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Comparing Kentucky-grown Freshwater Prawn with Marine Shrimp: Results of a Taste Test

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ABSTRACT

A blind taste test was conducted for three boiled seafood products among 112 participants at Kentucky State University. The products were previously frozen freshwater prawn tails (Product A), previously frozen marine shrimp tails (Product B), and fresh prawn tails (Product C). After tasting, participants were surveyed in order to elicit their preferences for different product attributes, their rating of the overall acceptability of products, and their willingness to purchase the products.

The data were statistically analyzed and the following are included in the main results: (1) participants rated the appearance of prawn higher than the appearance of marine shrimp, (2) participants exhibited a higher probability of purchasing frozen prawn than frozen marine shrimp, (3) older respondents gave higher-than-average ratings to the appearance and odor of fresh prawn and flavor of marine shrimp, and (4) males were more inclined to purchase fresh prawn than were females.

INTRODUCTION

Freshwater prawn (*Macrobrachium rosenbergii*) is a relatively new aquaculture crop in Kentucky and neighboring states. Currently, Kentucky and Tennessee have an excess of 40 and 80 water hectares in prawn production, respectively. Dasgupta and Tidwell (2003) showed that small-scale freshwater prawn (hereafter denoted only as prawn) farming offers a good income potential; however, their results indicate that average breakeven prices ranged from $8.60/kg to $17.28/kg (year 2000 dollars), depending upon stocking density, feeding rate, and pond management technology. Such high breakeven prices make marketing prawn challenging, particularly when the average wholesale price of Gulf of Mexico shrimp was $4.93/kg for 2001 (Dasgupta and Tidwell 2003).

In wholesale marketing, U.S. prawn has to compete with marine shrimp and imported prawn, and the resulting low prices are not attractive to small-scale producers. The last 5 years of production and marketing of prawn in Kentucky have shown that the only profitable marketing channels are either direct sales to consumers or sales to white tablecloth restaurants. In order to ensure long-term survival of these markets and to allow opening of new markets, it is important for industry specialists to understand consumer perceptions of prawn.

Dillard et al. (1986) conducted some preliminary studies investigating consumer acceptance of prawn in Mississippi restaurants. They found that 77 % of consumers (sample size: 852) rated prawn similar to marine shrimp. Eighty-eight percent of consumers indicated that they would be repeat customers for prawn if it were available in restaurants. Recently, Woods (1999) did a market development study for prawn in Kentucky and Ohio. Consumer surveys, based on taste testing of prawn, were conducted in three cities to elicit consumer preferences for different attributes of prawn (sample size: 122). Of many attributes, taste and freshness were considered to be most important. Kentucky consumers indicated strong preference for a "grown in Kentucky" label, but this was not important to out-of-state consumers. A focus group study (78 observations) was also conducted to compare frozen prawn versus marine shrimp. The cooked products were randomly given to individual tasters, who completed a questionnaire after tasting the products. The results indicated that proportionately more consumers believed that marine shrimp have firmer flesh and stronger "shrimp-like" flavor than freshwater prawn.

This paper reports the results of a taste test of Kentucky grown prawn and marine shrimp conducted among 112 subjects at Kentucky State University. The test was performed to evaluate similarities and differences in consumer perception of prawn and marine

Table 1. Summary statistics (mean ± SD) for different product attributes and demographics for prawn and marine shrimp taste test (N = 112). Means within each row followed by different letters are significantly different ($P \leq 0.05$).

Attribute	Product		
	Previously frozen prawn (A)	Previously frozen marine shrimp (B)	Fresh prawn (C)
Appearance[1]	7.79 (±1.13) a[2]	6.89 (± 1.85) b[2]	7.50 (±1.47) a[2]
Odor[1]	6.59 (±1.98)	6.04 (± 2.29)	6.50 (±1.76)
Texture[1]	7.30 (±1.46)	7.16 (±1.59)	7.31 (±1.49)
Flavor[1]	7.32 (±1.52)	6.98 (±2.09)	7.01 (±1.90)
Overall acceptance[1]	7.47 (±1.37)	7.17 (±1.87)	7.17 (±1.74)
Willingness to buy[3]	Yes: 74% a	Yes: 54% b	Yes: 645 ab
	Demographics[4]		
Gender	Male: 48%		
Age groups	Under 20s: 14%; 20s: 25%; 30s: 24%; 40s: 23%; 50+: 14%		
Smoking habit	Smoker: 21%		

[1] Answers on appearance, odor, texture, flavor and overall acceptance were rated on a 1 to 9 scale, where 1: dislike extremely and 9: like extremely.

[2] Average rating for appearance was significantly different for the three products (F-statistic = 10.327, p-value = 0.00); multiple comparison test indicated significant differences in average ratings between products A and B, and B and C; no significant differences in average ratings between products A and C. Average ratings of all other product attributes were not significant across the three products.

[3] The 'willingness to buy' table entry indicates the percentage of 112 respondents indicating that they were willing to purchase the product. Chi-square test statistic, comparing the equality of the proportion of respondents willing to purchase the three products (null hypothesis) = 10.255 ($P = 0.006$).

[4] Information on other socio-economic/demographic variables such as income, education, and race were unavailable in the survey data.

shrimp. This paper has two broad purposes: (1) investigating consumer perceptions of prawn and marine shrimp and (2) exploring the causality of consumer ratings of product attributes and willingness to purchase. It contributes to the pool of knowledge that assists marketers in identifying specific population niches that would demand freshwater prawn.

MATERIALS AND METHODS

A taste test was conducted among 112 randomly selected participants at Kentucky State University. Individuals were given three products: boiled prawn that was previously frozen (product A), boiled marine shrimp that was previously frozen (product B), boiled fresh prawn (product C). Care was taken to ensure that the three products were accessible to most consumers: products A and C were farmed-raised in Kentucky and product B (Key West pink shrimp, *Penaeus duorarum*) was purchased from a grocery store in Frankfort, Kentucky. Fresh marine shrimp was not included in this study because it was unavailable in the area. Tail sizes of frozen/fresh prawn and marine shrimp were kept very similar to reduce the effect of size on differential product perceptions of consumers. This taste test was blind, i.e., products were not identified to the participants prior to tasting, and the sequence in which the three products were offered to the tasters was randomly changed from individual to individual. After tasting each product, the participants rated the product and they were asked to rinse their mouth prior to tasting the next product. A survey was conducted in which respondents indicated their preference for products A, B, and C with respect to the following attributes: appearance, odor, texture, flavor, and overall acceptability (hereafter known as simply "Overall"), on a 1 to 9 scale, where 1 was dislike extremely, 5 was neither like nor dislike, and 9 was like extremely. Participants were also asked to indicate whether they would purchase each of the products, provided the price of the three products was similar. The survey ended with questions about the participant's gender, age, and smoking habits. Table 1 contains summary statistics for some of the survey questions.

We used various statistical analyses to investigate consumer preferences for the three products A, B, and C. Analysis of variance and multiple comparison tests were used to compare mean ratings of the three; principal component analysis (PCA) was performed on consumer ratings of product attributes to investigate correlations across different products and to identify new, meaningful underlying variables and causal mechanisms among product attribute ratings. PCA investigated if the consumer ratings for the product attributes represented independent attitudinal dimensions or did the ratings measure a select num-

ber of underlying attitude-based components. The methodology of PCA involved standardizing input variables (i.e., variables used in PCA) to have a zero mean and unit variance. The goal was to extract a few components, such that each component accounted for the dispersion of several input variables. Hence, each component would be a latent variable, containing information of several observable variables. As such, a useful component would be one that would explain at least a single unit of variance; otherwise, the component would explain less variance that a standardized input variable. The variance of a component is an eigenvalue of the correlation matrix associated with the data (Johnson 1998). Hence, we selected those principal components that would explain more than one unit of total variance, i.e., their associated eigenvalues were greater than 1.

We used Bartlett's test of sphericity and the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy to determine if the data were suitable for PCA analysis. The null hypothesis (H_o) for Bartlett's test indicates that the data came from a population in which the input variables were uncorrelated, i.e., acceptance of H_o would indicate that PCA was unsuitable on the data set. The KMO measure compares observed correlations to partial correlations among input variables, to investigate if the data were sufficiently correlated to make PCA meaningful. In general, if two input variables shared a common component, their partial correlations would be small and the value of the corresponding KMO measure would be close to 1. If the input variables were not measuring a common component, their partial correlation would be large and the corresponding KMO measure would be close to zero. Consequently, if the KMO index were near zero, that data would be unsuitable for PCA analysis.

We also investigated potential relations between respondent preferences and sample segments based on gender, age and smoking habits. Information on other demographic variables such as race, education, and income were unavailable for the analyses. The "smoking habits" question was included because it was felt that smoking would affect tasting. The methodology used here was consistent with Engle and Kouka (1995) and Kinnucan et al. (1993). Kinnucan et al. (1993) provided the following conceptual framework for their technique: "Perceptions are formed by abstracting observed product characteristics into a limited number of dimensions such as taste, nutritional value and cost. These perceptual dimensions form the basis for preference formation . . . preferences are in turn assumed to determine the specific products that a consumer considers in a choice situation" (p. 275). A structural model of evaluating causality of consumer decisions following this approach involved estimating the following functions: (1) relation between attribute rankings (e.g., appearance, odor, texture, and flavor) and socio-demographic characteristics of respondents and (2) the relation between purchasing decision and attribute ranking/demographics. Since specific details of such models are available in Engle and Kouka (1995), we chose not to reiterate their development. Instead, we exhibit the structural model by adopting it from Engle and Kouka (1995):

(1) Rank of product attribute$_i$ = f_i (Demographic parameters),
(2) Probability [Willingness to purchase$_i$ = 1] = g_i (Ranking of product attributes$_i$, Demographic parameters), for i = product A, B, C.

Here, f_i represents linear functions; equation (1) is estimated using ordinary least square regression, and g_i represents the logistic cumulative distribution function, i.e., equation (2) is estimated using logistic regression (Engle and Kouka 1995). Willingness to purchase the products was quantified by three dichotomous variables: Buy A, Buy B, and Buy C. The response variable Buy A is defined by: Buy A = 1 implies that the respondent is willing to purchase product A; Buy A = 0 otherwise. Buy B and Buy C are similarly defined.

RESULTS

Table 1 reports averages and standard deviations for the attribute ratings of the three products. Average ratings for product appearance were significantly different across the three products (F-statistic = 10.327, P = 0.00). Multiple comparison tests indicated that average appearance ratings were not significantly different between products A and C; however, average ratings were higher for prod-

Table 2. Correlation of the first three principal components (PC 1, 2 and 3) with attributes of products A, B, and C (i.e., component loadings) and the percentage of explained variance associated with PC1, PC2, and PC3. PC1 is highly correlated with attributes of product A and C, i.e., PC1 refers to consumer opinion of prawn. Similarly, PC2 is highly correlated with different attributes of product B, i.e., PC2 aggregates consumer attitude of different marine shrimp characteristics. PC3 represents a latent variable that contrasts attributes of products A and C. N = 112.

Variable	PC1	PC2	PC3
Appearance A	0.479	−0.232	0.121
Appearance B	0.342	0.375	0.016
Appearance C	0.590	−0.092	−0.016
Odor A	0.581	−0.202	0.246
Odor B	0.256	0.684	−0.054
Odor C	0.551	−0.080	−0.128
Texture A	0.688	−0.230	0.139
Texture B	0.286	0.648	0.118
Texture C	0.568	0.072	−0.187
Flavor A	0.737	−0.253	0.236
Flavor B	0.392	0.800	0.135
Flavor C	0.672	−0.013	−0.415
Overall A	0.730	−0.389	0.297
Overall B	0.373	0.816	0.153
Overall C	0.704	−0.008	−0.421
Purchase A	0.546	−0.440	0.330
Purchase B	0.146	0.844	0.122
Purchase C	0.614	−0.098	−0.422
Eigenvalues	5.292	3.634	2.318
Percentage of explained variance	29.402%	20.186%	12.878%

ucts A and C, respectively, when compared with product B. This suggests that respondents were able to differentiate the appearance of prawn tails from shrimp tails. Table 1 also shows that average ratings on other attributes (odor, texture, flavor, and overall acceptance) were not significantly different across the three products. Table 1 reports the percentage of respondents exhibiting a willingness to purchase the three products: a chi-squared test indicated that the respondents' willingness to purchase differed across the three product types (test statistic = 10.255, P = 0.006). Multiple comparisons indicated that a proportionately higher number of consumers showed a willingness to purchase product A over product B (test statistic = 9.360, P = 0.002); however, there were no significant differences in the willingness to buy products B and C (test statistic = 2.232, P = 0.135), and products A and C (test statistic = 0.021, P = 0.885).

Principal component analysis further explored underlying correlations in the data set. The components corresponding to the three largest eigenvalues, individually accounted for 29%, 20%, and 13% of the total variation, respectively (Johnson 1998). The remaining components each accounted for a miniscule portion of the total variance, and they were rejected from the results. The Bartlett's test of sphericity produced a Chi-squared test statistic of 1,292.933 (df = 153, P = 0.00). This indicated that the input variables were not from an uncorrelated population, i.e., the population correlation matrix was not an identity matrix. The KMO measure was 0.73, i.e., the degree of common variance among input variables was middling, i.e., the extracted components would account for a fair amount of variance of the input variables.

Table 2 indicates the component loadings associated with the first three components (PC1, PC2, and PC3). The variables that have high loadings in PC1 include Appearance C, Odor A, Odor C, Texture A, Texture C, Flavor A, Flavor C, Overall A, and Overall C. The variables that have high loadings for PC2 include Odor B, Texture B, Flavor B, and Overall B, Purchase B. Clearly, PC1 is strongly correlated to many attributes of products A and C, i.e., PC1 is a latent variable that represents aggregate characteristics of both fresh and previously frozen cooked prawn. PC2, which is orthogonal to PC1 (i.e., refers to a different dimension of consumer perception), incorpo-

rates attributes of marine shrimp. This reveals that the respondents were able to distinguish between freshwater prawn and marine shrimp as different products. In PC3, Flavor C, Purchase C, and Overall C are all strongly (albeit negatively) correlated to the component; Purchase A is positively correlated to PC3. An intuitive interpretation of PC3 is less obvious: it represents a latent variable that contrasts products A and C.

Product attribute ratings were regressed with respect to consumer characteristics to determine any potential linkages. Each product's attribute ratings were regressed with respect to gender, age, and smoking habit: other demographic information was unavailable. Only three attributes ratings were found to have significant causality with consumer characteristics: appearance and odor of C and flavor of B. The following results were obtained (t ratios appear below corresponding coefficient estimates):

$$\text{Appearance C} = \underset{9.174}{6.849} + \underset{0.452}{0.126}\text{Gender} + \underset{0.116}{0.039}\text{Smoker} + \underset{2.221}{0.634}\,(\text{Age} \geq 30) + \text{residual}$$

$$\text{Odor C} = \underset{6.615}{5.869} + \underset{0.627}{0.210}\text{Gender} - \underset{-0.344}{0.139}\text{Smoker} + \underset{2.716}{0.933}\,(\text{Age} \geq 30) + \text{residual}$$

$$\text{Flavor B} = \underset{5.751}{6.045} - \underset{-1.066}{0.420}\text{Gender} - \underset{-1.190}{0.506}\text{Smoker} + \underset{2.303}{0.926}\,(\text{Age} \geq 30) + \text{residual}$$

R^2 for the above regressions were 4.6%, 6.8%, and 7.5%, respectively, which partially reflects the cross-sectional form of the dataset (R^2 in cross-sectional data regressions tend to be lower than in regressions using time-series data (Nakamura and Nakamura 1998)). Similar low fit is prevalent in other preference analyses where consumer preference ratings were regressed against socio-demographic characteristics, for example Dasgupta et al. (2000), Engle and Kouka (1995), and Foltz et al. (1999). The above results indicate that respondents 30 years or older tended to have higher ratings, on average, with respect to appearance and odor of fresh prawns (product C) and flavor of frozen marine shrimp (B), than younger respondents.

The final portion of the consumer perception model investigated potential linkages between consumer characteristics and preferences with respect to purchasing decisions. Table 3 reports the results of three Logit regressions with Buy A, Buy B, and Buy C as dependent variables. Goodness-of-fit is reported for each regression using the percentage of accurate predictions and likelihood ratio index (Greene 1990). Clearly, gender was the only consumer characteristic that directly affected purchasing decisions: males were more inclined to buy product C than females. Other results indicated that a high rating on odor and flavor of product A tended to improve its likelihood to be purchased. The flavor rating tended to have similar effects on the purchasing probability of the corresponding product. In addition, Table 3 shows that a high odor rating for products A and B, respectively, decreased and increased the purchasing likelihood for product B. A poor rating on the appearance of A and the texture of B was related to a high probability of purchasing C. Interestingly, a high rating on the flavor of product B was associated with a high probability of purchasing product C.

Apart from outlining the obvious (i.e., flavor was important in making purchasing decisions), the Logit regression results suggested that product freshness was valued by a segment of the respondents: individuals with low ratings on attributes of frozen prawn and shrimp preferred to purchase fresh prawn. The results also indicated that individuals who liked the flavor of boiled marine shrimp displayed a willingness to purchase fresh prawn.

DISCUSSION AND CONCLUSIONS

The following conclusions can be drawn from the blind taste test: (1) consumers rated the appearance of prawn higher than the appearance of marine shrimp (Table 1); (2) consumers exhibited a higher probability of purchasing frozen prawn than frozen marine shrimp (Table 1); (3) consumers rated fresh and frozen prawns similarly, and differently from marine shrimp (Table 2); (4) older consumers gave higher-than-average ratings to the

Table 3. Results from binomial Logit regression (Greene 1990) of willingness to purchase products A, B, and C, with respect to consumer demographics and beliefs about product attributes. Three dependent variables (Buy A, Buy B, and Buy C) are defined by: Buy A = 1 implies that a respondent is willing to purchase product A; Buy A = 0 otherwise. Buy B and Buy C are similarly designed for products B and C, respectively. N = 106.

	Dependent variable	Dependent variable	Dependent variable
	Buy A[1]	Buy B[1]	Buy C[1]
Independent variable	Estimated coefficient	Estimated coefficient	Estimated coefficient
Intercept	−2.471	−0.001	−6.306[1]
Gender	−0.904	−0.401	−1.221[1]
Age: 30s and 40s	−0.806	−0.591	−0.291
Age: 50+	1.183	0.707	0.592
Smoker	−1.088	−0.354	0.920
Appearance A	0.389	−0.630	−0.687[1]
Appearance B	−0.001	0.422	−0.001
Appearance C	−0.173	0.373	0.543[1]
Odor A	0.412[1]	−0.316[1]	0.260
Odor B	−0.302	0.334[1]	−0.254
Odor C	0.006	−0.008	−0.007
Texture A	0.294	0.299	0.380
Texture B	−0.155	0.054	−0.666[1]
Texture C	−0.133	−0.356	0.293
Flavor A	0.820[1]	−0.524	−0.598
Flavor B	−0.098	1.010[1]	0.430[1]
Flavor C	0.008	−0.336	1.391[1]
Accurate predictions	90%	83%	88%
Likelihood ratio index	52%	51%	54%

[1] This indicates that the estimated coefficient is significantly different from zero for $\alpha = 5\%$.

appearance and odor of fresh prawn and flavor of marine shrimp; (5) males were more inclined to purchase fresh prawn than were females (Table 3); and (6) consumers who rated the flavor of marine shrimp highly also tended to exhibit a strong willingness to purchase fresh prawn (Table 3).

Results of this paper are useful to develop marketing strategies that will make prawn appealing to consumers. For example, the results from appearance, odor, texture, and taste attributes can be used to differentiate freshwater prawn from marine shrimp: domestic prawn can be fresh, having a less fishy odor and a more delicate flavor than marine shrimp. Since older consumers show a greater inclination towards prawn, future advertisements should include healthful characteristics such as the lower in iodine and cholesterol content in prawn when compared with marine shrimp.

As a result of inherent similarities, freshwater prawn and marine shrimp are often grouped together in wholesale and retail markets. This is detrimental to the U.S. prawn industry because marine shrimp can be profitably sold at a lower price than domestic prawn at any market level (Dasgupta and Tidwell 2003). However, the results of this research showed that, once prawn and shrimp were tasted, consumers were able to differentiate the products (i.e., they were able to tell that prawn and shrimp were different), even in a blind test. While the greater willingness to purchase frozen prawn over frozen marine shrimp was an encouraging result, the caveat is that the participants in the taste test were informed that the two products were similarly priced. Since the results showed that consumers rate both prawn and shrimp highly, product pricing would be one of the chief determinants in making a purchasing decision.

The current prawn-marketing situation in Kentucky relies heavily on niche marketing, where fresh prawn are supplied to a specific consumer sector that is willing to pay a premium for quality. The domestic prawn industry's survival, in competition with marine shrimp in larger scale markets, will depend on greater product differentiation of prawn, consumer education on the uniqueness of prawn, and lowering of production cost.

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