Project title: Pear Consumer Preference Testing

Report type: Final Project Report

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Item	(type current year here)	(type additional year if relevant)
Salaries		
Benefits		
Supplies: Pears, Pear transport, pear conditioning, Trained panel profiling of pears, chemical analyses	$20,000	
Travel		
Total	$20,000	Total year 2

Budget 2
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Item	(type current year here)	(type additional year if relevant)
Salaries	$11,455	
Benefits	$5,125	
Wages		
Benefits		
Equipment		
Supplies	$300	
Travel	$900	
Miscellaneous – Panelist payment	$7,200	
Total	$24,980	Total year 2

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Item	(type current year here)	(type additional year if relevant)
Salaries		
Benefits		
Wages - for data analysis	$5,000	
Total	$5,000	Total year 2

Objectives
The objective of this project was to identify the pear sensory characteristics considered to be desirable by consumers in the Pacific Northwest (PNW). Previous research has provided information regarding the traits that make a well-liked pear, but this current research project proposed testing new varieties, and seeking to understand what sparks consumer interest in pears in current Pacific Northwest consumers. We were able to fully accomplish the objectives of this project.

Significant findings
- Twenty-three pear' varieties with varied sensory properties were profiled by a trained sensory panel (n=10) and important differences among those properties were identified between them.
- Consumer (n=219) testing of 12 pear varieties determined the sensory attributes (pear flavor, sweetness and juiciness) that mostly influenced their acceptability and willingness to pay.
- Relationships among sensory properties (from the trained sensory panel) and the consumer liking of the pears were determined and allowed to identify consumer preferences.
- Consumer preferences of 12 pear varieties (Bartlett and Seckel in the summer set and Paragon, Green Anjou, Concorde and Comice in the winter set) were determined.
- Willingness to pay showed different tiers, for Summer varieties, first Bartlett, followed by the second tier 573 and Seckel, and the third tier 642, 417, and 720. For Winter varieties there are two tiers, the first one composed by Paragon, Concorde, and Green Anjou and the second one composed by Comice, Gem (not ripened), and Bosc.

Results and Discussion

Pears used in the research
One key objective of this research was to source a large and diverse array of pears for both the descriptive analysis and consumer sensory evaluation portions of the study. Many growers, researchers and other stakeholders were interviewed for advice and pear sourcing suggestions in the months leading up to the trials to ensure a large and diverse sample of fruit was available for evaluation. A large sample set of **23 pears** (11 summer and 12 winter varieties) were obtained for descriptive analysis and instrumental measures. Pears were evaluated at two time points, October, and December, depending on their seasonality. Based on the findings obtained through the descriptive analysis procedure, a diverse set of six pears per trial were selected for consumer sensory evaluation at the Oregon State University Food Innovation Center (OSU FIC) in Portland, OR. Each set of six pears represented a range of seasonal pear sensory attributes on offer within the U.S. Varieties tested are listed in **Table 1.** Codes were used to identify proprietary varieties.

Instrumental measurements of the pears evaluated by the trained panel
For both summer and winter season, there were significant differences ($p<0.05$) in most of the physicochemical measurements conducted in twelve of the varieties profiled by the trained panel (see **Table 2** and **3**). The selection of these set of pears reflected those that were tested by the consumers. The **summer varieties** presented highly significant ($p<0.0001$) differences on the means of all the physicochemical measurements conducted (**Table 2).** For weight, the values ranged between 126.0-310.9g. 720 presented the highest weight of the six varieties, and Seckel the lowest. The other four varieties presented more similar weights that ranged between 186.1-230.6g. Hunter et al. (2009) reported mean fruit weights of approximate 231g for 720 and 135g for Bartlett. In our study the weights for these two varieties were higher.

Firmness was the measurement that presented more differences among the six varieties. Typically, the firmness of pears is between 6-7kg when harvested, and between 2-3kg or less when ready for consumption (S. Musacchi, personal communication). Based on this fact all summer varieties had an optimum for consumption except for 720 (5.6kg) and 642 (5.3kg). Bartlett presented the lowest firmness (0.8kg). Seckel and 573 had very similar firmness. The soluble solids content (SSC), ranged between 12.3 and 16.3°Brix. There were not significant differences on the SSC of most of the tested varieties, specifically Bartlett, 573, 720 and 417. The most distinct pear was Seckel that presented the highest content of SSC.

The results of the physicochemical characterization of the winter varieties are shown in **Table 3**. The mean weight of the six selected varieties ranged from 186.5 to 262.4g. Concorde presented the highest mean weight (262.4g) and was significantly different from the mean weight of Paragon (186.5g), Comice (196.5g) and Green Anjou (204.8g). The firmness means of the six varieties were among the range consider optimum for consumption. The two varieties with the highest firmness were Gem (not ripened) (3.3kg) and Green Anjou (3.1kg). The firmness of the other four varieties was around 1kg or less. Vaysse et al. (2005) reported a firmness of 1.1kg for Comice before consumption. Jaeger et al. (2003) reported a firmness of 0.6 kg for ripe Comice and 1.7kg for ripe Bosc. The findings of these two studies align with the results we obtained for these two varieties. The mean SSC ranged from 10.2 to 18.6°Brix. Bosc presented the lowest SSC (10.2°Brix). Jaeger et al. (2003) reported an SSC of 12.3 g for ripe Bosc. The variety with the highest content of soluble solids was Paragon (18.6°Brix).

Trained Panel Descriptive Analysis
A total of 10 (80% female) panelists within an age range of 24-60 years old and with previous experience in conducting descriptive analysis underwent a training period of 15 hours. The training

was divided in 10 sessions of 1.5h each within a period of 3 weeks and one day. Over a series of training sessions, the panelists were familiarized with the sensory characteristics, terms and reference standards that have been previously used for the sensory profiling of pears for pears (Jaeger et al., 2003). The final list of attributes comprised 18 attributes, of which eight were related to aroma/ flavor, three to taste, one to mouthfeel and six to texture.

Summer Pears: The PCA of the significant attributes (p<0.05), explained 65.40% of the variation among the summer pears, with 49.86% and 15.54% explained by PC1 and PC2, respectively (**Figure 1**). PC1 was defined by the positively loaded attributes *pear flavor, pear aroma*, *grassy/green aroma* and *flavor*, *floral aroma* and *flavor*, and *sour* in contrast to the negatively loaded attributes of *fruity flavor*, *apple aroma* and *flavor,* and *astringent*. PC2 was associated with the contrasting relationship of *apple flavor,* and *fruity flavor* with *vanilla flavor*, *stemmy/woody aroma* and *juicy*. Pear varieties such as 573, Sylvania had higher associations with positively loaded attributes on PC1 while varieties like 720 and 391 had higher association with negatively loaded attributes.

Winter Pears*:* The PCA of the significant attributes (p<0.05), explained 69.62% of the variation among the winter pears, with 50.52.86% and 19.10% explained by PC1 and PC2, respectively (**Figure 2**). PC1 was defined by the positively loaded attributes *pear flavor* and *aroma*, *juicy, sweet*, f*ruity aroma* and *flavor*, and *vanilla aroma* and fl*avor* in contrast to the negatively loaded attributes of *grassy/green flavor*, *apple flavor, sour* and *astringent*. PC2 was associated with the contrasting relationship of *grassy/ green aroma and flavor* with *bitter*, *stemmy/woody flavor* and *other flavor*. Pear varieties such as Comice, Paragon and Concorde had higher associations with positively loaded attributes on PC1 while varieties like Green Anjou and Gem (not ripened) had higher association with negatively loaded attributes.

Consumer Sensory Evaluation
Two large-scale consumer sensory evaluation tests were conducted at the OSU FIC in Portland, OR. Consumer sensory evaluations were conducted to assess the quality of 12 pear varieties (six summer varieties and 6 winter varieties) to understand the effect of appearance, flavor and texture on consumer acceptability, willingness to pay and purchase intent.

Over 100 consumers were used for each sensory study (ie. Summer pears tested in October and winter pears tested in December). Consumers were recruited from the Portland Metro Area through the OSU FIC database and pre-screened for pear purchase behavior, consumption habits and demographics. Consumers who participated were given a $40 incentive to participate in the one-hour sensory test. Pears for the sensory evaluations were sliced just prior to each session. Sensory data were collected with Compusense® software. Consumer sensory evaluation of appearance, aroma, color, flavor, texture, firmness, juiciness, crunchiness, sweetness, tartness, and aftertaste was conducted utilizing 9-point hedonic scale ratings, just about right (JAR) scales, open ended questions, and willingness to pay. Sensory ratings for each attribute were analyzed using analysis of variance.

Summer pears: Consumers rated the overall appearance of pears 417 (small squat pear shape with orangish red color), 573 (mid-sized yellow green pear with some blush), Bartlett and 720 (larger blocky shaped yellowish green pear with occasional red blush) significantly higher (p=0.00) than the Seckel and 642 (a small, apple shaped Asian European cross that is yellow with a red spotty blush) varieties **(Table 4)**. The color of the skin of 417 (orangish red color) was more liked than 642 (yellow with a red, spotty blush) or Seckel, which were less well liked for skin color.

For the overall liking, results showed Bartlett, 573 and Seckel were liked significantly more (p=0.00) than pears 642, 417 and 720. The Bartlett also received the highest mean score for pear flavor liking (7.62) and was liked significantly more in this attribute than all other summer pears tested except for

the Seckel (7.02) (p=0.00). The Bartlett and Seckel varieties were rated by the most consumers as just about right for pear flavor (76% and 64% respectively). When regarding sweetness preferences, the Bartlett and Seckel were the two varieties in this study among the summer pear varieties that most exemplified the sweetness consumers prefer in a pear. These pears scored highest in sweetness liking (7.55 and 6.93 respectively) and were rated just about right in sweetness by the most consumers (80% and 73% respectively).

The Bartlett was liked significantly more (p=0.00) than all other summer pears tested for juiciness (7.75) and was rated by 86% of all consumers tested as just about right in juiciness, whereas the next highest rated pear in this attribute was the Seckel at 68%. Very few consumers rated any of the pears as having too much pear flavor, sweetness or juiciness as these were highly desirable attributes and were qualities linked to varieties with the highest overall liking such as the Bartlett (7.33) and Seckel (6.75). Pear 417, which was described by many consumers in open ended comments as "bland" or "lacking flavor," was rated by 90% of consumers as having too little pear flavor. It was also rated by 73% as not sweet enough and 52% as not tart enough. Pear 417 was rated significantly lower than the highest rated pears (Bartlett, 573 and Seckel) in overall liking, even though it had the highest mean score in overall appearance liking (7.45) and skin color liking (7.68). The pears with the lowest overall liking scores (720, 642 and 417) had the fewest number of consumers rating just about right for pear flavor and sweetness and the most consumers rating the pears as too firm, too crisp/crunchy and too dry/mealy. The three varieties that were rated as just about right in firmness by the most consumers were the Bartlett (66%), 573 (64%) and Seckel (59%).

Winter pears: The appearance of the Gem (not ripened) (7.71), Concorde (7.27), Green Anjou (7.21) and Comice (7.13) were liked significantly (p=0.00) more than the Paragon (Comice x Bartlett cross, smaller pear, thin skin ripens from green to yellow, slightly misshapen) and Bosc (**Table 5**). The skin color of the Gem (not ripened) (7.90), with its light green color that turns yellow when ripe and up to 35% red blush was liked significantly (p=0.00) more than all the other pears tested except the Comice (7.46). The aroma of the Concorde (6.73) and Comice (6.66), both known to be highly aromatic were liked significantly (p=0.00) more than all other pears tested except the Paragon (6.53) and Green Anjou (6.13).

The Paragon had the highest mean score for overall liking (7.46) and was rated between like moderately and like very much on the 9-point hedonic scale. The Green Anjou (6.99), Concorde (6.98) and Comice (6.80) were rated statistically similarly (p=0.00) to the Paragon in overall liking, while the not ripened Gem (not ripened) (6.24) and Bosc (5.86) were significantly (p=0.00) lower in this attribute. The same pears that were rated highest in overall liking also were rated highest in pear flavor, with Paragon at the top (7.54), followed by Comice (7.13), Green Anjou (6.97) and Concorde (6.96). These four pears were liked significantly (p=0.00) more in pear flavor than the Bosc (5.92) and not ripened Gem (5.86). The Paragon was rated by 73% of consumers as just about right in flavor (Figure X). The liking responses for sweetness also showed preferences for the same four varieties, Paragon, Green Anjou, Concorde and Comice (Table X). These varieties were rated by most consumers as just about right in sweetness, where the Bosc and not ripened Gem (not ripened) were both rated by over 50% of consumers as not sweet enough. The Bosc was rated statistically (p=0.00) lower in tartness/acidity liking than the other five winter pear varieties with a mean score near neither like nor dislike on the 9-point hedonic scale (5.28).

In overall texture liking, the Concorde (7.29) and Paragon (7.10) were scored significantly (p=0.00) higher than the other varieties tested except the Green Anjou (6.90). The firmness liking of these three varieties were rated significantly (p=0.00) higher than the Comice and not ripened Gem. The Gem (not ripened) was rated by 54% of consumers as too firm, while the Comice was rated by 49% of consumers as too soft. The Paragon (7.60), Concorde (7.56), Green Anjou (7.41) and Comice

(7.16) were all well liked in juiciness with mean scores at or above like moderately; over 80% of consumers rated these four varieties as just about right in juiciness. The not ripened Gem and Bosc were rated significantly (p=0.00) lower in juiciness liking; 44% rated the Gem as too dry/mealy, while 45% rated it as too crisp/crunchy. The skin texture of the Paragon and Gem (not ripened) were rated by over 75% of consumers as just about right, whereas the skin texture of the Comice was rated by 47% as too thick/tough.

Preference mapping (Descriptive analysis + Consumer Sensory Evaluation)
Summer (S) pears: As shown in **Figure 3**, five clusters were identified based on the consumers' (n=107) liking of the six summer varieties, 71.8% of the variance within consumers accounted for. Bartlett and Seckel were the most preferred varieties and 80% of the consumers were satisfied or liked these two varieties the most. Bartlett is one of the major cultivars grown in North America (Westwood, 1993), so this result is unsurprising given that consumers are likely to be very familiarized with this variety and have a particular preference for it.

Consumers in **Cluster S1** (n= 33) liked Seckel the most. Seckel pear was mostly characterized for its juicy texture. The second variety most liked by the consumers in this cluster was Bartlett, followed by 417. Consumers in Cluster 1 (73% women) were characterized as having consumed mostly Bartlett pears in the last year. Participants in **Clusters S2** (n=29) and **S4** (n=27) liked Bartlett the most. Bartlett pear was characterized with positive attributes such as *pear aroma, grassy/ green aroma, pear flavor, sweet* taste, and *juicy* texture. Consumers in **Cluster S2** (69% women) responded that Bartlett was the type of pear that they had eaten the most in the last year. Consumers in **Cluster S4** (63% women) consumed Bartlett the most in the last year. These consumers also indicated that their favorite pear variety is Bartlett, mostly because of its *sweetness, juiciness,* and *texture (crispness).*

Consumers in **Cluster S3** (n=8) presented the highest preference for the red pear varieties 642 and 417 and the lowest liking for Bartlett. The red pears, which were liked by 20% of the consumers overall, were characterized by attributes such as *stemmy/woody aroma, fermented aroma, stemmy/woody flavor, fermented flavor, bitter taste, astringent,* and *grainy/gritty texture.* This finding might be an indicator that there is a potential niche group that prefers the red varieties. These pears have a very different sensory profile compared to the profiles of more traditional and well-known varieties such as Bartlett. In the last year, 80% of the consumers in cluster 3 (100% women) consumed Asian pears. They indicated this variety as their favorite because of the *texture* (e.g., *crunchy, crispness*), *juiciness* and *flavor* (e.g., *apple flavor*).

Consumers in **Cluster S5** formed also a small cluster (n=10) of 50% women. They mostly consumed Bosc, followed by Bartlett in the last year. This cluster presented a profile of consumers open and willing to explore new varieties of pear. 573 was not presented as one of the possible options to select. However, 573 was preferred by 60% of the consumers in the study and was the most liked variety for Cluster 5. This pear was mainly characterized by attributes such as *floral aroma*, *green/grassy flavor*, *floral flavor* and *sour taste.* This pear has been recently released in North America and has been described as *firm* with *sweet, juicy flavor* and rosy, yellow-green skin (Vineland Research and Innovation Centre, 2022). 30 % of these consumers expressed having *tried some of the newer varieties and liked them too,* or they made comments such as: *no particular favorite; I like the unique differences,* and *I like ripe pears that have a complex sweetness, some tartness and juicy.* These comments may be indicative of these consumers being more willing or open to try or appreciate newer varieties such as 573.

Winter(W) pears: Four clusters were identified based on the consumers' (n=112) liking of the six winter pear varieties. 81.4% of the variance within consumers preferences was accounted for (see **Figure 4**). Comice and Paragon were the varieties most liked by the consumers; 75% were satisfied

with the sensory profile of these pears. Both varieties were characterized by attributes such as *pear aroma, fruity aroma, pear flavor, fruity flavor, sweet taste* and *juicy texture.* Consumers in **Cluster W2** (n=12), **Cluster W3** (n=45), and **Cluster W4** (n=25) expressed the highest preference for Comice and the lowest for Bosc (Cluster W2 and W3) and Green Anjou (Cluster W4).

Fifty percent of the consumers (n=112) were satisfied with Green Anjou, Gem (not ripened) and Concorde. The Green Anjou sensory profile was characterized with the following attributes: *grassy/green flavor, apple flavor, sour taste* and *astringent.* Gem (not ripened) was mostly characterized with texture-related attributes such as *crispy, crunchy, skin toughness* and *firm.* Concorde was profiled as having a *vanilla aroma*, *vanilla flavor* and *bitter taste.*

Consumers in **Cluster W1** (n=29) liked Bosc the most. Overall, this variety satisfied the liking/preference of 25% of the total consumers. Bosc was mainly described as having a *stemmy/woody flavor.* When asked about the pear varieties consumed in the past year, 79% of consumers in Cluster W1 (41% women) indicated Bosc (79%) as their most consumed variety, followed by Bartlett (76%) and Asian pears (65%). For consumers in **Cluster W2** (n=12) (58% women), Comice was the most liked and Green Anjou was the second most liked variety. Green Anjou was described with attributes such as *apple flavor*, *grassy/green flavor*, *sour taste*, and *crispy texture.* Consumers in this cluster expressed that their most frequently consumed pears in the last year were Bartlett (100%), Bosc (75%), and Comice (67%). The favorite varieties for these consumers were Bartlett (42%) and Asian pears (25%).

Based on the preference mapping results, consumers in **Cluster W3** (n=45) (62% women) preferred Comice the most, followed by Paragon and Green Anjou. Comice and Paragon were mostly described by *pear aroma*, *pear flavor* and *sweet taste.* When characterizing the consumers in Cluster 3, the pear varieties most commonly consumed in the last year were Bartlett (89%) and Green Anjou (71%), followed by Red Anjou (62%) and Asian pears (62%). **Cluster W4** (n=25) (56% women) gathered consumers who had also had the highest preference for Comice. Clusters 3 and 4 shared some characteristics. As in Cluster 3, Paragon was also the second most liked variety followed by Concorde. When asked about the most consumed pears in the last years, the most commonly mentioned varieties in Cluster 4 were Bartlett (96%), Green Anjou (68%), Bosc (68%), and Asian Pear (68%). Comice was consumed by 36% of the consumers in this cluster and Concorde by 24%. The favorite pear for the consumers in Cluster 4 was Bartlett (44%) because of its *size, color, taste overall, perfect pear flavor, right amount of sweetness, juiciness,* and *classic pear [type]*.

Willingness to Pay
A questionnaire tool to estimate the willingness to pay was developed. The tool included questions to elicit the willingness to pay following the contingent valuation methodology. Grocery store prices for fresh pears in the Portland area were collected and used in the questionnaire. The bids for different pear samples allowed us to estimate the WTP for each pear sample, and the marginal value of the salient pear quality characteristics. The average respondent, based on the self-reported sociodemographic responses, was on average of White ethnicity, female, older than 35, college educated, self-reported healthy, had a household with at least two members, the household had one child less 18 years old, and the household income was greater than $60,000/year.

Summer Pears: Results are presented in **Table 6** and **7** The highest WTP was for Bartlett. This variety had the highest overall liking for flavor with 7.33. The second highest WTP was for Happy with 1.92, this variety had the second highest overall liking for flavor with 6.76. The third highest WTP was for Seckel with 1.89, and this variety had the third highest overall liking for flavor with 6.75. When estimating the pairwise statistically significant differences, the WTP for Bartlett was higher compared to each of the other varieties. There were significant differences Happy and the

other varieties (642, 417, and 720). There were statistically significant differences between Seckel and 642, 417 and 720. This result indicates the presence of three tiers of varieties, in terms of WTP, first Bartlett, followed by the second tier 573 and Seckel, and the third tier 642, 417, and 720.

Winter Pears: Results are presented in **Table 8** and **9**. The highest WTP value was for Paragon at $2.19/lb. This variety also had the highest mean liking score for overall flavor at 7.46 (on a 1-9 scale, 1=dislike extremely, 9=like extremely; hereafter, all liking scores will consider this scale), despite a lower appearance liking score (6.62). The second highest WTP is for Concorde with $2.09/lb, with a mean liking of overall flavor at 6.98 and overall appearance at 7.27. The third highest mean WTP was for Green Anjou with $2.05/lb, with a mean liking of the overall flavor of 6.99 and an overall appearance of 7.21. Importantly when estimating the statistically significant differences across WTP values, we note that there are no differences between Paragon and Concorde but were between Paragon and Green Anjou. These results show that there are two tiers of Winter pears in terms of the WTP, the first one composed by Paragon, Concorde, and Green Anjou and the second one composed by Comice, Gem (not ripened), and Bosc.

Tables and Figures

Table 1. Pear varieties, harvest season and inclusion into the consumer evaluations.

Pear Variety	Season	Consumer Trials
Bartlett	Summer	x
720- Cross between Bartlett and a numbered U.S. selection, large fruit, yellowish-green skin with red blush, white flesh, good storage variety, https://www.ontario.ca/page/pear-production-ontario	Summer	x
573- Bartlett heritage, yellow green pear with some blush, denser texture, sweet, juicy	Summer	x
804- Early season pear, mild sweet flavor, red blush over smooth yellow skin with grit-free white flesh, slightly firm, https://www.ontario.ca/page/pear-production-ontario	Summer	
391- Related to Bartlett, late season pear with small to medium sized fruit, yellow with a red blush, sweet and juicy, https://www.ontario.ca/page/pear-production-ontario	Summer	
417- Asian/European hybrid, bright red color, crisp, juicy, low acid pear, slightly sweet flavor	Summer	x
642- Red-skinned/blush, yellow fleshed Asian pear that is apple-like in taste, juicy and crisp texture	Summer	x
Seckel	Summer	x
Starkrimson	Summer	
Summer Blood Birne	Summer	
Sylvania	Summer	
Pear Variety	**Season**	**Consumer Trials**
Abate Fetel	Winter	
Bosc	Winter	x
Comice	Winter	x
Concorde	Winter	x
Forelle	Winter	
Gem, not ripened (nr)	Winter	x
Green Anjou	Winter	x
Packham's Triumph	Winter	

Paragon	Winter	**x**
Red Anjou	Winter	
OHUS-US783012-022	Winter	
US79453-007	Winter	

Table 2. Trained panel physicochemical measurements, **summer pear varieties** (n=10).

Variety	Weight (g)	Firmness (kg)	Soluble solids (°Brix)
Bartlett	198.5±11.0 ab	0.8±0.1 a	12.4±1.2 a
573	221.0±11.2 ab	2.4±0.3 b	12.3±1.9 a
720	310.9± 27.1 c	5.6±0.6 c	13.0±0.4 ab
417	186.1±28.8 b	3.5±0.4 d	12.3±0.6 a
642	230.6±25.7 a	5.3±0.4 c	15.0±0.9 bc
Seckel	126.0±5.1 d	2.1±0.3 b	16.3±1.2 c
p-value	**<0.0001**	**<0.0001**	**<0.0001**

Table 3. Trained panel physicochemical measurements, **winter pear varieties** (n=10).

Variety	Weight (g)	Firmness (kg)	Soluble solids (°Brix)
Bosc	224.8±13.6 abc	1.1±0.1 a	10.2±0.5 a
Comice	196.5±8.2 bc	0.7±0.2 a	16.1±1.1 b
Concorde	262.4±37.3 a	1.5±0.3 a	14.2±0.5 c
Gem (nr)	234.2±21.0 ab	3.3±0.9 b	13.3±0.4 cd
Green Anjou	204.8±15.8 bc	3.1±1.0 b	12.8±0.9 d
Paragon	186.5±20.6 c	0.89±0.1 a	18.6±2.8 e
p-value	**<0.0001**	**<0.0001**	**<0.0001**

Table 4. Consumer liking responses for varietals tested in October (summer pears), n=107

Summer Pears	Overall Liking	Appearance Liking	Color of Skin	Aroma	Pear Flavor	Sweetness	Tartness/ Acidity
Bartlett	7.33 a	7.32 a	7.12 ab	6.86 a	7.62 a	7.55 a	6.58 a
573	6.76 a	7.33 a	7.31 ab	6.99 a	6.81 b	6.75 b	6.30 ab
Seckel	6.75 a	6.26 b	6.46 b	5.06 c	7.02 ab	6.93 ab	5.93 b
642	5.45 b	6.11 b	6.83 bc	5.18 c	5.14 c	5.70 c	5.28 c
417	5.32 b	7.45 a	7.68 a	6.71 a	4.79 c	4.92 d	4.74 c
720	5.13 b	6.94 a	7.12 ab	6.03 b	5.24 c	4.93 d	5.28 c
HSD value	0.68	0.61	0.56	0.54	0.66	0.66	0.62
p-value	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Summer Pears	Overall Texture	Firmness	Juiciness	Crispiness/ Crunchiness	Aftertaste
Bartlett	6.85 a	6.44 a	7.75 a	6.01 a	6.89 a
573	6.49 ab	6.70 a	6.13 b	6.26 a	6.28 a
Seckel	6.30 ab	6.59 a	6.74 b	6.03 a	6.40 a
642	5.87 b	6.17 a	6.74 b	6.39 a	5.31 b
417	5.79 b	6.09 a	6.23 b	6.24 a	5.03 b

720	4.64 c	4.70 b	4.07 c	4.93 b	5.09 b
HSD value	0.80	0.80	0.66	0.81	0.66
p-value	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Table 5. Consumer liking responses for varietals tested in December (winter pears), n=112

Winter Pears	Overall Liking	Appearance Liking	Color of Skin	Aroma	Pear Flavor	Sweetness	Tartness/ Acidity
Paragon	7.46 a	6.62 bc	6.69 c	6.53 ab	7.54 a	7.35 a	6.46 a
Green Anjou	6.99 a	7.21 ab	7.06 bc	6.13 ab	6.97 a	6.94 a	6.28 a
Concorde	6.98 a	7.27 a	7.17 bc	6.73 a	6.96 a	6.91 a	6.06 a
Comice	6.80 ab	7.13 ab	7.46 ab	6.66 a	7.13 a	6.88 a	6.16 a
Gem (nr)	6.24 bc	7.71 a	7.90 a	6.05 bc	5.86 b	5.99 b	6.06 a
Bosc	5.86 c	6.22 c	5.98 d	5.46 c	5.92 b	5.74 b	5.28 b
HSD value	0.70	0.64	0.64	0.60	0.71	0.71	0.68
p-value	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Winter Pears	Overall Texture	Firmness	Juiciness	Crispiness/ Crunchiness	Aftertaste
Paragon	7.10 a	7.04 a	7.60 a	6.38 ab	6.65 a
Green Anjou	6.90 ab	6.96 ab	7.41 a	6.29 abc	6.77 a
Concorde	7.29 a	7.16 a	7.56 a	6.89 a	6.47 a
Comice	6.25 bc	6.19 c	7.16 a	5.65 c	6.24 ab
Gem (nr)	6.20 bc	6.30 bc	6.08 b	6.47 ab	6.28 a
Bosc	6.13 c	6.53 abc	6.51 b	6.04 bc	5.52 b
HSD value	0.73	0.71	0.62	0.73	0.74
p-value	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Table 6. Willingness to pay (WTP) mean, WTP pairwise comparison between summer pear varieties.

Varieties	WTP mean	Standard error	WTP-Pairwise comparison between varieties		
			Varieties		t-value
Bartlett	2.10	0.066	Bartlett	573	2.83**
573	1.92	0.067	Bartlett	Seckel	3.28***
Seckel	1.89	0.066	Bartlett	642	6.84***
642	1.62	0.072	Bartlett	417	7.64***
417	1.55	0.075	Bartlett	720	7.80***
720	1.54	0.075	573	Seckel	0.43
			573	642	4.19***
			573	417	5.08***
			573	720	5.25***
			Seckel	642	3.81***
			Seckel	417	4.72***
			Seckel	720	4.88***
			642	417	0.97

			642	720	1.13
			417	720	0.15
Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% levels					

Table 7. Overall appearance and overall flavor rating score and pairwise comparison between summer pear varieties

Varieties	Rating score		WTP-Pairwise comparison between varieties		
	Mean (Std. dev)		Varieties	t-value	
	Overall appearance	Overall flavor		Overall appearance	Overall flavor
Bartlett	7.32	7.33	Bartlett-573	-0.05	2.52**
	(1.25)	(1.64)	Bartlett-Seckel	4.41***	2.55**
573	7.33	6.76	Bartlett-642	5.14***	7.16***
	(1.34)	(1.67)	Bartlett-417	-0.67	8.03***
Seckel	6.26	6.75	Bartlett-720	1.875*	8.39***
	(2.14)	(1.68)	573-Seckel	4.37***	0.04
642	6.11	5.45	573-642	5.08***	4.96***
	(2.08)	(2.16)	573-417	-0.60	5.72***
417	7.45	5.32	573-720	1.87*	6.18***
	(1.60)	(2.00)	Seckel-642	0.52	4.91***
720	6.94	5.13	Seckel-417	-4.60***	-5.66***
	(1.64)	(2.16)	Seckel-720	-2.62***	6.12***
			642-720	-3.25***	1.08
			642-417	-5.27***	0.46
			417-720	2.28**	0.66
Single, double, and triple asterisks (*, **, ***) indicate significance at 10%, 5%, and 1% levels					

Table 8. Willingness to pay (WTP) mean, WTP pairwise comparison between winter pear varieties.

Varieties	WTP mean	Standard error	WTP-Pairwise comparison between varieties		
			Varieties		t-value
Paragon	2.19	0.067	Paragon	Concorde	1.46
Concorde	2.09	0.067	Paragon	Green Anjou	2.07**
Green Anjou	2.05	0.067	Paragon	Comice	3.55***
Comice	1.96	0.066	Paragon	Gem (nr)	5.58***
Gem (nr)	1.81	0.067	Paragon	Bosc	7.14***
Bosc	1.69	0.070	Concorde	Green Anjou	0.6
			Concorde	Comice	2.05**
			Concorde	Gem (nr)	4.11***
			Concorde	Bosc	5.71***
			Green Anjou	Comice	1.45
			Green Anjou	Gem (nr)	3.54***

			Green Anjou	Bosc	5.16***
			Comice	Gem (nr)	2.14**
			Comice	Bosc	3.83***
			Gem (nr)	Bosc	1.72*
Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% levels					

Table 9. Winter pear varieties-Overall appearance and overall flavor rating score and pairwise comparison between varieties.

Varieties	Rating score		Rating score-Pairwise comparison between varieties		
	Mean (Std. dev)		Varieties	t-value	
	Overall appearance	Overall flavor		Overall appearance	Overall flavor
Paragon	6.62	7.46	Paragon-Green Anjou	-2.72***	2.33***
	(1.70)	(1.42)	Paragon-Concorde	-3.07***	2.13***
Green Anjou	7.21	6.99	Paragon-Comice	-2.23**	2.94***
	(1.59)	(1.61)	Paragon-Gem	-5.38***	5.36***
Concorde	7.27	6.98	Paragon-Bosc	1.51	6.80***
	(1.47)	(1.93)	Green Anjou-Concorde	-0.26	0.04
Comice	7.13	6.80	Green Anjou-Comice	0.41	0.80**
	(1.71)	(1.91)	Green Anjou-Gem	-2.53**	3.14***
Gem (nr)	7.71	6.24	Green Anjou-Bosc	3.91***	4.60***
	(1.31)	(1.96)	Concorde-Comice	0.67	0.70**
Bosc	6.22	5.86	Concorde-Gem	-2.35**	2.86***
	(2.17)	(2.06)	Concorde-Bosc	4.22***	4.22***
			Comice-Gem	-2.86***	2.18***
			Bosc-Comice	-3.46***	-3.57***
			Gem-Bosc	6.20***	1.43***
Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% levels					

Figures

Figures 1 & 2. PCA of all significant attributes of the **summer and winter season pears** as determined by the trained panel (n=10). The aroma and flavor-related attributes are presented in green. The aroma-related attributes are represented as -A and the flavor-related attributes are represented as -F. The basic taste attributes are presented in yellow, and the texture-related attributes are presented in red. Pears varieties highlighted in yellow were evaluated by consumers at OSU FIC.
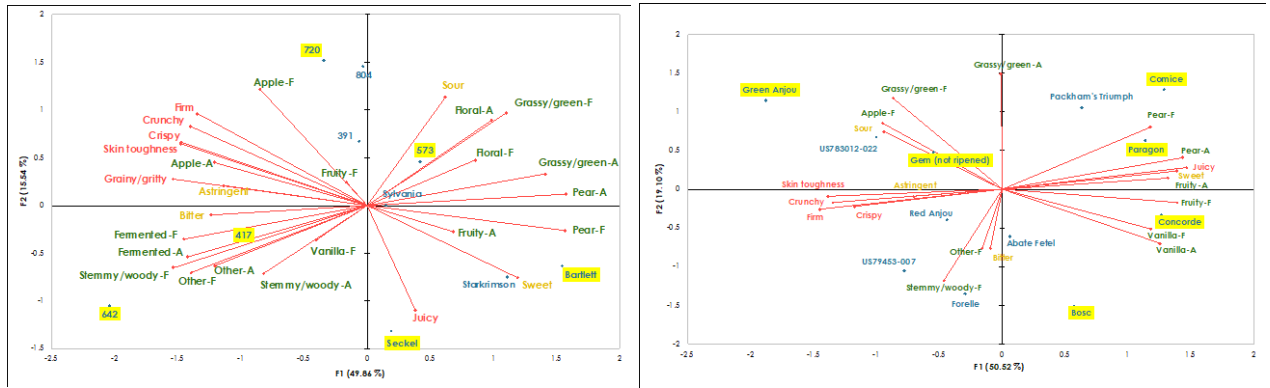
Figure 3. Preference map of sensory profiling data for six **summer pear varieties** explaining 71.8% of the total variance overlaid by consumer (n=107) liking data via a Vector model. Percentages represent regions whereby the given percentage of consumers have a preference above the mean.
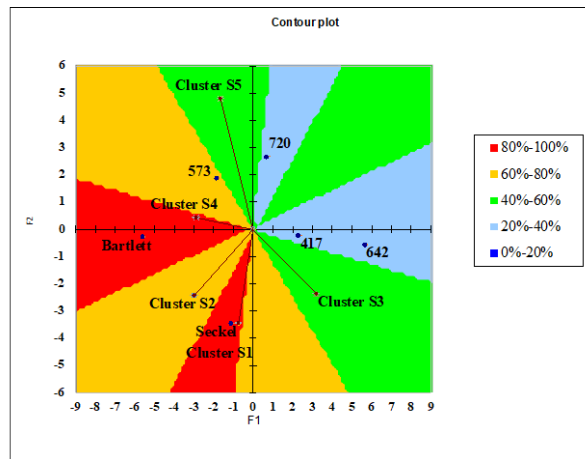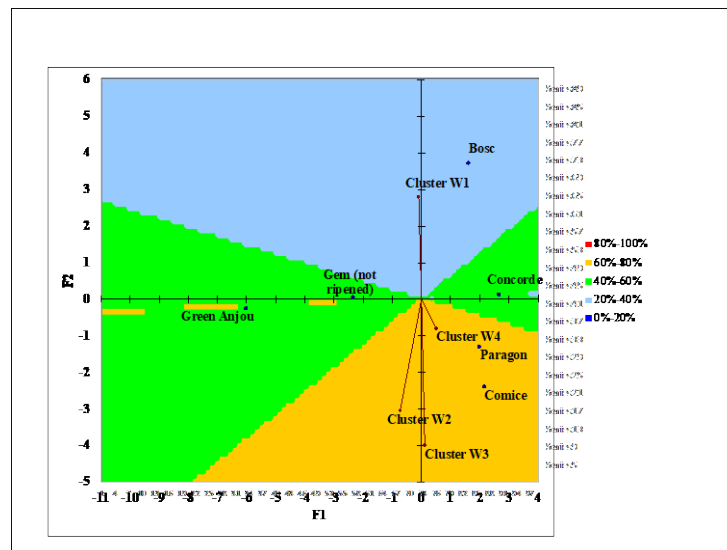

Figure 4. Preference map of sensory profiling data for six **winter pear varieties** explaining 81.4% of the total variance overlaid by consumer (n=112) liking data via a Vector model. Percentages represent regions whereby the given percentage of consumers have a preference above the mean.

Executive summary

Project title: Pear Consumer Preference Testing

Keywords: pears, consumer acceptance, purchasing, preference map, descriptive analysis

Abstract:

The objective of this study was to better understand pear consumers in the Pacific Northwest region of the United States, specifically the sensory attributes that they desired in a pear. To accomplish this, descriptive analysis (DA), consumer acceptance data and preference mapping were combined to determine the sensory profile of pear varieties from the summer and winter season. The willingness to pay (WTP) of the pears evaluated by consumers was calculated using a contingent valuation approach. A trained sensory panel (n=10) evaluated multiple sensory attributes (appearance, aroma/flavor, taste, mouthfeel and texture) of 23 pear varieties grown in the PNW. A selection of twelve pears, six from summer and six from winter season, were evaluated by consumers (n=219) for their liking of different attributes of the pears. Results showed that the trained panelists significantly discriminated the summer and winter pears on most of the sensory modalities. To identify the attributes driving consumer acceptability, external preference mapping was applied. Attributes such as pear aroma, pear flavor, sweet, sour and juicy were identified as most contributing attributes to the liking of the summer pears. Conversely, *fermented aroma, stemmy-woody aroma*, *fermented flavor, stemmy-woody flavor, grainy-gritty* attributes were associated with a reduction in consumer liking. Based on preferences for specific sensory attributes, different clusters of consumers were identified. For the summer varieties, 573, Bartlett and Seckel were identified as having the broadest appeal, satisfying between 60% and 80% of the consumers. For the winter varieties, 75% of the consumers identified Comice and Paragon as the most appealing. Pear consumers (n=107) rated the overall flavor liking of the summer pears Bartlett, 573 and Seckel significantly higher (p<0.5) than 642, 417 and 720. For the winter varieties, consumers (n=112) rated the overall flavor liking of Paragon, Green Anjou, Concorde, and Comice as significantly higher (p<0.5) than not ripened Gem and Bosc. For both sets of varieties, the WTP values were consistent with the overall flavor scores. Willingness to pay showed different tiers, for summer varieties, first Bartlett, followed by the second tier 573 and Seckel, and the third tier 642, 417, and 720. For winter varieties, there were two tiers, the first one composed of Paragon, Concorde, and Green Anjou and the second one composed by Comice, not ripened Gem, and Bosc.

 The introduction of these cultivars should satisfy t14he largest group of consumers in the Pacific Northwest market. Attributes such as crispness, firmness, juiciness, flavor, aroma, tartness, sweetness, sugar/acid balance were rated by over 77% of both sets of panelists (n=219) as important or very important in their purchase intent. Second to eating quality were shelf life attributes (freshness, ripeness, and shelf life), followed by appearance attributes (attractive and uniform external color, pear size, free of defects, uniform shape). Taste and flavor appeal and health and nutrition were the highest ranked factors in influencing overall food choices and eating patterns. The most important resources to help increase consumer interest in eating pears at home were in-store sampling and tasting with a recipe. Individual farmers and universities were rated as the most trusted sources of information of those listed on how food is produced, while the media, food manufacturers and social media were the least trusted.