

## **Sensory attributes and consumers' willingness to pay for apple cultivars grown at different altitudes**

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### **Resumen**

**Previous studies on the consumers' acceptance of apple cultivars state that their sensory properties have a large influence on consumers' willingness to pay (WTP). Following this evidence, our objective was to study the effect of sensory properties in consumers' WTP for apples in Spain. Two apple' cultivars ('Golden Delicious' and 'Reineta') grown at two different altitudes (higher and lower) were investigated. A total of 195 apple consumers participated in the experiment conducted in Zaragoza (Spain). The experiment consisted of two steps. First, participants were asked to rate four sensory attributes (firmness, juiciness, mealiness and sweetness) for the four apple samples. Second, participants should indicate their maximum WTP for each apple. Finally, socio-demographic, fruit and apple consumption and purchase habits information was collected. Results indicated that the WTP for 'Golden D.' was higher than for 'Reineta' and, higher for the apples grown in high altitude than for the ones grown in low altitude. The only sensory property that did not influence the WTP for the four apples was mealiness. Juiciness and sweetness positively influenced the WTP for all the apples except for 'Golden D.' grown in low altitude where no effect was detected. Firmness negatively influence the WTP for 'Golden D.' and positively for 'Reineta' but only for the one cultivated in low altitude. These findings indicate that sweeter and juicer apples might be marketed with higher prices and that higher firmness is only appreciated in some specific cases.**

**Keywords:** Aragon, preferences, tasting.

### **INTRODUCTION**

Previous studies on the consumers' acceptance of apple cultivars conclude that sensory quality (flavour, taste and texture) is one of the most important factors influencing the decision to buy apples, being even more important than price (Bonany et al., 2003). Other studies state that consumers are willing to pay premium prices for apple cultivars that are perceived superior in textural (e.g., firmness) and in flavour (e.g., sweetness) characteristics (Hong et al 2018). Then, the consumers' sensory evaluation and the willingness to pay for apples are related and, this relationship has been studied in several papers (Gallardo et al. 2017; Hong 2018; among others). Following them, our objective was to study the effect of apples sensory properties in consumers' WTP for apples in Spain. Two apple cultivars ('Golden Delicious' and 'Reineta') grown at two different altitudes (higher and lower) were investigated. Combining data from an experimental auction with

a sensory evaluation of untrained consumers, the present study aims to: *i*) test whether the WTPs and the sensory properties differs among apple cultivars at two growing altitudes; *ii*) measure the effect of sensory properties (firmness, juiciness, mealiness and sweetness) and consumers' socio-demographic characteristics on the WTPs for the four apples.

## **MATERIAL AND METHODS**

### **Products, participants, and experiment description**

Two apple cultivars, a widespread ('Golden Delicious') and a local ('Reineta') apple, were selected, both produced in two different growing altitudes. For the lower altitude, apples cultivated in a valley site (Ebro valley, Zaragoza, ca. 300 m a.s.l.) and for the higher altitude, apples cultivated in a hilly site (Manubles valley, Moros, ca. 800 m a.s.l.) were studied. The apples were kept in the cold storage (1.5 °C under normal atmosphere and 80% relative humidity (RH)) until the evaluations (4 and 6 weeks of cold storage for 'Reineta' and 'Golden D.', respectively).

Participants were recruited by the research team with the help of consumer's associations and public institutions in different locations (universities, town hall learning centers, community activity centers, etc.) in Zaragoza (middle-sized town in the Northeast of Spain close to the two growing sites). The target population was primary food shoppers of the household who consume apples at home and older than 18 years.

The experiment was conducted in 20 working sessions of around 10 participants, reaching a total of 195 participants. Each session lasted approximately 1 h and were carried out either in the morning, mid-day, afternoon, or evening. The experiment protocol was approved by the Ethical Committee of CITA. All participants voluntarily joined the experiment and before, they received information on the nature of the experiment and signed an informed consent form of participation. To keep the anonymity, each participant was assigned an identification number. The experiment was conducted from October to November 2019, when the apples were in season.

The working sessions consisted of three tasks: consumer evaluation test, the experimental auction, and the completion of a brief questionnaire. First, each participant received two apple slices of the same cultivar ('Golden D. '), one for each growing site (hilly and valley) with some information about the cultivars and the growing attitude. They were asked to rate four sensory attributes (firmness, juiciness, mealiness and sweetness) using a 9-point hedonic scale (1 = dislike extremely; 9 = like extremely). The descriptors were developed by consensus by the authors considering their experience and previous literature on sensory analysis of apple. After, participants were asked for the maximum price they would be willing to pay for each of them. In a second round, the other two slices from the second cultivar ('Reineta') were also rated for the same descriptors, and the maximum price they would be willing to pay was also asked. Finally, a questionnaire gathering information on socio-demographic characteristics and fruit and apple purchase and consumption habits was completed.

### **Statistical analyses**

First, paired t-tests were performed to analyse whether differences in WTP and sensory attributes scores between growing sites (hilly and valley) exist for the two apples cultivars. Second, the WTP for each of the four apple was related with the sensory attribute's evaluations and the consumers' socio-demographic characteristics and a Tobit

model was specified and estimated (Greene, 2008). This model was chosen because, as observed in table 1, often participants give zero values for the WTPs.

## RESULTS AND DISCUSSION

Around 60 percent of the respondents were women with an average age of 51 years. Regarding education, 47% of the respondents had a university degree and around 26% of them had primary or secondary studies, respectively. The average family size was 3 members and 70% of households had not kids younger than 18.

The WTPs for ‘Golden D.’ was higher than for ‘Reineta’ and, statistically higher for the apples cultivated in the hilly than in the valley (Table 1). The results of the t-tests showed significant differences on all the sensory attributes (firmness, juiciness, mealiness, sweetness) between apples grown at the hilly and at the valley for both cultivars, except for the juiciness in ‘Reineta’ cultivar. In the case of ‘Golden D.’, consumers reported a higher firmness, juiciness, and sweetness on the hilly fruit than on the valley, while the contrary happened for mealiness. In the case of the local cultivar ‘Reineta’, consumers scored firmness lower for the fruit grown in the hilly, while the contrary happened for the rest of sensory attributes, except for juiciness, where no statistically differences were found.

According to the Tobit model, mealiness is the only sensory property that did not influenced the WTP for the four apple samples (Table 2). Juiciness and sweetness positively influenced the WTP for all the apples except for ‘Golden D’ grown in the valley, where no effect of these attributes in the WTP was detected. Firmness negatively influenced the WTP for ‘Golden D.’ cultivar, whereas it had a positive influence in the case of ‘Reineta’ grown in the valley.

Higher educated consumers were more willing to pay for ‘Golden D.’ cultivated in the hilly and older consumers for ‘Golden D.’ in the valley. In addition, consumers with higher income level were more willing to pay for both ‘Reineta’ apples while females were less willing to pay for the ‘Reineta’ cultivated in the valley.

Our results corroborate previous studies stating that the effect of sensory attributes in the WTPs differs across apple cultivars (Gallardo et al., 2016; Hong et al., 2018). However, previous findings on the effect of sensory attributes on the WTPs were the same for some of the attributes but different for other compared to our findings.

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## TABLES

Table 1. Summary statistics and pairwise comparisons of WTPs and sensory attributes evaluations by apple cultivar and growing attitude.

<b>WTP</b>	Golden D.			Reineta		
	Hilly	Valley	t-test	Hilly	Valley	t-test
Mean	2.10	1.65	9.05***	1.62	1.42	3.18***
Standard deviation	0.69	0.63		0.98	0.85	
Minimum-Maximum	0-4	0-4.3		0-4	0-4	
% of zero bids	0.51	3.1		16.4	16.4	
<b>Firmness</b>						
Mean	7.34	6.06	8.18***	4.67	6.36	-8.18***
Standard deviation	0.12	0.13		0.18	0.16	
<b>Juiciness</b>						
Mean	7.43	6.08	9.27***	5.71	5.48	1.21
Standard deviation	0.11	0.12		0.16	0.15	
<b>Mealiness</b>						
Mean	3.70	4.73	-5.97***	6.61	4.69	9.71***
Standard deviation	0.15	0.16		0.16	0.17	
<b>Sweetness</b>						
Mean	6.47	6.18	1.72*	4.77	3.69	5.92***
Standard deviation	0.14	0.14		0.18	0.16	

\*\*\*, \*\*, and \* denote statistical significance at 1%, 5%, and 10% significance levels.

Table 2. Effects of sensory attributes evaluations and consumers' socio-demographic characteristics in WTPs for the apples: estimations of the Tobit model.

	Golden Hilly	Golden Valley	Reineta Hilly	Reineta Valley
Constant	1.3715 (3.66)***	1.5904 (3.98)***	0.1181 (0.22)	0.4702 (1.05)
<b>Sensory attributes</b>				
Firmness	-0.0711 (-2.30)**	-0.0835 (-1.94)**	0.0462 (1.37)	0.0688 (1.98)**
Juiciness	0.0826 (2.46)**	0.0203 (0.49)	0.1139 (2.43)**	0.0762 (1.79)*
Mealiness	-0.0283 (-1.22)	-0.0212 (-1.17)	-0.0396 (-1.10)	-0.0389 (-1.29)
Sweetness	0.0889 (3.29)***	0.0161 (0.66)	0.1277 (3.63)***	0.0985 (3.37)***
<b>Socio-demographics</b>				
Years (continuous)	-0.0028 (-0.81)	0.0060 (1.85)*	0.0013 (0.24)	0.0023 (0.56)
Female (dummy)	0.0500 (0.53)	0.0486 (0.50)	-0.1632 (-1.18)	-0.3665 (-2.75)***
High income (dummy)	0.0265 (0.15)	0.1296 (0.70)	0.4568 (1.67)*	0.5137 (1.98)**
Education (1 to 3)	0.1239 (1.77)*	0.0659 (0.96)	0.0911 (0.86)	-0.0348 (0.86)

Note: t-ratios are in parenthesis; \*\*\*, \*\*, and \* denote statistical significance at 1%, 5%, and 10% significance levels, respectively.