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Eliciting Consumers' Health Consciousness and Price-Related Determinants for Polyphenol-Enriched Olive Oil

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ABSTRACT

Several studies have evaluated consumer interest in olive oil as a functional food due to its multiple health benefits, but to date, no author has assessed consumers' additional premium price for a differentiated product enriched with its own polyphenols. This paper aims to investigate which predictors are related to health consciousness by assessing the willingness to pay an additional premium price for olive oil with functional properties. In addition, the study assesses how self-perceived nutritional knowledge affects price levels and interest in olive oil characteristics. The survey was carried out in Italy and the statistical analyses were conducted in two stages: the first adopted an econometric approach to evaluate which variables are related to the additional premium price for the product while in the second stage, inferential statistics were performed to obtain information on the role of self-perceived nutritional knowledge. Based on these outcomes, the prominent role of extrinsic characteristics, such as Geographical Indications (GIs), local attributes and health nutritional information emerged, reaffirming the strong link with the territory and health concerns of modern olive oil consumers. Finally, high self-perceived nutritional knowledge respondents were aware of the antioxidant properties of olive oil and registered the highest price thresholds.

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KEYWORD Consumers' knowledge; pricing threshold; antioxidant attributes; olive oil preferences; functional olive oil; ordered logit

1. Introduction

Our modern lifestyle has undergone significant changes influenced by rising incomes and consumer awareness (Guiné et al., 2020). There have been important developments involving the food industry, and even so-called traditional products have not been left behind. Indeed, innovation

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in this field serves to expand and strengthen the market share (Kühne et al., 2010; Sodano, 2002; Spina et al., 2021) in a context where the level of information can affect consumer behaviour (Cagnina et al., 2018; Vindigniet et al., 2022). At the same time, meaningful changes to people's conception of nutrition have also been observed. The current trend is for those foods that promote health and simultaneously reduce the risk of disease (Zanchini et al., 2022).

Consumers have been so interested in demanding high quality and highly differentiated olive oils (Di Vita et al., 2021a; Erraach et al., 2014; Roselli et al., 2018) that it has progressively become a multi-purpose product. A combination of habits, sensory, traditional, environmental and hedonistic motivation have been added to the nutritional properties of this product as drivers of consumer choices (Casini et al., 2014; Cavallo et al., 2018; Del Giudice et al., 2015; Peršurić, 2020; Polenzani et al., 2020). Concurrently, the product attractiveness of olive oil has grown as a result of its beneficial human health effects, due to its intrinsic biological properties, as shown by different medical studies (Gavahian et al., 2019; Pérez-Jiménez et al., 2007). In fact, olive oil contains several functional constituents, vitamins A, E, and K, minerals, such as calcium, magnesium, iron, and potassium, plus amino acids (Carzedda et al., 2021). It is also rich in monounsaturated fat and polyphenols and has many antioxidant properties (Martín-Peláez et al., 2013; Serreli & Deiana, 2018).

In this direction, it has been suggested that a diet rich in polyphenols over a long period is beneficial because of their antioxidant and anti-inflammatory characteristics, which help to reduce cancerous and cardiac diseases (Cicerale et al., 2012; Gorzynik-Debicka et al., 2018; Yamagata et al., 2015).

The high number of polyphenols of olive oil, together with vitamin E, act against oxidative stress remarkably, slowing cellular ageing down and reducing the development of several health issues. In addition, some researchers have increasingly been turning their attention to the enhanced level of polyphenols in food and their characteristics (Kelly et al., 2019; Silva & Pogačnik, 2020).

In that respect, the productive process of the olive oil industry is now targeting polyphenols when designing new health-giving products. The role of antioxidants for food habitual consumers has also been investigated (Ares et al., 2010; Markosyan et al., 2009; Zaikin & McCluskey, 2013).

Consequently, the consumers' responses to fresh and processed fruit enriched with antioxidants and consumer acceptance of agro-food products with naturally increased content of polyphenols have been investigated in several food products (Markosyan et al., 2009; Pappalardo et al., 2019; Roselli et al., 2020).

Generally, researchers have found a certain propensity towards polyphenols and antioxidant-enriched food products (Di Vita et al., 2020; Roselli et al., 2018). In a recent study, the acceptance of consumers for a differentiated olive oil with a higher content of polyphenols was tested and it was shown that small market niches may exist (Mattas & Tsakiridou, 2017) even if a higher content of polyphenols is due to the extraction by ultrasound technology (Roselli et al., 2020). In addition, current marketing tools, such as e-commerce, could help producers reach more consumers interested in the functional characteristics of olive oil (Borsellino et al., 2018).

However, several unsolved questions remain to be addressed, first and foremost the difficulty of quantifying consumer intention to purchase this product. Despite different studies that have explored healthy or functional olive oil, thus providing empirical evidence on consumers' nutritional knowledge (Di Vita et al., 2020; Gámbaro et al., 2013), no study has explored the contemporary association among the different levels of subjective knowledge and the willingness to pay an additional price for an olive oil with functional properties. In addition, even though earlier studies aimed at evaluating the attitudes of consumers towards an extra virgin olive oil with a higher quantity of natural polyphenols obtained through ultrasound extraction (Roselli et al., 2020), no study has evaluated the willingness to buy an enriched one.

Therefore, this study focuses on the evaluation of consumers' additional premium for an extra virgin olive oil (EVOO) enriched with its phenolic compounds. When there is a total phenol content of at least 500 mg/kg, olive oil can bear health claims on the food label. Therefore, the olive oil containing less than 5 mg of hydroxytyrosol and its derivatives per 20 g of product, has to be considered as standard (Commission Regulation EU, 432/2012).

Compared to an EVOO with a high phenol content, a new product based on phenol-enrichment has shown a higher absorption of polyphenols by the body, resulting in greater health benefits (Artajo et al., 2006; Rubió et al., 2012). An EVOO enriched in such compounds has also enhanced antioxidant and anti-inflammatory properties (Silva et al., 2015).

The remaining part of the paper is organized into five different sections. The first presents a short compendium of research background on consumer trends towards functional and healthier olive oil, thus presenting the aims and research questions. The second section includes the research design and the methodological aspects of the survey. The third part of the paper shows the main results deriving from the ordered logit analysis, while the fourth section discusses the main outcomes by linking them with the extant related literature. Finally, the last section synthesizes the main findings of the study by presenting the implications and limitations of the research.

2. Research background

2.1. Literature

The present study originates from the current literature based on consumer acceptance of a functional and healthy olive oil. Although several theoretical insights and contributions have been provided, the interrelationships between olive oil attributes and consumer beliefs from a health perspective remain widely unexplored. Consequently, this study was developed taking into account three different lines of investigation linked to sensory attributes, consumer beliefs and habits, and the extrinsic characteristics of olive oil.

2.1.1. Sensory evaluation of olive oil consumers

Consumer preferences for olive oil embrace a complex set of perceived sensory qualities. Among these, the most required include organoleptic attributes such as taste, acidity, colour and aroma (Peršurić, 2020; Sayadi et al., 2017).

Once, consumers tolerated an imbalance in flavour, as long as the product had health-giving benefits. In fact, it was often believed that an unpleasant-tasting product must be good for your own well-being (Lesschaeve & Noble, 2005). However, now consumers are looking for both pleasant-tasting food and health-giving benefits.

The sensory properties of EVOO are also affected by the polyphenol content. This is interesting because a belief in health properties can be changed into a sensory experience (Roselli et al., 2017). Indeed, while the consumers cannot exactly appraise most of the product information on the label referring to properties, such as origin, extraction method, and organic process, they can verify the presence of polyphenols in the product by means of its bitter and pungent taste. The varying intensity of flavour is determined by the concentration of polyphenols that trigger our taste buds. In EVOO then, this sensory perception is linked to the phenolic compounds in them (Servili & Montedoro, 2002), and can have a clear, long-lasting aftereffect, whose intensity can vary greatly (Vitaglione et al., 2015).

Some evidence in the literature has argued that although consumers perceive the sensory characteristics of olive oils, they are unable to associate them with health-giving substances, such as polyphenols and recognize superior quality due to bioactive components (Barbieri et al., 2020; Santosa et al., 2013). As mentioned above, the presence of polyphenols adds a bitter and pungent characteristic to the product, while consumers seem to be more likely to prefer a sweeter taste (Delgado & Guinard, 2011; Recchia et al., 2012). However, a recent study on breadsticks fortified with phenolic-rich extracts from olive leaves showed consumers were more inclined to choose the enriched breadsticks (Conte et al., 2021).

2.1.2. Consumers beliefs and habits towards healthy olive oil

Research on olive oil consumer behaviour has demonstrated how personality traits greatly affect consumer choices (Yangui et al., 2016), thus indicating how attitudes can be deemed as predictors of purchase decisions (Polenzani et al., 2020).

Throughout the process of choosing and consuming olive oil, beliefs assume crucial importance, and in particular, the literature has found that healthiness drives the olive oil buying decision of a certain segment of consumers since quality seekers are aware of olive oil's health benefits (Chrysochou et al., 2022).

Studies have indicated that the consumers' preference for a healthier olive oil is based on their nutritional knowledge (Santosa et al., 2013; Santosa & Guinard, 2011). Indeed, this individual knowledge influences the choices they make according to their beliefs, which in turn are connected to their education, profession, and degree of health awareness, the information at their disposal, their lifestyle and natural curiosity. A recent study underlined that individual knowledge concerning functional olive oil is greatly influenced by different qualities, and as a result, the same product label may bear different health indications for more and less knowledgeable consumers (Di Vita et al., 2020).

In addition, nutrition and health-giving claims are utilized on food packaging in order to raise consumer awareness as regards making healthy food choices and boost a healthy diet (Karelakis et al., 2020).

2.1.3. Extrinsic characteristics of olive oils

The role of extrinsic characteristics in olive oil choices has been widely explored. Within this complex and heterogeneous category of attributes, consumers attach importance to credence attributes, such as production methods and country or region of origin, as well as other extrinsic cues like price and brand (Ballco & Gracia, 2020; Di Vita et al., 2021b; Del Giudice et al., 2015)

Many researchers have emphasized the importance of certified geographical origin as the driving force behind consumer behaviour (Caporale et al., 2006; Panzone et al., 2016). Roselli et al. (2020) consider the origin of the product a decisive factor because of its multi-faceted nature, involving the concepts of typical, safe, and traceable (Menapace et al., 2011; Van der Lans et al., 2001).

The literature indicates that Geographical Indications (GIs), such as Protected Designations of Origin (PDO) and Protected Geographical Indications (PGIs) labels, positively influence the choices of the olive oil consumers (Scarpa & Del Giudice, 2004), who are willing to pay more for them. Moreover, a particular aspect is linked to the high polyphenol content in the PDO Italian EVOOs (Caporaso et al., 2015).

The GIs, along with the local attributes, allow firms to differentiate their production in the consumers' eye. It has also been observed that these labels provide consumers with different utilities since there exists a trade-off among them (Di Vita et al., 2021a), and only rarely olive oil consumers tend to make an association between these labels (Cacchiarelli et al., 2016). In fact, while consumers show a positive WTP for local origins, this does not always occur for PDO olive oil (Ballco & Gracia, 2020). Consequently, even locally produced olive oil generates high-quality expectations since consumers view it as a high-end product and usually display a greater willingness to purchase (Di Vita et al., 2021b, Perito et al., 2019).

As far as brand is concerned, it is generally conceived as less important than other attributes (De Gennaro et al., 2021). Nevertheless, a recent study revealed the importance of brand and private label for a certain segment of consumers who prefer mild-tasting olive oils and buy mainly at large retail stores (Di Vita et al., 2021b). It is a determining factor in the success of a firm's strategy as it conveys additional information about the quality of the product (Dekhili et al., 2011; Del Giudice et al., 2015; Duquenne & Vlontzos, 2012). For all these reasons, brand was also included in our survey.

Finally, the role of price has been widely emphasized in the literature on olive oil consumer preferences and behaviour. It represents a key driver of olive oil consumption in traditional as well as international markets (Chrysochou et al., 2022; Mtimet et al., 2011). Price seems to be more important than other credence attributes, such as the certification of origin, organic method and local production, and it still represents an essential quality cue (Del Giudice et al., 2015, Di Vita et al., 2021a).

2.2. Aims and research questions

In light of previous literature, for the first time, this study sheds light on price-related determinants for olive oil with functional properties by trying to evaluate how consumers react based on their nutritional knowledge. Hence, to fill the aforementioned gap in the literature, the first objective of this study is to provide further insights on functional olive oil by exploring the willingness to pay an additional premium for a polyphenol-enriched olive oil, thus investigating in-depth whether and to what extent olive oil attributes and consumer beliefs influence additional price-levels. In addition, this paper aims to assess possible differences based on knowledge. Consumers were grouped according to their own nutritional knowledge about olive oil properties. Therefore, these objectives can be synthesized in the following research questions:

R1) Are consumers interested in antioxidant-enriched olive oil and eventually willing to spend an additional price premium when purchasing it?"

R2) Which olive oil attributes positively influence the intention to pay more for an olive oil with functional properties?

R3) Is there a relationship between consumer beliefs and willingness to pay an additional premium price for a polyphenol-enriched olive oil?

R4) Do socio-demographic characteristics play a role in consumer preferences for a polyphenol-enriched olive oil?

R5) Does self-perceived nutritional knowledge influence additional price levels for polyphenols-enriched olive oil?

3. Methodology

3.1. Data collection

Data was gathered using a multi-section survey that was administered by trained interviews using the face-to-face method. To collect a sample that would capture possible differences in terms of consumption and attitude across the regions of Italy, the interviews were carried out in different metropolitan cities using the same questionnaire. In particular, in southern Italy, the survey was conducted in the city of Reggio Calabria, where a total of 374 questionnaires were gathered. In northern Italy, two cities were selected; specifically, Milan and Turin, where a total of 287 questionnaires were collected. The administration of the questionnaire was conducted outside several large-scale retail shops and within farmers' markets. The selection of the respondents, which was carried out through random walk recruitment (Annunziata & Vecchio, 2013), lead to the collection of a convenience sample. The use of a convenience sample implies caution in generalising the results but is accepted in the literature because the reliability of the results is not prejudiced, particularly when the population is large and randomization is not possible (Etikan et al., 2016). To collect a reliable sample and thus consistent answers, the interviewers checked the respondents' actual involvement in extra virgin olive oil purchases (Di Vita et al., 2021a).

Before administering the final survey, two preliminary steps were conducted: a focus group and a pilot survey (Timpanaro et al., 2013). The first preliminary phase was addressed to identify the main issues related to olive oil consumption and differentiation and the main predictors of consumer behaviour towards a polyphenol-enriched olive oil. During the focus group, a first version of the survey was developed by debating with entrepreneurs, food technologists and stakeholders in the olive oil sector. The second preliminary step was related to and subsequent to the first; in fact, the pilot survey was necessary to test the draft questionnaire and verify the effectiveness of the questions. Once the pilot survey was concluded, a tree section survey was obtained as

follows: I) general characteristics of olive oil consumption where binary questions and multi-choice questions were included; II) beliefs related to intrinsic, extrinsic and healthy properties of olive oil investigated using seven-point Likert scale; III) socio-demographic features of the sample investigated with binary and multi-choice questions. Plus, the socio-demographics have been included in the survey because they are needed to characterize consumers and can be considered strong predictors of consumer behaviour (Symmank et al., 2017).

Based on current literature (Pedret et al., 2018) and the focus group discussions, the product was presented to the respondents in order to verify their interest in terms of an additional premium price for an extra virgin olive oil enriched with its own phenolics (500 mg total phenols/kg).

Since the aim of the study was to explore what moves consumers towards high-polyphenol olive oil, an additional question was included in the survey. Specifically, the question was: *“How much are you willing to pay an additional premium price (APP) for an olive oil with a high polyphenol content? The amount of phenolic compound in this product is 500 mg total phenols/kg”*. The base product on which the effect of high polyphenol content in terms of APP was assessed, was an Italian extra virgin olive oil. The starting price was detected through a market survey. In this respect, direct observations of the most recognized brands were carried out in large retail stores and supermarkets, covering both areas of investigation (Di Vita et al., 2021b). This step allowed us to identify the average price to be presented to consumers during the interviews, which was 7.00 €/litre.

The answer included five alternatives: not willing to pay an APP; willing to pay up to 10% more than conventional olive oil; willing to pay from 10% to 20% more than conventional olive oil; willing to pay from 20% to 30% more than conventional olive oil; more than 30%.

Data collection resulted in 661 valid surveys as depicted in [Table 1](#) that show the main characteristics of respondents. Concerning the segmentation of age cohorts and the importance of household composition, more indications are needed. The groups indicated by Brosdahl & Carpenter (2011) were used. The authors divided respondents based on age in Millennials (1982–2000), Generation X (1961–1981); Baby Boomers (1943–1960) and Silent Generation (1925–1942). In the study, Millennials and respondents born in 2001 were merged in the category of younger generations; instead, Baby Boomers and Silent Generation are in the group of Older Generations. Focusing on household composition, this was considered as an ordinal categorical variable given that different numbers of members influence the purchasing process of food differently.

Table 1. Socio-demographic features of the sample (n = 661).

Variables	Categories	Frequency	Percent
Gender	Male	372	56.28
	Female	289	43.72
Age Cohort	Younger generations	255	38.58
	Generation X	339	51.29
Education	Older generations	67	10.14
	Elementary and middle school	167	25.26
	High School	286	43.27
	University	191	28.90
Household composition	PhD	17	2.57
	1–2 members	195	29.50
	3–4 members	350	52.95
	>4 members	116	17.55
Income	Up to 1500 €/month	158	23.90
	1501–3000 €/month	337	50.98
	3001–4000 €/month	109	16.49
	Over 4000 €/month	45	6.81
	No answer	12	1.82
BMI	Underweight	13	1.97
	Normal weight	381	57.64
	Overweight	209	31.62
	Obese	58	8.77
Origin	Southern Italy	374	56.58
	Northern Italy	287	43.42

3.2. Research design

The analysis was carried out in three different steps. The first one addressed the 1st research question and was based on descriptive frequencies analysis concerning the willingness to pay for olive oil with functional properties. The second step was developed through the adoption of an econometric approach, by performing an order logit regression using the additional premium price as a dependent variable to explore and address the 2nd, 3rd and 4th research questions. Finally, the third step was conducted using an inferential approach to answer the 5th research question. This evaluation was carried out by segmenting the sample in two sub-samples, on the basis of self-perceived nutritional knowledge related to properties and antioxidant compounds, thus relating the frequency distribution with the additional premium price, olive oil attributes and consumer beliefs. To investigate self-perceived nutritional knowledge, the following single item (on a 7-point Likert scale) was adopted: *“How high do you think your level of knowledge of the properties and antioxidant compounds of olive oil is?”*

3.3. Econometric model

The evaluation of the willingness to pay for a polyphenol-enriched olive oil was carried out using an ordered logistic regression since the dependent variable was expressed as a categorical Additional Premium Price (APP) in five

alternatives. The ordered logistic model is specific for ordinal outcomes and can be considered as a latent variable model where the original categorical variable (Y) is a function of a single continuous latent variable (Y^*) used to deal with the discrete alternatives of the Y variable (D'Amico et al., 2016; Rabe-Hesketh & Skrondal, 2008; Wooldridge, 2016). Based on these considerations, the latent model can be written as follows (1):

$$Y_i^* = \alpha \text{Regressor}_i + \beta \text{Regressor}_i + \dots \dots \sigma \text{Regressor}_n + \varepsilon_i \quad (1)$$

The equation can be simplified by considering regressors as a vector of independent variables and related coefficients (2):

$$Y_i^* = X_i \beta + \varepsilon_i \quad (2)$$

In both equations Y_i^* indicate the latent and continuous variable and ε_i the vector of error terms, while in equation (2) X_i represents the vector of independent variables or regressors and β the vector of coefficients. A set of intercept terms are included in the model as cut points α_1 from α_{j-1} , where J represents the number of discrete alternatives, indicating the threshold for switching from one category of the original variable Y to another one (Williams & Quiroz, 2020). In this way, the latent variable and the observed variable Y are connected as follows (3; D'Amico et al., 2016):

$$Y_i = j \text{ if } \alpha_{j-1} < Y_i^* \leq \alpha_j \quad (3)$$

Where $j = 1$ to J and $\alpha_0 = -\infty$ and $\alpha_j = +\infty$

The method permits to address categorical variables, but some disadvantages occur. In fact, coefficients derived by ordered logit can be interpreted just in terms of the direction of the effects and qualitatively (Greene & Hensher, 2010). In order to solve these problems and obtain an outcome in terms of probability, the application of average marginal effects was carried out (Boes & Winkelmann, 2006).

A two-step variable selection was performed; the first was based on literature evaluation as shown in Table 2. This summarizes the variables used in the regression and their characteristics in terms of type and scale level. In addition, the following interaction terms were generated and adopted in the stepwise selection: Age cohort*BMI; Education*Gender; Education* BMI; Gender*BMI; Income*Education.

The first step was preliminary to the second and it was based on the statistical selection using the stepwise backward method (Di Vita et al., 2020). Starting from an original set of variables, represented by those in Table 2, the stepwise selection removes regressors generating the lowest inflation in the residual sum of squares (Derksen & Keselman, 1992) and leaving only significant variables (Setti et al., 2016).

Table 2. Variables selected in literature.

Categories	Variables	Type	References
Beliefs	Olive oil prevent cancer	Categorical (1–7)	Tripoli et al. (2005)
	Olive oil reduce oxidative stress	Categorical (1–7)	Lombardi et al. (2021)
Extrinsic attributes	Brand	Categorical (1–7)	Dekhili et al. (2011)
	Geographical Indications	Categorical (1–7)	Albayram et al. (2014)
	Health nutritional information	Categorical (1–7)	De Gennaro et al. (2021)
	Local olive oil	Categorical (1–7)	Perito et al. (2019)
	National Olive oil	Categorical (1–7)	Krystallis et al. (2008)
Intrinsic attributes	Blend of olive oils from EU	Categorical (1–7)	Krystallis et al. (2008)
	Bitter	Categorical (1–7)	Di Vita et al. (2021c)
	Spicy	Categorical (1–7)	Di Vita et al. (2021c)
Habits	Price paid	Categorical (1–4)	Dekhili et al. (2011)
	Olive oil uncooked	Categorical (1–7)	Di Vita et al. (2021c)
Socio-demographic	Age cohort	Categorical (1–7)	Ilak Peršurić (2020)
	BMI	Categorical (1–7)	Soriguer et al. (2009)
	Consumer's origin	Dummy	Ilak Peršurić (2020)
	Education	Categorical (1–4)	Yangui et al. 2016
	Household composition	Categorical (1–3)	Marakis et al. (2021)
	Gender	Dummy	Yangui et al. (2016)
	Income	Categorical (1–4)	Ilak Peršurić (2020)

The stepwise selection provided the final model used to describe which predictors affect consumers' willingness to pay an APP for a polyphenol-enriched olive oil. In this phase, the issue of multicollinearity among variables was addressed using the Variance Inflation Factor (VIF; Di Vita et al., 2022). The analysis was performed without interaction terms since interaction variables are naturally multicollinear (Mehmetoglu & Jakobsen, 2016) and by considering the model acceptable if the ratio $1/VIF$ is greater than 0.2 (Chen et al., 2019).

3.4. Inferential Tests based on self-perceived nutritional knowledge

Once variables that significantly affect the additional premium price for a polyphenol-enriched olive oil were found, other considerations using the chi-square inferential test have been made. Indeed, consumers' self-perceived nutritional knowledge of olive oil was evaluated using a single-item question (Bryła, 2020; La Barbera et al., 2016). The question was organized through a 7-point Likert scale, where 1 indicated that consumers perceived herself/himself unaware of the nutritional properties of olive oil, 7 otherwise. The mean score of self-perceived knowledge was obtained (2.27) and used to divide the sample into "high self-perceived knowledge" ($n = 249$) and "low self-perceived knowledge" ($n = 412$). Two groups were used to obtain insights related to the role of knowledge in the willingness to pay for polyphenol-enriched olive oil and to understand whether knowledge can affect consumers' perception of beliefs and extrinsic and intrinsic attributes of olive oil. The chi-square test was adopted to address these aspects because

it is used to verify the null hypothesis that the distribution of frequencies observed is random and thus the variables are independent. Otherwise, when the test is significant null hypothesis can be rejected to accept an alternative hypothesis indicating that a relationship among the variables exists (Franke et al., 2012).

4. Results

By observing the frequency distribution, derived from the stated willingness to pay an APP for polyphenol-enriched olive oil, we ascertain that consumers show a certain interest in such a product. In fact, fixed a starting price of 7.00 €/l, 46.2% of the respondents were willing to pay an additional premium-price of up to 10% (7.70 €/l), which represents the mode of frequency distribution. The second class, in terms of relative frequency, was not willing to pay, suggesting that healthy properties of olive oil can be considered as differentiation characteristics for the majority of consumers. Concerning the other options related to the additional premium price, the frequency distribution observed was the following: 10.3% of the consumers were willing to pay a premium price of 10% to 20% (7.70–8.40 €/l) more than conventional olive oil; 3.18% declared they are willing to pay an additional premium of between 20% and 30% (8.40–9.10 €/l) and finally, 1.5% more than 30% (> 9.10 €/l).

4.1. Econometric model on the whole sample

Switching on the results of the econometric model, Table 3 reports the variables selected by the stepwise backward selection. Among the original pool of variables, nine of them, plus an interaction term, were selected. The

Table 3. WTP as APP for a functional olive oil enriched in polyphenols.

Variables	Coefficient	p-Value
Age cohort	0.367	0.088
Health nutritional information	0.096	0.081
Local olive oil	0.070	0.029
Age*BMI	-0.125	0.047
Olive oil prevents cancer	0.093	0.023
Price paid for an extra virgin olive oil	0.444	0.000
Spiciness	0.086	0.032
Household composition	0.203	0.090
GI label	0.146	0.000
Blend of olive oils from the EU	-0.083	0.030
/cut1	2.544	
/cut2	4.958	
/cut3	6.346	
/cut4	7.566	
Goodness of fit	Mc Fadden r square	0.061
	Log likelihood	-702.363

Table 4. VIF analysis of the significant variables.

Variables	VIF	1/VIF
Age cohort	1.04	0.963
Health nutritional information	1.13	0.886
Local olive oil	1.32	0.758
Olive oil prevents cancer	1.17	0.854
Price paid for an extra virgin olive oil	1.17	0.856
Spiciness	1.13	0.883
Household composition	1.13	0.884
GI label	1.12	0.890
Blend of olive oils from the EU	1.32	0.759
Mean VIF	1.17	

validation of the regression, in terms of multicollinearity among independent variables, is provided in Table 4. Outcomes of the VIF analysis suggest that the level of collinearity between the variables can be considered acceptable as the 1/VIF ratios are above 0.2.

As regards socio-demographic predictors, the age cohort affects significantly the willingness to pay an APP for polyphenol-enriched olive oil, indicating that as the age of consumer increases, the additional premium price increases. Age cohort was significant also in interaction with BMI, thus providing deeper insight into the role of the predictor. When the role of age is combined with BMI, it is possible to observe that older consumers with higher BMI are less willing to pay for the product evaluated. The household composition was significant in the final model suggesting that families with children are more attentive to health aspects and are more willing to pay for the functional properties of olive oil. Moving on to the role of belief, the results suggest that people concerned with cancer disease are more interested in the polyphenol content of olive oil being more willing to pay for that component. Regarding the extrinsic characteristics of the product, several variables were observed to be significant, mainly related to information and olive oil origins. The model indicates that the importance attached by consumers to health nutritional information on the label positively affects the additional premium price for olive oil with functional properties, suggesting the potential role of claims displayed on the label. Information on the label is also important when GIs are included; in fact, a relation between certified olive oil and the functional component has been observed. Olive oil origin can also be related to functional properties; in fact, olive oils locally produced positively affect the willingness of consumers to pay an additional premium price. Conversely, those derived from a blend of olives coming from other EU countries are less valued by consumers, probably due to the lower quality of these raw materials and as such this negatively motivates the willingness to pay for a functional product.

Regarding the intrinsic attributes, the spiciness was selected by the stepwise process. Based on the interpretation of the coefficient, it is possible to indicate that consumers who consider important this attribute are more willing to pay for an olive oil enriched in polyphenol. Finally, the role of purchasing habits, in particular, the actual price paid for the product can be related to the functional property. Indeed, consumers who currently pay a higher price for extra virgin olive oil are also more interested in polyphenol content being more willing to pay for a differentiated product.

The findings of the ordered regression presented in [Table 3](#) were quantitatively described using average marginal effects depicted in [Table 5](#). In fact, as indicated in the methodology section, coefficients of ordered models provide just qualitative information related to the direction of the effect and the magnitude, while marginal effects are needed to describe the variation in probability based on the variation of independent variables. For example, marginal coefficients indicate that older people are more willing to pay an additional premium price: from 10% to 20% (3%) and from 20% to 30% (2.8%). The other coefficients are not significant, while an interesting information is provided by the negative coefficient for the class “not willing to pay”, suggesting that is less probably that older are unwilling to pay for functional properties (−7.7%). Another example related to interest in local olive oil suggests that consumers who consider important this attribute are more willing to pay up to 10% (almost 1% more) and between 10% and 20% (almost 1% more). The marginal effects for the other class are irrelevant, as they cannot be approximated to 1%. High marginal effects can be observed in the case of the price paid for extra virgin olive oil. In fact, consumers who pay a high price for the product are more likely to pay up to 10% more (3.8%), from 10% to 20% (3.5%), between 20% and 30% (1.3%) and more than 30% (almost 1% more). A strong negative effect occurs for the class “not willing to pay”: those who pay a high price for extra virgin olive oil are less likely (−9.3%) to be unwilling to pay for its functional properties.

Table 5. Average marginal effects for the significant variables obtained by the stepwise ordered logit.

Variables	Not willing to pay	Up to 10%	From 10 to 20%	From 20 to 30%	More than to 30%
Age cohort	−0.077*	0.030*	0.028*	0.011	0.005
Health nutritional information	−0.020*	0.008*	0.007*	0.002*	0.001
Local olive oil	−0.014**	0.006**	0.005**	0.002**	0.001*
Age*BMI	0.026**	−0.011**	−0.010**	−0.004*	−0.002*
Olive oil prevents cancer	−0.019**	0.008**	0.007**	0.002**	0.001*
Price paid for an extra virgin olive oil	−0.093***	0.038***	0.035***	0.013***	0.007***
Spiciness	−0.018*	0.008**	0.007**	0.003**	0.001*
Household composition	−0.043*	0.018*	0.016*	0.006	0.003
GI label	−0.030***	0.013***	0.011***	0.004***	0.002**
Blend of olive oils from the EU	0.017**	−0.007**	−0.006**	−0.002**	−0.001*

***, **, * = significance at 0.01, 0.05, and 0.10 levels, respectively

4.2. Inferential statistics based on self-perceived nutritional knowledge

As indicated in the methodology section, the role of consumers' self-perceived nutritional knowledge was tested on the additional premium price classes, beliefs and extrinsic and intrinsic predictors selected by step-wise, by distinguishing the whole sample into two sub-categories: high and low self-perceived nutritional knowledge. Starting with the additional premium, **Figure 1** shows the relative frequencies observed according to the level of knowledge, taking into account the following classes: not willing to pay an additional premium; willing to pay up to 10%; from 10% to 20%, from 20% to 30%, more than 30%. The distribution was significant at a p-value of 0.01 indicating that a relation exists. Consumers with high self-perceived knowledge show a greater willingness to pay for olive oil with functional properties in the 10% to 20% and 20% to 30% classes, while low self-perceived knowledge can be related to the premium price of up to 10%. This result suggests that the higher the self-perceived knowledge, the more consumer preferences move towards a higher value of APP for the enriched product.

By observing the other variables, significant relations were obtained for each test (**Table 6**). Indeed, consumers with low self-perceived knowledge attach more importance to healthy nutritional information, in particular, for

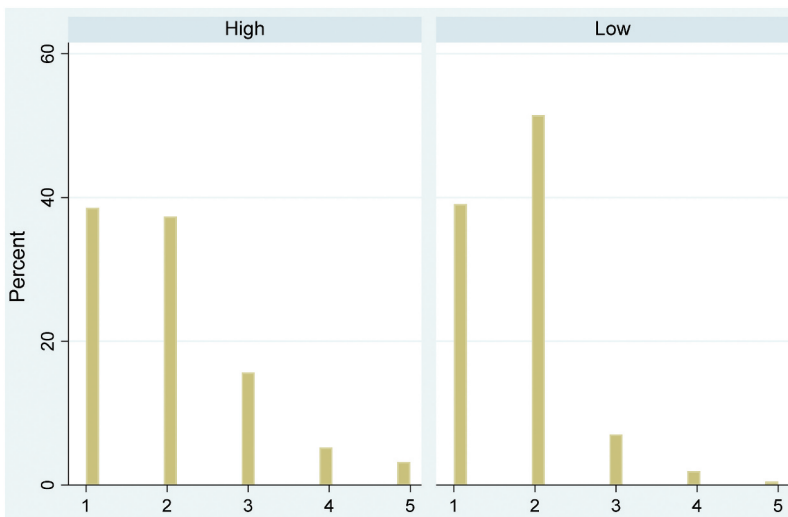


Figure 1. Different additional premium prices between high and low self-perceived nutritional knowledge.

the scores 5 and 6. Concerning the importance attached to local olive oil, the low level of knowledge can be linked to a greater interest in this aspect; in fact, score 7 was the main selected by these consumers.

Belief regarding cancer prevention was mainly related to consumers with high self-perceived knowledge, in particular, scores from 4 to 7 indicating that disease prevention can be a topic of interest for these consumers.

The spiciness was the only intrinsic sensory attribute significant in the regression model; analysing the differences based on self-perceived knowledge, it can be seen that consumers with a high level of knowledge attach more value to this feature in particular, scores 4, 5 and 7 were the most selected. GI labels based on the mean score appear to be a feature of minor importance; however, consumers with high self-perceived knowledge consider these certifications more important, thus recognising a higher quality of products and attributing a higher health value to them.

The last extrinsic attribute is related to products derived from a blend of European olive oils, in other words, products that are sold at lower prices in the large-scale retail trade. Such products are poorly considered by consumers, and between the two classes of self-perceived knowledge, more by those who declare a low level of nutritional knowledge.

5. Discussion

This study is the first to investigate the willingness to pay for an olive oil enhanced in polyphenols, thus enriching the existing literature on healthy product attributes, and representing a starting point for this field of research. In this regard, the main outcomes of our research confirm our initial assumption that fair consumer attentiveness to enriched olive oil exists. In fact, although extra virgin olive oil is considered a functional food itself (Aparicio-Soto et al., 2016; Stark & Madar, 2002) since it contains a variety of bioactive compounds that are extensively deemed to be potentially beneficial for health, the results of our study show that consumers display a fair amount of interest in the enhanced product.

R1. The initial hypothesis was fully corroborated since olive oil attributes are perceived as positively correlated to the willingness to pay an additional price for an increased polyphenols content. This allows for a positive response to our first research question since more than 50% of respondents declared they were willing to pay an additional premium price. In particular, a large part of the sample was willing to pay up to 10%, while only a small segment was willing to spend up to 20%. Consequently, a marked willingness to pay was discovered, albeit at a moderate additional price, to obtain more health-giving benefits from a product with enhanced nutritional characteristics due to the higher polyphenols content. This first result is quite in line with

Table 6. Inferential statistics using self-perceived nutritional knowledge and significant olive oil characteristics (score 1 = not important; score 7 = very important).

Variables	Stated knowledge	Mean score	Score 1	Score 2	Score 3	Score 4	Score 5	Score 6	Score 7	Chi-square statistics
Health nutritional information	Low	5.39	2.91	3.16	3.88	9.47	22.82	37.86	19.90	15.540***
	High	5.10	4.02	5.22	6.83	16.06	16.47	31.33	20.08	
Local olive oil	Low	4.31	36.65	2.91	1.70	3.64	4.37	8.50	42.23	26.216***
	High	3.65	40.16	8.03	4.82	4.02	7.63	7.63	27.71	
Olive oil prevents cancer	Low	4.08	17.23	10.44	10.19	16.50	14.32	17.96	13.35	23.696***
	High	4.78	9.64	4.02	7.23	19.28	18.47	20.88	20.48	
Spiciness	Low	3.56	22.33	15.05	12.38	12.86	15.05	16.75	5.58	40.450***
	High	4.41	11.24	8.43	9.64	18.88	18.47	16.87	16.47	
GI label	Low	2.31	60.19	7.28	6.07	8.74	8.01	5.34	4.37	27.438***
	High	3.11	41.77	8.84	7.63	12.05	8.84	9.64	11.24	
Blend of olive oils from the EU	Low	4.96	12.62	6.80	6.80	6.80	12.38	22.33	32.28	63.449***
	High	3.61	32.53	9.24	8.43	12.45	8.03	10.04	19.28	

*** = Significance at 0.01.

previous studies that identified a small market segment made up of consumers with a favourable propensity towards innovative olive oils, such as those naturally enhanced with polyphenols or enriched with vitamins (Roselli et al., 2020; Hamam et al., 2022).

R2. The second step of the survey was addressed to identify the main olive oil attributes, questioning which positively influence the intention to pay more.

Concerning the role of extrinsic characteristics, this study highlights the prevailing presence of credence attributes, such as geographic and national origin as well as health information. These attributes, indeed, have been included in this category (Fernqvist & Ekelund, 2014; Maesano et al., 2020). The favourable appreciation for the “local” attribute confirms how the choices of Italian olive oil consumers are deeply influenced by local productions, being more sensitive to farm location (Cacchiarelli et al., 2016). This outcome is consistent with several previous studies whereby locally produced olive oils are perceived as superior for the outside ones’ (Panzone et al., 2016; Perito et al., 2019). The prominent role of territory and regional/national origin in olive oil quality evaluation is also confirmed by the relevant importance that respondents attached to GIs labelling. This result is quite in line with what has been widely demonstrated in the existing literature (Panico et al., 2014; Pérez Y Pérez et al., 2020).

The importance of territorial proximity in olive oil consumption is also corroborated by the consumers’ preference expressed for the national origin of the product. By highlighting the negative coefficient of the variable “blend of olive oils coming from other EU countries”, a positive correlation with national production can be inferred. This implies that the olive oil produced throughout the country is still perceived as a high-quality product and therefore preferred over imported ones.

Concerning the last extrinsic attribute, our findings show that health information labelling is considered a significant attribute to pay an additional price for when purchasing a fortified olive oil. Limited importance of health claims was found in the literature since they play a marginal role in olive oil choices (Boncinelli et al., 2016, De Gennaro et al., 2021). However, this study points out that consumers can be very sensitive to the health information of olive oils. Yet, to effectively differentiate the product and satisfy consumers interest, it is important to study how to introduce the information to the consumers, as different claims may have both different effects and effectiveness (Viscecchia et al., 2019). Consequently, providing more information on the health benefits of olive oil in an effective form could help to reduce the

information asymmetry of consumers, thus facilitating smoother coordination among the players right down the chain (Roselli et al., 2020; Torquati et al., 2021), and reduce health risks (Yoo et al., 2015).

As for the sensory characteristics, the role of spiciness clearly emerges. Despite astringency and bitterness have been negatively correlated with consumers' taste preferences (Cavallo & Piqueras-Fiszman, 2017) and an unwillingness to pay for these attributes has been demonstrated (Caracciolo et al., 2020), this study highlights a favourable appreciation for spiciness. Nevertheless, the acceptance of this attribute denotes increasing consumers' attention towards this sensation, which is often mistakenly associated with olive oil defects. This result confirms the relevance of this attribute that ensures quality and freshness and corroborates current findings, even if a limited segment of consumers showed a certain propensity towards bitter and spicy olive oil (Cavallo et al., 2019).

R3. As for the third research question on consumers' beliefs, the outcomes of this study confirm that olive oil is thought to be healthy (Chrysochou et al., 2022). In fact, respondents felt that olive oil enriched in polyphenols can help prevent some forms of cancer and as such, and, consequently, they are willing to pay more for it. Our results confirm the previous studies that highlighted consumers' growing health concerns and their consequent willingness to direct their eating habits towards products able to boost their immune system and somehow prevent certain illnesses (Niva, 2007; Prättälä, 2003).

R4. The fourth research question was addressed to understand the role of socio-demographic characteristics. In this respect, the role of age and household composition emerged. As for age, only the elderly seems significantly willing to pay more for a polyphenol-enriched olive oil. Indeed, older consumers can be more sensitive towards functional foods because they are more inclined to safeguard their health and prevent disease, and such products are created to provide further nutritional and health-giving benefits at a time in life when they are needed (Song et al., 2019; Zanchini et al., 2022).

Finally, even if the body mass Index (BMI) was not considered relevant as a physical characteristic in consumers' attitudes of olive oil (Di Vita et al., 2020), the statistical significance of the interaction variable "Age*BMI" allows for further considerations. Indeed, the BMI, being negatively correlated with old age, reveals that overweight elder consumers are not interested in paying more for a functional olive oil. This result is consistent with a previous study on cheese consumers, whereby older overweight subjects were not willing to pay more for a healthier cheese characterized by a low salt content (de-Magistris & Lopéz-Galán, 2015) and confirms that in some cases, other categories may also be interested in functional foods (Zanchini et al., 2022). It allows observing a disaffection among older and overweight consumers towards functional and healthier foods.

As far as household composition is concerned, our results confirm that olive oil consumption is mainly restricted to the family environment. It affects food buying decisions and significantly influences attitudes and perceived quality, as supported in the literature by several authors (Gil et al., 2007; Krystallis et al., 2008; Lanfranchi et al., 2014). This finding highlights that families with children may be more inclined to consume functional foods. This outcome finds confirmation in recent studies arguing that parents feel a greater responsibility towards their family unit, and they tend to be more informed about their diet and nutrition (Bentivoglio et al., 2021; Marakis et al., 2021; De Cianni et al., 2022).

Finally, the results of our research, in line with the current literature, suggest that older people and families with children show a stronger interest in information regarding health and nutrition on the label (Contini et al., 2015; Siegrist et al., 2008).

R5. The fifth research question asks if a different level of nutritional knowledge otherwise affects the price-sensitiveness of olive oil since it is certainly considered one of the factors influencing food choices. As widely reported in the literature, it has a positive influence on opting for a healthier diet (Worsley, 2002). As well as the impact that knowledge has on food choices and eating habits, underlining how this is a dominant driving force behind food consumer behaviour (Gámbaro et al., 2013; House et al., 2004; Moorman et al., 2004; Pieniak et al., 2010).

Interestingly, our study pointed out how consumers with low self-perceived knowledge attach more importance to health nutritional claims. Maybe, those who believe their knowledge is limited must make up for it with more information to fill this gap.

Conversely, consumers with high self-perceived nutritional knowledge are less prone to choose and pay for food with nutritional information as this information does not add any value to them. Moreover, the lower their self-perceived nutritional knowledge, the more respondents give importance to local oil. This first outcome is quite in line with previous contributions, in that less informed consumers are more attentive to locally produced olive oil since they know more about brand renown and producers' reputations and even their production procedures (Di Vita et al., 2021 b; Rodríguez Cohard et al., 2017).

Therefore, consumers with limited self-perceived knowledge may feel more reassured by the local origin of the olives and familiarity with the territory. Indeed, health-giving claims and the provision of information regarding the origin of olive oil may support the creation of a culture about the product (Roselli et al., 2020), despite their influence being rather marginal (De Gennaro et al., 2021). However, the lack of knowledge on nutrition acts as a brake on paying more for an oil enriched in polyphenols. Our research shows how this consumers' segment is

willing to pay up to 10% more. This implies that consumers with partial knowledge are willing to pay a limited amount of additional price, probably mostly due to curiosity rather than a fuller awareness of functional properties.

On the contrary, in relation to an additional premium price, consumers with a high self-perceived knowledge show a greater willingness to pay for functional olive oil in the 10% to 20% and 20% to 30% classes. This finding is consistent with other studies that highlighted how objective and subjective knowledge increase interest in functional and healthy food (Gámbaro et al., 2013; Topolska et al., 2021).

The major levers for this consumers' segment are represented by a belief they prevent cancer and by the certification label with geographical indications that presupposes a high health consciousness and a higher quality in the requirements of the final product. In addition, the correlation with the spicy attribute is particularly interesting. Consumers with a high level of knowledge attach more value to this feature, revealing their awareness of the antioxidant content and sensory properties (Santosa et al., 2013), hence they are more willing to pay more for oil with an increased content in polyphenols, knowing that the spicy attribute is a characteristic of superior EVOO (Cicerale et al., 2016). This is truly consistent with a previous study that highlights how bitterness and pungency, which are attributes strictly dependent on the high polyphenol content, have been deemed as essential by informed consumers (Di Vita et al., 2020).

6. Conclusion

6.1. Main findings

This study analysed price-related determinants for olive oil with functional properties, assuming the higher polyphenol content leads consumers to pay more. Our analysis was not based on naturally enhanced polyphenols, as previous literature has already done, but it took into account the willingness to pay for an innovative food product added with natural antioxidants, which is olive oil further enriched with phenols extracted from the olives themselves. It allowed to get useful insight into consumers' interest in enriched olive oil, in terms of an additional premium price for such a product.

As first commented, consumers show quite a good awareness of the antioxidant properties of olive oil. In addition, the prominent role of extrinsic characteristics emerged, such as GIs, local attributes and health nutritional information, reaffirming the strong link with the territory and health concerns

of modern olive oil consumers. As far as the intrinsic attributes were concerned, only spiciness was considered relevant in influencing WTP for a polyphenol-enriched olive oil. This is the most important sensory attribute among respondents with a high level of nutritional knowledge. In addition, the belief that consumers have regarding the role of olive oil in preventing cancer was confirmed.

Regarding the role of socio-demographics, this study highlighted that older people and families with children can be more interested in polyphenol-enriched olive oil, being willing to pay an additional premium price for such products.

Finally, as concern the “consumer perception of functionality” and its knowledge, two sub-sample were identified. In low perceived nutritional connoisseurs, nutritional information and geographical origins, such as GIs and local attributes, were more relevant in the willingness to pay more for olive oil with functional properties. Conversely, high self-perceived nutritional respondents are aware of the antioxidant properties of these olive oils, believe in their cancer prevention actions, and attach more importance to the spiciness, this class of consumers is the one who registered the highest pricing thresholds.

6.2. Implication

This paper provides several implications for both academicians and enterprises. This is the first evaluation that assessed the interest in an extra virgin olive oil enriched with its own phenolic compounds and what factors may influence the additional premium price for such a product. The results confirm consumers’ interest in a fortified olive oil, providing initial insights into the positive attitude towards an innovative product enriched in polyphenols leading to the possibility for producers to differentiate their products. Furthermore, several variables as regressors were significant in the identification of additional premium price thresholds enriching the current literature related to the determinants of healthy food consumption. An understanding of what drives consumer preference could be worthwhile when devising successful marketing strategies for those companies wishing to satisfy such consumer needs.

Moving on to the implications for enterprises, there exists a relatively high proportion of consumers willing to pay a premium price for functional components; the results from our study show a growing trend towards enriched olive oils that companies and food market operators should consider for product differentiation. In particular, large companies that can develop new products at relatively low costs could invest in developing an

olive oil enriched in polyphenols. This objective should be achieved in a productive context attentive to environmental sustainability given consumer interest.

6.3. Limitation and further research steps

The evaluation carried out in this paper is not free of limitations, which should be taken into account for the generalization of the results. The first limit is related to the adoption of a convenience sample, which implies caution when results are extended to the general population. Another aspect that can be improved in future studies concerns the use of psychological constructs relating to knowledge or beliefs that collect pools of variables coded from the literature. Concerning the innovative products, consumers' positive assessment of their characteristics may be over-expressed because it has not been compared with products with increasing or natural polyphenol content. Finally, the work was carried out in Italy, thus the results may not be significant for consumers in other countries.

Another important limitation of this study relies on the stated preferences of consumers based on their opinions and not on their behaviour. In addition, the use of a questionnaire can lead to a certain susceptibility in obtaining socially desirable responses. Nevertheless, the results contribute to the existing debate on functional food products by providing useful understanding of consumer preferences for fortified olive oils.

Future research could be directed to exploring the role that sensory attributes have on consumer acceptance, thus assessing their WTP for an olive oil with functional properties. The comparison of consumer acceptance of polyphenol enrichment could be assessed as an attribute level using a conjoint experiment. In this way, market segmentation based on product attributes could be developed. Finally, the assessment of the willingness to pay for olive oil with a higher phenolic content could be undertaken in cross-country evaluations.

Disclosure statement

No potential conflict of interest was reported by the authors

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