Received 24 October 2022
Revised 6 April 2023
Accepted 12 May 2023

Drivers of liking and value perception for a new apple cultivar in Italy

Sergio Rivaroli, Roberta Spadoni, Stefano Tartarini and Roberto Gregori
Department of Agricultural and Food Sciences, Alma Mater Studiorum – Università di Bologna, Bologna, Italy
Bettina Riedel
Fondazione Alma Mater, Bologna, Italy
Paola Draicchio and Luca Folini
Fondazione Fojanini di Studi Superiori, Sondrio, Italy
Themistoklis Altintzoglou
Department of Marketing Research, Nofima, Tromsø, Norway, and
Maurizio Canavari
Department of Agricultural and Food Sciences, Alma Mater Studiorum – Università di Bologna, Bologna, Italy

Abstract

Purpose – Combining sensory evaluations and hypothetical valuation mechanisms, this study aims to investigate the impact of consumers' product sensory attributes on willingness to pay (WTP) and overall liking for a new apple cultivar.

Design/methodology/approach – A sample of non-expert participants (n = 122) evaluated the overall liking and just-about-right (JAR) attributes. A variable transformation approach was applied to make linear and interval regression models between the JAR attributes, overall liking scores and participants' WTP.

Findings – The study reveals the high consumer appreciation for the new apple in both hedonic and economic terms. After controlling the anchoring effect's bias, the predicted mean WTP for the new apple cultivar was €3.26 per kilogramme. Crunchiness and flavour significantly affect both participants' overall liking and WTP.

Research limitations/implications – The main limitation is the non-probabilistic sampling procedure, which does not allow for the generalisation of the results. Penalty analysis for JAR attributes in monetary and hedonic terms is beneficial for optimising the product and evaluating its potential in the marketplace.

Practical implications – The findings provide helpful directions for product optimisation in future breeding programmes to ensure the long-term sustainability of the new apple cultivars in the marketplace.

The authors thank ERSAF (Ente Regionale per i Servizi all'Agricoltura e alle Foreste, Milano, Italy) for their financial support and Fondazione Fojanini (Sondrio, Italy) for logistic and organizational support. The authors thank the Food, Agriculture and Resource Economics Laboratory (FARE-Lab) at the Alma Mater Studiorum - University of Bologna in Italy for the technical support in realising each procedure step.

British Food Journal
Vol. 125 No. 13, 2023
pp. 410-424
Emerald Publishing Limited
0007-070X
DOI 10.1108/BFJ-10-2022-0865

Originality/value – This study provides evidence of the beneficial synergy of mixing sensory-oriented research with the behavioural economics field of study.

Keywords Just-about-right-scale, Penalty analysis, Willingness to pay, Contingent valuation, Apple, Italy

Paper type Research paper

1. Introduction

Understanding whether a new product is aligned with consumers' expectations and preferences is crucial for its commercial success. This dilemma raises the interest of scholars to explore the consumers' perception of the product from sensory and hedonic perspectives besides its economic appreciation. The apple market is highly competitive (Harker *et al.*, 2003), characterised by numerous cultivars and a wide range of sensory characteristics. However, unlike other fruit, single apple cultivars are increasingly becoming consumer-recognised due to easily detectable brands on the market (Luby and Bedford, 2015). Introducing a new cultivar is a significant challenge and investment in this context. Knowing if the new cultivar can satisfy the customer and assessing its likely economic appreciation in the market is essential for proper strategic planning. In addition, testing the relationship between sensory product characteristics, hedonic judgements and consumers' value perception is paramount for at least two reasons. Firstly, planning appropriate production and marketing strategies is devoted to improving product competitiveness. Second, the opportunity to capture new consumers' interest or increase the interest of actual apple consumers could help improve fruit intake for public health reasons (Radavelli-Bagatini *et al.*, 2021).

In previous studies, just-about-right (JAR) questions for determining the optimum level of intensity of sensory attributes have been combined with a hedonic scale in consumer testing for optimising food products (Lawless and Heymann, 2010), including apple (Hampson and Quamme, 2000). Despite the great debate about JAR questions' potential bias on overall liking scores (see, for example, Ares *et al.*, 2014; Jaeger *et al.*, 2015, amongst others), they continue to be widely accepted in sensory and marketing studies. Penalty analysis on JAR data identifies directional information for product reformulation. For example, Xiong and Meullenet (2006) explored, using a regression approach, how much overall liking is affected when an attribute is not JAR, thus providing actionable information for optimising a product.

Due to consumers' tendency to make a trade-off between food product quality (Meiselman, 1995) and its price, revealing the connections between sensory attributes and value perception is essential before launching a food product in the market. Value perception is usually operationalised using the willingness to pay (WTP) concept, which allows the expression of the individual's perceived value in monetary terms. WTP is the maximum amount of money a consumer is willing to pay to buy a good. Thus, defining a priority of impacts on WTP for each sensory attribute is beneficial for product development and marketing strategies. In this light, consumers' preference towards a new food product can be conducted through a hypothetical market simulation using a stated preference approach.

The contingent valuation method (CVM) is a survey-based approach amongst the stated preference approaches for determining the value of non-market goods and services (Bateman *et al.*, 2002; Kokthi *et al.*, 2021). While the validity of the WTP elicited by the CVM has been questioned due to hypothetical responses that overestimate WTP (Lusk and Schroeder, 2004), recent literature suggests that biases are less significant for low-priced private goods like apples (e.g. Murphy *et al.*, 2005; Vecchiato *et al.*, 2021). Our study adopts a double-bound discrete choice contingent valuation approach to elicit the consumers' WTP. Respondents are asked whether they would be willing to pay a specific price for a product. According to Vecchiato *et al.* (2021), though consumer preferences towards new food products can be approached through the hypothetical market and affective methods like those cited above,

their disjointed application could not accurately predict consumer behaviour and preferences. This critique raises the need to bridge the gap between an ambivalent (i.e. sensorial and hypothetical or non-hypothetical evaluative methods) approach to studying and developing a new food product.

The sensory-affective studies that include tasting are mainly concerned with processes after purchase. Suppose a consumer has already consumed a product. In this case, the memory of the beliefs formed due to the earlier taste experience will influence his subsequent repurchase, not the original taste experience itself. Thus, as Grunert (2003) and Garber *et al.* (2003) described, testing products under-informed conditions and in a specific consumption context is a way of measuring food preferences to predict actual consumer behaviour. Amongst others, Barnes *et al.* (2014) linked sensory analysis of local cheese brands with consumer WTP. Baba *et al.* (2016) said the hedonic evaluation significantly impacted consumer beef preferences. Furthermore, Gwin *et al.* (2012) used consumer sensory tests and choice-based conjoint analysis to examine consumer attitudes about beef meat. Similarly, Mueller *et al.* (2010) combined an online discrete choice experiment with a separate sensory hedonic test to understand the interplay of sensory wine characteristics and extrinsic attributes. Papoutsi *et al.* (2019) investigated the effect of expectations for the snacks, blind tasting and product information on hedonic judgements and WTP. Furthermore, Stiletto *et al.* (2021) estimated the consumers' WTP for the reputational attributes of ready-to-eat pomegranate arils and discriminated the elicited preferences between tasting and non-tasting situations. Likewise, Hung and Verbeke (2018) adopted a non-hypothetical and JAR approach to study how sensory attributes influence consumers' WTP for new processed meat products. Interestingly, Chengyan and Tong (2011) used choice experiments and sensory evaluation to investigate consumers' preferences and WTP for various apple varieties, showing which quality attributes consumers like or dislike. Similarly, Lawless *et al.* (2015) studied the impact of product sensory attributes on WTP for a nutraceutical-rich juice blend using sensory evaluations and a non-hypothetical Becker–DeGroot–Marschak auction mechanism.

Previous studies pointed out as specific sensory attributes, such as crunchiness, juiciness, sweetness, sourness and flavour, may influence the consumer's overall liking more than others (Ares *et al.*, 2014; Charles *et al.*, 2017; Gatti *et al.*, 2011). In light of this consideration, and based on what aforementioned, overall liking and WTP for the new apple cultivar were evaluated considering these five attributes. Specifically, the study aimed to answer the following research questions: (RQ1) What is the consumer's liking and WTP for the new apple cultivar? (RQ2) Which sensory attributes influence consumers' overall liking and WTP more than others?

This research is unique because it combines sensory evaluations and hypothetical valuation mechanisms, incorporating penalty analysis to determine how specific sensory attributes affect willingness to pay. So, this study tried to fill the gap of limited literature about the economic valuation of specific sensory attributes that are not optimal, providing directions for future product optimisation in apple breeding programmes.

2. Materials and methods

A two-stage survey was administered between December 2021 and January 2022. During the first stage (appearance valuation), participants were asked to provide their online informed consent after presenting the scope of the study. Respondents completed a Contingent Valuation (CV) training task preparatory for the follow-up stage. In the follow-up stage (sensory evaluation), considering the COVID-19 precautions of avoiding as far as possible contacts, participants were required to complete the product evaluation autonomously at home with hedonic, JAR and CV tasks. Furthermore, since the study aimed not to determine and distinguish differences between sensorial product variations, we opted for involving non-trained sensory panellists. Penalty analysis based on responses referred to the product

compared to their ideal one was adopted to establish which specific sensory attributes were responsible for increasing or decreasing overall liking and WTP for a new apple cultivar, leading to helpful information for agronomic and marketing applications.

2.1 Participants

The sensory evaluation and the CV were applied by a shop-intercept convenience sample of consumers without previous experience in sensory analysis. Two hundred forty citizens were recruited on the eleventh and twelfth of December 2021 amongst people walking through the central square of Sondrio (Italy), where a public two-day event was organised to present a new apple cultivar. People aged 18 years or above and residents in Italy were recruited based on their interest in participating, responsibility for food purchases in their families, and fruit consumption at least once a week. No cash incentives were used. One hundred twenty-two participants completed the two-step survey. The sample characteristics are shown in Table 1.

2.2 Sample

The apple sample studied (*Malus domestica* Borkh.) is an innovative winter cultivar not yet commercially available, bred by the Alma Mater Studiorum Università di Bologna. The apples were harvested on the 25th of October 2021 from an experimental orchard managed by the Fondazione Fojanini (Sondrio, Italy) and stored in a refrigerated storage room at 2 °C. Apples free from visual defects and with a diameter between 70 and 90 mm were removed from the fridge 24h before the two-day event, cleaned with a wet cloth, placed in a resealable food bag with a capacity not exceeding one apple and offered to interviewees for the follow-up step of the study.

Data collected	N	%	% Italy (2021[a]; 2019[b])
Sex			
Male	54	44.26	48.82
Female	68	55.74	51.18
Age group (years)			
18–24	7	5.74	8.15
25–34	18	14.75	12.47
35–44	22	18.03	14.62
45–54	34	27.87	18.91
55–64	29	23.77	17.64
≥65	12	9.84	28.21
Education level			
University	55	45.08	19.70
High school	53	43.44	34.92
Middle School	14	11.48	25.22
Primary school	–	–	12.93
None	–	–	7.24
Occupational status			
Employed full-time	85	69.67	54.60
Employed part-time	10	8.20	6.82
Occasional employment	5	4.10	7.88
Retired	18	14.75	24.29
Looking for work	4	3.28	6.40

Note(s): [a] Sex, Age group, and Education level; [b] Occupational status

Source(s): Authors work / ISTAT-Permanent census of population and housing, for data referred to the Italian population

Table 1.
Sample characteristics

2.3 Procedure

Respondents were told that the purpose of the study was double. First, determine how much consumers value the new apple. Second, how much the new apple matched their expectations from a hedonic and sensory viewpoint. Furthermore, respondents were informed that the survey would take place in two phases: directly, at the moment (i.e. registration and training step) and privately at home (i.e. follow-up stage).

2.3.1 Registration and training step. During the registration step, participants received the product description as follows: "*You can participate in a study for evaluating a new cultivar of apple. This apple is selected by the breeding programme of the Alma Mater Studiorum Università di Bologna among ancient apple cultivars thanks to the help of consumers' opinions. Considering the current COVID-19 pandemic, we will offer you an apple sample for tasting later at home, during one of the primary daily meals, to complete the survey. Remember, your sensory opinion is important for us, and it is important that before tasting the apple, you will wash your mouth with water and eat a neutral biscuit (e.g. non-salted crackers)*".

When consumers accepted to participate through an online informed consent, they were given a picture postcard containing a quick response code and a web address for accessing and completing the online survey. A univocal four-digit code with the instruction to declare it during the in-home part of the experiment was given to participants to link the information collected during the two steps of the study. After performing an online CV training task and providing information about the sample characteristics (i.e. sex, age, educational level and occupational status), participants received a free apple sample.

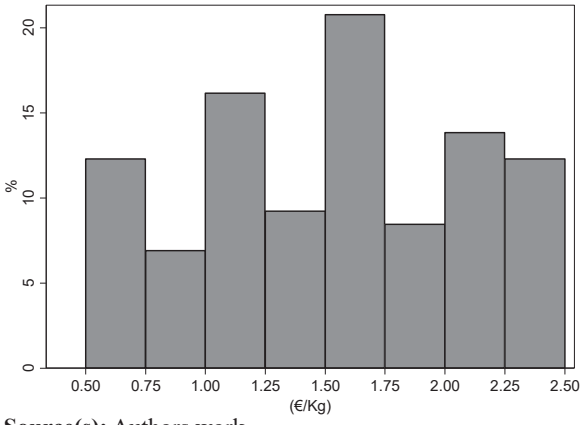
2.3.2 Follow-up stage. The information resulting from hedonic, JAR and CV tasks was collected through a self-administered online questionnaire and formed the basis of the follow-up step. In light of the COVID-19 pandemic, we let respondents autonomously perform the task at home, during one of the day's meals, at room temperature, after rinsing the mouth with water and eating a neutral biscuit (e.g. non-salted crackers) before tasting the apple. This task setting did not allow us to control the environment and context fully and the quality of the apple sample during the sensory evaluation. However, in line with Kole *et al.* (2009), this research benefits from collecting sensory information during a real consumption experience in a daily family eating situation.

2.3.3 Eliciting hedonic and WTP response. The hedonic linking response was obtained on a nine-point labelled category scale (1 = "Dislike extremely", 9 = "Like extremely"), and the economic valuation of the new apple cultivar was performed by applying the CVM. Amongst the CVM techniques for eliciting the WTP, this study adopted the Double-Bounded Dichotomous Choice for its efficiency in WTP estimation (Hanemann *et al.*, 1991). The online survey was characterised by two consecutive questions (Q1 and Q2) on whether respondents would buy 1 kg of the new apple cultivar they had just tasted at a given selling price. Depending on dichotomous buy/do not buy responses, this method revealed the upper and lower bounds of respondents' WTP. During Q1, respondents were initially presented with a randomly selected price (P_i). The price was randomly selected from a range between € 0.50 to € 2.50, and Figure 1 presents the distribution of P_O in Q1. The range of apple prices was based on ISMEA data for 2020–2021, in which the average retail price was 1.58€/kg (ISMEA, 2021), and considering ±1.00€/Kg as retail price deviation from the average price level. Depending on the *yes* or *no* response to Q1, a 50% price increase (P_h) or a 50% discount (P_l) was considered in Q2. Thus, from the combination of responses to Q1 and Q2, four paired outcomes were possible: (1) no-no; (2) no-yes; (3) yes-no; (4) yes-yes. Thus, the respondents' WTP for 1 kg of the new apple cultivar will fit into one of four intervals: $(-\infty; P_l)$, (P_l, P_O), (P_O, P_h) and $(P_h, +\infty)$, and the discrete outcomes of the bidding process (D) are defined as follows:

$$D = \begin{cases} 1 & WTP \leq P_l \quad (No - No\ responses) \\ 2 & P_l \leq WTP \leq P_0 \quad (No - Yes\ responses) \\ 3 & P_0 \leq WTP \leq P_h \quad (Yes - No\ responses) \\ 4 & P_h \leq WTP \quad (Yes - Yes\ responses) \end{cases} \quad (1)$$

Thus, data collected through the double-bound discrete choice CV online survey was organised as left-censored for No-No responses, right-censored for Yes-Yes responses, and interval-based for both No-Yes and Yes-No responses given by each respondent.

2.3.4 Eliciting hedonic and WTP determinants. Empirical literature validated the "crunchiness", "juiciness", "sweetness", "sourness" and "flavour" as the main attributes determining consumers' appreciation for apples (see, for example, Ares *et al.*, 2014; Charles *et al.*, 2017; Gatti *et al.*, 2011, amongst others). Thus, the current research considered these five attributes as determinants of consumers' WTP and overall liking for the new apple cultivar. The JAR questions included in the follow-up step of the study allowed consumers to describe the product in terms of the five sensory attributes using a 5-point scale (1 = "Not enough . . . ", 3 = "Just about right", 5 = "Much too . . . "). In line with Xiong and Meullenet (2006), each JAR variable was recoded into two new variables (i.e. *too little* and *too much*). The middle category (i.e. 3 = JAR) of the 5-point JAR scale represents the ideal level of the sensory attribute and is coded 0 in both new variables. In the new '*too much*' variable, responses coded 4 (*too much*) and 5 (*way too much*) in the JAR scale were re-encoded 1 and 2, respectively, while all other responses were recoded 0 (Table 2). Likewise, in the '*too little*' variable, JAR responses 1 (*way too little*) and 2 (*too little*) were recoded as 2 and 1, and all other responses were re-encoded as 0. This coding method allows interpreting the intercept as the estimated value for the product with all the JAR scales in the middle point. At the same time, the coefficients estimated for the



Source(s): Authors work

Figure 1. Starting point price distribution in Q1 on whether the respondent would buy 1 kg of the new apple cultivar they had just tasted at a given selling price (n = 122)

	Variable coding				
	Not enough	. . .	JAR	...	Much too
Original scale	1	2	3	4	5
Too much	0	0	0	1	2
Too little	2	1	0	0	0

Source(s): Authors work

Table 2. Recording of just-about-right (JAR) scale into "*too much*" and "*too little*" variables

too little and *too much* variables represent the penalty assigned for 1-point deviation from the ideal point. In case of 2-point deviations, the penalty is doubled.

2.4 Empirical models and data analysis

Two empirical models were adopted to establish which specific sensory attributes are the most accountable for increasing or decreasing the participants' WTP and overall liking.

2.4.1 WTP model. For assessing the penalty in euros, we assumed that each respondent i had a WTP for 1 kg of the new apple cultivar (WTP_i^*), which is the latent variable in equation (2) below:

$$WTP_i^* = \beta X_i + \varepsilon_i \tag{2}$$

where β is a vector of coefficient, X_i is a vector of the 11 determinants of the WTP (i.e. 10 JAR recoded variables and the initial selling price P_0), while the error term ε_i is assumed to have a mean zero and be normally distributed. Thus, according to Hanemann *et al.* (1991), WTP_i^* is unobserved, but it lies in the range from a lower bound (L_i) to upper bound (U_i) in line with the right- and left-censored and interval data collected. If a respondent has a "Yes-No" response, the probability of the true $WTP \subset [P_0, P_h]$ could be represented by equation (3):

$$Pr(P_0 \leq WTP \leq P_h) \tag{3}$$

whereas if the respondents respondent has a "Yes-Yes" response, the probability of the true $WTP \subset [P_h, \infty]$ is:

$$Pr(P_h \leq WTP) \tag{4}$$

The same rule applies to the "No-Yes" and "No-No" responses.

Given the nature of the dependent variable (i.e. WTP), the data were analysed using an interval regression model (Cawley, 2008) in STATA 16 (StataCorp, LLC, College Station, Texas, USA), using the interval regression command "intreg". Thus, the individual WTP_i^* was calculated using the interval regression model, using post-estimation command prediction. For evaluating the penalty in euros for JAR-scale variables, the value of the initial bidding price (P_0) was incorporated in the empirical model for detecting the anchoring effect's bias, applying the method proposed by Herriges and Shogren (1996) and Liou (2015) as follows:

$$WTP_i^c = \left(WTP_i^* - kP_0\right) \Big/ (1 - k) \tag{5}$$

where WTP_i^c is the corrected value of WTP_i^* for each observation, P_0 is the starting selling price, and k is the anchoring effect coefficient, i.e. the coefficient of the variable P_0 estimated from the interval regression model. Bootstrapping with 5,000 replications was used to construct the confidence interval of the mean and the median WTP_i^* and WTP_i^c. According to Bateman *et al.* (2002), this is a robust technique that does not require any prior assumption about the nature of the data.

2.4.2 Overall liking model. According to Xiong and Meullenet (2006, p. 190), the JAR-recoded variable transformation can be used to model the relationship between hedonic liking and JAR-scale attributes using any regression procedure. Thus, in this study, the 10 JAR recoded variables were included in a linear regression model for assessing the penalty in overall liking, estimating the deviation from the ideal of each sensory attribute. So, we assumed that each respondent i had an overall liking for 1 kg of the new apple cultivar equal to Y_i^* and it is related to the five pairs of JAR recoded variable X_i in the following way:

$$Y_i^* = \beta_0 + \beta X_i + \varepsilon_i \quad (6)$$

where β_0 is the model intercept, which can be interpreted as the estimated mean of overall liking for the new apple cultivar if all sensory attributes are JAR, β is a vector of regressor coefficients for the five pairs of JAR recoded variables, ε_i is the error term assumed to have mean zero and be normally distributed, and despite Y_i^* is not observed for each respondent *i,* it lies in the interval $[Y_{i1}; Y_{i9}]$. Regression analysis was performed using STATA 16, considering the absolute liking score as the dependent variable and the JAR recoded variables, indicating if respondents described the new apple cultivar as different from their ideal as regressors.

3. Results

Two models were adopted to elicit the effect of an attribute not being JAR on WTP and overall liking. These models reveal the very high consumer appreciation for the new apple in hedonic terms (i.e. 7.598 on a 9-point Likert scale) and economic value (M = 2.23, 95% CI [2.14, 2.32]). The opportunity to identify the penalty in euros for attributes not being optimal is relevant for connecting WTP to the five sensory aspects considered in the study. Instead, identifying the penalty in overall liking is suitable for determining how much the JAR attributes influence the acceptance of a new apple cultivar. The % of not-JAR responses was generally less than the 20% threshold, and both not-JAR typologies (i.e. *too less* or *too much*) were represented.

3.1 Penalty in euros and overall liking

The estimated parameters based on Eq. (2) and Eq. (6) are presented in Table 3, separately for the penalty in euros and overall liking. Patterns were similar for WTP and overall liking, considering that a reduction in WTP and overall liking occurred because of *too little* crunchiness (only 4.92% of respondents) and tastiness (23.77 of respondents). Furthermore, it is noteworthy that a WTP reduction occurred because of *too much* crunchiness (only 13.12% of respondents) or *too much* tastiness (7.38%). Instead, an additional decrease in overall liking occurred because of *too little* sweetness (20.49% of respondents) or too much sweetness (9.84%).

Variables	% of Responses not JAR	WTP		Overall liking	
		β	SE	β	SE
Intercept		1.707***	0.294	8.062***	0.128
Too crunchy	13.12	−0.708***	0.173	−0.524	0.476
Not crunchy enough	4.92	−0.764**	0.374	−2.176***	0.604
Too juicy	10.66	0.370	0.231	−0.024	0.344
Not juicy enough	8.20	0.074	0.293	0.626	0.398
Too sweet	9.84	0.037	0.192	0.163	0.337
Not sweet enough	20.49	−0.231	0.220	−0.960***	0.320
Too sour	14.75	−0.288	0.233	0.055	0.324
Not sour enough	15.58	−0.094	0.177	−0.195	0.213
Too much flavour	7.38	−0.509	0.291	0.039	0.341
Not enough flavour	23.77	−0.340**	0.164	−0.450**	0.217
P_0		0.561***	0.173		
ML R^2		0.264			
R^2				0.321	
p		0.000		0.000	

Note(s): *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$
P_0=Starting bidding price
Source(s): Authors work

Table 3.
Penalty analysis in euros and overall liking (n = 122) for a new apple cultivar

Looking at the regression coefficients of the interval regression model, it seems clear that crunchiness was the most controversial sensory attribute, and deviation from the ideal had the highest impact on decreasing WTP. The −0.764 ($p < 0.05$) *not crunchy enough* coefficient indicated that with increasing crunchiness over the *too little* region, WTP increased by 0.764€/Kg. Meanwhile, for every unit of *too much* crunchiness, WTP decreased by 0.708€/Kg ($p < 0.001$). When both coefficients of a pair of recoded variables are not zero and significantly impact the WTP, it suggests that there are two different types of consumers: one group places less importance on the crunchiness of the new apple cultivar, while another group values this sensory aspect highly (Table 4). So, the proportions of consumers who consider this attribute *too little* (4.92% of respondents), *too much* (13.12% of respondents) *and* JAR (81.96% of respondents) should be carefully considered by developers, given that only attributes received at least 20% of non-JAR responses should be considered deviating from the ideal (Plaehn, 2012). The consumers' overall liking for the same attribute increased by 2.176 ($p < 0.001$) for every unit of increasing crunchiness over the *too little* region (i.e. 1 to 3). Regarding the flavour, both WTP and overall liking increase by 0.340 ($p < 0.05$) and 0.450 ($p < 0.05$), respectively, by increasing the product tastiness over the *too little* region. Finally, overall liking increased by 0.960 ($p < 0.01$) for every unit increase in sweetness over the *too little* region.

3.2 WTP and overall liking

The estimated parameters based on Eq. (2) show that the coefficient of variable P_0 is positive and statistically significant, suggesting that the initial bid has positively influenced participants' WTP. Thus, an evident starting point bias must be considered for correcting

	Too crunchy		Not crunchy enough	
Data collected	N	%	N	%
Sex				
Male	7	43.75	3	50.00
Female	9	56.25	3	50.00
Age group (years)				
18–24	1	6.25	1	16.67
25–34	3	18.75	1	16.67
35–44	3	18.75	1	16.67
45–54	5	31.25	1	16.67
55–64	2	12.50	1	16.67
≥65	2	12.50	1	16.67
Education level				
University	10	62.50	4	66.67
High school	5	31.25	1	16.67
Middle School	1	6.25	1	16.66
Primary school	–	–		–
None	–	–		–
Occupational status				
Employed full-time	12	75.00	4	66.67
Employed part-time	–	–	1	16.67
Occasional employment	–	–		
Retired	3	18.75	1	16.66
Looking for work	1	6.25		

Note(s): A description of this fewer subset of the sample was done despite the awareness that it cannot be considered significant
Source(s): Authors work

Table 4.
Cluster profiles: "too crunchy" (n = 16) and "not crunchy enough" (n = 6)

the predicted WTP for each observation. After controlling the anchoring effect's bias by applying Eq. (5) and using a bootstrapping procedure to construct confidence intervals of the mean and the median WTP values, the mean and the median WTP for 1 Kg of the new apple variety were 3.26€ and 3.71€, respectively (Table 5).

Based on the regression model of Eq. (6), the potential maximum mean score of overall liking would be 8.062 ($p < 0.001$) if all the sensory attributes considered were at the JAR level. Considering the observed and predicted mean value of overall liking scores, i.e. 7.598 on a nine-point Likert scale, the model did yield a satisfactory prediction of the hedonic variable for each respondent. The maximum potential improvement margin of overall liking achievable after applying appropriate adjustments of attributes not been JAR was 0.464 (Table 6).

4. Discussion

Understanding the optimum intensity of different sensory attributes on consumers' overall liking for a food product is essential for food companies. Previous works have explored the relations between hedonic and specific sensory aspects (see, for example, Ares *et al.*, 2014; Gondal *et al.*, 2021; Guinard *et al.*, 2016; Jaeger *et al.*, 2015; Li *et al.*, 2015; Plaehn and Horne, 2008, amongst others). Other studies focused on the relationship between consumers' overall liking, specific individual aspects (i.e. individual traits, socio-economic aspects, specific attitudes) and WTP (see, for example, Naspetti *et al.*, 2020; Schouteten *et al.*, 2019; Teuber *et al.*, 2016, amongst others) instead. These studies did not confirm the connections between the individual components of liking and consumers' WTP. In comparison, few studies examined the effect of specific sensory attributes on overall liking and WTP jointly (see, for example, Bi *et al.*, 2012; Hung and Verbeke, 2018; Lawless *et al.*, 2015; Schouteten *et al.*, 2019; Vecchiato *et al.*, 2021, amongst others). Using the JAR scale to compare willingness to pay and overall liking, we can identify which sensory qualities may impact the market success of a potentially delicious yet expensive food product.

This study assessed consumers' preference for a new apple variety by combining sensory evaluations and hypothetical valuation mechanisms, adapting the penalty analysis on how WTP is affected by specific sub-optimal sensory attributes.

Mean and median	WTP	[95% of CI]
Before controlling bias		
Mean	2.230	[2.141–2.318]
Median	2.321	[2.224–2.417]
After controlling bias		
Mean	3.258	[3.086–3.431]
Median	3.711	[3.291–4.130]

Source(s): Authors work

Table 5. Mean and median of predicted WTP for a new apple cultivar in euro/Kg (n = 122)

Variables	Overall liking	[95% of CI]
Intercept	8.062	[7.809–8.315]
Observed mean	7.598	[7.358–7.839]
Predicted mean	7.598	[7.462–7.735]
Maximum improvement	0.464	[0.327–0.600]

Source(s): Authors work

Table 6. Mean of potential, observed and predicted overall liking (n = 122) for a new apple cultivar

The new apple cultivar under investigation was proven to be acceptable for consumers. Nevertheless, the study pointed out room for improvement for specific sensory attributes, such as crunchiness, flavour and sweetness, confirming the extant literature (see, for example, Daillant-Spinnler *et al.*, 1996; Gatti *et al.*, 2011; Jaeger *et al.*, 1998; Kühn and Thybo, 2001; McCluskey *et al.*, 2007). In accordance with Jaeger *et al.* (1998), who identified mealiness as an undesirable characteristic linked to a fluffy texture and stale taste in apples, our study revealed that only a small fraction of consumers viewed the new apple cultivar as insufficiently crunchy in terms of their enjoyment rating, indicating that this was the primary disadvantage in terms of their overall satisfaction. The sweetness and flavour were not perfectly balanced sensory items, confirming that some consumers expected the new apple cultivar to be tastier and sweeter for a whole positive hedonic experience. These findings also confirm those of Kühn and Thybo (2001), who concluded that flavour and sweetness were two primary sensory aspects positively associated with taste preference.

Nonetheless, we must consider two aspects. First, these sensory attributes are below or close to the cut-off point of 20% of non-JAR responses to reject them from being just-about-right attributes. Second, the sample in this study comprises lay consumers with no experience in sensory evaluation and CV. This aspect points out that the new apple cultivar is very close to being considered an ideal apple, ready to launch at an attractive price.

Although the patterns are similar, it is noteworthy that sensory aspects that influence the consumers' hedonic experience partially differ from those that influence the individuals' WTP, confirming what emerged in other studies (Lawless *et al.*, 2015; Vecchiato *et al.*, 2021). Vecchiato *et al.* (2021) pointed out that this can occur because buying a product depends on emotional aspects. In contrast, the formulation process of the WTP is mainly cognitive-based, grounded on comparisons with the prices of other apples. Our study shows the double tendency of the sensory aspect of apple crunchiness, suggesting the presence of two consumer segments: one with a higher preference for firmer and crispier apple texture and another that prefers a less crunchy, more mealy texture. A possible motivation for this dual-sided crunchy perception is the consumer's comparison of the new apple cultivar with other cultivars, considered a reference point for formulating the economic judgement.

Moreover, this study confirms previous research that flavour significantly impacts consumers' WTP (Dinis *et al.*, 2011). Thus, as in this study, the taste attribute must be carefully considered because it is a complex and challenging trait to evaluate, particularly for not-trained consumers. Specifically, the flavour of an apple could be very diverse, depending on the cultivar. Therefore, the consumer experience could strongly influence the results since other consumers could expect and perceive different aromas (i.e. Golden Delicious aroma, Red apple aroma, ripe-apple aroma or green-apple aroma).

5. Conclusions

This study used a stated preferences approach to measure how sensory attributes directly affect the perceived value and gain insight into consumers' preferences for a new apple cultivar. Additionally, the study compared these findings to traditional penalty analysis on hedonic responses, providing a more comprehensive view of consumer behaviour. Despite the WTP measures may be affected by overestimation bias due to the use of CVM, calculating the cost of sensory attributes not being JAR as a differential in monetary units should provide reliable information about the perceived value difference. Studying this difference with overall liking's sensory components offers more realistic valuations and innovative insights into selecting adequate agronomics, post-harvested and marketing strategies for promoting this new apple cultivar.

The analysis shows that crunchiness has the most significant impact on WTP and overall liking for our product. This aspect is less severe due to the low percentage of non-JAR responses. A one-unit change in crunchiness rating increases (or decreases) WTP by 0.764 (or 0.708) euros, depending on personal consumers' preference for apple texture. Instead, a one-unit change in crunchiness rating increases consumers' hedonic appreciation for the new apple cultivar on an average of over 2 points scale, although it is noteworthy that the maximum possible improvement is 0.4 points. Considering the large proportion of consumers who consider this sensory aspect adequate (81.96%), the developers must consider focussing more on those open-field and postharvest initiatives devoted to preventing mealiness and promoting crunchiness, sweetness and flavour (see, for example, Griñán *et al.*, 2019; Lisanti *et al.*, 2021; Robinson *et al.*, 2017, amongst others). It is well known that fruit attributes mainly depend on each cultivar's genetic determinants, but fruit phenotype can be influenced and modulated by environmental conditions and cultivation practices.

Additionally, results have implications for producers and breeders. Information referring to the consumers' WTP provides a good direction for a more appropriate pricing strategy. The consumers' bid and the products' overall liking demonstrate that some internal fruit characteristics affect product pricing and appreciation. What emerged from the results is that the product seems perceived as not ripe at an optimal level because too crunchy, not sweet enough and not enough flavoured. The cause can be attributable to having proposed slightly greener apples to avoid problems of over-ripening. This aspect reflects the relevance of adopting all those actions along the food supply chain management in offering an apple in an ideal customer condition (from production to in-store management). Thus, if the product is priced correctly, the customers are willing to bring it home and taste it, and if it is consistent with their expectations, this enhances the probability of repurchasing.

Though the approach adopted in this study provides pertinent information about consumers' preferences for the new apple cultivar, these findings must be generalised with caution. The consumer sample used in this study suffers from some limitations. One is the relatively small convenience sample of lay consumers, who may not represent the target population. Using a larger random sample can help reduce the risk of selection bias and improve reliability. Consumer test results could be paired with a sensory analysis based on a Quantitative Descriptive Analysis and an expert panel to obtain a detailed sensory profile of the new apple cultivar.

Furthermore, although the follow-up experiment was done in a daily family consumption environment, this aspect does not guarantee that the actual purchasing situation could be the same. Despite acknowledging the limitations of CVM related to the hypothetical market approach, findings align with previous studies emphasising that this bias is less severe for private goods characterised by a low price. Thus, this approach helps collect joint sensory and economic information in a family context consumption. Despite the limitations mentioned above, we maintain that this interdisciplinary study could help plant breeders and marketing managers become aware of the importance of joint consideration of sensory and economic aspects for improving apple industry competitiveness.

References

Ares, G., Dauber, C., Fernández, E., Giménez, A. and Varela, P. (2014), "Penalty analysis based on CATA questions to identify drivers of liking and directions for product reformulation", *Food Quality and Preference*, Vol. 32, pp. 65-76, Elsevier.

Baba, Y., Kallas, Z., Costa-Font, M., Gil, J.M. and Realini, C.E. (2016), "Impact of hedonic evaluation on consumers' preferences for beef attributes including its enrichment with n-3 and CLA fatty acids", *Meat Science*, Vol. 111 No. 34, pp. 9-17.

Barnes, R.N., Bosworth, R.C., Bailey, D. and Curtis, K.R. (2014), "This document is discoverable and free to researchers across the globe due to the work of AgEcon Search . Help ensure our sustainability", *International Food and Agribusiness Management Review*, Vol. 17 No. 3, pp. 115-138.

Bateman, I., Carson, R.T., Day, B., Hanemann, M., Jones-Lee, M., Hanley, N. and Hett, T. (2002), "Economic valuation with stated preference techniques: a manual", edited by Bateman, I., Edward Elgar.

Bi, X., House, L., Gao, Z. and Gmitter, F. (2012), "Sensory evaluation and experimental auctions: measuring willingness to pay for specific sensory attributes", *American Journal of Agricultural Economics*, Vol. 94 No. 2, pp. 562-568.

Cawley, J. (2008), "Contingent valuation analysis of willingness to pay to reduce childhood obesity", *Economics and Human Biology*, Vol. 6 No. 2, pp. 281-292.

Charles, M., Endrizzi, I., Aprea, E., Zambanini, J., Betta, E. and Gasperi, F. (2017), "Dynamic and static sensory methods to study the role of aroma on taste and texture: a multisensory approach to apple perception", *Food Quality and Preference*, Vol. 62 June, pp. 17-30, Elsevier.

Chengyan, Y. and Tong, C. (2011), "Consumer preferences and willingness to pay for existing and new apple varieties: evidence from apple tasting choice experiments", *Product and Marketing Reposrts*, Vol. 21 June, pp. 376-383.

Daillant-Spinnler, B., MacFie, H.J.H., Beyts, P.K. and Hedderley, D. (1996), "Relationships between perceived sensory properties and major preference directions of 12 varieties of apples from the Southern Hemisphere", *Food Quality and Preference*, Vol. 7 No. 2, pp. 113-126.

Dinis, I., Simoes, O. and Moreira, J. (2011), "Using sensory experiments to determine consumers' willingness to pay for traditional apple varieties", *Spanish Journal of Agricultural Research*, Vol. 9 No. 2, p. 351.

Garber, L., Hyatt, E., Starr, R., Marshall, D., Wansink, B., Cardello, A., Civille, G., *et al.* (2003), "Measuring consumer response to food products. Commentaries. Authors' reply", *Food Quality and Preference*, Vol. 14 No. 1, pp. 3-15.

Gatti, E., Di Virgilio, N., Magli, M. and Predieri, S. (2011), "Integrating sensory analysis and hedonic evaluation for apple quality assessment", *Journal of Food Quality*, Vol. 34 No. 2, pp. 126-132.

Gondal, T.A., Keast, R.S.J., Shellie, R.A., Jadhav, S.R., Gamlath, S., Mohebbi, M. and Liem, D.G. (2021), "Consumer acceptance of brown and white rice varieties", *Foods*, Vol. 10 No. 8, pp. 1-19.

Griñán, I., Galindo, A., Rodríguez, P., Morales, D., Corell, M., Centeno, A., Collado-González, J., *et al.* (2019), "Volatile composition and sensory and quality attributes of quince (Cydonia oblonga Mill.) fruits as affected by water stress", *Scientia Horticulturae*, Vol. 244, pp. 68-74.

Grunert, K.G. (2003), "Purchase and consumption: the interdisciplinary nature of analysing food choice", *Food Quality and Preference*, Vol. 14 No. 1, pp. 39-40.

Guinard, J.X., Myrdal Miller, A., Mills, K., Wong, T., Lee, S.M., Sirimuangmoon, C., Schaefer, S.E., *et al.* (2016), "Consumer acceptance of dishes in which beef has been partially substituted with mushrooms and sodium has been reduced", *Appetite*, Vol. 105, pp. 449-459, Elsevier.

Gwin, L., Durhamb, C.A., Miller, J.D. and Colonna, A. (2012), "Understanding markets for grass-fed beef: taste, price, and purchase preferences", *Journal of Food Distribution Research*, Vol. 43 No. 2, pp. 91-111.

Hampson, C.R. and Quamme, H.A. (2000), "Use of preference testing to identify tolerance limits for fruit visual attributes in apple breeding", *HortScience*, Vol. 35 No. 5, pp. 921-924.

Hanemann, M., Loomis, J. and Kanninen, B. (1991), "Statistical efficiency of double-bounded dichotomous choice contingent valuation", *American Journal of Agricultural Economics*, Vol. 73 No. 4, pp. 1255-1263.

Harker, F.R., Gunson, F.A. and Jaeger, S.R. (2003), "The case for fruit quality: an interpretive review of consumer attitudes, and preferences for apples", *Postharvest Biology and Technology*, Vol. 28 No. 3, pp. 333-347.

Herriges, J.A. and Shogren, J.F. (1996), "Starting point bias in dichotomous choice valuation with follow-up questioning", *Journal of Environmental Economics and Management*, Vol. 30 No. 1, pp. 112-131.

Hung, Y. and Verbeke, W. (2018), "Sensory attributes shaping consumers' willingness-to-pay for newly developed processed meat products with natural compounds and a reduced level of nitrite", *Food Quality and Preference*, Vol. 70, pp. 21-31, Elsevier.

ISMEA (2021), "Mele: principali Dinamiche Della Campagna 2021/22", available at: https://www.ismeamercati.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/11875

Jaeger, S.R., Andani, Z., Wakeling, I.N. and MacFie, H.J.H. (1998), "Consumer preferences for fresh and aged apples: a cross-cultural comparison", *Food Quality and Preference*, Vol. 9 No. 5, pp. 355-366.

Jaeger, S.R., Hunter, D.C., Kam, K., Beresford, M.K., Jin, D., Paisley, A.G., Chheang, S.L., *et al.* (2015), "The concurrent use of JAR and CATA questions in hedonic scaling is unlikely to cause hedonic bias, but may increase product discrimination", *Food Quality and Preference*, Vol. 44, pp. 70-74, Elsevier.

Kokthi, E., Canco, I. and Topulli, E. (2021), "Whose salad is organic? An attribute segmentation perspective-evidence from Albania", *Economia Agro-Alimentare*, Vol. 23 No. 2, pp. 1-26.

Kole, A.P.W., Altintzoglou, T., Schelvis-Smit, R.A.A.M. and Luten, J.B. (2009), "The effects of different types of product information on the consumer product evaluation for fresh cod in real life settings", *Food Quality and Preference*, Vol. 20 No. 3, pp. 187-194, Elsevier.

Kühn, B.F. and Thybo, A.K. (2001), "The influence of sensory and physiochemical quality on Danish children's preferences for apples", *Food Quality and Preference*, Vol. 12 No. 8, pp. 543-550.

Lawless, H. and Heymann, H. (2010), in Lawlwss, H.T. and Heymann, H. (Eds), *Sensory Evaluation of Food: Principles and Practices*, 2nd ed., Springer, New York.

Lawless, L.J.R., Drichoutis, A.C., Nayga, R.M., Threlfall, R.T. and Meullenet, J.F. (2015), "Identifying product attributes and consumer attitudes that impact willingness to pay for a nutraceutical-rich juice product", *Journal of Sensory Studies*, Vol. 30 No. 2, pp. 156-168.

Li, B., Hayes, J.E. and Ziegler, G.R. (2015), "Maximizing overall liking results in a superior product to minimizing deviations from ideal ratings: an optimization case study with coffee-flavored milk", *Food Quality and Preference*, Vol. 42, pp. 27-36, Elsevier.

Liou, J. (2015), "Bias correcting model of starting point bias with censored data on contingent valuation method", *Environmental Economics*, available at: https://businessperspectives.org/journals/environmental-economics/issue-226/bias-correcting-model-of-starting-point-bias-with-censored-data-on-contingent-valuation-method

Lisanti, M.T., Mataffo, A., Scognamiglio, P., Teobaldelli, M., Iovane, M., Piombino, P., Rouphael, Y., *et al.* (2021), "1-Methylcyclopropene improves postharvest performances and sensorial attributes of Annurca-type apples exposed to the traditional reddening in open-field Melaio", *Agronomy*, Vol. 11 No. 6, pp. 1-14.

Luby, J.J. and Bedford, D.S. (2015), "Cultivars as consumer brands: trends in protecting and commercializing apple cultivars via intellectual property rights", *Crop Science*, Vol. 55 No. 6, pp. 2504-2510.

Lusk, J.L. and Schroeder, T.C. (2004), "Are choice experiments incentive Compatible? A test with quality differentiated beef steaks", *American Journal of Agricultural Economics*, Vol. 86 No. 2, pp. 467-482.

McCluskey, J.J., Mittelhammer, R.C., Marin, A.B. and Wright, K.S. (2007), "Effect of quality characteristics on consumers' willingness to pay for gala apples", *Canadian Journal of Agricultural Economics*, Vol. 55 No. 2, pp. 217-231.

Meiselman, H.L. (1995), "Quality: introduction to the special issue", *Food Quality and Preference*, Vol. 6 No. 3, pp. 135-136.

Mueller, S., Osidacz, P., Francis, I.L. and Lockshin, L. (2010), "Combining discrete choice and informed sensory testing in a two-stage process: can it predict wine market share?", *Food Quality and Preference*, Vol. 21 No. 7, pp. 741-754, Elsevier.

Murphy, J.J., Allen, P.G., Stevens, T.H. and Weatherhead, D. (2005), "A meta-analysis of hypothetical bias in stated preference valuation", *Environmental and Resource Economics*, Vol. 30 No. 3, pp. 313-325.

Naspetti, S., Alberti, F., Mozzon, M., Zingaretti, S. and Zanoli, R. (2020), "Effect of information on consumer preferences and willingness-to-pay for sparkling mock wines", *British Food Journal*, Vol. 122 No. 8, pp. 2621-2638.

Papoutsi, G.S., Klonaris, S. and Drichoutis, A. (2019), "The health-taste trade-off in consumer decision making for functional snacks: an experimental approach", *British Food Journal*, Vol. 123 No. 5, pp. 1645-1663.

Plaehn, D. (2012), "CATA penalty/reward", *Food Quality and Preference*, Vol. 24 No. 1, pp. 141-152, Elsevier.

Plaehn, D. and Horne, J. (2008), "A regression-based approach for testing significance of 'just-about-right' variable penalties", *Food Quality and Preference*, Vol. 19 No. 1, pp. 21-32.

Radavelli-Bagatini, S., Anokye, R., Bondonno, N.P., Sim, M., Bondonno, C.P., Stanley, M.J., Harms, C., *et al.* (2021), "Association of habitual intake of fruits and vegetables with depressive symptoms: the AusDiab study", *European Journal of Nutrition*, Vol. 60 No. 7, pp. 3743-3755, Springer Berlin Heidelberg.

Robinson, T.L., Rufato, A.D., Rufato, L. and Dominguez, L.I. (2017), "Is fruit dry matter concentration a useful predictor of 'Honeycrisp' apple fruit quality after storage?", *Acta Horticulturae*, Vol. 1177, pp. 151-155.

Schouteten, J.J., Gellynck, X. and Slabbinck, H. (2019), "Influence of organic labels on consumer's flavor perception and emotional profiling: comparison between a central location test and home-use-test", *Food Research International*, Vol. 116, September 2018, pp. 1000-1009, Elsevier.

Stiletto, A., Rozzanigo, E., Giampietri, E. and Trestini, S. (2021), "Taste beats reputation in new food products choice: the case of ready-to-eat pomegranate among young consumers in veneto region (Italy)", *Horticulturae*, Vol. 7 No. 7, doi: 10.3390/horticulturae7070179.

Teuber, R., Dolgopolova, I. and Nordström, J. (2016), "Some like it organic, Some like it purple and some like it ancient: consumer preferences and WTP for value-added attributes in whole grain bread", *Food Quality and Preference*, Vol. 52, pp. 244-254, Elsevier.

Vecchiato, D., Torquati, B., Venanzi, S. and Tempesta, T. (2021), "The role of sensory perception in consumer demand for tinned meat: a contingent valuation study", *Foods*, Vol. 10 No. 9, pp. 1-16.

Xiong, R. and Meullenet, J.F. (2006), "A PLS dummy variable approach to assess the impact of jar attributes on liking", *Food Quality and Preference*, Vol. 17 Nos 3-4, pp. 188-198.

Corresponding author
Sergio Rivaroli can be contacted at: sergio.rivaroli@unibo.it