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EFFECT OF COOKING ON THE NUTRITIVE VALUE OF THE PROTEIN OF COD

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ABSTRACT

The nutritive value of cod protein was not adversely affected by proper baking or simmering or by the rewarming of baked fillets. Overbaking or long heating may have caused a small deterioration of the nutritive value.

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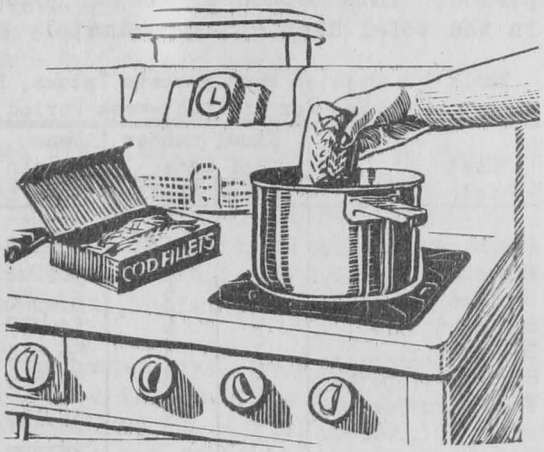
The need for greater care in preparing, cooking, and serving the limited food supply available during the war suggested that a comparative study be made to determine the effect of different cooking methods on the nutritive value of fishery products.

Relatively few references are available in the literature on the effect of cooking on the nutritive value of the protein of different foods. Seegers and Mattill (1935) concluded after a critical survey of the experimental data reported in the literature that the nutritive value of the proteins of meats and cereals was decreased only if the degree of heating was intense or prolonged. Andross (1940) found that eggs cooked for a longer time than necessary were more difficult to digest than those cooked according to recommended methods.



EXPERIMENTAL METHODS: Preliminary feeding experiments with rats showed that quick-freezing of raw fish had no adverse effect on the nutritive value of the protein. These results indicated that quick-frozen fish could be used as the control food, and that the nutritive value of the cooked samples did not change when they were quick-frozen and fed to the rats in the frozen state.

Fillets of cod (Gadus callarius) were baked at 375° F. for 25 minutes, broiled at 375° F. for 25 minutes, or simmered at 185° F. for 20 minutes, according to the methods recommended by Whiteman (1943). One sample was baked at 450° F. for 35 minutes and another was boiled for 20 minutes, these two samples thus being subjected to a greater degree of cooking than is ordinarily recommended.

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One sample of fish baked at 375° F. was held over water at 170° F. for 60 minutes to simulate holding for delayed serving. Another sample of baked fish was stored in the refrigerator and reheated the next day to simulate use as left-overs.

Approximately 10 ounces of cod fillets was cooked according to each method every week or 10 days during the experiment. Each sample to be baked or broiled was first covered lightly with vegetable oil to keep the fish from sticking to the pan during the cooking process. As soon as the fish had cooked the required time, the sample was wrapped in cellophane and placed in the freezing unit to be quick-frozen. This procedure permitted the fish to be removed after an exactly determined cooking time and made it possible to feed the rats over a considerable period of time with portions from the same batch of cooked material.

The effect of cooking and holding methods on the supplementary nutritive value of the protein of cod was determined by means of growth experiments with rats. The rats were allotted to groups at an initial weight of 49 to 55 grams. The experiment lasted 8 weeks, and during this time the rats were housed individually in cages fitted with screen floors. To supplement the daily allowance of fish, a basal diet, consisting of the following in parts by weight, was fed ad libitum:

Cornstarch - 80	Wilson's liver concentrate powder - 0.5	Wheat embryo - 2
Lard - 10	Dried brewer's yeast - 1.5	Cod liver oil - 2
	U.S.P. XI salt mixture No. 2 - 4	

The amount of fish fed daily to each rat was increased from a protein equivalent of 3 grams of fresh or frozen fish during the first 2 weeks to 5 grams during the third, fourth, and fifth weeks, and 7 grams during the remainder of the experimental period. This method of graded dosage was designed to keep the level of protein in the total diet at approximately 11 percent.

Table 1 - Data on Mean Protein Intake, Food Intake, and Gain in Weight of Groups of Rats Fed for an Eight-week Period on Basal Diet Plus Cod Prepared in Various Ways

Diet fed	Final number of rats		Mean protein intake 1/	Mean food intake 2/	Mean protein in diet as consumed 3/	Mean gain in live weight 4/	Estimated mean gain in live weight 5/
	Males	Females	Grams	Grams	Percent	Grams	Grams
Fresh	3	5	56.339	533.20	10.9	124.00	134.45
Frozen	4	7	56.264	504.60	11.3	125.73	126.09
Broiled	8	3	53.526	485.26	11.1	124.36	123.65
Simmered	5	6	54.799	471.75	11.7	118.36	118.15
Boiled	7	3	55.514	477.48	11.8	127.80	118.98
Baking at 450°F.	5	3	54.516	451.24	12.1	110.00	112.43
Kept warm for 60 minutes	4	7	56.132	442.70	12.7	108.73	107.94
		Mean	55.289	479.967		119.986	

1/ This value includes the protein content of the fish fed and that of the basal diet consumed. The basal diet contained 1.6 percent protein.

2/ This value includes basal diet as fed plus analyzed protein content of fish fed increased by 15 percent to approximate moisture equivalent of basal ration. This correction equivalent was used since protein of supplemental diet furnished calories as well as protein in undetermined quantities.

3/ The data for all rats with a mean protein intake in diet in excess of 15 percent were discarded.

4/ Standard deviation of mean gain in live weight of all rats = 22.68 grams.

5/ The estimated mean gain in live weight for groups were calculated from multiple regression coefficients involving protein intake, food intake, and gain in weight, as shown in Tables 2 and 3, and text.

The data for the groups fed the cod fillets baked at 375° F. for 25 minutes and those fed the reheated baked fish that had been stored for 24 hours in the refrigerator were not included in the summary of group data, because these rats were inadvertently offered an average of 67.4 and 68.4 grams of proteins, respectively, for the 8-week period instead of about 55 grams. It was not possible to include the data for these groups in a statistical analysis of variance and arrive at a reasonable answer.

Lanham and Lemon (1938) reported data indicating that the protein intake was the limiting factor in producing gain in live weight when diets were fed that contained 15 percent or less of protein by weight. Therefore, in the experiment reported here, the data were discarded for those rats that consumed the basal diet in such small quantities that the protein content of the total food intake exceeded 15 percent. The diets of most of the rats contained 11 to 12 percent total protein, as indicated in Table 1 (p. 2).

The basic data presented in Table 1 indicate considerable variation in sex allotment and mean food intake for groups and lesser variation in the mean protein intake. It was, therefore, desirable to study the effect of these variables on the mean gain in live weight of groups. The method of multiple regression was used to estimate the mean gain in live weight for groups and sub-groups for variation in food and protein intake (Snedecor, 1940).

Table 2 - Data on Mean Protein Intake, Food Intake, and Gain in Weight by Sexes

Sex	Number	Mean protein intake	Mean food intake	Mean gain live weight		Standard deviation
				Actual	Estimated	
		Grams	Grams	Grams	Grams	Grams
Male	36	54.943	483.69	128.83	128.91	22.39
Female	34	55.655	476.02	110.62	110.30	19.20

Total regression equation for estimating group gain in weight:
For males it equals 43.989 - 0.9190 protein intake + 0.2798 food intake;
For females it equals 47.579 - 1.1647 protein intake + 0.2686 food intake.

With respect to the effect of variable sex distribution, the data in Table 2 show a smaller difference in mean gain in live weight for over-all groups by sex than is usually the case. The total multiple regression equations were also found to be quite similar for the two sexes. An analysis of variance showed that the members of the two sexes reacted alike to the experimental variable. The data were, therefore, combined for statistical treatment (Tables 1, 3, 4, and 5).

The regression equation was found to be: estimated group gain in live weight equals 45.0977 - 1.2125 protein intake + 0.2957 food intake. The F value of 1.12 determined by analysis of variance of group data (Table 5, p. 4) indicates that the differences found between group gains in live weight cannot be considered statistically significant. This means that the methods of cooking or holding which were tested did not significantly alter the nutritive value of the protein.

Although there are no statistically significant differences, it is apparent that the rats did not grow as well as would be expected (estimated mean gain in live weight) when fresh cod was fed as compared with the frozen or cooked fish. This difference is also noted in the data for the individual sexes. An attempt at interpretation will have to await further studies. Overbaking the fillets at 450° F. for 35 minutes and holding the ordinarily baked fillets (375° F. for 25 minutes) over warm water for 60 minutes gave somewhat less satisfactory results than with the other methods of cooking. The mean gain in live weight per gram of

protein consumed averaged 2.02 and 1.94 grams, respectively, for rats fed these two products, as compared with a range in group means of 2.16 to 2.32 grams for the rats fed fillets cooked by the other methods.

Table 3 - Calculation of Sums of Squares and Products, and Correlation Coefficients for Data in Table 1

n = 70	Protein intake X_1	Food intake X_2	Gain in weight Y
Sum	3,870.22	33,597.7	8,399.0.
Mean	55.289	479.967	119.986
Protein intake:			
SX_1^2, SX_1X_2, SX_1Y	216,970.107	1,882,080.701	467,932.990
Correction terms	213,980.041	1,857,578.435	464,371.111
Sx_1^2, Sx_1x_2, Sx_1y	2,990.066	24,502.266	3,561.879
$\sqrt{Sx_1^2}$, $\sqrt{(Sx_1^2)\ (Sx_2^2)}$, etc.	54.6815	34,388.9602	10,304.9583
r_{12}, r_{Y1}		0.7125	0.3456
Food intake:			
SX_2^2, SX_2Y		16,521,301.880	4,113,983.400
Correction terms		16,125,792.076	4,031,244.033
Sx_2^2, Sx_2y		395,509.804	82,739.367
$\sqrt{Sx_2^2}$, $\sqrt{(Sx_2^2)\ (Sy^2)}$		628.8957	118,518.0360
r_Y^2			0.6981
Gain in weight:			
SY^2			1,043,275.000
Correction term			1,007,760.014
Sy^2			35,514.986
$\sqrt{Sy^2}$			188.4542
Sy			22.6780

Earlier in this article it was stated that two other methods of preparation were used; namely, baking at 375° F. for 25 minutes and reheating these baked fillets after refrigerating for 24 hours. The data for these groups were not included in the statistical summary because these rats erroneously received a greater daily allowance of protein than the others. The rats fed the baked fish had a mean gain in live weight of 139.89 grams (487 grams total food intake) and those fed the reheated baked fish had a mean gain in live weight of 129.43 grams (489 grams total food intake). Although a direct comparison of group data is not possible, the growth was satisfactory, indicating that these methods of cooking were without adverse effect on the nutritive value of the protein.

SUMMARY: Baking or broiling cod fillets at 375° F. for 25 minutes and simmering or boiling the fillets for 20 minutes had no adverse effect on the supplementary nutritive value of the fish protein. Reheating baked fillets after they had been refrigerated for 24 hours was also satisfactory.

Less satisfactory results, but still within the limits of variability of the experiment, were obtained when fillets were fed that had been baked at 375° F. for 25 minutes and then held over water at 170° F. for 60 minutes to simulate

holding for delayed serving or when the fillets had been baked at 450° F. for 35 minutes to simulate overcooking.

Table 4 - Calculations of Squares and Products for Total, For Groups, and Within Groups. Calculations of Correlation Coefficients Within Groups

Source of variation	Protein intake X_1	Food intake X_2	Gain in weight Y
Protein intake:			
Line 3, Table 2	2,990.066	24,502.266	3,561.879
Groups	68.094	480.900	0.219
Rats within groups	2,921.972	24,021.366	3,561.660
$\sqrt{Sx_1^2}, \sqrt{(Sx_1^2)\ (Sx_2^2)}$, etc.	54.0553	31,666.0272	9,666.8444
r_{12}, r_{Y^1}		0.7586	0.3684
Food intake:			
Line 3, Table 2		395,509.804	82,739.367
Groups		52,338.826	10,383.044
Rats within groups		343,170.978	72,356.323
$\sqrt{Sx_2^2}, \sqrt{(Sx_2^2)\ Sy^2}$		585.8080	104,761.5092
r_{Y^2}			0.6907
Gain in weight:			
Line 3, Table 2			35,514.986
Groups			3,533.932
Rats within groups			31,981.054
$\sqrt{Sy^2}$			178.8325

These studies give no clue to the effect of the different methods of cooking or holding on quantitative losses of protein or on the appearance, flavor, or texture of the cooked fillets. These considerations, therefore, are paramount

Table 5 - Analysis of Variance of Data on Mean Gain in Weight, and Errors of Estimate for Groups of Rats Reported in Table 1

Source of variation	Degrees of freedom	Mean gain in live weight		R^2	Errors of estimate		
		Sum of squares	Mean square		Degrees of freedom	Sum of squares	Mean square
Total	69	35,514.986		0.5342	67	16,542.881	
Error	63	31,981.054	507.636	0.5341	61	14,899.973	244.262
Groups	6	3,533.932	588.989		6	1,642.908	273.819

F = 1.12

in the selection of the method of cooking, since none of the methods had a statistically significant effect on the supplementary nutritive value of the protein of cod fillets.

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SLOW FROZEN

QUICK-FREEZING TECHNIQUE

QUICK FROZEN

Quick-freezing technique has been discussed as a process based upon the coordinated results of many investigations by scientific research workers. The resultant technique, when applied to the preservation of food, can make a useful contribution to the well-being of the people.

The purpose of quick-freezing is to preserve the quality, texture, taste, appearance, and health-giving properties of foods at their prime.

Meat, fish, poultry, vegetables, and fruit can be processed and preserved in such excellent condition that even after prolonged cold storage they are, when cooked, indistinguishable from fresh products.

The technique covers:

1. QUALITY CONTROL, INCLUDING SELECTION AND PRE-TREATMENT OF PRODUCTS
2. PACKAGING
3. QUICK-FREEZING
4. REFRIGERATED TRANSPORT
5. COLD STORAGE

More detailed information on this subject is available in Fishery Leaflet 203, which was taken from a paper written by H. W. Dunsford, Associate Member of the Institute of Refrigeration, St. Martin's-le-Grand, London. The leaflet may be obtained, free of charge, from the U. S. Fish and Wildlife Service, Merchandise Mart, Chicago 54, Ill.