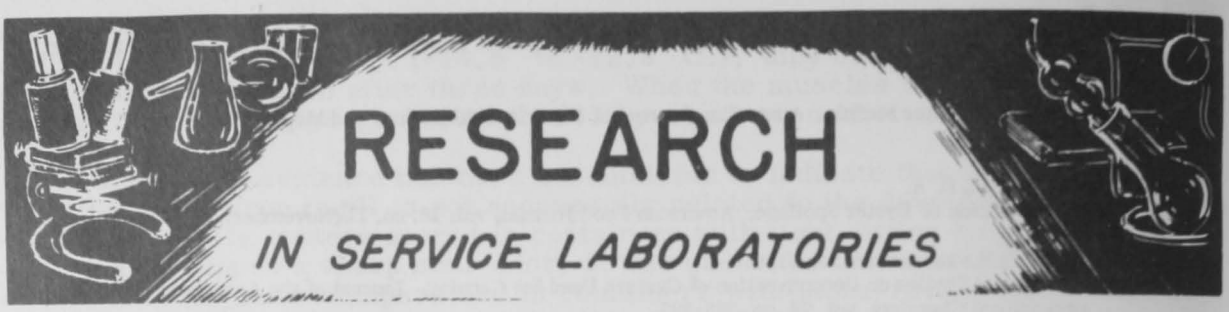
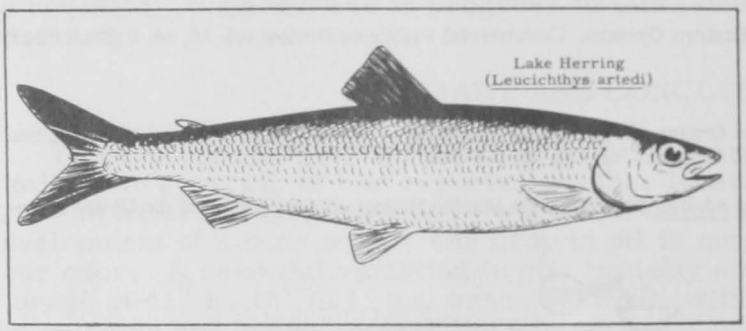


COLD STORAGE LIFE OF FRESH-WATER FISH--NO. 3[1/]

(Lake Herring, Northern Pike, and Whitefish)

INTRODUCTION

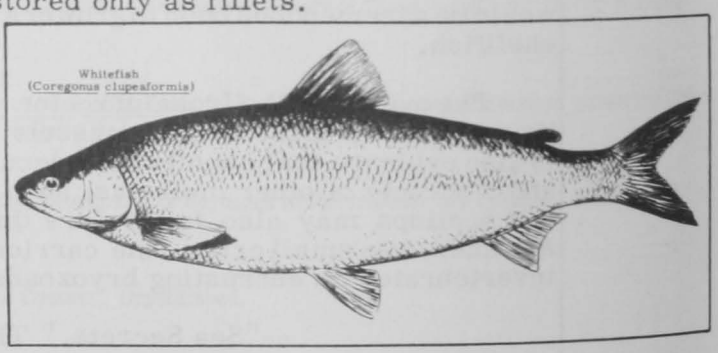
The various species of fresh-water fish constitute a valuable source of high-quality protein food in the United States. Notwithstanding this fact, relatively little is known about the frozen-storage characteristics of these fish. Data on their cold-storage life, if available, would greatly assist the producer in selecting the best handling procedures and in adjusting to fish-marketing changes. The data would also help the sports fishermen to make better use of their catches.



A project designed to evaluate the frozen-storage characteristics of certain species of fresh-water fish was started at the Seattle Technological Laboratory about 5 years ago. The first report of the findings was published in the September 1954 (Myauchi and Stansby 1954); the second, in November 1955 (Osterhaug and Myauchi 1956). In this paper, the results of cold-storage tests on three new species (lake herring, Leucichthys artedi; northern pike, Esox lucius; and whitefish, Coregonus clupeaformis), are reported.

COLLECTION AND TREATMENT OF SAMPLES

The fish used in this study were collected in Minnesota. Samples of the lake herring and of the whitefish were stored in the round as well as in other market forms. The northern pike were stored only as fillets.



Three lots of fish, one for each species studied, were shipped from the point of collection to the Seattle laboratory. The lake herring and the whitefish were shipped frozen, and the northern pike was shipped iced.

The two lots of frozen fish (lake herring and whitefish) were frozen in commercial freezers, packed in suitable containers with dry ice, and shipped to Seattle by express or air freight. The two lots, which were received in good condition, were placed immediately in storage at 0° F.

1/ This work was carried out under a project financed in part by the Refrigeration Research Foundation.

The single lot of iced fish (northern pike) was shipped in the round from Litchfield, Minn., on February 1, 1955, and arrived, well iced, in Seattle on February 3. The fish were held overnight at the laboratory in storage at 34° F. before being filleted and packaged for freezing. The individually cellophane-wrapped fillets were frozen on shelves in a room at -20° F. and then were packed in waxed cartons and stored at 0° F.

RESULTS AND DISCUSSION

Table 1 gives data on the cold-storage history of the three species of fish. Owing to the small samples of fish received the initial zero-storage organoleptic tests of these widely-accepted fish (lake herring and whitefish) were omitted.

Table 1 - Cold-Storage Life of Certain Fresh-Water Fish Stored 0° F.

Description of Sample						Condition of Samples Stored at 0° F. for:				
Common Name	Scientific Name	Source	Date Caught	Method of Shipping	Packaging Used for Storage	3 Months	5 Months	7 Months	9 Months	11 Months
Lake herring (South Shore)	Leucichthys artedi	Lake Superior, (Duluth, Minn.)	Dec. 1, 1954	Frozen	In the round, glazed; packed in 5-pound wax cartons, overwrapped with wax paper heat-sealed.	Firm and bright but with slight reddish discoloration in belly cavities of some fish; some off-flavor.	Texture tender, moist, and firm; bright; flavor bland. (very good)	Texture soft; meat mottled pink with yellow spots near nape; flavor "muddy" or "scorched" (not acceptable)	Rancid (not acceptable)	Rancid (not acceptable)
					Scaled, headed, and gutted; packed in 1-pound cartons; overwrapped with 450 MSI cellophane, heat sealed.	Texture tender and moist; flavor good.	Texture firm; slight discoloration of nape; flavor good. (good)	Texture firm; considerable discoloration of nape; slight off-flavor in nape and belly cavity. (acceptable)	Texture firm; skin had darkened, nape and belly cavity showed yellow discoloration; slight rancidity of nape and belly cavity. (acceptable?)	Rancid (not acceptable)
					Fillets packed in 1-pound waxed cartons, overwrapped with 450 MSI cellophane, heat sealed.	Texture moist and tender; flavor good, similar to lake smelt or silver smelt.	Texture moist and flaky; two fillets had yellow spots on meat; flavor mild with no off-flavors noted. (acceptable)	Some yellow discoloration over surface of fillets; some rancidity noted in dark meat, nape area, and edges of belly cavity. (acceptable)	Texture firm but spongy with excess expressible liquid; surface of meat yellow; some rancidity throughout. (not acceptable)	Rancid (not acceptable)
						1 Month	2 Months	3 Months	4 Months	7 Months
					Breaded fillets packed in 1-pound waxed cartons, overwrapped with 450 MSI cellophane, heat sealed.	Good	Good	Fried fillets had very good flavor. (acceptable)	Two of the baked fillets had a slight rancid flavor. (acceptable)	Skin of baked fillets slightly rancid, meat mild to flat. (acceptable)
						0 Months	3 Months	6 Months	9 Months	12 Months
Northern pike	Esox lucius	Litchfield, Minn.	Feb. 1, 1955	Iced	Fillets, wrapped in MSAT cellophane, packed in waxed carton.	Texture soft; flavor bland.	Texture firm, tender and flaky; meat white; flavor mild and pleasant.	Meat had darkened; some rancidity. (acceptable)	Texture firm; meat had darkened; moderate to strong rancidity. (not acceptable)	Discontinued
White-fish 1/	Coregonus clupeaformis	Red Lake, Minn.	Aug. 15, 1954	Frozen	In the round, packed in polyethylene bags.	-	Variable; sample inadequate in size.	Slight darkening along backbone, no off-flavors or rancidity. (acceptable)	Texture firm; reddish color along backbone and belly wall; some rancidity in fat. (acceptable)	Texture soft; dark meat was brown; slight rancidity in dark meat. (not acceptable)
					Eviscerated, packed in polyethylene bags.	-	-	-	Texture firm, meat white; flavor normal. (acceptable)	No further samples available.
					Fillets, wrapped in MSAT cellophane.	-	Samples not adequate for judging.	Slight darkening around edges and along center line; off-flavors in tail portion and posterior belly flaps; fat slightly rancid. (acceptable)		Texture firm; yellow-brown discoloration; moderate amount of rancidity throughout. (not acceptable)

1/ Zero-month organoleptic tests omitted owing to small size of samples.

The northern pike, which were shipped iced and then filleted before being frozen, remained acceptable through 6 months of frozen storage. By 9 months, the meat had darkened somewhat, and moderate to strong rancidity had developed.

The whitefish were found to be acceptable through 9 months of storage. By 12 months, all of the samples had darkened in color and were slightly to moderately rancid.

The lake herring that had been frozen and stored in the round were judged not to be acceptable at the seventh-month examination, owing to discoloration and autolytic breakdown in the belly cavity. The meat along the belly flaps was strongly mottled from gray to brownish red, with yellowish spots near the nape. There was also a strong tendency for the rib bones to protrude into the belly cavity. Strong "muddy" or "scorched" off-flavors were noted. After 9 months of storage these samples were also rancid.

The lake herring that had been scaled, headed, and gutted before being frozen remained "acceptable" through the ninth-month examination, but they were judged "not acceptable" at 11 months, owing to the development of rancidity. These fish might have had a longer frozen-storage life if the original cleaning of the belly cavity had been more thorough.

Frozen fillets of lake herring remained acceptable through the seventh-month examination, but by the ninth-month examination they had become spongy in texture and somewhat rancid throughout.

Frozen breaded fillets of lake herring remained acceptable through 7 months of storage. No further storage was possible because, at that time, the samples were used up.

FRESH-WATER FISH CURRENTLY UNDERGOING STORAGE TESTS

Because the storage tests reported here are based on only single batches of each species and because many of the variables remained uncontrolled, these results cannot be considered as determining conclusively the storage life of these species. To employ our limited resources more efficiently, we have decided therefore to concentrate on a single species of fish during the coming year and thereby obtain better control of the many variables. The species chosen is lake herring from Lake Superior and Lake Huron. The results of this investigation, when completed, will be given in the next report on this project.

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COLD-STORAGE STUDIES ON GULF OF MEXICO YELLOWFIN TUNA

Exploratory studies to anticipate, and possibly forestall, technological problems in the newborn Gulf tuna industry are being conducted. Thirty-nine yellowfin tuna were frozen in brine tanks and in refrigerated dry-wells aboard the fishing vessel or in warehouse freezers ashore. The fish (from 40 to 150 pounds each) were studied by Service technologists, and then were placed in frozen storage. They will be examined at periodic intervals to determine the storage effects, if any, upon the color and flavor of the meat. Individual fish will be processed and canned at inter-

vals during the storage period for studies of the effects of processing after prolonged storage periods.

The tuna were taken by the Service's exploratory fishing vessel Oregon during long-line fishing operations off the delta of the Mississippi River. The cruise, one of many during the past year, was designed to further test the commercial feasibility of a year-round tuna fishery in the Gulf area. A canning expert from the Service's Technological Section supervised preparation of the samples.

FUNGICIDAL PROPERTIES OF MODIFIED UNSATURATED FISH OILS

Comparative studies made at Florida Southern College of the fungicidal activities of inorganic copper salts and of a modified unsaturated fish oil showed the fish oil to be approximately 32 times as active in preventing mold development. The inorganic salts studied (commonly used as fungicidal agents) were copper sulfate and basic copper acetate; the fish oil was modified by chemically uniting it with a quaternary ammonium compound. The work was sponsored by the Service with funds made available by Public Law 466, the Saltonstall-Kennedy Act of 1954. A potentially large field of application for fish oils will be opened if the research is successful.

Experimental pump and probe disigned to introduce fish oil nematocides into the ground surrounding the roots of citrus trees threatened by the "spreading-decline" nematode.

The comparative degrees of growth of a mold, Candida albicans, in cultures containing the above salts or the modified fish oils were studied. The culture, containing approximately nine ten-thousandths of an ounce of modified unsaturated fish oil per gallon, evidenced no growth of the mold, while those containing much larger quantities of the two copper salts were quickly overgrown with the mold. Further studies are continuing.

This work is the result of one phase of a general program dealing with research on the insecticidal, fungicidal, and nematocidal characteristics of fish oils. Results to date have been promising in both the fungicidal and nematocidal fields. Research on the latter field is now out of the laboratory and into the pilot-study phase. Problems of application of the nematocidal fish oils to nematodes in the underground roots of citrus trees are being studied.

Note: See Commercial Fisheries Review, March 1956, p. 9; June 1956, p. 13.

NORTH ATLANTIC SHRIMP KEEPING QUALITY IN COLD STORAGE

Gulf of Maine or Northern shrimp were found to have good keeping quality when brine-frozen with heads on aboard the Service's exploratory fishing vessel Delaware, and then ashore thawed, processed, packaged, refrozen, and stored at 0° F. under conditions approximately equivalent to commercial practice. The samples were considered of "commercially-acceptable" quality after 14 months' storage (the period of the last examination).

On June 6, 1955, supplies of Northern shrimp, Pandalus borealis (average heads-on length 3.5 inches) were caught by the research vessel during exploratory fishing operations in North Atlantic waters. These were promptly brine-frozen with heads on at 0° to 5° F. aboard the vessel and stored at about 5° F. in the fish hold. Sample lots of the frozen shrimp, after landing, were distributed to local processors for evaluation. A small representative lot was processed for storage tests at the laboratory.

The samples were prepared for storage as follows: the thawed shrimp were beheaded; washed in fresh water; packed in waxed cardboard cartons (5-lb. size); and refrozen in a plate freezer at -20° F. The carton lids were then removed, and the shrimp were glazed by dipping twice in water at 32° to 35° F.; after which the lids were replaced. The cartons were overwrapped with aluminum foil and finally with kraft wrapping paper to protect the foil. The packages were stored at 0° F.

Organoleptic observations of the raw and cooked shrimp were carried out at periodic intervals. The shrimp showed a white mottling of the shell which was believed due to local dehydration resulting from the brine-freezing operation. This detracted somewhat from the appearance but was not considered serious by those examiners who understood the nature of the spotting. The periodic examinations revealed the following:

INITIAL EXAMINATION: Color was a pleasing light pink; flavor was mild, pleasing, and sweet, and the texture was tender. Over-all rating was "like very much."

SIX MONTHS' STORAGE: Color was a good pink but slightly dull. Flavor was considered to be good with no off-flavors, and the texture was firm. Over-all rating was "like moderately."

NINE MONTHS' STORAGE: Color was fair, but there was some slight yellowing; flavor was fair, lacking the characteristic sweet flavor, but with discernible off-flavors; texture was firm and approaching the slightly tough stage. Over-all rating was between "like slightly" and "like moderately." (The rating "like slightly" is considered to be the lower limit of commercial acceptability.)

FOURTEEN MONTHS' STORAGE: Color was fair, showing slight yellowing; flavor was fair, lacking the characteristic sweet flavor, but with no discernible off-flavors; texture was satisfactory, but appeared to have become softer. Over-all rating was between "like slightly" and "like moderately."

TECHNICAL NOTE NO. 34 - GROWTH CHARACTERISTICS OF THE PINK YEAST THAT CAUSES DISCOLORATION OF OYSTERS

Oysters of the finest grade and free of defects when packaged were found to have pink spots after being held in frozen storage for various periods of time and then thawed, and the thaw liquor was found to have a pink color. A study was undertaken to determine the cause of this phenomenon. The literature indicated that the agent causing the pink discoloration is a supposedly asporogenous yeast belonging to the genus Torulaceae. The work reported here, however, showed that the pink yeast may produce ascospores.

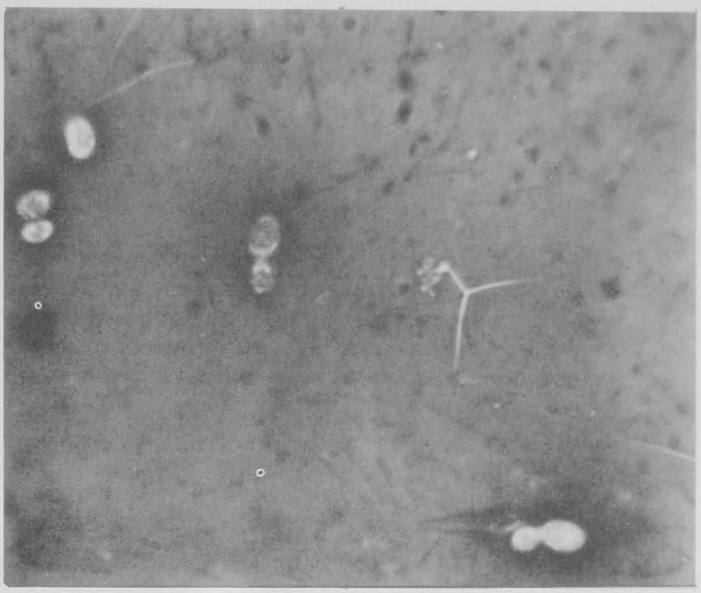

Fig. 1 - Pink yeast culture showing asci and ascopores.

EXPERIMENTAL

A representative sample consisting of four oysters with pink spots was thawed, removed from the package, and blendored in a sterile Waring Blendor jar. The resulting disintegrated homogeneous material was used to inoculate tubes of Sabouraud's broth media. Subsequently, Sabouraud's agar plates, to which had been added one drop of sterile 50-percent lactic acid prior to pouring the agar, were streaked from the growth that developed in the broth tubes. (The lactic acid reduces the overgrowth of colorless colonies that interferes with the growth of the pink yeast. The organism causing this growth is a gram positive rod that possibly may become chromogenic under proper conditions.) After 3 to 4 days of incubation at room temperature, pink colonies appeared on the plates.

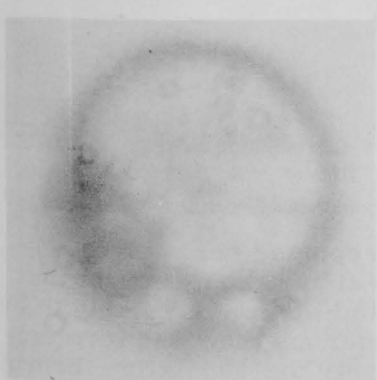

Fig. 2 - An ascus with ascopores enclosed in sac.

These colonies were confluent, shiny, butyrous, and pink; and a few were discrete. A smear made from a colony, after being stained with methylene blue and examined under oil immersion, showed yeast cells, some of which were budding. Fresh preparations were studied under the microscope over the period of an hour or two--depending upon the evaporation of the media--and each ascus[1/] was noted to contain from one to four ascospores.[2/] Seven to eight transfers were made of the cultures, and each showed the same characteristics of growth, indicating that each was pure. The final culture was then allowed to remain undisturbed at room temperature on a Sabouraud's agar slant for 4 years[3/] in large test tubes that were tightly sealed.

After this long dormant period, the culture was examined for the presence of spores by the method of Dorner, as is recommended in the Manual of Methods for

1/ Ascus--the membranous oval or tubular spore sac in ascomycetes.
2/ Ascospore--one of the spores contained in an ascus.
3/ This long period of time was made necessary by work on other projects.

Pure Culture Study of Bacteria. Ink Powder (Nigrosin Electroencephalograph) was used for the counterstain (pure nigrosin powder was not available). Microscopic examination showed that the culture contained asci, each of which had from one to four ascospores (fig. 1 and 2).

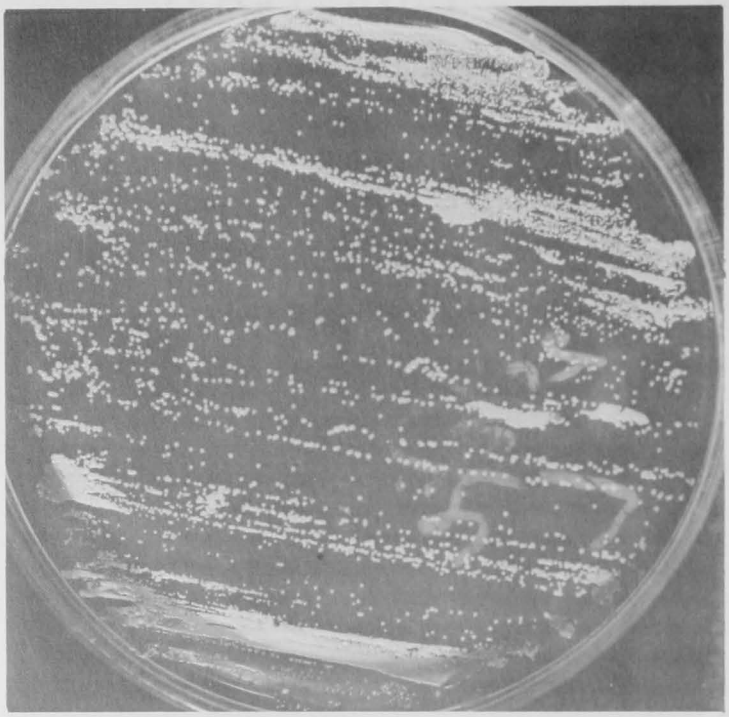

Fig. 3 - Pink yeast growing on a plate of Sabouraud's agar.

To determine if these 4-year-old cultures could still be revived, I inoculated Sabouraud's broth tubes with them. The pink yeast colonies grew satisfactorily (fig. 3); the surface contour of the cells appeared to be normal (fig. 4); and the cells were found to bud normally, and no spores were present (fig. 5).

DISCUSSION

It was noted about 6 years ago that pink yeast would grow and form pigment at temperatures down to -35° F. (McCormack 1950). Since that time, there has been a great increase in the quantity of oysters held under frozen storage, with some evidence of a higher incidence of losses due to pink yeast. During the early part of the present oyster season, for example, there was considerable concern over the problem of colored oysters.

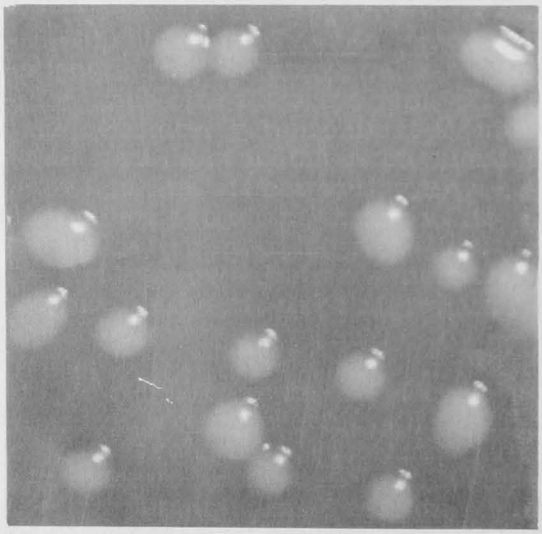

Fig. 4 - The surface contours of pink yeast cells appear normal.

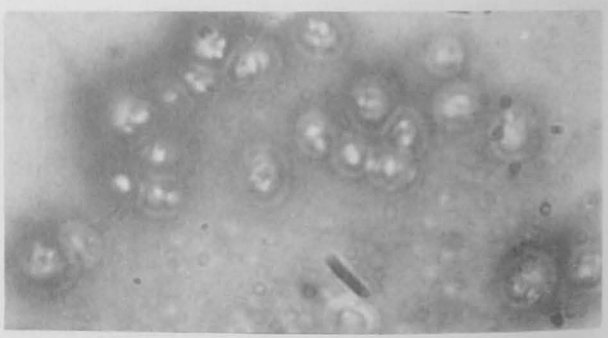

Fig. 5 - A culture showing budding cells but no spores.

The facts reported here that pink yeast produces spores suggest that the avenues of contamination are likely to be much more numerous than was formerly believed when only the vegetative form of the organism was studied by itself. On the basis of our present incomplete knowledge, however, we can conclude only that there is greater need for further research on this and other causes of pink and red color in shucked oysters.

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FROZEN FISH FILLETS AND STEAKS IDEAL PROTEIN FOODS

Frozen ocean perch, cod, and haddock fillets, and halibut steaks are recommended by the U. S. Fish and Wildlife Service as ideal protein foods.

Fillets are the sides of the fish cut lengthwise away from the backbone. They are practically boneless and have little or no waste. Steaks are cross-section slices of the larger sizes of dressed fish, usually about $\frac{3}{4}$ of an inch thick.

Frozen fillets and steaks may be thawed prior to cooking. Normally, it is suggested that they be thawed overnight in the refrigerator or left at room temperature for 3 to 4 hours. However, if you're in a hurry, the fillets or steaks may be cooked without thawing if additional cooking time is allowed.

Fillets or steaks may be prepared by any of the basic cooking methods of frying, baking, broiling, and steaming, or in an endless variety of combination dishes.

The important thing to remember in cooking fish, however, is that it must not be overcooked. Just enough cooking for the meat to flake easily will leave the fish moist and tender and bring out the delicate flavor.

The home economists of the Fish and Wildlife Service recommend Ocean Perch Creole as a delectable but economical and easily-prepared protein dish.

OCEAN PERCH CREOLE

2 POUNDS OCEAN PERCH FILLETS
$\frac{1}{4}$ CUP BUTTER OR OTHER FAT
2 TABLESPOONS FLOUR
2 CUPS TOMATO JUICE
2 TABLESPOONS CHOPPED ONION
3 TABLESPOONS CHOPPED PIMIENTO
$\frac{1}{2}$ TEASPOON SALT
DASH PEPPER
RICE RING

Skin fillets and cut into one-inch pieces. Melt butter, blend in flour and add all remaining ingredients except rice. Cook, stirring occasionally, about 15 minutes or until fish flakes easily when tested with fork. Serve hot in rice ring. Serve 6.