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Abstract

Ethylene treatment has proven an effective way to shorten the postharvest period required for winter Anjou pears to ripen and allows market availability year round. However, the eating quality of pears may vary under different treatments. A sensory experiment and a consumer survey including valuation, assessments of sensory characteristics, purchasing habits, and demographics were conducted. Analysis indicates that the treatment-induced eating quality significantly affects consumers' willingness to pay (WTP). Mean WTP for each treatment indicates that consumers prefer the pears with a 6-day treatment and on average are willing to pay a premium of $0.25/pound compared to the market price.

Key words: Pears, Sensory, Willingness to pay

JEL: Q13, M31

Running Head: Treatment-induced Quality in Pears

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Introduction

The Anjou pear is one of the most popular pear varieties in the United States. Ninety-eight percent of U.S. Anjou pears are grown in the Pacific Northwest with an average production of 9.8 million boxes (44 pounds per box) each year (Washington Growers Clearing House, 2009). However, the feasibility of marketing immediately after harvest is challenging owing to Anjou pears' ripening requirements. To generate the normal ripening capacity for Anjou pears, which are harvested at optimal commercial maturity,[1] the fruit needs to be conditioned at 30°F (-1°C) for a period of 60 days. The pears without sufficient chilling are termed as "under-chilled" fruit. As Anjou pears are harvested in September, consumers who purchase pears packed prior to November typically complain that the fruits do not soften sufficiently after one week of ripening at room temperature (Kupferman 1994). Thus, the requirement of the chilling period prevents the market availability of Anjou pears with a desirable eating quality during September and October each year.

Scientists have developed ethylene treatments that shorten the conditioning time for Anjou pears. Chen et al. (1996) found that a that-day conditioning treatment with ethylene is sufficient to induce normal ripening capacity of under-chilled Anjou pears, which allows year-round marketing of Anjou pears. One purpose of this study is to evaluate consumers' response

[1]The optimum commercial maturity for Anjou pears requires flesh firmness between 66.7N (15 lbs force) and 57.8N (13 lbs force) (Chen and Mellenthin 1981).

to fresh pears' sensory characteristics after being conditioned with ethylene. This article investigates the level of the sensory qualities that consumers prefer in pears and how much they are willing to pay for these qualities. Further, we examine which ethylene treatment induces the optimal sensory qualities.

There have been many previous studies that investigate the relationship between food product attributes and consumer preferences. External attributes such as size, grade, cultivars, and reputation are found to be important influences on product price and demand (Tronstad, Huthoefer, and Monke 1992, Carew 2000, Quagrainie, McCluskey, and Loureiro 2003). However, internal attributes or eating quality are key drivers which determine repeated purchases (Kajikawa 1998, Brennan and Kuri 2002, Miller et al. 2005, McCluskey et al. 2007). Kajikawa (1998) argued that internal apple characteristics such as brix, brix/acid ratio, and juiciness have a significant effect on the prices of imported apples in Japan. McCluskey et al. (2007) found that firmness and soluble solids content significantly affect consumers' willingness to pay for Washington Gala apples. Miller et al. (2005) reported that consumers make the decision to purchase apples based on their experiences with internal attributes such as taste and flavor. Moreover, Brennan and Kuri (2002) found that once consumers develop a preference for a product based on sensory characteristics, it is unlikely that they will change.

The measurements of internal attributes, especially for fresh fruit, can be obtained in multiple ways: public information, measurements with scientific instruments, and sensory analysis with either trained panels or consumers. In a hedonic price analysis of the Japanese market for imported apples, Kajikawa (1998) used publicly available varietal sample averages for growing regions by season to represent the attributes of apples including brix, acid and juiciness. McCluskey et al. (2007) used scientific instruments including both destructive and

non-destructive measurements to identify the objective eating quality of Washington apples, as well as the sensory analysis to obtain the subjective assessments from consumers.

Sensory analysis is a method that can be used to quantify and understand consumer responses to food products. Foster (2004) argued that this approach helps researchers to understand and manipulate formulations in a predictable fashion helping clients to develop a successful product. This method has been applied to the economic studies in a wide range of products including wine, dairy, cigars, cheese, meat, citrus, and coffee (Combris, Lecocq, and Visser 1997, Maynard and Franklin 2003, Freccia, Jacobsen, and Kilby 2003, Grunert et al. 2004, Hobbs 2006, Poole et al. 2007, Donnet et al. 2008).

Sensory analysis has also been applied to pears. Predieri et al. (2002) conducted a sensory analysis to evaluate different indicators of preference for two varieties: Harrow Sweet and Williams Bartlett from the Emilia-Romagna region in Italy. They found that a longer shelf-life was positively correlated to perceived juiciness, sweetness, and aroma. Turner et al. (2005) conducted a sensory evaluation of multiple pear products including red and green Anjou, red and green Williams, Bosc, and Comice grown in the U.S. Pacific Northwest. They found that red and green Anjou pears were ranked lower than the other varieties. Their study is a content analysis of pear appearance rankings and overall liking scores, and no eating quality attributes are analyzed.

Willingness to pay (WTP) studies for pear quality attributes have also been performed in previous studies. Gamble et al. (2006) conducted a conjoint analysis to evaluate how consumers value appearance aspects on pears. Combris et al. (2007) conducted an experimental auction to measure the effect of information on the willingness-to-pay for Rocha pears. They found that having access to safety information and tasting the fruit reduced the premium individuals were

willing to pay for a higher concentration of soluble solids.

The current article utilizes sensory analysis and the contingent valuation (CV) method to evaluate consumers' WTP for Anjou pears with different levels of ethylene treatment. The objective of this study is to estimate a model that examines the relationship between sensory attributes and consumers' WTP for Anjou pears and to test whether the level of ethylene treatment plays an essential role in determining consumers' WTP. A sensory experiment and a consumer survey were conducted to obtain consumers' assessments on pears' eating quality as well as the socio-demographic characteristics, which both affect consumers' WTP for pears. A double-bounded dichotomous choice CV model is employed to estimate consumers' WTP for Anjou pears and the mean WTP for pears with each of the four levels of ethylene treatments: 2 days, 4 days, 6 days with ethylene, and 7 days without ethylene treatment. This study provides information for pear producers regarding the most suited post-harvest conditioning procedure for Anjou pears, which induces the most desirable eating quality to fit consumers' preferences.

The remaining sections are organized as follows. The contingent valuation method is presented in the next section. This is followed by the description of the survey data and the discussion of results and implications. Conclusions are drawn the final section.

Methodology

The CV approach is commonly used to elicit consumer's willingness to pay through a dichotomous choice, market-type questioning format. There are typically two types of bidding procedures used in dichotomous choice CV approaches: the single-bounded and double-bounded dichotomous choice. The double-bounded approach had been proven to be asymptotically more

efficient than the single-bounded approach (Hanemann et al. 1999). The single-bounded approach involves only one bid amount by asking participants one dichotomous choice question. The binary responses of participants will be either "yes" or "no" reflecting whether they are willing to buy the product at the offered price. The double-bounded approach engages in two consecutive bids in which the second bid is contingent upon the response to the first bid. That is, a participant is first offered an initial bid and is asked whether he or she is willing to buy the product, if the answer is "yes", which means the individual is willing to pay the amount of the first bid, then a higher price will be presented to the individual as the second bid. If the answer to the first bid is "no", which means the individual is not willing to pay the amount of the initial bid, then she or she will be presented with a lower price as the second bid. Therefore, each individual gives two responses to the two successive bids. The four possible outcomes of responses in a double-bounded model will be: "no, no," "no, yes," "yes, no," and "yes, yes."

Since consumers' WTP is a latent variable which is not directly observable, the sequential questions serve to place upper and lower bounds on the true WTP in a way that consumers' WTP can be partitioned into four intervals based on the answers to the double-bounded bidding questions: (1) $(-\infty, B_D)$, the respondent's WTP is lower than the offered discounted price B_D when both bids are rejected ("no, no"); (2) $[B_D, B_I)$, the respondent's WTP is between the lower bid B_D and the initial bid B_I when the initial bid is rejected but the lower bid is accepted ("no, yes"); (3) $[B_I, B_P)$, the respondent's WTP is above the initial bid but lower than the higher bid B_P when the initial bid is accepted but the higher bid is rejected ("yes, no"); (4) $[B_P, +\infty)$, the respondent's WTP is higher than the premium price when both bids are accepted ("yes, yes").

Let WTP_i denotes individual *i*'s WTP for the tasted pear. The discrete outcomes of the bidding process are:

$$(1) \qquad Y = \begin{cases} 1 & if \;\; WTP_i < B_D \\ 2 & if \;\; B_D \le WTP_i < B_I \\ 3 & if \;\; B_I \le WTP_i < B_P \\ 4 & if \;\; WTP_i \ge B_P \end{cases}$$

The WTP function (or bid function) for the specific type of pear for individual *i* is specified as:

$$(2) \qquad WTP_i = \alpha - \rho B_i + \lambda' z_i + \varepsilon_i, \qquad \text{for } i = 1, \ldots, n$$

where B_i is the ultimate bid that individual *i* faces, z_i is a vector of explanatory variables associated with individual *i*, including the assessments of eating attributes and the demographics; the error term ε_i captures possibly unobservable factors and characteristics affecting the decision. α, ρ, and λ are the unknown parameters to be estimated. The distribution of the error term is assumed to follow a cumulative logistic distribution with mean zero and variance σ^2, i.e., $\varepsilon \sim G(0, \sigma^2)$. In the empirical implementation of the model, we define G(·) to have a standard logistic distribution having zero mean and standard deviation $\sigma = \pi / \sqrt{3}$.

The qualitative dependent variable in (1) can be expressed as the choice probability for individual *i*:

$$(3) \qquad \Pr(Y_i = j) = \begin{cases} = \Pr(WTP < B_D) = G(\alpha - \rho B_D + \lambda' z_i) = \dfrac{e^{\alpha - \rho B_D + \lambda' z_i}}{1 + e^{\alpha - \rho B_D + \lambda' z_i}} \\ = \Pr(B_D \le WTP < B_I) = G(\alpha - \rho B_I + \lambda' z_i) - G(\alpha - \rho B_D + \lambda' z_i) = \dfrac{e^{\alpha - \rho B_I + \lambda' z_i}}{1 + e^{\alpha - \rho B_I + \lambda' z_i}} - \dfrac{e^{\alpha - \rho B_D + \lambda' z_i}}{1 + e^{\alpha - \rho B_D + \lambda' z_i}} \\ = \Pr(B_I \le WTP < B_P) = G(\alpha - \rho B_P + \lambda' z_i) - G(\alpha - \rho B_I + \lambda' z_i) = \dfrac{e^{\alpha - \rho B_P + \lambda' z_i}}{1 + e^{\alpha - \rho B_P + \lambda' z_i}} - \dfrac{e^{\alpha - \rho B_I + \lambda' z_i}}{1 + e^{\alpha - \rho B_I + \lambda' z_i}} \\ = \Pr(WTP \ge B_P) = 1 - G(\alpha - \rho B_P + \lambda' z_i) = 1 - \dfrac{e^{\alpha - \rho B_P + \lambda' z_i}}{1 + e^{\alpha - \rho B_P + \lambda' z_i}} \end{cases} \quad for \quad j = \begin{Bmatrix} 1 \\ 2 \\ 3 \\ 4 \end{Bmatrix}$$

The log-likelihood function is:

(4) $$L = \sum_i \begin{cases} I_{Y_i=1} \ln G(\alpha - \rho B_D + \lambda' z_i) \\ + I_{Y_i=2} \ln[G(\alpha - \rho B_I + \lambda' z_i) - G(\alpha - \rho B_D + \lambda' z_i)] \\ + I_{Y_i=3} \ln[G(\alpha - \rho B_P + \lambda' z_i) - G(\alpha - \rho B_I + \lambda' z_i)] \\ + I_{Y_i=4} \ln[1 - G(\alpha - \rho B_P + \lambda' z_i)] \end{cases}$$

where $I_{Y_i=j}$ is an indicator function for the event that individual *i* chooses the j^{th} alternative. Maximum likelihood method is the commonly used approach to estimate the model.

Mean WTP and Marginal Effects

There are two ways to compute the mean WTP in literature. An approach proposed by Hanemann (1989) is to re-estimate the likelihood function by restricting all the λ's to be zero and obtain the constrained $\tilde{\alpha}_j$ and $\tilde{\rho}_j$, the mean WTP for the j^{th} sample is then calculated as $\tilde{\alpha}_j / \tilde{\rho}_j$. An alternatively approach is based on a random utility framework, where consumers are willing to buy Anjou pears when the utility of purchasing the pears is at least as great as purchasing the other commodities (Kaneko and Chern 2003). The mean WTP can be calculate as $(\alpha + \lambda' z_i)/\rho$. The latter approach is used in this study since consumers' demographic characteristics are considered playing a role in affecting their willingness to pay for Anjou pears.

The marginal effect of an explanatory variable on WTP represents the impact of an incremental change in the variable on consumers' mean willingness to pay for Anjou pears. It can be calculated as the partial derivative of the mean WTP function with respect to the k^{th} explanatory variable: $\partial(WTP)/\partial z_k = \lambda_k / \rho$.

Data

The sample pears were commercially harvested from one orchard in mid-September 2008 and were placed at room temperature (72°F) for 24 hours prior to storage in the cold (33°F). Then they were moved to a conditioning room held at 65°F to 74°F for treatments with or without ethylene (2 days, 4 days, 6 days with ethylene, and 7 days without ethylene). Following conditioning, all fruit were returned to cold storage (33°F) to simulate transit. Before they were presented to consumer for evaluation, the fruit were ripened at room temperature (68°F) for 3 days to simulate what a consumer would usually after purchase.

A consumer survey including the sensory experiment was conducted in Portland, Oregon, in October, 2008. Recruitment of participants for each test consisted on sending an online *screening* questionnaire to about 5,000 consumers in the Portland, Oregon metro area, individuals were asked about their willingness to participate in the pear taste test. Of those who completed the questionnaire, a planned sample size of 120 consumers were recruited and offered a $25 incentive for their participation (Meilgaard et al. (1999) suggests a standard sample size for a central location test of over 100 consumers. We recruited 20 extra participants for each test to account for last minute cancellations).

Participants were asked to taste the four samples of Anjou pears with different treatments, then they were asked to rate the attributes of tasted pears including overall desirability, flavor, sweetness, juiciness, firmness, and texture, using a 9-point Likert scale, with 1 denoting "dislike extremely," 5 denoting "neither like nor dislike," and 9 denoting "like extremely." The order of sample presentations was random by treatment, and the respondents were not informed about the treatment any sample received.

CV questions were asked in conjunction with the taste experiment. The participants were also asked about their preferences for pears and shopping habits, as well as demographic information. Summary statistics of the main socio-demographic variables are presented in Table 1. A comparison of the participants' demographics with the 2000 U.S. Census for Portland, Oregon is presented in Table 2. Table 3 presents summary statistics of consumers' ratings for the sensory characteristics of the sample pears across different ethylene treatments. Results indicate that there were not statistically significant differences between overall liking, flavor, sweetness, and texture across 2-days ethylene and 7-days without ethylene. Whereas, rating for the same variables, for the 6-day ethylene treatment were higher than 4-day ethylene treatment. Juiciness across treatments were all statistically significant different. As for firmness, there were no differences between 6 and 4-day ethylene treatment, but the 2-days samples were rated firmer than the 7-days without ethylene.

The majority of the survey respondents were Caucasian (91%) and female (78%). These proportions are higher than those for the general population in Portland. The median age of the participants was in the range 35 to 44 years, which contains the median age of the population 35.2. Only 25% of the responded households had children under 18 years old. The level of education in our sample is higher than the general population. Thirty-one percent have 2-year college or technical degree, and 69% have a Bachelor's or higher degree. The median income was within the range $40,000 to $59,999, which was also the mode income range, containing the median household income $40,146.

Sixty-four percent of the respondents reported that they eat fresh pears every week when they are in season. The vast majority (90%) of the respondents prefer "locally grown" pears. Most people consider price as an important factor when purchasing pears with 60% "somewhat

important" and 20% "extremely important." Appearance (lack of blemishes) is also considered important by many consumers (69%). Twenty-four percent of the respondents answered that it is "extremely important" for pears to be organic, and 46% reported being organic is "somewhat important." About 48% stated that they usually buy organic pears. These percentages for buying organic questions reveal that a considerable proportion of respondents value organic as an important character of pear quality. This result is consistent with the findings of a national survey that Portland, Oregon, is the top ranked U.S. city for consumer understanding and preferences for organic products (D'Ambrogi 2006.)

The WTP questions in this study were designed based on the double-bounded dichotomous choice format to elicit consumers' WTP for Anjou pears with different levels of ethylene treatment. After tasting one pear sample, the respondents were asked if they would be willing to purchase the pears at an initial price $1.49/lb. This initial price was selected based on the average of pear prices in the grocery stores during the first week of October 2008 in the Portland metropolitan area, where the survey was conducted. A follow-up question was asked regarding whether they would like to pay a discounted or premium price contingent on their response to the initial price. If the initial response was "no," the discounted price was then randomly set at one of the following levels: $1.39/lb, $1.29/lb, $1.19/lb, $1.09/lb, or $0.99/lb. Similarly, if the initial response was "yes," the premium price was randomly set at one of the following levels: $1.59/lb, $1.69/lb, $1.79/lb, $1.89/lb, or $1.99/lb. The distribution of responses to the discount and premium bids offered is presented in Table 4.

In response to the questions about preferences for pear attributes, most respondents indicated that they preferred the pears with 6-day ethylene treatment, followed by the 4-day treatment, then the 2-day treatment pears, and least liked the pears that did not receive an

ethylene treatment. The average overall desirability rating was 7.46 out of 9 for 6-day treatment pears, and only 4.26 for pears without ethylene treatment. The ratings reveal that flavor, sweetness, juiciness, and texture, improved in the opinion of the respondents significantly by increasing the number of days with ethylene treatment. Correspondingly, a majority of the respondents (76%) were willing to pay a premium for the 6-day treatment pears, and about half (46%) were glad to pay even above the premium price. Only half of the consumers were willing to pay a premium for the 4-day treatment pears, and the other half rejected buying the pears at the initial price $1.49/lb. For the 2-day treatment and no treatment samples, most of the respondents (79% and 77%, respectively) expressed that they would not buy the pears at the initial price, and over half of the respondents (49% and 58%, respectively) would not buy the pears if offered at the discounted price.

Model Specification

Due to multicollinearity among the variables representing the pear characteristics, sweetness, juiciness and firmness are chosen as the representative tasting factors in the empirical model, owing to their importance as internal attributes of fresh fruit according to previous studies (Kajikawa 1998, McCluskey et al. 2007). Consumers' demographic variables age, gender, children, ethnicity, and income are also included. We utilize the following model specification[2]:

[2]Alternative models were also estimated, including models which grouped the data by treatment and a model with pooled data that utilized interaction of the treatment and attribute variables. The reason for considering alternative model specifications was to identify whether there exists a

(5) $$WTP_{ij} = \alpha_j - \rho_j B_{ij} + \lambda_{j1} Sweetness_{ij} + \lambda_{j2} Juiciness_{ij} + \lambda_{j3} firmness_{ij} + \lambda_{j4} Children_{ij}$$

$$+\lambda_{j5} Age_{ij} + \lambda_{j6} Gender_{ij} + \lambda_{j7} Ethnicity_{ij} + \lambda_{j8} Income_{ij} + \lambda_9 D_2 + \lambda_{10} D_4 + \lambda_{11} D_6 + \varepsilon_i ,$$

Where $i = 1, \ldots, n$, denotes the i^{th} individual; $j = 1, 2, 3, 4$, represents the j^{th} sample; B_i is the final bid that individual *i* was offered; *Sweetness, Juiciness,* and *Firmness* are individual *i*'s ratings for the pear attributes; *Children* indicates the presence of children under 18 years old in the household; *Age* indicates the respondent's age group; *Gender* indicates whether the respondent is male; *Ethnicity* indicates the individual is Caucasian; *Income* indicates the income level of the household; D_2, D_4, D_6 are variables indicating the tasted sample received 2 days, 4 days, and 6 days ethylene treatment, respectively; and α, ρ, and λ*'s* are unknown parameters to be estimated.

Results and Implications

The model in (5) was estimated using maximum likelihood with the GAUSS statistical package. The parameter estimates are presented in Table 5. As expected, the coefficient for the bid is negative and statistically significant in all estimated versions of the model. This implies that pears are a normal good, and, *ceteris paribus*, consumers are less likely to buy a good that is more expensive. We first discuss the model with variables indicating the three types of ethylene

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treatment effect or interactions in addition to the treatment-induced pear attributes, and whether the effects of the pear attributes on consumers' WTP differ across samples. The estimation results are similar across the models and thus are not presented in this article. Interested readers can obtain the results from the authors upon request.

treatment effects: 2 days, 4 days, and 6 days. The three sensory variables *Sweetness*, *Juiciness* and *Firmness* are all positive and statistically significant. At the same time, the three treatment indicator variables are all insignificant, which suggests that it is the treatment-induced eating qualities that affect consumers' willingness to pay. The estimation results are similar across the models with and without the treatment indicator variables. The three sensory variables *Sweetness*, *Juiciness* and *Firmness* are all positive and statistically significant. The significance of these variables suggests that these sensory attributes are important for consumers' purchase decisions. The demographic variables are insignificant except for the *Children* variable, which has a positive and significant relationship with WTP.

The marginal effects associated with explanatory variables are presented in Table 7. *Firmness* has the largest marginal effect among the sensory variables, suggesting that it is a key factor that affects consumers' willingness to pay. Based on the pooled model without treatment indicators, consumers are willing to pay 5.7¢, 3.7¢, and 8.5¢ more, respectively, as the rating of *Sweetness*, *Juiciness* and *Firmness* increases by one. The respondents with children under 18 years old are on average willing to pay 9.6¢ more to buy Anjou pears than those without children.

We now examine consumers' mean WTP for pears with different levels of ethylene treatments. Following Kaneko and Chern's (2003) approach, the mean WTP is calculated as the ratio $(\alpha + \lambda' z_i)/\rho$. The estimated mean WTP's for the Anjou pears with different levels of ethylene treatment are presented in Table 8. On average, consumers are willing to pay \$1.74/lb, \$1.53/lb, \$1.19/lb, and \$1.09/lb for the four types of pears with 6-day, 4-day, 2-day ethylene treatment, and 7-day without ethylene treatment, respectively. This result indicates that 6-day ethylene treatment is most desirable among the four to induce the "target" eating quality that

consumers most prefer. Compared to the average market price $1.49/lb, consumers were willing to pay a premium of $0.25 and $0.04 for the pears with 6-day and 4-day ethylene treatments, respectively.

Conclusions

Firms want to supply what consumers want. In the case of Anjou pears, supplying pears with optimal sensory characteristics can be difficult because of the way the product ripens. This challenge limits market availability during September and October each year. Treatments with ethylene may solve this problem by shortening the conditioning time of Anjou pears. However, the eating quality of pears may vary as the treatment time differs. It is important for pear producers to understand how conditioning with ethylene treatment affects eating quality attributes and consumers' willingness to pay.

This article uses sensory analysis and contingent valuation to evaluate consumers' WTP for pears with different levels of ethylene treatments. A taste experiment and a consumer survey were conducted to collect data on consumers' WTP, their assessments of pear characteristics, and their demographics. We find that treatment-induced sensory characteristics significantly affect WTP. The sensory variables *Firmness*, *Sweetness*, and *Juiciness* are significant factors explaining consumers' WTP. Respondents with children under 18 years old have a higher WTP. The mean WTP's for pears with the four types of treatments are $1.74/lb, $1.53/lb, $1.19/lb, and $1.09/lb, for 6-day, 4-day, 2-day ethylene treatments, and 7-day without ethylene treatment, respectively; compared to the benchmark average price of $1.49/lb in Portland-area grocery stores at the time of the experiment. This implies that consumers are willing to pay a premium

of $0.25/lb for the pears that receive the 6-day treatment compared to the market price. The pears without ethylene treatment have the least desirable eating qualities.

Finally, an important aspect deemed not the focus of this study yet worth mentioning, is the potential cost to the industry from adopting this technique. Costs are not to estimate simplistically. Whereas the inputs needed to apply ethylene are a storage room able to keep temperature at about 16-21 °C (60-70 °F) and an ethylene dispenser, there might be additional costs implicitly related. For example, handling and shipping pears with lower firmness might require extra caution during transit, supermarket storage, and shelf. This paper provides evidence that premium prices could be realized if applying ethylene to Anjou pears in early stages after harvest. To estimate the costs and benefits of applying ethylene along the whole marketing chain was not our aim and requires further thorough investigation.

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Table 1. Summary Statistics for Demographic Variables

Variable	Description	Frequency
Age	Age group of the participants:	
	18-24	5.83%
	25-34	26.67%
	35-44	20.00%
	45-54	23.33%
	55-64	20.00%
	65+	4.17%
Gender	1 if male	21.67%
	0 if female	78.33%
Children	1 if there are children under 18 years old in the household	25.00%
	0 otherwise	75.00%
Ethnicity	1 if white	90.83%
	0 otherwise	9.17%
Education	Education group of the participants:	
	1 = high school or technical degree	30.83%
	2 = four-year college degree	40.00%
	3 = advanced degree	29.17%
Income	Income group of the participant:	
	1 = <$40,000/year	26.67%
	2 = $40,000 - $ 59,999/year	26.67%
	3 = $60,000 - $ 79,999/year	16.67%
	4 = $80,000 - $ 119,999/year	20.83%
	5 = $120,000 /year or more	9.17%

Table 2. Comparison of Main Demographics Between the Participants and the Portland, Oregon Population

Socio-demographic Characteristic	Sample	Portland Population
% of Female	78.33%	50.60%
Median Age	35 - 44	35.2
% of White	90.83%	77.90%
% of Households with children under 18 years old	25.00%	18.60%
Median of Household Income	$40,000 - $59,999	$40,146

Table 3. Summary Statistics of Consumers' Ratings for Anjou Pears with Ethylene Treatment for Different Numbers of Days

	2-days with ethylene		4-days with ethylene		6-days with ethylene		7-days without ethylene	
Variable	**Mean**	**Std**	**Mean**	**Std**	**Mean**	**Std**	**Mean**	**Std**
Overall desirability	4.44c	1.96	6.31b	1.73	7.46a	1.60	4.26c	2.35
Flavor	4.74c	1.93	6.40b	1.72	7.43a	1.44	4.68c	2.11
Sweetness	3.92c	1.92	5.69b	1.99	7.07a	1.92	3.63c	2.04
Juiciness	3.13c	1.94	5.79b	2.06	7.94a	1.42	2.42d	1.58
Firmness	4.90b	2.04	6.36a	1.94	6.92a	1.79	4.22c	2.45
Texture	4.11c	2.06	5.99b	2.01	7.22a	1.59	4.04c	2.28

*Scale: 1 – 9, with 9 denoting most preferred.

*Letters should be read by row for each variable. Different letters denote statistically significant differences, same letters denote not statistically significant differences.

Table 4. Percentage of Respondents in Each WTP Category by Treatment Level

WTP category	Response	2-days with ethylene	4-days with ethylene	6-days with ethylene	7-days without ethylene
$(-\infty, B_D)$	"no, no"	48.70%	24.79%	6.90%	57.89%
$[B_D, B_I)$	"no, yes"	30.43%	22.22%	17.24%	19.30%
$[B_I, B_P)$	"yes, no"	14.78%	25.64%	29.31%	12.28%
$[B_P, +\infty)$	"yes, yes"	6.09%	27.35%	46.55%	10.53%

Table 5. WTP Estimation Results for Anjou Pears

	Without treatment Indicator variables			With treatment Indicator variables		
Variable	**parameter**	**std**	**p-value**	**parameter**	**std**	**p-value**
Intercept	2.884***	0.585	0.000	3.068***	0.607	0.000
Bid	-5.305***	0.333	0.000	-5.330***	0.334	0.000
Sweetness	0.304***	0.063	0.000	0.307***	0.063	0.000
Juiciness	0.197***	0.053	0.000	0.158**	0.069	0.022
Firmness	0.453***	0.056	0.000	0.457***	0.057	0.000
Children	0.510**	0.239	0.033	0.512**	0.239	0.033
Age	-0.023	0.078	0.766	-0.025	0.078	0.746
Gender	-0.142	0.235	0.545	-0.142	0.235	0.546
Ethnicity	-0.176	0.326	0.589	-0.165	0.326	0.611
Income	-0.102	0.079	0.199	-0.101	0.080	0.206
D2	--	--	--	-0.244	0.288	0.396
D4	--	--	--	0.054	0.324	0.866
D6	--	--	--	0.213	0.401	0.596

***, **, * denote significant levels of .01, .05, .1, respectively

Table 6. Marginal Effects of Explanatory Variables, All Treatments

	Without treatment Indicator variables			With treatment Indicator variables		
Variable	**parameter**	**std**	**p-value**	**parameter**	**std**	**p-value**
Sweetness	0.057***	0.012	0.000	0.058***	0.012	0.000
Juiciness	0.037***	0.010	0.000	0.030**	0.013	0.022
Firmness	0.085***	0.010	0.000	0.086***	0.010	0.000
Children	0.096**	0.045	0.033	0.096**	0.045	0.032
Age	-0.004	0.015	0.766	-0.005	0.015	0.746
Gender	-0.027	0.044	0.545	-0.027	0.044	0.546
Ethnicity	-0.033	0.061	0.590	-0.031	0.061	0.612
Income	-0.019	0.015	0.199	-0.019	0.015	0.205
D2day	--		--	-0.046	0.054	0.395
D4day	--		--	0.010	0.061	0.866
D6day	--		--	0.040	0.075	0.596

***, **, * denote significant levels of .01, .05, respectively.

Table 7. Mean WTP for Anjou Pears with Different Levels of Ethylene Treatment

	2-days with ethylene			4-days with ethylene		
Variable	**parameter**	**std**	**95% Confidence Interval for Mean WTP**	**parameter**	**std**	**95% Confidence Interval for Mean WTP**
WTP	1.19***	0.036	(1.12, 1.26)	1.53***	0.033	(1.46, 1.59)
	6-days with ethylene			**7-days without ethylene**		
Variable	**parameter**	**std**	**95% Confidence Interval for Mean WTP**	**parameter**	**std**	**95% Confidence Interval for Mean WTP**
WTP	1.74***	0.034	(1.67, 1.81)	1.09***	0.053	(0.98, 1.19)

*, **, *** denote significant levels of .1, .05, .01, respectively.