Quality attributes driving US green-skin avocado consumption

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Abstract
The objectives of this paper are to assess consumer acceptance of Florida green-skin avocados, and to identify potential growth areas for the long-term viability of the industry. Results of the study will allow the Florida avocado industry to monitor consumer satisfaction in the short run, and to improve Florida avocado positioning on the market in the long-run. The present study is a first empirical attempt to model green-skin avocado preferences in the US market; it also contributes to the literature on tropical fruit demand in the U.S. market.

Introduction
US avocado per capita consumption has doubled from 1.59 kg in 2007 to 3.22 kg in 2016, consumer demand has outpaced domestic production with imports reaching over 900,000 Metric Tones (MT) or about 88.7 percent of the total supply in 2017 (Fig. 1), and were valued at $2.64 billion. The 'Hass' cultivar comprises the bulk of avocado imports, accounting for more than 93.02% of the volume traded in 2017, followed by organic Hass at 4.56%, and green-skin avocados at about 2.42% (USDA/FAS, 2018).

In recent years, U.S. avocado production has fluctuated from a low of 113,855 Metric Tons (MT) in 2017 to a high of 269,977 MT in 2010; yield variability is due to alternate bearing and environmental stress. Domestic avocado production takes place in California and Florida; California accounts for about 83% of the total avocado production while Florida accounts for the 17% of the domestic avocado production. California grows predominantly the Hass cultivar, it accounts for 96 percent of the state's total avocado production; California's Hass avocados are marketed from November to October with most of the crop marketed from May to July.

Figure 1. U.S. avocado imports and domestic production.
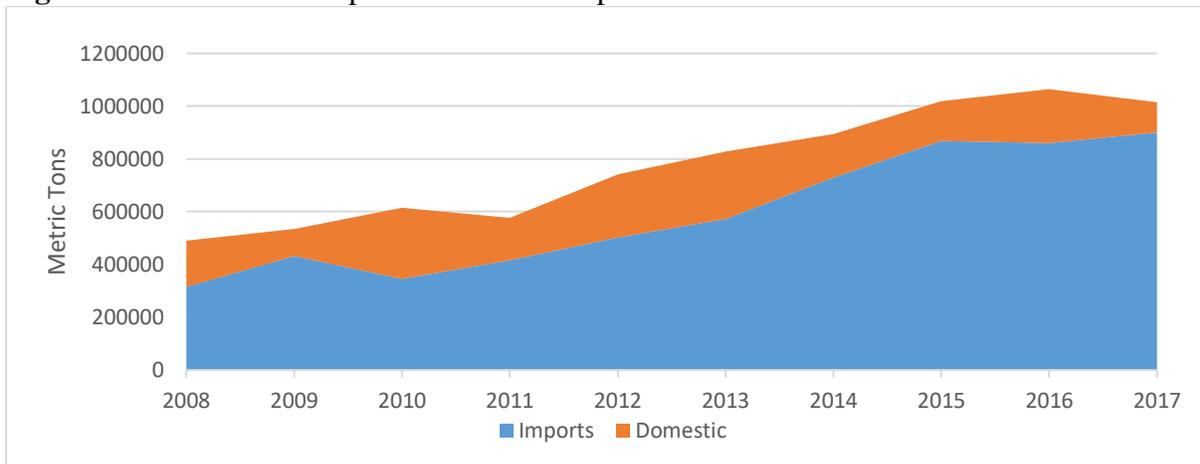
Florida produces green-skin avocados, which represent about 60 early and late cultivars marketed from June to March following a predetermined harvest schedule. The bulk of production occurs from July to October (Fig. 2). US green-skin avocado imports come from the Dominican Republic (DR) mainly from October to March; the DR supplies about 99.41% of the total U.S. green-skin avocado imports and accounts for roughly one-third of the total supply of green-skin avocados in the U.S. (USDA/AMS, 2018; USDA/FAS, 2018).

Figure 2. US Green-skin avocado monthly average supply 2008-17
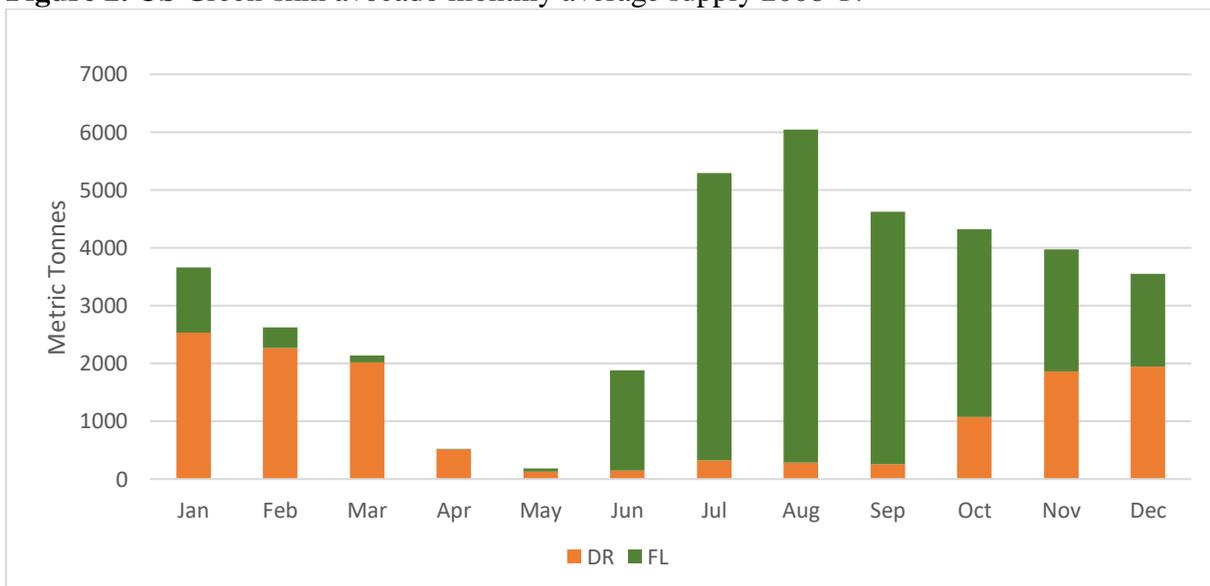
While domestic production and trade of green-skin avocados may seem significantly lower compared to the production and trade volumes of the Hass cultivar, the Florida avocado industry represents a very important component of the Florida agricultural economy. To illustrate this, annual farm gate sales were worth about $19.1 million in the 2016/17 crop year; the bulk of the

crop is sold out of the state, the avocado industry is an important contributor to the state's economy with an overall economic impact close to \$100 million a year (A. Hodges, personal communication; USDA/ERS 2018).

Size and nutritional facts, specifically fat and calorie content differentiate green-skin avocados from Hass avocados. Green-skin avocados are considerably larger than Hass avocados. Fat content in green-skin avocados is lower; a golf balled size portion of green-skin avocados contains 3 grams of fat, most of it unsaturated while the same size portion of Hass avocados has 4.6 grams of fat. The difference in fat content results on different calorie content, the same size portion of green-skin avocados has 36 calories versus 50 calories for Hass avocados. Because of their creamy texture, Hass avocados are usually preferred for guacamole and dips while the firmer texture of green-skin avocados make them preferred for salads (AICR, 2013).

US total retail sales of green-skin avocados were \$69.9 million in 2012 with 75% of the sales taking place in the US east coast, specifically in the northeastern (28%) and the southeastern (47%) regions (Hass Avocado Board, 2014). The green-skin cultivar is favored over "Hass" by consumers interested in a lower calorie-count, and consumers from the Caribbean, Central and South America.

Florida avocado marketing standards have been in effect since 1957, they are cultivar and calendar specific, and based on factors such as minimum weight and diameter requirements. Quality factors are not considered part of the marketing standards; therefore, it is of paramount importance for the long-term viability of the industry to periodically monitor consumer acceptance of the fruit, and to better understand how consumer preferences are evolving. This issue is even more critical given the competitive pressure of Hass avocados in the market, and green-skin avocado imports from the DR.

Accordingly, the objectives of the present study are to assess the current consumer acceptance of Florida green-skin avocados, and to identify potential growth areas for the long-term viability of the industry. Results of the study will allow the Florida avocado industry to monitor consumer satisfaction in the short run, and to improve Florida avocado positioning on the market in the long run. The present study is a first empirical attempt to model green-skin avocado preferences in the US market; it also contributes to the literature on tropical fruit demand in the U.S. market.

Conceptual framework

Because of the increasing supply of agricultural products and the growing competition in import markets, consumer satisfaction is a fundamental element in the product strategy. Industry surveys of fruit quality and associated consumer perceptions are necessary to monitor ongoing consumer acceptance of the product and for strategic planning. Therefore, identifying the product's characteristics that enhance the consumer's experience is critical to improve the product and to develop marketing strategies. Market oriented quality improvements are the result from insights on quality characteristics that are deemed as the most relevant for consumers.

Several approaches to study consumer behavior have been proposed (Darby and Karny, 1973, Steenkamp, 1990). One of these approaches suggests that consumer quality evaluation is based on a two-stage consumer perception process: quality expectation and experienced quality (Fernqvist and Ekelund, 2014). Quality expectation is based on informational stimuli such as price or brand, which is used by the consumer to make assumptions about the product's quality attributes (Steenkamp,1990). However, consumers can only evaluate quality attributes after actual consumption of the product; these attributes are divided into experience and credence quality attributes (Oude Ophuis and Van Trijp, 1995).

Taste, flavor and freshness are important experience attributes evaluated in a fresh fruit consumption experience (Migliore et al., 2015). On the other hand, credence quality attributes are hard to evaluate on the basis of consumption of the product and may refer to a wide range of intangible characteristics such as health attributes, origin, production method, and fair trade to name a few. Health credence attributes such as fat content, and low calorie content have been shown to affect consumer preferences in several studies (Light et al.,1992; Wardle and Solomons,1994; Sandrou and Arvanitoyannis, 2000).

Origin, more specifically country of origin has been found to be an important factor related to consumer food preferences; previous studies have found domestic produce to be preferred over imports, and local or regional food to be preferred over food with less specified origins (Fernqvist and Ekelund, 2014). Demographic factors such as age, gender, income and education have been found to play an important role in consumer preferences for fresh fruits (House et al., 2011; Migliore et al., 2015; Gao et al., 2014)

Several studies have been conducted to evaluate consumer preferences for fresh fruits in the US market, with the citrus and the apple industries being the focus of many of these studies (Campbell et al., 2004; House et al., 2011; McCluskey et al., 2007; McCluskey et al., 2011) House et al., 2011 conducted a sensory analysis test to determine which attributes had the highest impact on the willingness to purchase fresh mandarins. It was found that sweetness, shape, acidity and flavor were the most important factors influencing the willingness to purchase mandarins. McCluskey et al., 2013 evaluated how internal fruit quality characteristics influenced consumers' willingness to pay for both the Gala and Red Delicious apple cultivars. Firmness and sweetness were the quality characteristics that positively influenced consumers' willingness to pay for both cultivars.

Few formal studies have been conducted to evaluate consumer preferences for avocados, particularly Hass avocados (Gamble et al., 2010, and Migliore et al., 2017). Gamble at al. 2010, evaluated consumer preferences for Hass avocados in Australia. The study considered the impact of quality characteristics such as maturity (assessed as dry matter content), preferred ripeness (measured as firmness), and flesh damage (measured as bruise incidence and bruise size) on future Hass avocados purchase probability. Findings suggest that increases in dry matter content, and changes from medium to soft firmness levels are positively related with future purchase intent. Regarding flesh damage, at low prices consumers' maximum tolerance of bruise size and incidence is up to 25 and 10 percent respectively; while at higher market prices consumers' maximum tolerance of bruise size, and bruise incidence is 10 and 5 percent respectively.

A more recent study explored Italian consumer's preferences for avocados (Migliore et al., 2017). The main objective was to identify the factors that drive consumer avocado consumption, factors evaluated included quality characteristics such as pre-purchase attributes, experienced quality attributes, credence attributes and demographic variables. Findings indicate that actual consumption attributes (taste, texture, and ripeness), credence attributes (local origin, and organic certification), and demographic variables (gender and income) have a significant effect over avocado frequency consumption.

In contrast to citrus and apples, consumer preferences for avocados in the US market remains an unexplored area; to the best of our knowledge, formal studies about U.S. consumer preferences for green-skin avocados have not been published. The present study constitutes a first attempt to identify the factors that drive green-skin avocado consumption in the US market.

Empirical model and data
To evaluate the impact of green-skin avocado characteristics on a consumer's purchase decision, the consumer's utility derived from the consumption of the product follows the random utility framework and takes the form Ui= Vi+ ε_i where Ui is the utility of green-skin avocado consumption, Vi is the deterministic component and ε_i is the stochastic component. Assuming a linear utility function, an ordered probit model is formulated to measure the effects of different quality attributes, and demographic variables on the purchase intention following the form:

$$y_i^* = X_i\beta' + \varepsilon_i$$

Where β' is the vector of unknown parameters being estimated; X_i is the vector of independent variables such as credence attributes, quality attributes, and demographic characteristics; ε_i is a random variable error term with normal distribution. The dependent variable, y_i^*, denotes green-skin avocado purchase intention.

The data used in the present study were obtained from an online survey conducted in January 2017, survey participants were recruited using Qualtrics panels. Because most of the Florida avocado crop is sold in the US east coast, two cities in the US east coast, Boston (Northeast region) and Miami (Southeast region) were selected as representative markets based on fruit market availability data from the USDA Agricultural Marketing Service (USDA/AMS).

To be eligible to take the survey, participants should have consumed fresh green-skin avocados during the last thirty days. A total of 632 consumers agreed to participate in the survey; however, only 355 surveys were completed, 178 surveys in Boston and 177 surveys in Miami, resulting in a response rate of 56%. A summary of the demographic characteristics of the participants is included in Table 1.

The majority of the participants were female. Age ranges in the sample for those 45 and more are similar to the US general population, the age range from 18 to 44 years old is overrepresented in the sample; however, it may better approximate the population that buys fresh avocados. The ethnic composition of the sample is close to the US general population. The survey participants have a higher education level compared to the US general population, especially bachelor's degree and higher. The mode income range of $50,000-$74,999 in the sample includes the median US

household income of $57,617. The number of households with children in the sample is overrepresented compared to the US general population. Household size is 2.9 persons, which is very similar to the US general population.

Table 1. Descriptive Statistics for Demographic Variables

	Total (n=355)	US Census	Boston (n=178)	Miami (n=177)
Female	68.45%	50.8	71.91%	64.97%
Age:				
18-24	13.52%	9.8%	13.48%	13.56%
25-34	27.89%	13.6%	30.34%	25.42%
35-44	22.54%	12.7%	19.10%	25.99%
45-59	19.15%	20.3%	19.66%	18.64%
60 and more	16.9%	20.4%	17.42%	16.38%
Ethnicity:				
White	65.63%	61.1%	79.21%	51.98%
Hispanic	20.00%	17.8%	7.30%	32.77%
Others	14.37%	21.1%	13.49%	15.25%
Education:				
High school or less	14.36%	39.8%	10.67%	18.08%
Some college/Assoc.	32.68%	29.0%	33.15%	32.20%
Bachelor's degree	35.77%	19.3%	39.89%	31.64%
Advanced degree	17.18%	11.9%	16.29%	18.08%
Household Income:				
Under $30,000	13.80%	25.8%	12.36%	15.25%
$30,000-$49,999	16.34%	17.9%	12.36%	20.34%
$50,000-$74,999	31.55%	17.7%	29.78%	33.33%
$75,000 -$100,000	20.00%	12.3%	20.22%	19.77%
$100,000 and more	18.31%	26.2%	25.28%	11.31%
Children in the	46.76%	22.8%	40.45%	53.11%
Household size (Mean)	2.99	2.7	2.90	3.09

Initial questions in the survey were related to the importance of several credence and quality attributes when purchasing fresh avocados such as importance of origin and importance of calorie

Table 2. Variable definition

Variable	Definition
HFC	Rating of High Fat Content, rated on a 5-point scale with 1= not at all important, 3= somewhat important and 5= very important
LCC	Rating of Low Calorie Content, rated on a 5-point scale with 1= not at all important, 3= somewhat important and 5= very important

FL_ORIG	Rating of Florida origin, rated on a 5-point scale with 1=not at all important, 3= somewhat important and 5=very important
RIPE	1if right stage of ripeness, 0 otherwise
FLESH_DMG	1 if flesh damage, 0 otherwise
EXP_TAST	1 if expected taste, 0 otherwise
TEXTURE	1 if firm texture, 0 otherwise
FEMALE	1 if female, 0 otherwise
CHILD	1 if children in the house, 0 otherwise
AGE	1 if older than 30 years, 0 otherwise.
HISPANIC	1 if Hispanic, 0 otherwise
INC_L30	1 if Household income less than $30k, 0 otherwise
INC_30-49	1 if Household income between $30k to $49.9k, 0 otherwise
INC_50-74	1 if Household income between $50k to $74.9k, 0 otherwise
INC_75-99	1 if Household income between $75k to $99.9k, 0 otherwise

content among others; variable definitions and details on the scales used for the questions are presented in Table 2. Then participants were asked about their green-skin avocado experienced quality during the most recent consumption experience (latest 30 days); specifically, participants were asked if the fruit had the right ripeness stage, if there was any internal flesh damage, if the fruit had a firmer texture, and if the fruit had the expected taste. After the importance of quality and credence attributes, and recent consumption experience were evaluated, participants were asked to state their likelihood of repeated purchase of green-skin avocados. Finally, in the last section of the survey, demographic information about the survey participants was collected.

Results
The variables considered in the model include three categories: credence attributes (high fat content, low calorie content, Florida origin), quality attributes (ripeness, flesh damage, expected taste and texture) and demographic variables (age, gender, children in the house, ethnic group, and income).
A total of 355 observations were used in the present study, the results of the ordered probit model are presented in Table 3. Variables that significantly impact the likelihood of purchase of fresh green skin avocados include high fat content, low calorie content, Florida origin, expected taste, texture (firm texture) and Hispanic ethnic origin. Marginal effects of significant variables

calculated at the independent variables means are reported in Table 4. The marginal effects indicate changes in the probability of consumers stated likelihood of purchasing green-skin avocados given the changes in the independent variables. All the credence attributes considered were significant, the credence attribute with the strongest marginal effect is origin, particularly Florida origin; participants who know that green-skin avocados are from Florida are 15% more likely to indicate that they are Very Likely and Extremely Likely to purchase green-skin avocados. Health credence attributes that significantly increase purchase likelihood for consumers to indicate that they are Very Likely or Extremely Likely to buy green-skin avocados include high fat content (5.8%), and low calorie content (4.3%), respectively.

Table 3. Parameter Estimates of Ordered Probit Model

			Number of Obs = 355
			LR chi2 (15) = 192.53
			Prob > chi2 = 0.0000
Log likelihood =-456.81342 =455456456.81342			Pseudo R2 = 0.17
Variables	Coefficient	Std. Err.	P>z
HFC	0.283	0.101	0.005
LCC	0.212	0.093	0.024
FL_ORIG	0.729	0.090	0.000
RIPE	0.242	0.235	0.304
FLESH_DMG	-0.031	0.246	0.898
EXP_TAST	0.869	0.302	0.004
TEXTURE	0.958	0.260	0.000
FEMALE	-0.200	0.223	0.369
CHILD	0.302	0.215	0.160
AGE	0.003	0.007	0.626
HISPANIC	0.555	0.253	0.029
INC_L30	0.242	0.358	0.498
INC_30-49	0.009	0.337	0.977
INC_50-74	-0.216	0.289	0.455
INC_75-99	-0.330	0.323	0.308
/cut1	2.471	0.617	0.000

/cut2	3.962	0.627	0.000
/cut3	5.744	0.669	0.000
/cut4	7.808	0.729	0.000

Experienced quality attributes also play an important role regarding likelihood of green-skin avocado purchase. If fruit quality comes in line with consumers taste's expectation consumers are 15.3% more likely to indicate that they are Very Likely and Extremely Likely to purchase green-skin avocados. Fruit with a firmer texture increases the likelihood of purchase for consumers to indicate that they are Very Likely and Extremely Likely to purchase green-skin avocados by 21.1%. Finally, consumers of Hispanic origin are consumers are 12% more likely to indicate that they are Very Likely and Extremely Likely to purchase green-skin avocados.

Table 4. Marginal Effects of Significant Independent Variables in Ordered Probit Model

	Change in probability of indicating willingness to purchase green-skin				
Variable	Not at all	Not very	Somewhat	Very likely	Extremely
HFC	-0.021	-0.036	-0.000	0.045	0.013
LCC	-0.016	-0.027	-0.000	0.033	0.010
FL_ORG	-0.056	-0.093	-0.000	0.116	0.034
EXP_TAST	-0.087	-0.110	0.043	0.122	0.031
TEXTURE	-0.062	-0.114	-0.035	0.155	0.056
HISPANIC	-0.037	-0.068	-0.015	0.091	0.030

Discussion

Results of the present study indicate that fresh green-skin avocado consumption is influenced by credence attributes, experienced quality attributes and demographic factors. The credence attributes considered included product origin and health credence attributes such as high fat content, and low calorie content. Interestingly, results indicate that among the credence attributes evaluated consumers place a higher valuation on origin; specifically Florida origin compared to health credence attributes. Several studies have found that domestic origin is associated with a bundle of attributes such as higher quality, and food safety (Vanden Lans et al., 2001; Onozaka and Mc Fadden, 2011; Gao et al., 2014). Because of the wide meaning of the origin attribute, it is possible to better understand the relative importance consumers place on it. Particularly for avocados, Migliore et al. (2017) found that for Italian avocado consumers, domestic origin matters as it increases by 1.5 times the probability to consume avocado with a higher frequency.

Regarding the health credence attributes considered, there is a tradeoff between fat content and low calorie content as consumers place a higher valuation on higher fat content. While it may seems a bit counter intuitive, more important than calorie content is nutritional contribution to dietary needs (Bergh 1992). Avocado is rich in fatty acids, which have been associated to a decreased risk of cardiovascular disease (López Ledesma et al., 1996; Richard, Kefi, Barbe,

Bausero, & Visioli, 2008). Therefore, the positive perception of the benefits associated with healthy fats content on avocados largely overcome the benefits of low calorie content.

Credence attributes play an important role for green-skin avocado purchase; however, results indicate that some of the experience attributes considered have a larger effect on purchase likelihood, which signals a more experience based approach towards green-skin avocado purchase. A positive eating experience is enhanced by the right balance of attributes such as taste, texture, color and shape (Tan 2000). Texture (firmer texture) and expected taste respectively, were the attributes with the highest impact on repeated purchase likelihood. Shwefelt (1999) states that today's consumers are actually more sensitive to minor differences in texture than flavor and use texture as the primary limiting factor for acceptability. Expected taste is an important experienced quality attribute that has a significant effect on repeated purchase intentions. Our results are consistent with the findings of Razeto et al (2004) who found that texture and flavor, respectively are the top factors driving avocado acceptability in a sensory evaluation test conducted by a trained taste panel. Finally, Hispanic origin is an important demographic driver for green-skin avocado consumption. Ethnic preferences are the result of familiarity with the fruit, and eating habits developed during the childhood, which have a significant impact on fruit consumption among adults (Prescott and Bell, 1995).

Concluding remarks

The findings of this study offer an insight about current consumers' acceptance of Florida avocados, and provide a starting point for discussions about future growth for the Florida avocado industry. Experienced quality attributes are the most important drivers behind repurchase decisions; results indicate that the industry is delivering a fruit that is consistent with consumers' expectations in terms of expected taste and texture. Any changes to expected taste and texture will have a significant impact over future purchase decisions. Additionally, flesh damage is not an issue, which signals good postharvest practices along the supply chain.

In the long term, the industry should start looking at growth areas to unlock value from the consumers' side. Our results suggest that consumers have a very positive view about Florida origin; however, it remains to be seen to what extent it might be possible for the industry to get additional gains on this value proposition. Low calorie content was thought to be one of the strongest selling points for green-skin avocados; however, consumer preferences for higher fat content presents an opportunity for the industry to evaluate consumers acceptance of green-skin avocado cultivars with a higher oil content; it seems an area worth to explore. Demographic trends are a tailwind for the Florida green-skin avocado industry, Hispanics are the ethnic group with the highest grow rate in the US, in the near future it will continue to be the natural target market for green-skin avocados.

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