OYSTER-PROCESSING RESEARCH FOR ATLANTIC AND GULF COASTS

The technological research program for the study of the oyster industry of the South Atlantic and Gulf Coasts under the terms of the Saltonstall-Kennedy Act became fully active during February 1955 when contracts were signed with three Universities in the Gulf Coast States. The research programs of the three groups of investigators will supplement each other with practically no overlapping.

Oysters being gathered by tongs.

The largest group, at Florida State University, Tallahassee, Fla., will make periodic chemical and other analyses of typical local oysters. A second major phase of the program at Tallahassee will be to study the possibility of freezing special products, such as blanched oysters, breaded (raw and fried) oysters, smoked oysters, creamed or scalloped oysters, and oyster stews. Also a project of particular interest will be the relationship of changes in the fat content of oysters to quality deterioration in frozen storage of oyster products. This group is headed by Dr. Betty M. Watts of the Section of Food and Nutrition, assisted by Dr. Harvye Lewis and four graduate students. Dr. R. W. Menzel of the Zoology Department also will cooperate in obtaining samples of known history, most of which will be from Apalachicola or from nearby Panacea.

The second contract group at Louisiana State University, Baton Rouge, La., will study the effect of variables during the actual freezing processes on quality and amount of drip. They will also make a bacteriological study of oysters from the shell through the shucking, washing, freezing, storage, and thawing operations. A battery of quality tests now being used on shrimp will be used by the Baton Rouge group on all lots of oysters to be frozen, to determine which variables are correlated with organoleptic quality. The group at Baton Rouge will also make periodic collections of oysters in the Gulf States west of Florida so information can be obtained on seasonal and environmental effects on chemical and physical composition. The Baton Rouge work will be under the direction of Dr. E. A. Fieger, Department of Agricultural Chemistry and Biochemistry; Dr. Arthur F. Novak and several graduate students will assist in the work.

The third contract group at Tulane University, New Orleans, La., is working under the direction of Dr. Fred R. Cagle, Department of Zoology. Dr. Milton Fingerman has begun a study of the physiology of the bleeding reaction of oysters.

This bleeding reaction which is chiefly characterized by excessive drip formation on thawing the frozen oysters is much greater for Gulf Coast oysters than for those of the Chesapeake Bay and farther north. It is of primary concern in solving many of the problems encountered in handling and freezing Southern oysters. Dr. Fingerman also plans to investigate the causes of and the physiological basis of the quite variable dark pigmentation found in many of these oysters. This also detracts from their more general acceptance in inland areas.

The staff of the Fishery Technological Laboratory at College Park, Md., will be responsible for the general direction of the contract groups and liaison between the groups. Samples from the entire area have already been collected during the months of November, December, and January. The staff at College Park will continue collections of samples of Atlantic oysters north of Florida during the remainder of the season and will analyze most of all samples collected for chemical and physical composition. These data will be compared with similar data on oysters from all the other main production areas, thus getting essential information on effect of seasonal and geographical variability on composition, as well as variables introduced by different handling practices in commercial processing plants.

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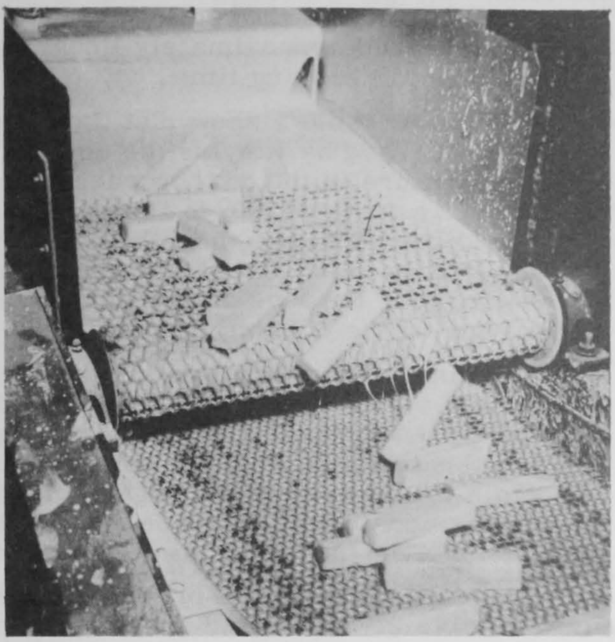
WEIGHT CHANGES DURING THE COOKING OF FISH STICKS

The booming fish-stick industry is producing approximately 50 million pounds of sticks a year and with the increased competition in this new product, processing costs have become of increasingly great importance. The processing of the fish sticks is a relatively complex procedure. Close control is required at all stages in the operation to prevent waste and consequent losses in time and money. In addition to weight losses in cooking, other losses may be incurred during the operation of sawing the sticks from frozen blocks of fish fillets, during the batter-dipping and breading operations, and during the packaging of the finished sticks. This report of observations and of research results on a pilot-plant scale of fish-stick manufacture will point out some means of minimizing losses during the processing, and in particular during the cooking of the fish sticks.


Frozen fish fillet blocks being cut into uniform fish sticks in a modern conveyor-belt-equipped plant.

In general, the following precautions are suggested to prevent large losses and at the same time to maintain production of an appealing product. Since the weight and shape of the stick is determined, to a large extent, by the initial operation of sawing the sticks, careful and continuing attention should be paid to the accuracy with which the sawing blades are set. By this practice, a maximum yield per pound of purchased raw material may be obtained. In addition, closer tolerances can be set for the "fill" of packages. Further, the increase in weight of fish sticks, due to the adherence of breading, is determined by the consistency of the batter. Once a satisfactory batter is obtained, all subsequent mixes should be made in the same proportions. Breakage of the soft, cooked fish stick during the packaging operation can be reduced by the employment of responsible personnel and by the constant supervision of the foremen. Broken sticks, while salable, bring a lower price per pound than do the intact fish sticks. An understanding of the factors involved in the changes in weight occurring during the actual cooking process is necessary to eliminate this source of possibly substantial losses during operation.



Fish sticks are passed through a batter by conveyor belt prior to being breaded.

Tests conducted at the Boston Fishery Technological Laboratory indicated that, under adequately engineered conditions, the following factors, in the main, determined the weight changes occurring during the cooking process:

1. Cooking time.
2. Temperature of the cooking oil.
3. Composition of the breading material.
4. Condition of the cooking oil.

Frozen sticks, each very close to 25 grams in weight, were dipped into a batter (6 parts of water to 4 parts of commercially-prepared dry batter mix), and were allowed to drain on a screen. They were then rolled in either a dry commercially-prepared breading material or in mixtures of the commercial material containing varying amounts of a type of commercially-prepared bread crumbs. These operations caused an increase of 25 $\pm$ 5 percent in the weight of each stick owing to the adherence of the batter and breading.

Cooked fish sticks being packed in institutional packages prior to freezing and storage.

The variously breaded sticks were then cooked in cottonseed oil maintained at 360°, 375°, 390°, and 405° F. The cooking times were at predetermined intervals between $\frac{3}{4}$ of a minute and 3 minutes, inclusive. The results of the study on sticks prepared with straight commercial breading are shown in table 1. Observations of the sticks were made at frequent intervals during the several cooking periods under study to determine the rate and type of changes occurring. During the first few seconds in the hot oil, the sticks increased slightly in weight, evidently due to the absorption of oil by the breading. After the breaded sticks had been immersed in the oil for approximately one minute, the oil commenced to "boil" due to the escape of water vapor from the sticks. The sticks examined at this time were thawed but were still very cold. The sticks left in the hot oil for periods greater than about 1 minute showed losses in weight which increased approximately linearly with the increase in cooking time.

Table 1 - Effect of Cooking Temperature and Time on Changes in Weight of Fish Sticks during Deep-Fat Frying

Cooking Time	Weight Changes 1/			
	Cooking Temperature (° F.)			
	360	375	390	405
Seconds	.........(Percent).......			
45	+2	+1	+3	+1
60	+1	-1	-1	-1
75	+1	-1	-2	-1
90	-5	-4	-5	-6
120	-6	-9	-6	-
150	-17	-	-	-
180	-24	-	-	-

1/ Expressed as parts gained or lost in weight by 125 parts of breaded, cooked fish sticks prepared from 100 parts of fish.

The data in table 1 show that the effect on weight caused by varying the cooking oil temperature in the narrow range of temperature studied (360° to 405° F.) is relatively slight. The length of the cooking period was the most important single factor in determining the loss of weight in fish sticks during the cooking operation.

In commercial production the processors cook their sticks as nearly as possible to a constant predetermined color. Since higher oil temperatures shorten the time required to obtain the desired color, higher oil temperatures considerably reduce the weight losses involved in the cooking of fish sticks.

The effect of adding bread crumbs to the standard commercial breading material on weight losses during cooking is shown in table 2. The bread crumbs, owing to the occurrence of complex heat-induced chemical reactions, brown far more rapidly than do wheat cereal-based mixtures. Further, the rate of browning was determined by the bread-crumb/breading ratio and by the oil temperature used. With the exception of the fish sticks prepared with a commercial breading material and of those prepared with bread crumbs alone, all sticks in this study were judged to be of good color shade. The former were considered to be too light and the latter to be of too dark a shade. With this consideration in mind, the data in table 2 show that, as a result of the shorter immersion times necessary, losses in weight during cooking were minimized when bread crumbs were used as a part of the breading mixture.

Table 2 - The Effect of Addition of Bread Crumbs to Standard Breading Material on Changes in Weight of Fish Sticks during Deep-Fat Frying

Bread Crumb-Breading Material Ratio 1/	Weight Changes 2/			
	Cooking Temperature (° F.)			
	3/ 360	4/ 375	5/ 390	5/ 405
	.........(Percent)...........			
0.0	-5	-1	+3	+1
0.33	-3	-5	+2	0
0.66	-5	-4	0	-1
1.0	-10	-11	-1	-2

1/ Proportions of bread crumbs added to standard breading material.
2/ Expressed as parts gained or lost in weight by 125 parts of breaded, cooked fish sticks prepared from 100 parts of fish.
3/ Cooking time was 90 seconds.
4/ Cooking time was 75 seconds.
5/ Cooking time was 45 seconds.

The data in table 2, however, seem to indicate that fish sticks prepared from bread crumbs alone undergo a greater loss in weight than do sticks containing only the commercial breading mix and cooked under identical conditions. Those sticks prepared from mixtures of breading and bread crumbs, as might have been expected, undergo intermediate losses in weight.

The "condition," or the time in use, of a particular lot of cooking oil had a small effect on the weight changes in the sticks during cooking. The amount of oil which could be extracted from fish sticks increased with the "condition" of the oil. With fish sticks prepared from both breader mix and from breader mix containing bread crumbs, the older and thus the more viscous the cooking oil, the greater was the amount of oil absorbed. Fish sticks cooked in fresh oil contained about 8 percent oil while those prepared in old oil contained about 9.5 percent of absorbed oil.

A processor, therefore, may, by careful control of the cooking time, the oil temperature, the breading composition, and the "condition" of the oil, so regulate his processing as to bring about very little or no loss in weight in his fish sticks during the cooking operation.

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