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Factors Influencing Consumers' Attitude Towards Biopreservatives

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Abstract: Biopreservatives have received considerable attention in recent years as natural alternatives to synthetic preservatives. This seems to be a response to an increased demand for natural and organic foods. This study investigates the potential market for products enriched with biopreservatives in Italy. Data were collected from a sample of Italian consumers (N = 479) using a web-based survey. The main results indicate that 64% of respondents declared themselves to be willing to consume biopreservatives only if they replaced synthetic preservatives. Principal component analysis (PCA) was applied to reduce the number of variables. The factorial scores of the components obtained from PCA were used for a Cluster Analysis related to consumers' perceptions about biopreservatives. Moreover, the survey highlights that the respondents had positive opinions about biopreservatives, although they showed difficulty in perceiving the exact meaning of the term. The study could provide useful implications for food manufacturers and facilitate the design of marketing strategies for foods enriched with biopreservatives.

Keywords: biopreservatives; shelf life; essential oil; organic foods; consumers' attitude; willingness to pay

1. Introduction

Delivering food in good conditions from the production site to the consumer often requires the use of additives. Food additives are defined by Regulation (EC) No 1333/2008 [1] as "substances that are not normally consumed as food itself but are added to food intentionally for a technological purpose", to promote food safety and extend product shelf life. In fact, traditionally, the control of food-spoiling and pathogenic microorganisms is ensured by the use of synthetic substances. Despite the benefits that some food additives apparently have, consumers feel that additives should be reduced in their foods and that they are 'bad' for their health [2]. Arbindra et al. [3] and Shim et al. [4] pointed out that the consumers' perception of food additives is generally negative.

Consumers face many food choices associated with food additives every day. In general, they prefer food with no additives, but if not available, consumers will choose foods containing natural additives over synthetic analogues [5–11]. In particular, natural additives [12] have been gaining interest from producers and consumers. Generally, consumers have a high-risk perception of industrially produced and processed foods [13]. In contrast, the word "natural" on food labels evokes mainly positive associations [14]. According to Lockie et al. [13], Rozin [14] and Siipi [15] "naturalness" is an attribute that enhances the positive perception of foods, making these products more desirable to the corresponding non-natural ones. During past decades, the market demand for

natural and organic products has grown in many industrialized countries [16–18], as well as the request for ready-to-eat food products and fresh fruits and vegetables [19]. Consumers consider ready-to-eat products as very perishable and perceive freshness as the most important factor influencing food choice, both during purchase and consumption [20–22]. Nevertheless, these products are the most exposed to contamination by spoiling and even pathogenic microorganisms, thus requiring particular care to ensure consumer safety and product shelf life [23].

In this general trend, consumer attention is growing towards the properties of medicinal plants (especially organic ones) and the production of essential oils (EOs) and hydrosols (or hydrolates), which are both obtained during the distillation of aromatic plants. The use of EOs as natural preservatives may be useful to improve food safety, mainly because of their antioxidant and antimicrobial activities [24]. EOs are hydrophobic compounds and can be directly applied to food products by means of surface treatments (application on the surface by dipping, spraying, brushing, and panning), or included within the matrix (e.g., in minced meat). EOs can be also enclosed in antimicrobial edible films or coatings, generally made of biomaterials such as proteins or carbohydrates, with the addition of plasticizers and, eventually, jellying agents [25]. The micro- or nano-encapsulation of EOs and bioactive molecules into edible carriers (e.g., cyclodextrins, proteins, etc.) is another technique that allows us to increase the stability and bioactivity of the active compounds and to reduce the impact on the flavour of the food product. On the contrary, hydrosols are hydrophilic, and therefore they are usually applied to food products by means of washing treatments (e.g., vegetables, fruit, ready-to-eat salads, etc.) [23].

Nevertheless, in spite of these wide possibilities of application, few of the preservatives containing EOs for use in food products are currently available on the market, and they are typically used in the food industry as flavouring agents [26]. Biopreservatives can represent a source of natural alternatives to conventional preservatives to improve food shelf life and safety [27].

The regulations are strengthening to reduce the food-related risk of consumption and to preserve the health of consumers [28], and preservatives are included in the legal category of food additives, according to Regulation (EC) 1333/2008 [1]. However, EOs used as biopreservatives, as long as they are not listed in the EU Regulation on food additives, are usually included in the ingredient list as an ingredient: e.g., organic essential oil of oranges. If the EO is manufactured and distributed according to Regulation (EC) 1334/2008 [29] on food flavourings, Regulation (EU) 1169/2011 [30] on food labelling gives us another option for the ingredient list, which is "natural flavourings". Finally, if the manufacturer can demonstrate that the EO is added to obtain a certain technological purpose during processing, leaving residues that do not present any health risk and do not have any technological effect on the finished product, then it can be considered as a "processing aid" (Regulation (EC) 1333/2008, art. 3), and according to Regulation (EU) 1169/2011, is not reported in the ingredient list.

In any case, among the information contained on the label, the consumers pay particular attention on the expiry date and they consider it an important quality attribute [31,32]. Stranieri and Baldi [33] investigated a sample of Italian consumers, and they highlighted how consumers pay attention to product shelf life, especially for fresh-cut vegetables. As a consequence, considering that these vegetables are very perishable products, the consumers' choices in purchase are mostly guided by the perceived level of freshness [34,35]. In this respect, EOs can have a significant antimicrobial impact. Nevertheless, their use in foods is quite limited due to both a high cost and a possible adverse impact on sensory characteristics and product acceptability [36]. Moreover, from a regulatory point of view, there is not much on the topic of natural preservatives, and in fact the term "biopreservative" is neither regulated nor used on the label.

Therefore, the main objective of this research was to identify the potential for the development of the biopreservatives market through the analysis of consumer perception and acceptance of natural food preservatives as an alternative to synthetic preservatives. In particular, to understand the real consumer acceptance of biopreservatives, we concentrated our analysis on three fresh products (fresh-cut

vegetables, meats and cheeses). The study also aims to provide information for food manufacturers regarding the most appropriate marketing levers for the enhancement of biopreservatives.

2. Materials and Methods

The direct survey of consumers was concerned with the perception of natural preservatives as an element for both improving the shelf life of food products and replacing synthetic preservatives with natural preservatives, with the aim of understanding the type of message communicated to the consumer.

The questionnaire was distributed throughout Italy by ADICONSUM (Consumers and Environment Defence Association), who administered the questionnaire via email to its members and through Facebook, collecting 479 complete answers. Participation took place in an absolutely anonymous form, and the participants were informed in advance that the data collected would have been treated in an extremely confidential manner and used only for scientific research purposes. However, respondents were recruited from diverse community centres.

The self-administered questionnaire contained questions with closed-ended response alternatives on a five-point Likert-type scale. The content validity of the questionnaire was ascertained by a pre-test to collect elements to assess completeness and clarity of the questionnaire. Specifically, the survey allowed us to investigate the consumer perception and knowledge about biopreservatives and to assess the interest in the purchase and the willingness to pay towards food products treated with natural preservatives, as an alternative to synthetic preservatives.

The questionnaire consists of questions on the knowledge of biopreservatives to investigate the awareness about the preservatives. Some of these questions contained definitions from the EU Regulation, which indirectly allowed us to evaluate whether the legislation is understandable for the consumer or if there is an actual lack of clarity from the regulatory point of view, as highlighted on more than one occasion in the literature about novel food products or technologies [37–39]. In particular, the focus of the investigation was on consumer knowledge of the definition of preservative and the difference between natural and synthetic preservatives. The perception of information that can be transmitted by product labelling was analysed considering both the mandatory and hypothetically voluntary information on the labels [40]. The aim of these questions was to analyse the importance to the consumers of information contained on the label and their perception of different claims [41,42]. Other questions were related to consumer preferences, their willingness to pay for natural preservatives (as percentage of synthetic preservatives), and the use on several food products.

To understand the consumers' acceptance regarding natural preservatives, we also asked questions about their purchasing habits of food products and the frequency of purchase of organic products to verify whether or not there was a correlation between the consumption of organic products and interest in purchasing and willingness to pay for products treated with natural preservatives. According to Dickson-Spillmann et al. [43], consumers consider organic foods to be healthier, uncontaminated, and purer than conventional foods, and not altered or polluted by synthetic additives or by excessive human interference. Finally, we also asked about information relating to personal data (gender, age, profession, level of education, etc.).

A Principal Component Analysis (PCA) was applied (computed using IBM SPSS Statistics-version 20.0.0) on the original data to reduce the initial diversity of a certain number of variables [44]. The factorial scores of the components obtained from PCA were used for a Cluster Analysis related to consumers' perceptions about biopreservatives.

3. Results and Discussion

A total of 479 respondents completed the questionnaire. In the sample, 64% of respondents were 25–44 years old and 58.2% were male. The sample contained a high percentage of graduates. The apparent imbalance of the sample can be considered a strength of the questionnaire, because it allowed us to investigate the capacity of highly educated people to evaluate natural preservatives.

To evaluate the knowledge of consumers, we asked them to define preservatives and natural preservatives. In this respect, 94.8% of the sample answered the question "what is a preservative" correctly, according to the definitions given by Regulation (EC) 1333/2008. As for the term "biopreservative", although 46% of the sample answered correctly, it is true that there is still much uncertainty about the meaning of this term. Indeed, when consumers were asked the difference between natural and synthetic preservatives, only 38.8% of the respondents answered correctly. With regards to the definition of flavourings, 65.8% of the sample answered correctly.

Although most respondents read food labels (87% from often to always), there was no significant correlation between the frequency of reading labels and the knowledge about biopreservatives. Moreover, considering different information that consumers can find on the label, the data obtained demonstrate a greater concern of the respondents for the expiry date and the presence of food additives (Figure 1).

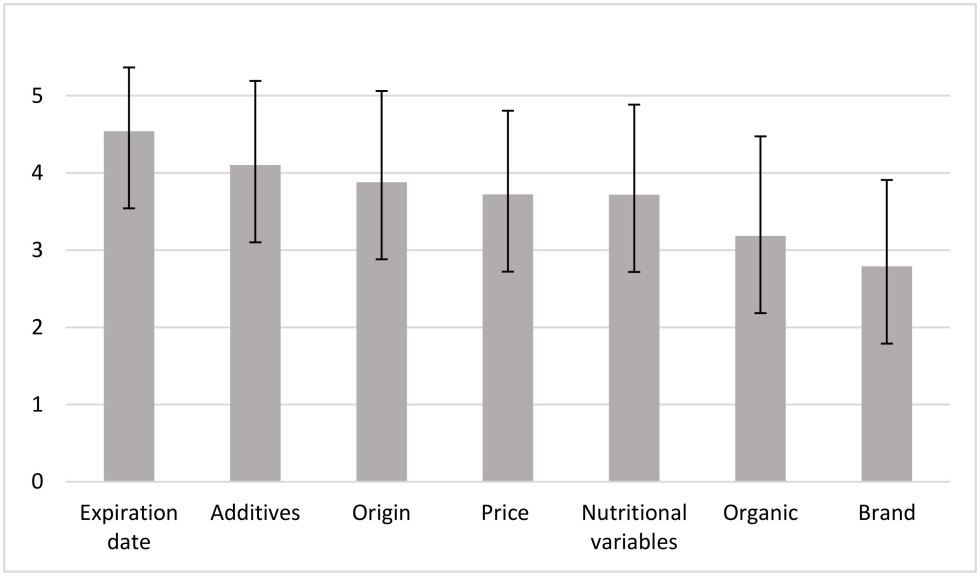

Figure 1. The level of attention paid to different information on the label (mean and standard deviation). (Attributes importance (scale 1 to 5: where 1 = Not important and 5 = Very important)).

Furthermore, the claims "without preservatives", "without added preservatives" and "organic", which are actually used in food labels, have been compared with the claims "natural" or "bio" preservatives, which are not currently included in the labelling regulation, so that we can consider these as hypothetical labels. The results showed that the new claims would be less appreciated than the current ones, with the claim "without preservatives" receiving a significantly higher value than the claim "with natural preservatives" ($p < 0.05$), and the claim "with biopreservatives" being assessed as worse than the others ($p < 0.01$) (Figure 2).

The results showed that most participants agreed with the statement about the safety of food biopreservatives. A total of 79% of respondents considered biopreservatives to be less harmful to health than synthetic preservatives, and 55% of them thought that biopreservatives cause less damage to the environment than conventional preservatives. Only 22% of respondents think that biopreservatives improve the flavour of the food compared to the synthetic preservatives. With regards shelf life, only 17% of respondents considered biopreservatives to be better than the synthetic ones. However, the respondents appreciated the use of biopreservatives, especially in the preparation of fruit (71%), fresh-cut vegetables (47%), and meat (42%). They seemed less concerned about processed products. In fact, only 33.6% of respondents said they would prefer the use of biopreservatives in bakery products, and only 6% in processed food products. Finally, the majority of the respondents answered that they were willing to consume biopreservatives only if they replaced the synthetic ones (64.3%). A total of

13.6% thought that they would be willing to consume biopreservatives only if they increased the shelf life of the food products.

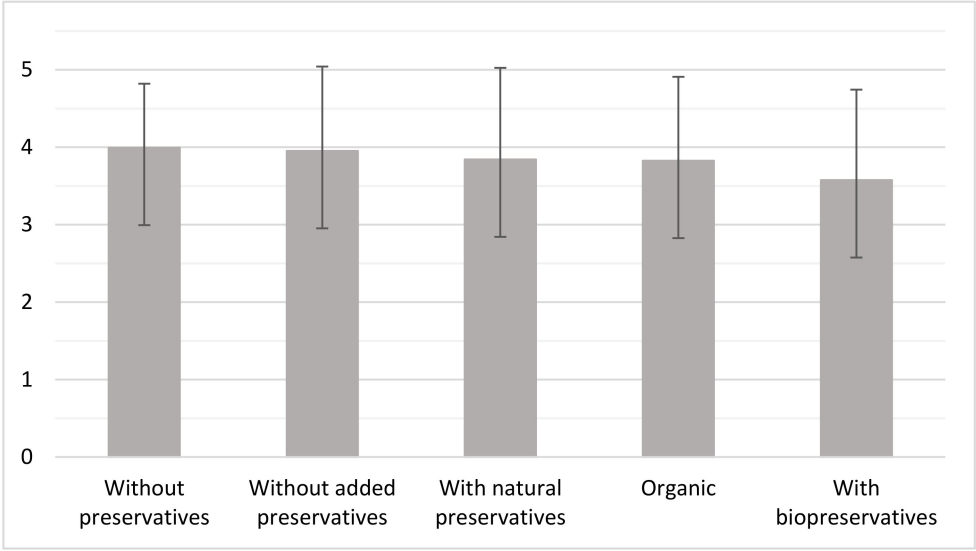

Figure 2. The importance of the claims on hypothetical labels for the product choice (mean and standard deviation). (Attributes importance (scale 1 to 5: where 1 = Not important and 5 = Very important)).

Moreover, we have tried to understand the willingness to pay for food products treated with biopreservatives as preservative replacers. A total of 67.8% are willing to pay for fresh-cut vegetables with "only" biopreservatives; of these, 55.7% are willing to spend between 10–20% more and 12.1% are willing to pay up to 30%. In the case of semi-hard cheeses treated with synthetic preservatives on the rind, 63% of respondents were willing to pay between 10–20% more for the same product treated with biopreservatives, and 13% of respondents were willing to pay up to 30%. Conversely, 24% of respondents were unwilling to pay more for cheese treated with biopreservatives.

To understand the determinants in the preference of a product treated with biopreservatives over conventional products, we have completed our study with a Principal Component Analysis (PCA). This method allowed us to reduce the initial diversity of certain number of variables to a smaller number of Principal Components and to simplify the interpretation of the phenomenon. The PCA can be used when the sample adequacy of the model, indicated by the KMO index [45], is more than 70%; the total variance explained should be greater than 65–70% of the total variance represented by the variables used.

The PCA was applied to variables obtained by the questionnaire answers, representing three main aspects of the phenomenon: sensitivity to label claims (influence of different label claims in the product choice, level of attention paid to different information present on the label and to the price); consumers' behaviour and choices; and personal characteristics. The KMO of our data is equal to 0,703 (Table 1) and the total variance explained reaches a good level (68.35%), with the first eight main components identified (Table 2).

Table 1. The results of the Principal Component Analysis (PCA)—KMO and Bartlett's Test.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.703
Bartlett's Test of Sphericity	Approx. Chi-Square	2638.368
	Df	190
	Sig.	0.000

Table 2. The determinants of consumers' preference towards biopreservatives. A rotated component matrix is shown.

Variables	Components							
	CP1	**CP2**	**CP3**	**CP4**	**CP5**	**CP6**	**CP7**	**CP8**
Sensitivity to label claims								
Influence of the label: "with natural preservatives"	0.780	0.235	0.165			−0.103		
Influence of the label: "with biopreservatives"	0.766	0.246	0.234			−0.108		
Influence of the label "Organic product"	0.512		0.640	0.148				
Level of attention to Ingredients	0.297	0.739	0.180				−0.142	
Level of attention to the Product origin	0.143	0.570	0.314	0.147		0.207	0.270	0.110
Level of attention to Nutritional Information	0.415	0.545					0.148	0.127
Level of attention to Organic certification	0.378	0.300	0.704					
Level of attention to Brand		0.118	0.104				0.755	
Level of attention to Price			0.140	0.126		0.186	0.722	
Consumers behaviour								
Frequency of reading label		0.819					0.201	0.116
Frequency of organic food consumption		0.190	0.803					0.169
Unwillingness to pay more for a cheese treated with natural preservatives				0.914				
Unwillingness to pay more for a salad treated with natural preservatives			0.106	0.913				0.103
Willingness to pay more for food treated with natural preservatives					0.909	0.116		
Willingness to pay more for food treated with natural preservatives in substitution of synthetic ones	0.115			0.165	0.789	0.269		
Willingness to pay more for food treated with natural preservatives if the shelf life of the product increase						0.842		0.110
Preference for a ready-to-eat fruit salad treated with biopreservatives, expiring at 5 days respect the same product without preservatives expiring at 3 days			0.127		0.225	0.650		0.213
Personal Characteristics								
Age	0.154	0.115	0.460				0.197	0.438
Knowledge about biopreservatives	0.131		0.135					0.679
Gender	0.450					0.122	0.219	0.614

Description of the seven principal main components identified:

CP1 (21.2% of the total variance explained): mainly a female component, susceptible to the indication on the label of "natural preservatives" and "biopreservatives", as well as to organic products and organic certification, where the willingness to pay (WTP) a product treated without synthetic preservatives is weak.

CP2 (8.92% of the total variance explained): a youth component that pays attention to the label, to ingredients, and the origin and nutritional information, but not the brand.

CP3 (7.88% of the total variance explained): older people, with a fair knowledge of the topic, the frequent consumption of organic products, susceptible to the indication on the label of organic products and organic certification and who give little importance to the price.

CP4 (7.48% of the total variance explained): a component with no willingness to pay more for products treated with natural preservatives, no interest in biopreservatives, slightly price sensitive, not interested in organic production or in the products' origin.

CP5 (6.96% of the total variance explained): a component very favorable to the purchase of products treated with biopreservatives, even if they do not replace synthetic preservatives and albeit with a reduced shelf life.

CP6 (5.47% of the total variance explained): a component with high WTP for products treated with natural preservatives if the shelf life of the product increases; generally attentive to the price.

CP7 (5.25% of the total variance explained): a male and youthful component, sensitive to the brand and price and attentive to the origin of the products.

CP8 (5.15% of the total variance explained): a male and elderly component, characterized by a very limited knowledge about biopreservatives, moderately favorable to the use of biopreservatives and having little interest in the origin of the food products.

The factorial scores of the previous eight main components obtained from PCA were used for a Cluster Analysis. A two-step clustering method was applied adopting the squared Euclidean distance algorithm for case processing.

As the eighth component was not very explanatory, we decided to reduce to seven the principal components for the analysis. A four-cluster solution showed the most distinctive profile [46] and was thus the solution retained (Figure 3). The four identified clusters possess an acceptable measure of cohesion and separation, with a silhouette coefficient of 0.43 [47]: Cluster 1 (16.7% of the sample); Cluster 2 (60.3%); Cluster 3 (10.6%); Cluster 4 (12.3%).

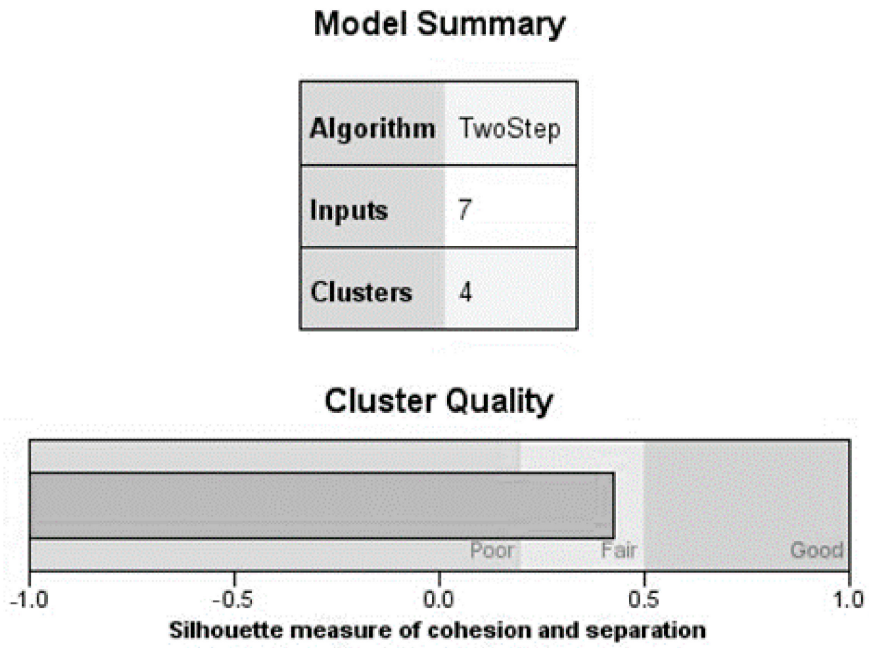

Figure 3. The results of the Cluster Analysis with seven principal components.

Their description is given below (Table 3).

Table 3. Main characteristics of consumers segments (n = 479): mean scores of variables within the groups (standard deviation within brackets).

Clusters	1 (Enthusiastic)		2 (Rational)		3 (Disinterested)		4 (Conscious and Attentive)		Total	
Personal characteristics										
Gender (0 = female, 1= male)	0.45	(0.501)	0.40	(0.491)	0.51	(0.505)	0.37	(0.488)	0.42	(0.494)
Age	38.05	(10.467)	36.75	(11.515)	37.24	(12.239)	35.98	(13.309)	36.923	(11.641)
Knowledge about biopreservatives *	2.35	(0.873)	2.47	(0.858)	2.39	(0.918)	2.56	(1.038)	2.46	(0.890)
Sensitivity to label claims										
Level of attention to Nutritional Information *	3.94	(1.173)	3.72	(1.183)	3.43	(1.118)	3.68	(1.105)	3.72	(1.169)
Level of attention to Brand *	2.64	(1.183)	2.86	(1.120)	2.55	(1.101)	2.86	(1.025)	2.79	(1.120)
Level of attention to Organic certification *	3.63	(1.354)	3.23	(1.249)	2.65	(1.230)	2.81	(1.238)	3.18	(1.292)
Level of attention to Product origin *	4.06	(1.205)	4.00	(1.091)	3.31	(1.516)	3.53	(1.056)	3.88	(1.182)
Level of attention to Price *	3.81	(1.092)	3.59	(1.080)	3.96	(1.183)	4.03	(0.909)	3.72	(1.084)
Level of attention to Ingredients *	4.24	(1.046)	4.16	(1.055)	3.86	(1.281)	3.85	(1.096)	4.10	(1.090)
Consumers behavior										
Frequency of reading label *	3.05	(1.146)	2.94	(1.054)	2.75	(1.214)	2.81	(1.025)	2.92	(1.084)
Frequency of organic food consumption *	1.76	(0.945)	1.72	(0.940)	1.37	(0.958)	1.49	(0.858)	1.66	(0.939)

* Scores on a five-point Likert-type scale (1 = minimum; 5 = maximum).

Enthusiastic (Cluster 1—80 cases): a cluster with less knowledge about the meaning of preservatives and biopreservatives than other individuals, who frequently purchase organic products and declare an unconditional interest in the purchase of products treated with biopreservatives. These consumers are not interested in the shelf life of food products and are willing to pay higher prices than other respondents. It is a niche market with a high prevalence in families of people with professional work, e.g., lawyers, engineers, etc., which would deserve the positioning of a differentiated product of high added value.

Rational (Cluster 2—289 cases): a cluster composed mainly of women (60%), with high educational levels, knowledge of the properties of preservatives, and a high WTP (both for cheese and fresh-cut vegetables treated with biopreservatives). In this group, we find consumers of organic products, attentive to the reading of the label, and in particular to the ingredients and health aspects. The interest in buying is combined with the search for products in which natural preservatives replace synthetic ones.

Disinterested (Cluster 3—51 cases): a cluster with equal representation of men and women, more so than the rest of the sample, with lower-than-average levels of education and very limited knowledge of preservatives. This group expresses a very low WTP, practically zero in the case of cheese and fresh-cut vegetables, consistent with the indication of high importance attributed to the price.

Conscious and attentive (Cluster 4—59 cases): a cluster composed largely of workers or the unemployed, attentive to the price and shelf life of the food products purchased. They show good knowledge about preservatives in food processing, despite a low level of education.

The marketing positioning opportunities of biopreservatives on the consumers basically depends on the strategic objective that the offer (single or aggregate) has. In this context, if the goal is to maximize profit or minimize costs (communication and distribution), the most interesting positions, from the point of view of potential turnover (segment size and WTP), appear to be the clusters 2 and

1. Even cluster 4, although small in size, deserves attention, but it would require a marketing-mix oriented towards products, in particular fruit and vegetables, which are able to combine a good shelf life with low prices.

In general, our results showed that consumers have different levels of understanding of biopreservatives in different situations and do not perceive food additives and biopreservatives in the same way. In fact, as previous literature suggested [4,48,49], consumers hardly recognized food additive information on product labels, showing limited awareness of food additives. The provision of accurate information on the presence/absence of food additives is considered to be an important factor affecting the purchase decision [50,51]. Consumers tend to amplify the risk when a food item or a technology is unknown [52]. Numerous surveys have shown that consumers express concerns about their daily diet, and they are worried about being exposed to synthetic preservatives [43,53]. However, in recent years, consumers have been exploiting new media to become more informed, and social media has become more and more influential in determining their concerns about food quality attributes [54].

Another relevant finding of our study is that the less organic food the respondents consumed, the more they cared for price and the less for the presence of preservatives in convenience foods. Regular organic food consumers preferred biopreservatives compared to synthetic preservatives. However, our results pointed out that even when consumers profess a strong support for environmental attributes, they are still extremely price sensitive. These findings are in line with the literature related to the consumer' approach to the decision to purchase sustainable food [18,55,56].

4. Conclusions

We investigated the factors affecting the acceptance for products treated with EOs as natural preservatives through a direct survey of consumers. Our aim was to analyse consumer knowledge and perception of the information currently used by companies and to verify acceptance of biopreservatives. Moreover, consumer acceptance and willingness to pay were analysed with respect to shelf life and replacement of synthetic preservatives with natural preservatives.

The results of our direct survey highlighted the difficulty in perceiving the exact meaning of the term "biopreservative", which, however, was generally associated with positive opinions such as the reduction of damage to health or positive environmental impact. Moreover, the term had a lower impact on the consumer than the claim "without preservatives".

Our results suffer from two main limitations. Firstly, the sample analyzed in this study is not representative of the whole Italian population. However, the relationships between the variables analyzed and the consumers' perceptions about biopreservatives remain valid and allow us to obtain interesting results. Secondly, there is not a clear understanding by consumers of biopreservatives and our study might suffer from hypothetical bias which could have affected the estimation of consumers' acceptance [10,41,42].

The findings of this research constitute an opportunity for food companies; suppliers of foods added with biopreservatives should thus concentrate on organic and high-quality foods with a low level of processing. The results obtained could also help scientists in addressing the research in this field, with the aim of meeting the requirements of both consumers and food industries. Moreover, this study also expresses the need for a consumer campaign and a better education on food biopreservatives.

This study shows how research on consumer preferences and priorities (e.g., naturalness vs. shelf life; biopreservatives vs. price; etc.) can be of paramount importance to promote the scientific and technological evolution of food manufacturing toward practical applications of biopreservatives, which could be fundamental in the future market for their potential to decrease the negative impact of foods on health and environment.

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Writing—original draft, M.A.P.; Writing—review & editing, M.A.P., E.C. and A.S. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest: The authors declare no conflict of interest.

: Data Availability: The data supporting the findings of this study are available from the corresponding author (M.A.P.) and the first author (M.A.P.) upon reasonable request.

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