

## Consumers (Dis)Preference for Bitterness in Extra Virgin Olive Oil: A Field Experiment

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### ABSTRACT

Globally, bitterness in food is not a preferred attribute by consumers, for several reasons. In the case of Extra Virgin Olive Oil its presence is fundamental as it is a healthiness indicator, being strictly linked to the antioxidant content. The current study aimed to assess the extent of Italian consumers' preferences for bitterness taste of Extra Virgin Olive Oil. Real choices made by shoppers at the store shelf of a hypermarket were recorded and then compared with the selected Extra Virgin Olive Oil sensory profiles evaluated by a professional panel. Findings reveal that bitterness exerts a negative willingness to pay equal to -1.18 €/liter. Furthermore, consumers tend to overestimate the perception of Extra Virgin Olive Oil bitterness compared to sensory experts. Results provide new evidences of consumer preferences for sweet sensory profile of Extra Virgin Olive Oil and bitter aversion.

**Keywords:** *in-store experiment; real choices; sensory panel, taste preferences, willingness to pay*

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## 1 Introduction

Extra Virgin Olive Oil (EVOO) has been the most used fat in Mediterranean countries in centuries, and it is, indeed, the characterizing element of Mediterranean diet and a valuable agricultural crop for Southern Europe countries in terms of both farm income and cultivated area (Mili, 2016). In the last decades, thanks to olive oil research advancements, it has been highlighted that specific agronomic techniques and innovative production processes can lead EVOO to be a nutraceutical product (Roselli et al., 2018). The phenolic compounds contained in EVOO are several: oleuropein, hydroxytyrosol and tyrosol. These compounds have beneficial effects on human health being strong antioxidants and radical scavengers (Rigacci and Stefani, 2016). According to scientific evidences, the higher the polyphenol content in EVOO the more this appears to be beneficial for human health; but, on the other hand, the more bitter the product tastes (Vitaglione et al., 2015). Unfortunately, the majority of consumers seems to have a negative preference for food products with a bitter taste (Vecchio et al., 2019).

An extensive literature review underlined the lack of consumers' preference towards bitter EVOOs. In fact, the general tendency highlighted by previous literature is that consumers tend to like EVOOs with a neutral taste and without bitterness (Delgado et al., 2013; Vecchio et al., 2019).

The objective of this study is to expand the current knowledge, investigating to what extent bitterness affects consumers' choice in the case of EVOO; providing also a precise measurement in terms of consumers' willingness to pay (WTP) for this attribute. The present research conducted a field experiment in an everyday food shopping location (i.e. hypermarket) in the city of Naples (the largest town in Southern Italy). All EVOOs available on the store shelf were evaluated by a professional sensory panel in order to have an objective bitterness measure for each oil. Subsequently, a sample of 196 consumers were interviewed close to the store shelf after purchasing at least one bottle of EVOO to investigate the drivers of choice. The resulting data were analyzed through a conditional logit, in order to understand how product sensory and non-sensory characteristics drive consumers' preferences, with a specific focus on bitterness.

Starting from the assumption that consumption statistics indicate that an average Italian household purchases at least a bottle per week (International Olive Oil Council, 2015), we can define an average Italian consumer as highly familiar with EVOO products, and, thus with their intrinsic properties, such as taste (Cavallo and Piqueras-Fiszman, 2017). So, this allows to suppose that this is a case of re-purchase decision. In this framework, on the basis of Discrete Choice Model (DCM), we developed a field experiment to investigate how the decision of the consumer occurs within the shop for EVOO products, with a particular focus devoted to the sensory features of products. The study adds to the current literature providing direct insights of consumer preferences inside an everyday (real) choice context, i.e.: a hypermarket.

The remainder of the paper is the following: the subsequent section presents a brief literature background, then a detailed description of the data collection and econometric model is offered, subsequently the core results of consumers' preferences for EVOO attributes are discussed, finally implications and future research developments are depicted.

## 2 Literature Background

Several researches, in recent years, have shown that consumers in western countries, although revealing a marked preference for healthy food (Bimbo et al., 2017; Del Giudice et al., 2018; Fernqvist and Ekelund, 2014; Sogari et al., 2018), at the same time have an aversion to food with a bitter and pungent taste (Drewnowski and Monsivais, 2012; Cavallo et al., 2019; Vecchio & Cavallo 2019). The reasons behind these preferences would seem to be attributable to evolution, since bitter taste signals potentially harmful substances (Lunceford and Kubanek, 2015).

This aversion is not constant for all kinds of food, being best tolerated in foods with a hedonic function (Cavallo & Materia, 2018; Harwood et al., 2013; Masi et al., 2016). While, in the case of EVOO, bitterness is paired with a enhanced healthiness (Cartea and Velasco, 2008; Caporaso et al., 2015). In olive oil, bitter and pungent tastes are due to the presence of antioxidant substances that play an important role in protecting human cells from free radicals (Owen et al., 2000; Stark and Madar, 2002; Servili et al., 2009). This implies that the more pungent and bitter EVOO is, the better its health properties. Furthermore, antioxidants also prolong shelf life (Garcia et al., 2003).

Unfortunately, several studies have shown the negative response of consumers to bitterness. Garcia et al. (2001) in one of the earliest studies on this topic, tested EVOOs with different levels of bitterness on an untrained Spanish consumer group. Although greater bitterness meant higher levels of polyphenols, the

greater the bitterness, the lower the consumer acceptability. Mtimet et al. (2008) showed that Japanese consumers prefer EVOO with a neutral taste. Delgado and Guinard (2011) concluded that bitterness and pungency were negatively assessed by a sample of 110 untrained US consumers, while fruit was positively evaluated. The same oils were also subjected to a trained panel receiving a positive judgment in relation to bitterness and spiciness. Similar results were also obtained by Recchia and colleagues (2012) which presented to a sample of 74 untrained Finnish consumers four Italian EVOOs, two of which could be defined as "of excellent quality" and two as "of regular quality". Another analysis of drivers of liking of EVOO was carried out by Valli et al. (2014) in Swiss consumers; they found that the products rated as being of superior quality were the ones with enhanced "ripe fruity" and "sweet" features, the opposite was for other attributes, especially "bitter".

If Japanese, American, Finnish and Swiss consumers are relatively new to olive oil consumption, same results come from studies of consumers living in countries where EVOO is part of the traditional diet. Chan-Halbrendt et al. (2010) in a survey with a sample of 204 olive oil consumers in Albania, a country where oil consumption is part of the traditional diet, concluded that only 7% of the sample appreciated the pungent characteristics, a percentage that drops to just over 5% due to the bitter characteristic. When subjected to a trained panel, the two "excellent quality" oils showed a high bitter and spicy value, while untrained consumers showed a clear preference for oils where bitter and spicy were moderate. Also in Italy, a recent study on EVOO market confirmed that a higher level assigned by the experts to EVOO sensory profile has a negative effect on the price of this product (Cavallo et al., 2018); while Panico et al. (2014) and Di Vita et al. (2013) confirmed that pungency in olive oil is not appreciated by Italian consumers.

However, in the case of preferences towards bitterness in EVOO, exposure could play an important role. In fact, the only exceptions to the general aversion towards bitterness have been found in consumers with high familiarity with bitter products (Vecchio et al., 2019). Mtimet et al., (2013), studied consumers from Tunisia, a country in which EVOO is highly produced and consumed, so that we can suppose consumers are highly familiar with the product. This conjoint study considered two options for EVOO taste: *bland* and *strong*<sup>1</sup>, actually consumers were willing to pay more for one of the two taste profiles, specifically the one which comprehended enhanced bitterness. While, in Vazquez-Araujo (2015) six commercial olive oils were proposed to 100 Spanish consumers and 100 US consumers. While the Spanish consumers appreciated bitter oils, the American ones preferred the sweet ones. Finally, it is worth citing the results of an experiment conducted by Pardo et al. (2018) in Argentina, in the two cities of Buenos Aires and Mendoza; where in the first there is no, historical, culture of olive oil; while Mendoza, instead, has a very old tradition in the cultivation and consumption of oil. The two samples of consumers were exposed to three different oils, with different levels of bitterness. In Buenos Aires the preferred oil was not only bitter but also flawed; while the experiment revealed a completely different result in Mendoza, where consumers best preferred the product with the highest level of bitterness, that was also rated as the one with the best sensory quality by a trained panel. These insights suggest that the familiarity of consumers with the product, leads to a match between the consumers' and the experts' ratings of sensory quality for EVOO.

### 3 Materials and Methods

#### 3.1 Methodological framework

Traditionally, DCM are widely used to explain how the decision-making process occurs in the mind of the consumer during purchase or during information collection phase, and how she/he trades off all the attributes of the products that she/he can infer upon the available cues (Grunert, 2005). Generally, consumers' choices are expressed within an experimental design, where respondents indicate their preferences choosing from a controlled set of hypothetical products. Being each product a combination of several a priori fixed attributes, respondents are forced to trade-off between levels of the studied variables (Hanemann and Kanninen, 1999). The main limit of hypothetical choices is the lack of realism in the simulated task implying differences between the hypothetical and real willingness to pay. The extent to which individuals might behave inconsistently, when they do not have to back up their choices with real commitments, is linked to the notion of hypothetical bias (Hensher, 2010). Moreover, a Hawthorne effect may bias choice experiments' results, this can actually occur when the subjective knowledge to be in an experiment alters the individual's behavior (Roethlisberger, 1939). In the literature many attempts were made to mitigate the hypothetical bias. However, most of the studies simply inform

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<sup>1</sup> *Strong* it is used as an indication of a sensory profile characterized by enhanced presence of bitterness, pungency and fruitiness and *bland* as an indication of a mild flavor, according to the sensory profile defined by the EU Regulation No. 1227/2016

respondents before starting the survey (Lusk and Schroeder, 2004, Johansson-Stenman and Svedsäter, 2008, Alfnes et al., 2010, Moser et al., 2013, Fitzsimmons and Cicia, 2018).

In this framework, building on the work of Thiene et al. (2013) and Del Giudice et al., (2018) we developed a field experiment to investigate how the real decision process of consumer occurs within the shop for EVOO products, with a focus devoted to the sensory features of products. In our approach, respondents have been interviewed after selecting the product from the shelf of a large hypermarket. Respondents do not choose from a combined set of products but from the full set of available selections available on a real retailer shelf, while attribute combinations are the ones really observed on the market.

### 3.2 Data collection

Data collection was performed in three consecutive steps: store data gathering, EVOO sensory profiling and consumer preferences measuring. In the first step, one hypermarket located in Campania region (Southern Italy) was chosen as the data gathering location, as 71% of household purchases of EVOO in Italy are performed inside the large distribution channel (ISMEA, 2019). Campania region was selected as cases-study area due to its highly differentiated offer of EVOO. Whereas, the selected retailer had one of the largest EVOO shelves available within the Italian market, counting 68 products.

In the second phase, the whole assortment of EVOOs at the selected hypermarket was screened and recorded. Considering the information available to shoppers observing the EVOO bottles, the most relevant attributes driving consumers' preferences according to previous studies were analyzed (Carbone et al., 2018; Carlucci et al., 2014; Del Giudice et al., 2015). Specifically, the collected information were: price (expressed in euro per liter); 100% Italian origin; presence or absence of Protected Designation of Origin (PDO) or Protected Geographical Indication (PGI); bottled or not in Central Italy<sup>2</sup>; commercialized or not as Private Label; commercialized or not by a top brand (one of the five companies with the highest market share in Italy according to Information Resources Incorporated (IRI) InfoScan<sup>®</sup> retail data, 2017); presence or absence of organic certification.

Next, EVOO bitterness was evaluated by a sensory panel for each product. To this purpose, a panel of ten experts analyzed the 68 different EVOOs samples<sup>3</sup>. The tasting profiling was conducted blind, to avoid any information bias. A panel supervisor expressed the final score, ranging from zero to five, as an arithmetic average of values expressed by single tasters. Table 1 shows EVOOs attributes' descriptive statistics.

**Table 1.**  
Descriptive statistics of the EVOOs attributes

Variables	Type	Range	Average	Standard deviation
Price/liter	Continuous		7.66	3.66
Sensory attributes				
<i>Bitterness</i>	Ordinal	0 - 5	1.81	1.27
Search attributes on the label				
<i>PDO/PGI</i>	Dichotomous	Yes:1 No:0	0.22	0.42
<i>Central Italy bottling</i>	Dichotomous	Yes:1 No:0	0.69	0.46
<i>Private label</i>	Dichotomous	Yes:1 No:0	0.18	0.38
<i>Brand</i>	Dichotomous	Yes:1 No:0	0.32	0.47
<i>100% Italian</i>	Dichotomous	Yes:1 No:0	0.56	0.5
<i>Organic</i>	Dichotomous	Yes:1 No:0	0.10	0.31

Sample: 68 observ.

Subsequently, consumers selecting EVOO at the shelf were observed, and their choice was recorded. Consumers were interviewed just after they had put in their shopping cart the bottle of EVOO. Thus, the respondents were in a real-life situation in which spontaneously choose to select a specific EVOO among the full set of options available on the shelf – before knowing that they were going to be interviewed. Interviews, about thirty each day, were conducted over the course of a week, either in the morning and the afternoon.

<sup>2</sup> Central Italy refers to locations within the following regions: Lazio, Marche, Toscana and Umbria (according to Eurostat definition)

<sup>3</sup> The sensory analysis was carried out by a private company that analysed the EVOOs bitterness according to the protocol described in Appendix II of the EU Regulation n. 2568/91.

The post-selection questionnaire was structured in three core sections: (1) information about purchases, consumption of EVOO and preferences for different EVOO attributes expressed through a Likert scale ranging from 1 to 7 (1="strongly disagree" and 7="strongly agree"); (2) bitterness rating of the chosen product using a scale ranging from 1 to 5 (only if the chosen item was bought/tasted before) (Ribeiro et al., 2011; Padilla et al., 2007; Pripp et al., 2004); (3) socio-demographic characteristics.

**Table 2.**  
Sample characteristics (N=196)

Variable	Definition	Mean (frequency)	SD	Frequency in %
Age	In years	39.1	13.5	
Gender				
	Male	(96)		49
	Female	(100)		51
Household size	Persons per household	3.8	1.3	
Highest educational level achieved				
	Lower than high school	(35)		17.9
	High school	(89)		45.4
	College/University	(72)		36.7
Monthly net household income				
	Less than 1000 €	(9)		4.6
	1001 - 2000 €	(89)		45.4
	2001 - 3000 €	(56)		28.6
	3001 - 4000 €	(13)		6.6
	More than 4000 €	(8)		4.1
	No answer	(21)		10.7
-Consumption of EVOO	Liters per household/ monthly	3.4	1.5	
-When buying EVOO, I care about price	1-7 Agreement scale	5.5	1.3	
-When buying EVOO, the criterion "produced in my own country" is very important to me	1-7 Agreement scale	5.9	1.1	
-When buying EVOO, I care about brand	1-7 Agreement scale	3.3	1.8	
-When buying EVOO the criterion "organically produced" is very important to me	1-7 Agreement scale	5.3	1.7	
-When buying EVOO, taste is very important to me	1-7 Agreement scale	6.4	1.1	
-I do appreciate "sweet" EVOO	1-7 Agreement scale	5.9	2.0	
-I do appreciate "fruity" EVOO	1-7 Agreement scale	3.8	2.1	
-I do appreciate "pungent" EVOO	1-7 Agreement scale	3.3	2.1	
-I do appreciate "bitter" EVOO	1-7 Agreement scale	2.9	2.0	

As shown in table 2, a total of 196 consumers, of which 51% females, were interviewed. The average age of respondents was just under forty years, belonging to households of four members, on average. The level of education was quite high, as 36.7% hold a university degree. Furthermore, interviewees were mostly of low-middle income groups. The average household consumption of EVOO was 3.4 liters per month. All respondents had already bought the bottle of EVOO they had chosen. The most preferred oil attributes, resulted in taste ( $M=6.7$ ), Italian origin ( $M=5.9$ ), price ( $M=5.5$ ) and the organic production method ( $M=5.3$ ). The least significant attribute was brand ( $M=3.3$ ). From a sensory point of view consumers showed a clear preference for EVOOs with a sweet taste ( $M=5.9$ ) and clear negative preference for bitter products ( $M=2.9$ ).

Of the 68 bottles of EVOO available at the store shelf, only twenty were purchased by the 196 consumers. Table 3 shows the extrinsic attributes of the eight most purchased bottles, chosen by 88.3% of shoppers. The three most popular references, sold by the market leader in Italy, were purchased by 57.7% of

observed consumers. It is interesting to note that none of the eight bottles was obtained according to the organic method and none was 100% Italian. All except one, were produced by the five market leading brands. All eight EVOOs were bottled in Central Italy (which, however, does not mean they were made with Italian olives).

**Table 3.**  
Extrinsic attributes of the eight most purchased bottles of EVOO

EVOO	Choices (%)	Brand leader	Central Italy bottled	Price (euro/liter)	Organic (1= yes; 0= no)	Private label (1= yes, 0= no)
#1	27.55	1	1	4.89	0	0
#2	16.84	1	1	4.89	0	0
#3	13.27	1	1	4.89	0	0
#4	8.16	1	1	4.69	0	0
#5	7.65	0	1	5.98	0	0
#6	7.65	1	1	4.69	0	0
#7	4.08	1	1	6.18	0	0
#8	3.06	1	1	6.99	0	0

### 3.3 Empirical model

Formally, using the observed responses obtained from consumers' choices, we estimated consumers' preferences in terms of willingness to pay (WTP) for different EVOO attributes. Following the classic random utility framework (Mc Fadden, 1974), the individual  $i$  maximizes his utility ( $U_{ij}$ ) choosing from  $j$  among  $J$  alternatives, with  $U_{ij}$  function of characteristics of attributes of the choices ( $x_{ij}$ ) and its price  $p_j$ . More specifically, the utility in "WTP space" following Train and Weeks (2005) and Thiene and Scarpa (2009) can be expressed as:

$$U_{ij} = -\lambda p_j + (\lambda \omega)' x_{ij} + \varepsilon_{ij} \quad (1)$$

Where  $p_j$  is the price of the  $j$ -th alternative,  $\omega$  represents the estimated vector of WTP of the  $i$ -th consumer for the  $j$ -th attribute, while  $\lambda$  is random scalar and with  $\varepsilon_{ij}$  being a random error term i.i.d. distributed.

## 4 Results

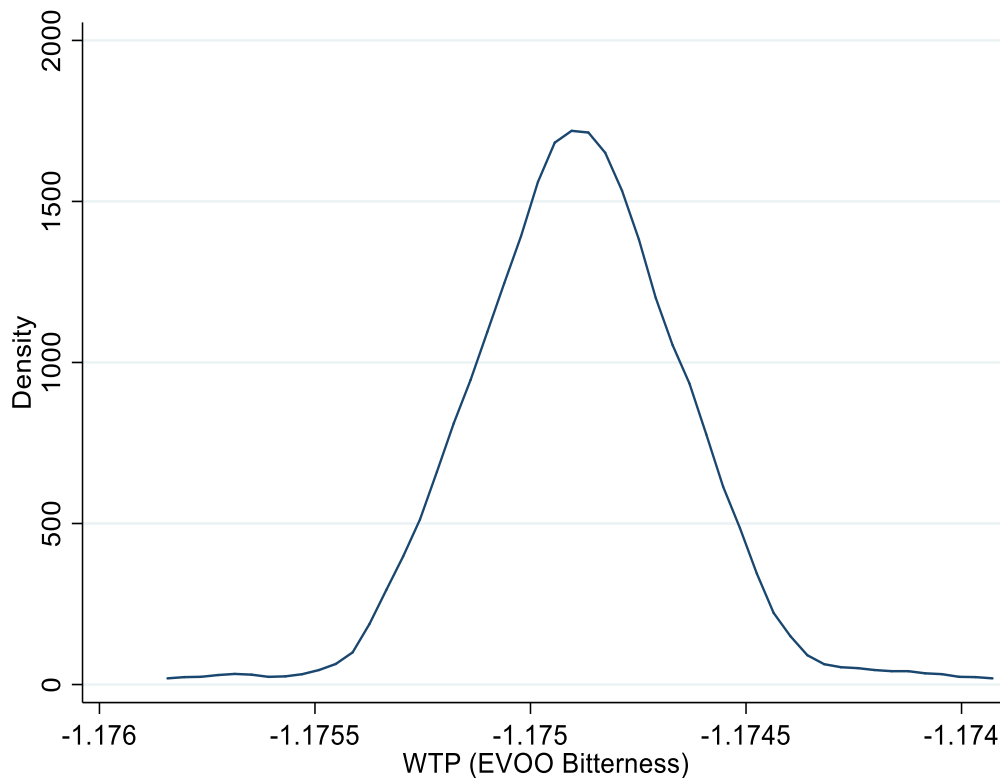
Conditional Logit maximum likelihood estimates are shown in Table 4. The model has been built according to a stepwise procedure that highlighted the non-importance of three attributes: 100% Italian, PDO/PGI and organic. To facilitate the elaboration of significant variables, we eliminated these variables from subsequent elaborations.

**Table 4.**  
Conditional Logit Output and WTP

	WTP (€/liter)	std.err	t-stat	p-value
Private label	-10.645	3.078	-3.46	0.001
Brand	6.347	0.962	6.60	0.000
Central Italy bottled	5.917	1.183	5.00	0.000
Price (coef.)	-0.173	0.053	-3.25	0.001
Bitterness	-1.175	0.511	-2.30	0.022
<i>bitterness × female</i>	-0.051	0.289	-0.18	0.859
<i>bitterness × age</i>	0.007	0.012	0.61	0.54
<hr/>				
σ				
Bitterness	0.007	0.196	0.04	0.97

Estimated parameters represent direct estimates of WTP, identifying the consumers’ preference for brand into a willingness to pay of about 6.3 €/l (Table 4). The preference for Central Italy bottling is of about 5.9 €/l, while private label is negative and around -10.6 €/l. Focusing on bitterness, it emerges that this attribute shows a negative willingness to pay equal to -1.18 €/l. The parameter related to the bitterness was also randomized in the model, but this hypothesis must be rejected. The parameter is negative over the whole population. In other words, there is no consumer segment in our sample that shows a positive preference for bitterness. This conclusion is also reinforced by data reported in Fig. 1 which shows that the distribution of the WTP parameter for bitterness is centered on -1.175 €/l with a very limited variance.

Table 4 also reveals the interaction of bitterness with gender and age. In literature, it has been pointed out that women show a greater preference for bitterness, as well as this preference increases with age. In our case this has not been verified. Figure 2, finally, compares the score assigned by experts and consumers to bitterness for the eight most sold EVOOs. The scores of the two groups are highly consistent with a substantial difference; consumers systematically tend to overestimate the perception of bitterness compared to experts.



**Figure 1.** Distribution of willingness to pay for bitterness

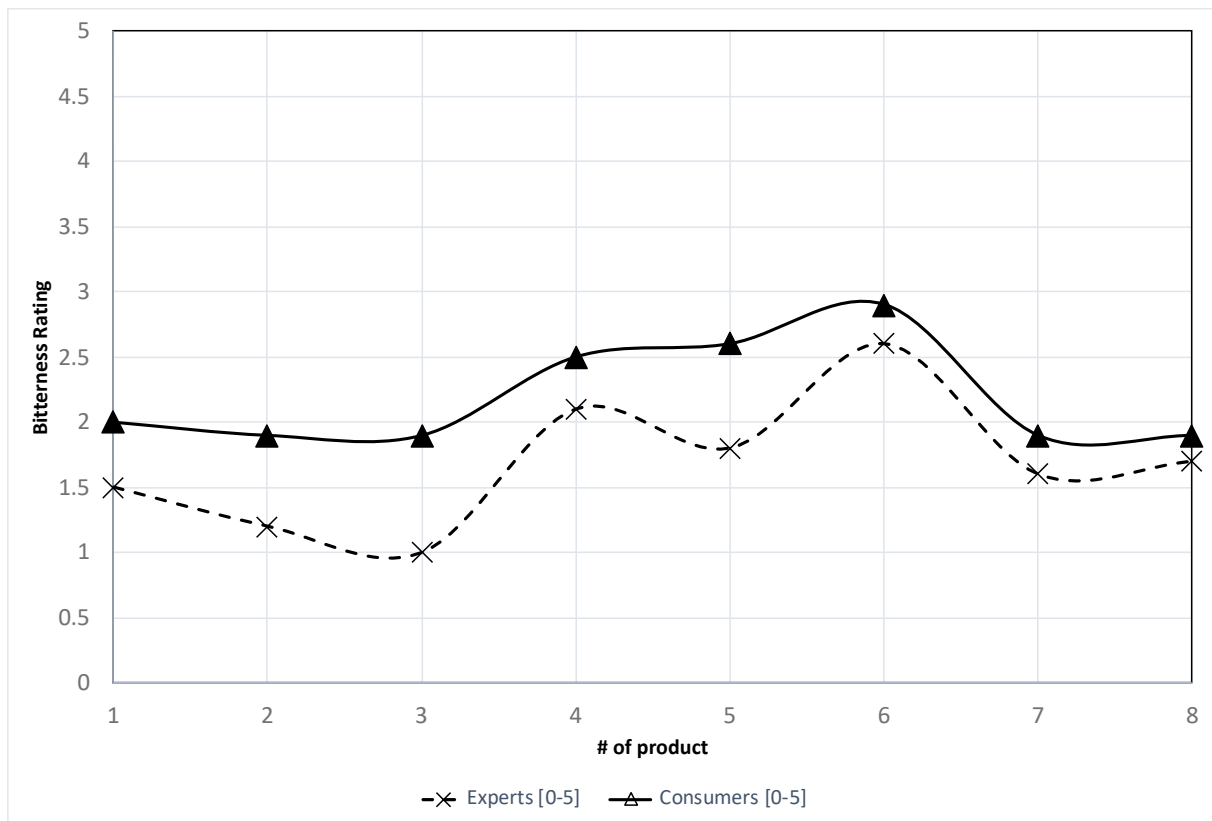


Figure 2. Scores assigned by experts and consumers to bitterness for the 8 most sold EVOOs

## 5 Discussion and Conclusions

In this research, we conducted a field experiment to understand consumer preferences for bitterness of EVOO. At first, a professional sensory panel has performed a complete measurement of bitterness for a full set of available EVOOs of a hypermarket shelf (68 products). Subsequently, we recorded the real choices of consumers inside the hypermarket, finally individuals were interviewed to investigate drivers of EVOO selection. We then implemented an econometric model of analysis, traditionally dedicated to stated preferences, to uncover the motivations of our non-hypothetical, revealed preferences data. This data gathering process has the great advantage of not being affected by the traditional forms of hypothetical bias (Penn & Hu, 2018), i.e. the difference in stated values versus real values (when individuals behave inconsistently, not backing up their stated choices with real commitments).

The results of the current study reveal that consumers have a negative willingness to pay equal to -1.18 €/l for bitterness in EVOO and that there is no consumer segment holding a positive preference for bitterness. Outcomes are consistent with other studies which show that consumers prefer EVOO with plain, neutral taste (Recchia et al, 2012; Delgado et al. 2013). Furthermore, results suggest that, contrary to bitterness, sweetness is perceived as a cue for EVOO quality (Predieri et al. 2013; Clodoveo et al., 2014) and an important driver for consumer choices.

In addition, findings show a pivotal role played by EVOO brand that has the power of summing up several aspects of quality and allows consumers to take a quick decision while shopping for oil. This result appears in line with previous literature that indicated the role of the brand in summarizing different quality elements, especially in the case of low involvement products and quick decisions (Vranešević and Stančec, 2003), due to the reputation that brands build over the years (Costanigro et al., 2012). Conversely, the presence of private label, indicates the lack of a recognized brand on the label of the product. This entails a significant negative WTP, being linked to an absence of brand engagement by the consumer (Liu et al., 2018), that, in turn use this attribute as an indicator for price discounts (Bronnmann & Asche 2015), so that, in the end, most of private label purchases mainly appeal high price conscious consumers (Glynn & Chen, 2009).



When this information is missing, consumer tends to rely on elements not strictly related to quality, such as, for example, bottling location. This is due to the belief that the origin area can influence the intrinsic quality of the product, both for the environment in which olives grow, and for the tradition in processing belonging to that area. The importance of the attribute “bottled in Central Italy” confirms, on one side, consumers interest towards EVOO origin. Whereas, on the other side, we must consider that, actually, bottling place is not necessarily an indicator of origin, so there is a tendency by the consumers to confuse the bottling place with the origin of the product (Cicia et al., 2005). This is likely to happen when the place of bottling has a long tradition in EVOO production and rural tourism (Carlucci et al., 214), as in the case of Central Italy (e.g. Tuscany and Umbria). While the current study has not confirmed the importance of the organic attribute, highlighted in previous studies (Carfora et al., 2019; Del Giudice et al., 2015; Lombardi et al., 2017). This could be due to the real setting of the experiment (Vermeir and Verbeke, 2006), or to the non-attendance to one or more of the product attributes (Caputo et al., 2016).

The current study suffers several limitations. First, whilst it relies on a wide choice set (68 products), it does not cover the entire range of possible EVOO options. Furthermore, the number of interviewed shoppers is limited (196) and located in one, single store location and thus not representative of the general population. Additionally, consumers from Campania, the area in which the study was performed, boast a strong exposure to EVOO that might have driven final outcomes.

Therefore, future studies should involve larger (nationally representative) samples and include multiple stores to yield more robust and reliable findings. Finally, further research should more deeply focus on the role of brand in EVOO purchases compared to other extrinsic attributes (as, for example, nutritional and health claims). Notwithstanding the previously mentioned shortcomings, this study offers important practical implications for oil producers interested in better satisfying final customers. Suggesting, for example, to exploit the strong role of brand on EVOO purchasing choices. Moreover, findings provide some useful guidance also to policy makers concerned with the negative effects of asymmetric information on the market. As bottling location misleading consumers' quality expectations.

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