6-1998

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June 1998 Bulletin Number 864

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Aylin Özayan, R. Wes Harrison[1] and Samuel P. Meyers[2]

Background and Justification

Seafood mince meat can be used to formulate a variety of value-added food products such as seafood stuffings and dips, battered and breaded seafood products, seafood sausage and patties, and soup bases. Such minces can be derived from a number of sources. For instance, the United States fishery and aquaculture industries yield large numbers of animal species and numerous processing by-products that have potential for further processing into food-grade minced meat. Commercial fishing activities create large amounts of under utilized fish species, which are netted along with more desirable species. In other instances, by-products of conventional seafood processing may also be use for minced meat production, or commercial species may simply be too small to process economically (Regenstein, 1986).

The Louisiana crawfish industry is an example of how smaller animals can go underutilized. Crawfish is Louisiana's third

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largest aquaculture industry with a gross farm value of 33.2 million dollars (Louisiana Summary, 1997). Nearly all of the crawfish harvested in Louisiana comes from either the Atchafalaya Basin or is farm-raised. After harvesting, most crawfish are sorted into three or four grades, with the larger grades either processed for export to European markets or sold live (or boiled) on the domestic markets at a premium price. Depending on the season, the price range in the domestic live market for these crawfish is between $.50 and $1.25 per pound. The intermediate or peeler grade is typically hand peeled and sold as fresh or frozen tailmeat. The live price range for this grade is between $.30 and $.70 per pound. However, according to industry experts as much as 20% of the annual crawfish catch is too small for hand peeling. These smaller crawfish are by-products of the grading process and are usually either priced well below the current market, culled by the grader for return to the producer, or discarded by the processing plant.

Researchers at Louisiana State University have been studying the utilization of these undersized crawfish as a source of a value-added minced meat. This research has resulted in a technique whereby a commercial meat/shell separator is used to extract minced-meat from small sized crawfish. The process involves boiling undersized whole animals, which are then processed using a commercial meat/shell separator. Both whole animals and crawfish tails have been used in preliminary studies. Animals used for production of tail-only mince are of course deheaded prior to meat separation. The meat/shell separator removes the crawfish meat from the shell portion of the animal. Throughout the process, careful time/temprature controls are maintained to insure maximum product quality. The process results in a finely ground food-grade crawfish mince.

The objective of this study was to investigate the market potential for minced meat products derived from Louisiana's undersized crawfish. Specific objectives were to: (1) identify potential markets for crawfish mince-based products and the product attributes needed for market acceptance; and (2) estimate potential buyer preferences for food grade products derived from undersized crawfish minced meat.

Review of Literature

Numerous studies have demonstrated the technical feasibility of processing underutilized by-products into edible minced meat. Lee, et al. (1993) showed that edible minced meat could be obtained from blue crab processing by-products. Mechanical meat-shell (or meat-bone) separators were used to extract 50-80% food-grade mince from picking table by-products and undersized claws. Gates and Parker (1992) also showed the feasibility of deriving food grade minces from blue crab processing by-products. Studies have also been conducted on fish minces derived from fish frames (Pigott, 1994).

In all of these investigations, mechanical recovery systems were used to fabricate minced meat seafood products. More recently, studies have examined the utilization of crawfish processing by-products, focusing on use of fresh processing by-products as a source of flavor compounds, and as a natural source of the carotenoid astaxanthin, used as a flesh and integument color enhancer (Chen and Meyers, 1992).

Only a few studies have examined the marketing of crawfish products. Dellenbarger, et al. (1990) reported that the on-farm area devoted to crawfish production decreased by about 5,000 acres in 1990. They concluded that this decrease could have been attributable to the decline in the demand for crawfish caused by an economic recession and/or the availability of lower priced substitute products. Their study emphasized the need to develop new markets or to expand existing markets to increase crawfish sales. Later, Yen, et al. (1995) investigated the determinants of crawfish consumption in Houma, Louisiana. These aforementioned studies have contributed to the body of knowledge concerning minced-meat recovery and to the understanding of the crawfish industry's current markets. However, no research was found that examines markets for new value-added products derived from undersized crawfish. The present study differs from the previous research in this respect.

METHODS

The methodological approach of the study is divided into two stages. The first phase utilizes conjoint analysis to identify and measure potential buyer preferences for two products derived from crawfish mince. The second stage involves analyzing demographic information of potential buyers and their current use of selected seafood products. The procedures associated with the conjoint study are presented in this section.

Conjoint analysis (CA) is a statistical technique used for measuring, evaluating, and ranking the relative importance of the individual characteristics of a product, as well as providing a means to estimate the preferred combination of product characteristics. It is an important tool for market research because it allows for a buyer's total utility for a multidimensional product to be decomposed into part-worth utilities for each attribute of the product. For instance, Huang and Fu (1995) used CA to analyze consumer preferences for various attributes of Chinese sausage. Taylor et al. (1997) used CA to examine the preferences of retailers and restauranteurs for ratite meat in the south central United States. Gan and Luzar (1993) used a similar procedure to estimate consumers willingness to pay for waterfowl hunting in Louisiana. Halbrendt, et al. (1990) used CA to determine the utility values for nine different hybrid striped bass products. They also added variables for market level and attribute-market interactions to allow for inter-industry comparisons. Anderson and Bettencourt (1993) applied the conjoint approach to examine buyer preferences in the New England market for fresh and frozen salmon.

There are essentially three steps involved in a conjoint study. Firstly, relevant product attributes and their levels must be defined in a manner that is consistent with the buyer's understanding of the product. Secondly, an experimental design and a survey instrument must be constructed to collect the conjoint data. At this stage, a set of hypothetical products are defined by combining product attributes at various levels. Subjects are then asked to evaluate their overall preference ratings or rankings of the hypothetical products. The final step of CA involves estimation of the

buyer's part-worth utilities. Each step is discussed in greater detail in the following sections.

Selection of Product Attributes

Since little is known regarding the potential market for minced crawfish meat, focus group interviews were used to obtain information about the possible use of crawfish mince and to determine the relevant product characteristics for these type products. The use of focus group interviews varies widely in market research, but their purpose in conjoint analysis is to provide exploratory information about relevant attributes for new products. They involve a small group discussion led by a moderator who poses a series of semi-structured, open-ended questions intended to identify relevant product attributes and associated attribute levels (Louviere, 1988). The results of the focus group interviews were used to develop the questionnaire used in this study.

The focus groups for this study consisted of seafood processors, seafood wholesalers, distributors, seafood restaurant and delicatessen managers, and chefs from South Louisiana. Two focus group discussions were conducted in two major Louisiana cities. The first was conducted in Baton Rouge with two delicatessen managers and two restaurant chefs. The second group discussion, held in New Orleans, included two seafood wholesaler/distributors, one restaurant owner/chef, a representative of the Louisiana Seafood Promotion and Marketing Board, and two seafood processors. During the focus group discussions, the moderator[2] first allowed the participants to examine (look, feel, and taste) the minced crawfish products. The participants were then asked several open ended questions about potential uses for the crawfish mince.

Focus Group Results

The results of the group discussions indicated that crawfish mince might best be marketed to restaurants for use either as a base and/or as a stuffing ingredient for various menu items. The consensus was that a base or stock type product could be used to flavor soups and chowders. The stuffing product could be used as

a meat substitute for various recipes such as crawfish bisques, sausages, and other items that require a stuffing ingredient.

Next, the potential attributes of the soup/chowder base and stuffing products were explored. Several of the restaurant participants suggested that they currently prepare their own stocks and stuffing products by chopping whole crawfish or crawfish tails. They indicated that the minced product would be successful only if it could be substituted for either whole crawfish or crawfish tailmeat. The restauranteurs also indicated that the price of the mince would need to be discounted relative to seasonal prices for fresh crawfish tailmeat. The form of the minced product also was discussed and felt to be important. The discussion focused on various forms, such as a fresh product (never frozen), a frozen product that could be stored for later use, and some expressed an interest in a dehydrated bouillon cube form. The possibility of offering a product with added spices and salt also was discussed. However, the group participants did not desire a product with MSG or other preservatives.

Results of the focus group discussions indicated that the most relevant attributes were the price, form, and flavor of the product. The flavor attribute is important because minced crawfish can be derived from two different sources. Undersized whole crawfish yield a relatively strong flavor, whereas unpeeled crawfish tails yield a milder flavor. Therefore, the flavor attribute was also included in the conjoint analysis to determine the best source for the minced products. Specifically, the attributes and their associated levels (a total of 18 levels) are the product price, which is expressed as a percentage of the current price of fresh crawfish tail meat (at levels of 30%, 50%, and 70%); the product form (with levels defined as fresh, never frozen; frozen; and dehydrated, semi-moist bouillon cube), and the product flavor (with levels identified as strong or hearty and mild).

Experimental Design

In all, two three-level attributes (price and form) and one two-level attribute (flavor) were identified based on the focus group results. A full profile approach would involve 18 (3X3X2) profiles for the soup/chowder base product and an equal number for the

stuffing product. Subjects would have difficulty in rating 36 product profiles. To cope with this problem, the number of treatments were reduced using a mixed (3X3X2) confounded block design. This reduces the number of profiles a subject must evaluate to six, and allows for a test of all attribute main effects plus all two-way and three-way interactions. The design used in this study was adapted from a design discussed in Cochran and Cox (p. 174, 1957). Readers interested in a detailed discussion of this adaptation are referred to appendix 1.

The Survey and Conjoint Data Collection

A mail survey was constructed to collect the conjoint data and other relevant information. A copy of the questionnaire is presented in appendix 2. The names and addresses of all seafood restaurants listed according to the standard industrial classification (SIC) 5812 were purchased from American Business Information Marketing Incorporated for the Gulf South region of the United States (Louisiana, Mississippi, Alabama, and Texas). The mailing list contained 1599 seafood restaurants. The experimental design called for 12 different questionnaires with the only difference between them being the conjoint section (appendix 1). The sample was divided at random into 12 groups with sample size 133 for 9 groups, and 134 for 3 groups. The questionnaires were then sent to seafood restaurants in their respective groups.

Dillman's Total Design Method (TDM) was followed for both the survey design and implementation (Dillman, 1978). The first mailing of the survey was mailed the first week of November, 1996. One week after the original mailing, a postcard reminder was sent to the original mailing list. The objective was to thank those who had responded and to remind those who had not responded. Three weeks after the original mail-out, another letter and a replacement questionnaire were sent to all nonrespondents. In this study, instead of the seven-week follow up that Dillman suggests, phone calls were made at random to individuals who had not responded. Another questionnaire and a cover letter were sent to those individuals who agreed to respond.

A total of 260 responses were received, resulting in a 16.3 percent response rate. Of these responses, 69 of the respondents

did not answer the conjoint section of the questionnaire, and 36 questionnaires were incomplete, leaving 155 usable questionnaires for the conjoint analysis. After testing for the significance of interaction effects (appendix 2), all main effect part-worth values were estimated using ordinary least square regression.

The Conjoint Model

In conjoint measurement, a customer's utility for a product is a function of the part-worth utilities. In order to find a customer's total utility for a product, part-worth utilities for the product attributes must be estimated. A common approach for estimating part-worth utility values is to model customer preferences using mean deviation coding, which is a dummy variable technique that yields parameter estimates that are expressed as deviations from the overall mean preference rating (Halbrendt et al., 1990). The model used to estimate the part-worth utilities is:

$$R_n = \alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 + \alpha_3 x_3 + \alpha_4 x_4 + \alpha_5 x_5 + e_n$$

where,

R_n = the preference rating for the nth respondent,

x_1 = 1 and x_2 = 0 represents the 30% price level,

x_1 = 0 and x_2 = 1 represents the 50% price level,

x_1 = -1 and x_2 = -1 represents the 70% price level,

x_3 = 1 and x_4 = 0 represents the fresh product form,

x_3 = 0 and x_4 = 1 represents the frozen product form,

x_3 = -1 and x_4 = -1 represents the dehydrated bouillon cube product form, and

x_5 = 1 or -1 for the mild and concentrated flavor, respectively.

The intercept α_0 represents the overall mean rating, and the coefficients α_1, α_2, α_3, α_4, and α_5 represent the part-worth estimates associated with the respective levels of price, form, and flavor. The part-worth values are estimated using ordinary least squares (OLS) regression.

Conjoint Model Results

The part-worth estimates relate the preference rating to the combinations of various attribute levels. Table 1 presents the OLS part-worth estimates for the soup/chowder base and stuffing ingredient products. The F statistics show that both models are significant at the 99 percent level of confidence, and the adjusted R^2s are 0.0945 and 0.1252 for the soup/chowder base and stuffing products, respectively (table 1). The primary cause for the somewhat low R^2s is that aggregating responses across individuals introduces additional variation due to differences in each respondents' subjective rating for the same product.

A t-test is used to test the null hypothesis that the part-worth estimate for each attribute level is equal to zero. The part-worth utilities for 30% and 70% price and dehydrated and fresh forms are statistically significant at the 1% level for the soup base product. Similarly, part-worth utilities are significant for the 30% and 70% price and the dehydrated, frozen, and fresh forms at the 1% level for the stuffing ingredient.

The relative effect of each attribute level on the respondent's preference rating can be determined by comparing the part-worth utilities. For both products, the lowest price has a positive effect on buyer preferences, whereas the highest price has a negative effect. This result is consistent with economic theory. The fresh and frozen forms have positive effects and the dehydrated bouillon form has a negative effect for both products. The highest contribution to customer preferences comes from a fresh product with a part-worth utility of 1.06 for the base product. A dehydrated product had a negative effect of -1.29 on the buyer's preference for the soup base product. The results for the stuffing ingredient are similar to that of the soup base product with part-worth utilities of 1.05 for a fresh product, and -1.53 for a dehydrated bouillon product.

These results indicate that the selected market has a relatively strong preference for a fresh (never frozen) crawfish minced meat product. This means that demand for the mince-based products

Table 1. OLS estimates of part-worth utilities for main effects of the soup/chowder base and seafood stuffing ingredients derived from southern crawfish, 1997

VARIABLE	BASE				STUFFING			
	Part-worth Estimate	Standard Error	T statistic[1]		Part-worth Estimate	Standard Error	T statistic	
Grand Mean	5.349	0.102	52.66	***	5.336	0.099	54.03	***
30% Price	0.413	0.144	2.88	***	0.341	0.139	2.44	***
50% Price	-0.003	0.144	-0.02		0.135	0.139	0.96	
70% Price	-0.410	0.144	-2.85	***	-0.476	0.139	-3.41	***
Fresh Form	1.055	0.144	7.34	***	1.053	0.139	7.54	***
Frozen Form	0.33	0.144	1.63		0.471	0.139	3.37	***
Dehydrated Form	-1.288	0.144	-8.96	***	-1.525	0.139	-10.91	***
Mild Flavor	-0.016	0.102	0.16		0.119	0.099	1.20	
Concentrated Flavor	0.016	0.102	-0.16		-0.119	0.099	-1.20	
R^2	0.099				0.129			

[1] T-statistic for mean deviation indicates whether the variables are significantly different from the grand mean. *** Implies significance at the 1% level, ** implies significance at the 5% level, and * implies significance at the 10% level. N = 155.

may be seasonal, since fresh crawfish is in supply only during the spring and early summer months. However, although the fresh product was the most preferred form, the frozen product's effect is significant and positive for the stuffing product. Moreover, there was only a slight difference between the market's preference for the fresh and frozen forms given the same levels for price and flavor. For instance, the estimated utility for a fresh stuffing product with combination of 30% price and concentrated flavor was 6.85, whereas, a frozen product with the same combination of price and flavor was 6.27 (table 1). This suggests that a frozen product may be acceptable to a small segment of the overall market.

Although flavor was not significant, concentrated flavor has a positive effect and mild flavor a negative effect for the base product. On the other hand, for the stuffing product, mild flavor has a positive effect and concentrated flavor a negative effect. The difference in preference for the flavor attribute can be explained by the different uses for these two ingredients. A base is expected to be used as a flavorant. The finding that crawfish soup base with concentrated flavor is preferred is consistent with this expectation. On the other hand, a stuffing ingredient is expected to be mixed with other ingredients as a filling. The finding that a stuffing product with mild flavor is preferred indicates that users do not want a filler that masks other flavors in the product.

Measure of the Relative Importance of Product Attributes

Part-worth utility values also can be used to compute the relative importance of the product attributes. The relative importance weights are calculated in a manner described by Halbrendt, et al. (1990). First, the highest and the lowest part-worth utilities are determined for each attribute. The difference between the highest and lowest part-worth values establishes the utility range for the attribute. Once a range for each attribute has been determined, the relative importance of the ith attribute is calculated as follows: RI_i = [Utility $Range_i$ /Σ Utility Ranges for all Attributes] X 100, where RI_i is the relative importance measure for the ith attribute. The relative importance of each attribute is presented in table 2.

Table 2. Relative importance of the selected attributes for the soup/chowder base and seafood stuffing ingredients derived from southern crawfish, 1997

Attribute	Soup/Chowder Base	Seafood Stuffing Ingredient
Product Form	73%	70%
Product Price	26%	23%
Flavor Concentrate	1%	7%

The most important attribute is product form, contributing over 70% to the preference rating for a soup/chowder base product. Following form, price is the second most important attribute, accounting for 26% of the preference rating. Similarly, for the seafood stuffing product, form is most important, contributing 70% to the preference rating, and price is the second most important, with a contribution of 23%. On the other hand, flavor in both cases is the least important attribute. For the stuffing ingredient, flavor has a 7% contribution to the preference rating, whereas for the soup/chowder base, the contribution is negligible.

These results imply that form is the most important characteristic in developing minced meat products from undersized crawfish. This is not a surprising result given that these products are entirely unknown to the buyer. This result also demonstrates the importance of developing minced meat products that maintain the quality associated with fresh crawfish tailmeat. It should be noted that, even though price is secondary, it is still a significant factor. The potential buyer's preference for a discounted price creates challenges for food scientists and/or industry to develop these products that can be marketed below current prices for crawfish tailmeat.

Calculation of Total Utility

Since interaction effects were found to be insignificant in the sample, the additive decision model was used to find the market's overall utility for specific product profiles. This allows for a ranking of the 18 products tested by conjoint analysis. The total utility for each profile is calculated using the OLS part-worth estimates. The following formula is used:

$$U_{ijk} = G + \Sigma PW_{ijk}$$

where U_{ijk} is the total utility for the product profile defined by the attribute combination given by levels ijk, G is the overall mean preference rating given by the OLS intercept (α_0), and ΣPW_{ijk} is the summation of all part-worth utilities associated with the product profile defined by levels, ijk. The market's utility values for the soup/chowder base and seafood stuffing products are presented in table 3.

Table 3. Customer utility values for the soup/chowder base and seafood stuffing ingredients, 1997

Product Specifications	BASE		STUFFING	
	Estimated Utility[1]	Rank	Estimated Utility	Rank
30% price, fresh form, concentrated flavor	6.83	1	6.85	8
30% price, fresh form, mild flavor	6.80	2	6.64	2
50% price, fresh form, concentrated flavor	6.42	3	6.61	3
50% price, fresh form, mild flavor	6.38	4	6.41	1
30% price, frozen form, concentrated flavor	6.01	5	6.27	11
70% price, fresh form, concentrated flavor	6.01	6	6.06	4
30% price, frozen form, mild flavor	5.98	7	6.03	6
70% price, fresh form, mild flavor	5.98	8	6.03	9
50% price, frozen form, concentrated flavor	5.60	9	5.82	5
50% price, frozen form, mild flavor	5.56	10	5.79	7
70% price, frozen form, concentrated flavor	5.19	11	5.45	13
70% price, frozen form, mild flavor	5.16	12	5.21	10
30% price, dehydrated form, concentrated flavor	4.49	13	4.27	15
30% price, dehydrated form, mild flavor	4.46	14	4.06	17
50% price, dehydrated form, concentrated flavor	4.07	15	4.03	14
50% price, dehydrated form, mild flavor	4.04	16	3.83	12
70% price, dehydrated form, concentrated flavor	3.66	17	3.45	18
70% price, dehydrated form, mild flavor	3.64	18	3.22	16

[1] Highest utility is assigned ranking 1, lowest utility is assigned ranking 18.

These values show that the most preferred product for the soup/chowder base product is a fresh product, with a price discounted 30% from crawfish tail meat, and with a concentrated crawfish flavor. The lowest utility is assigned to the 70% price in combination with a dehydrated bouillon product and a mild flavor. Similarly, the most and the least preferred stuffing products have the same form and price characteristics as for the base product; however, they differ in flavor characteristics. The most preferred seafood stuffing product has a mild flavor, whereas the least preferred product has a concentrated flavor.

Descriptive Survey Results

Demographic information for the sample of seafood restaurants is presented in table 4. The distribution of these restaurants across the states show 48% of the restaurants are located in Louisiana, 17% are in Mississippi, 20% are in Alabama, and 15% are in Texas. About 60% of these restaurants have 10 to 50 employees. In terms of annual sales, the highest percentage (36%) corresponds to restaurants with annual sales of $500,000 to $1 million. The remaining restaurants have higher and lower sales and employee numbers respectively, indicating that the most likely market will

Table 4. Distribution of target customers (seafood restaurants) according to their demographic characteristics, 1997

Employee number	%	Annual sales	%	Location	%
1 to 4	7	<$500,000	29	Louisiana	48
5 to 9	10	$500,000-$1 Million	36	Mississippi	17
10 to 19	28	$1 Million-$2.5 Million	22	Alabama	20
20 to 49	36	$2.5 Million-$5 Million	5	Texas	15
50 to 99	9	$5 Million-$10 Million	5		
100 to 249	5	$10 Million-$20 Million	1		
>250	3	>$20 Million	0		
NR[a]	2	NR	2		

[a] NR indicates that a respondent did not answer the question.

consist of restaurants with annual sales within the range of $500,000-$2.5 million and employee numbers within the range of 10-50.

The distribution of the responses to the question regarding the respondents' current use of selected seafood ingredients (see appendix 3, question 2) is presented in table 5. The most commonly used ingredients are processed shrimp, crab meat, and crawfish tails. Processed shrimp is the most common ingredient, which is used by 80.6% of the sample. Crabmeat is the second most common ingredient, which is used by 68.4% of the respondents. Although crawfish is the least common ingredient, 40% of the restaurants use whole crawfish and about 58% use crawfish tail meat.

Table 5. Current use of crawfish, shrimp, and crab products by restaurants in the Gulf-South region of the United States ,1997

	USE OF SELECTED SEAFOODS					
	Crawfish		Shrimp		Crab	
	Count	%	Count	%	Count	%
Whole	62	40	112	72.3	46	29
Processed Meat	90	58.1	125	80.6	106	68.4
			N=155			

A cross tabulation of the amounts of base and stuffing ingredients used by the respondents according to their use of crawfish, shrimp, and crab products is presented in table 6. Crab is the most widely used stuffing ingredient since 72.6% of the 101 respondents using crab in their restaurants also use crab as a stuffing ingredient. A little more than 12% of the respondents use greater than 300 pounds of crab stuffing per month. Shrimp stuffing is used by 39.8% of the respondents, and crawfish stuffing is used by 31.7% of the respondents. With the exception of crawfish stuffing, most of the restaurants use greater than 50 pounds of the selected seafood ingredients per month. Although

Table 6. Current use of selected base and stuffing ingredients for restaurants in the Gulf-South region of the United States ,1997

	CRAWFISH INGREDIENTS			
	BASE		STUFFING	
	Count	%	Count	%
None	72	71.3	63	62.4
<50lbs	15	14.9	17	16.8
50-150lbs	4	4.0	11	10.9
150-300lbs	0	0	1	1.0
>300lbs	3	3.0	3	3.0
NR[a]	7	6.9	6	5.9
	n= 101		n=101	

	SHRIMP INGREDIENTS			
	BASE		STUFFING	
	Count	%	Count	%
None	93	61.6	80	53
<50lbs	38	25.2	25	16.6
50-150lbs	5	3.3	16	10.6
150-300lbs	4	2.6	5	3.3
>300lbs	1	0.7	14	9.3
NR	10	6.6	11	7.3
	n= 151		n=151	

	CRAB INGREDIENTS			
	BASE		STUFFING	
	Count	%	Count	%
None	74	66.1	25	22.3
<50lbs	27	24.1	34	30.6
50-150lbs	4	3.6	27	24.1
150-300lbs	0	0	6	5.4
>300lbs	0	0	14	12.5
NR	7	7	6	5.4
	n= 112		n=112	

N=155

[a] NR indicates that a respondent did not answer the question

N = the total number of usable questionnaires.

n is less than N because of cross tabulation.

not as common as shrimp and crab stuffing, 85.1% of the respondents use less than 50 pounds of crawfish stuffing per month. Other results show an even more limited use of base products relative to stuffing. For example, only 21.9%, 31.8%, and 27.7% of the respondents use crawfish, shrimp, or crab bases, respectively. Of those that use some of these base ingredients, 86.2%, 86.8%,and 90.2% of the restaurants use less than 50 pounds per month, respectively. In summary, only a relatively small percentage of the respondents use either crawfish base or stuffing products, and of those that use these products, the majority use less than 50 pounds per month. This suggests that the restaurant market for these products may be a somewhat small niche.

A cross tabulation of all respondents that use the selected base and stuffing ingredients by their response to the question of whether they make or buy a base and stuffing ingredient (see appendix 3, question 3) is presented in table 7. Most of the respondents using the selected seafood bases buy these products from a supplier. For instance, 68.2%, of the respondents who use crawfish base purchase it from an outside supplier. However, most of the respondents using the selected seafood stuffings make these products in their restaurants. For example, 87.5% of the respondents who use crawfish stuffing, make the stuffing in their restaurant. This result indicates that the restaurant market for ready-made crawfish bases (though somewhat small) may already be developed, whereas, the market for ready-made crawfish stuffings may be underdeveloped.

The distribution of responses to the question regarding the respondents' interest in buying the new minced meat product (see appendix 3, question 9) is presented in table 8. The majority of the respondents indicated that they would be willing to buy the minced crawfish products given the characteristics described in the conjoint analysis. That is, 72.3% of the respondents who carry crawfish products would be willing to buy the crawfish mince meat if it were available with the preferred combination of product attributes. Moreover, 61.9% and 71.4% of the respondents carrying shrimp and crab products indicated an interest in buying the new products, respectively. This suggests that a potential market for products of this type may exist. However, the market appears to be somewhat small.

Table 7. Procurement practices of selected base and stuffing ingredients for restaurants in the Gulf-South region of the United States, 1997

	USERS OF CRAWFISH INGREDIENTS			
	BASE		STUFFING	
	Count	%	Count	%
Buy	15	13.6	4	12.5
Make	3	68.2	28	87.5
NR[a]	4	18.2	0	0
	n= 22		n=32	

	USERS OF SHRIMP INGREDIENTS			
	BASE		STUFFING	
	Count	%	Count	%
Buy	36	75.0	8	13.3
Make	8	16.7	50	83.3
NR	4	8.3	2	3.3
	n= 48		n= 60	

	USERS OF CRAB INGREDIENTS			
	BASE		STUFFING	
	Count	%	Count	%
Buy	22	71.0	15	18.5
Make	5	16.1	53	65.4
NR	4	12.9	13	16.0
	n=31		n= 81	

N= 155

[a] NR indicates that a respondent did not answer the question.

N = the total number of usable questionnaires.

n is less than N because of cross tabulation.

Table 8. Willingness to purchase new base and stuffing products derived from Louisiana's undersized crawfish by restaurants in the Gulf-South region of the United States, 1997

CRAWFISH INGREDIENTS	Count	%
Yes, I would buy the new products	73	72.3
No, I would not buy the new products	24	23.8
NR[a]	4	4.0
		n= 101

SHRIMP INGREDIENTS	Count	%
Yes, I would buy the new products	93	61.6
No, I would not buy the new products	54	35.8
NR	4	2.6
		n= 151

CRAB INGREDIENTS	Count	%
Yes, I would buy the new products	80	71.4
No, I would not buy the new products	28	25.0
NR	4	3.6
		n= 112

N= 155

[a] NR indicates that a respondent did not answer the question.

N = the total number of usable questionnaires.

n is less than N because of cross tabulation.

Summary and Conclusions

The overall objective of this study was to investigate the market potential for minced meat products derived from undersized crawfish. Specific objectives were to: (i) identify potential markets for crawfish mince-based products, and the product attributes needed for the products' acceptance in these markets, and (ii) estimate the buyer's preferences for new minced meat food products derived from undersize crawfish.

Focus group discussions indicated that a potential market for the crawfish mince meat is seafood restaurants where the mince could be utilized as ingredients for various menu items. Among the most promising were use as a crawfish soup/chowder base. Moreover, for crawfish tail mince, a good use was determined to be as a stuffing ingredient for various recipes such as bisques, boudin, and sausage (where currently chopped crawfish are used). The relevant attributes for these products were determined to be the product's price, form, and flavor.

Conjoint analysis showed that the strongest attribute effects for both products were associated with the product's form, with the highest preferences being a fresh, never frozen product. On the other hand, the least preferred form was a dehydrated bouillon product. Thus, the dehydrated form was the least preferred product characteristic for both the base and stuffing products. The most preferred product for the soup/chowder base was a combination of a fresh product with a price discounted 30% from crawfish tailmeat and a concentrated crawfish flavor. Similarly, the most preferred crawfish stuffing product was associated with a fresh form and a price discounted 30% from crawfish tailmeat. However, the stuffing product differed from the base product in that a mild crawfish favor was preferred.

The frozen product form was significant for only the seafood stuffing product. However, in both instances, the part-worth utility for frozen form was positive and only slightly different for the fresh product forms. This suggests that even though the potential market has a relatively strong preference for a fresh

(never frozen) product, a frozen product may be acceptable if it retains most of the quality characteristics attributable to a fresh product. Further research is needed to identify the market segment most interested in the frozen product and to isolate those quality characteristics most preferred by this group of customers. A better understanding of how prospective customers perceive fresh-quality and frozen-quality attributes will provide food scientists with valuable information for developing technology to produce frozen minced-based products.

Another important finding of this study is the market's desire for base and stuffing products that are priced well below the price of crawfish tail meat. The profitability of these new products depends upon whether they can be produced economically. Thus, further research is needed to determine the costs of processing these products.

In addition, restaurants responding to the survey reported a somewhat limited use of crawfish base and stuffing ingredients. Therefore, the market for these products may not be large enough to support large scale production of minced meat base and stuffing products. On the other hand, the limited use of these products may simply be a result of their absence in the marketplace. This is supported by the fact that the majority of the respondents expressed a willingness to purchase both types of products if they were available. Additional research is needed to determine whether these products can be produced commercially meeting government and industry requirements accompanied by a cost analysis to determine financial feasibility.

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Appendix 1: Experimental Design

Two basic procedures are used in conjoint analysis: the two-factor-at-a-time approach and the full profile approach. In the former approach, the factors (or attributes) are considered on a pairwise basis. In this procedure, the respondent is asked to rank various pairs of factor levels from the most preferred to the least preferred. Although the two-factor-at-a-time approach is simple to apply and reduces information overload on the part of the respondent, it lacks realism because the subject is not exposed to the total product.

The full-profile approach is more realistic because it utilizes the complete set of attributes. The major limitation of this approach is the possibility of information overload. In the full-profile approach, there are numerous ways for stimulus set construction. In simple experiments with a small number of attributes and levels, it is possible to use all product profiles, i.e., a full-factorial design. In this type of design, product profiles are constructed by generating all possible combinations using the various levels of the attributes, and the respondents rate (or rank) the complete set of hypothetical products. For example, an experiment with 3 attributes and 2 levels would have 8 product profiles for respondents to evaluate.

However, as the number of attributes and levels increase, the number of profiles increase and the full-factorial design becomes impractical since respondents can provide consistent answers for only a limited number of profiles. Fortunately, alternative experimental designs can be used to reduce the number of profiles. These include the fractional-factorial design, split-plot design, and the confounded-factorial design.

A commonly used method to reduce the number of treatments is the fractional-factorial design, where the profiles evaluated are a subset of the full-factorial design. Fractional-factorial designs are orthogonal, meaning that certain effects are estimated independently of one another. This type of design has the advantage that all main effects can be estimated, but only at the expense of

confounding attribute interactions (Green, 1974). The split-plot design also can be used to reduce the number of profiles. In this type of design, the total number of profiles (main plot) are split into smaller subgroups. Split-plot designs are advantageous if one is interested in estimating a subset of main and interaction effects, but information is lost on some of the main effects. This design is one in which certain main effects are hidden (or confounded) with some interaction effects, as contrasted with confounded-block designs, where the confounding is restricted to interactions (Cochran and Cox, 1957).

Like the fractional or split-plot design, a confounded-block design reduces the number of profiles a subject must evaluate, but unlike the split-plot design, it allows for estimation of all the main effects. Unlike the fractional-factorial design, it also allows for estimation of attribute interactions (Cochran and Cox, 1957). The presence of attribute interactions has implications regarding the functional form of the subject's preference function. If present, interaction effects imply that product attributes are not preferentially independent. Hence, an additive preference function is inappropriate for estimation of part-worth utilities. In most instances, it is impossible to know *a priori* if interactions exist. Therefore, it is preferable to test for the significance of attribute interactions.

In this study, there are two three-level attributes, and one two level attribute. A full profile approach would involve 18 (3X3X2) profiles for soup/chowder base product and an equal number for the stuffing product. Subjects would have difficulty in rating 18 product profiles using a mail survey. To cope with this problem, the number of treatments was reduced using a mixed (3X3X2) confounded-block design. This reduced the number of profiles a subject had to evaluate to six, and allowed all two-way and three-way interactions to be tested.

The design used in this study consists of 4 replications of 3 blocks of 6 product profiles (table A1). The block size is restricted to 6 to keep all main effects unconfounded with blocks. The main effects of each attribute are unconfounded because every block contains each level of the attribute the same number of times. Thus, if the price (P) attribute occurs at levels 30%, 50%, and 70%

Table A1. Experimental design (3X3X2 confounded-block design) used in the conjoint section of the mail survey, 1997

REP I			REP II			REP III			REP IV		
Ia[1] PFL[2]	Ib PFL	Ic PFL	IIa PFL	IIb PFL	IIc PFL	IIIa PFL	IIIb PFL	IIIc PFL	IVa PFL	IVb PFL	IVc PFL
100[3]	200	000	200	000	100	100	200	000	200	000	100
210	010	110	010	110	210	010	110	210	110	210	010
020	120	220	120	220	010	220	020	120	020	120	220
201	001	101	101	201	001	201	001	101	101	201	001
011	111	211	211	011	111	111	211	011	011	111	211
121	221	021	021	121	221	021	121	221	221	021	121

[1]a, b, and c represents the 3 blocks within the replications I, II, III, and IV.

[2]Attributes: P=Price, F=Form, and L=Flavor.

[3]Levels of P: 0= 30%, 1 = 50%, and 2= 70% of the market crawfish tail meat price,
Levels of F: 0= fresh, 1=frozen, and 2=dehydrated, semi-bouillon cube form,
Levels of L: 0=mild flavor, 1=concentrated flavor.

(denoted by 0,1, and 2 in table 1), it is unconfounded if every block contains an equal number of 0s, 1s, and 2s for that attribute. That is, every block contains two sets of profiles that contain every level of P. For example, the first three and last three profiles in block Ia contains the three levels of P (table A1).

Similarly, the main effects of F and L are also unconfounded because each level (also denoted by 0,1, and 2) for form (F) appears twice in each block, and each level (denoted by 0 and 1) for flavor (L) appears three times in each block. The P/L and F/L interactions are also kept unconfounded because every possible combination of the levels of attribute P and F with the levels of L can appear once in every block. However, since it was not possible to place all 9 combinations for the interactions of P/F (3 X 3) nor all 18 combinations of the interactions of P/F/L (3X3X2) in every block, they were partially confounded. The relative information on P/F will be reduced by 1/8, and that on P/F/L will be reduced by 3/8. Although there is some information loss with this design, it is possible to test the significance of the interaction effects.

APPENDIX 2: QUESTIONNAIRE

A survey of the market potential for new crawfish food products

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Purpose of the Questionnaire

The purpose of this questionnaire is to determine the usefulness of a new crawfish product for use as a base or ingredient for stuffing. The questionnaire begins with several general questions about your current usage of shrimp, crab, and crawfish products. The latter part of the questionnaire is intended to determine the potential marketability of the new crawfish product.

1. Please indicate whether you currently use the following ingredients for any of your menu items *(Circle appropriate answers).*

1. Whole crawfish	4. Whole shrimp	7. Whole crab
2. Crawfish tails	5. Shrimp tails (peeled shrimp)	8. Crab meat
3. Crawfish base	6. Shrimp base	9. Crab base

2. Please select the category that most closely reflects your average monthly use of the following seafood ingredients ***(Circle appropriate answers).***

CRAWFISH BASE	CRAWFISH STUFFING
1. None	1. None
2. Less than 50 lbs per month	2. Less than 50 lbs per month
3. 50 to 150 lbs per month	3. 50 to 150 lbs per month
4. 150 to 300 lbs per month	4. 150 to 300 lbs per month
5. Greater than 300 lbs per month	5. Greater than 300 lbs per month

SHRIMP BASE	SHRIMP STUFFING
1. None	1. None
2. Less than 50 lbs per month	2. Less than 50 lbs per month
3. 50 to 150 lbs per month	3. 50 to 150 lbs per month
4. 150 to 300 lbs per month	4. 150 to 300 lbs per month
5. Greater than 300 lbs per month	5. Greater than 300 lbs per month

CRAB BASE	CRAB STUFFING
1. None	1. None
2. Less than 50 lbs per month	2. Less than 50 lbs per month
3. 50 to 150 lbs per month	3. 50 to 150 lbs per month
4. 150 to 300 lbs per month	4. 150 to 300 lbs per month
5. Greater than 300 lbs per month	5. Greater than 300 lbs per month

3. Please indicate whether you currently make or purchase your bases or stuffings ***(Circle appropriate answers).***

BASE	STUFFING
1. We make our own base	1. We make our own stuffing
2. We buy all our bases	2. We buy our stuffing
3. Other (please specify)_____	3. Other (please specify)_____

Recall this new minced meat product is extracted from fresh whole crawfish. The result is a high quality and low cost raw material that can be used as a base or as an ingredient for stuffings in various menu items.

4. Please rank the following product characteristics in terms of their relative importance to you assuming you were going to use this product **as a base** for some of your menu items ***(1=least important, 5=most important).***

   _____Flavor
   _____Form (E.g. fresh form, frozen form, dehydrated form)
   _____Texture (E.g. ground meat, puree)
   _____Seasonings (E.g. with seasonings, without seasonings)
   _____Purchase Price

5. Please review the six boxes shown below. Each box contains information about product features for using the new minced meat as a **BASE**. ***Please rate each box using a scale from "0" to "10", where: 0 = Least preferred combination of product features, 10 = Most preferred combination of product features.***

Price: 50% of the current market price for tail meat **Form:** Fresh (never been frozen) **Flavor:** Mild crawfish flavor RATING_____	**Price:** 50% of the current market price for tail meat **Form:** Dehydrated (semi-moist bouillon form) **Flavor:** Concentrated crawfish flavor (high crawfish fat content) RATING_____
Price: 70% of the current market price for tail meat **Form:** Fresh (never been frozen) **Flavor:** Concentrated crawfish flavor (high crawfish fat content) RATING_____	**Price:** 50% of the current market price for tail meat **Form:** Fresh (never been frozen) **Flavor:** Mild crawfish flavor RATING_____
Price: 30% of the current market price for tail meat **Form:** Frozen **Flavor:** Concentrated crawfish flavor (high crawfish fat content) RATING_____	**Price:** 70% of the current market price for tail meat **Form:** Frozen **Flavor:** Mild crawfish flavor RATING_____

6. Would your preference change, if you were to use this mince as an **ingredient for stuffings**? ***(Circle appropriate answer)***

    1. Yes (Please Continue with Question 7)
    2. No (Please Continue with Question 9)

7. Please rank the following product characteristics in terms of their relative importance to you assuming you were going to use this product **as a stuffing ingredient** for some of your menu items ***(1=least important, 5=most important)***.

    _____Flavor
    _____Form (e.g. fresh form, frozen form, dehydrated form)
    _____Texture (e.g. ground meat, puree)
    _____Seasonings (e.g. with Seasonings, without Seasonings)
    _____Purchase Price

8. Please review the six boxes shown below. Each box contains information about product features for using the new minced meat as a **STUFFING INGREDIENT**. ***Please give your preference rating using a scale from "0" to "10", where: 0 = Least preferred combination of product features, 10 = Most preferred combination of product features.***

Price: 70% of the current market price for tail meat **Form:** Dehydrated (semi-moist bouillon form) **Flavor:** Concentrated crawfish flavor (high crawfish fat content) RATING_____	**Price:** 50% of the current market price for tail meat **Form:** Fresh (never been frozen) **Flavor:** Mild crawfish flavor RATING_____
Price: 70% of the current market price for tail meat **Form:** Frozen **Flavor:** Mild crawfish flavor RATING_____	**Price:** 70% of the current market price for tail meat **Form:** Fresh (never been frozen) **Flavor:** Concentrated crawfish flavor (high crawfish fat content) RATING_____
Price: 30% of the current market price for tail meat **Form:** Frozen **Flavor:** Concentrated crawfish flavor (high crawfish fat content) RATING_____	**Price:** 30% of the current market price for tail meat **Form:** Dehydrated (semi-moist bouillon form) **Flavor:** Mild crawfish flavor RATING_____

9. Would you be interested in purchasing a minced-meat crawfish product if it were available to you with the characteristics you described in the previous question ***(Circle appropriate answer).***

    1. No
    2. Yes

10. Please indicate what percentage (%) of your total seafood purchases are bought from the following suppliers.

    _____ % The Docks or Fishermen
    _____ % Seafood Wholesalers or Distributors
    _____ % Food Brokers
    _____ % Seafood Processors
    _____ % Importers
    _____ % Other (please Specify)

11. Please indicate the interval that most closely defines the number of employees your business has ***(Circle appropriate answer).***

    1. 1-4
    2. 5-9
    3. 10-19
    4. 20-49
    5. 50-99
    6. 100-249
    7. More than 250

12. Please indicate the interval that most closely defines your average annual sales ***(Circle appropriate answer).***

    1. Less than $500,000
    2. $500,000-$1 Million
    3. $1 Million - $2.5 Million
    4. $2.5 Million - $5 Million
    5. $5 Million - $10 Million
    6. $10 Million - $20 Million
    7. More than $20 Million

Are there any additional comments you would like to make regarding this study? If so, please use this space for this purpose.

Your contribution to this effort is very greatly appreciated.

APPENDIX 3: TESTS FOR INTERACTION EFFECTS

The validity of interaction effects are tested using analysis of variance (ANOVA). ANOVA is a statistical technique that tests the influence of certain variables (factors) on a dependent variable through analyzing the sample variance and estimating the means for the factors. This technique allows for handling two or more independent variables simultaneously and does not place any restrictions on the number of means. With ANOVA, both the main and interaction effects of factors can be tested and estimated. The ANOVA model is:

$$R_{ijkn} = G + P_i + F_j + L_k + (PF)_{ij} + (PL)_{ik} + (FL)_{jk} + (PFL)_{ijk} + B_s + T_r + e_{ijkl}$$

where,

R_{ijkn} = the nth respondent's rating for the ijkth combination of attribute levels for the soup/chowder base and the stuffing product;
G = the overall response mean;
P_i = the ith price treatment effect (i = 30%, 50%, and 70% of the crawfish tail meat price);
F_j = the jth form treatment main effect (j = fresh, frozen, and dehydrated form);
L_k = the kth flavor treatment main effect (k = mild or con centrated crawfish flavor);
$(PF)_{ij}$ = the ijth two-way price-form treatment interaction effect;
$(PL)_{ik}$ = the ikth two-way price-flavor treatment interaction effect;
$(FL)_{jk}$ = the jkth two-way form-flavor treatment interaction effect;
$(PFL)_{ijk}$ = the ijkth three-way price-form-flavor treatment inte action effect;
B_s = the sth block effect (s=1,2,3);
T_r = the rth replication effect (r=1,2,3,4);
e_{ijkn} = error associated with the ijkth combination of the product for the nth respondent.

Although there were 155 questionnaires with complete conjoint responses, the confounded design requires a common number of observations for the 12 groups to test for attribute interactions. Eight questionnaires was the largest common number of responses within each of the 12 groups. Therefore, 96 questionnaires were used to test for interaction effects. The null hypothesis for ANOVA is that the within-treatment response means for each source of variation are equal. Rejection of the null hypothesis for a particular source of variation implies that the treatment effect is significant. The possible sources of variation in the preference ratings are the product attributes, i.e., main effects for price (P), form (F), and flavor (L), and interaction effects price/form (PF), price/flavor (PL), form/flavor (FL), and price/form/flavor (PFL). In addition to the attribute effects, other possible sources are the design requirements, i.e., replications (rep I, rep II, rep III, rep IV) and blocks within replications (Ia, Ib, Ic). The ANOVA model assumes that the error term (e_{ijk}) is normally distributed with a zero expected value and a constant variance (i.e., homoscedastic). White's test (Kmenta, 1986) was used to test for the presence of heteroscedastic errors. The test failed to reject the null hypothesis of homoscedastic errors at the 99 percent level of confidence. Therefore, no attempt was made to correct for heteroscedasticity.

Results of Interaction Tests

Table A2 presents the ANOVA results for both the soup/chowder base and the stuffing product. The main effects for both product form and price are significant at the 1% and 5% levels for the base and stuffing products, respectively. However, there is no statistical difference between the preference ratings assigned for the levels of the flavor attribute for either of the two products. The interaction effects were insignificant for both base and stuffing products. Also, the replication and blocks within replication effects were insignificant for both base and stuffing products. Insignificance of replications and blocks within replication effects implies that these are not significant sources of variation.

The ANOVA results imply that main effects for product form and price significantly affects the restaurant buyer's preference for the base and stuffing products. However, different levels of

flavor do not change the preference ratings. Moreover, the insignificance of the interaction effects implies that respondents perceive the attributes independently for both types of products. This result implies that the respondents evaluate product attributes independently from one another. Therefore, an additive preference model can be used to estimate the respondent's part-worth utilities. This result lends evidence to support the assumption that most conjoint studies make about the insignificance of attributes interactions. However, one should be cautious about generalizing this result to other studies and other attributes not yet tested. Since interactions were found to be insignificant, an additive preference model was assumed for the analysis.

Table A3. ANOVA results for the soup/chowder base and for the seafood stuffing ingredients derived from southern crawfish, 1997

		BASE			STUFFING		
Source	DF	SS	MS	F-value[1]	SS	MS	F-value
Replications	31	47.65	1.54	0.14	74.15	2.39	0.24
Blocks Within Repl.	64	395.00	6.17	0.56	486.44	7.60	0.75
Main Effect Price (P)	2	69.57	34.79	3.15 **	73.40	36.70	3.63 **
Main Effect Form (F)	2	482.29	241.15	21.86 ***	734.18	367.09	36.32 ***
Main Effect Flavor (L)	1	22.56	22.56	2.05	0.03	0.03	0.003
PF Interaction	4	4.11	1.03	0.09	36.21	9.05	0.90
PL Interaction	2	38.64	19.32	1.75	33.30	16.65	1.65
FL Interaction	2	12.67	6.33	0.57	15.85	7.92	0.78
PFL Interaction	4	70.55	17.64	1.60	21.26	5.32	0.53
Error	463	5107.40	11.03		4679.02	10.11	
Total	575	6250.44	10.87	0.98	6153.83	10.70	1.06

[1] *** implies significance at the 1% level, ** implies significance at the 5% level.

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