° to 65° F., on weight increase in dipped scrod-haddock fillets did not appear to be significant.

Effect of Brine-Freezing and of Storage: The popularly-accepted belief that fillets from brine-frozen fish absorb more water or brine than do fillets of iced fish did not appear to be substantiated in these tests. Owing probably to the very short immersion periods, fillets of brine-frozen fish did not undergo a weight increase significantly different from those of fillets of iced fish. The weight increases in fillets from brine-frozen fish stored 18 weeks were, nevertheless, less uniform than the weight gain in other fillets.

SALT CONTENT: Effect of Strength of Brine: The concentration of salt in the brine was found to be a major factor in determining salt uptake by fillets (table 1). There appeared to be a direct relationship between the salt absorbed by fillets dipped for the same period of time and the concentration of salt dissolved in the dipping solution.

In some of the studies with strong brines (20 and 26 percent by weight), the salt absorbed by the fillets appeared to deviate from the relationship. These deviations were probably due to slight variations in fillet surface area exposed to the brines in the various weighed groups of fillets. In strong brines, the slight differences in surface area were sufficient to affect measurably the final salt content of the fillets.

Effect of Fillet Volume: The salt uptake by fillets dipped for short intervals of time appeared to be primarily a surface effect. Thus, the ratio of surface area to the weight of the fillets determined the amount of salt found in the fillets so treated. As in the weight-increase studies, the lesser surface area of haddock fillets was reflected in a lower salt content than in scrod-haddock fillets. The difference was small in dilute brines, but became significantly greater in the more concentrated brines.

Effect of Brine Temperature: Differences in brine temperature affected the rate of uptake of salt by the fillets. Fillets dipped in brines maintained at 45° ± 5° F. absorbed about 15 to 20 percent less salt than did fillets dipped for an equivalent length of time in corresponding concentrations of brine maintained at 65° ± 5° F.

Effect of Storage Time on Fish in Ice: The fillets prepared from fish held in ice for 1-, 5-, and 10-day periods evidenced only slight differences in salt uptake during the dipping process. The absolute differences in percentage salt content of fillets of these fish, after being dipped in solutions containing up to 15 percent of salt, were very small and amounted to only fractions of 1 percent. There were no consistent differences in the salt content that could be related to the various periods of storage of the fish in ice.

Effect of Increased Immersion Time: An increased immersion period caused significant increases in the amount of salt absorbed by the dipped fillets (table 2). The rate of absorption was greatest during the first 5 seconds of immersion and became smaller as the immersion period was increased. After 30 seconds of immersion, the salt content of the fillets was about 60 percent greater than in the fillets dipped for 5 seconds. After 120 seconds, a period 24 times as long as the 5-second immersion time, the salt content had increased by 120 to 145 percent.

The extent to which salt was absorbed by fillets during extended immersion was, in each case, determined by the brine concentration (table 3). Thus, fillets dipped for a period of 5 seconds in 5-, 10-, or 15-percent brines evidenced total salt contents of 0.4, 0.7, and 1.0 percent, respectively. After 120 seconds of immersion in these same brines, the fillets contained 1.0, 1.6, and 2.4 percent salt, respectively.

FREE DRIP: Effect of Strength of Brine: The experimental results indicate (table 1) that the loss of free liquid (free drip) by thawed fillets may be minimized by the incorporation of small quantities of salt into the fillets prior to freezing. The table shows the relationship between free drip and the concentration of salt in the solution into which the fillets were dipped. As was reported by Tarr and Sunderland (1940), a salt content of at least 0.8 percent in the fillet was found necessary to reduce drip effectively. The loss of liquid from unbrined thawed fillets after $3\frac{1}{2}$ hours of thawing at room temperature (about 75° F.) varied between 4 and 6 percent of the fillet weight. The incorporation into the fillets, by means of appropriate brining procedures, of from 0.8 to 1.2 percent salt reduced the free drip during thawing to a maximum of about 2.3 percent. The studies further indicated that incorporation of quantities of salt greater than about 1.2 percent into the fillets did not result in an appreciable further reduction in free drip during thawing.

Table 3 - Salt Uptake 1/ by Scrod-Haddock 2/ Fillets Dipped for Increasing Periods of Time in Different Concentrations of Sodium-Chloride Brine 3/

Concentration of Salt in Brine	Salt Content of Fillets Immersed for:				
	5 Sec.	10 Sec.	30 Sec.	60 Sec.	120 Sec.
	. . . .	. . . . . . (Percent)	. . . .		
5	0.42	0.49	0.59	0.67	0.98
10	0.73	0.85	1.21	1.44	1.62
15	0.99	1.11	1.56	2.25	2.41

1/ Salt content of undipped fillet: 0.14 to 0.20 percent.
2/ Scrod haddock, iced less than 1 day.
3/ Brine temperature: 65° ± 5° F.

Effect of Brine-Freezing and of Storage: The loss of free liquid from fillets prepared from fish brine-frozen at sea and stored in the round for 1 week and for 18 weeks was probably determined by one or both of two factors. These were: (1) the residual salt content in the fillet after water thawing of the round fish; and (2) the length of time in storage of the round fish prior to processing. Fillets prepared from brine-frozen fish that had been held in frozen storage for one week contained about 0.4-percent salt. These fillets, refrozen after undergoing the experimental dipping procedures, yielded, when thawed, normal amount of free liquid (table 1). The table shows that such fillets undergo variations in free drip very similar to those of iced fish. The fillets from brine-frozen fish that had been stored for 18 weeks had a residual salt content of 0.7 percent, probably due to inadequate thawing processes, and evidenced a lesser amount of free drip.

Effect of Storage Time on Fish in Ice: The free drip from fillets prepared from fish held in ice for 1 and for 5 days showed a variation with the concentration of the dipping solution consistent with that evidenced by fillets of very fresh fish. Those from fish held for 10 days in ice, however, evidenced a greatly reduced loss of free liquid. The effect was reproducible in repeated tests on these fillets. It is possible that the difference may have been due to a greater loss of liquid from fish stored in ice for 10 days than occurred in fish similarly stored for 1 or for 5 days.

PRESS DRIP: Effect of Strength of Brine: The quantity of press drip (the liquid that may be expressed from a frozen fillet by means of pressure) is affected by the salt content of the fillet (table 1). Press drip in unbrined fillets from iced fish generally amounted to from 27 to 30 percent; whereas in fillets containing from 1.5 to 2.0 percent salt the press drip was reduced to about 18 to 22 percent. No reduction in the amount of press drip was observed in fillets containing less than about 1.5 percent salt. Since the usual commercial brine-dipping procedures do not involve the absorption of such a quantity of salt, the press drip from fillets is not noticeably affected by commercial dipping processes.

Effect of Increased Immersion Time: In fillets containing 1.6 percent salt as a result of immersion for 120 seconds in a 10-percent salt brine, the weight increase per 10-pound fillet sample was found to be 7.3 percent (table 2). Press-drip losses in such cases amounted to 36 percent of the core-sample weight. This weight loss may be compared with 18 to 22 percent weight loss in cores from fillets containing approximately equal quantities of salt but dipped for only 20 seconds in a 15-percent brine (table1).

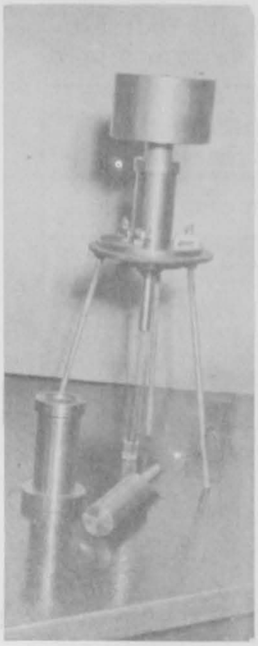

Fig. 3 - Apparatus for determining press drip in frozen fish.

Effect of Brine Freezing and of Storage: Fillets from fish that had been brine-frozen and stored appeared to be less sensitive to the salt effect. A smaller reduction in press drip with an increase in salt concentration in the dipping solution was observed. Fillets that were dipped into tap water contained 0.64 percent salt and released 29 percent press drip. Fillets that were dipped in a 26-percent brine contained almost 3.0 percent salt and released 24 percent press drip.

Effect of Storage Time on Fish in Ice: Storage of the eviscerated fish in ice for periods of up to 10 days did not appear to cause significant differences in the press drip obtained from the frozen-thawed fillets prepared from them.

PRESS-DRIP SOLIDS: The quantity of solid material that is dissolved or suspended in press-drip liquid appeared to increase slightly with increasing concentration of salt in the fillets. The increase was noted under all experimental conditions (table 1). Difference in percentage of press-drip solids from fillets of fish that had been subjected to varying preprocessing treatments were not sufficiently great to be considered significant. The increased quantities of press drip obtained from fillets dipped in brines for extended periods (table 2) appeared to cause lower press-drip solids values.

TEXTURE: The dipping process did not appear to have an immediate effect upon the texture of haddock fillets (table 1). Approximately equal amounts of force were required to shear samples prepared from fillets that had been dipped in tap water or in a saturated (26-percent) brine. Treatment of the fish prior to processing also appeared to have little immediate effect upon the degree of tenderness. Refrozen processed fillets prepared from fish brine-frozen at sea and held in frozen storage for 18 weeks required shearing forces very similar to those required by fillets of the very freshest fish. Fillets from fish held in ice for up to 10 days also evidenced little or no changes in tenderness after brine-dipping and freezing. The experimental results, however, seemed to indicate that the fillets of haddock were less tender than those of scrod haddock. An increase in applied force of approximately 28 percent or 7 pounds was required to shear the larger fillets.

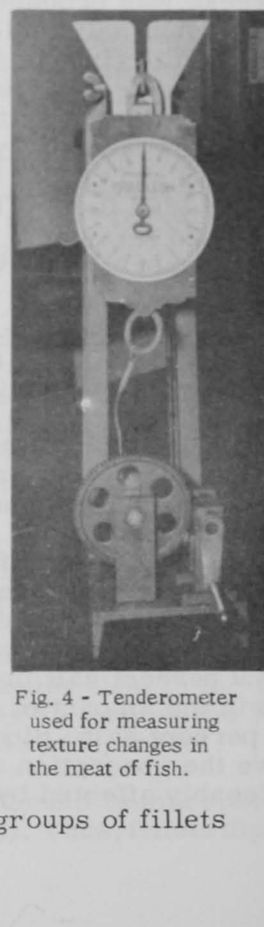

Fig. 4 - Tenderometer used for measuring texture changes in the meat of fish.

ORGANOLEPTIC RATINGS: The palatability scores (based on appearance, flavor, and texture) for fillets from very fresh scrod haddock and haddock showed little decrease with increased salt content (table 1). In the case of fillets of fish that were brine-frozen at sea and stored for 1 week and for 18 weeks prior to being processed, the drop in flavor scores (table 1) due to excessive saltiness was apparent. However, where an optimum quantity of salt was present, the flavor scores of both groups of fillets from brine-frozen fish were in the same range as those of the freshest iced fish. The flavor scores, in the case of the fillets from fish iced up to 10 days, apparently were lowered by two factors: the post-mortem age and the increasing saltiness. The effects of brine dipping upon palatability were evidently restricted to the masking of the flavor of the fish by the excessive quantities of salt incorporated into the fillets that had been dipped into strong brine.

Fig. 5 - Preparation of fillets for organoleptic tests.

SALINE PALATABILITY: The desirability of all experimental samples, when studied in terms of saline palatability as determined by the taste panel, showed a steady increase as the salt content approached a range of from 0.9 to 1.2 percent (table 1). Scores for palatability fell off sharply on either side of this range. Thus, after a 20-second dip in 5-percent salt brine, a fillet usually contained from 0.45- to 0.55-percent salt and was usually rated by a taste panel as being "bland." All fillets that contained approximately one-percent salt were rated as most pleasing (optimum) in saline flavor. Samples containing more than about 1.2-percent salt were considered slightly too salty. These ratings appeared to hold regardless of prior experimental treatment.

CONCLUSION AND RECOMMENDATIONS

Weight increases in dipped fillets were determined by the immersion time, strength of the brine, and the fillet surface area. Factors such as brine temperature, storage period of eviscerated fish in ice, and freezing and storage as round brine-frozen fish did not significantly affect weight increase. Salt uptake in dipped fillets was determined by the strength of the brine, the fillet surface area, the immersion time and the temperature of the brine. Storage of eviscerated fish in ice did not significantly affect salt absorption by the fillets.

Incorporation of certain quantities of salt into fillets reduced both the free drip and the press drip from such fillets. A salt content of 0.8 percent or more in the fillet reduced the free drip to a minor matter. Press drip was reduced by incorporation of about 1.5-percent salt in the fillets.

The saline palatability of a cooked fillet was greatest when the salt content was between 0.80 and 1.20 percent. This rating appeared to hold under all experimental conditions.

The quality and palatability of fillets prepared from brine-frozen round fish were not affected by dilute or intermediately strong brines. Strong brines masked the flavor of such fillets in the same manner as in fillets of iced fish.

The following brine dips are recommended on the basis of the tests:

Large haddock fillets--immerse for 20 seconds in a brine containing 15 percent by weight of salt.

Scrod haddock fillets--immerse for 20 seconds in a brine containing 10 percent by weight of salt.

Fillets of thawed brine-frozen fish--immerse for 20 seconds in a brine containing 6 to 8 percent by weight of salt.

LITERATURE CITED

Association of Official Agricultural Chemists,
1950. Official Methods of Analysis, 7th Edition, Box 540, Benjamin Franklin Station, Washington, D. C.

Birdseye, C.
1929. Some Scientific Aspects of Packaging and Quick-Freezing Perishable Flesh Products. II. Packaging Flesh Products for Quick-Freezing. Industrial and Engineering Chemistry (Industrial Edition), vol. 21, pp. 573-76. III. Sanitary Measures in a Fish Dressing Plant. Ibid. vol. 21, pp. 854-57.

Lemon, J. M.
1940. Fish Refrigeration. Refrigeration Data Book and Catalog. The American Society of Refrigerating Engineers, New York, fourth edition, pp. 37-46.

Magnusson, H. W.; Pottinger, S. R.; and Hartshorne, J. C.
1952. Freezing Fish at Sea - New England. Part II. Experimental Procedures and Equipment. Commercial Fisheries Review, vol. 14, no. 2, pp. 8-15.

Pattison, E. S.
1930. Freezing Fish by the Birdseye System. Food Industries, vol. 2, pp. 159-61.

Puncochar, J. F., and Pottinger, S. R.
1953. Freezing Fish at Sea. Food Technology, vol. 7, no. 10, pp. 408-411.

Stansby, M. E. and Harrison, R. W.
1942. Preliminary Investigations of Methods for Freezing and Storing Fillets of Some Pacific Northwest Fish. U. S. Fish and Wildlife Service. Special Scientific Report No. 15, Washington, D. C.

Tarr, H. L. A.
1941. Formation of Drip in Fish Muscle and Its Control in Defrosted Fish. Fisheries Research Board of Canada, Progress Reports of the Pacific Fisheries Experimental Stations No. 47, pp. 5-9, Vancouver, B. C.

__________ and Sunderland, T. A.
1940. Drip in Unfrozen and Frozen Fillets Controlled by Brining. Fisheries Research Board of Canada, Progress Reports of the Pacific Fisheries Experimental Stations No. 45, pp. 19-20, Vancouver, B. C.

Taylor, H. F.
1933. Fishing Industry Grows with Refrigeration. Refrigerating Engineering, vol. 25, pp. 321-323.

Tressler, D. K. and Murray, W. J.
1932. How Brining with Pure Salt Improves Fillets. Fishing Gazette, vol. 49, no. 2, pp. 24-26.

IODINE FROM SEA WEEDS

A new process is reported for recovering iodine from the residual waters resulting from treatment of sea weeds. The water containing iodine is atomized to a fine fog and mixed with a gas which liberates the iodine. Steam or hot air is blown in to remove the iodine vapors, which are condensed and recovered as small crystals.

--Industria Conservera, April 1953