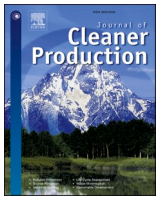
Journal of Cleaner Production 497 (2025) 145121

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro



Integrating biodiversity information into consumer preferences for extra virgin olive oil: Evidence from a real choice experiment in France

Ivana Radić Jean [a], Maurizio Canavari [b], Claire Cerdan [c], Federica Consentino [d,*], Iuri Peri [d]

[a] CIRAD, UMR Innovation, 3400, Montpellier, France
[b] Department of Agricultural and Food Sciences, University of Bologna, 40126, Bologna, Italy
[c] Département Environnement et Sociétés, CIRAD, 34980, Montferrier-sur-Lez, France
[d] Department of Agriculture, Food and Environment, University of Catania, 95125, Catania, Italy

ARTICLE INFO

Handling Editor: Giovanni Baiocchi

Keywords:
Real choice experiment
Olive oil
Biodiversity
Geographical indication
Organic production
Consumers

ABSTRACT

This research examines the influence of biodiversity information on consumer preferences for Extra Virgin Olive Oil (EVOO) that features Geographical Indication (GI). Conducted in a specialty food shop in Montpellier, France, and using a Real Choice Experiment (RCE), the study focuses on how GI and organic labels interact. Participants were divided into two groups: one group was provided with details about the benefits to biodiversity associated with GIs, while the other received no supplementary information.

Analysis through a multinomial logit model (MNL) indicated that both GI and organic labels enhance consumer preference, though they serve as partial substitutes instead of complements.

The inclusion of biodiversity information on GI and organic labels highlights that these labels are considered substitutes, and biodiversity information further reinforces this perception. This finding is crucial for producers aiming to stand out in markets where quality is prioritized. The results suggest that integrating biodiversity messaging into marketing strategies could effectively increase the perceived value of GI-labelled products, as evidenced by a statistically significant effect observed in the analysis. Furthermore, the study supports the new EU GI Regulation's voluntary framework for producers to implement sustainable practices, potentially aiding in market differentiation through biodiversity conservation. Although the real-world setting of the RCE presented some challenges, such as ensuring that the experimental conditions mimicked authentic purchasing environments, the research provides valuable insights for future investigations into how environmental information affects consumer behavior in purchasing contexts.

1. Introduction

Over the past decade, significant research attention has been directed towards Geographical Indication (GI). Initially conceived to communicate product quality, this concept has since matured into a multifaceted instrument for fostering rural development (Sylvander et al., 2007; Belletti and Marescotti, 2011; Marescotti and Belletti, 2021; Guareschi et al., 2023; Menapace and Moschini, 2024; Consentino et al., 2024). More recently, the scientific community and practitioners have viewed GI as a pivotal tool in safeguarding biodiversity (Dal Ferro and Borin, 2017; Milano and Cazella, 2021). While GIs integration with EU conservation varieties - traditional or locally adapted plant varieties that the EU seeks to preserve due to their genetic diversity and cultural significance - is currently limited, the relationship between GIs and conservation varieties is expected to strengthen as the number of both increases (Vakoufaris, 2024). Santilli (2012) suggests a comprehensive definition of biodiversity, encompassing multiple elements. It comprises a richness of cultivated plant species (interspecific diversity), various cultivars within species (intraspecific or genetic diversity), and the diversity inherent in agroecosystems or cultivated ecosystems. Recognizing agriculture as a human endeavour profoundly influencing biodiversity, he emphasizes the inseparable link between local knowledge, cultural practices, and agricultural biodiversity. GIs could contribute to protecting biodiversity by promoting the use of heirloom,

* Corresponding author.
E-mail addresses: ivana.radicjean@gmail.com (I.R. Jean), maurizio.canavari@unibo.it (M. Canavari), claire.cerdan@cirad.fr (C. Cerdan), federica.consentino@phd.unict.it (F. Consentino), peri@unict.it (I. Peri).

https://doi.org/10.1016/j.jclepro.2025.145121
Received 24 October 2024; Received in revised form 19 February 2025; Accepted 22 February 2025
Available online 27 February 2025

less productive cultivars that might otherwise be abandoned, ensuring the preservation of genetic diversity (Vakoufaris, 2024). In addition to their role in biodiversity conservation, these varieties often offer distinctive flavor profiles and sensory qualities that can enhance the uniqueness of GI-labelled products. In this perspective and according to the author, GI labels represent not only goods but also embody the cultural and biological heritage intrinsic to a particular territory. The alignment of GI with agricultural biodiversity goals hinges on all stakeholders' concerted efforts.

Initially covered by EU Regulation No. 1151/2012, GI has recently been the subject of a new regulation, EU Regulation 2024/1143. The extent to which GIs can promote environmentally sustainable production has long been debated (Bérard and Marchenay, 2006; Vandecandelaere et al., 2009; Santilli J., 2012; Belletti et al., 2015). In this regard, the new regulatory framework has introduced sustainability and transparency requirements into the GI scheme, stipulating that a group of producers can agree on sustainable practices to be followed in the production of GI. On a voluntary basis, the producer group may create and regularly update a sustainability report based on verifiable information in terms of environmental, social, economic, or animal welfare commitments. These practices, however, might entail additional costs for producers, which could necessitate compensation to ensure their adoption and long-term sustainability (Bramley et al., 2009). In this sense, the potential impact of sustainability reports on consumer preference needs to be assessed. Within the European Union (EU), another significant quality scheme revolves around organic production labelling. This labelling serves as a guarantee that the product adheres to the organic production regulations outlined in EU Regulation No 2018/848. Organic production embodies a comprehensive approach to agricultural management, food production and integrates the adoption of environmentally responsible practices, promoting high levels of biodiversity protection.

This study considered the added value of promoting Extra Virgin Olive Oil (EVOO) labelled with GI, focusing on the general role of such labels in enhancing consumer awareness of sustainability advantages and specifically emphasizing their potential positive impact on biodiversity. Although there is extensive academic discussion on the role of GI as a quality scheme that may protect biodiversity protection, no previous study has specifically examined how the perceived value of biodiversity impacts consumer purchases of GI-labelled products.

Moreover, while most studies examining consumer preferences for EVOO have relied on hypothetical choice experiments, there is a noticeable gap in the literature regarding studies that investigate consumer preferences using non-hypothetical or real choice experiments.

Considering the recently introduced regulation for GI (Regulation (EU)) No 2024/1143), it could be valuable for producers to investigate whether explicitly stating how production practices conserve biodiversity increases consumers' willingness to buy.

This research aims to show the influence of information about biodiversity protection on consumer choice for EVOO with GI, with high reliability and authenticity of the expressed intention of buying, as the study takes place in the context of the real purchase. The two largest quality schemes have been considered: GI and organic labels. The study's objective is to investigate how the information about the positive effect of GI on biodiversity preservation influences the consumers' willingness to buy these two quality schemes when the product is EVOO, applying a Real Choice Experiment (RCE). The hypothesis on which the work is based is that the consumer preference for GI EVOO increases when information about GIs positive impact on biodiversity is presented.

Results could advance the literature and have practical implications for producers and marketers. First, the study used high-quality, locally produced EVOO, with a GI label or organic label as products of interest in an RCE. The high-quality and rather expensive EVOO can be considered a luxury food product, offering insights into consumer preferences for premium goods. Researchers employing RCE tend to use reference products with lower monetary value. Second, the study stepped out « to the real world» and set up in a specialty food shop, which reflected the reality of decision-making and purchasing. This approach provides valuable insights not only for academic purposes but also for producers and marketers aiming to understand consumer behavior in authentic retail settings, as most real choice experiments available in the literature are conducted in experimental economics labs. Following the debate about the difference between lab and field settings for experimental auctions, the study notes that the major difference is the control the researcher has over the experiment in the lab setting. Indeed, the experiment in the field can have important implications on findings regarding the effects and significance of factors (Canavari et al., 2019; Vecchio and Borrello, 2019).

1.1. State of art on consumer preference studies

Belletti et al. (2015) investigated to what extend GI could be considered as a model for protecting the environment, including biodiversity. According to them, biodiversity emerges as one of the most emphasized environmental aspects within the GI system. Cheng (2023) highlights how GIs can sustain agri-food production while protecting biodiversity, particularly by valuing heirloom cultivars and promoting sustainable practices, further reinforcing their environmental role. In the literature, origin-based products, including those with GI labels, are often seen as pivotal frameworks for biodiversity preservation and GI labels act as quality indicators, fostering consumer trust and an emotional connection with the product (Bérard and Marchenay, 2006; Vandecandelaere et al., 2009).

Numerous studies have examined consumer preferences for olive oil, revealing that GI and organic certifications positively influence market positioning and willingness to pay (Chousou et al., 2018; Erraach et al., 2014; Fotopoulos and Krystallis, 2001; Menapace et al., 2011; Philippidis and Sanjuan, 2003; Sgroi et al., 2024). Consumers who prioritize the origin of olive oil tend to value factors like olive variety (Dekhili et al., 2011), while others place greater emphasis on intrinsic features such as raw materials, production processes, and production area (Carbone et al., 2018). Studies reveal the importance of GI and organic labels in shaping purchasing decisions for EVOO (Cañada and Vázquez, 2005; Kizos and Vakoufaris, 2011; Aprile et al., 2012; Di Vita et al., 2013; Bajalqui de la Cruz, 2023; Lanfranchi et al., 2024; Delpozo et al., 2024).

The geographical origin of EVOO is the most influential factor for consumers, serving as a signal of quality and authenticity (Carlucci et al., 2014). The importance of providing transparent information to justify the higher prices of GI-labelled products is well-documented in studies by Wongprawmas et al. (2012) and Belletti et al. (2015). According to them, for GIs with an environmental focus, effectively communicating territorial and ecological attributes for GIs is crucial, having an impact also on consumers' willingness to pay. Solér et al. (2017) affirm that consumers are willing to pay more for sustainably produced commodities, enhancing the importance of protecting high-biodiversity coffee by voluntary sustainability standards.

In the study of Vlontzos and Duquenne (2014), consumers showed more confidence in organic certification as an assurance of quality compared to other types of certifications. However, consumers often lack trust in the claimed organic origin of certified products when the labelling is unclear. This suggests that consumer trust in organic certifications is not absolute but depends heavily on the transparency and clarity of the information provided (Sandalidou et al., 2002).

Agri-food products often involve information asymmetries between producers and consumers regarding quality and credence attributes (Rangnekar, 2004). Distinctive labels play a key economic role in reducing this asymmetry by providing valuable information to consumers. Skilled and informed consumers are essential for achieving sustainability in origin-based products (Chabrol and Muchnik, 2011). Literature reveals that consumers are willing to pay more when provided

with detailed information about a product's attributes, especially regarding environmental or production practices (Lusk et al., 2004; Daunfeldt and Rudholm, 2014). Additionally, Fenger et al. (2015) state that the availability of clear and comprehensive information significantly reduces uncertainty about a product's value, thus increasing willingness to pay. Consumer preference for EVOO frequently investigates consumer characteristics and the importance of various product attributes (Dekhili et al., 2011; Erraach et al., 2014; Krystallis and Ness, 2005; Tsakiridou et al., 2006; Yangui et al., 2016). Some studies employ both experimental and qualitative methods, with real choice experiments (RCEs) being a popular approach for eliciting consumer preferences (Bazzani et al., 2017; Papoutsi, 2023). Unlike hypothetical choice experiments, which may overestimate willingness to pay, RCEs require consumers to commit to their stated choices, providing more accurate insights (Lusk and Schroeder, 2004). Indeed, real-world purchasing decisions are dynamic and influenced by factors such as the option to delay or withhold transactions, further underscoring the need for authentic experimental settings (Bazzani et al., 2017).

2. Materials and methods

A Real Choice Experiment (RCE) is applied to this study to investigate consumers' preferences for organic and GI EVOO. The experiment was set up in a Montpellier (city in the olive-producing region Occitanie in the south of France) specialty food shop. From data obtained by RCE, a multinomial logit model (MNL) has been applied. As the study aimed to demonstrate the influence of information about biodiversity on consumer preference, we focused on the effect of the information using a between-sample design, randomly assigning respondents to a treatment group and a control group.

2.1. Sample recruitment and survey procedure

The study was conducted from October to December 2017 in a specialized origin food shop (Epicerie fine de terroir), where consumers were recruited. We chose the specialized origin food shop as the product used in RCE is a high-quality product, with a high price range, and the target group was people frequenting such shops.

The first two weeks were dedicated to the preparation phase, which involved several key activities. This included getting to know the shop, its products, and the type of clientele, as well as negotiating with the shop owner, who was willing to transform his commercial space into a sort of "economic lab in the field" but wanted to ensure that our presence and RCE would not bother the clientele. Additionally, we refined the survey vocabulary in collaboration with the shop owner and conducted trial interviews with friends and family to demonstrate the friendliness of the approach to consumers.

The final "test" and the approval of the shop owner to set the RCE was an encounter with his wife who acted "undercover" as a random consumer in the shop. We conducted the survey in person using a Computer-Assisted Personal Interviewing (CAPI) approach, facilitated by the Qualtrics platform (Qualtrics, Provo, UT). The survey was conducted on a tablet connected to the Internet, ensuring real-time data collection and efficient interview management. No personal data was collected during the survey to ensure participants' anonymity and privacy. The shop owner informed the clients from his mailing list about the experiment and displayed a poster about it at the front door of the shop. At the shop, we used the convenience sampling mall intercept method to recruit consumers.

We asked consumers to participate in the survey voluntarily, following two phases of exclusion/recruitment criteria.

First, we asked about their frequency of olive oil consumption, and if the potential participant did not consume olive oil, the interview ended.

Second, we asked for the acceptance of consumers to participate in the survey after a detailed explanation of experimental procedures, and the reasons why it is obligatory to purchase the product selected as a preferred one.

We interviewed a total of 102 consumers. Around half of the sample (49 consumers) was provided with information about the beneficial influence of geographical indications on biodiversity. The surveys were conducted in the French language and each survey lasted an average of 12 min. Table 1 represents the summarized socio-demographic characteristics of the sample (see Fig. 1).

Table 1 shows a predominance of male (72.55%) and young participants (20–30 years) compared to female (27.45%) and participants over 60 years old (23.53%). Most participants categorize themselves into economic categories that report being able to afford some luxury (50.98%) or having no economic issues (31.37%), which aligns with a target audience interested in high-quality products. Regarding preferred places to purchase olive oil, 52.94% choose supermarkets, but a notable share prefers specialty shops (19.61%) or direct producers (13.73%). Fig. 2 visually illustrates the number of participants based on their preferred olive oil purchasing outlets: directly from the producer, specialized shop, supermarket, online, or other.

Later, we asked a set of questions about the existing knowledge of agricultural biodiversity, and the agricultural biodiversity of olive groves, considering Santilli's (2012) definition of agrobiodiversity (definition 1) as follows:

"Agrobiodiversity consists of a diversity of species of cultivated plants (interspecific diversity), different varieties (intraspecific or genetic diversity), and the diversity of agroecosystems or cultivated ecosystems. Since agriculture is a human activity affecting biodiversity, local knowledge and culture are also considered integral parts of agrobiodiversity".

To understand surveyed consumers' knowledge and awareness of varieties, we asked participants to indicate which of the 20 proposed olive varieties they recognized by name. Table 2 shows the list of varieties we proposed for recognition, representing the list of authorized varieties for the GI of olive oil PDO Nimes.

Since we wanted to know the influence of information about biodiversity on consumer preference, we used a between-subject design, based on the random assignment of the respondents to the control group or the treatment group.

The Control group participant had no additional information other than the information provided on the label. The Treatment group participant received additional information about GI being beneficial for biodiversity before starting the RCE. We explained biodiversity to the participants as follows:

Biodiversity, as the totality of living beings, their genetic heritage

Table 1
Socio-demographic characteristics of the sample.

Socio-demographic characteristic	%
Category of sex	
Male	72,55
Female	27,45
Age group	
20–30	26,47
31–40	20,59
41–50	14,71
51–60	12,75
>60	23,53
Self-described economic category of the participant	**%**
Have to be very careful about what they spend, and sometimes their income is not enough for the necessary purchases	12,75
They can sometimes afford a little luxury	50,98
They have no economic problems and when they want to buy something they do it	31,37
Preferred place to purchase olive oil	**%**
Directly from the producer	13,73
In a specialized shop	19,61
In a supermarket	52,94
Online	1,96
Other	11,76

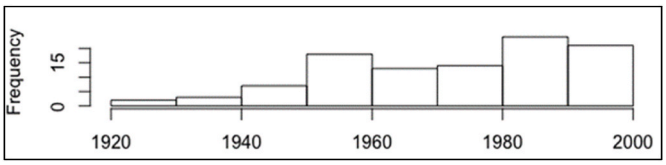


Fig. 1. Frequencies of participants' decade of birth.

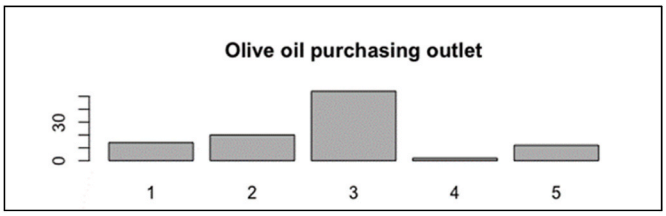


Fig. 2. Number of participants for each olive oil purchasing outlet - 1. Directly from the producer - 2. Specialized shop - 3. Supermarket - 4. Online - 5. Other.

Table 2
Lists of varieties native to the south of France.

1. Picholine	6. Groussaldo	11. Olivastre	16. Lucques
2. Negrette	7. Aglandau	12. Broutignan	17. Oliviere
3. Noirette	8. Amelau	13. Vermillau	18. Menudel
4. Sauzen vert	9. Pigalle	14. Cul blanc	19. Clermontaise
5. Rougette	10. Piquette	15. Verdale de l'Herault	20. Pignan

and the ecological complexes in which they evolve, cannot exist without the practices and knowledge developed by the societies that create, maintain, or reduce it. Protecting geographical origin can help to take account of this cultural biodiversity, and even reactivate it. To do this, it is essential to consider not only the "characteristics" of the product but also its characteristics and production methods.

Finally, we invited each consumer to taste the four types of olive oil predisposed for the RCE.

2.2. Real choice experiment: product and attribute selection

Based on the aim of the study, we applied price, GI label, and Organic Label as attributes and each of them has its levels, as demonstrated in Table 3.

Following, Table 4 shows the olive oil types selected for the RCE: olive oil without any EU quality label, olive oil with a GI label, olive oil with an organic label, and olive oil with both GI and organic labels.

The attributes "Organic label" and "GI label" were binary: with or without a label. The price attribute had four levels: €11, €13, €15, and €17, based on market prices of similar products. However, we had to consider a constraint imposed by the producer, who required that the product not be offered at a price lower than the retail price at their facility and website. As a result, in the choice experiment, organic olive oil was priced at €15 or €17, while GI olive oil was priced at €13 or €17. Specifically, olive oil with both labels was priced at €17 per liter, reflecting its premium positioning in the market. This constraint placed the price attribute in a higher range. To account for these conditions

Table 3
Attributes and levels.

Attributes	Levels
Price (€/l)	11 €/l - 13 €/l - 17 €/l
GI label	With – Without
Organic label	With – Without

Table 4
Product selection.

Product	Price	GI Label	Organic Label
A	11 €/l	Without	Without
B	13 €/l	With	Without
C	15 €/l	Without	With
D	17 €/l	With	With

while maintaining the efficiency of the experimental design, we used Ngene software (Choice Metrics, 2018). We conducted two pilot studies to collect preliminary data and estimate the priors, representing participants' approximate preference patterns. These priors were then input into the Ngene software to refine the design, optimizing it for the main study. The design we chose as a final version has the following efficiency measurements, shown in Table 5. The final design achieves a D-optimality of 68.22%, indicating it is reasonably efficient, with a low D-error (0.6179) reflecting precise parameter estimation. However, the A-error (1.8991) and high S-estimate (47.7925) suggest some variability, which may warrant refinement depending on study requirements.

In the final design, participants were presented with 12 choice tasks during the experiment. Each task consisted of three olive oil options or bottles (Fig. 3) and a "no choice" option. The bottles varied based on price (set at €11, €13, €15, or €17), and options that included olive oil bottles featuring both the GI and organic labels, either one of the labels or none. Aside from these price attributes and labels, all products were identical in quality and other characteristics: locally produced in the region, high-quality, and with consistent production standards. Indeed, this study used four types of olive oil by the same producer, a family farm and mill situated in the Herault department of the Languedoc region.

2.3. Econometric specifications

For analyzing the data from the RCE, we used the multinomial logit model (MNL).

Using MNL, we assumed that consumer preferences are homogeneous and independent of irrelevant alternatives.

In the first phase of the analysis, we included only the choice data in the model, and in the second phase of the analysis, we included the choice data and the treatment data in the model. In the first phase, the model focused solely on participants' choice data, while the second phase expanded the analysis by incorporating both choice data and additional treatment-related variables to capture their combined effects.

The RCE data was modeled following the random utility theory (McFadden, 1986) according to which the choice behavior is affected by the utility in a way that the decision maker chooses among different product alternatives, the one alternative which provides the greatest relative utility. The utility provided by the product alternative j is not directly observable and is a sum of two components.

$$Unj = Vnj + \varepsilon nj$$

Vnj – representative component of utility, a function of observed variables; εnj – random error term, unobserved factors that affect the choice.

Lancaster's theory (Lancaster, 1966) of consumer choice defines the observable utility component Vnj as a function of its attributes. The utility function is a function of the price, the non-price attributes and the

Table 5
Efficiency measurements.

D error	0,6179
A error	1,8991
B estimate	3,5976
S estimate	47,7925
D optimality	68,22%

Fig. 3. Example of the choice task.

unobserved factors.

Accordingly, in this study application, the model is specified as follows:

$$Unj = \beta 0 + \beta 1 price + \beta 2 organic + \beta 3 GI + \varepsilon nj$$

We analyzed the data from the survey using R (and R studio as an interface) and the package mlogit (Croissant, 2020; R Core Team, 2020).

In the first phase, for choice model estimation (Model 1), we used the mlogit discrete choice model, with the following syntax:

$$CHOICE \sim price + GI + org + GI * org$$

where CHOICE is the dependent variable on the left-end side of the formula, while the independent variables are on the right-end side of the formula. Price is a continuous variable, while GI (for Geographical Indication) and org (for organic) are introduced as binary (dummy) variables.

This notation also allows to include the GI:org interactions. For the multinomial variables, one of the existing options is excluded to serve as a baseline. Only the differs in utilities are considered to identify the best fitting choice model, as for decision-making about the choice only differences in utility matter, meaning that the only relevant estimation is the difference of the parameters estimated not their absolute levels (Train, 2009).

In the second phase, for the choice model estimation, including the treatments (Model 2), we used the mlogit discrete choice model with the following syntax:

$$\text{the CHOICE} \sim price + GI + org + GI : GItreat + GI : org + GI : org : GItreat$$

where CHOICE is the dependent variable on the left-end side of the formula. On the right side of the formula are the independent variables.

GI:GItreat is the interaction term between the variables GI and GItreat, which gives the estimation for the utility of GI under the treatment group. GI:org is the interaction term between the variables GI and org, which gives the estimation for the joint utility of GI and organic. Finally, GI:org:GItreat is the interaction term between the variables GI, org and GItreat, which gives the estimation for the utility of both organic and GI under the treatment.

3. Results

Each created model contains 1224 observations based on responses of 102 individuals, performing 12 choice tasks each. Every choice task included four alternatives (including the no-choice alternative), for a total of 4896 choices. Table 6 represents the estimates of Model 1 "MNL model with only the product attributes" and the estimates of Model 2 "MNL model including treatments". Model 1 is the basic estimation that accounts for the heterogeneity of consumers' preferences and correlation across taste parameters. Model 2 is the estimation that accounts for the treatment. It has to be taken into account that the overperformance of the model is fairly low, due to the constraints of RCE, and therefore cannot be used for prediction purposes. However, exploring the interactions between y variables are importante.

The alternative specific constants (ALT 2, ALT 3, ALT 4) are estimated to indicate the utility of each option relative to the first option and to highlight the difference in preference with the "no buy" (ALT4) option. As expected, the ASC estimates for ALT2 and ALT3 are not significant since the characteristics of the product for these alternatives are randomly assigned by the software. As the estimate for ALT4 (the no-buy option) is negative and significant, thus people perceive a higher utility when obtaining the product rather than when not having it. This indicates that the respondents perceive the product itself (high-quality EVOO) as having value.

As expected, the coefficient for the price is negative, which indicates that the price increase will decrease consumers' utility and lower the likelihood of purchase. The coefficients for GI label and organic label are positive, indicating that the utility is higher with the presence of the label. The estimate for interaction between GI and organic is negative and significant at the 0.01 level. This means that the utility of products, which are labelled with both GI and organic labels, is not simply the sum of individual utilities for GI and organic labels, but rather less, thus confirming that these two concepts partially overlap and are perceived as substitutes by consumers.

The estimate for the interaction between GI, organic, and treatment is negative and significant at the 0.001 level. This suggests that biodiversity information reduces the perceived complementarity between GI and organic labels, indicating that consumers may view these attributes as partially substitutable when biodiversity benefits are explicitly highlighted. The estimate for interaction between the GI and organic (−0.197196) and the estimate for interaction between GI, organic, and treatment (−0.352171) suggest that the GI label and organic label might be substitutes, and even more so if the GI label is accompanied with the information about biodiversity.

4. Discussion and conclusions

The purpose of this paper was to examine the consumer preference EVOO labelled with GI when accompanied by positive information regarding biodiversity. GI is more than a cultural heritage marker or a market differentiation tool. Indeed, it can also play a central role in sustaining biodiversity-rich ecosystems (Milano and Cazella, 2021). The introduction of a new GI policy framework encourages producers to adopt sustainable agricultural practices, and for the first time, biodiversity has been explicitly introduced into EU regulation on GI as follows:

Sustainability practices should contribute to one or more environmental, social, or economic objectives. The environmental objectives should include … the preservation of biodiversity, the conservation of rare seeds, local breeds and plant varieties … [1]

This new policy framework follows Belletti et al. (2015). Indeed, they proposed that integrating GI with environmental concerns holds promise for enhancing the value of GI products in the market. Moreover, they advocated for a shift not only towards individual producers

[1] REGULATION (EU) 2024/1143 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 April 2024 on geographical indications for wine, spirit drinks and agricultural products, as well as traditional specialities guaranteed and optional quality terms for agricultural products, amending Regulations (EU) No 1308/2013, (EU) 2019/787 and (EU) 2019/1753 and repealing Regulation (EU) No 1151/2012.

Table 6
MNL from model 1 and model 2.

Model			Model 1 (MNL with only the product attributes)			Model 2 (MNL including treatments)		
Coefficients	Estimate	Std, Error	z-value	Pr(>|z|)	Estimate	Std. Error	z-value	Pr(>|z|)
ALT 2	−0,1946	0,1535	−12,682	0,2047	−0,1943	0,1537	−12645	0,206
ALT 3	0,0958	0,1469	0,6523	0,5142	0,0960	0,1472	0,6525	0,5141
ALT 4	−2,769,992	0,7495	−36,957	0,0002 ***	−27,657	0,7511	−36821	0,0002 ***
Price	−0,3463	0,0513	−67,542	1,436e-11 ***	−0,3475	0,0514	67625	−1,356e-11 ***
GI	0,5429	0,0753	72,130	5,471e-13 ***	0,4273	0,1017	42055	2,605e-05 ***
Organic	10,238	0,0993	103,120	<2,2e-16 ***	10,441	0,1005	103858	<2,2e-16 ***
GI:organic	−0,3749	0,0727	−51,598	2,472e-07 ***	−0,1972	0,0982	−20079	0,0447**
GI:treatment					0,2295	0,1362	16851	0,0920*
GI:organic:treatment					−0,3522	0,1310	−26877	0,0072 ***

adopting additional environmental practices for GI but also for revising product specifications to incorporate environmentally friendly attributes.

The integration of sustainable production management into GI leads back to the possibility of integrating organic farming principles into GI production, considering that both organic certification and GI are associated with traditional agricultural practices.

Some studies showed how consumers consider both GI and organic labels as indicators of quality (Scarpa and Del Giudice, 2004; Becker, 2009; Aprile et al., 2012; De Magistris and Gracia, 2016; Roselli et al., 2018; Di Vita et al., 2013; Ceccacci et al., 2024) and, in a way, these two labels might be partial substitutes. For instance, a study on olive oil (Roselli et al., 2018; Erraach et al., 2021; Carzedda et al., 2021) found a correlation in using the two types of certifications. In the study conducted by Wongprawmas et al. (2012), marketing researchers proposed the integration of GI labels with organic labels. Vandecandelaere et al. (2009) suggest that combining GI label and organic label might be a good strategy for market positioning for new GI. Liberatore et al. (2018) did not find environmental aspects to play a fundamental role in increasing willingness to pay for olive oil, the increase of WTP for olive oil was due to nutritional and health aspects. In a study about preferences for sustainability-related labels in olive oil, Erraach et al. (2017) consider the organic label to tackle the environmental dimension of sustainability and GI label to tackle the social dimension of sustainability.

In this research, the interaction between the GI label and organic label has been tested with a focus on the biodiversity role. According to the results, the utility of products labelled with both GI and organic labels is not simply the sum of the individual utilities for GI and organic, but rather less. Hence, the GI label and organic label might be considered partial substitutes, and even more so if the GI label comes with information about biodiversity.

Belletti et al. (2015) suggested a multi-attribute approach to strengthening the marketing strategy of GI, particularly by integrating environmental attributes into the differentiation strategy. This study contributes to their recommendation by demonstrating how incorporating biodiversity information into the narrative of GI-labelled products enhances their perceived value. Specifically, the findings show that consumers provided with biodiversity-related information perceive greater utility in products with GI labels, which aligns with Belletti et al.'s perspective that environmental attributes can bolster the market differentiation of GI products. Moreover, this supports the idea that biodiversity messaging can serve as a practical tool for engaging environmentally conscious consumers and increasing willingness to pay for GI-labelled products. Thus, this work focused on how the narration of biodiversity can affect consumers' choice of purchase. Fenger et al. (2015) demonstrate that providing consumers with information through storytelling elements can lead to heightened interest, offering a practical implication of utilizing this approach to expand the reach of potential customers. According to the study's result, promoting the value of products bearing GI by incorporating information about biodiversity into the narrative and communication to consumers through storytelling could be an effective strategy. The results show that the consumers who read the information about GI being beneficial for biodiversity perceive a higher utility of GI and a higher likelihood of purchasing EVOO with a GI label. Our findings suggest that Geographical Indication (GI) and organic labels are perceived as substitutes rather than complementary by consumers, so we recommend that stakeholders carefully consider the added value of using both labels simultaneously.

Information about biodiversity could be translated into valuable and practical tool for EVOO producers who are interested in market differentiation of their GI olive oil products, and improvement of communication of their product to the consumers. Especially for the French producers who are seeking quality rather than quantity, evidence about the importance of information about biodiversity as an added value for consumers represents an interesting implication. In this sense, producers while contributing to environmental preservation, can strengthen the market appeal of their GI products. Producers could then embrace a shift in communicating biodiversity benefits to attract consumers and make them more environmentally conscious. This study could serve to encourage producers to join the sustainability voluntary scheme under the new GI EU Regulation, given the increasing interest shown by consumers in GI and their efforts and benefits in the conservation of biodiversity and sustainable production. At the same time, the study provides further evidence to policymakers on the crucial role of biodiversity in the GIsystem and encourages them to promote the inclusion of biodiversity communication in GIsustainability reports under Regulation (EU) 2024/1143, thereby enhancing consumer awareness and supporting sustainable production practices.

5. Limitations and future research

The study faced several challenges and limitations. Being a Real Choice Experiment (RCE) set in a real shop, the sample was not purposefully selected, leading to an imbalance between men and women in the sample, with a higher percentage of men. This, however, could reflect the fact that, in that shop, the main customers were predominantly men. People were not comfortable with the RCE setting in which they would finish the experiment by buying something as if they felt obliged to buy. Explaining the rules of the RCE in French proved to be a challenging task, compounded by the requirement that participants would only purchase a product if they expressed a desire to do so. However, the research could serve as a preliminary study for defining a conceptual framework for further investigations regarding the link between biodiversity, included in the broader concept of environment, and geographical indications in consumer research.

Future studies could incorporate sensory tests as separate components or alongside the choice experiment which influenced the choices of certain participants. In instances where participants did not find any of the oils palatable, they consistently opted for the "no buy" final option of the experiment. It may be recommended to incorporate the sensory consumer test concurrently with the choice experiment to gauge how consumers' preferences are influenced by the taste of olive oil as one of the attributes. Despite the limitations, this research indicates that

consumers' preference for products with GI is positively affected when presented in association with information about biodiversity. Therefore, including information on biodiversity for GI products may be a useful marketing strategy for producers who are inclined towards environmentally respectful production.

The temporal distance between the time when the RCE was conducted and the present day, however, should not be seen as a limitation. Indeed, research applying real choice experiments for high-quality products such as EVOO is still limited, especially regarding biodiversity and GI. This study fills an ongoing gap in the literature on consumer preferences. Although the data were collected in 2017, the importance of sustainability, and specially biodiversity in consumer perception has become increasingly central in contemporary context, as evidenced by regulatory developments, and growing consumer interest in environmentally respectful practices.

Further research could explore whether the findings of this study extend to other products with both GI and organic certifications for other high-value agricultural goods. Investigating consumer preferences in different geographic or cultural contexts could also provide valuable insights. This approach would improve the understanding of how biodiversity-related information and the interaction between certifications apply across diverse markets and product categories, offering broader implications for producers and policymakers.

CRediT authorship contribution statement

Ivana Radić Jean: Writing – review & editing, Writing – original draft, Validation, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Maurizio Canavari:** Validation, Supervision, Software, Methodology, Formal analysis, Data curation, Conceptualization. **Claire Cerdan:** Supervision, Resources, Project administration, Funding acquisition. **Federica Consentino:** Writing – review & editing, Visualization, Investigation. **Iuri Peri:** Writing – review & editing, Validation, Supervision, Project administration, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

Our deepest thanks and warmest thoughts go to the memory of Professor and dear friend Maurizio Canavari, who left us far too soon. It was truly a privilege to work with him. His remarkable contributions to research will never be forgotten.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jclepro.2025.145121.

Data availability

Data will be made available on request.

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