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Research paper

Innovation in traditional foods: A laboratory experiment on consumers' acceptance of extra-virgin olive oil extracted through ultrasounds

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ABSTRACT

The use of ultrasounds for the extraction of extra-virgin olive oil is an emerging technology capable of improving both the efficiency of the process and the quality of the final product. However, this technology has not been introduced yet on the market mostly because of the uncertainty about consumers' acceptance. This study aimed to investigate consumers' preferences towards extra-virgin olive oil obtained through ultrasound-assisted extraction. For this purpose, a laboratory experiment was performed by combining sensory evaluation and experimental auction to elicit consumers' willingness-to-pay under different information scenarios. The results of the study suggested that extra-virgin olive oil extracted through ultrasounds may be, generally, accepted by consumers. Whilst, no empirical evidences emerged to support the hypothesis that consumers are also willing to pay a premium price for such innovative product.

1. Introduction

Extra-Virgin Olive Oil (EVOO) is one of the main pillars of Mediterranean diet (Trichopoulou et al., 2014), and its consumption is increasing worldwide thanks to its sensory and nutritional properties (Roselli et al., 2018a; Xiong et al., 2014). EVOO also owns an excellent healthy potential (Clodoveo et al., 2014; Roselli et al., 2017) supported by several medical studies proving that its regular consumption is significantly associated with lower incidence of several diseases (Estruch et al., 2013; Pérez-Jiménez et al., 2007; Sofi et al., 2008).

Although the demand of olive oil is rising all over the world, the majority of global consumption is concentrated within the Mediterranean countries, where most of production also occurs (IOC, 2019). In these countries, EVOO can be considered a Traditional Food Product (TFP)[1] being produced and consumed from centuries, strongly linked to local gastronomic heritage, commonly and frequently used, and widely appreciated for its naturalness and peculiar taste (Guerrero et al., 2010, 2009; Vanhonacker et al., 2010).

The traditional character of EVOO represents one of its main market strengths, particularly attractive from an industrial perspective, especially for small and medium enterprises which are mostly involved in the production of traditional foods (Almli et al., 2011; Pieniak et al., 2009). In fact, many consumers express strong interest in being informed and guaranteed about the authenticity of TFPs, and they associate higher quality to them (Molnár et al., 2011).

Nevertheless, the traditional character of EVOO may also represent a barrier to the introduction of innovations in its production process. As highlighted by Guerrero et al. (2012), from a consumer's perspective, a noticeable incompatibility exists between the concepts of "tradition" and "innovation" in the food domain. Tradition is a distinctive character of food strictly linked to the cultural heritage, and it is perceived by consumers as something to be preserved for future generations.

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[1] According to Guerrero et al. (2009), a traditional food product may be defined as "*a product frequently consumed or associated with specific celebrations and/or seasons, normally transmitted from one generation to another, made accurately in a specific way according to the gastronomic heritage, with little or no processing/manipulation, distinguished and known because of its sensory properties and associated with a certain local area, region or country*" (p. 348).

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Conversely, innovation is mainly associated with changes, namely new processes and/or new products, and, consequently, it is a breakdown from tradition. This explains why the introduction of innovations in TFPs is controversial (Moskowitz and Hartmann, 2008).

In the food domain, consumers' acceptance or rejection of innovations is the result of a complex decision-making process which involves an assessment of the perceived risks/benefits associated with the innovation (Ronteltap et al., 2007). When innovations are applied to TFPs, their acceptance is strongly dependent on the type of product and the type of innovation (Guerrero et al., 2009). In general, the innovations that provide consumers with tangible and relevant benefits in terms of sensory profile, nutritional value, healthiness, safety, and convenience are normally accepted also in TFPs, provided that they do not harm substantially the traditional character of the product (Guerrero et al., 2009; Kühne, Vanhonacker, Gellynck, & Verbeke, 2010; Vanhonacker et al., 2013). Heterogeneity in consumers' acceptance of innovations in TFPs has been also detected among consumers' segments, and, also in this case, it seems strongly influenced by the perceived impact of a given innovation on the traditional character of the product (Kühne et al., 2010; Vanhonacker et al., 2013).

In sum, due to the traditional character of EVOO, the introduction of changes in its production process without knowing the implications on consumers' perception and acceptance, can be potentially risky for producers (Vanhonacker et al., 2013).

Effectively, in the last decades, despite a rapid advancement of technological progress, the production process of EVOO did not change substantially (Clodoveo, 2013). The only innovation that has been extensively introduced was the so-called "continuous-type" extraction system which helped to improve significantly the efficiency of the mechanical process of olive oil extraction (Clodoveo, 2013, 2016).

Besides, in the last years, the research in this field provided several new technologies aimed to improve the quality of EVOO, and to increase the efficiency of its production process (Clodoveo, 2016). Among these, the use of ultrasounds for the extraction of EVOO is an emerging technology that showed several benefits for both producers and consumers (Clodoveo, 2019).

Ultrasounds are sound waves with frequency beyond the limit of human hearing (18−20 kHz) (Awad et al., 2012). The use of ultrasounds within the food industry has been subject of research and development for many years, and it has proved to be useful in several processes (e.g. sterilization, freezing, drying, emulsification, homogenization, extraction, etc.), providing, in general, shorter working times and increased efficiency (Awad et al., 2012; Chandrapala et al., 2012; Chemat et al., 2011; Patist and Bates, 2008). In particular, high-power ultrasounds, involving the use of sound waves at low frequency (20–100 kHz) and high power (upper 10 kW), are capable to generate high pressures, strong shear forces, and relevant temperature gradients in the propagating media, resulting in various physical and chemical effects that can be selectively used from a technological point of view (Jayasooriya et al., 2004).

Several studies were carried out to investigate the effects of high-power ultrasounds application on olive paste during the malaxation step of olive oil extraction, including laboratory scale studies (Bejaoui et al., 2016a,b; Jiménez et al., 2007), pilot plant scale studies (Bejaoui et al., 2018; Clodoveo et al., 2013a,b; Iqdiam et al., 2018), and also full scale studies (Amirante et al., 2017; Amirante and Clodoveo, 2017; Clodoveo et al., 2017). In particular, full scale studies showed that the use of ultrasounds for the extraction of EVOO is a technology capable of improving both the efficiency of the process - through higher extraction yields, shorter processing times, reduced operating and maintenance costs - and the quality of final product with higher content in polyphenolic compounds which are important for their antioxidant effects. The ultrasound treatment also affects sensory characteristics of EVOO by lowering the intensity of pungency and bitterness which are not well appreciated by a part of consumers (Cavallo et al., 2019; Salazar-Ordóñez et al., 2018b; Vázquez-Araújo et al., 2015).

However, this new technology is still to be transferred on the market (Clodoveo, 2019). Since the majority of innovations fails to gain any success on the food market (Dijksterhuis, 2016), even more so when innovations are applied to TFPs such as EVOO (Guerrero et al., 2012), it is fundamental to consider the point of view of consumers during the early stages of new product development, in order to prevent failures and subsequent waste of resources (Van Kleef et al., 2005).

To the best of our knowledge, few explorative studies have been conducted to investigate consumers' preferences for an EVOO obtained through a novel processing technique (Roselli et al., 2018b, 2020). In this context, the present study aimed to go beyond such knowledge, and to provide a real assessment of consumers' acceptance of an innovation applied to a traditional food, namely EVOO extracted through ultrasounds. In particular, the current research investigated in-depth the role of information and sensory properties in affecting consumers' willingness-to-pay (WTP). For this purpose, a laboratory experiment was performed, and a non-hypothetical experimental auction mechanism was applied to obtain individuals' WTP for different EVOO products.

2. Theoretical framework

According to Steenkamp (1997), consumers have a peculiar behaviour when it comes to search for information or purchase food. The proposed framework states that every decision happens with the influence of three categories of elements: the food, the environment and the person.

Concerning the product, literature proposed that food products have both intrinsic and extrinsic attributes (Enneking et al., 2007), which are able to guide differently consumer behaviour. Intrinsic attributes can be either search, experience or credence, according to the possibility of ascertaining about their existence at the purchase or the consumption moment (Caswell and Mojduszka, 1996). Among credence attributes, there is also the production method that can be very important for a product that is perceived as traditional (Del Giudice et al., 2018; Espejel et al., 2007). In fact, changes in the production method can alter the perceptions of consumers in the case of a product that takes most of its positive evaluations from typicality and traditionality features (Caporale et al., 2006). Moreover, intrinsic experience attributes can be known only by consumers who already tried the product, as taste characteristics. While for first-time purchases, consumers must rely on extrinsic attributes in order to choose the preferred product among the available options (Mueller and Szolnoki, 2010). Among extrinsic attributes, labels are important since they disclose several key elements that consumers can use for their decision making (Verbeke and Ward, 2006) as origin, production method, and brand.

The environment is also capable to influence how consumers perceive and make their decisions about food products. Indeed, food products are usually low priced and frequently purchased (Hamlin, 2010), therefore consumers often undertake a quick decision making (Petty and Cacioppo, 1986). Thus, consumers use shortcuts and rules of thumb to make their decisions, consequently environmental stimuli are able to deviate the decisions of consumers (Kim et al., 2016; Michael and Becker, 1973).

Furthermore, a third group of elements that influence consumers is related to personal and individual traits, as they influence how actually the elements in the world are perceived and, thus, how this information is actually evaluated by the single consumer.

Our experiment builds on the assumptions of the model proposed by Steenkamp (1997) to investigate the acceptability of a traditional food product such as EVOO with a process innovation entailing modifications of the sensory profile and its health content.

In the case of EVOO, authors mostly refer to how intrinsic attributes of the product are considered by consumers. Past researches showed that the most important attributes guiding consumer choices are place of origin, sensory profile, brand and production technique (Caporale and Monteleone, 2001; Dekhili and d'Hauteville, 2009; Del Giudice et al.,

2015; Finardi et al., 2009; Menapace et al., 2011; Mtimet et al., 2011; Ranalli et al., 1999; Ribeiro and Santos, 2004; Muñoz et al., 2015; Salazar-Ordóñez et al., 2018a). Focusing on taste, despite bitter and pungent sensory features can be an indicator of superior healthy quality of the product, these characteristics are not always preferred by consumers (Cavallo et al., 2019). While, being EVOO a traditional food product, consumers generally appreciate innovations such as organic farming or integrated pest management but could negatively evaluate a process innovation. In addition, the existence of a strong brand can raise consumers' expectations when innovations are applied to a product (Salazar-Ordóñez et al., 2018b). The importance of brand in the EVOO market has been highlighted by previous researches (Del Giudice et al., 2015; Salazar-Ordóñez et al., 2018a), but it is also confirmed by the fact that, in 2015 in Italy, approximately 40% of olive oil market shares were held only by three companies (Fondosviluppo, 2016).

In the current experiment, the characteristics of the product are taken into account together with taste. In order to analyse the effect of different product attributes on consumers' evaluations, we applied a choice set in which the products are characterized by the most salient extrinsic attributes of EVOO: origin (considered with a PDO certification), brand (considering two types of brands, one from a small firm and the Italian EVOO market leader), and processing method (the ultrasounds extraction vs. traditional method). Finally, since information has been extensively demonstrated as a core driver of consumers' food acceptance (Costanigro et al., 2011; Galmarini et al., 2013; Lusk and Briggeman, 2009), the current experiment has also measured individuals' EVOO evaluations under different information scenarios (*i.e.:* blind, label information, full information and informed tasting).

3. Materials and methods

3.1. An overview of the experimental approach

A within-subjects laboratory experiment in standardized conditions was performed to investigate how consumer preferences are affected by different levels of information about the method of extraction used for EVOO.

The experiment was designed by combining sensory evaluation and experimental auction following the approach proposed by Combris et al. (2009). This experimental approach has been previously applied by several scholars to effectively evaluate the effects of information on consumer preferences for food products with innovative features (among others, see: McFadden and Huffman, 2017; Lee et al., 2018; Teuber et al., 2016). Indeed, sensory characteristics have a significant weight in affecting the final decision of choosing among different food products and, thus, they should not be overlooked (Combris et al., 2009). On the other hand, experimental auction is a method which is increasingly used for eliciting individual willingness-to-pay (WTP) in studies concerning food products, and specifically focused on forecasting new product success (Lusk and Shogren, 2007). The main advantage of using experimental auction is related to the nature of this method which is "incentive compatible". This implies that participants are induced to elicit a willingness-to-pay which reflects sincerely the monetary value attached to a given product, so avoiding the problem related to hypothetical bias (List and Gallet, 2001; Lusk and Shogren, 2007).

In particular, in this study, the Vickrey-style fifth-price auction with the full-bidding approach (Vickrey, 1961) was applied. In this procedure, all bidders simultaneously submit sealed bids for all the auctioned goods, then the four highest bidders buy the product paying the fifth highest bid. This mechanism was selected because it is both incentive compatible, and the number of possible winners is sufficiently large to include low-involved participants (Lusk et al., 2007).

3.2. Recruitment of participants

The experiment was performed in the Spring 2017, and it involved a total of 200 participants living in Southern Italy, a geographical area characterized by a long and rooted tradition in the production and consumption of EVOO. Participants were recruited on a voluntary basis in two cities, namely Naples and Bari. A preliminary invitation was launched on various social networks to find volunteers willing to participate at the experiment which was presented in a generic way. The subjects who answered to the invitation were screened according to three eligibility criteria: (i) being at the age of majority (over 18 years); (ii) being household responsible for food purchasing, and (iii) having bought EVOO at least once in the last year. The subjects who declared to satisfy these conditions were invited to take part at the experiment through a written notification which included a description of the general purpose of the experiment and its procedures. The subjects who agreed to participate were subsequently called, and they were provided with information on the date, time and place where the experiment session would have been held.

3.3. EVOO products

In the experiment, four different EVOO products were tested and compared by all participants. The main characteristics of these EVOO products were the following ones.

1) *PDO_ULTRA*: EVOO obtained through ultrasound-assisted extraction, fully compliant to the standards of the Protected Designation of Origin (PDO) "Dauno Gargano", manufactured and branded by a small firm located in Puglia region (Italy);
2) *PDO_TRAD*: EVOO obtained through conventional extraction system, fully compliant to the standards of the PDO "Dauno Gargano", manufactured and branded by a small firm located in Puglia region (Italy);
3) *PDO_LEAD*: EVOO obtained through conventional extraction system, fully compliant to the standards of the PDO "Dauno Gargano", manufactured and branded by the leader company of the Italian EVOO market (IRI, 2015);
4) *CONV_LEAD*: the EVOO with the highest market share in Italy, obtained through conventional extraction system, blend of products from different EU countries, manufactured and branded by the leader company of the Italian EVOO market (IRI, 2015).

This experimental design should provide straightforward information on the direct effect of ultrasound extraction on consumer preferences, by comparing *PDO_ULTRA* versus *PDO_TRAD* evaluations. Additionally, it should broadly portray the potential market space of the ultrasound extracted EVOO (comparing the performance of *PDO_ULTRA* with the ones of *PDO_LEAD* and *CONV_LEAD*), in a heavily competitive landscape where leading brands also set the sensory standards. However, we must underline that the two leader brand oils carry different features compared to the first two products (namely: brand for the *PDO_LEAD* and brand plus origin for the *CONV_LEAD*) and thus direct comparisons with the other two EVOO should be made taking into account these confounding effects.

It is important to highlight that the first two products (*PDO_ULTRA* and *PDO_TRAD*) were obtained in the same firm located in Puglia region (Italy), and under the same conditions, except for the sonication treatment. In particular, both the products were extracted from a homogeneous batch of olives, and through the same olive mill plant, specifically equipped with a prototype device for ultrasounds application on olive paste during the malaxation step. This device was turned on and off alternately, and the oils coming from each procedure were stored separately in two homogeneous lots. Afterwards, the two different products were chemically analysed, bottled and regularly labelled.

The third and fourth products (*PDO_LEAD* and *CONV_LEAD*), being

both branded by the leader company of the Italian EVOO market, were supposed to be more familiar to participants, and, therefore, they were included as additional control products to increase the realism of the experiment and the external validity of overall findings (Vecchio and Borrello, 2019). These two EVOO were bought at the same point of sale in sufficient quantity for the experiment, and, then, they were stored in appropriate conditions until their use.

All the products used in the experiment were packaged in glass bottles of 0.75 L, and regularly labelled with all the legally required information (e.g. expiration date, net content, origin).

Preliminarily, the four EVOO products were submitted to a sensory evaluation by a panel of trained tasters according to the International Olive Council method described in the Reg. EU 1348/2013 - Annex XII (revision of Reg. EEC 2568/91). Sensory test showed that all the four EVOO products were free of defects, but different in terms of intensity of positive sensations, namely fruity, bitter and pungent. Looking at Fig. 1, it should be noted that all the positive sensations were less intense for *PDO_ULTRA* (the EVOO obtained through ultrasounds) compared to *PDO_TRAD* (the counterpart product obtained through the conventional extraction method).

3.4. Experimental procedure

The experiment was organized in multiple sessions of 10 participants each, following exactly the same protocol (within-subject design). In each session, participants were welcomed in a computer laboratory with a large display in front of the room. Each participant received immediately an identification number and a monetary compensation of 20 Euro, by clearly specifying that it was an economic incentive exclusively given for their time spent in the experiment. Participants were also asked to read and sign an informed consent form.

All the experiment sessions were conducted by the same moderator who strictly read printed instructions in order to minimize session effects. No interaction among participants was allowed throughout the experiment.

At the beginning of each session, the moderator explained the auction procedure to participants, and, subsequently, a training auction with four different chocolate bars took place. Participants were also given the opportunity to request further clarifications to ensure that the auction procedure was clearly understood from everyone.

Each session included 4 consecutive experimental rounds under different information scenarios as specified in the following.

Round 1 (blind tasting). Participants received in sequence the four EVOO products chosen for the experiment. Each product was presented in standardized glass (10 mL per glass) with a two grams slice of white and unsalted bread. No information was provided about all the EVOO products. Participants were asked to taste each EVOO product, and to evaluate them in terms of overall liking by using a 9-points hedonic scale where 1= "extremely unpleasant", and 9= "extremely pleasant". For each EVOO product, participants were also asked to express secretly (via computer) the maximum price they were willing to pay for purchasing a bottle of 0.75 L. After having tasted each EVOO product, participants were invited to rinse their mouth with still water and a slice of green apple. This round assessed the role of taste on individual WTP, not affected by information.

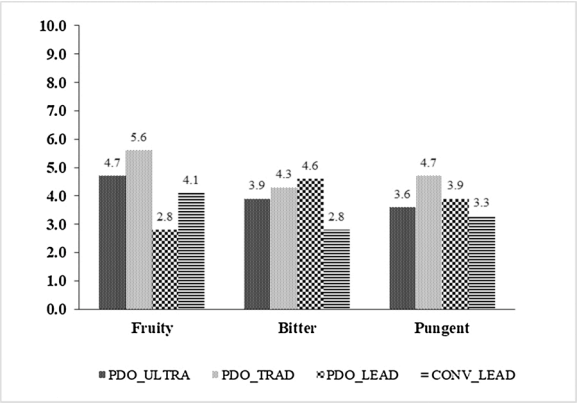

Fig. 1. Positive sensory sensations of EVOO samples (scale ranging from 0 to 10).

Round 2 (label information). As stated by the information processing theories (Dörnyei and Gyulavári, 2016; MacInnis and Jaworski, 1989), a label information is encoded in a symbolic form with a cognitive meaning. During the encoding process, label cues may be transformed, and people may assign to them a meaning that may or may not be similar to the real form of the cue (Olson, 1980). For example, consumers strongly associate local cues on labels to desirable environmental and food safety outcomes and these beliefs are also the most important predictor of WTP for labels when no sensory/experience information is available. Consequently, region and PDO information are important drivers for EVOOs choice (Del Giudice et al., 2015; Di Vita et al., 2013). To this purpose, a full display of EVOO products, as appeared in a local supermarket, was reconstructed in the laboratory. This display showed 60 different bottles of EVOO, regularly labelled, including those chosen for the experiment. Participants were invited, one by one, to carefully look and touch the bottles of EVOO on the display. Then, the moderator took from the display, one by one, the bottles of EVOO chosen for the experiment, and showed them to participants highlighting the main label information: the brand, the presence or not of the cue for PDO "Dauno Gargano", and the method of extraction (conventional or ultrasound-assisted). For each of the showed products, participants were asked to express secretly (via computer) the maximum price they were willing to pay for purchasing it (all the four products were packaged in glass bottle of 0.75 L).

Round 3 (full information). In this round, detailed labels were provided to participants: a brief script informed about the type of manufacturer, the origin of the olives, and the method of extraction for each product. According to the information processing theories (Dörnyei and Gyulavári, 2016; MacInnis and Jaworski, 1989), we expected that this round would allow to detect the direct effect of detailed information on WTP (compared to the evaluations expressed in the previous round). Such information consisted of brief and non-technical texts which were delivered to participants via pc monitors (see Appendix A). Attention was paid to how the texts were framed to describe the four EVOO products. The four texts were balanced to have the same number of words (120 Italian words), the same linguistic style, and similar structure. In detail, for each EVOO, participants were informed about the type of manufacturer (small firm vs. large firm), the origin of olives (PDO "Dauno Gargano" vs. blend of olive oils from EU countries), and the method of extraction (conventional vs. ultrasound-assisted). Afterwards, for each of the described EVOO, participants were asked to express secretly (via computer) the maximum price they were willing to pay for purchasing a bottle of 0.75 L.

Round 4 (informed tasting). Stemming from the available evidence of the relationship between taste and labels (Combris et al., 2009; Nalley et al., 2006) which found that WTP for food products changed when location of origin and taste information were made available, participants were exposed to a final *informed tasting* round. Participants received in sequence the four EVOO products chosen for the experiment. Each product was presented in standardized glass (10 mL per glass) with a two grams slice of white and unsalted bread. For each EVOO product, participants were asked, first, to read its description (the same provided in the round 3), then, to taste it, and, finally, to express secretly (via computer) the maximum price they were willing to pay for purchasing a bottle of 0.75 L. After having tasted each EVOO product, participants were invited to rinse their mouth with still water and a slice of green apple.

To avoid presentation order and anchoring effect, randomization of

the sequence of the four EVOO products was applied in each experimental session and in each round.

At the end of each session, the sale of products was conducted according to the fifth-price auction procedure carefully explained to participants before starting the experiment. Specifically, in order to avoid demand reduction effects, just one round and just one EVOO product were randomly drawn to select the reference auction for product sale. Then, sealed bids of the selected auction were disclosed to participants, and the four highest bidders bought a bottle of EVOO with actual payment of the fifth highest bid.

3.5. Data analysis

All the measures expressed by participants in the different experimental rounds, namely sensory rating (overall liking) and willingness-to-pay (WTP) were stored in a database, and descriptive statistics (mean and standard deviation) were calculated as first step of the analysis.

Then, statistical differences between the various measures expressed by participants were analysed by performing pairwise comparisons using Wilcoxon signed-rank test (Wilcoxon, 1945) with a statistical significance of $p<0.05$. Wilcoxon signed-rank test is a non-parametric test used to compare repeated measurements on a single sample, as in this experiment, and to assess whether paired distributions are different or not (paired difference test). The null hypothesis is that no statistical difference between the two distributions under comparison could be observed. This test is suggested as alternative to the paired Student's *t*-test when measurements cannot be assumed normally distributed. Indeed, in this experiment, both sensory ratings and WTP were not expected to hold the assumption of normal distribution.

In addition, to move beyond from the simple identification of statistical significance, effect sizes were also calculated as proposed by Cohen (1988) and following its guidelines for interpretation: a large effect size is 0.5, a medium effect size is 0.3, and a small effect size is 0.1.

While, for the comparison between different rounds, a repeated measures ANOVA and post hoc comparison test of means was performed with WTP as the dependent variable and individuals and rounds as the independent variables. In this case, the Greenhouse–Geisser F statistic was used. When the F statistic was significant, comparisons between rounds were made, in order to test whether the bids were different for the same product across information conditions. In detail, pairwise comparisons of marginal linear predictions were measured to calculate effect sizes.

4. Results and discussion

The final consumer sample consisted of 200 participants recruited in Naples (n. 100) and Bari (n. 100), two big cities in Southern Italy. The composition of the sample in terms of age and gender is summarized in Table 1.

The sample included 129 females (65%) and 71 males (35%) in the age range of 18–74 years. The prevalence of females was justified by the fact that, according to Italian tradition, females are more frequently involved as household responsible for food purchasing.

The results of sensory rating (overall liking) expressed by participants in blind conditions during the experimental round 1 are shown in Table 2.

It is possible to observe that, despite the four EVOO products had different sensory characteristics, as shown in the preliminary panel test, no relevant differences emerged in the sensory ratings expressed by participants. In fact, the mean scores of sensory rating for each product (ranging from 4.80 to 5.27) appeared to be very similar, and also placed in the middle of the 9-points hedonic scale (5= "it leaves me indifferent"). In particular, no statistically significant differences emerged in the comparison between *PDO_ULTRA/PDO_TRAD*, namely the EVOO products exclusively differentiated on the basis of sonication treatment. This means that, in blind conditions, consumers have been unable to discriminate sensory characteristics of the two products. Moreover, no large differences, although statistically significant ($p<0.05$), were detected in the comparisons between *PDO_TRAD/PDO_LEAD*, and *PDO_LEAD/CONV_LEAD* considering that the relative effect size resulted to be lower than 0.5.

A possible reason for this can be provided considering that participants were not expert tasters and thus, in blind conditions, they found it difficult to discriminate sensory characteristics of the different EVOO products. As a consequence, participants tended to express neutral judgements for all the tasted products. This is a quite common result obtained in other blind sensory tests conducted for EVOO (Caporale et al., 2006; Delgado et al., 2013).

The results of WTP expressed by participants for each EVOO product, and in the four experimental rounds (under different information scenarios) are shown in Table 3, and also graphically represented in Fig. 2.

During the round 1 *(blind tasting)*, the WTP expressed by participants reflected exactly the results of sensory ratings. Indeed, as no substantial differences emerged in terms of overall liking among the tasted products, no statistically significant differences were detected for all the pairwise comparisons of WTP. Coherently, the average values of WTP for each product, ranging from 4.20€ to 4.43€, resulted to be very similar. In particular, comparing the average values of WTP for *PDO_ULTRA* and *PDO_TRAD*, namely the EVOOs just differentiated on the basis of sonication treatment, they resulted to be essentially analogous (4.40€ and 4.43€, respectively).

In the round 2 *(label information)*, participants expressed their WTP after having seen the bottle of each EVOO and the relative label, so by miming the real setting where consumers are faced with products on the shelfs of a supermarket. Contrarily to the previous round, in this new scenario, all the pairwise comparisons of WTP for each product were statistically significant, and the average values of WTP, ranging from

Table 1
Composition of consumer sample.

	Naples		Bari		Total sample	
	No.	Percentage	No.	Percentage	No.	Percentage
Participants	100	100 %	100	100 %	200	100 %
Gender:						
Males	35	35 %	36	36 %	71	36 %
Females	65	65 %	64	64 %	129	64 %
Age cohorts (years):						
18–29	25	25 %	15	15 %	40	20 %
30–40	22	22 %	34	34 %	56	28 %
41–50	26	26 %	28	28 %	54	27 %
51–74	27	27 %	23	23 %	50	25 %

Table 2
Comparison[a] of sensory rating (overall liking) expressed by participants in blind conditions (1-9 hedonic scale).

EVOO products	Mean	Standard deviation	Effect size[b] (z-statistics)		
			PDO_TRAD	*PDO_LEAD*	*CONV_LEAD*
PDO_ULTRA	5.01	1.91	0.1290 (1.824)	−0.0616 (−0.871)	0.0453 (0.640)
PDO_TRAD	5.27	1.84		−0.2073*** (-2.931)	−0.0561 (−0.793)
PDO_LEAD	4.80	1.85			−0.1462** (2.067)
CONV_LEAD	5.11	1.82			

[a] Pairwise comparison through Wilcoxon signed-rank test (***=p<0.01; **=p<0.05; *=p<0.10).
[b] The effect size was calculated as proposed by Cohen (1988). Cohen's guidelines suggest that a large effect size is 0.5, a medium effect size is 0.3, and a small effect size is 0.1.

Table 3
Pairwise comparison of willingness-to-pay expressed by participants (€/0.75 L bottle).[a]

Round	EVOO products	Mean	Standard deviation	Effect size [b] (z-statistics)		
				PDO_TRAD	*PDO_LEAD*	*CONV_LEAD*
Round 1	*PDO_ULTRA*	4.40	2.61	−0.0581 (−0.822)	−0.0581 (−0.821)	−0.0011 (−0.015)
	PDO_TRAD	4.43	2.45		−0.1213 (−1.716)	−0.0590 (−0.835)
	PDO_LEAD	4.20	2.73			0.0945 (1.337)
	CONV_LEAD	4.29	2.42			
Round 2	*PDO_ULTRA*	6.32	3.05	−0.1678** (−2.373)	−0.3511***(−4.965)	−0.7319***(−10.351)
	PDO_TRAD	6.09	2.92		−0.2659*** (−3.76)	−0.6744***(−9.537)
	PDO_LEAD	5.81	2.75			−0.7128*** (−10.081)
	CONV_LEAD	4.30	1.80			
Round 3	*PDO_ULTRA*	6.66	3.27	−0.3349*** (−4.736)	−0.5885***(−8.322)	−0.7828***(−11.071)
	PDO_TRAD	6.32	3.01		−0.4980*** (−7.043)	−0.7847***(−11.097)
	PDO_LEAD	5.64	2.52			−0.7820*** (−11.059)
	CONV_LEAD	4.06	1.55			
Round 4	*PDO_ULTRA*	6.18	3.35	−0.1771** (−2.504)	−0.5186***(−7.334)	−0.6822***(−9.648)
	PDO_TRAD	5.95	2.95		−0.4452*** (−6.296)	−0.6899***(−9.756)
	PDO_LEAD	5.17	2.46			−0.5612*** (−7.936)
	CONV_LEAD	4.11	1.67			

[a] Asterisks represent statistical significance of Wilcoxon signed-rank test (*** = $p < 0.01$; ** = $p < 0.05$; * = $p < 0.10$). Student t tests and the Kolmogorov–Smirnov tests revealed identical outcomes.
[b] The effect size was calculated as proposed by Cohen (1988). Cohen's guidelines suggest that a large effect size is 0.5, a medium effect size is 0.3, and a small effect size is 0.1.

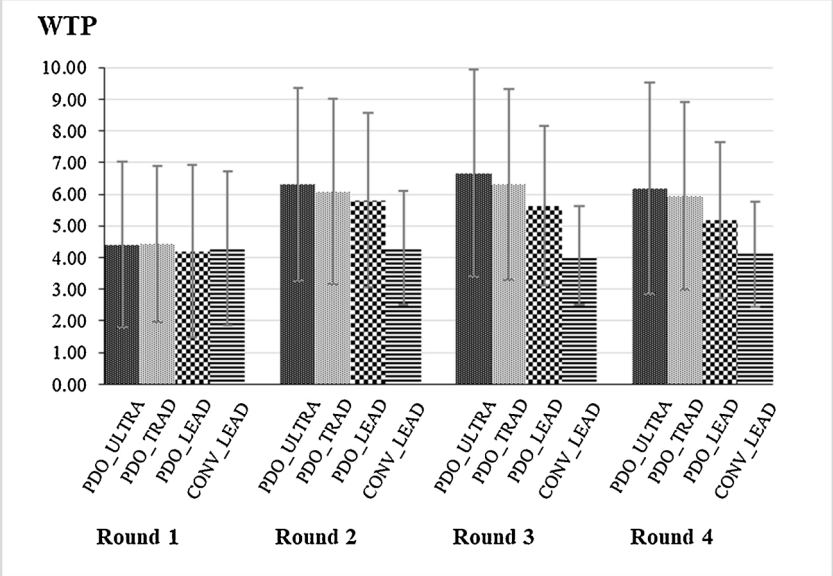

Fig. 2. Means and Standard Deviations of WTP expressed by participants (€/0.75 L bottle).

4.30€ to 6.32€, resulted to be rather different. So, it is possible to argue that label information had a strong effect on the expression of WTP, and this may be explained by considering consumers' expectations, namely the impressions that consumers had by looking at extrinsic cues of each product (Piqueras-Fiszman and Spence, 2015). In particular, as shown in Table 4, compared to round 1, the mean WTP increased significantly for EVOOs carrying the cue of PDO "Dauno Gargano". So, it is very likely that this quality cue affected considerably consumers' preferences by generating positive expectations. Moreover, it should be noted that the mean WTP for *PDO_ULTRA* (6.32€) was slightly higher compared to that for *PDO_TRAD* (6.09€). Probably, the label indicating *"extracted through ultrasounds"* stimulated in the participants an expectation with respect to a greater economic value of the bottle. However, future studies should verify this interpretative hypothesis by explicitly testing the

Table 4
Comparison of willingness-to-pay expressed by participants among rounds (€/0.75 L bottle).[a]

EVOO products	Round2 vs Round1		Round3 vs Round2		Round4 vs Round3	
	Δ WTP [b]	*p*-value	Δ WTP [b]	*p*-value	Δ WTP [b]	*p*-value
PDO_ULTRA	1.91***	(0.000)	0.34**	(0.016)	−0.48***	(0.001)
PDO_TRAD	1.66***	(0.000)	0.23	(0.109)	−0.37**	(0.011)
PDO_LEAD	1.61***	(0.000)	−0.17	(0.232)	−0.47***	(0.001)
CONV_LEAD	0.01	(0.953)	−0.23**	(0.048)	0.04	(0.711)

[a] Pairwise comparison through post-hoc repeated ANOVA test by round (*** = $p < 0.01$; ** = $p < 0.05$; * = $p < 0.10$).
[b] The effect size is calculated as pairwise comparisons of marginal linear predictions.

expectations stimulated by the labels.

During the round 3 *(full information)*, participants were provided with more detailed information on the characteristics of the four EVOO products, regarding, in particular, the type of manufacturer (small firm vs large firm), the origin of olives (PDO "Dauno Gargano" vs blend of olive oils from EU countries), and the method of extraction (conventional vs ultrasound-assisted). In general, the WTP elicited by participants in this round seemed to confirm and reinforce the preferences already expressed in the previous round. Specifically, all the pairwise comparisons of WTP for each product were statistically significant, and the mean WTP, ranging from 4.06€ to 6.66€, were rather different. Compared to the previous round (*label information*), the mean WTP increased significantly only for the ultrasounds extracted EVOO, while decreased for the *CONV_LEAD* product. Effectively, in this round, participants received more information about the type of manufacturer (small firm vs. large firm), and the ultrasounds label caught the attention of consumers and caused an increase in evaluations. Focusing on the comparison between *PDO_ULTRA* and *PDO_TRAD*, it should be noted that, on average, a slightly higher WTP was confirmed for the EVOO extracted through ultrasounds (6.66€ and 6.32€, respectively). This would entail that, also when consumers received more detailed information on the new technology used for EVOO extraction, they reacted by increasing their quality expectations for the product which attracted their attention.

Lastly, during the round 4 (*informed tasting*), participants expressed their WTP after having tasted each EVOO by knowing in advance its relative information. So, in this round, as in a real setting of repeat purchases, participants assessed each EVOO by considering both their intrinsic properties (taste) and extrinsic cues (information). Once again, the mean WTP for each product, ranging from 4.11€ to 6.18€, resulted to be rather different one from another, with all pairwise comparisons being statistically significant. In particular, the highest WTP were registered for the two EVOOs carrying both the PDO "Dauno Gargano", and the brand of small firm (*PDO_ULTRA* and *PDO_TRAD*). Moreover, it should be noted that the EVOO obtained through ultrasounds still received a mean WTP slightly higher compared to its conventional counterpart (6.18€ and 5.95€, respectively). However, comparing the results of round 4 with those of round 3, it is possible to observe a significant reduction of the mean WTP for the EVOOs carrying the PDO "Dauno Gargano". This can be related to a "disconfirmation" effect (Piqueras-Fiszman and Spence, 2015) due to the fact that prior consumers' expectations about the cue of PDO "Dauno Gargano" were not confirmed by sensory evaluation. As a consequence, in the attempt to minimize the discrepancy between what was expected and what was experienced, consumers reacted by reducing their WTP.

5. Conclusions

This study aimed to investigate the role of information and sensory evaluation in affecting consumers' acceptance of EVOO obtained by using a new technology based on ultrasound-assisted extraction. This technology was demonstrated to be capable of improving both the efficiency of the process and the quality of the final product. However, when new technologies are introduced in the production process of TFPs, such as EVOO, consumers' acceptance is not easily predictable being strongly influenced by the perceived impact of the innovation on the traditional character of the product. This uncertainty discourages manufacturers from investing economic resources in new technologies even in the presence of proven advantages. Therefore, a preliminary understanding of consumers' acceptance is crucial to provide insights on the potential marketability of food products incorporating a new technology.

In this study, a laboratory experiment in standardized conditions was performed to elicit consumers' willingness-to-pay for purchasing different EVOO products. In particular, the EVOO obtained through ultrasound-assisted extraction was tested and compared with three additional control products. The experiment involved a sample of regular EVOO consumers living in Southern Italy.

The results of the study provided strong empirical evidences suggesting that EVOO obtained by using the new technology based on ultrasound-assisted extraction may be, on average, accepted by consumers. Effectively, in all the experimental settings, the WTP expressed by consumers for the innovative product resulted no lower compared to the WTP expressed for the others control products. Specifically, in blind conditions, consumers did not find significant sensory differences among the EVOO extracted through ultrasounds and the other control products. Subsequently, the claim on the label *"extracted through ultrasounds"* did not affect negatively the quality expectations of consumers, and this tendency has been confirmed also when more detailed information about the innovative method of extraction was provided. Finally, in the results of the informed tasting, reflecting a real setting where consumers are involved in repeat purchases, the mean WTP for the EVOO extracted through ultrasounds was, once again, higher compared to the mean WTP expressed for the others control products.

However, it is important to highlight that, while consumers' acceptance of EVOO extracted through ultrasounds can be outlined from experimental results, on the other hand, no sufficient empirical evidences emerged to support the hypothesis that consumers are also willing to pay a premium price for such innovative product. Indeed, the differential of WTP for the ultrasound-extracted EVOO compared to its conventional counterpart resulted to be quite limited in term of magnitude (6.18€ vs 5.95€ in the informed tasting). In addition, a necessary caution should be taken in the interpretation of experimental results that may be affected by some limitations related to, in particular, the size of consumer sample, the specific combination product/attributes used in the evaluation settings, and, to some extent, the effect of scrutiny and moral obligation (Vecchio and Borrello, 2019). Therefore, the costs of the extraction process based on ultrasound application should be carefully analysed and compared to the costs of traditional process in order to identify a significant competitive advantage associated to the adoption of this innovation.

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Declaration of Competing Interest

The authors report no declarations of interest.

Appendix A

List of the printed instructions provided during the experiment

PDO_ULTRA
Extra-Virgin Olive Oil "Dauno Gargano" is fully compliant to the standards of the Protected Designation of Origin (PDO) "Dauno Gargano". The olives are mainly of the variety "Ogliarola Garganica", manufactured and branded by a small firm located in Puglia region (Italy). The production, the environmental and cultivation conditions of the olive groves are traditional and typical of that area, they provide the olives and the derived oil specific qualitative characteristics. The Extra-Virgin Olive Oil "Dauno Gargano" is obtained through an ultrasound-assisted extraction technology.
PDO_TRAD
Extra-Virgin Olive Oil "Dauno Gargano" is fully compliant to the standards of the Protected Designation of Origin (PDO) "Dauno Gargano". The olives are mainly of the variety "Ogliarola Garganica", manufactured and branded by a small firm located in Puglia region (Italy). The production, the environmental and cultivation conditions of the olive groves are traditional and typical of that area, they provide the olives and the derived oil specific qualitative characteristics. The Extra-Virgin Olive Oil "Dauno Gargano" is obtained through a conventional extraction system.
PDO_LEAD
Extra-Virgin Olive Oil "Dauno Gargano" is fully compliant to the standards of the Protected Designation of Origin (PDO) "Dauno Gargano". The olives are mainly of the variety "Ogliarola Garganica", manufactured and branded by the leader company of the Italian EVOO market. The production, the environmental and cultivation conditions of the olive groves are traditional and typical of that area, they provide the olives and the derived oil specific qualitative characteristics. The Extra-Virgin Olive Oil "Dauno Gargano" is obtained through a conventional extraction system.
CONV_LEAD
Extra-Virgin Olive Oil "Classico" is produced by the leader company of the Italian EVOO market. Extra-Virgin Olive Oil "Classico" is a blend of products from different EU countries, manufactured and branded by the leader company of the Italian EVOO market. The production, the environmental and cultivation conditions of the olive groves are traditional and typical of that area, they provide the olives and the derived oil specific qualitative characteristics. The Extra-Virgin Olive Oil "Classico" is obtained through conventional extraction system.

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