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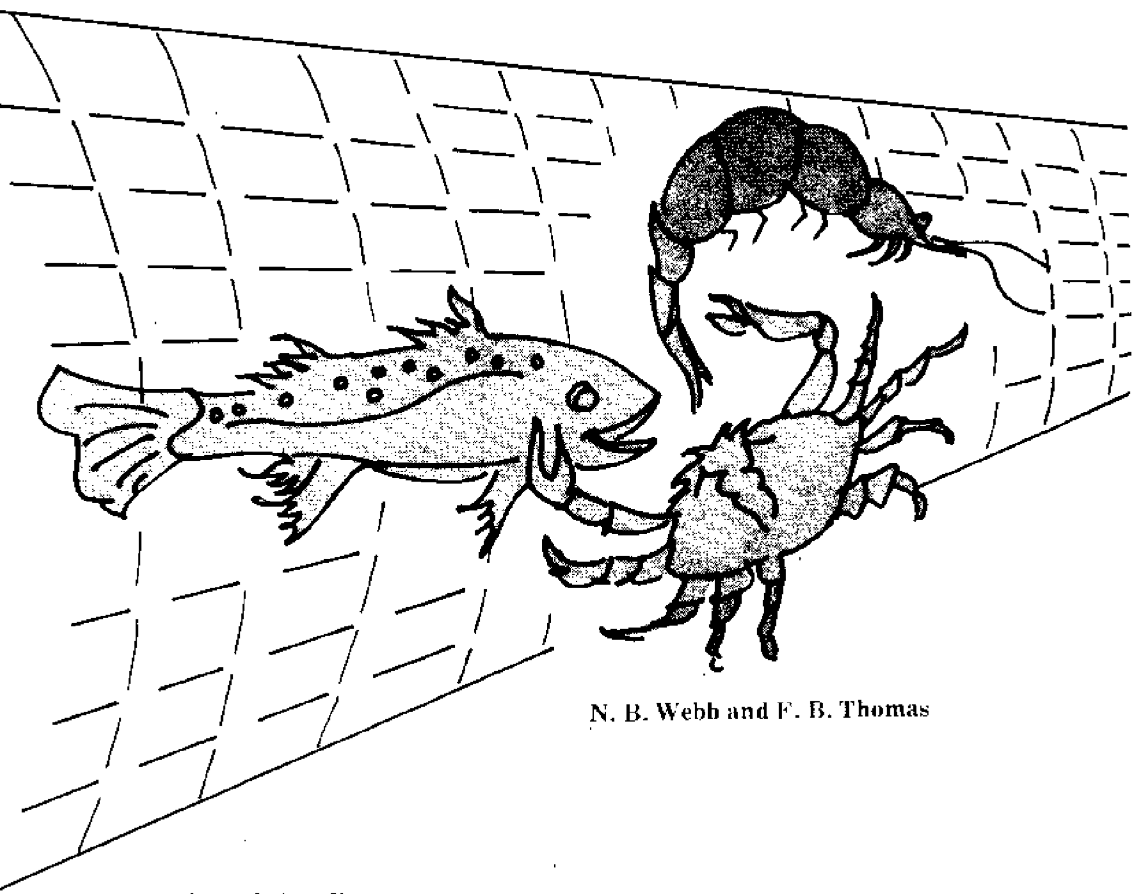

N. B. Webb and F. B. Thomas

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N. B. Webb
Associate Professor, Department of Food Science,
N. C. State University at Raleigh

F. B. Thomas
Extension Professor, Department of Food Science,
N. C. State University at Raleigh

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Development of Seafood Patties Utilizing Mechanically Separated Fish Tissue

I. INTRODUCTION

The development of flesh-separating machines was a major technological advancement for the seafood industry (Miyauchi and Steinberg, 1970). These machines permit the recovery of fish muscle tissue which was previously used for inedible purposes. The mechanical recovery and use of fish flesh from processing wastes and underutilized species not only increases the availability of more edible protein but can boost the income from the fishing industry (Carver and King, 1971 and King and Carver, 1972).

Noble (1972) stated that for years manual processing discarded large quantities of high quality fish tissue due to productive haste. Flesh-separating machines can provide significant quantities of edible flesh from heretofore defined wastes and trimming from fish filleting and crustacea processing operations (Miyauchi and Steinberg, 1970).

Steinberg (1972) stated that the use of mechanically recovered minced fish flesh offers the following advantages: (1) better use of the resource by increased yields, (2) the use of more species, (3) reduction of wastes, (4) greater flexibility in methods of processing and (5) expanding and developing new markets by offering the consumer a variety of products and prices. The potential for increased yields and lower costs represents a major step toward the total utilization of fishery resources.

The development of mechanical systems for separating muscle tissue from the bone, skin and fins of fish has made possible a substantial quantity of high quality, minced, fish muscle tissue. When such breakthroughs occur, many problems arise which require extensive research and development. In the case of minced fish tissue, further research and development are needed on such factors as product characterization, stability, utilization and distribution logistics. Although the Japanese have been utilizing minced fish tissue for an extended period of time, their methods cannot necessarily be applied in the United States and more specifically to North Carolina.

North American halibut fishermen noted a 91% yield increase in muscle tissue by using a mechanical fish flesh-separating machine to recover wasted flesh from the processing operations (Noble, 1972). Miyauchi and Steinberg (1970) reported that the total yield of fish flesh processed by mechanical separation ranged from 36-60%, whereas the yield of flesh using conventional filleting techniques ranged from 25-30%. According to Crawford *et al.* (1972), mechanically separated fish yielded a 34.3-101.9% increase in edible flesh over hand filleting techniques. In addition to increased yield, Steinberg

(1972) stated that mechanical flesh separation permits the blending of various fishery species for improvement in product flavor and texture. It also allows the opportunity to alter and stabilize the product through the use of additives such as antioxidants and artificial flavors. Since mechanically separated fish flesh is in a comminuted form, it can easily be used for preparing such items as canned fish, frankfurters and fish cakes (Carver and King, 1971).

The shelf life of mechanically separated minced fish blocks is extremely important. Teeny and Miyauchi (1972) found that fish blocks prepared from minced Pacific coast rockfish, *Sebastes brevispinis* (Bean) and *S. flavidus* (Ayres), had a shelf life in excess of 9 months at 0°F, based on flavor and texture evaluations. Raw breaded fish sticks prepared from these frozen blocks had a shelf life of 2-6 months when stored at 0°F.

Presently, there is interest in the convenience and marketability of marine products developed from minced fish tissue. Fish patties are a type of product which provides convenience, easy marketability and a practical way to use fish which might not otherwise be utilized. Due to the increasing need for high protein foods and the limited types of products now being made from minced fish, much research is needed to stimulate the development of new and different products.

Our Food Science laboratory has been working on problems associated with the processing and utilization of mechanically separated fish tissues for several years. Much of the research has involved the determination of functional properties of minced tissue from various species and processing systems (Ivey, 1969; Webb *et al* 1970; Hardy, 1973 and Webb, 1974). This work has been directed toward the development of basic data on minced fish tissue from various species processed by specific methods in order to more readily assist in the development of new products. In addition, work has been conducted on the development of new consumer products to demonstrate product development concepts for the processor to apply in the utilization of minced fish tissue (Miller 1974).

In a recent study by the National Marine Fisheries Service, a substantial percent of food service establishments indicated an interest in breaded fish cakes prepared from minced fish tissue (Moreland, 1974). However, this study indicated that the texture of the fish cakes was not desirable and reformulation was recommended. It appears that the minced fish tissue must be combined with other ingredients which will improve the texture of the finished products. Also, it is important to maintain a high level of fish tissue in the finished product by the addition of materials such as flaked fish, while reducing or eliminating surface breading. The fast food service business has the facilities for preparing and serving breaded or unbreaded patties which can be cooked directly from the frozen state. In most food service establishments, fish patties offer the potential of being an economical replacement for intact fish muscle presently sold as fish sandwiches or fish sticks while maintaining a high level of protein with short preparation and serving time.

The objective of this research was to develop a frozen seafood patty from mechanically separated fish muscle tissue, crabmeat and pre-cooked and flaked fish which could be rapidly cooked for the fast food service industry.

II. Patty Formula Development — Effect of Species and Method of Muscle Tissue Preparation

Materials and Methods

Four experimental formulae were prepared, as shown in Table 1, using various combinations of crabmeat (*Callinectus sapidus*), fish, water and other ingredients. Fresh, raw summer flounder (*Paralichthys dentatus*), Weakfish (*Cynoscion regalis*), Atlantic croaker (*Micropogon undulatus*), spot (*Leiostomus xanthurus*) and pigfish (*Orthopristes chrysoptera*) were mechanically separated using a Yanagiya "Neo-Press" mini-fish separator (3.50 mm extrusion holes). In addition, fresh spot and flounder were steamed whole (15 min. at 212°F) and the meat flaked, free of skin and bone and used in the formula to obtain distinct particles for determining the effect upon textural properties. Special (body meat) pasteurized crabmeat was used.

The patties were prepared by mixing the mechanically separated fish tissue, NaCl and water thoroughly (3 min., 4°C) in a Hobart mixer-grinder. The seasonings, phosphate and soy flour were added and mixed with the subsequent addition of hydrogenated vegetable oil. After mixing to an emulsion consistency, the crabmeat, and the flaked fish—as required by the formula—were added and mixed slowly until dispersed throughout the mix-

Table 1. Fish and crabmeat patty formulations.

	%			
Ingredients	**Formula 1**	**Formula 2**	**Formula 3**	**Formula 4**
Crabmeat	9.3	5.0	9.2	9.1
Flounder, m.s.[1]	—	—	—	23.0
Weakfish, m.s.	—	—	23.0	—
Croaker and spot mixture, m.s.	—	75.0	—	—
Pigfish, m.s.	70.1	—	—	—
Spot, s. and f[1]	—	—	46.0	—
Flounder, s and f	—	—	—	44.6
Water	4.7	5.0	6.0	7.6
Hydrogenated vegetable oil (Crisco)	9.3	10.3	9.2	9.1
Phosphate (Calgon No. G 31077)	0.3	0.3	0.3	0.3
Soy flour (Central Soy, Promosoy 100)	1.8	—	1.8	1.8
Seafood seasoning[2]	4.5	4.5	4.5	4.5

[1] m.s. = mechanically separated, s and f = steamed and flaked.
[2] Consisting of 2.30% NaCl, 1.40% dextrose, 0.45% mustard flour, 0.30% Old Bay Seafood seasoning (Baltimore Spice Co., Baltimore, Md.) and .05% monosodium glutamate.

ture. Patties were prepared using a hand-operated patty former, dipped in a glazing solution (0.5% citric acid, 0.5% lemon marinade[1] and 99.0% water), packed and frozen at −25°F until evaluated. Trials 1, 2 and 3 were evaluated after 2 days frozen storage, whereas Trial 4 was evaluated after 47 days frozen storage.

The patties were prepared for evaluation by cooking in an electric fry pan (350°F) and rated for appearance, aroma, texture and falvor on a hedonic scale (9 = like extremely; 1 = dislike extremely) by a 6-member panel.

Results and Discussion

The results of the panel evaluations for appearance, aroma, texture and flavor for the patties prepared from each of the four formulae are shown in Table 2. The patties were rated relatively high on the hedonic scale, except for Formula 2. The formulae rated in acceptance according to the following descending order: 4, 3, 1 and 2. The formulae (Nos. 1 and 2) which contained a high proportion of mechanically separated tissue were found to be less desirable, regardless of species differences. Also, a reduction in crabmeat in Formula 2 as compared to Formula 1 indicated that the modification contributed to a reduction in the quality of the patties. However, this could not be definitely established due to differences in species. The use of steamed and flaked fish tissue was of significant benefit in improving the textural properties of patties which contained relatively high amounts of mechanically separated tissue.

It is evident that the flounder used in Formula 4 resulted in an exceptionally high quality patty even after 47 days frozen storage. Thus, if flounder were available at an economical cost it would be the best choice. However, it was evident that a combination of crabmeat, mechanically separated weakfish and steamed and flaked spot gave a highly acceptable product. Therefore, it would appear that several species could be used for this type of product provided that the level of mechanically separated tissue is kept relatively low (less than 50%).

Table 2. Panel sensory evaluation scores for various fish patty formulations.

Formula	Panel Scores[a] Appearance	Aroma	Texture	Flavor
1	6.63	7.00	6.63	7.10
2	5.28	6.33	6.14	5.28
3	6.43	7.63	7.50	7.43
4	8.20	8.00	7.50	8.30

[a] Nine-point hedonic scale; where 9 = Dislike Extremely and 1 = Dislike Extremely.

[1] Lemon marinade was supplied by Foote and Jenks, Inc., Jackson, Mich.

III. Evaluation of the Quality and Storage Stability of Seafood Patties

Materials and Methods

Two patty formulations which incorporated crabmeat and two kinds of fish (weakfish and spot) were prepared as shown in Table 3. Special, pasteurized crabmeat was used. The weakfish was mechanically separated, block frozen (2½ months at −25°C), thawed, ground and used in the formulations. The spot used in Formula 1 was fresh dressed and steam cooked (15 min. at 212°F), chilled and the meat flaked free of skin and bones. The spot used in Formula 2 was mechanically separated, frozen and stored at −25°C for one week. Prior to using in the formula, the minced tissue was thawed and steam cooked, as described in Formula 1. All other ingredients were identical for the two formulae.

On the basis of the results of the four formulations developed in Section II, experiemental formulae were developed to more precisely determine the attributes of mechanically separated tissue. Since Formula 3, Section II, received a relatively high rating for all quality attributes, it was used as a basis for the development of the formulae in this experiment. Flounder was not used due to the market value being high. The crabmeat and mechanically separated (m.s.) weakfish were used at essentially the same level as that of Formula 3, Section II. Spot was used to determine the effect of a high level (69.9%) as compared to a low level (23.3%) of mechanically separated fish tissue. Steamed and flaked spot replaced mechanically separated spot in Formula 2.

The patties were prepared by mixing the mechanically separated tissue (minced), NaCl and water thoroughly using a Hobart mixer. The seasonings, MSG, phosphate and soy flour were added and blended thoroughly with the subsequent addition of the vegetable fat and mixing continued to obtain a

Table 3. Fish and crabmeat patty formulations.

Ingredients	% Formula 1	Formula 2
Crabmeat, special	9.3	9.3
Weakfish, m.s.[1]	23.3	23.3
Spot, m.s.	—	46.6
Spot, s and f[1]	46.6	—
Water	5.1	5.1
Hydrogenated vegetable oil (Crisco)	9.3	9.3
Phosphate (Calgon No. G31077)	0.2	0.2
Soy flour (Central Soy, Promosoy 100)	1.0	1.0
Seafood seasoning[2]	4.6	4.6

[1] m.s. = Mechanically separated; s and f = steamed and flaked.
[2] Consisting of 2.30% NaCl, 1.40% dextrose, 0.60% mustard flour, 0.30% Old Bay Seafood Seasoning and 0.1% monosodium glutamate.

uniform consistency. The crabmeat and flaked spot (Formula 1) were added last with slow mixing for a short time in order to uniformly distribute the large particles without disintegration. The patties were formed by using a hand operated mold and divided randomly into four lots for subsequent treatment as indicated below:

Treatment A: Patties were wrapped in freezer paper and frozen raw at −25°F. After 24 hrs. they were unwrapped, glazed, rewrapped and returned to the freezer. The glazing solution consisted of 0.5% citric acid, 0.5% lemon marinade and 99.0% water as stated in Section II.

Treatment B: Patties were cooked in an electric fry pan at 350°F for 6 minutes, wrapped and frozen at −25°F. After 24 hrs. they were unwrapped, glazed as in Treatment A, rewrapped and returned to the freezer.

Treatment C: Patties were glazed prior to freezing as in Treatment A, wrapped and frozen raw at −25°F.

Treatment D: Patties were frozen raw at −25°F.

Patties from each treatment were evaluated after 3, 30 and 45 days frozen storage for rancidity by the thiobarbutic acid (TBA) test (Tarladgis *et al.*, 1960) and for appearance, texture, aroma and flavor on a hedonic scale (9 = like extremely; 1 = dislike extremely) by a 6-member panel. Patties from Treatments A, C and D were cooked in an electric fry pan at 350°F, and those from Treatment B were heated in an oven (350°F) for panel evaluation. The percent cook yield was calculated by differences in weight.

Results and Discussion

The percentages retained of the glazing solution for Treatments A, B and C are shown in Table 4. Treatment B, which was cooked, frozen and glazed, had the highest retention followed by Treatment C (glazed prior to freezing), with Treatment A (frozen and then glazed) retaining the least. The glaze was used on the basis that it would prevent dehydration and reduce oxidation of the frozen patties.

The cooking loss for each of the treatments and freezer storage times are shown in Table 5. In general, the cooking loss decreased substantially between 3 and 30 days storage time but was highly variable thereafter. There was little difference in cooking loss between the patties of Formulae 1 and 2 for Treatment A. However, the cooking loss was substantially lower for Formula 1 than Formula 2 patties for all other treatments which was explained by differences in the amount of mechanically separated tissue. The glazing treatment resulted in higher cooking losses except for the patties which were precooked.

The results of the panel evaluations for the patties prepared by the two formulae and various treatments are presented in Tables 6, 7, 8 and 9. The

Table 4. Percentage retention of glaze for patties receiving various treatments.

Treatment[1]	Uptake of Dip, %
A	4.54
B	6.27
C	5.02
D	—

[1]Formulae 1 and 2 combined.

Table 5. Percentage lost during cooking for Formulae 1 and 2 patties receiving various treatments

Storage Time, Days	Formula 1				Formula[1]			
	A	B[1]	C	D	A	B[1]	C	D
3	29.6	17.8	20.1	16.8	27.2	23.7	25.0	26.25
30	24.2	8.8	23.0	17.6	22.1	17.2	22.2	18.00
45	23.4	2.8	20.0	12.3	27.0	—	27.2	17.30

[1] These values are for cook loss upon reheating of the pre-cooked product.

results are based upon a relatively small panel (6 member) consisting of technical personnel of the seafood research laboratory at N. C. State University. However, the panel members were trained to detect small differences in flavor, texture, appearance and aroma attributes. Thus, it was our conclusion that the results were of significant value in the assessment of the relative quality ratings for the patties receiving the various treatments as well as overall acceptability for each attribute.

The ratings for appearance (Table 6) indicated that the patties prepared by Formula 1 were slightly higher than those for Formula 2, initially and throughout storage, regardless of the method of treatment. The patties which were frozen raw and subsequently glazed (Treatments A and C) were rated slightly higher for appearance than those which were pre-cooked and subsequently glazed (Treatment B) or those which received no glaze (Treatment D).

The rating for texture (Table 7), with minor exceptions, indicated that patties prepared by Formula 1 were superior to those prepared by Formula 2. It was believed that the exceptions (Treatment A, at 3 and 45 days and Treatment B, initially) were due to variations within sampling units. The patties receiving the application of a glazing solution, either prior to or after freezing, (Treatments C and A) were rated approximately the same in texture, with pre-cooking (Treatment B) and no glazing (Treatment D) being rated slightly lower. However, when the values for Treatment D are com-

Table 6. The effect of formulation, glazing application and storage time on the appearance of seafood patties.

Formula[1]	Treatment	Storage Time, Days	Mean and Std. Dev.[2]
1	A	3	6.25 ± 1.25
		30	7.43 ± 0.49
		45	7.14 ± 0.73
	B	3	5.67 ± 1.11
		30	7.67 ± 0.44
		45	6.67 ± 0.72
	C	3	6.25 ± 1.38
		30	7.59 ± 0.49
		45	7.00 ± 0.57
	D	3	6.75 ± 0.75
		30	7.43 ± 0.65
		45	7.00 ± 0.57
2	A	3	6.00 ± 0.86
		30	6.58 ± 1.16
		45	6.87 ± 0.44
	B	3	5.86 ± 0.89
		30	6.43 ± 0.62
		45	—
	C	3	5.85 ± 0.78
		30	7.00 ± 0.28
		45	6.71 ± 0.41
	D	3	5.71 ± 1.04
		30	6.87 ± 0.49
		45	6.43 ± 0.69

[1] Formula 1: Crabmeat (9.3%), mechanically separated weakfish (23.3%) and flaked spot (46.6%).
Formula 2: Crabmeat (9.3%), mechanically separated weakfish (23.3%) and mechanically separated spot (46.6%).
[2] Evaluated on a hedonic scale (9 = like extremely to 1 = dislike extremely).

pared with those for Treatment A it was concluded that the application of a glaze had no significant effect upon texture.

In general, the ratings for aroma (Table 8) show very little difference between formulae, except that the ratings for Treatment A were higher at all storage times for Formula 1 than Formula 2. Also, the ratings for Treatment A for Formula 1 were the highest of any of the treatments for all storage times. Thus, it would appear that Formula 1, Treatment A patties

Table 7. The effect of formulation, glazing application and storage time on the texture of seafood patties.

Formula[1]	Treatment	Storage Time, days	Mean and Std. Dev.[2]
1	A	3	7.00 ± 0.33
		30	6.71 ± 0.90
		45	6.86 ± 1.63
	B	3	4.60 ± 0.94
		30	6.83 ± 0.72
		45	7.34 ± 1.22
	C	3	7.50 ± 0.50
		30	7.28 ± 0.92
		45	7.50 ± 0.67
	D	3	7.76 ± 0.78
		30	7.00 ± 0.67
		45	7.14 ± 0.73
2	A	3	6.58 ± 0.77
		30	7.59 ± 0.71
		45	7.14 ± 0.73
	B	3	6.72 ± 0.69
		30	6.28 ± 0.48
		45	—
	C	3	6.63 ± 0.69
		30	7.71 ± 0.61
		45	7.00 ± 0.57
	D	3	5.63 ± 1.47
		30	7.50 ± 0.80
		45	6.87 ± 0.87

[1] Formula 1: Crabmeat (9.3%), mechanically separated weakfish (23.3%) and flaked spot (46.6%).
Formula 2: Crabmeat (9.3%), mechanically separated weakfish (23.3%) and mechanically separated spot (46.6%).
[2] Evaluated on a hedonic scale (9 = like extremely to 1 = dislike extremely).

indicated the best combinations for appearance, texture and aroma. However, the flavor ratings (Table 9) indicated a different pattern than the other attributes. On the basis of the ratings for flavor it would appear that the type of treatment had a substantial effect upon the type of formulation. For Formula 1, Treatment C was consistently the best throughout storage. However, Treatment D was found to retain a high flavor rating throughout storage for both Formula 1 and 2. Also, Treatments A and C were rated

Table 8. The effect of formulation, glazing application and storage time on the aroma of seafood patties.

Formula[1]	Treatment	Storage Time, days	Mean and Std. Dev.[2]
1	A	3	7.17 ± 0.83
		30	7.43 ± 0.82
		45	8.00 ± 0.33
	B	3	6.25 ± 1.25
		30	7.00 ± 0.86
		45	7.17 ± 0.28
	C	3	6.60 ± 1.28
		30	7.14 ± 0.73
		45	7.67 ± 0.44
	D	3	6.50 ± 1.30
		30	7.00 ± 0.86
		45	7.67 ± 0.44
2	A	3	6.12 ± 0.85
		30	7.14 ± 0.73
		45	6.85 ± 0.60
	B	3	6.25 ± 0.82
		30	7.00 ± 0.57
		45	—
	C	3	7.00 ± 0.50
		30	7.14 ± 0.73
		45	6.83 ± 0.83
	D	3	6.86 ± 0.78
		30	7.14 ± 0.73
		45	6.72 ± 0.81

[1] Formula 1: Crabmeat (9.3%), mechanically separated weakfish (23.3%) and flaked spot (46.6%).
Formula 2: Crabmeat (9.3%), mechanically separated weakfish (23.3%) and mechanically separated spot (46.6%).
[2] Evaluated on a hedonic scale (9 = like extremely to 1 = dislike extremely).

quite high after 30 and 45 days storage. When both formulae are considered, Treatment C was found to be the best method for maintaining a good flavor attribute.

It was of significant importance that the results of the panel evaluations showed relatively high ratings for all treatments and storage times. When all treatments were combined, there were no significant differences between the two formulae. However, the patties receiving Treatment D, which did

Table 9. The effect of formulation, glazing application and storage time on the flavor of seafood patties.

Formula[1]	Treatment	Storage Time, days	Mean and Std. Dev.[2]
1	A	3	7.28 ± 0.61
		30	7.28 ± 0.82
		45	5.83 ± 1.50
	B	3	6.50 ± 1.00
		30	7.28 ± 0.41
		45	6.33 ± 0.67
	C	3	7.43 ± 0.63
		30	7.43 ± 0.49
		45	7.50 ± 0.50
	D	3	7.43 ± 0.65
		30	7.14 ± 0.49
		45	7.60 ± 0.40
2	A	3	7.00 ± 0.57
		30	7.59 ± 0.57
		45	7.00 ± 0.25
	B	3	7.00 ± 0.28
		30	6.86 ± 0.53
		45	—
	C	3	7.17 ± 0.83
		30	7.43 ± 1.06
		45	7.00 ± 0.57
	D	3	5.43 ± 1.79
		30	7.33 ± 0.44
		45	7.00 ± 0.75

[1] Formula 1: Crabmeat (9.3%), mechanically separated weakfish (23.3%) and flaked spot (46.6%).
Formula 2: Crabmeat (9.3%), mechanically separated weakfish (23.3%) and mechanically separated spot (46.6%).
[2] Evaluated on a hedonic scale (9 = like extremely to 1 = dislike extremely).

not have a surface glazing treatment, indicated a slightly higher rating for Formula 1 for all attributes after 45 days storage. This would suggest that the increased amount of raw, minced tissue contributed to a slight reduction in quality. Differences in quality were not detected for the two formulae among the other three treatments.

In general, the ratings by the panel indicated that a combination of weakfish, spot and crabmeat for the preparation of frozen unbreaded patties produced a very satisfactory product up to 45 days storage. The use of a surface glaze was found to be of substantial value in maintaining stability of the quality attributes during frozen storage. There was very little difference between the two methods of applying the surface glaze (Treatment A, application after initial freezing or Treatment C, application prior to freezing). However, pre-cooking with subsequent glazing (Treatment B) resulted in a reduction in quality of the frozen patties. It should be noted that the patties which did not have a surface glaze (Treatment D) received relatively acceptable ratings on the hedonic scale. Therefore, it may be possible to incorporate citric acid and lemon extractives in the initial formulations to attain an excellent product and thereby omit the process of surface glazing.

The TBA results for patties prepared by Formula 1 are presented in Figure 1. The absorbance (mu) for patties which were not surface glazed (Treatment D) increased after 30 days storage but decreased to a slightly lower value than the 3 days storage level by day 46. Treatments A and B showed essentially no change throughout the 45-day storage period. TBA values for patties receiving Treatment C had a trend similar to those receiving Treatment D but the absorbance values were not substantially different from Treatments A and B. These results substantiate the finding of the panel.

The TBA test results for patties prepared by Formula 2 are presented in Figure 2. The results indicated that patties, which were unglazed (Treatment D), gave higher TBA values than the other three treatments after 30 days storage. An increase in TBA values was observed for Treatments A and C, with the latter showing only a slight increase. Apparently, the glazing assisted in preventing oxidative rancidity but the results were not substantially different. The TBA values for all treatments of Formula 2 patties were slightly higher than those for Formula 1. It was concluded that this occurred as a result of using a higher level of mechanically separated fish tissue in Formula 2, which probably contained components from the skin and bones, and thereby increased the rate of oxidative rancidity. Moerck and Ball (1974) reported that mechanically deboned chicken meat increased significantly in TBA value during storage at 4°C. The increase in TBA values exceeded 1.3 after 6 days storage with values increasing to 20 after 13 days storage. The rancidity threshold level has been reported to be a TBA value of 1.0 (Watts, 1962). An antioxidant (Tenox II) was effective in preventing increases in TBA values. Thus, on the basis of the panel and TBA results, the use of only mechanically separated fish muscle tissue in patty formulations would not be prohibitive for storage periods exceeding 45 days. However, the minced fish tissue used in these studies was processed under closely controlled pilot laboratory conditions and would be expected to have relatively high quality ratings.

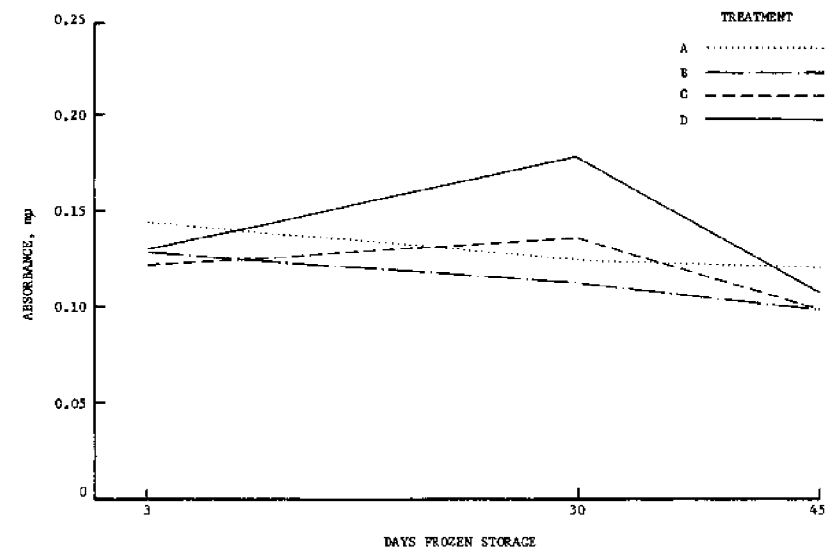

Fig. 1. Effect of type glazing, precooking and storage time on the TBA values of frozen seafood patties (Formula 1).

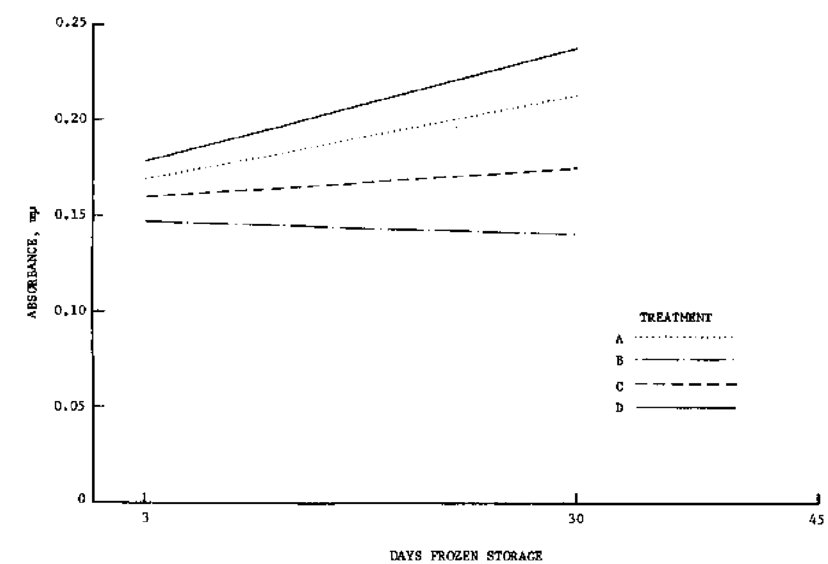

Fig. 2. Effect of type glazing, precooking and storage time on the TBA values of frozen seafood patties (Formula 2).

IV. Comparison of Bluefish and Crabmeat in Seafood Patties

Materials and Methods

Two trials were conducted in this experiment in which various combinations of crabmeat and four species of fish were used. The two formulations for the patties are given in Table 10.

The experiment was conducted to determine if the crabmeat contributed significantly to the quality of seafood patties in relation to steamed and flaked fish tissue. Bluefish *Pomatomus saltatrix* (Linnaeus) was substituted for the crabmeat in Formula 2 as it was presumed to be the most likely species to show differences in quality due to its relatively poor stability.

To prepare the fish, raw, frozen (3 mos.) flounder, weakfish and bluefish were thawed overnight at room temperature. These fish were steamed for 15 minutes at 212°F, skinned and the meat flaked from the bones. The fresh spot was hand skinned and deboned and used in the raw condition. The crabmeat was taken from the body meat, designated as special (regular) type, and was pasteurized prior to use.

To prepare the patties (Table 10), the spot tissue, NaCl, water and phosphate were chopped in a silent cutter to form a uniform blend and the seasonings, MSG, soy flour and hydrogenated vegetable oil added and chopped to an emulsion consistency. The emulsion was transferred to a Hobart mixer-grader and the flaked fish and crabmeat (Formula 1) added and mixed gently to a uniform consistency with care being taken not to destroy the flaked particles. The patties were formed in a hand press and glazed in a marinade solution consisting of 4.0% malic acid, 4.0% lemon marinade, (Foote and Jenks) and 92.0% water. The patties were individually quick frozen (IQF) on trays at −25°F and subsequently (24 hrs) packaged and stored at −25°F for 12 days prior to evaluation.

Table 10. Fish and crabmeat patty formulations.

	%	
Ingredients	**Formula 1**	**Formula 2**
Crabmeat	17.8	—
Flounder, s and f[1]	17.8	17.8
Weakfish, s and f	17.8	17.8
Bluefish, s and f	—	17.8
Spot, fresh	22.2	22.2
Water	8.9	8.9
Hydrogenated vegatable oil (Crisco)	8.9	8.9
Phosphate (Calgon No. G 31077)	0.2	0.2
Soy flour (Central Soy, Promosoy 20/60)	1.8	1.8
Seafood seasoning[2]	4.6	4.6

[1] s and f = steamed and flaked.
[2] Consisting of 2.2% NaCl, 1.3% dextrose, 0.5% mustard flour, 0.5% Old Bay Seafood Seasoning and 0.1% monosodium glutamate.

Evaluation of the patties was done by cooking from the frozen condition in an electric fry pan (350°F) and evaluating for appearance, aroma, texture and flavor using a hedonic scale (9 = like extremely; 1 = dislike extremely) by a 6-member panel.

Results and Discussion

The panel ratings for the two patty formulations (Table 10) are presented in Table 11. Formula 1 contained crabmeat, flounder, weakfish and spot whereas in Formula 2 bluefish was substituted for the crabmeat. The remaining ingredients were identical for both formulae.

The results of the panel scores indicated that there was no substantial difference in the use of bluefish as a substitute for crabmeat. These results are of major significance since bluefish has often been associated with strong off-flavors and aromas and is considerably less expensive than crabmeat. However, it should be noted that a long-term storage study was not conducted for this experiment, but all fish had been frozen 3 mos. in the raw condition prior to use. Furthermore, it was theorized that the steam cooking of the bluefish prior to use in the formula may have reduced the enzymatic activity of the muscle tissue and thereby improved the stability. It was concluded that crabmeat could be eliminated from seafood patty formulations if flaked fish were used in order to obtain the desired texture in the finished patties.

Table 11. Panel sensory evaluation scores for fish patties with bluefish replacing crabmeat.

	Panel Scores[1]			
Formula	**Appearance**	**Aroma**	**Texture**	**Flavor**
1	7.0	7.7	7.3	7.7
2	7.3	7.6	7.2	7.7

[1] Hedonic scale (9 = Like Extremely and 1 = Dislike Extremely).

V. Utilization of Mechanically Separated Catfish Tissue and Crabmeat in Patties.

Materials and Methods

Channel catfish (*Ictalurus punctatus*) were taken from lakes near Raleigh, North Carolina, processed and the muscle tissue removed by hand filleting, and sampled for the determination of fat, moisture, protein and ash (AOAC, 1970). Also, the tissue was evaluated for yield, soluble protein, emulsifying capacity and pH. In addition, the catfish were eviscerated, deheaded and mechanically separated to obtain a minced fish for preparation of patties.

Two trials were conducted for the development of unbreaded patties, each with varying amounts of ingredients according to the formulations shown in Table 12. To prepare the patties, quick-frozen (7 days) mechanically separated catfish was thawed and blended in a Hobart mixer with the NaCl and water to form a slurry. The seasonings and cornmeal (Formula 2) were added and the mixture blended thoroughly with the vegetable fat being subsequently added and further blended to obtain a uniform mixture. The crabmeat was added last with gentle mixing in order to obtain complete dispersion without destroying the integrity of the particles. Patties were formed using a hand operated mold from the mixture and individually frozen at −25°F.

The patties were prepared for panel evaluation after 30 days frozen storage by cooking from the frozen condition in an electric fry-pan at 350°F. They were evaluated on a 5-point scale for appearance, aroma, texture and flavor, where 5 = like extremely to 1 = dislike extremely.

Table 12. Catfish patty formulations.

	%	
Ingredients	Formula 1	Formula 2
Crabmeat, special	10.0	15.0
Catfish, m. s.[1]	66.3	45.0
Water	10.0	10.0
Hydrogenated vegetable oil	10.0	10.0
Cornmeal	—	16.3
Seafood seasoning[2]	3.8	3.8

[1] m.s. = Mechanically separated
[2] Consisting of 2.0% NaCl, 1.0% dextrose, 0.5% mustard flour, 0.2% Old Bay Seafood Seasoning and 0.1% monosodium glutamate.

Results and Discussion

Table 13 shows the results of three trials on the determination of chemical and physical properties of channel catfish muscle tissue. It was found that

Table 13 Proximate composition and functional properties of catfish muscle tissue.

	Ave.	r
Moisture, %	74.98	74.47 - 75.25
Fat, %	4.17	3.50 - 5.50
Ash, %	1.02	1.01 - 1.04
Protein, %	19.83	18.23 - 20.99
Emulsifying Capacity, g oil/ 20 g slurry[1]	194	178 - 204
Soluble Protein, %	19.2	
pH	6.55	

[1] Slurry was prepared by blending 20.0 g. fish tissue with 450 ml of 0.58 M NaCl for 2 min. at 1°C.

the composition of catfish muscle is similar to other species of fish. Firth (1969) reported the range in composition for fish as: moisture 66-84%; oil 0.4-25%; protein 13-24%; and ash 0.5-2%. The soluble protein and emulsifying capacity data indicated that the catfish muscle would be a relatively good binder.

The results shown in Table 14 indicated a slightly higher yield for the mechanically separated tissue as compared to hand filleting. Also, it was observed that there was substantially less labor required for the mechanical processing. In preparing the muscle tissue, it was observed that when the catfish were mechanically separated prior to the development of rigor and stored at 45°F, a green discoloration occurred within 2-3 hrs. This condition did not occur in post rigor, minced tissue or when it was immediately frozen after pre-rigor mechanical separations.

Preliminary evaluation in the use of catfish muscle tissue for the preparation of patties indicated that an acceptable product texture could not be obtained without the addition of supplemental ingredients. Panel results (Table 15) showed that the patties made by Formula 1 were rated relatively low for texture and flavor although the appearance and aroma were rated relatively high. Therefore, in Formula 2, the amount of catfish was de-

Table 14. Percent yield of hand and mechanically separated catfish tissue.

Trial	Yield, Hand %	Yield, Mechanical %
1	39.3	37.2
2	39.0	46.8
3	40.8	42.1
Ave.	39.7	42.0

Table 15. Panel sensory evaluation scores for catfish patties.[1]

Formula Number	Appearance	Aroma	Texture	Flavor
1	4.0	4.5	3.0	3.0
2	3.2	3.8	4.0	3.8

[1] Based on a 5-point scale; where 5 = like extremely and 1 = dislike extremely.

creased, the crabmeat increased and cornmeal added in an attempt to increase texture and flavor without substantially lowering appearance and aroma. The taste panel scores showed that Formula 2 was preferred for flavor and texture but appearance and aroma decreased. Although appearance and aroma were lowered, it was determined by the panel that Formula 2 had a higher overall acceptability. It was concluded that catfish patties may have possibilities as a marketable item for institutional food programs while utilizing waste materials such as the meat left on the bone frames following filleting operations.

VI. Conclusions

Recently there has been widespread interest in the utilization of minced fish tissue obtained from the mechanical separating process. However, there are many problems encountered in developing acceptable products with minced fish tissue.

On the basis of these experiments, it was concluded that mechanically separated fish muscle tissue can be effectively used to prepare catfish and seafood patties provided that supplemental ingredients are used in formulating the products. The use of steamed and flaked fish tissue was effective in increasing texture ratings in seafood patties made with relatively high amounts of minced fish tissue. There was an indication that pre-cooking of headed and eviscerated fish (steaming and flaking) may assist in maintaining acceptable flavor and aroma for frozen bluefish. Furthermore, the selection of a desirable species was found to be an extremely important factor. The concept for developing the type of patties prepared in these experiments was based upon the elimination of surface breading on seafood products. This type of product was conceived so that it could be grilled direct from the frozen condition by institutional and fast food service users. The experimental samples showed that such a method of preparation can be satisfactorily accomplished.

This investigation indicated that the texture and flavor of products developed with minced fish tissue can be improved by such techniques as the addition of flaked fish tissue, and the application of a surface glaze to the frozen patty.

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