LOW TEMPERATURE SMOKED FISH FILLETS: A POTENTIAL NEW PRODUCT FORM FOR FLORIDA FISH

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W. Steven Otwell, John A. Koburger,
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Technical Paper No. 19
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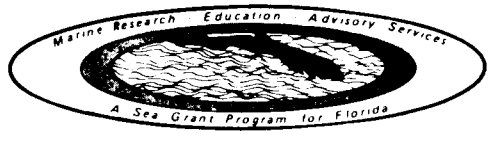

Florida Sea Grant

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ABSTRACT

The objective of this work was to develop a new product form which could expand the use of traditional and underutilized Florida fish. The product is a skinless and boneless fish fillet which has been flavored by a low temperature smoking (LTS) process. The LTS process requires less heat energy for production and provides a greater product yield than the traditional hot smoking process. The LTS fillets can be frozen and are cooked prior to serving. Market surveys with over 400 respondents have indicated a very positive consumer reaction. The LTS fillets are a unique seafood form which provides consumers with a new seafood choice.

Key words: Smoked fish, underutilized fish, new product.

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Barbara Prichard, secretary, prepared all drafts and the final reports.

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Judy King, statistician, prepared the informative statistical analysis of the consumer survey data.

SUMMARY

The objective of this work was to develop a new product form to expand the use of traditional and underutilized Florida fish.

The product is a skinless and boneless fish fillet which has been flavored by a low temperature smoking (LTS) process. Prior to serving, the finished product must be cooked. The combination of first low temperature smoking to impart flavor, then cooking results in a final product that differs from the traditional hot smoked fish.

Product development work has outlined a recommended product process as determined with product ratings by preference panels. The basic recommended procedure is a 4 percent brine soak for 30 minutes, air drying, smoking for 1½ hours at temperatures from 80°F to 120°F, then frozen storage. All various cooking methods, including baking, broiling, and frying, were rated acceptable.

Acceptable LTS fillets were produced from mullet, grouper, snapper, Spanish mackerel, and cod. Frozen storage of the whole fish or 3 months frozen storage of the finished fillets was not detrimental to the quality and panel preference for the LTS fillets.

Consumer surveys by professional market survey firms in Tampa and Jacksonville indicated a very positive consumer reaction to LTS fillets. Ninety-one percent of the primary food shoppers interviewed said they would buy LTS fillets if they were available. A high percentage of the 402 respondents indicated they would order LTS fillets if available in restaurants.

The LTS fillets are a unique seafood form which could provide consumers a new seafood choice. There is no one best method for production of LTS fish fillets. Industry production of LTS fillets will require necessary process modification to assure volume production with quality control.

Low Temperature Smoked Fish Fillets:

A Potential New Product Form For Florida Fish

W. Steven Otwell, John A. Koburger and Robert L. Degner[1]

INTRODUCTION

A new product form has been developed to expand the use of traditional and underutilized fish species harvested in Florida. This product is a skinless and boneless fish fillet which has been flavored by a low temperature smoking process. The combination of first low temperature smoking (LTS) to impart flavor, then cooking either by frying, baking, or broiling results in a final product that differs from traditional hot smoked fish.

The basic production process was derived from modifications of the cold smoking techniques commonly used in Europe to produce kipper fillets from herring. The recommended LTS process requires only 1½ hours smoking time at temperatures between 80°F to 120°F (27° to 49°C); whereas, hot smoking processes usually require a smoking time between 4 to 12 hours at temperatures in excess of 140°F (60°C). The smoked flavor and color are similar to that associated with traditional hot smoked fish, but the LTS process requires less heat energy during production and minimizes product dehydration. The boneless and skinless features of the product should be more appealing to the typical American consumer, and the finished product can be cooked by all the various methods typically used to prepare regular, uncured fish. Thus, this new product form

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combines the desirable features of both regular fish and traditional hot smoked fish.

Although the recommended LTS temperatures are lower than the required smoking temperature specified in the U. S. Food and Drug Administration's Good Manufacturing Practice Regulations (GMP's) for hot smoked fish[2], this product is essentially cold smoked and subsequent handling procedures, and frozen storage must comply with the GMP's for handling perishable foods. Currently, the GMP's for smoked fish are being revised and should include guidelines for cold smoked products. These guidelines should provide considerations for lower smoke temperatures if proper sanitation and storage are employed. Thus, LTS fillets provide product quality and safety to assure consumer satisfaction.

The recommended LTS process can provide a final product yield from the raw fillets in excess of 98 percent as compared to lower product yield, 50 to 75 percent from raw fish products entering the smokehouse for preparation by traditional hot smoking methods. The finished LTS product can be packaged whole or in controlled portions for frozen storage. Tests have demonstrated that LTS fillets can remain frozen for over three months with no detrimental effects on flavor or texture. Thus, this new product is well suited to meet the typical requirements for producers, retail outlets, restaurants, and fast food firms, i.e. high yield, portion control, and extended shelf-life.

The LTS fillet is a non-species specific product which permits use of a variety of fish species to produce the same product form. The original product development was conducted using mullet, Mugil cephalus,

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[2]Smoked and Smoked-Flavored Fish, Code of Federal Regulations, Title 21, Part 128A, subpart A, effective date February 12, 1970.

but subsequent tests have verified successful production of the LTS fillets from grouper, snapper, cod, and Spanish mackerel. These results indicate the LTS fish fillets can be made from lean or fatty fish, and from popular or underutilized fish. The fish species used would be based on the economic discretion of the producer. The producer must consider fish availability, fillet yield, fillet size, and labor costs.

This product is an excellent way to utilize 'spent' (roe removed) mullet carcasses. During recent years, foreign seafood firms have expanded their demand for mullet roe. More than 250 thousand pounds of roe was purchased in 1978 form the southeastern region of the United States (personal communications, 1979). This accounts for about one million pounds of whole mullet. Florida is the principle mullet roe exporting state. Market value for the roe alone provides an adequate net revenue and high enough return on investment to mullet fishermen to encourage catching the mullet, even if no market exists for the carcass. Since roe production is highly seasonal, and 'spent' or cut mullet carcasses cannot be successfully stored, large volumes of carcasses are available during roe season and must be sold at very low prices. The fillets, an excellent protein source, could be recovered as an LTS product for additional profit.

The LTS fillets are a unique seafood form which could provide consumers with a new seafood choice. A broader product choice should increase the overall demand for seafoods. Further, it may be possible to introduce certain underutilized fish, i.e. jacks, croakers, bluefish, etc., in the form of LTS fillets.

PRODUCT DEVELOPMENT

Initial product development work concentrated on the utilization of mullet, Mugil cephalus. Large mullet were harvested in the fall of 1979 with commercial gill nets set along the West coast of Florida. Ripe roe was removed from the female mullet and marketed through commercial channels. Boneless and skinless fillets were hand cut from the remaining fresh carcasses. The fillet yields were approximately 20-25% of the live weight. Tests were designed to determine the effects of brine concentrations, smoking times, methods of cooking, and frozen storage on acceptance of LTS mullet fillets. Figure 1 outlines the standard production process. After the fillets were cleaned and/or thawed, the standard production process consisted of soaking in a brine solution, air drying, low temperature smoking, packaging, and storage (Figure 1).

Brining

The effects of various brine concentrations (0, 2, 4, and 6 percent salt) on product preference was determined using the standard production process. A two percent brine concentration equalled two cups of salt per nine gallons of fresh water, four percent equalled four cups, etc. The smoking time was 1 1/2 hours at 120°F (49°C). The LTS samples were deep fat fried at 350°F (177°C) for two minutes. Unidentified samples of the finished products were presented to taste panelists, who scored their level of product preference per brine concentration. The highest percentage of panelists preferred LTS fillets presoaked in a four percent brine (Table 1) which indicated the four percent brine provided the preferred flavor. The results indicated the panelists expected a salt flavor with smoked fish but excessive salt was objectionable. On the

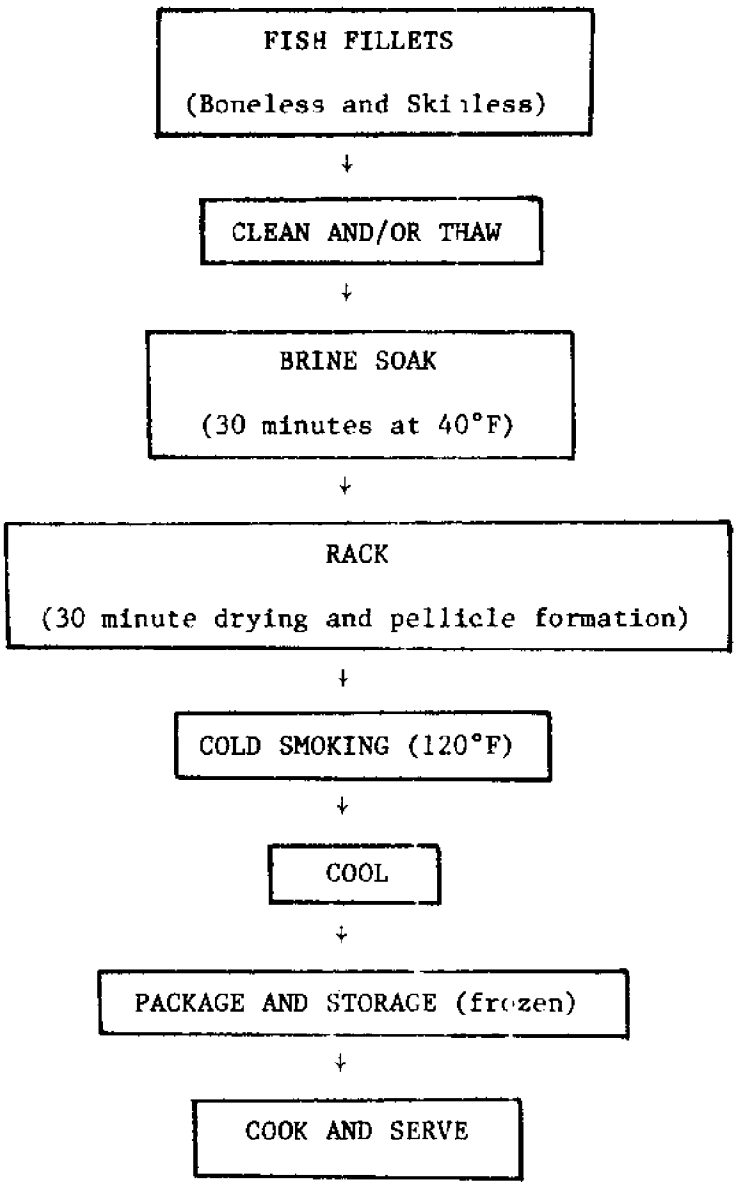

Figure 1. Standard process for the production LTS fish fillets.

basis of these results, a brine concentration of four percent was selected for use in continuing studies.

Table 1.--Effect of brine concentration on panel preference for fried [illegible] mullet fillets previously smoked for 1½ hours.

Percent Brine	Scoring				
	Liked Best			Liked Least	
	1	2	3	4	Totals[a]
	Percent[b]				
0	0	2	13	85	100
2	12	30	52	7	101
4	53	38	5	3	99
6	35	30	30	5	100

[a]Totals percentages may not sum to 100 percent due to rounding.

[b]Percentages are based on 30 preference panelist scorings obtained in three test replications for a total of 90 observations per brine concentration.

Smoking Time

The effects of various smoking times (no smoking, 1½, and 3 hours) at 120°F (49°C) on product preference was determined using standard procedures. All fillets were presoaked in a four percent brine for 30 minutes prior to smoking. All smoking was done in a Koch Grandprise smokehouse with an external smoke generator. Smoke was produced from hickory dust smoldering on electric resistance coils. The smoking chamber was vented for air flow, but there were no humidity controls. The air vents were fully opened during the first half hour of smoking and closed during the final hour.

Unidentified fried samples of the finished product were presented to a 20 member sensory panel. Fillets used in this test were not previously frozen. The panelists rated product aroma, color, texture, flavor, and overall preference based on a 9 point scale (9 = excellent; 1 = extremely poor). The results (Table 2) indicated the panelists preferred some smoke time, but there was no significant difference in preference for product smoked 1½ or 3 hours. The longer smoke time, however, produced a slightly darker, tougher product. Based on the highest overall rating and energy conservation, the 1½ hour smoke time was selected for further studies.

Table 2.--Effect of smoking time on panel preference for fried LTS mullet fillets previously soaked in four percent brine.

Product Characteristics	Time of Smoking		
	3 hrs.	1½ hrs.	None
	Mean Rating[a]		
Aroma	7.1	7.1	6.7
Color	6.4	7.3	6.4
Texture	6.8	7.3	7.0
Flavor	7.2	7.0	6.2
Overall preference[b]	7.2*	7.5*	6.3†

[a]Ratings are based upon a preference scale where 9 = excellent and 1 = extremely poor. Mean ratings are based on 20 preference panelist ratings obtained in two replications per smoking time.

[b]According to a Duncan's Multiple Range test, mean ratings for overall preference followed by the same symbol are not different at the 0.05 level of significance.

Packaging and Storage

Routine packaging methods were used to prepare the finished LTS fillets for frozen storage. Three to five pounds of fillets were

initially wrapped in freezer paper, then wrapped with aluminum foil. The packages were placed on freezer shelves in single layers to assure rapid cooling. The packages were noticeably hardened in less than eight hours after exposure to the freezer temperature of -20°F (-29°C). The packages remained frozen (-20°F or -29°C) until further testing. No tests were conducted on packaging methods but subsequent tests were conducted to determine the effect of prolonged frozen storage.

Cooking Method

To determine if there was a preferred method of final preparation, the LTS fillets were fried in peanut oil for two minutes at 350°F (177°C), broiled for six minutes in an electric oven, and baked in an aluminum foil wrap for 20 minutes at 450°F (232°C). The fillets were prepared by the standard production process using a four percent brine and 1½ hour smoke time at 120°F (49°C). Fillets used for these tests were not previously frozen. Panel preference for cooked samples were rated on the same nine point scale (9 = excellent; 1 = extremely poor). Panelists rated product aroma, color, texture, flavor, and overall preference. The results (Table 3) indicated all three cooking methods are acceptable. There was no significant difference in overall preference for any one final product preparation, but the fried product was rated the highest preference for color and flavor. Frying tended to darken the product from a pale yellow to an attractive golden brown color. Continued frying caused excessive browning. Broiling and baking caused a white, gelatineous exudate to form on the surface. These proteinaceous substances gave an objectionable product appearance.

Table 3.--Effect of cooking procedure on panel preference for LTS mullet fillets.

Product Characteristics	Cooking Method		
	Fried	Broiled	Baked
	Mean Ratings[a]		
Aroma	7.1	6.5	7.0
Color	7.2	6.3	6.4
Texture	6.6	7.0	6.7
Flavor	7.4	6.7	7.0
Overall preference[b]	7.1*	6.7*	7.0*

[a]Ratings are based upon a preference scale where 9 = excellent and 1 = extremely poor. Mean ratings are based on 20 preference panelists ratings obtained in two replications per cooking method.

[b]According to Duncan's Multiple Range test, mean ratings for overall preference followed by the same symbol are not different at the 0.05 level of significance.

RECOMMENDED PRODUCTION PROCESS

Based on the product development work, the recommended basic production process is outlined below. This process was developed utilizing mullet fillets, but has been successfully used on fillets from grouper, snapper, cod, and Spanish mackerel. Random check weighing for the various species indicated the proper procedure should provide a product yield in excess of 98 percent of the initial raw fillet weight.

It should be noted that this procedure has been developed using only one particular smokehouse. Variations in thermal characteristics, airflow rates, and humidity control in different smokehouses could influence the required smoking time and exact smoking temperature. Likewise, the thickness of the fish fillet could influence the required brine concentration and smoking time. Variations in the ratio of dark muscle to white muscle tissue could affect product appearance and flavor. Production procedures must be determined for respective types of smokehouses and fish, but the recommended production process should serve as an approximate starting method.

Brining

Clean fish fillets (skinless and boneless) are soaked in a prechilled ($40^{\circ}F$ or $45^{\circ}C$) salt brine. The recommended salt concentration is four percent (four cups salt per nine gallons water). The soak time should be no less than 30 minutes. Occasional, gentle stirring will assist the soaking process. After brining, the fillets should be washed with a light rinse of clean water. The soaked fillets should be air dried on racks held in refrigeration until a glaze-like pellicle develops on the surface. A drying time of approximately 30 minutes has been found adequate.

Smoking

Racks of fillets should be placed in a preheated smokehouse. The fillets should be smoked for 1½ hours at 120°F (49°C) in moderate smoke. If humidity controls are available maintain a relative humidity of approximately 60 percent. Smoking temperatures between 80 to 120°F (27° to 49°C) may be effective depending on the characteristics of different smokehouses and fillet thicknesses. Air flow rates can be adjusted to control dehydration of the product. The finished product is not cooked, but has a pale yellow, damp appearance and the surface flesh becomes firm.

Packaging and Storage

The LTS fillets must be store frozen at 0°F (-20°C) or below. The fillets should be packaged layered with freezer paper and wrapped in plastic bags. Avoid bulk packaging to permit a more rapid freeze.

Cooking

Thaw frozen fillets in refrigeration overnight; then fry, bake, or broil as desired. Deep fat frying at 350°F (177°C) until golden brown is an excellent cook method. Frying does not require batter or breading.

PRODUCTION WITH VARIOUS SPECIES

Application of the basic production process was determined for four different fish species. These were grouper (Epinephelus sp.), snapper (Lutjanus sp.), cod tails (Gadus morhua), and Spanish mackerel (Scomberomorus maculatus). All fish fillets had been previously frozen for at least one month. Only boneless, skinless fillets were used from each species. All raw fillet sizes were within a six to ten ounce range. The fillets were thawed, then processed by the recommended basic process. The finished products were fried by standard procedures then presented to a 20 member preference panel for evaluations of aroma, color, texture, flavor, and overall preference. Remaining fillets were packaged and frozen for storage studies.

The panel results indicated there was essentially no difference in the product characteristics for LTS fillets made from grouper, snapper, or cod tails. No statistical tests were used to compare means, but there was a higher overall preference for LTS mackerel fillets (Table 4). The mackerel may have provided a better flavor and texture due to the higher fat content. It is interesting to note that the overall preference for these species was similar to that recorded for fried mullet fillets.

Table 4.--Sensory evaluations of LTS fillets prepared from various fish species.

Fish Species	Product Characteristics				Overall Preference
	Aroma	Color	Texture	Flavor	
	Mean Ratings[a]				
Spanish Mackerel	7.8	7.8	7.6	8.1	8.2
Cod	7.1	7.6	7.1	6.9	7.0
Grouper	7.2	7.8	7.1	7.0	7.0
Snapper	6.9	7.3	6.8	7.2	6.9
Mullet[b]	7.1	7.2	6.6	7.4	7.1

[a]Ratings are based on a 9.0 scale where 9 = excellent and 1 = extremely poor. Mean ratings are based upon 20 observations. No statistical tests were used to compare means.

[b]The sensory evaluations for fried mullet are taken from Table 3 for the purpose of comparison.

STORAGE STUDIES

Storage studies were conducted to determine the influence of frozen storage on the quality of LTS fillets. Panelists rated general preference for LTS fillets prepared from whole, fresh mullet and whole mullet which had been frozen (-20°F or -29°C) for six weeks. All LTS fillets were fried at 350°F (177°C) for two minutes prior to presentation to the panelists. Half of the LTS fillets prepared from the whole, fresh mullet were frozen (-20°F or -29°C) for two weeks prior to preference rating, and the other half were cooked and rated immediately after production or unfrozen. Likewise, the LTS fillets prepared from whole mullet which had been previously frozen for six weeks prior to smoking were divided into two groups, LTS fillets not frozen and LTS fillets frozen two weeks before cooking and rating. This design allowed evaluations of the final cooked product as influenced by previous frozen storage of the initial raw carcass prior to smoking or frozen storage of the LTS fillets, and combinations of the two storage treatments.

The results indicated six weeks frozen storage of whole mullet prior to smoking did not have any apparent detrimental effect on final product preference (Table 5). Likewise, two weeks frozen storage of the finished product did not decrease product preference. Average product ratings in all sensory categories were higher for the frozen products, but there was no significant difference in overall general preference for the LTS fillets which had never been frozen versus the frozen LTS fillets. These results tend to indicate frozen storage of the initial raw carcasses and of the finished product is not detrimental to production of the LTS fillets.

Table 5.--Effect of frozen storage on panel preference for fried LTS mullet fillets.

Product Characteristics	Source of Fillets: Fresh Mullet — LTS Fillets: Not Frozen	Fresh Mullet — LTS Fillets: Frozen 2 Weeks	Mullet Frozen 6 Weeks — LTS Fillets: Not Refrozen	Mullet Frozen 6 Weeks — LTS Fillets: Frozen 2 Weeks
	Mean Ratings[a]			
Aroma	7.7	8.3	7.8	7.9
Color	7.6	8.4	8.3	8.2
Texture	8.0	8.1	7.9	7.6
Flavor	7.8	8.4	8.1	7.9
Overall Preference[b]	8.0*	8.3*	8.2*	8.1*

[a]Ratings are based upon a scale where 9 = excellent and 1 = extremely poor. Mean ratings are based on 20 preference panelists ratings obtained in two replications per fillet type, frozen or unfrozen.

[b]According to Duncan's Multiple Range test, mean ratings for overall preference followed by the same symbol are not different at the 0.05 level of significance.

A second series of extended storage studies were conducted to determine the influence of long term frozen storage on LTS fillets. The fillets were prepared as previously noted from grouper, snapper, cod tails, and Spanish mackerel. The fillets were prepared by the recommended basic process, then packaged and frozen for 30 and 90 days at -20°F (-29°C). After storage, the fillets were thawed in refrigeration, then fried for presentation to the preference panel. Panelists rated various sensory characteristics on a 9.0 scale (9 = excellent; 1 = extremely poor).

There was a slight decrease in average overall preference after three months of frozen storage, but the ratings were still judged to be acceptable (Table 6). This slight decrease was due to lower ratings for texture and flavor. Prolonged frozen storage had caused a slight increase in product toughness and produced a slightly detectable off-flavor described as initial rancidity. Product aroma and color was stable during frozen storage. If the original smoked fillets had been prepared from fresher fish fillets, the frozen storage life could have been extended. The research results indicate that a frozen storage period of three to four months is acceptable.

Table 6.--Sensory evaluations of influence of frozen storage on LTS fillets prepared from various fish species

Product Characteristics	Species[a]	Storage Time (days) 0	30	90
		Mean Ratings[b]		
Aroma	SM	7.8	7.5	8.1
	C	7.1	7.1	7.3
	G	7.3	7.1	6.8
	S	6.9	6.4	6.9
Color	SM	7.8	7.9	8.1
	C	7.7	7.1	6.9
	G	7.8	7.8	6.8
	S	7.4	6.7	7.2
Texture	SM	7.6	7.9	7.3
	C	7.1	6.0	6.2
	G	7.1	7.2	5.2
	S	6.8	6.9	6.2
Flavor	SM	8.1	8.3	7.5
	C	6.9	6.7	6.6
	G	7.0	7.2	5.7
	S	7.2	6.8	6.0
Overall Preference	SM	8.3	8.3	7.7
	C	7.0	6.5	6.6
	G	7.0	7.1	6.0
	S	6.9	6.6	6.2

[a]SM = Spanish mackerel; C = Cod tails; G = Grouper; S = Snapper

[b]Ratings are based on a 9.0 scale where 9 = excellent; 1 = extremely poor.

CONSUMER SURVEY

A comprehensive market survey was designed to determine the market potential for the LTS fillets. The basic objective was to assess consumers' reactions to this new product form and to determine any necessary product improvements. These results may encourage industry commercialization of the product, thereby expanding the processing and consumption of Florida seafoods. A more complete description and analysis of the market survey is reported elsewhere[3].

Briefly, consumer test samples were LTS mullet fillets prepared by the recommended basic process. Each cold smoked fillet had been previously frozen for approximately one month. The fillets were thawed at 40°F (4°C) and deep fat fried in peanut oil at 350°F (177°C) for two minutes. The six ounce cooked fillets were cut into two ounce samples and presented warm to consumers. The fish species was not identified to the consumers. Face-to-face interviews were conducted immediately after the consumers had sampled the test product. The interviews were conducted by two independent marketing firms located in relatively large shopping malls in Tampa and Jacksonville, Florida. At each location, the firms supplied test kitchens for sample preparation and professionally trained interviewers.

The principle investigators designed the questionnaires and monitored the interview process. All consumers were prescreened to select those that eat fish and those that were over 18 years of age. Consumers were selected to assure an equal representation of sex, but there were no

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[3]Degner, R. L., W. Steven Otwell, and John A. Koburger. 1980. Consumer Acceptance of Low Temperature Smoked Fish Fillets, FAMRC Industry Report 80-3. Food and Resource Economic Department, IFAS.

additional screening criteria. A total of 402 consumers were interviewed, 200 in Jacksonville and 202 in Tampa. The interview included twenty questions concerning product characteristics, suggested improvements, buying intentions at various price levels, preferred package size, and species identification. The entire interview required approximately five minutes.

Results from the consumer surveys indicated a very positive consumer reaction to the test product. There were no significant differences in consumer responses from the two cities which enabled the combining of responses for most analyses. Consumer ratings for the product characteristics indicated that the test product had a very high appeal (Table 7). Consumers generally agreed that the product would be acceptable as a family meal, as a special meal for friends, or as a restaurant item. The overall rating for the LTS mullet fillets was significantly higher (7.9) than that recorded for typical hot smoked fish (6.9) that the respondents had previously eaten.

The mean ratings for the product color, flavors, and texture indicated the consumer felt the final product was nearly 'just right' (Table 8). Ninety-one percent of the consumers, identified as the 'primary family food shopper', said they would buy the product if available (Table 9). The preferred package size would be 12 to 16 ounces (Table 10). Over 50 percent of the primary food shoppers would be willing to substitute the cold smoked fillets for currently available frozen fish fillets at least 1/3 to 1/2 of the time (Table 11).

Table 7.--Consumer ratings of characteristics of the test product and previously eaten smoked fish.

Characteristics	Both Cities[a]	Tampa	Jacksonville
	----------Mean Rating----------		
Smell	7.8	-----	-----
Overall Taste	8.2	-----	-----
Overall Appeal[b]	7.9	-----	-----
As a Family Meal	-----	7.4	8.0
As a Special Meal for Friends	-----	6.4	7.0
As a Restaurant Meal	6.6	-----	-----
Rating of Previously Eaten Smoked Fish[b]	6.9	-----	-----

[a]Means are based on a rating scale where 10 = excellent and 0 = extremely poor. Where only one mean is reported for both cities, a t-test indicated that differences between cities were not statistically significant at the 0.05 level.

[b]A paired t-test indicates the difference between the overall appeal rating and the rating given previously eaten smoked fish is statistically significant at the 0.01 probability level, t = 5.49 with 319 degrees of freedom.

Table 8.--Consumer ratings of physical attributes of the smoked fish fillets.

Attribute	Mean[a] value	Standard deviation	Percent of respondents[b]
Exterior color	2.6	0.6	-----
Much too dark	-----	-----	2.2
Slightly too dark	-----	-----	33.1
Just right	-----	-----	63.2
Slightly too light	-----	-----	1.5
Much too light	-----	-----	0.0
Total			100.0
Interior color	2.7	0.5	-----
Much too dark	-----	-----	1.2
Slightly too dark	-----	-----	30.9
Just right	-----	-----	66.7
Slightly too light	-----	-----	1.0
Much too light	-----	-----	0.3
Total			100.0
Smoked flavor	3.0	0.6	-----
Much too "smokey'	-----	-----	2.2
Slightly too "smokey"	-----	-----	7.7
Just right	-----	-----	78.4
Not quite enough smoked flavor	-----	-----	11.7
Need much more smoked flavor	-----	-----	0.0
Total			100.0
Texture	2.8	0.5	-----
Much too tough	-----	-----	0.5
Slightly too tough	-----	-----	28.1
Just right	-----	-----	69.2
Not quite tough enough	-----	-----	2.2
Need to be much tougher	-----	-----	0.0
Total			100.0
Salt	2.9	0.6	-----
Much too salty	-----	-----	2.0
Slightly too salty	-----	-----	16.9
Just right	-----	-----	65.9
Not quite enough salt	-----	-----	14.9
Needs much more salt	-----	-----	0.3
Total			100.0

[a]Means were calculated by assigning numerical values of 1-5, respectively, to the semantic differential scales in the order listed. Thus, a mean of 3.0 would indicate a "just right" rating on each attribute. According to Chi-square tests for each attribute there were no statistically significant differences in ratings between the two cities. There was a total of 402 observations.

[b]Total percentages may not sum to 100 percent due to rounding.

Table 9.--Primary food shoppers' purchase intentions for the test product.

Purchase intentions[a]	Number	Percent
Yes, would buy if available	171	91.0
No, would not buy	17	9.0
Totals	188	100.0

[a]Chi-square analysis indicates no statistically significant difference in purchase intentions by city, $\chi^2 = 0.90$, with 1 degree of freedom. Chi-square analyses for purchase intentions by age, income, race, or household size were not statistically valid because of sparse numbers of observations.

Table 10.--Primary food shoppers' preferred package sizes for frozen fish fillets.

Preferred package size[a]	Number	Percent[b]
Ounces		
8	28	16.4
12	38	22.2
16	63	36.8
32	21	12.3
48	10	5.9
Various[b]	11	6.4
Totals	171	100.0

[a]When the 32 and 48 ounce package classifications are combined and the "various" category eliminated, chi-square analysis indicates no statistically significant difference in package size preferences between cities, $\chi^2 = 2.73$, with 3 degrees of freedom.

[b]The "various" size category includes responses that ranged from 0.33 to 6 pounds.

Table 11.--Primary food shoppers' indicated substitution of the test product for currently available frozen fish fillets.

Rate of Substitution	Tampa		Jacksonville		Both Cities[a]	
Percent	Number	Percent	Number	Percent	Number	Percent
100	7	9.1	23	25.3	30	17.9
75	8	10.4	11	12.1	19	11.3
33-50	39	50.7	46	50.6	85	50.6
20-25	23	29.9	11	12.1	34	20.2
Totals[b]	77	100.0	91	100.0	168	100.0

[a]Chi-square analysis indicates a statistically significant difference between cities at the 0.01 probability level. $\chi^2 = 12.74$, with 3 degrees of freedom.

[b]Total percentages may not sum to 100 percent due to rounding.

The LTS fillets were also perceived as a desirable restaurant item (Table 12). Over 68.5 percent of all the respondents expressed a willingness to order the LTS fillets if available in restaurants. Responses were categorized by their typical frequency for ordering regular fish fillets. The responses indicated 78.3 percent of the frequent purchasers of regular fish would order the LTS fillets, and more impressively, 55.7 percent of the respondents that were 'never' purchasers of regular fish in restaurants would order the LTS fillets if available.

Table 12.--Respondents' intentions to order the test product if available in restaurants, by current frequency of fish fillet orders.

Current frequency of fish fillet orders	Number of respondents	Order intentions for test product			
		Yes	No	Do not know	Totals
		----------Percent----------			
Never	61	55.7	36.1	8.2	100.0
Infrequently, less than once per month	108	63.9	29.6	6.5	100.0
Frequently, one to three times per month	175	78.3	16.6	5.1	100.0
Very frequently, once per week or more	56	60.7	30.4	8.9	100.0
All respondents	400	68.5	25.0	6.5	100.0

Since mullet is often considered a low value fish, it was interesting to note that 76.0 percent of all consumers could not identify the fish species prepared as the test product (Table 13). In Tampa, where mullet is a more commonly eaten fish, a significantly larger percentage of consumers could identify the test product as mullet fillets. However, the identification of the fish did not influence the overall product ratings.

Table 13.--Respondents' ability to correctly identify species from which test products were made.

Response	Tampa		Jacksonville		Both cities[a]	
	Number	Percent	Number	Percent	Number	Percent
Did not know species	77	38.7	83	41.1	160	39.9
Correctly identified species	65	32.7	29	14.4	94	23.4
Incorrectly identified species	57	28.6	90	44.6	147	36.7
Totals[b]	199	100.0	202	100.0	401	100.0

[a]Chi-square analysis indicates a statistically significant difference in responses between cities at the 0.01 probability level, $\chi^2 = 21.40$, with 2 degrees of freedom.

[b]Total percentages may not sum to 100 percent due to rounding.

CONCLUSION

This report has provided the basic production process, expected frozen storage life, and consumer evaluations of a new product form which could increase the use of traditional and underutilized fish harvested in Florida. Results indicate that the product could be produced with existing processing facilities and the product form suits the basic requirements for retail outlets, including most restaurants. The very positive consumer acceptance should encourage industry exploitation.

Industry production of LTS fillets will require necessary process modifications to assure volume production with quality control. This report supplies the basic starting methods. Refinements in brining, spice formulations, smoking, and packaging may be required to assure company standards. At present, there is no one best method for production of LTS fish fillets. Future production of these products will depend on industry innovation.