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HOW TO COOK FROZEN FISH WITHOUT PRETHAWING

Part II - The Effect of Oven Temperature on Cooking Time for Frozen Halibut Steaks

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BACKGROUND

The popularity of prepackaged foods has increased tremendously. The convenience of the meal-size frozen-food package has been an important aid in selling foods that require no prethawing, such as frozen vegetables. The sale of frozen fish fillets and steaks, however, has been retarded somewhat by a lack of specific reliable instructions for cooking fish without prethawing.

Because little experimental work has been conducted on this problem, a study has been undertaken at the Service's Seattle Technological Laboratory. The first objective of the project was to determine a criterion for "doneness" in fish (when cooked) that would be reproducible. Previously, fish had been considered done if it flaked easily when tested with a fork. This criterion was too indefinite for controlled experiments.

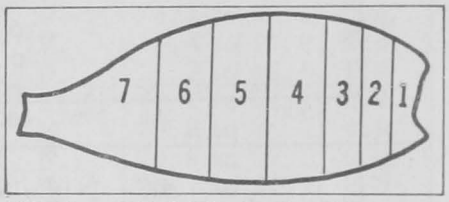

FIG. 1 - SHOWS HOW EACH HALIBUT WAS CUT:
1. 1½-INCH SINGLE STEAKS (300 GMS.)
2. 1-INCH SINGLE STEAKS (300 GMS.)
3. 1-INCH DOUBLE STEAKS (600 GMS.)
4. ½-INCH SINGLE STEAKS (300 GMS.)
5. 1-INCH DOUBLE STEAKS (600 GMS.)
6. 1-INCH SINGLE STEAKS (300 GMS.)
7. 1½-INCH SINGLE STEAKS (300 GMS.)

The work of Helen Charley (1952), which was used as a reference throughout the project, was based on the assumption that the logical criterion for "doneness" in protein foods was the internal temperature. Accordingly, a series of controlled palatability taste tests evaluating frozen halibut steaks baked to internal temperatures of 130° to 135° F., 145° to 150° F., 155° to 160° F., and 170° to 175° F. indicated that the 155° to 160° F. range was preferred for flavor, texture, and juiciness (Osterhaug and MacFarlane 1955).

With a standard internal temperature for baking frozen halibut steaks having been established, the next objective was to find the time required for frozen (27° F.) halibut steaks of different thicknesses to reach an internal temperature of 155° to 160° F. at various oven temperatures. The results are reported in this paper.

EXPERIMENTAL PROCEDURE

Frozen halibut steaks, ½, 1, and 1½ inches in thickness, were used for this study. A steak weighing 300 grams,[1/] regardless of thickness, was always used as a matter of convenience. Although a 300-gram ½-inch steak was large and thin, it was possible to cut it from a large fish. A 300-gram 1-inch steak was readily available from any medium size halibut and the 300-gram 1½-inch steak was thick and chunky but still had a steak shape.

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1/ 300 GRAMS EQUALS 10.58 OUNCES OR 0.8 POUND.

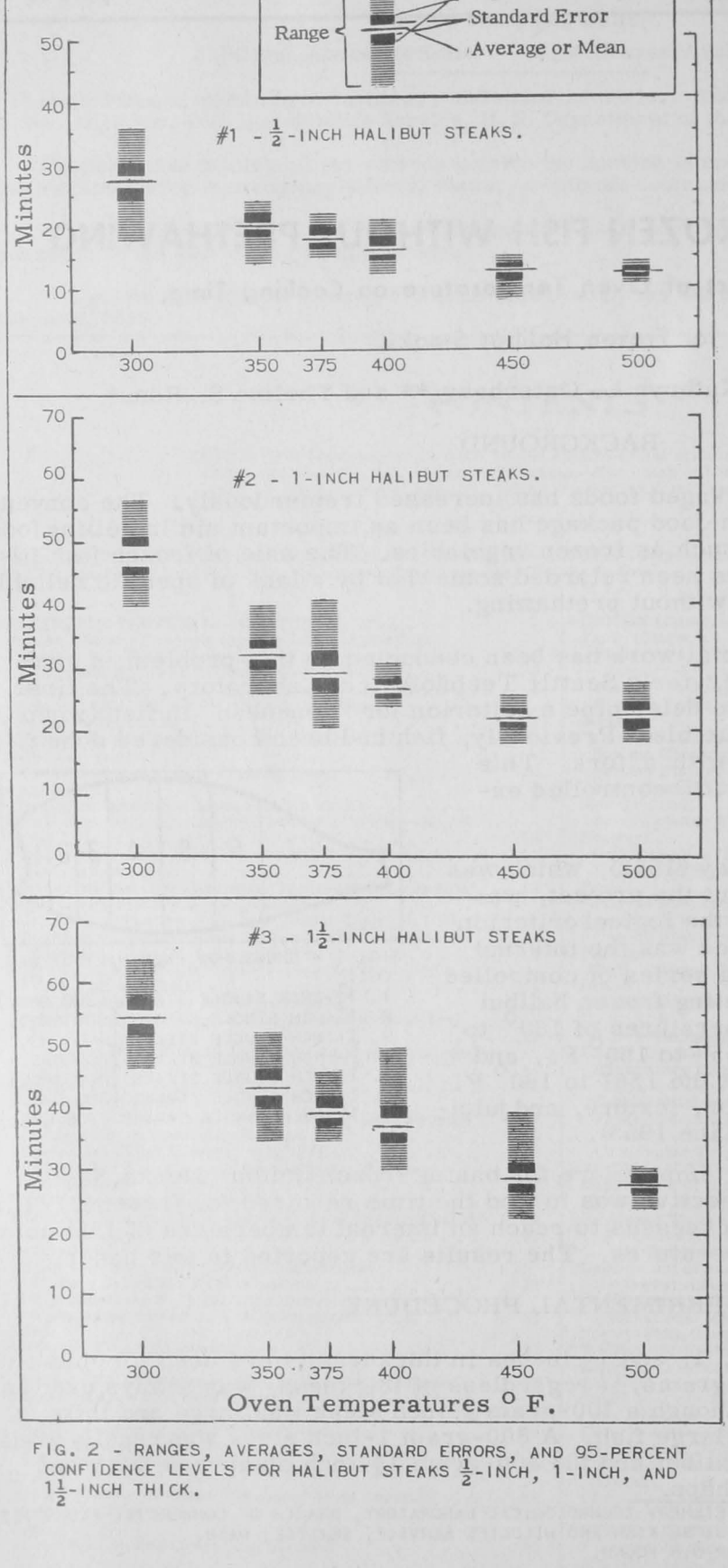

FIG. 2 - RANGES, AVERAGES, STANDARD ERRORS, AND 95-PERCENT CONFIDENCE LEVELS FOR HALIBUT STEAKS ½-INCH, 1-INCH, AND 1½-INCH THICK.

The initial internal tem ature of 27° F. was selected the preoven temperature for frozen halibut steaks becaus represented the temperature the average ice-cube compa ment in a household refrigera Oven temperatures of 300°, 3 375°, 400°, 450°, and 500° were used. Because the opt mum temperature for cookin fish could be expected to fal within the range of 350° to 400° F., 375° F. was also i cluded in the series.

Commercially-frozen ha but was purchased from a wholesaler because with a bandsaw he could accurately and quickly cut frozen halibu into steaks ½, 1, or 1½ inche thick. The 1½-inch steaks were cut from the collar sec tion of the fish because it wa relatively easy to get a singl 300-gram weight from this chunky portion. As the cutti progressed toward the cente of the halibut, single 1-inch steaks were cut; next, doubl 1-inch (600 grams) steaks; an finally ½-inch steaks (fig. 1).

Each steak was wrapped in heavy-weight aluminum fo and stored at 0° F. until use

A recording potentiome with glass-covered copper-constantin thermocouples wa used to record the internal temperature of the steaks as they were being cooked. To standardize the temperature the ovens of the household-type electric range, special thermostats were installed t limit the fluctuation in oven temperature to plus-or-min 10° F. In the preparation o the steaks for baking, they were trimmed to exactly 30 grams. The frozen samples then were brined for 1 minut in a solution of ½ cup salt to quart of tap water to season the steaks and start the thaw ing process. After the exce moisture was wiped off, an

pick was used to make an opening for the insertion of the thermocouple in the 1- and 1½-inch steaks. An electric drill was used to form this opening in the ½-inch steaks while they were still frozen because there was danger of the ice pick piercing the opposite surface of the thin steaks.

The partially-thawed steaks were placed on a tinned-steel baking sheet. The thermocouple then was inserted. When the internal temperature reached 27° F., the steak was placed in the preheated oven, and the timing device was started. As soon as the potentiometer recorded an internal temperature of 155° to 160° F. in the steak, the timing apparatus was stopped. The steak was taken out of the oven, and the temperature allowed to drop several degrees before the thermocouple was removed to check the maximum temperature reached. After the steak cooled an additional ½ hour, it was removed from the baking sheet, and its weight recorded. The loss in weight was calculated. Any unusual circumstances or irregularities were noted on the data sheet.

DISCUSSION

The statistical measures used were those that were recommended by the Statistics Section, U. S. Fish and Wildlife Service, Seattle, Wash. The average, the standard error, and the 95-percent confidence interval were computed. The average was calculated by dividing the sum of the samples by the number of samples. The standard error, which is a measure of variability of the same average, was found by dividing the standard deviation by the square root of the number of cases. The 95-percent confidence interval was computed by taking the mean, plus or minus t_{α} [2/] times the square root of the variance over the number of samples.

Table 1 - Confidence Intervals of 95 Percent for ½-, 1-, and 1½-Inch Steaks

Thickness of Steaks	No. of Samples	Oven Temperature	Time Intervals	Range
			. . .(Minutes) . . .	
½-inch	13	300° F.	24.5 to 30.5	6.0
	13	350° F.	18.2 to 21.6	3.4
	12	375° F.	16.8 to 19.2	2.11
	12	400° F.	14.1 to 17.5	3.4
	12	450° F.	11.4 to 14.0	2.6
	12	500° F.	11.2 to 12.6	1.4
1-inch	15	300° F.	45.1 to 51.1	6.0
	14	350° F.	29.9 to 34.8	4.9
	17	375° F.	26.8 to 32.2	5.4
	13	400° F.	25.7 to 27.7	2.0
	12	450° F.	20.2 to 23.8	3.6
	13	500° F.	20.6 to 24.2	3.6
1½-inch	13	300° F.	52.1 to 57.7	5.6
	14	350° F.	40.5 to 46.3	5.8
	12	375° F.	37.4 to 41.6	4.2
	14	400° F.	34.9 to 40.3	5.4
	13	450° F.	26.9 to 31.3	4.4
	12	500° F.	26.5 to 29.5	3.0

The charts in figure 1 show (1) the range of cooking time in minutes for ½-, 1-, and 1½-inch steaks at the various oven temperatures, (2) the standard error of the mean, and (3) the 95-percent confidence level for the mean. Because there are 95 chances in 100 that the 95-percent confidence level will contain the true mean, this interval might be used as the standard cooking time. Table 1 summarizes these intervals for ½-, 1-, and 1½-inch steaks cooked at different oven temperatures.

RESULTS

It was observed that the longer the cooking time, the less accurate were the predictions that could be made on cooking time. For example, the cooking time for ½-inch steaks at 300° F., varied from 18 to 36 minutes. With greater variability in the cooking time at the lower temperatures, a certain measure of subjective judgment must be used. Therefore, the 95-percent confidence interval will be use-

2/ T SUB ALPHA.

ful as a guide because the average time required to cook a ½-inch steak at 300° F will be between 24.5 to 30.5 minutes 95 percent of the time. Conversely, the coo ing time at higher temperatures can be given more accurately with a minimum of judgment expected on the part of the homemaker. For example, ½-inch steaks coo ed at 500° F. required 11 to 14 minute and the 95-percent confidence interval was between 11.2 to 12.6 or plus or minus 1.4° F. A similar comparison was shown with both 1- and 1½-inch steaks cooked at 300° F. and 500° F.

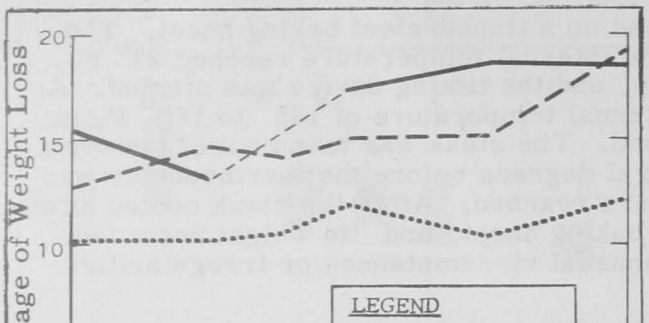

FIG. 3 - PERCENTAGE OF WEIGHT LOSS IN HALIBUT STEAKS AFTER COOKING.

There was an increased odor and visible dehydration of the steaks at ten peratures of 400° F. and above. With higher oven temperatures there was a general increase in weight loss (fig. 3 Most of the samples lost between 10 pe cent and 20 percent of their weight. A 300° F., the weight losses averaged b tween 10 percent and 15 percent; at 500 F the weight losses averaged between 13 percent and 19 percent. The weight loss for ½-inch steaks was consistently lowe than that for the other thicknesses, eve though more surface area was exposed i these thinner steaks. The short cooking time involved may be the factor that keep the weight loss low. Some inconsistencies, however, are as yet unexplained.

CONCLUSION

The standard cooking times (the time it takes to reach an internal temperatur of 155° to 160° F. from 27° F.) established by the data for ½-, 1-, and 1½-inch fr zen halibut steaks at various oven temperatures seem to be sufficiently reliable to be useful. The average, the standard error, and 95-percent confidence interval fo the mean are given. Since 95 times out of 100, the 95-percent confidence interval contains the true mean, it is believed that this interval will be helpful as a guide i cooking fish.

The study has emphasized the need for investigation into related problems, such as controlled experiments concerning weight losses. Because of the limited number of samples, additional research will be necessary before any of these dat are utilized as instructions on packages of frozen fish.

A further study is in progress. The object of this study, Part III, will be to obtain data on the cooking time required to raise frozen halibut steaks at different predetermined preoven temperatures to an internal temperature of 155° F. to 160°

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