Citrus Attributes: Do Consumers Really Care Only About Seeds?

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Introduction

Florida accounted for 70% of utilized production of citrus in the U.S. during the 2007-08 season (USDA, NASS, 2008). The Florida citrus industry is facing a challenge in the tangerine sector. The value of Florida tangerines produced fluctuates from $55 million to $80 million from 1993 – 2008, overall US value of tangerine production has been increasing during the same period, from $92 million to $219 million (USDA, NASSa). The percent of US tangerine production attributable to Florida has dropped from a high of 67% in the 99-2000 crop year to 27% in the 07-08 crop year (Figure 1). The difference has been picked up by California, whose share of tangerine production increased from 24% to 69% during the same time period.

According to Norberg (2007), Clementines accounted for 58% of tangerine volume in the 05-06 crop year. Other major varieties include Honey/Murcott (8%), Sunburst (7%) and Manadarin/Royal (7%).

Though a variety of types of citrus have historically been offered by retailers, little work has been done to brand the variety of citrus. Recently, the Clementine tangerine has had market success, being offered at most retailers in 5-lb. boxes. Growth in sales of Clementines from crop year 2003/04 – 2005/06 was over 60% in dollar sales. Tangerines grown in Florida, such as the Murcott and Sunburst have seen declines in the same time period of 25% and 30% respectively. Differences between these tangerines are numerous. The Florida citrus industry has focused on breeding for flavor, large size and juiciness in the Murcott and Sunburst. Murcotts are medium in size, have a yellowish-orange peel and deep orange flesh, and not easily peelable (Hodgson, 1967), with small, but potentially numerous seeds. The Sunburst tangerines are medium in size with a dark orange peel and flesh (Futch and Jackson, 2003). Sunbursts have a peel that is somewhat easy to remove, as well as a medium number of seeds. The Clementine ranges in size from medium-small to medium, has a deep orange to reddish-orange peel and deep orange flesh, is easily peelable and is generally seedless and was introduced into California citrus in 1914 (Hodgson, 1967).

Little market research has been conducted to develop a better understanding of how consumers make decisions regarding citrus purchases. Retailers communicate to the industry (personal communication, Florida Department of Citrus) that the top concern of consumers is seedlessness. However, the number of seeds in a tangerine cannot be observed at purchase. Identifying a fruit by variety may communicate a level of seeds, however, variation may occur from one piece of fruit to the other. The purpose of this study is to identify the factors that affect consumer choice of fresh citrus. Although we are interested in how all characteristics influence choices, we are particularly interested in the seed amount. This is because a general belief that the increasing market share of the tangerine is a result of products introduced to the market with little to no seeds.

A study of UK consumers was conducted in 1995 to determine consumer awareness of attributes of citrus (Poole and Baron, 1996). The hypothesis of this study was that consumers, who may be uneducated about citrus attributes, would largely choose fruit based on appearance. In this study, 300 face-to-face interviews were conducted with citrus consumers (determined by a screening question). Only 23% of consumers in this study were able to recall varietal names of citrus purchased, though many were aware of the country of origin of the fruit. When respondents were asked to rank citrus characteristics, juiciness, skin quality, sweetness and texture were ranked as the most important of ten factors. Least important factors were packaging, size, and ease of peeling. The authors continue to note that consumers satisfaction is based on attributes largely unknown at the time of purchase, yet the consumer is unable to distinguish between different products (as judged by ability to name a variety). The question was raised as to whether U.K. supermarkets were imposing specifications that did not match consumer preferences. For example, specifications often focused on packaging, which was the least important factor identified by consumers.

In 2004, Campbell et al. used conjoint analysis to evaluate consumer preferences for Satsuma Mandarins. In this study of 605 consumers, price, skin color, fruit size, area of surface with blemishes, number of seeds, production region label, and organic production practices were studied. Consumers were presented with 20 pictures of fruit with specific attributes and asked to select which they would be most interested in purchasing. Surveys were administered in nine cities in Alabama and Georgia at five different supermarket chains. Results showed the overall sample put the highest emphasis on seeds, followed by price, blemish, color, size, type of production and production region (either US or Alabama). Respondents in this study did not try the fruit and sensory characteristics were not included in the conjoint analysis.

Data

In 2008, three consumer surveys were conducted investigating consumer preferences for new and existing varieties of citrus (mainly tangerines and tangelos – a hybrid between tangerines and grapefruit or pummelos). In each survey, approximately 100 adult consumers and 50 children (aged 8-17) were sampled, divided equally among three cities (Tampa, Florida; Chicago, Illinois; and Baltimore, Maryland). During the survey, taste tests were performed with different varieties of tangerines. Though the species of tangerine varied, the survey method was constant for each survey. Respondents were recruited by mall intercept in each location to participate in a citrus taste test. A summary of the demographics of the participants is included in Tables 1 (adult) and 2 (children).

Initial questions in the survey focused on current purchase patterns for citrus and other fresh fruits and juices. Participants were then presented with 4 – 6 different tangerines (each was presented with one whole fruit and 1 slice of the fruit) and asked to rate that tangerine's appearance and color, then, after tasting the slice, the flavor, color of the fruit flesh, sweetness, acidity, juiciness, ease of peel, amount of seeds, size, and shape. Finally, respondents were asked to identify their likelihood to purchase this fruit if they were adults and the likelihood to eat the fruit if they were children.

Analysis

The data were analyzed using an ordered probit model with following regression equation:

(1) $y_i^* = \beta' x + \varepsilon_i$

where y_i^* is the unobserved category denoting the respondents true likelihood of choosing citrus products; x_i is the independent variable denoting the respondent demographics, consumption and purchase behavior, and sensory rating of citrus attributes in the taste test; and ε_i is a random variable with normal distribution. The observed variable y_i, denoting respondent purchase (or consumption) intention of citrus in the survey is

(2) $y_i = j$ if $\mu_{j-1} \leq y_i^* \leq \mu_j$, *j=1,2,3,4,5*

where $\mu_0 = -\infty$, $\mu_5 = \infty$, μ_1 is normalized to zero for model identification; μ_j (j=2,3,4) are unknown threshold parameters being estimated with β; y_i represents the categories the respondent stated likelihood of purchasing (or eating for children) citrus products in taste test. It takes the values of 0, 1, 2, 3 and 4 for categories of *Not at all Likely, Not Very Likely, Somewhat Likely, Very Likely and Extremely Likely*, respectively.

With a normal distribution, the probability for participant purchase intention in different categories can be specified as

(3) $Prob(y_i = j) = \Phi(\mu_j - \beta' x) - \Phi(\mu_{j-1} - \beta' x),\ j=1,2,3,4,5$

Where Φ is the cumulative standard normal distribution.

The log-likelihood function is

(4) $\mathcal{L} = \sum_{i=1}^{N} \sum_{j=1}^{5} d_{ij} \log\,[\Phi(\mu_j - \beta' x) - \Phi(\mu_{j-1} - \beta' x)]$

where *N* is the total number of participants, $d_{ij} = \{ {}^{1\ if\, \mu_{j-1} \le y_i^* \le \mu_j}_{0\ otherwise}$. The parameters are estimated with a maximum likelihood method. Equation (3) gives the probability that a respondent's likelihood of purchasing (eating) is in the *jth* category.

In the model, the marginal effects of independent variables are not equal to the coefficients. For continuous variables, such as age, the marginal effects of independent variable x_k on the probability of respondent purchase likelihood in *jth* category calculated as:

(5) $ME_{jk} = \frac{\partial Prob(y_i = j)}{\partial x_k} = -[\phi(\mu_j - \beta' x) - \phi(\mu_{j-1} - \beta' x)]\beta_k$

For dummy variables such as some demographic and behavioral variables, the marginal effect of x_k is calculated as

(6) $ME_{jk} = [\Phi(\mu_j - \beta' x) - \Phi(\mu_{j-1} - \beta' x)] - [\Phi(\mu_j - \beta' x_{-k}) - \Phi(\mu_{j-1} - \beta' x_{-k})]$

where x_{-k} is a vector of independent variables with x_k being zero.

Results

Independent variables used in the model are reported in Table 3. The variables included in the adult model are from three categories: demographics (city, age, gender, household income, household size, ethnicity, and whether or not children are present in the household); respondent purchase and consumption behavior (percentage of total household grocery shopping by respondent, whether or not the respondent has eaten a tangerine in the last thirty days, and the frequency of consumption of fresh citrus by respondent); and sensory attribute ratings (appearance, flavor, juiciness, number of seeds, size, shape, color, sweetness, and acidity). The model representing children include the same variables, with the following variables excluded: household income, whether or not children are in the household, percent of household shopping, and frequency of consumption of citrus. These variables were not collected during surveys with respondents under the age of 18.

The results of ordered probit models are presented in Tables 4 (adult) and 5 (children). Marginal effects of significant variables calculated at the independent variable means are reported in Tables 6 (adults) and 7 (children). Variables that significantly affected the willingness to purchase the tangerine for adults included city, income, whether or not they had eaten tangerines in the last 30 days, shopping percent, and all sensory attributes except for overall appearance. Variables that significantly affected the willingness to eat the tangerine for children included city, ethnicity, age, and all sensory attributes except for overall appearance and size of fruit. The marginal effects of significant coefficients at independent variable means indicate the changes in the probability that a consumer stated likelihood of purchasing (eating) the citrus being tested with the changes in the independent variables. For instance, adults in Chicago are 5.6% and 4.4% more likely than respondents in Tampa to indicate they are *Very Likely* and *Extremely Likely* to purchase the tangerine. This implies that with same type of tangerine, Chicago adult consumers are more likely to indicate a willingness to purchase compared to Tampa adult consumers. In the case of children, Baltimore children consumers were 3.2% and 4.6% less likely than respondents in Tampa to indicate they are *Very Likely* or *Extremely Likely* to eat the tangerine.

Adult consumers with household income under $30,000 were 8.3% and 9.4% more likely than adult consumers with household incomes above $100,000 to indicate they are *Very Likely* and *Extremely Likely* to purchase a tangerine. Adult consumers with household incomes between $30,000 and $50,000 were 7.3% and 5.5% more likely than those with higher incomes (above $100,000) to indicate they are *Very Likely* and *Extremely Likely* to purchase a tangerine. This is consistent with the fact that citrus fruits (orange, grapefruit and tangerines) are the least expensive fruits in the U.S. based on dollar value per serving – only the price of watermelon and apples are lower than that of orange and grapefruit, and price of tangerines is in the middle range of most of fruits (Reed, Frazão and Itskowitz 2004). The larger the percent of shopping a person completed for the household, the more likely they were to indicate a willingness to purchase the tangerine.

Adults that indicated they had consumed tangerines in the last thirty days were 4.1% and 2.8% more likely than those who had not consumed tangerines to indicate they are *Very Likely* and *Extremely Likely* to purchase a tangerine. This variable was not significant for children. This implies that there is a segment of the adult population that prefers tangerines, but among children, previous consumption doesn’t improve prediction of likeability of the fruit.

Sensory ratings were significant in many cases. For adults, the sensory attribute with the strongest marginal effect is sweetness, with adults who felt the tangerine had the best level of sweetness being 28.7% more likely to indicate they were *Very Likely* or *Extremely Likely* to purchase the fruit. For children, the sensory attribute with the strongest marginal effect is shape of the fruit, with children rating the shape as ideal 20.8% more likely to indicate they were *Very Likely* or *Extremely Likely* to eat the tangerine. Shape was the second strongest sensory attribute for adults, increasing their likelihood to indicate they were *Very Likely* or *Extremely Likely* to purchase the tangerine by 21.3%. The impact of all sensory variables for children and adults on the likelihood to indicate they are *Very Likely* and *Extremely Likely* to purchase (eat) the tangerine is shown in Figure 2.

Conclusions

Very few studies have examined the attributes of citrus and how they impact willingness to purchase fresh fruit. In this analysis, consumers were presented with multiple tangerines for taste tests and then asked to identify their willingness to purchase the products. Information was collected on the respondents' demographics, purchasing history, and sensory ratings of each fruit after taste test. Studies were conducted both with adults and children to determine if preferences change with age. The resulting model provides interesting results for the citrus industry to consider.

The Florida Department of Citrus has indicated number of seeds is an important factor as denoted by retailer preferences, and Campbell et al. found seeds to be the most important factor when rating Satsuma mandarins in a conjoint analysis. However, our study found a different result. The number of seeds was significantly related to willingness to purchase for adults and eat for children, but the impact of seeds is relatively low. Those indicating the fruit had the perfect amount of seeds were less than 10% (5% for children) more likely to indicate they would purchase the tangerines.

Flavor, however, was extremely important, with sweetness, acidity and overall flavor each increasing the likelihood to rate the product favorably by 15% or more (except in the case of sweetness for children's ratings, which increased likelihood to rate the product favorably by 14%). These results appear to indicate that flavor does in fact trump the number of seeds when it comes to consumer preferences.

Overall appearance was the only sensory variable not significantly related to either the adults' indication of willingness to purchase or the children's' indication of willingness to eat. For children, size was also not important, and for adults, size had one of the smaller impacts on willingness to purchase. This is consistent with the findings of Poole and Baron, who found packaging, size, and ease of peel as the least important factors. However, Poole and Baron's original hypothesis was that consumers will judge based on appearance or related factors that can be observed at the time of purchase. The importance of shape of the fruit in our study seems to validate this hypothesis. Children and adults who rated the tangerine as an ideal shape were approximately 21% more likely to rate the product highly.

Given the differences between the Clementine and Florida tangerines (Murcott and Sunburst for example), it is important for the citrus industry to understand consumer preferences. Clementines are less likely to have seeds than Murcotts and Sunbursts, they are likely smaller, and a slightly different color. However, according to our research, color, seeds, and size are the three smallest factors impacting willingness to purchase tangerines. Trained sensory panels can be used to identify different levels of sweetness and acidity in the different types of tangerines. Interestingly, in our study, Clementines did not perform well on these characteristics. On a scale of 1 to 9, with nine being the highest, Clementines were rated an average of 6.3 for overall flavor by 153 consumers (adults and children). During the panel that included Clementines, only 56% rated the sweetness as just right, which was the lowest of the six fruits sampled in this session. Finally, 66% indicated Clementines had the correct level of acidity, which was similar to other samples, but 12% indicated it was not at all sour enough, which was higher than any other fruit sampled. Though Murcotts were not included in the panel with the Clementine, in a different panel, consumers (n=154) rated Murcott varieties from 6.6 – 7.1 on overall flavor; 67 – 76% on correct level of sweetness; and 71 – 83% on ideal level of acidity.

The results from our study suggest that sweetness, shape, acidity and flavor are the most important factors in leading adults and children to increase their willingness to try a tangerine, and rate factors such as seeds, size of fruit, color, and overall appearance as less important. This however, does not explain why the Clementine variety has experienced such large growth while Murcott and Sunburst varieties have shrunk in popularity. One major difference factor between these fruits that was not considered was the ease of peel. In this study, consumers had one slice of fruit and were to evaluate ease of peel from the pre-sliced fruit. This does not simulate actual consumption, and hence was left out of the study. Future research should consider ease of peel, including having consumers peel the fruit from start to investigate if this is part of the explanation for the changing consumer preferences. Another factor left out was packaging. Although previous research indicates packaging has little impact (Poole and Baron), their study is ten years old and was performed in the U.K., so future research should also ask about packaging preferences.

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Table 1. Descriptive Statistics for Citrus Taste Panels (Adults)

	Total Sample (n=309)	Baltimore (n=101)	Chicago (n=102)	Tampa (n=106)
Gender Percent Male	49.5	50.5	49.0	49.1
Household Income				
Under $30,000	11.3%	11.9%	15.9%	9.4%

$30,000-49,999	48.5%	36.7%	67.1%	54.7%
$50,000-74,999	12.0%	15.8%	2.4%	17.9%
$75,000-99,999	10.0%	14.9%	9.8%	7.5%
$100,000 and more	7.1%	12.9%	3.7%	5.6%
Household Size	3.3	3.1	3.5	3.3
Children present in the household	49.8%	55.2%	49.6%	45.2%
Ethnicity				
White/Caucasian	55.7%	59.4%	51.0%	56.6%
Black/African-American	33.0%	26.7%	37.3%	34.9%
Age (Mean)	38.5	39.3	39.0	38.8

Table 2. Descriptive Statistics for Citrus Taste Panels (children)

	Total Sample (n=157)	Baltimore (n=54)	Chicago (n=51)	Tampa (n=52)
Gender				
Percent Male	50.3	55.6	47.1	48.1
Ethnicity				
White/Caucasian	52.2	42.6	40.2	31.7
Black/African-American	27.4	51.9	16.3	18.6
Household Size	4.4	4.0	4.9	4.4
Age (Mean)	12.4	12.6	12.3	12.2

Table 3. Variable definitions

Variable	Definition
City	= 1 if Baltimore, = 2 if Chicago, = 3 if Tampa
Age	Age of respondent
Male	Dummy variable for male gender
HH Income	Household Income
HH Size	Number of members of household
White/Caucasian	Dummy variable if race is White
Black/African-American	Dummy variable if race is Black
Shopping Percent	Percent of household grocery shopping by respondent
Eat_Tang	Dummy variable if respondent ate tangerines within the last 30 days
Freq_Fresh_Citrus	Frequency of consumption of fresh citrus
S_Appear	Sensory rating of appearance during taste test
S_Flavor	Sensory rating of flavor during taste test
S_Juicy	Sensory rating of juiciness during taste test
S_Seed	Sensory rating of satisfaction with number of seeds during taste test
S_Size	Sensory rating of size of fruit during taste test
S_Shape	Sensory rating of shape of fruit during taste test
S_Color	Sensory rating of external color of the fruit during taste test
S_Sweet	Sensory rating of sweetness during taste test
S_Acid	Sensory rating of acidity during taste test

Table 4. Parameter Estimates of Ordered Probit Model for Adults

Variables	Coefficient Estimate	Standard Error	Approx Pr > |t|
Constant	-5.718	0.411	<.0001
Baltimore	0.090	0.092	0.331
Chicago	0.252	0.088	0.004
Age	0.000	0.003	0.934
Gender	-0.017	0.079	0.831
Under $30k	0.449	0.163	0.006
$30k-$50k	0.325	0.123	0.009
$50k-$75k	0.094	0.139	0.499
$75k-$100K	0.113	0.154	0.464
HH_Size	-0.009	0.026	0.726
White/Caucasian	-0.029	0.116	0.806
Black/African-American	0.169	0.128	0.187
No_Children	0.007	0.080	0.931
Eat_Tang	0.176	0.082	0.031
Freq_Fresh_Citrus	-0.008	0.042	0.841
Shopping_Percent	0.088	0.049	0.071
S_Appear	-0.008	0.055	0.892
S_Flavor	0.377	0.061	<.0001
S_Juicy	0.290	0.072	<.0001
S_Seed	0.196	0.052	0.000
S_Size	0.225	0.078	0.004
S_Shape	0.537	0.064	<.0001
S_Color	0.131	0.071	0.066
S_Sweet	0.725	0.077	<.0001
S_Acid	0.458	0.078	<.0001
Threshold Parameters			
_Limit2	1.060	0.084	<.0001
_Limit3	2.389	0.103	<.0001
_Limit4	3.590	0.116	<.0001
#Obs		1014	
Log Likelihood		-1118	

Table 5. Parameter Estimates of Ordered Probit Model for Kids

Variables	Coefficient Estimate	Standard Error	Approx Pr > |t|
Constant	-2.770	0.422	<.0001
Baltimore	-0.198	0.120	0.100
Chicago	0.022	0.113	0.847
Age	-0.047	0.019	0.017
Gender	-0.033	0.088	0.705
HH_Size	-0.021	0.025	0.399
White/Caucasian	-0.350	0.124	0.005
Black/African-American	-0.194	0.140	0.166
Eat_Tang	0.127	0.095	0.181
S_Appear	0.094	0.066	0.155
S_Flavor	0.470	0.076	<.0001
S_Juicy	0.231	0.082	0.005
S_Seed	0.102	0.061	0.099
S_Size	0.084	0.085	0.324
S_Shape	0.524	0.076	<.0001
S_Color	0.150	0.079	0.056
S_Sweet	0.343	0.090	0.000
S_Acid	0.254	0.090	0.005
Threshold Parameters			
_Limit2	1.038	0.103	<.0001
_Limit3	2.141	0.121	<.0001
_Limit4	3.258	0.133	<.0001
#Obs		644	
Log Likelihood		-768.97	

Table 6. Marginal Effect of Significant Independent Variables in Order Probit Model for Adults

	Change in Probability of Indicating Willingness to Purchase Tangerine				
Variable	Not at All Likely	Not Very Likely	Somewhat Likely	Very Likely	Extremely Likely
Chicago	-0.007	-0.039	-0.054	0.056	0.044
Under $30k	-0.009	-0.059	-0.109	0.083	0.094
$30K-$50K	-0.010	-0.052	-0.066	0.073	0.055
Eat_Tang	-0.006	-0.029	-0.034	0.041	0.028
Shopping_Percent	-0.003	-0.014	-0.018	0.020	0.015
S_ Flavor	-0.011	-0.061	-0.077	0.086	0.063
S_ Juicy	-0.009	-0.047	-0.060	0.066	0.049
S_ Seed	-0.006	-0.032	-0.040	0.045	0.033
S_ Size	-0.007	-0.036	-0.046	0.051	0.038
S_ Shape	-0.016	-0.087	-0.110	0.123	0.090
S_ Color	-0.004	-0.021	-0.027	0.030	0.022
S_ Sweet	-0.022	-0.117	-0.149	0.166	0.121
S_ Acid	-0.014	-0.074	-0.094	0.105	0.077

Table 4. Marginal Effect of Significant Independent Variables in Order Probit Model for Kids

	Change in Probability of Indicating Willingness to Eat Tangerine				
Variable	Not at All Likely	Not Very Likely	Somewhat Likely	Very Likely	Extremely Likely
Baltimore	0.007	0.032	0.039	-0.032	-0.046
White/Caucasian	0.011	0.055	0.072	-0.052	-0.086
Age	0.001	0.007	0.010	-0.007	-0.011
S_ Flavor	-0.015	-0.074	-0.097	0.073	0.114
S_ Juicy	-0.007	-0.037	-0.048	0.036	0.056
S_ Seed	-0.003	-0.016	-0.021	0.016	0.025
S_ Shape	-0.016	-0.083	-0.108	0.081	0.127
S_ Color	-0.005	-0.024	-0.031	0.023	0.036
S_ Sweet	-0.011	-0.054	-0.071	0.053	0.083
S_ Acid	-0.008	-0.040	-0.052	0.039	0.061

Figure 1. Florida Percent of U.S. Tangerine Crop

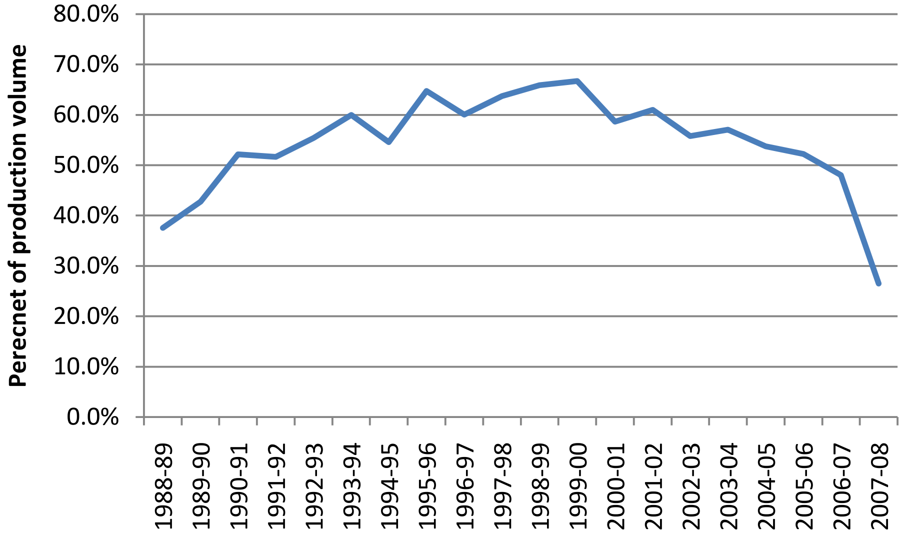

Figure 2. Impact of Sensory Attributes on Willingness to Purchase (Eat) Tangerines