SOME FACTORS AFFECTING THE COLOR OF FISH STICKS

In the course of its booming growth, the young fish-stick industry has encountered several problems. Not the least of these has been the attainment of the proper appetizing color for the cooked sticks--a large factor affecting their consumer acceptance. The Boston laboratory has for some time been studying the problem of color of fish sticks as part of a general research project on the product.

Preliminary tests indicated that the combination of at least four factors determine the ultimate color of the cooked product. These are:

1. Temperature of the frying oil.
2. Cooking time.
3. Composition of the breading.
4. "Condition" of the frying oil.

The first three factors are of prime importance and are interrelated in their coloring effect on the finished product. The fourth factor, owing to the trend toward continuous frying processes and toward concurrent oil clarification, has become of lesser importance.

More refined experiments on the color of fish sticks requires the development of a system of color measurement. Existing systems were considered and found to be not readily adaptable. Scientifically, color is measured in terms of hue, brilliance, and saturation. The preliminary studies had indicated that, in the case of fish sticks, hue and saturation were determined in large part by the composition of the breading, and that the cooking times and temperatures primarily affected the brilliance (or shades between black and white) of the product.

An arbitrary but adequate system for comparisons of brilliance of color was developed for use in the laboratory. A specific number was assigned to each shade of fish-stick color obtained by varying the process of frying. A very pale product, differing little from an uncooked item, merited designation "1." A very dark product, not quite burnt, merited a "10." A moderately-dark product was given a "7," while a moderately-light product was rated at "4." Lithographed pictures of fish sticks on commercial labels were used as guides for the range "4" to "7."

Samples of the fish sticks, experimentally prepared at various cooking times and oil temperatures were frozen and stored for a few days. The sticks were then heated at about 400° F. for 20 minutes and examined by a small panel of technologists. The shades of colors rated as acceptable to one or more of the laboratory staff ranged from about "3" to "8." The shade preferred by the members was about "6." Thus, their figures could be used to determine the effect of a variation in processing upon the color shade of fish sticks.

The effect of cooking time and oil temperature upon the shade of color of fish sticks is shown in table 1. As was expected, the higher the frying-oil temperature, the shorter was the cooking time necessary to attain a desired shade. For example, the shade-of-color "7," attained by cooking fish sticks for 150 seconds at an oil temperature of 360° F., was attained in 75 seconds in oil at 405° F. The studies showed the importance of close control of cooking times and oil temperatures in the production of a uniform shade of fish-stick color.

Table 1 - Effect of Cooking Time and Oil Temperature on the Shade (Brilliance of Color) of Fish Sticks

Cooking Time	Shade (Brilliance of Color) 1/ Cooking Temperature (° F.)			
	360	375	390	405
Minutes	(Shade No.)			
¾	2	3	3	5
1	3	4	5	6
1¼	4	4	6	7
1½	4	6	8	8
2	5	7	8	-
2½	7	-	-	-
3	8	-	-	-

1/ The color shade designations (1 to 10) were arbitrarily developed specifically for this experiment (and, possibly, a few succeeding experiments). A very pale product, differing little from an uncooked item, merited designation "1." A very dark product, not quite burnt, merited a "10." A moderately-dark product was given a "7," while a moderately-light-colored product was rated at "4." Lithographed pictures of fish sticks on commercial labels were used as guides for the range "4" to "7." The shades of color rated as acceptable to one or more members of the laboratory staff ranged from about "3" to "8." The shade preferred by the average panel member was about "6."

The breading composition primarily determined the hue of the finished stick. Breading mixes based on cracker meal caused a golden-yellow hue on the final cooked product. Mixes based on wheat cereals caused the formation of a golden-brown hue and the use of bread crumbs resulted in a reddish-brown hue. Fish sticks covered with cracker meal failed to deepen in shade noticeably during extended cookery. Those prepared from bread crumbs darkened in shade the fastest, while sticks prepared with wheat cereal mixes darkened at a slower rate.

Table 2 - Effect of Variation in Composition of Breading Material on the Shade (Brilliance of Color) of Fish Sticks at Different Oil Temperatures.

Bread Crumb-Breading Material Ratio 1/	Shade (Brilliance of Color) Cooking Temperatures (° F.)			
	360 2/	375 3/	390 4/	405 4/
	(Shade No.)			
0:1	4	4	3	5
1:2	6	6	5	6
2:1	7	7	6	8
1:0	8	9	8	9

1/ Proportions of bread crumbs added to standard breading materials.
2/ Cooking time was 90 seconds.
3/ Cooking time was 75 seconds.
4/ Cooking time was 45 seconds.
Note: For definition of shade gradations, see note 1, table 1.

The effect of variation of breading composition on the color shade, attained by fish sticks fried in oils maintained at different temperatures and also upon the cooking time required, is shown in table 2. As the ratio of bread crumbs to wheat cereal base mix was increased, the shade of color obtained at a particular temperature and cooking time was deepened. Fish sticks prepared from a mixture of 1/3 bread crumbs added to 2/3 of a wheat cereal breading attained a color shade of "6" after cooking for 45 seconds in oil at 405° F. When the bread-crumb ratio was raised to 2/3, fish sticks fried under identical conditions merited a rating of "8."

The "age" of the frying oil has a noticeable affect upon the color shade of fish sticks. After frying in very fresh oils, a light color shade was noted. When the oil had been in use for a short time, the oil darkened slightly, and the color shade of the fish sticks produced was also slightly darker than that of sticks cooked in the fresh oil.

In summary, the desired hue of color and uniform shade may be obtained in fish sticks. The producer, to obtain the definite hue and brilliance of color he desires, must consider (1) the composition of the breading, (2) the cooking times and oil temperatures, and (3) the "age" of the oil. Further, to insure a continuing uniformity of shade of color in his product, he must maintain close control over cooking times and oil temperatures.

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PREPARATION OF A SMOKED SALMON CAVIAR SPREAD

The development and evaluation of food products from Alaska fish were initiated two years ago at the Ketchikan Fishery Products Laboratory (1) to study fish-processing techniques in order that numerous inquiries might be answered and (2) to develop and evaluate new or improved products from Alaska fish in order to encourage off-season industries in the Territory. Many inquiries are from "newcomers" to Alaska who wish to utilize and preserve for home consumption the many species of fish and shellfish in Alaska's coastal waters. Other inquiries are from individuals and companies planning new enterprises or products. In some cases commercial procedures are not directly applicable, and in others information is lacking on the particular species of fish or on processing techniques. For these reasons experimental work is being carried out and information published on methods suitable for both home and commercial purposes. Two reports, primarily for Alaskans, have been released.1/ Preliminary considerations for the production of fishery specialty products in Alaska were summarized recently by Landgraf.2/

Experimental work is now in progress on the development of various smoked fish products and the preparation of precooked frozen products from Alaska fish and shellfish. Each report in the present series will summarize the studies on one or more phases of the project. This report deals with the preparation of a smoked salmon caviar spread.

During the past few years various studies have been conducted by the Fish and Wildlife Service to find ways and means of utilizing more efficiently the 5 to 10 million pounds of salmon eggs which are available in Alaska during the salmon season.

At present much of this valuable foodstuff is wasted. It was the purpose of this study to develop an economical method of utilizing this material for food. The preparation of a whole-grain caviar requires carefully-selected mature eggs. The most practical approach, considering the variation in raw material, was the preparation of a spread or paste using as simple a method as possible. It was thought also that a spread would have more possibilities for market development on a more extensive scale.

1/ Home Canning Alaska Fish and Shellfish, by R. G. Landgraf, Jr., Christine Heller, and John A. Dassow. Technical Report No. 4, Fisheries Experimental Commission of Alaska, Fishery Products Laboratory, Ketchikan, Alaska. Specialty Food Products from Alaska Herring, by R. G. Landgraf, Jr., and H. J. Craven. Technical Report No. 6, Fisheries Experimental Commission, Fishery Products Laboratory, Ketchikan, Alaska.

2/ Technical Note No. 28 - "Possibilities for the Production of Fishery Specialty Products in Alaska", by R. G. Landgraf, Jr., Commercial Fisheries Review, Vol. 15, No. 12, pp. 18-19 (December 1953).

EXPERIMENTAL: Initial trials showed that either fresh or frozen salmon eggs of any species could be used successfully in the preparation of a spread. Chum salmon (Oncorhynchus keta) eggs which had been frozen and stored from 1 to 12 months were used in these tests. Chum salmon eggs are large and easy to obtain and handle.

It was apparent from early trials that if the final spread was to be smooth in texture, the eggs must be ground and strained to remove the shells and membrane. The strained-egg liquor was similar to tomato juice in appearance and consistency and was used as the main ingredient in all developmental work.

Most fish pastes and spreads prepared for these experiments or now marketed follow the same general formula, differing principally in the main ingredient and degree of seasoning. In addition, spreads usually consist of a binder, a spreading agent (fat), water or other liquid, a filler (flour), and, in some cases, coloring materials.

In the case of salmon caviar spreads, it was found that these additives, with the exception of certain seasonings, were not only unnecessary, but were detrimental to the final appearance, flavor, and texture of the product. Flour, in percentages ranging from 1 to 14, was added as a filler to the spreads; however, this caused the final product to have a pasty taste and texture. The use of a spreading agent (oleomargarine, vegetable shortening, or cottonseed oil) resulted in an objectionable oily taste. The use of a binder (dried skim milk) was unnecessary, since it was found that the egg liquor became firm naturally when heated. Of the numerous seasonings used, the addition of salt, garlic salt, and pepper sauce proved to add the best flavor to the product. Preliminary smoking of the eggs also added a desirable flavor.

Cooking trials of the spread in $2\frac{3}{8}$-ounce jars were carried out at temperatures ranging from 130° to 240° F. It was found that samples cooked below 170° F. would not firm sufficiently, while those cooked over 200° F. became hard and rubbery. The optimum cooking temperature--that which gave the final product the most desirable consistency in the shortest possible time--was found to be $197^{\circ} \pm 2^{\circ}$ F. Using this cooking temperature, the consistency of the final product was dependent entirely upon the length of the cook.

The following procedure was used in the preparation of the experimental packs of smoked salmon caviar spreads. Skeins of chum-salmon eggs which had been frozen in 30-pound berry tins and stored at 0° F. from 1 to 12 months were allowed to thaw in air. The skeins were then removed from the tin and immersed in 95-degree salinometer brine (2.8 pounds salt per gallon of water) for 25 minutes. After being drained, the brined eggs were placed on smoking trays which were covered with greased aluminum foil. The eggs were smoked for $2\frac{1}{2}$ hours at 115° to 120° F.

The eggs were removed from the smokehouse and allowed to cool. They were then passed through a hand-operated, corn-mill-type grinder. The resultant slurry was strained through fine wire screen (16-mesh). The recovery of a strained smoked-egg liquor from raw frozen salmon eggs averaged 60 percent. This is the basic formula:

4.5 lb. (2,080 g.) smoked-egg liquor
0.23 lb. (104 g. or 5% by weight) salt
3 tsp. garlic salt
1 tsp. pepper sauce

The salt, garlic salt, and pepper sauce were added to the egg liquor. The ingredients were mixed together, then poured into $2\frac{3}{8}$-ounce jars ($1\frac{3}{4}$-inch diameter by $2\frac{3}{4}$-inch height). The lids, having rubber gaskets, were screwed on tightly, and the jars were immersed in a hot-water bath at 197° F. for 1 hour.

The final product was a bright reddish-orange in color (similar to that of fresh salmon eggs), creamy, and smooth-textured. The product spread easily on crackers, and had a mild, smoky taste. It was easily blended with other foods, such as cream cheese, for variety or to reduce the high salt content. The proximate analysis of a typical sample of the smoked spread is given in table 1.

KEEPING QUALITY: Normally a product of this type must be kept refrigerated to minimize the possibility of bacterial growth (such as Clostridium). The need for continuous refrigeration would limit the sales value of the product. Experiments were conducted to improve the keeping quality so that the spread might be stored safely at room temperature for a year or longer.

Table 1 - Proximate Composition of a Spread Prepared from Chum-Salmon Eggs

	Percent
Protein 1/	27.6
Moisture 1/	45.7
Ash 1/	10.0
Oil 2/	10.1
Carbohydrate 3/	6.6
Salt (as NaCl)	8.7

1/ Analyses according to modified Methods of Analysis of the Association of Official Agricultural Chemists (1950).
2/ Analysis according to the method of Stansby and Lemon (1937) as modified by Voth (1946).
3/ By difference.

Products having a pH below 4.5 or having a salt content above 8 percent will not, in most cases, support the growth of Clostridium botulinum. Attempts at lowering the pH of the product, which is normally 5.6, were made, using acetic, citric, and hydrochloride acid. When the pH of the spread was lowered to 4.4, using any of the above acids, the flavor of the final product was impaired, that is, a sour taste was quite noticeable. Hence, this method was discarded.

To determine whether a spread having a high salt content would be acceptable, a series of trial packs was prepared having a total salt content of from 4 to 9 percent. A spread having a salt content as high as 9.5 percent was still considered to be acceptable by the Laboratory taste panel. To check the possible hazard of botulism from the product, a pack of smoked salmon caviar spread (salt content and proximate composition--table 1) inoculated with Clostridium botulinum was prepared. The inoculated pack was sent to the National Canners Association Laboratory at Berkeley, California,3/ for incubation and feeding tests.

In a final report, the National Canners Association Laboratory concluded that this smoked-salmon-egg-spread, with a salt (sodium chloride) content greater than 8 percent, presents no hazard of botulism when stored at room temperature.

Storage tests with this spread at room temperature for one year have shown that a strong flavor develops as the time in storage progresses. Although the off-flavor is not excessively offensive, it does detract from the quality of the product.

Since antioxidants are used to protect other oily foodstuffs against oxidative rancidity, a test series was initiated recently in which 0.04 percent by weight of an antioxidant (18 percent butylated hydroxyanisole and 22 percent butylated hydroxytoluene in a winterized cottonseed oil) was incorporated with the regular ingredients. Sample jars of the antioxidant-treated and regular spreads were stored in an incubator at 37° C. and are being examined organoleptically at monthly intervals. The first monthly examination has indicated that neither the regular or antioxidant-treated spread has developed a pronounced off-flavor. The regular spread has developed a somewhat stronger fishy off-odor than the anti-oxidant protected spread.

3/ Acknowledgment of assistance in this experiment is made to Charles T. Townsend, George K. Polk, Charles P. Collier, and Ransom N. Getchell, Western Branch Laboratories, National Canners Association, Berkeley, California, who furnished the spore suspensions of Clostridium botulinum and who incubated the pack and conducted animal-feeding tests on the inoculated product at intervals.

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