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# Customer preferences heterogeneity toward avocado: a latent class approach based on the best–worst scaling choice modeling

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## Abstract

Consumption of the avocado fruit and its availability in the retail market has increased in recent decades and with it the desire to learn more about the market and consumer choices. This research aims to explore the consumers' preference heterogeneity toward avocado fruit in Italy assessing their personal eating orientation and socio-demographic factors. To achieve this purpose, the answers of 817 Italian consumer of avocado were collected using a structured questionnaire shared online at national level. A survey based on the best–worst method was conducted to assess the declared preferences of individuals toward a set of intrinsic, extrinsic and credence attributes of avocado, as well as a latent class analysis of subject preferences indexes was applied to identify different clusters of individuals. The distribution of preferences indexes was investigated among latent classes, which were regressed on the socio-demographic variables covariates using multinomial logistic regression. The results suggest that the desirable attributes for choosing avocado were taste, consistency (ready to eat) and affordable price. In addition, five consumer profiles in the Italian context were defined (named *Hedonistic*, *Avocado fruit lovers*, *Sustainability sensitive*, *Value for money* and *Health sensitive*) and characterized in terms of preferences and socio-demographic features. The study addresses a topic that has already been explored, but with an unexploited approach (latent class analysis combined with best–worst choice modeling). Therefore, the results help fill the gap in the existing literature by enriching it with a study that characterizes avocado consumers' preferences considering their heterogeneity in terms of perception and socio-demographic characteristics.

**Keywords:** Avocado, Choice experiment, Consumer profiles, Liking, Quality attributes

## Introduction

The expansion of markets and globalization have placed in the consumer's face new, unconventional food choices, untethered from the gastronomic and production traditions of their countries (Pollard et al. 2002). These dynamics have particularly affected tropical fruits: in recent years, the traditional fruit basket of consumers in Western countries has been joined by a variety of "new" tropical fruits, such as bananas and

pineapples, which have slowly been integrated into consumers' daily diets. Among these fruits, the avocado (*Persea americana*) shows a worldwide increase in terms of international trade, representing an important income-generating activity for the economies of local producers (ex: Latin American countries) and new economic opportunities for new areas. The avocado world production increased in the last 10 years (2011–2020) to 50.5% (Nyakang'i et al. 2023). The significant interest for the avocado is due the phytochemicals content (pigments such as chlorophylls and carotenoids, tocopherols and sterols) (Woolf et al. 2009), highly variable between cultivars (Ramos-Aguilar et al. 2021) that would protect against several chronic diseases of which the fruits (peel, pulp and seed) are rich (da Silva et al. 2022), but also to follows new eating orientation based on healthy, sporty and sustainable lifestyles.

Botanically avocado is a *drupa* and its image is far from usual fruits because it is low in starch, sugars but it has a high content of fat (up to 30%), in addition, it shows the highest protein levels if compared to other fruits. The edible part is the pulp (the most used form is in salad or for the guacamole), but the other fruits component can be alternatively used improving the use in the circular economy (Páramos et al. 2020; Nyakang'i et al. 2023). For imported avocado the quality loss increases with the time from harvest to consumption: the regular monitoring of post-harvest phases guarantees the customer preferences acceptance (Ledger et al. 2006). Ripe fruits or ready-to-eat avocados are becoming more and more popular in the northern Europe market channel, but this purchasing orientation could increase the risk of fruit' damage at the retailer point. The absence of external and internal damage (skin spotting, external rots, flesh bruising or seed cavity browning) is required to all members of the supply chain, while the eating quality is mainly in function of texture and flavor properties related to the cultivars, the stage of ripeness, the dry matter and the oil content.

Several visual parameters of the fruit are evaluated, as mandated by European regulations, to assess its quality, ensure product standardization and acceptable shelf-life. Unfortunately, this type of assessment is very limited: in fact, there is no proven correlation between the current industrial approach and consumer perception of product quality (Kyriacou et al. 2018). In fact, currently this type of evaluation is limited to ensuring an ideal of acceptance related to the appearance of the products, which is expressed in terms of the absence of defects of the outer and inner parts of the fruits, color, and shape, regardless of their flavor. Consequently, over the past two decades the appearance of produce has mostly determined its marketing value, and breeding companies have devoted most of their resources to an intensive search for varieties that are more attractive to the eye at the expense of taste (Giuggioli et al. 2021; Rocha et al. 2013). However, in addition to the external (extrinsic) and internal (intrinsic) quality parameters that describe avocado, consumers are more and more attentive to other product attributes linked to sustainability values both of the product and the supply chain (Magwaza and Tesfay 2015). Credence features, instead, are intangible outcomes related to environmental conservation, origin, supporting small-scale agriculture and local rural communities, farmers living or producing conditions and workers' rights (Moser et al. 2011). Thus, consumer evaluation of product's quality is a complex process determined by assessing the utility of the many extrinsic, intrinsic and credence attributes that define a product, simultaneously. Some studies in the scientific literature considered the consumer

behavior and preferences toward avocado only considering quality aspects of chemical and physical fruit characteristics, like ripeness (firmness) and internal defects (bruising) (Gamble et al. 2010); other authors included in their study avocado attributes such as peel and pulp color, weight and dimensions (Marín-Obispo et al. 2021). Lugo-Ruiz (2019) indeed investigated on consumer preferences for avocado packaging. Through model logit other studies investigated on consumer preferences to avocado fruit considering more than 4 attributes, including intrinsic, extrinsic and credence for Italian consumers (Ballen et al. 2022) or quality attributes in relation to food habit of consumers and the frequency of consumption (Migliore et al. 2017). However, to date, no study has yet investigated consumer stated preference toward a set of credence, intrinsic and extrinsic attributes in the same choice experiment by exploiting the strengths of the best–worst scaling methodology. Furthermore, discriminating among individuals based on their expressed preferences enabled the identification of distinct avocado consumer profiles, also characterized in terms of socio-demographic factors and their attention to seasonality and fruit maturity stage.

In this context, the aims of this research were double: (1) determine the preferences level of consumers toward a set of quality attributes describing the avocado fruit applying the best–worst (BWS) experimental design; (2) define the heterogeneity of individuals in terms of avocado preferences, purchasing and consumption styles and habits, and socio-demographic characteristics using the latent class analysis (LCA) approach.

The present study represents an endeavor to contribute to the existing literature by examining the roles of various attributes in relation to one another, including several characteristics of avocados that may influence consumer choices. The methodology employed in this paper enables us to contemplate numerous selected attributes and the potential for identifying distinct patterns in avocado consumption.

## Methods

### Participants, procedure and tools

A choice experiment was conducted through a structured questionnaire submitted online to respondents from September to November 2022 using mailing list, social network and WhatsApp at national level. In this study, a non-probability sampling method was employed considering a convenience sample of avocado consumers. This method is widely used due to the increasing diffusion of online-based survey and consists of selecting a sample whose elements are familiar to the subject under study, thus being appropriate even without using a statistical criterion. The latter aspect is a strength of this sampling method (Lerro et al. 2020). Respondents were required to be 18 year of age or older to participate and previously indicated the avocado shopping responsibility in the household. These two recruitment criteria were included at the beginning of the questionnaire. The questionnaire, that respects the ethical standards defined by the Declaration of Helsinki, was developed in Italian, was anonymous and did not include sensitive data (approval protocol n. 0630095 by the University Bioethics Committee of the University of Turin, <https://www.unito.it/ricerca/strutture-e-organi-la-ricerca/comitato-di-bioetica-dellateneo/>). Informed consent was provided to the participants prior to attendance. The questionnaire was created developing three main sections, addressing, respectively: (1) socio-demographic characteristics,

(2) avocado purchasing and consumption habits and finally, and (3) the avocado declared preferences. The second section was structured with several double check-all-that-apply (CATA) questions that were used to measure the purchasing and consumption habits of avocado by respondents. In these questions, consumers are presented with a list of terms and asked to select all (from 1 to more possible answers) those that reflect their preferences that reflect the individuals' avocado purchasing and consumption style (Ares and Jaeger 2015). The details of the information required in the different questionnaire sections are described in Table 1.

**Table 1** Questions and possible answers (codified) contained in the Sects. "Introduction" and "Methods" of the questionnaires employed in the survey

	Possible answers
<i>Socio demographic characteristics (Sect. "Introduction")</i>	
Age	1 = 18–25; 2 = 26–35; 3 = 36–45; 4 = 46–55; 5 = 56–65; 6 = > 65
Gender	0 = male; 1 = female
Family size	1 = 1 component; 2 = 2 components; 3 = 3 components 4 = 4 components; 5 = > 4 components
Educational level	1 = primary school; 2 = lower secondary school; 3 = upper secondary school; 4 = master's degree
Monthly average income of the family	0 = Less than 1000 €; 1 = 1000–2000 €; 2 = 2000–4000 €; 3 = 4000–6000 €; 4 = Over 6000 €; 5 = I won't answer
<i>Avocado purchasing and consumption habits (Sect. "Methods"—CATA questions) (0 = no choice/1 = choice)</i>	
Do you consume avocados at a specific time of year?	No (I consume it throughout the year)/Yes (specify)
Why do you consume avocados?	I like it It's good for your health Versatile in cooking
What type of product do you usually buy? (more than one answers were admitted)	Fresh fruit Processed product (e.g., guacamole, fruit juices, smoothies, etc.) Portioned (ready to eat) Paired with other foods (e.g., sushi, sandwich, etc.)
Where do you usually buy avocados? (more than one answers were admitted)	Specialized shop (greengrocer) Super/hypermarket Outdoor markets Organic shops Online Buying groups
At what time of ripeness do you prefer to buy avocados:	Already ripe (ready to eat) Not yet ready to eat (I prefer to ripen at home) I do not perceive the difference I do not evaluate this difference
How often do you buy avocados?	1–2 times per week Less than 1 time per week 1 time per month Occasionally (a few times a year)
What is your usual use? (more than one answers were admitted)	Consumption of the fresh product Raw preparations (salads, sandwiches, sauces) Cooked
Did you know that there are different varieties of avocados on the market in Italy?	Yes/ No
Do you know that they are starting to grow avocados in Italy?	Yes/No

### Consumer preferences assessment toward avocado attributes

The third and last section of the questionnaire was dedicated to the implementation of the best–worst scaling (BWS) questions scheme (Table 2) in order to obtain the preferences level for 12 attributes describing avocado. The BWS methodology is part of the discrete choice experiments (DCE) and was introduced by Finn and Louviere at the beginning of the 90' (Finn and Louviere 1992) and methodologically refined by Marley and Louviere (2005). Furthermore, the BWS design application also found confirmation in determining preferences toward different attributes describing agri-food products. For example, the best–worst scaling approach was employed to determine consumer preferences for meat, fruit and vegetables, honey, salad and craft beer and spirit (Merlino et al. 2018, 2019, 2020; Massaglia et al. 2019b; Sparacino et al. 2022). This approach was also applied to explore food values in other previous researches (Lusk and Briggeman 2009; Cohen 2009; Bazzani et al. 2018; Cerroni et al. 2022). The methodology is based on a choice experiments during which the participants choose the pair of maximum difference between the proposed product attributes, determines a minimal cognitive effort compared to the ranging or ranking procedures. Moreover, the methodology allows for a preference choice of attributes in different combinations including the effect of randomization on the final preference score assigned to the single item. In addition, the possibility of exploring attributes of a different nature further emphasizes this advantage. In our research, a total of 12 avocado attributes were selected through an in-depth scientific literature review, which was based on studies related to avocado consumer preferences and the quality characteristics of the fruit. We balanced these items among the three categories of quality attributes: intrinsic, extrinsic, and credence. Specifically, the chosen avocado attributes were: intrinsic (Variety, Health benefits, Taste—creaminess, aroma, etc.); extrinsic (Affordable price, Appearance—integrity of the skin, absence of visible defects, etc., Color—green skin, Color—dark skin, Consistency to the touch—already ripe = ready to eat, Consistency to the touch- hard = ripe, Brand awareness) and credence (Certifications—i.e., ethics, environmental sustainability, controlled supply chain certifications, etc., Seasonality).

During the choice experiment, respondents are shown a subset of items from the main list of 12 attributes. For each set (Table 2), the respondent had to indicate the item that he/she considered the best/preferred (BEST) and the worst/least preferred (WORST) for the choice of avocado during purchase.

Indicate the most important (BEST) and the least important (WORST) attributes during the milk choice:

**Table 2** Example of a best–worst scaling question (choice set)

Least important (only one choice)	Milk attributes	Best important (only one choice)
◦	Expiration date	◦
◦	Price	◦
◦	Fat content	◦
◦	Packaging material	◦

This activity is repeated several times, varying the particular subset of items in a systematic way, typically according to an experimental design. In this research, starting from a set of  $t=12$  avocado attributes, the items were organized in the BWS questions in accordance with the standard design commonly used in balanced incomplete block design (BIBD) (Sparacino et al. 2022):  $s=9$  choice sets each containing  $c=4$  attributes; the single attributes appeared  $r=3$  times throughout the  $s$  sets. Four different versions of the questionnaire were created by the software to increase the possible combinations of attributes through the BW questions.

The experimental design and attributes combinations were developed using the Sawtooth software (SSI version 8.4.6, Orem, UT, USA; <http://www.sawtoothsoftware.com/>).

In general, in best–worst scaling response processes might not be equally driven due to emotion, personal and socio-demographic features of individuals. In this research, however, whose measured preference results could have real-world implications in predicting actual choice behaviors in the avocado consumer market, assessment of external validity is critical. Generally, there seems to be support in the literature between preferences measured by the BWS method and actual choices of goods in supermarkets (Louviere and Woodworth 1983; Lee et al. 2007). One approach to addressing selection bias in consumer samples is to include general questions about the population to which respondents belong, or to ask respondents to consider variables that may help avoid personal reporting (Lusk and Briggeman 2009; Wittenberg et al. 2016). In our research, we developed the BWS (best–worst scaling) question by asking respondents to consider their avocado purchases, aiming to enhance our understanding of the avocado-consumer population and potentially provide insights beyond participants' personal characteristics. Other data regarding purchasing and consumption habits collected in the survey served to enhance the external validity of our findings. Finally, the BWS assumes that preferences are sufficiently similar among individuals in the sample and that the mean is representative of the group. This assumption may not be reasonable for all samples: in this regard, we applied latent class analysis to explore differences between subgroups (Lusk and Briggeman 2009; Wittenberg et al. 2016; Cerroni et al. 2022).

### Data analysis

Data collected from the BWS questions were analyzed using the *Sawtooth software* (SSI version 8.4.6, Orem, UT, USA; <http://www.sawtoothsoftware.com/>). The software input was a matrix structured in  $n$  rows that represent the single respondent ( $n$  = sample size) and 18 columns which are to be considered as 9 pairs of columns. In fact, the first of the 18 columns contain the position (from 1 to 4) of the attribute chosen as BEST in the first set of attributes (first question BW), while the second column indicates the position of the attribute chosen as WORST (from 1 to 4). This indication proceeds for the remaining 8 pairs of columns (representing the other 8 BW questions). A last column includes the version (from 1 to 4) of the questionnaire.

The software provides an aggregate value of preference per single attribute obtained based on the sample size (Average Raw Score or A-RS) based on the Bayes Hierarchical Estimation (HB) and starting from the count ratio (the number of times the single attribute was selected as best— $count_{BEST}$ , and the number of times it was selected as



worst-count *WORST*). Specifically, the A-RS is defined calculated in a probabilistic point of view following this formula (1):

$$A - RW = \frac{\text{CountBEST} - \text{CountWORST}}{r * N} \quad (1)$$

where COUNTbest is the number of times the single item was selected as BEST; COUNTworst is the number of times the single item was selected as WORST;  $N$  is the sample size; and  $r$  is the number of times the single attribute appears in the questionnaire, that in our case was equal to 3.

The analysis conducted in this research was performed, as with DCEs more generally, by assuming that respondents make choices according to a random utility model (RUM). RUMs assume that an estimate of how much a respondent prefers item A over item B is provided by the frequency with which item A is chosen over item B in repeated choices. Therefore, frequencies of choice estimate utilities on the relevant latent scale. BWS essentially aims to provide more information about choice at the lower end of this scale without having to ask additional questions specific to the lower ranking items. It thus allows for the measurement of average utility (or preference) by considering the maximum difference pair for each set. In our research, the respondent was asked to rate four items: A, B, C and D. If the respondent indicates that A is the best and D is the worst, these two answers inform us about five of the six possible implied paired comparisons:  $A > B$ ,  $A > C$ ,  $A > D$ ,  $D < B$ ,  $D < C$ . The only paired comparison that cannot be inferred is B versus C. In this way the coupled of maximum differences was indicated. The Sawtooth software estimated the utility function considering the total responses (number of best and number of worst for each attributes) by the sample using a cyclical algorithm  $k(k-1)/2$  of possible paired comparisons. The preference level scores (Average Raw score), made using the Hierarchical Bayes Estimation (HB) technique and calculated for each avocado attribute, were considered to generate a rank of preferences of the total sample. To understand the correlation between the 12 attributes, a correlation analysis was conducted using the Bravais–Pearson correlation method.

### Consumer clusters assessment

The latent class analysis *Sawtooth software* (SSI version 8.4.6, Orem, UT, USA; <http://www.sawtoothsoftware.com/>) was used to identify different consumer groups heterogeneous in terms of declared preferences toward avocado. The relative index of preference instead, whose sum is equal to 100, was employed as dependent variables in the LCA model. This approach allows the estimation of the probability that an individual respondent is in any of the latent classes. Individual respondents were assigned to the class in which they had the highest probability of belonging based on the degree of preference expressed by individual attribute. The best segmentation model was chosen by selecting the lowest log-likelihood (LL) and relative Bayesian Information Criterion (BIC) value of each model.

Finally, to understand how socio-demographic backgrounds changed between consumer groups, a multinomial logistic regression (MLR) analysis was conducted considering socio-demographic categorical variables (with more than 2 groups) and using the software-selected consumer cluster as the reference group (Niva and Vainio 2021).

The standard deviation was used as an indicator of variability within the sample (in the analysis of preferences). General linear model with deviation contrasts was used in order to explore the mean preferences between the consumer clusters. The p-value for each attribute was calculated for the validation of the homogeneity of the cluster segmentation.

The cluster characterization in function of avocado purchasing and consumption habits was also conducted. All the statistical analyses were performed using SPSS.28.0 for Windows.

### 3. Results

#### 3.1 Participant's characteristics

On a total of 1089 intercepted individuals, only the answers of 817 respondent, that declared to purchase and consume avocado, were considered in the data analysis. Regarding the sample socio-demographic profile, there were more women (86%) than men (14%).

The age distribution was relatively even across different age categories except fewer participants aged over 56 years. Approximately 87% of participants had a medium–high level of education and were equally distributed among the average income categories, except a low inclusion in the highest income group. Approximately 85% of participants were in the households with at least 2 components, and almost the half of respondents were employed.

#### 3.2 Avocado preferences

Considering the entire sample of avocado consumers ( $n=817$ ), the employed best–worst scaling model estimates the level of importance (A-RS) for each attribute of avocado considered in this survey, as shown in Table 3.

**Table 3** Consumer avocado preferences scores for the 12 product attributes: count report and A-RSs

Rank	Label	COUNT Best	COUNT Worst	Best–Worst	Av. Raw score	St. dev
1	Taste (creaminess, aroma, etc.)	1293.0	129.0	1164.0	2.229	1.287
2	Consistency to the touch (already ripe = ready to eat)	1142.0	233.0	909.0	1.754	1.633
3	Affordable price	1074.0	324.0	750.0	1.362	1.812
4	Health benefits	814.0	308.0	506.0	1.081	1.755
5	Consistency to the touch (hard = ripe)	645.0	344.0	301.0	0.652	1.279
6	Certifications (ethics, environmental sustainability, controlled supply chain, etc.)	654.0	510.0	144.0	0.185	2.214
7	Appearance (integrity of the skin, absence of visible defects, etc.)	641.0	702.0	– 61.0	– 0.037	2.461
8	Color (dark skin)	309.0	584.0	– 275.0	– 0.576	1.195
9	Color (green skin)	235.0	704.0	– 469.0	– 0.674	1.101
10	Seasonality	266.0	903.0	– 637.0	– 1.294	1.502
11	Variety	167.0	1084.0	– 917.0	– 1.769	1.156
12	Brand awareness	104.0	1519.0	– 1415.0	– 2.914	1.651



The respondents' answers analysis highlights how the product taste, consistency to the touch (already ripe = ready to eat) and the affordable price as the most important attributes during the avocado purchasing process. On the contrary, the fruit brand, variety and the seasonality were the less important attributes considered during the decision-making process.

From the correlation matrix, it is possible to understand the interconnections between the preference indices calculated for the 12 avocado attributes (Table 4).

Firstly, a high number of correlations emerge among the proposed attributes, suggesting the potential identification of a distinct avocado selection model. However, to facilitate the analysis of the data, we opted to describe the correlation matrix, considering correlation indexes greater than or equal to 0.5. Generally, negative correlations appear among the specific avocado attributes (taste, consistency to the touch—ready to eat, and color—both dark and green) and certification, seasonality, as well as product brand. Going more in depth, certifications was negative associated with green color skin ( $r = -0.594$   $p < 0.01$ ), dark color skin ( $r = -0.500$   $p < 0.01$ ), and consistency to the touch ( $r = -0.508$   $p < 0.01$ ); brand was negatively correlated with taste ( $r = -0.515$   $p < 0.01$ ) and consistency to the touch ( $r = -0.550$   $p < 0.01$ ). Seasonality has a negative associated to the consistency to the touch ( $r = -0.506$   $p < 0.01$ ). At the same time, certification had a positive correlation with brand awareness ( $r = 0.539$   $p < 0.01$ ) and seasonality ( $r = 0.606$   $p < 0.01$ ).

#### Avocado consumer' heterogeneity

Five groups of individuals were identified and renamed according to the most relevant attributes considered for the avocado selection (Fig. 1). The cluster memberships in function of the individuals' socio-demographic characteristics resulting from the MLR model are described in Table 5. The final MLR including the significant predictor variables in the obtained five cluster of avocado consumers and the probability ( $\beta$ ) of each predicting variable to be associated to each group. The reference cluster selected by the software—the *Health sensitive* group—is omitted in the table on MLR results (Baji et al. 2013).

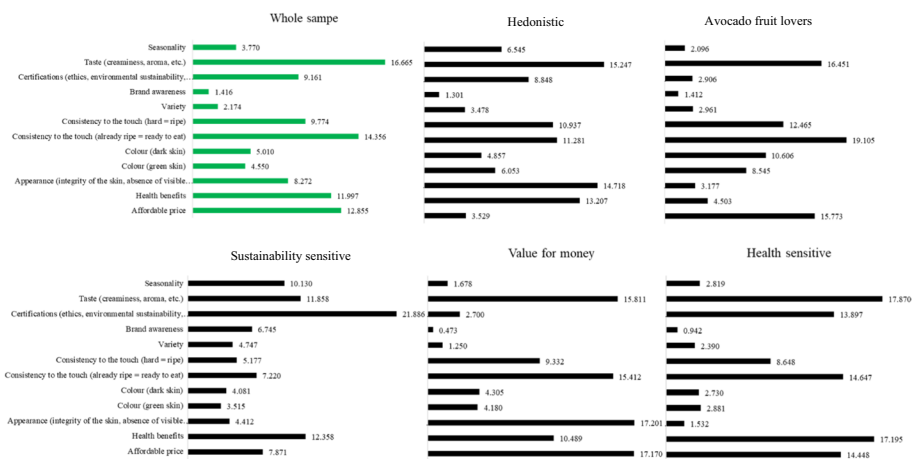
The biggest cluster, named *Value for money* (25.7% of the total sample), was composed by consumers that select the avocado combining the importance to the fruit appearance, taste, consistency (ready-to-eat) and health benefits with its affordable price. With respect to the whole sample, they distinguish them for the lower attention to the avocado certification, emphasizing, on the contrary, the importance of product external aspect (Fig. 1). Considering the socio-demographic features, the probability of belonging to the *Value for money* cluster, rather than the reference group, was significantly higher for younger (18–25 years old) and adult (36–45; 46–55) individuals. At the same time, people with the different monthly average incomes have a strong probability to be associated with this group of consumers (Table 5).

The second cluster was called *Avocado fruit lovers* (the 22.0% of the whole sample): in this case, the lower age groups were associated positively with the *Avocado fruit lovers* with respect to the *Health sensitive*. In parallel, the average income and the big family size appeared negatively associated with this consumer group. Therefore, we can predict that the *Avocado fruit lovers* was represented by young and single consumers with

**Table 4** Correlation matrix with correlation indexes higher than 0.5 are highlighted in bold

	Affordable price	Health benefits	Appearance (integrity of the skin, absence of visible defects, etc.)	Color (green skin)	Color (dark skin)	Consistency to the touch (already ripe = ready to eat)	Consistency to the touch (hard = ripe)	Variety	Brand awareness	Certifications (ethics, environmental sustainability, controlled supply chain, etc.)	Taste (creaminess, aroma, etc.)	Seasonality
Affordable price		-0.231**	0.149**	0.128**	0.265**	0.243**	-0.353**	-0.444**	-0.395**	0.228**	-0.492**	
Health benefits	-0.231**		-0.143**	-0.290**	-0.440**	-0.332**	-0.223**	0.227**	0.100**			
Appearance	0.149**	-0.143**		-0.079*	0.063	0.254**	-0.383**	-0.358**	-0.361**	-0.234**		
Color (green skin)	0.128**	-0.290**	0.741**		0.741**	0.123**	-0.112**	-0.594**	-0.594**	-0.135**	-0.397**	
Color (dark skin)	0.128**	-0.079*	0.741**	1		0.346**	-0.123**	-0.500**	-0.500**	-0.084*	-0.371**	
Consistency to the touch (already ripe = ready to eat)	0.265**	-0.332**	0.123**	0.346**	0.389**		-0.298**	-0.550**	-0.508**	0.358**	-0.506**	
Consistency to the touch (hard = ripe)	0.243**	-0.223**	0.254**	0.086*	0.389**	0.389**	-0.225**	-0.405**	-0.437**		-0.416**	
Variety	-0.353**	0.227**	-0.383**	0.086*		-0.298**		0.418**	0.142**	-0.098**	0.237**	
Brand awareness	-0.444**	-0.358**	-0.358**	-0.123**	-0.225**	-0.550**	0.418**		0.539**	-0.515**	0.468**	
Certifications	-0.395**	-0.361**	-0.361**	-0.500**	-0.437**	-0.508**	0.142**	0.539**		-0.258**	0.606**	
Taste (creaminess, aroma, etc.)	0.228**	0.227**	-0.135**	-0.084*	0.358**	0.358**	-0.098**	-0.515**	-0.258**		-0.279**	
Seasonality	-0.492**	0.100**	-0.234**	-0.371**	-0.506**	-0.506**	0.237**	0.468**	0.606**	-0.279**		

\*\* Correlation is significant at the 0.01 level (two-tailed); \* Correlation is significant at the 0.05 level (two-tailed)



**Fig. 1** Attributes relative importance for the whole sample and for the five consumer segments (Meyerding et al. 2019)

**Table 5** Latent class- MLR model: individuals variables predictivity on cluster membership

Clusters	Hedonistic		Avocado fruit lovers		Sustainability sensitive		Value for money	
	B	St. Error	$\beta$	St. Error	$\beta$	St. Error	$\beta$	St. Error
Constant	- 18.915***	0.946	- 0.737	0.938	- 0.346	0.979	- 2.790**	1.041
Age = 1	19.162***	0.646	1.573**	0.690	0.716	0.672	2.160**	0.737
Age = 2	19.113***	0.608	1.086	0.651	0.251	0.624	1.095	0.710
Age = 3	19.017***	0.614	1.167	0.657	0.272	0.634	1.353*	0.714
Age = 4	18.657***	0.693	1.123	0.700	1.147	0.656	1.773*	0.742
Age = 5	18.100	0.000	1.018	0.711	0.696	0.681	0.773	0.793
Family size = 1	- 0.779	0.561	- 0.472	0.540	- 0.950	0.566	0.372	0.574
Family size = 2	- 1.261**	0.502	- 0.873	0.478	- 0.990*	0.490	0.083	0.522
Family size = 3	- 2.088***	0.538	- 1.262*	0.479	- 1.720***	0.507	0.090	0.516
Family size = 4	- 1.073**	0.496	- 1.085*	0.478	- 1.255**	0.495	- 0.196	0.523
monthly average income = 0	0.608	0.547	- 0.319	0.469	0.984	0.563	1.385*	0.517
monthly average income = 1	0.983*	0.523	0.682	0.421	1.263**	0.543	1.837***	0.500
monthly average income = 2	0.500	0.522	0.605	0.407	1.576**	0.520	1.482**	0.491
monthly average income = 3	0.308	0.596	0.850*	0.440	1.131**	0.573	1.139*	0.539

The "Health sensitive" cluster was considered as the reference for comparison with the other consumer groups.

Model Fit Statistics: Nagelkerke Pseudo- $R^2 = 0.168$ . Full model  $\chi^2$  (df = 68) = 142.456,  $p$ -value < 0.001. Classification accuracy (67%)

\*  $p$ -value < 0.05; \*\*  $p$ -value < 0.01; \*\*\*  $p$ -value < 0.001

an age between 18 and 25 years old and a monthly average income quite high (4000–6000 €) (Table 5). These individuals choose avocados carefully based on color (both dark and green skin) and consistency to the touch (both ripe and ready-to-eat). In fact, those attributes reach the higher value di A-RS in this group comperees to others cluster and the whole sample. Additionally, they considered also the avocado price and taste as

important drivers during the purchasing process. *Avocado fruit lovers*, on the contrary, differs from the other groups in its limited attention on the health benefits of the fruit.

The *Health sensitive* cluster (21.9% of the whole sample) declared a high attention for the avocado health benefits and taste during the purchasing process. They select ready-to-eat consistency, without neglecting safety and sustainability of the product guaranteed by the certifications. On the contrary, appearance like integrity of skin or the color is not important during choice.

The *Sustainability sensitive* group (16.1%) based their choice only on certification (social and environmental sustainability), taste and health benefits. Additionally, and strictly related to sustainability, there is the high importance that this cluster gives to the seasonality of the fruit in comparison with the other avocado attributes. Considering the socio-demographic aspects, a unit increase of the family size (from 2 to 4 components) variable decreased the probability of belonging to the *Sustainability sensitive* group, rather than to the reference cluster. On the contrary, this group appeared strongly associated with the higher levels of monthly average income.

Finally, the smallest cluster was represented by the *Hedonist group* (14.3%). They placed high importance on the appearance of the avocado and on taste exalting the organoleptic aspects associated to the consistency, that only in this cluster was equal for the two categories (ready-to-eat and ripe). However, it seems that the intrinsic quality aspects of avocados were associated not only with the health benefits that this fruit naturally presents, but also with the certifications. In this group, the medium–low age ranges were positively associated with this cluster; hence, these individuals had the stronger probability of belonging to these age groups rather than to the reference cluster. On the contrary, these consumers had a high probability of not belonging to the family size categories biggest than 2 components. By analyzing the odd ratio calculated for this cluster, a unit increase of this factor monthly average income = 1 increased the probability of belonging to the Hedonist group by 2% (1-OR = 1–0.98).

At the end, the results related to characteristic of avocado consumer clusters are differently reported in following tables, describing the season of consumption and the reason why people consume it (Table 6), the preference for the consistency (Table 7) and the frequency of avocado purchase (Table 8).

**Table 6** Characterization of avocado consumer clusters based on individuals' purchasing and consumption habits (period of consumption, motivation for consumption)

Clusters	Do you consume avocado in a particular period (season) of the year?			Why do you consume avocado?			
	No (%)	Yes (%)	Chi-square	It's healthy (%)	I like it (%)	It's versatile in the kitchen (%)	Chi-square
Hedonistic	87	11	28.322*	16	77	7	15.365*
Avocado fruit lovers	90	8		6	89	5	
Sustainability sensitive	75	19		20	70	10	
Value for money	93	5		14	82	5	
Health sensitive	88	10		18	73	9	

\*  $p$ -value < 0.05

**Table 7** Characterization of avocado consumer clusters based on individuals' purchasing and consumption habits (Frequency of avocado purchase)

Clusters	How often do you buy avocado?				Chi-square
	Occasionally (%)	1 time per month (%)	Less than 1 time per week (%)	1–2 times per week (%)	
Hedonistic	42	27	20	10	14.112
Avocado fruit lovers	34	23	29	14	
Sustainability sensitive	37	16	29	18	
Value for money	36	24	27	14	
Health sensitive	33	20	33	14%	

**Table 8** Characterization of avocado consumer clusters based on individuals' purchasing and consumption habits (preferences of fruit ripening)

Clusters	In which moment of ripening do you prefer buy the avocado fruit?				Chi-square
	Already ripe (ready for consumption) (%)	Not yet ready for consumption (I prefer to complete ripening at home) (%)	Do not perceive this difference (%)	Do not evaluate this difference (%)	
Hedonistic	51	41	4	4	27.035*
Avocado fruit lovers	70	25	2	3	
Sustainability sensitive	48	40	4	8	
Value for money	55	34	4	7	
Health sensitive	60	33	1	7	

\*  $p$ -value < 0.05

## Discussion

From a novel food in the early 2000s, the avocado has become a conventional food accessible to all Italian consumers (Ahern 2019). The avocado market is continuously growing in Europe and also in Italy (Italiafruit 2022). At the same time, the consumption of avocados continues to increase and involves differentiated choice models based on the evaluation of the organoleptic and nutritional aspects, but also on the attention toward the environmental and social sustainability of the foreign supply chain (Gamble et al. 2010; Bustos and Moors 2018; Cho et al. 2021). It is well known that individuals' decision-making processes are complex, especially for products that are not part of the national culinary tradition. These processes exhibit constant dynamism, with the weight of various product attributes continuously fluctuating depending on time and place. In particular, in this work the consumer's attention toward quality parameters, also influenced by the management of the supply chain in the post-harvest phase, intrinsic/extrinsic and credence attributes was evaluated in order to provide choice profiles useful for the supply chain planning, assortment and marketing decisions. For this reason, origin was excluded among the choice attributes, as almost all avocados marketed in Italy are of foreign origin and as it has already been established in previous research that it has an important weight on avocado consumer decisions. Given this perspective, we believe

that the focus on origin might have diverted respondents' attention away from the qualitative aspects that are crucial for making strategic decisions regarding assortment planning and marketing campaigns.

Our results suggest that consumers today choose this fruit for its taste, evaluating its consistency (whether it is ready-to-eat) and price. Although some studies conclude that most Italians consume avocados for their nutritional value (Migliore et al. 2017; Italiafruit 2022), the perception of this fruit, which is purchased because it is liked, appears to have evolved in our study. This result is also confirmed by the responses of the consumers involved in this research regarding their purchase motivations (Table 6). It therefore seems that the avocado has evolved the positioning of this fruit in the mind of the consumer who seems to have learned to appreciate this fried food which, therefore, from a trendy product has found a hedonistic role in the kitchens of Italians. On the contrary, the considered sample does not recognize the discriminated factors for avocado choice in seasonality, variety and brand. This result is confirmed by other studies which explain how the low involvement with food leads to a low search for variety, and consequently seasonality (Derinalp Çanakçı and Birdir 2020). These results suggest that the choice of avocado is based on organoleptic and convenience aspects: the purchased product must be ready for consumption without requiring further maturation time after purchase. It seems that the consumer does not feel capable of determining the optimal time for consumption when purchasing an unripe fruit. Therefore, they rely on large-scale retail stores, which often sell fruit that is already ripe and ready for consumption. This result defines how a part of consumers, despite buying it, considers the avocado still an unfamiliar fruit. These findings are important for producers and distributors who today tend to market the product ready for consumption, thus meeting the needs of the consumer. The scarce attention paid to the brand could be connected to the scarce presence of brands on the national market (CSOItaly 2022). However, in light of these results, the national avocado supply chain should focus on the local avocado branding process to enhance consumer awareness of the short supply chain. Moreover, although for other fruits conventionally familiar to Italian consumers seasonality and variety seem to be discriminated by choice (Massaglia et al. 2019a), the unfamiliarity and constant presence of the avocado on market stalls (de-seasonalized) leads consumers to opt for this fruit throughout the year (Table 6). Hence, seasonality is among the quality attributes that show no effect on consumer choice, and it may be due to the low knowledge that consumers usually have about tropical fruits (Migliore et al. 2017). On the other hand, the analysis of the correlations suggests the definition of distinct purchasing styles highlighting how the search for seasonality for avocados, associated with certification and identifiable with a brand, does not align with the attention to aspects of visual and organoleptic quality of the fruit. This finding implies the existence of two separate decision-making tendencies for avocado, one sustainable and the other organoleptic. These attitudes, translated into different preferences toward the quality attributes of the avocado, are also recognizable in the five clusters obtained from the cluster analysis.

In particular, the *Value for money*, *Hedonistic* and *Avocado fruit lovers* groups emerge with a common trait: their preference for avocado, prioritizing sensory and visual quality aspects. These consumption patterns are similar to those relating to familiar products (Merlino et al. 2021, 2018). The other two groups, *Health sensitive*

and *Sustainable sensitive*, are instead connected by the evaluation of the sustainability and health aspects of avocado (Bustos and Moors 2018; Cho et al. 2021; Khan et al. 2021). However, by deepening the characterization of five groups, interesting distinctive aspects emerge in terms of socio-demographics and consumption habits, which could be useful for profiling different target individuals. Although there is no significant difference between the groups in terms of buying frequency, the *Health sensitive* and *Sustainability sensitive* clusters have expressed higher purchase frequencies than the others. This result, if analyzed considering the priorities of choice toward avocados, is in line with the results found in another study conducted on the Italian consumer. Five years after the work of Migliore et al. (2017), the link between purchase/consumption frequency and attention to sustainability aspects and avocado quality certifications still seems stable.

For example, for the *Value for money*, the simultaneous consideration of price and quality aspect suggests an evaluation of price oriented to the fruit quality assessment. This Group buys avocados because they like them, counting 34% of individuals who ripen avocados after purchase. For *Avocado fruit lovers*, on the other hand, young age probably affects the perception of avocado linked to a culinary pleasure. For these consumers, the avocado is trendy: it is the king of Instagram, a favorite food of millennials, a symbol of an Era, it can be found on the profiles of influencers, in the recipes of the most renowned chefs, in the "avocado toast" of the most popular restaurants, and even in the pots on the balconies of some houses (Ahern 2019). These consumers use it often (Table 7), and because of this, they are probably price conscious. They are exalted in the kitchen for its taste, but not for the health benefits and properties of the fruit. It is therefore assumed that they know this fruit well as they know the difference between green and dark and buy ripe avocados (70% of them) for immediate preparations and exotic dishes (Marín-Obispo et al. 2021) (Table 8).

The *Sustainability Sensitive*, on the other hand, are distinguished by an avocado buying style that is attentive to seasonality (Table 6). Sustainability and seasonality together with the related certifications also for this consumer target for avocados. These individuals correlate sustainability to the health benefits of this product, among other things (Surjawan and Abdillah 2018).

The *Hedonistic* group are the ones who buy avocados less often than the other clusters: they were the most disinterested in texture and degree of ripeness. They seem to be the least experienced, perhaps they don't know how to prepare it and the differences of use between ready to eat and ripe, but they still appreciate this fruit in terms of taste and health benefits (Drummond and Harris 2008).

Unlike to *Hedonistic* group, the preferences expressed by the *Health sensitives* are linked to the health and organoleptic aspects of the fruit, however expressed by subjects with a greater awareness and knowledge of the avocado in terms of qualitative differences according to the degree of ripeness. These orientations of choice are also confirmed by the statements of these individuals on consumption motivations: most of them buy avocados because it is good for their health, as well as because they like it (Bordim et al. 2021; Colozza 2021).



## Conclusions

In an increasingly globalized market, this work contributes to the discussion on the heterogeneity of consumer choice patterns toward imported, but increasingly familiar foods such as avocados. This study contributed to the theoretical understanding of consumer's responses to multiple quality cues of individuals' preferences for a large-set of both intrinsic, extrinsic and credence attributes, simultaneously, in the same choice experiment. Our results show how preferences are influenced by socio-demographic characteristics and, in particular, how perceptions toward avocados change especially as a function of the generational age of individuals. In general, we can state that a part of consumers has developed avocado choice models that are increasingly similar to those associated with familiar foods for consumers. On the other hand, it seems that unfamiliarity conditions yet another part of Italian consumers. However, the five different clusters of individuals were heterogeneous not only in terms of socio-demographic characteristics, but especially in terms of different levels of preference toward the attributes that defined the avocado.

The non-consideration of origin as an attribute of choice, although it could also be interpreted as a limitation of the research, was an experimental design development strategy desired by the authors in order to focus consumer attention on other quality parameters to define consumption patterns focused on the intrinsic/extrinsic quality and sustainability of the product, in order to define results that are also useful for product purposes. For example, consumers' heterogeneous assessment of fruit firmness could be useful to retailers in order to differentiate the degree of avocado ripeness in the market to meet the different needs of heterogeneous consumer targets. Furthermore, the results on the importance of seasonality and certification could be exploited by domestic avocado producers who, also in light of the results obtained in this research, should work toward the diffusion of seasonal products, recognizable by a brand name that to date consumers do not consider important in their choice of avocados. These consumers could be targeted for greater awareness of sustainability issues through promotional campaigns of the local avocado supply chain.

In fact, it has already been proven that local origin is important for Italian avocado consumers: this result, together with those obtained in this research about the consumer profiles' heterogeneity and whose targeted marketing campaigns may be necessary to conquer new markets, in particular for a nascent supply chain such as the Italian avocado.

Other limitations of the study lie in the non-probability sampling method, that, in our case, compromise the representativeness and the homogeneity of the resultant sample. Future research will be devoted to extending the sample and balancing it to make new assessments with a representative sample that would also allow comparisons between countries at the European and intercontinental levels. However, the consideration of socio-demographic and situational variables in the interpretation of stated preferences contextualizes the results to the considered sample.

Practical implications for both avocado producers and retailers by directing them to market products that more strongly meet consumer preferences in terms of seasonality and ripeness. In particular, although it appears that the market is moving toward offering the consumer an avocado that is still to be ripened, the results of this survey show that

consumer preferences are oriented primarily toward a ready-to-eat fruit: this trend could have concrete implications in policy makers' decisions to match supply and demand in terms of quality and quantity, not only with a view to meeting consumer demand, but also to reduce waste at the point of sale (the Italian consumer does not yet seem ready to decide on the level of ripeness independently at the time of purchase). In addition, based on the results of cluster analysis, specific marketing implications should be derived for each cluster. These results could be useful to develop more differentiated market segments for avocado fruit in terms of fruit quality standard and communication strategies, enabling consumers to make product choices according to their preferences.

#### Abbreviations

A-RS	Average Raw Score
BIBD	Balanced incomplete block design
BIC	Bayesian Information Criterion
BWS	Best-worst scaling
CATA	Check-all-that-apply
DCE	Discrete choice experiments
FAO	Food and drug administration
HB	Bayes Hierarchical
LCA	Latent Class Analysis
LL	Lowest log-likelihood
MLR	Multinomial logistic regression
OR	Odd ratio
RUM	Random utility model
WHO	World Health Organization

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#### Author contributions

NG was involved in the conceptualization, project administration, supervision, validation, writing—original draft, and writing—review and editing; VMM contributed to the conceptualization, methodology, formal analysis, software, data curation, visualization, writing—original draft, writing—review and editing, validation, and project administration; AS assisted in the data curation, visualization, and writing—original draft; CP was involved in writing—review and editing and supervision; DB performed writing—review and editing and supervision; SM performed the conceptualization and writing—review and editing. All authors have read and agree to be a published version of the final version of the manuscript.

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#### Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

#### Declarations

##### Ethical approval and consent to participate

The questionnaire was approved by the University Bioethics Committee of the University of Turin, <https://www.unito.it/ricerca/strutture-e-organismi-ricerca/comitato-di-bioetica-dellateneo/>). Protocol n. 0630095 of the 28/01/2022.

##### Competing interests

The authors declare no competing interests.

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