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Pesticide Safety in Greek Plant Foods from the Consumer Perspective: The Importance of Reliable Information

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Abstract: Greek consumers perceive an increased risk of pesticide residues in food. This study examined Greek consumers' perceptions on the safety of Greek plant-based food compared to those originating from other EU countries. Half of Greek consumers believe that Greek food is as safe as other European foods, while the other half disagree. According to a principal components analysis and a bivariate logistic regression, several factors, such as perceived safety of plant foods, education, age, gender, traceability, perceived benefits and risks of pesticides, actual pesticide use, and authoritative information sources, influence this attitude. Authoritative knowledge in this field can reduce risk perception and improve Greek consumers' attitudes towards food safety. Latent class analysis identified two categories of consumers. The first class receives limited information about pesticides, leading to a lower perceived pesticide benefits, higher mistrust of traceability and concerns about pesticide residues. In contrast, the second class actively searches for information from credible sources, endorses the Greek plant foods safety, acknowledges the pesticides benefits, and trust traceability. Official information is associated to reduced risk perception. Regulators should consider the impact of socio-demographic and other intrinsic characteristics on individuals' risk perceptions and prioritise transparency in risk communication strategies.

Keywords: food safety; risk perception; information sources; principal components analysis; logistic regression; latent class analysis; risk communication

1. Introduction

The agricultural sector has a significant role in achieving food security and improving food availability, especially in underdeveloped nations with high rates of malnutrition and poverty. Nevertheless, there is uncertainty regarding global agriculture's capacity to satisfy this need by augmenting food output [1]. Safe food is vital to achieve food security and healthy diets. Food safety can be described as the guarantee that food, when prepared and consumed in accordance with its intended purpose, will not pose any danger to the consumer. The presence of unsafe food poses a threat to the gradual achievement of the fundamental right to sufficient food within the framework of national food security, and undermines endeavors to ensure the preservation of health and overall well-being. The assurance of food safety is essential for the attainment of nutritious diets, expansion of market opportunities, economic progress, and overall food security. Food security is defined as the universal availability of adequate, safe, and nourishing food to sustain a healthy and productive life for all individuals [2].

Pesticides are frequently used across several agricultural sectors to enhance productivity and improve product quality [3]. Research indicates that agrochemicals have a positive effect on crop yields and food production overall. Ensuring enough food supplies for a growing population and addressing global food security challenges are critical priorities. Pesticides, if used efficiently, enhance our quality of life by protecting crops from pests, diseases and weeds, thereby minimising crop losses and ensuring a consistent food supply [4–6]. Therefore, as Cooper and Dobson (2007) noted [5], the prudent use of pesticides is of great importance to ensure the sustainability of agriculture and to protect public health. Pre- and post-harvest losses have a negative impact on poverty and malnutrition [4,7,8], making prevention of these losses one of the most important contributions of agrochemical use [9–11].

The use of pesticides has raised concerns regarding the potential impact on both the environment and human health [12]. However, there is an ongoing debate regarding the potential impact of pesticide residues on public health due to the challenges associated with assessing the significance of their occurrence in food [3,13]. Furthermore, the long-term effects of pesticide residues on human health are not fully understood and further research is needed to identify their potential hazards [14]. The main focus of existing research on the effects of pesticides on human health has been on cases of occupational exposure [12,15]. However, concerns have been raised about the potential adverse effects of pesticides on the health of the general population through food consumption. Several studies have shown that the presence of pesticide residues in food poses a potential threat to public health [15–17]. Numerous investigations have provided empirical support for the neurotoxic [18,19] and cytotoxic [20,21] properties of pesticides and their consequent influence on gene mutation, chromosomal impairment and DNA damage [16,22]. There is compelling evidence of a possible link between pesticide use and increased susceptibility to colorectal cancer [23]. Furthermore, prior research indicates a possible correlation between pesticide exposure and a higher vulnerability to Parkinson's disease [18,24]. Studies conducted earlier have demonstrated that the major method of pesticide exposure for young children residing in urban and suburban regions is via dietary intake [25,26]. This issue has caused great concern for the welfare of these children, given their susceptibility to potential neurological and neurodevelopmental effects, as well as their distinct behavioural characteristics [26–29]. However, Tago et al. (2014) [15] have contended that only a minimal number of health outcomes linked to pesticides can be classed as causal.

A number of recent studies have suggested that existing risk thresholds for pesticide exposure may not adequately account for potential synergistic effects resulting from exposure to a combination of pesticides [14,30–34]. However, there is still a lack of agreement on the consequences of interactions following exposure to combined chemicals, with concerns raised about the potential for synergistic interactions between many compounds at low doses, which could potentially increase toxicity [35,36]. The predictability of interactions is challenging due to various factors such as relative doses, routes, timing and duration of exposure. In addition, the biological persistence of mixture components and the specific biological targets involved also contribute to the complexity of predicting interactions [37]. In their study, Hernández and Lacasaña (2017) [38] concluded that synergistic effects in dietary exposure are rare and cannot be accurately predicted in terms of the toxicity of the individual components of the mixture.

Under current EU legislation, a sample remains compliant if multiple residues are present as long as each residue does not exceed the individual MRL set for each substance [39]. However, the European Food Safety Authority (EFSA) has published two cumulative risk assessments on dietary exposure to pesticides that have acute effects on the nervous system and pesticides that have chronic effects on the thyroid. They concluded, with varying degrees of certainty, that the combined dietary exposure did not exceed the regulatory assessment threshold in all European countries in 2014, 2015 and 2016 for pesticides with acute neurotoxic effects [40] and chronic thyroid effects [41]. According to EFSA and Dujardin (2021) [42], there was no substantial change in the exposure to pesticides associated with long-term thyroid effects and pesticides related to acute neurological effects during the period 2016 to 2018 compared to the previous reference period (i.e. 2014 to 2016).

According to the Special Eurobarometer Report published by the European Food Safety Authority [43], the highest proportion of people in the EU Member States who consider a high intake of fruit and vegetables to be an important part of a healthy diet is found among Greeks and Spaniards,

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with a prevalence of seventy per cent. Studies that examined the potential health benefits of fruit and vegetable consumption have shown that the positive effects of increased intake of these food groups outweigh any possible negative effects that may result from the presence of pesticide residues on them [44,45]. The research conducted by Sandoval-Insausti et al. (2020) [46], based on data collected from large cohort studies of health professionals, found no significant association between cancer risk and consumption of fruits and vegetables containing pesticide residues. Valcke et al. (2017) [45] suggest that it is advisable for public health messages to continue to promote regular and abundant consumption of a wide variety of fruits and vegetables among the general population.

The current body of research on the impact of pesticides on dietary health is inconclusive, making it difficult for the general public to access reliable information on the relationship between pesticides and health [47,48]. It is worth mentioning that there is inadequate discourse pertaining to the function of pesticides in sustainable food production [49]. Therefore, the evaluation of the risks and benefits associated with pesticides will remain a matter of public concern. It's essential to note that the public's perception of hazards may vary from those made by regulators, typically relying on empirical evidence [5,48,50–52] and specific risk assessment techniques [53]. The presence of pesticide residues was perceived as minimal by experts, but consumers rated these threats from neutral to substantial in a study by van der Vossen-Wijmenga et al. (2020) [52]. Therefore, their presence in food may increase risk perception [54–56].

According to Han et al. (2020) [57], there is evidence that the implementation of pesticide residue monitoring and control systems could effectively mitigate food safety concerns. According to Williams and Hammitt (2001) [58] and Han et al. (2020) [57], risk communication efforts to educate consumers about food safety issues must effectively address concerns about the reliability of regulatory processes and information sources. In addition, these efforts should focus on establishing appropriate information dissemination systems to bridge the gap between regulators and the public. Understanding the processes that ensure food safety is of paramount importance to consumers and includes both scientific knowledge and building trust through understanding systems and mechanisms [48]. A potential link between trust and risk perception could exist in situations where individuals have insufficient knowledge about an important issue. Siegrist (2021) [59] suggests that if consumers trust the official risk management organization, their perception of the technology is more likely to be positive and acceptable.

Our study specifically focuses on examining the influence of information dissemination on consumer perceptions regarding the safety of Greek food. The proliferation of information has increased significantly in recent times, primarily due to the advent of the Internet and other portable electronic devices that facilitate access to large amounts of data. The information explosion has brought about significant changes in the way individuals obtain and disseminate information. Moreover, it has played a crucial role in accelerating the widespread dissemination of news, knowledge and ideas on a global scale [60,61].

Harris et al. (2001) [62] suggest that consumers' impressions of the risks associated with pesticide residues are consistently influenced by emotional factors, perhaps leading to an overemphasis or exaggeration in their responses to novel information. According to Tiozzo et al. (2019) [63], media often present food hazard information when stories contain sensational aspects. This approach serves to maintain media attention and facilitate the progression of the story. The term 'post-truth era' now refers to a period in which subjective emotions and personal beliefs are more influential in shaping public opinion and decision-making processes, compared to objective facts and empirical data. This shift has been facilitated by the widespread availability of social media platforms, which enable the rapid dissemination of both accurate and misleading information, as well as the creation of echo chambers that reinforce pre-existing biases. As a result, trust in established institutions and authoritative individuals has declined [64,65], as the task of distinguishing between credible sources of information and misinformation has become increasingly difficult. According to Ueland et al. (2012) [66], cognitive processing of information from other sources and self-reflection on one's own circumstances are particularly important when considering dietary hazards. Lobb et al (2007) [67]

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found that the majority of consumers are exposed to a large amount of information about food hazards from a variety of sources, including the media, government, retailers and consumer organizations. Particularly in the digital age, the information landscape has changed, as a plethora of information is readily available and the amount of information on the Internet is challenging. As data is readily shared but rarely verified, its veracity is questionable [68,69]. Public trust, perceived expertise of the message sender and recipient, and demographic variables such as age, education level, ethnicity and socioeconomic status influence the reception of a food safety message [70].

The media play an important role in risk communication [71]. To ensure the effectiveness of risk communication, it is imperative to provide comprehensive details about the characteristics of the risk and its associated benefits, as well as to acknowledge the uncertainties inherent in risk management and to present available alternatives for risk reduction [72]. The influence of the media on consumers' attitudes and perceptions of risks related to food safety has been explored in previous studies [73,74]. The phenomenon of risk amplification by the media has been extensively studied in the scientific literature [71]. According to Hohl and Gaskell (2008) [55], extensive media coverage has a greater tendency to amplify risk perceptions and create a greater desire for measures to minimize such perceptions. The media often prioritize dietary hazards based on criteria that are more consistent with newsworthiness than rankings provided by experts [63,75,76]. Journalists may deem a story worth reporting despite the presence of ambiguous claims, as exemplified in the context of risk communication [77]. A study conducted by Tiozzo et al. (2019) [63] revealed disparities in the reporting of food hazards between government monitoring systems and mass media. The study conducted by Lobb et al. (2007) [67] showed that the level of trust individuals have in the information presented by the media has a direct impact on their propensity to purchase a food product. The researchers also found that trust in public authorities plays a moderating role in the relationship between fear and purchase likelihood, particularly among consumers with higher levels of education. Education acts by reinforcing the positive effects of trust in information provided by public institutions and by modifying the influence of subjective norms. According to Kehagia and Chrysochou (2007) [78], the Greek media is very sensitive when it comes to providing the public with comprehensive information on food hazards. Furthermore, there is an observed prevalence of exaggerated concerns in media portrayals of food dangers, namely with the presence of pesticide residues in food. The journalistic representation of risk frequently fails to acknowledge the intrinsic uncertainty linked to probability, so fostering a feeling that the risk will inevitably result in adverse consequences. Additionally, because these hazards are the ones that receive a lot of media attention but have low probability but great potential repercussions, they are often overestimated in this coverage [77]. This phenomenon has the potential to magnify risks, making them more likely to occur or more likely to cause harm [76].

In contrast, the study conducted by Koch et al. (2017) [79] found that media exposure was associated with a higher level of understanding of the regulatory elements of pesticides, which in turn led to a reduction in reported levels of perceived risk. Access to reliable and specialized sources that provide risk assessments or comprehensive descriptions of the strict regulations governing the trade and use of pesticides is of paramount importance. Non-adherents were significantly less likely to receive information about pesticides from knowledgeable sources than supporters of the benefits of pesticide use over threats [56]. In addition, individuals may use media coverage as a cognitive shortcut for understanding complicated issues, especially in situations where they have no direct expertise in risk management [63,80].

In a recent Eurobarometer survey conducted on behalf of EFSA, Greeks ranked first in terms of personal interest in food safety [43]. Previous Eurobarometer surveys [81,82] show this trend stable in recent years. This is supported by the findings of Simoglou and Roditakis (2022) [56], who found that Greek consumers were especially concerned about the impact of pesticide residues on their own health and that of their families. The present study aimed to improve our understanding of how Greek consumers perceive the safety of plant foods, their sources of information about plant protection products and food safety, and the predictive variables related to their attitudinal beliefs. In this respect, the purpose of the study is to answer the following research questions:

RQ1: How do Greek consumers perceive the safety of Greek plant-foods regarding pesticide residues compared to other EU Member States?

RQ2: Which socio-demographic and attitudinal variables predict Greek consumers' personal perspectives on Greek plant food safety?

RQ3: What is the role of information sources in the formation of consumer perceptions of the safety of Greek plant foods?

2. Materials and Methods

Data collection was facilitated by a questionnaire hosted on Google Forms and distributed via email, Viber and Facebook Messenger. The survey was also disseminated through online news forums and magazines. The questionnaire was accompanied by a short document describing the objectives of the study, a consent statement, an explicit privacy statement with reference to the GDPR regulation, and the names and contact details of the researchers. After 10 days, follow-up emails were sent or social media reposts were made to mitigate the risk of non-response. The large sample size (1846 respondents) provides an in-depth insight into Greek attitudes towards food safety.

The survey was conducted between 6 and 31 March 2021. The questionnaire was divided into two sections: socio-demographic information and attitudes. It included closed 5-point Likert scale questions about their perceptions or attitudes. The Likert scale response levels were as follows: 1 = strongly disagree, 2 = somewhat disagree, 3 = neither disagree nor agree, 4 = somewhat agree, and 5 = strongly agree, or 1 = never, 2 = rarely, 3 = occasionally, 4 = frequently, and 5 = routinely, depending on the context.

The data collected through the questionnaire were first subjected to descriptive statistical analysis. Following Simoglou and Roditakis (2022) [56], the median was used as an appropriate measure of central tendency to present and interpret the results. The non-parametric Kruskal-Wallis and Mann-Whitney U tests were used to compare ordinal variables.

Principal component analysis (PCA) was used to determine the basic information structure contained in the original interrelated variables and to summarize it using a smaller set of composite variables. An eigenvalue threshold greater than 1 was used as a criterion for the number of principal components (PCs) retained. The oblique (maximum) rotation resulted in more simplified PC loads, with each variable load on an individual PC. In the final analysis, only variables with loadings greater than or equal to 0.60 were retained. The adequacy of the PCA was assessed using the Kaiser-Meyer-Olkin (KMO) test, which uses values between 0 and 1 as a measure of sampling adequacy, and Bartlett's test of sphericity, where a significant result indicates that at least some pairwise correlations among variables are non-zero [83].

McDonald's ω reliability coefficient of internal consistency was calculated and reported for scale variables loading on a single PC. To obtain a single measure for each PC, the variables loading on a single PC were combined using composite scores for further analysis [83].

Participants' perceptions of the safety of Greek food products in comparison with products from other EU member states were used as the dependent variable in a binary logistic regression to identify potential predictors. Sociodemographic variables and factors retained from the PCA were included in the model as potential predictors. The calculated odds ratios (OR) and 95% confidence intervals (CI) are presented. Each independent variable in the model was subjected to the Wald test for statistical significance. Finally, performance metrics such as specificity and sensitivity, which represent the proportion of true negative and true positive observations predicted by the model, and AUC (area under the ROC curve, which represents the trade-off between true positive and false positive rates), which is an overall test of predictive accuracy and indicates the degree of discrimination between true positive and false positive values of the estimated model, are considered. Large AUC values (greater than 0.5-1) indicate an excellent model fit [83].

For the purpose of logistic regression analysis, participants' opinion variables were split into two levels with a binary outcome: "favour" = 1, after grouping the Likert response levels somewhat agree and strongly agree, and "disfavour" = 0, after grouping the Likert response levels strongly disagree, somewhat disagree" and neither disagree nor agree, following Simoglou and Roditakis (2022) [56].

Latent class analysis was used to identify potential underlying consumer categories that could explain the observed patterns across cases [84] in an effort to further clarify the significance of information sources on participants' perceptions of the safety of Greek plant foods. As class-defining variables, the original variables pertaining to the information sources used by participants for pesticide information were chosen. To characterize the differences between classes in greater detail, a chi-squared correlation test and a Mann-Whitney U test were conducted on the nominal background variables and the ordinal focus variables, respectively.

The statistical analyses were carried out using Jamovi 2.4.2 [85] and Jasp 0.17.3 [86], both of which use the R programming language.

3. Results

3.1. Characteristics of Survey Participants

All Greek regions were represented by a total of 1,846 respondents to the survey. The population under study is comprised of plant-based food consumers between the ages of 18 and 65 who reside in both urban and rural areas of Greece (the mainland and the Islands). The survey respondents' sociodemographic details are shown in Appendix A, Table A1. Both genders (females 48.5%) and all age groups were adequately represented. The majority of respondents (45.1%) resided in the south of Greece (including Athens), while 26.6% resided in the centre and 29.1% in the north. In accordance with Simoglou and Roditakis (2022) [56], the age groups were reduced to three for the purposes of the analyses. Of the participants, 22.5% were between the ages of 18 and 34, 58.1% were between the ages of 35 and 54, and 19.4% were older than 55. The vast majority of participants possessed at least a high school diploma and were primarily civil servants (44.1%), private employees (18.6%), self-employed individuals (12.1%), university students (11.7%), and farmers (5.3%). In addition, a number of personal habits relating to free time, smoking, sports participation, and vegetarianism were recorded (Appendix A, Table A1).

3.2. Participants' perspectives on the safety of Greek-produced plant foods in terms of pesticide residues in comparison to those of other EU member states.

The frequency distribution of participants' responses to the research question on whether or not they perceive Greek plant foods to be as safe as those from other EU member states (RQ1) was determined as follows. Strongly disagree (median = 1): n = 125 (6.77%); somewhat disagree (median = 2): n = 290 (15.71%); neither disagree nor agree (median = 3): n = 499 (27.03%); somewhat agree (median = 4): n = 600 (32.50%); Strongly agree (median = 5): n = 332 (17.99%). The median of the responses is 4 (IQR: 1), which in terms of central tendency indicates partial agreement with the statement. Following Simoglou and Roditakis (2022) [56], a binomial proportion test was applied after dividing the response rates into two levels with a binary outcome, i.e. 'agree' and 'disagree'. In accordance with the null hypothesis that the two levels are equally likely (p = 0.50), a non-significantly higher proportion of positive responses was found. The proportion of unfavourable responses was 0.495% (95% CI: 0.472 - 0.518%), n = 914, while the proportion of favourable ones was 0.505% (95% CI: 0.482 - 0.528%), n = 932 (p = 0.692).

3.3. The variables predicting the participants' attitudes towards the safety of Greek-produced plant foods research question

Principal components and logistic regression analyses identified socio-demographic and attitude variables as significant predictors of Greek consumers' perceptions of the safety of Greek-

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produced plant foods relative to those from other EU Member States with respect to pesticide residues (RQ2).

3.3.1. Principal components underlying the participants' attitudes

The analysis included 22 original variables with loadings greater than 0.60. Six principal components (PCs) were retained on the basis of the criterion of eigenvalues, as they explained a significant amount of variance (64.6%) and were considered to reasonably represent the underlying structure of the data (Appendix A, Table A2). The range of reliability coefficients (McDonald's) was 0.698% to 0.865%. The sum of squared loadings (eigenvalues) was greater than 1.0 for each PC. Bartlett's test of sphericity (p 0.001) and the KMO measure of sampling adequacy (0.829) indicated that the correlation matrix was appropriate for principal components analysis.

Four variables account for 13,502% of the variance in the first principal component, which summarizes variables representing "Official information sources" used by participants to learn about pesticides. As information sources, official websites, newsletters from public institutions, scientific periodicals, and agronomists had the strongest correlation with the first PC. Variables loading onto the second PC included participant opinions regarding pesticides' contribution to the national income and to increased food production, the inevitability of pesticide use, and assertions that pesticides' correct application safeguards the user or consumer. Therefore, this is related to "Perceived pesticide benefits" and accounts for 12.706% of the variance. The television and radio, the electronic and printed press, and social media were variables loading to the third principal component, "General information sources on pesticides", which accounts for 10.863% of the variance. Variables loading onto the fourth PC included food labelling and traceability information, and the safety of certified and integrated crop management food products. This is known as "Confidence in traceability" and it accounts for 10.205% of variation. The fifth PC consisted of variables representing "Perceived pesticides' risk", which accounts for 9,008% of the variance. Here contained are variables regarding the participants’ health being at risk due to pesticide residues, their uncertainty regarding the health of their own people, and their concerns regarding pesticide residues in food. The sixth PC was correlated with the participants' perceptions of the safety of plant food consumption, the low risk of consuming fruits and vegetables, and the existence of a framework for the control of pesticide residues in food. This variable is labelled "Perceived plant-food safety" and accounts for 8.288% of the variance.

The relationship of the six PCs is summarized in Figure 1. On the horizontal axis, perceived pesticide risk loads in the opposite direction to perceived plant-food safety, pesticide benefits and consumer confidence in certification, and is negatively correlated with these variables. It is also basically orthogonal to official sources of information, which also implies a rather negative relationship.

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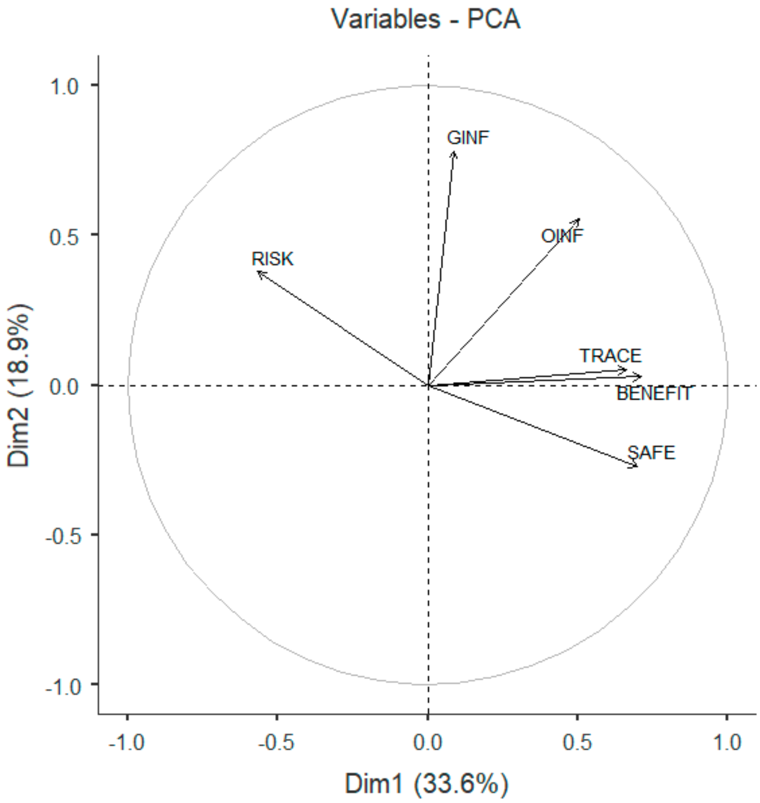

Figure 1. Graph showing the relationship between PCs using principal components analysis: OINF: Official information sources; BENEFIT: Perceived pesticides' benefits; GINF: General information sources; TACE: Confidence in traceability; RISK: Perceived pesticides' risk; SAFE: Perceived plant-food safety.

3.3.2 Predictive variables of participants' perceptions – Logistic regression model

A binary logistic regression analysis was conducted to identify any variables that might predict participants' attitudes towards the safety of plant foods. Specifically, the dependent variable concerns participants' responses to the statement that plant-based foods produced in Greece are as safe as those produced in other EU Member States in terms of pesticide residues. Using a stepwise procedure, background socio-demographic variables and the six principal components previously retained from the PCA were included in the model as potential predictors.

Specificity (percentage of cases correctly negatively predicted) and sensitivity (percentage of cases correctly positively predicted) are the performance parameters of the model. They have values of 0.74 and 0.71 respectively. The overall predictive accuracy of the model, as measured by the AUC value (area under the ROC curve), is 0.79 (Appendix A, Table A3), which is considered a very good model fit.

The regression coefficients for perceived plant-food safety ($b = 0.863$; $p < 0.001$), higher education level ($b = 0.553$; $p < 0.001$), age group ≥ 45 years ($b = 0.423$; $p < 0.001$), official information sources ($b = 0.408$; $p < 0.\ 001$), male gender ($b = 0.308$; $p = 0.010$), confidence in traceability ($b = 0.231$; $p < 0.001$) and perceived benefits of pesticides ($b = 0.228$; $p < 0.001$) are all positive and statistically significant. The results indicate that respondents who report higher levels of plant food safety, are better educated, over 45 years of age, more likely to obtain official information on plant protection products, male, have higher levels of trust in the traceability procedures of plant food production, and perceive greater benefits from plant protection products, have a higher likelihood of accepting the safety of Greek plant food.

The regression coefficients for perceived pesticide risks and pesticide user status are both negative and statistically significant (b = -0.123; $p = 0.045$ and b = -0.327; $p = 0.020$, respectively). This suggests that people are less likely to view plant foods from Greece as safer for pesticide residues than those from other EU countries if they have a high perceived risk of pesticide residues in food, and actually use plant protection products whether for professional or recreational purposes. In order to improve the analysis of the influence of pesticide user status on participants' opinions, certain key variables were controlled for. It was found that people who use pesticides reported a greater sense of safety regarding Greek plant foods compared to those who do not use pesticides (Mann-Whitney U, W = 371,479.0; $p < 0.001$), although this effect size is modest, as indicated by the rank-biserial correlation coefficient of 0.109. Nevertheless, there was a 45.05% probability for pesticide users (n = 788) to agree with the position of reduced monitoring frequency for Greek food compared to the EU. In contrast, individuals who do not use pesticides (n = 1058) had a 32.99% probability of expressing the same attitude ($\chi^2 = 27.860$; df = 1; $p < 0.001$). Similarly, it was observed that those who use pesticides had a 66.87% probability of agreeing with the tendency to consume food that they produce themselves. In comparison, a significantly lower percentage of non-users, 33.13%, showed this level of agreement ($\chi^2 = 146.420$; df = 1; $p < 0.001$). There is a statistically significant, albeit modest, positive correlation between these two original attitude variables (Spearman's $\varrho = 0.10$; $p < 0.001$).

According to the odds ratios, the odds of a participant assuming that Greek plant foods are as safe as in other EU Member States change by a factor of 2.46 (95% CI: 2.17 - 2.79) with each unit change in their propensity towards perceived plant food safety, by 1.73 (95% CI: 1.33 - 2.25) if they have a higher education level, by 1.50 (95% CI: 1.21 - 1. 87) if they belong to the age group ≥45 years, by 1.40 (95% CI: 1.22 - 1.61) with each unit shift towards obtaining official information, by 1.30 (95% CI: 1.05 - 1.62) if they are males, by 1.26 (95% CI: 1.12 - 1.42) with each unit increase in their trust in traceability, and likewise 1.23 (95% CI: 1.09 - 1.39) towards perceived benefits of pesticides. In contrast, participants' odds of perceiving Greek plant foods as safe change by a factor of 0.72 (95% CI: 0.55-0.94) if they are pesticide users and by 0.88 (95% CI: 0.78-1.00) for each unit change in perceived pesticide residue risk.

No other background variables or principal components were found to be significant predictors and are therefore not supported in the model.

3.4. Latent class analysis of the respondents

The Latent class analysis (LCA) was based on the original perception variables relating to the sources of information used by participants to obtain information on pesticide-related issues of general concern. The aim of the analysis was to determine the influence of the public's sources of information on agrochemicals and food safety issues on their perception of the safety of Greek food (RQ3). The analysis included eight original ordinal variables relating to official web pages, public agency bulletins, scientific periodicals, agronomists (official sources of information), television/radio, electronic and print press, and social media (general sources of information).

Based on previous findings by Simoglou and Roditakis (2022) [56], a two-class solution was chosen for further analysis. Class 1 (n = 871), with a prevalence probability of 0.468, comprised respondents who were less likely to agree with the research question (RQ1), as the median of the response distribution was 3 (IQR: 1), corresponding to neither disagreement nor agreement at the level of central tendency. In contrast, the median in class 2 responses (n = 975), which has a prevalence probability of 0.532, was 4 (IQR: 1), indicating a level of partial agreement with the research question. The median difference is statistically significant (Mann-Whitney U, W = 350,100.5; $p < 0.001$).

To further characterize the two groups of participants, the Mann-Whitney U test and the chi-squared test of association were performed, taking into account the focus variables (principal components, or original opinion variables) (Table 1) and the background variables (demographics) (Table 2), respectively. According to the results, class 1 consists of participants with a higher intensity of perceived pesticide residue risks ($p < 0.001$), a higher proportion of females ($p < 0.001$), residents of areas of northern Greece ($p < 0.001$), non-pesticide users ($p < 0.001$), civil servants and university students ($p < 0.001$), and secondary school graduates ($p = 0.011$). Class 2 is characterized by more frequent use of official and general sources of information on pesticides ($p < 0.001$), higher perceived benefits from their use ($p < 0.001$), higher confidence in the role of traceability in food safety ($p < 0.001$) and higher perceived safety of plant foods ($p = 0.001$). They are more likely to be male ($p < 0.001$), to live in southern Greece ($p < 0.001$), to be farmers ($p < 0.001$), to be employed in the private sector ($p < 0.001$), to be self-employed ($p < 0.001$), to be retired ($p < 0.001$) or unemployed ($p < 0.001$) and, finally, to be university graduates ($p = 0.011$). It is important to note that there was no statistically significant difference between the two groups in terms of the participants' high level of concern about their safety from pesticide residues in food ($p = 0.588$). Similarly, no statistically significant difference was observed in their level of neutrality towards the statement that Greek food is less frequently tested for residues compared to other European Union Member States ($p = 0.760$). The age of the participants in both classes did not show a statistically significant difference ($p = 0.738$).

Table 1. Characterization of perceptions between two classes of respondents as they were identified by the LCA on the basis of variables related to information sources (class 1, n=871, "Non-Supporters"; class 2, n=975, "Supporters").

Variables of focus	Mann-Whitney U Test	Rank-Biserial Correlation (*)	95% CI for Rank-Biserial Correlation	
			Lower	Upper
OINF: Official information sources	W = 8,249.0; $p < 0.001$	−0.981	−0.983	−0.978
BENEFIT: Perceived benefits	W = 283,684.0; $p < 0.001$	−0.332	−0.378	−0.284
GINF: General information sources	W = 344,139.0; $p < 0.001$	−0.190	−0.240	−0.138
TRACE: Confidence in traceability	W = 340,339.0; $p < 0.001$	−0.198	−0.249	−0.147
RISK: Perceived pesticides risk	W = 378,416.0; $p < 0.001$	0.109	0.056	0.161
SAFE: Perceived plant-food safety	W = 387,926.0; $p = 0.001$	−0.086	−0.138	−0.034
Pesticide residues in food make me concerned about my safety	W = 428,532.0; $p = 0.588$	0.009	−0.044	0.062
In Greece plant food is not tested for pesticide residues as often as in other EU Member-States	W = 428,008.0; $p = 0.760$	0.008	−0.045	0.061

(*): The rank-biserial correlation indicates the effect size. Negative coefficients are indicative of a greater intensity of attitude towards the test variables in class 2.

Table 2. Sociodemographic characterization of the two obtained classes of respondents.

Background variables		Class 1 (N = 871) "Non-Supporters"	Class 2 (N = 975) "Supporters"	Chi-Squared Test
Gender	Female	54.6 %	45.4 %	$X^2 = 38.183$; df = 1;
	Male	40.2 %	59.8 %	$p < 0.001$

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Age	18–44	47.6 %	52.4 %	$X^2 = 0.112$; df = 2;
	≥45	46.8 %	53.2 %	$p = 0.738$
Place of residence	Rural	40.6 %	59.4 %	$X^2 = 10.908$; df = 1;
	Urban	49.4 %	50.6 %	$p < 0.001$
Region	Northern Greece	52.8 %	47.2 %	$X^2 = 14.271$; df = 2;
	Central Greece	48.8 %	51.2 %	$p < 0.001$
	Southern Greece	42.6 %	57.4 %	
I use pesticides	No	61.6 %	38.4 %	$X^2 = 207.455$; df = 1;
	Yes	27.8 %	72.2 %	$p < 0.001$
Profession	Civil servants	53.1 %	46.9 %	$X^2 = 36.611$; df = 6;
	Farmers	30.6 %	69.4 %	$p < 0.001$
	Private employees	42.2 %	57.8 %	
	Retired	42.5 %	57.5 %	
	Self-employed	37.9 %	62.1 %	
	Unemployed	45.1 %	54.9 %	
	University students	52.6 %	47.4 %	
Education	Secondary education	52.6 %	47.4 %	$X^2 = 6.488$; df = 1;
	Higher education	45.6 %	54.4 %	$p = 0.011$

3. Discussion

The current relevance of food safety and food security lies in its geopolitical and environmental context. The world's growing population and the changing climate trends have heightened concerns about the accessibility and quality of food resources. Moreover, the interconnectedness of nations in terms of trade and resources underscores the need to implement effective strategies to ensure global food safety and security. The Food and Agriculture Organization (FAO) has identified key priorities for food security in its Strategic Framework for 2022-2031. These priorities encompass a range of tactics aimed at strengthening agricultural practices, promoting nutritious diets, protecting the environment and improving overall livelihoods. They aim to ensure universal access to safe and quality food while promoting sustainable agricultural practices [2].

The primary objective of this study was to gain an in-depth understanding of the attitudes and perspectives of Greek consumers regarding the safety of plant-based foods produced in Greece. The study aimed to ensure a comprehensive representation of the opinions of the Greek population by including participants from all regions, including both urban and rural areas. In addition, the sample consisted of individuals from different age groups, educational and professional backgrounds, with an equal distribution of both genders. Furthermore, this study also investigated the impact of information sources on customers' perceptions, providing useful insights into the determinants that shape their perspectives on pesticide residues in Greek plant foods.

The study of the data collected from the participants' responses to the statement under investigation, namely the safety of plant foods produced in Greece compared to other EU Member States in terms of pesticide residues, revealed no significant difference between supportive and opposing responses. Specifically, about half of the participants (49.5%) provided a negative response to the research question. The results of this study suggest that participants may have expressed concerns about the safety of plant-based foods produced in Greece compared to other European Union Member States. The presence of pesticide residues in food is a concern for Greek consumers, as evidenced by their high level of uncertainty. For example, when asked about their level of concern regarding pesticide residues in food and their impact on their safety, respondents expressed strong agreement at the central tendency level. According to a recent special Eurobarometer study conducted by the European Food Safety Authority [43], it was found that a significant majority of Greek participants, up to 99%, showed a personal interest in food safety. Furthermore, these Greek respondents were found to be the most interested among the respondents from the 27 EU Member States. Also, a series of Eurobarometer surveys conducted by the EFSA in 2010 [81], 2019 [82] and 2022 [43] have consistently shown that Greek consumers are more concerned about the presence of pesticide residues in food than their European counterparts. The aforementioned finding that half of the participants have an unfavourable perception of the safety of Greek food with regard to pesticide residues can be seen as an attitude in this particular context.

The evidence suggests that certain factors are associated with the likelihood of individuals endorsing the statement that Greek plant foods are as safe as their European counterparts. These factors include higher levels of education, older age, obtaining information about pesticides from official sources, male gender, expressing greater confidence in the safety and control measures of plant foods, expressing higher confidence in traceability and certification procedures, and perceiving substantial benefits from the use of pesticides. Individuals with a heightened risk perception of pesticide use tend to have unfavourable opinions about the safety of Greek plant foods. This implies that the way individuals perceive risk is an important factor in influencing their opinions about the safety of plant-based diets in Greece. It also highlights the importance of education and the availability of trustworthy information in shaping individuals' perspectives on pesticide use and food safety.

The perceived safety of plant-based foods is a robust and influential factor in shaping consumer perceptions of their safety. Participants generally agreed with the notion that plant-based foods are safe, at the central tendency level. In contrast, participants were neutral towards the statements that consuming fruit and vegetables does not pose a significant risk to consumers, and that plant foods are subject to official testing for pesticide residues. The perceived safety of plant foods highlight the importance of control measures and effective enforcement of pesticide and food safety regulations. According to a recent Eurobarometer survey, 28% of Greek consumers believe that both national and EU authorities effectively protect them from food hazards [82]. This statement suggests that there is a need for greater involvement of food safety authorities in the effective dissemination of information on the potential dangers associated with the use of pesticides to the general population in Greece. Considering the inherent challenge posed by the different risk perceptions of experts and laypersons [5,47,48,50–52,66,87], this is a challenging and demanding task for regulatory authorities. The aforementioned disparities in risk perception highlight the significance of implementing efficient communication strategies that effectively connect experts and the wider community.

Based on our findings, it can be concluded that higher education serves as an important factor in shaping Greek consumers' opinions about the safety of plant-based foods from Greece. An inverse relationship exists between educational level and the perception of higher risk, according to a study conducted by Williams and Hammit (2001) [58]. The more educated the consumers are, the more likely to trust information from public authorities and seem less susceptible to the influence of subjective norms [67]. These findings highlight the importance of education in influencing consumer attitudes towards food safety.

Perceived safety of Greek plant foods is strongly influenced by age, especially for those aged 45 and over. As confirmed by the results of the chi-squared test ($\chi^2 = 8.062$; df = 1; p = 0.005), this finding can be attributed to the increased likelihood of older participants to have a higher level of education than those in the younger age group.

The influence of the male gender on consumer perceptions is significant, resulting in a positive impact on the perception and acceptance of food safety. Several previous studies [56,79,88–91] have shown that female consumers tend to perceive greater risks in various areas, such as chemical residues. The results of this research show that gender has a significant effect on consumer perceptions and attitudes towards the safety of Greek food. It also highlights the need for targeted communication strategies to adequately address the different risk perceptions of individuals of different genders in relation to food safety issues.

The assurance and validation processes for traceability and certification of plant-based foods play a crucial role in shaping consumer perceptions of food safety in Greece. This underlines the importance of transparency and reliability in the processes used to ensure food safety. It is therefore vital that efforts are made to improve and disseminate these techniques in order to increase consumer confidence in food safety. The analysis focuses on the level of trust associated with the original variables, namely the value of the information provided by the labelling of plant foods, the notion of traceability for consumers and the perception of safety promoted by certification, particularly for products certified under integrated crop management. There was a positive consensus among the participants on all the variables mentioned. According to Ueland et al. (2012) [66], in the absence of direct control, trusted entities have the potential to take on the responsibility of consumer control. The results of our study indicate that consumers rely on certification, information provision and labelling as mechanisms to guarantee the quality of the food they purchase. This finding is consistent with previous research [88,92–98].

The influence of the perceived benefits of pesticides seems to shape the participants' perceptions in support of the assertion that Greek food is as safe as European food. The analysis of the predictor focuses on the constitutive variables related to the contribution of pesticides to the national income, their indispensability in ensuring crop production and food security, the inevitability of agrochemical use, and the notion that the proper use of pesticides can protect both the user and the consumer. In central tendency, respondents expressed agreement with all of the above items. The results of this study indicate that people's attitudes and perceptions of the safety of Greek food are influenced by their beliefs about the benefits associated with the perceived risk of pesticide residues [56,99]. Therefore, comprehending individuals' attitudes towards an issue could offer valuable insights into their perspectives and risk viewpoints. Furthermore, these findings emphasise the significance of weighing both perceived benefits and risks when formulating evaluations or decisions on controversial issues.

According to Slovic et al. (1980) [100], the key factor influencing risk assessment is risk perception. The participants' assessment of the risk associated with pesticides residues has a negative impact on their attitudes and beliefs about the safety of Greek food. This observation is consistent with the conclusions of Huang (1993) [101]. The participants' level of concern for their health and the health of their loved ones is influenced by their perception of the risk associated with pesticides. In addition, the presence of pesticide residues in food contributes to their concern for personal health. According to the results of this study, Greek consumers place a high priority on their own health and that of their loved ones when it comes to food safety. These results are broadly in line with the results of the special Eurobarometer survey on Greeks' concerns about pesticide residues in food [43]. Meagher (2019) [74] found that people feel more in control of biological food risks than chemical/technical risks. Dickson-Spillmann et al. (2011) [90] suggested that consumers show dose insensitivity, which leads to an increased risk perception of chemicals. Poor understanding of the regulatory system and legal limits for residues in food could also potentially contribute to increased risk perceptions [79]. Furthermore, the divergence between expert and non-expert perspectives on chemical hazards contributes to the complexity of this issue [5,47,48,50–52]. Understanding these factors can help policy makers and stakeholders develop effective strategies to address public concerns and improve risk communication. It is important to recognize that perceived risk plays a significant role in shaping people's attitudes and responses to controversial issues or products, so it is essential to take these perceptions into account when making informed decisions.

Participants' perceived safety of Greek food is negatively influenced by their user status, according to the regression model. This might not be expected given the findings of Simoglou and Roditakis (2022) [56], who documented that pesticide use positively influences the perception of the risk-benefit trade-offs associated with pesticide use, and the results of the present study on their

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supportive, though modest, attitudes towards the safety of Greek plant foods. However, the effect found may be attributable to the differences in views identified between individuals who use pesticides and those who do not. Our results provide evidence that pesticide users are significantly more inclined to agree with the statement that Greek food is not tested as frequently in the national monitoring programme as food from other EU Member States. In addition, pesticide users, whether professional or amateur, are also the most likely to consume plant foods that they have grown themselves, compared to individuals who do not use pesticides. The above findings could indicate an inherent behaviour that contributes to a general pessimistic effect in the regression model among users regarding the safety of Greek food. The results of this study suggest that those who use pesticides may have an increased sense of control and confidence in the safety of the agricultural products they produce. The phenomenon described may be associated with a sense of familiarity, as outlined in the literature. This can decrease feelings of uncertainty and enhance perceived control [66]. According to Leikas et al. (2009) [102], people tend to take personal responsibility for risks within their control, but not for risks beyond their control. However, it is imperative that further research is conducted to examine the underlying factors that contribute to these differences in attitudes and behaviours towards Greek food safety and the consumption of home-grown food. Furthermore, the notion that Greek food is less regularly tested may serve to reinforce the perception that it is comparatively less safe than food from other European Union Member States. It is worth mentioning that the 2021 EU report on pesticide residues in food [39] demonstrates Greece collected 36.26 samples per 100,000 residents, surpassing the EU average of 30.29. In addition, the percentage of non-compliant samples was found to be 3.14% in Greece, which is lower than the EU average of 3.65%, as determined by the exceedance of MRLs taking into account the measurement uncertainty.

The importance of information is significant in shaping consumer perceptions of pesticide use. The acquisition of pesticide-related information from authoritative sources is a strong indicator of individuals' favourable perceptions of the safety of Greek food. This suggests that the provision of reliable, objective information on the regulations and risk assessments regarding pesticide usage in Greek agricultural crops is crucial in shaping consumer opinions and attitudes. The principal components analysis (PCA) revealed the existence of a strong association between official information sources on pesticides, official websites, newsletters of public authorities and scientific publications with the principal component of ‘official sources of information’, while agronomists are the main providers of information on pesticides. In terms of the central tendency, participants expressed a preference for agronomists as their primary source of knowledge about pesticides, with occasional use of official websites, public authorities newsletters and scientific periodicals. The predictive power of general information sources, such as electronic press, TV/radio, press and social media, on consumer views was found to be insignificant.

A number of socio-demographic characteristics were also examined to determine their influence on the participants' assessment of the safety of Greek plant-based foods. These included place of residence, whether urban or rural, number of young children in the household, amount of leisure time available, smoking behaviour, adherence to vegetarianism, physical activity and occupation. The regression model showed no statistically significant effects of these factors on respondents' opinions.

Consumer information on pesticides and related food safety concerns is a major focus of this study. In order to further investigate the influence of information on the development of consumer opinions about the safety of Greek plant foods, two distinct consumer groups were identified using latent class analysis. The analysis was carried out on the basis of participants' responses to questions about the frequency with which they were exposed to information about pesticides from a range of information sources. The first group (class 1) consisted of people who often receive limited information about pesticides. This group includes individuals who disagree with the assertion that plant-based foods produced in Greece have an equivalent level of safety compared to those produced in other European Union Member States. Consumers with the above characteristics have a lower perceived benefit from pesticide use, less trust in traceability initiatives, greater concern about the risks of pesticide residues and less confidence in the safety of plant-based foods. This particular group of consumers is predominantly female, mainly abstains from pesticide use and is disproportionately represented among public servants and university students. The second group (class 2) of participants consists of individuals who are typically involved in obtaining information on pesticides from official or general information sources, with particular emphasis on official sources. This class includes individuals who support the assertion that plant foods from Greece have an equivalent level of safety to those produced in other Member States of the European Union. This group includes those who recognise the beneficial role of pesticides, those who have confidence in the traceability of food, those who perceive less risk from pesticides and those who have increased confidence in the safety of plant-based foods. This group consists mainly of males, people living in rural areas, people who use pesticides, farmers, people employed in the private sector, retired people, self-employed people and people who are currently unemployed.

The current study provides a contribution to the existing literature by classifying participants into two discrete categories: consumers who are engaged (class 2) and consumers who are not engaged (class 1) in the process of seeking information about pesticides and associated food safety concerns. This approach makes it easier to examine both the differences and similarities between these two groups of consumers. For instance, both groups of consumers exhibited a notable agreement regarding the potential adverse impacts of pesticide residues in food on their individual well-being (median = 5; IQR = 1; indicating strongly agree), and additionally, both groups expressed a neutral stance towards the frequency of Greek food testing in comparison to other EU Member States (median = 3; IQR = 1 for class 1; IQR = 2 for class 2; indicating neither disagree nor agree), with no statistically significant difference. Nevertheless, it was shown that consumers belonging to class 1 had elevated perceived risk scores and greater levels of worry in the comprehensive assessment of pesticide risk, as identified using principal component analysis.

It is crucial to assess the underlying knowledge base and belief systems, as well as the factors that contribute to these belief systems, such as consumer information behaviour, in order to understand the lifestyle choices that individuals make. This involves examining how individuals actively seek and cognitively process information about pesticides and food safety, while also considering the impact of socio-demographic and intrinsic characteristics on their risk perceptions. By understanding these variables, policymakers and educators can formulate targeted interventions to improve public understanding and decision-making regarding Greek food safety.

The results of the present study are consistent with the research conducted by Mazzocchi et al. (2008) [103], which highlighted the influence of trust in information from different sources on individuals' risk perceptions. In particular, the use of information from authoritative sources was found to reduce risk perception, while the provision of information from alternative sources tended to increase it. Therefore, the consumption of food safety news is likely to have a significant impact on the formation of individual and public perspectives on the entities responsible for the hazards associated with food safety crises [12]. Furthermore, Rembischevski and Caldas (2020) [104] have highlighted that the subjective aspects of humans, such as emotions and intuition, play a significant role in shaping their perceptions of the risks and benefits associated with food. These subjective factors appear to have a greater influence than rationality and decisions based on technical and scientific knowledge. Risk communication techniques that focus solely on filling scientific knowledge gaps may prove ineffective unless they are complemented by methods that recognize and respect the human dimension that influences individuals' views. The study by Koch et al. (2017) [79] showed that an improved understanding of the regulatory framework associated with pesticides led to a reduction in reported levels of perceived risk. Siegrist (2021) [59] posits that individuals who demonstrate trust in the official regulatory bodies tasked with risk management are more likely to have a favourable perception of a controversial issue. This is attributed to the fact that trust in public authorities acts as a moderating factor in the association between fear and decision to take action [67]. The effective mitigation of food safety concerns can be achieved through the implementation of pesticide residue monitoring and control systems [57]. This can be further enhanced by integrating risk communication strategies that successfully address apprehensions regarding the dependability of regulatory processes and information sources [48].

The process of making informed decisions relies on the availability of information that has the dimensions of accuracy, completeness, reliability, relevance and timeliness, as stated by Miller (1996) [105]. Therefore, it is imperative to collect and evaluate data from reliable sources before making important decisions. By advocating for the development of media, information and news literacy as an essential skill, policymakers can enhance the ability of citizens to effectively navigate the vast amount of information available to them, and thereby discriminate between trustworthy and untrustworthy sources. According to McGonagle (2017) [106], this does not only serve to improve the process of individual decision making, but also contributes to the development of a more educated and actively engaged society, thereby enabling the ability to make decisions based on informed knowledge.

There are several inherent limitations to our research. First of all, it is important to acknowledge that our results inevitably exclude individuals who are not proficient in communication technology, as they are only derived from a web-based survey distributed via email, Messenger and Viber, or online news forums and magazines. Individuals with these characteristics may be less educated or older. In addition, the data were collected through self-reporting, with no mechanisms in place to verify their accuracy. It should also be noted that although the sample used in this study is from a nationwide pool, it may not be an accurate reflection of the Greek population as a whole in various respects, such as education, occupation and individuals over the age of 65.

5. Conclusions

The aim of this study was to provide an in-depth understanding of the factors that influence Greek consumers' views on the safety of Greek plant-based foods compared to those produced in other EU Member States, with a particular reference to concerns about pesticide residues. Concurrently, the main focus of this study is to examine the influence of pesticide-related information on the perceptions and attitudes of Greek consumers towards food safety. The study found that Greek consumers have a balance between two conflicting perspectives on the safety of Greek food. Half of the respondents believe that Greek food has a level of safety comparable to other European foods, while the other half hold the opposite view. Several predictive factors have been identified that influence the dichotomous nature of Greek consumer behaviour. These factors include perceived safety of plant foods, higher education level, age, gender, perceived contribution of traceability to food safety, perceived benefits of pesticide use, perceived risk of pesticide residues in food, pesticide user status, and information obtained from authoritative-official sources. Obtaining information about pesticides and related food safety concerns emerges as a crucial determinant in shaping consumer perspectives. Receiving authoritative-official information was found to be associated with a reduction in risk perception and improved scores in focus-opinion variables, and a positive response to the research question on Greek food safety.

The results of our study suggest potential implications for the importance of providing accurate and timely information to the public. First, it is of utmost importance that administrative and regulatory institutions prioritize transparency in their risk communication strategies. It is highly important to give careful consideration to the impact of socio-demographic and other intrinsic attributes on individuals' perceptions of risk. By doing so, regulators can effectively build trust and credibility with consumers. It is also essential to ensure the efficient dissemination of official information across multiple platforms, including websites, social media platforms and public awareness campaigns. However, it is crucial to prioritize the maintenance of direct communication channels between public institutions and consumers. Such mechanisms, like agricultural warning services, or peripheral agriculture directorates should be further developed to take on an expanded role in informing the general public about food safety issues. Ensuring effective risk communication channels between public institutions and consumers, bridging the gap between experts and the general public, is essential to address concerns and inquiries and ultimately promote transparency and accountability. In addition, tailoring risk communication strategies to different socio-demographic sub-groups can ensure the effective delivery of information in a way that is understandable and relevant to a wide range of people, thereby promoting greater uptake and engagement. In addition, collaboration with other stakeholders such as consumer and producer organizations can further strengthen these communication initiatives.

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Appendix A

Table A1. Sociodemographic characteristics of the respondents (n = 1,846).

Demographic variables		Frequency	Percentage
Gender	Female	896	48.5%
	Male	950	51.5%
Age	18 – 24	220	11.9%
	25 – 34	195	10.6%
	35 – 44	404	21.9%
	45 – 54	669	36.2%
	55 – 64	304	16.5%
	≥ 65	54	2.9%
Educational background	Less than high school	31	1.7%
	High school – Technical education	397	21.5%
	Bachelor’s degree	727	39.4%
	Master's degree	565	30.6%

	Doctoral degree	126	6.8%
Residential geographical area	Northern Greece	540	29.3%
	Central Greece	473	26.6%
	Southern Greece	833	45.1%
Population of place of residence	Less than 10,000 inhabitants (rural)	468	25.4%
	More than 10,000 inhabitants (urban)	1378	74.6%
Underage children in the family	No	1027	55.6%
	Yes	819	44.4%
Plenty of spare time	No	735	39.8%
	Yes	1111	60.2%
Smoking habits	No	1404	76.1%
	Yes	442	23.9%
Vegetarian by choice	No	1722	93.3%
	Yes	124	6.7%
Physical activity habits	Never	243	13.2%
	Occasionally	1207	65.4%
	Systematically	396	21.4%
Professional or amateur pesticide users	No	1058	57.3%
	Yes	788	42.7%
Occupation	Civil servants	814	44.1%
	Private employees	344	18.6%
	Self-employed	224	12.1%
	Farmers	98	5.3%

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	Unemployed	71	3.9%
	University students	215	11.7%
	Retired	80	4.3%

Table A2. Results of the principal component analysis.

Original variables (5-point Likert scale statements)	Median [(1)]	IQR [(2)]	Principal components: OINF Official information sources	BENEFIT Perceived pesticides' benefits	GINF General information sources	TRACE Confidence in traceability	RISK Perceived pesticides' risk	SAFE Perceived plant-food safety	Uniqueness [(3)]
Official Websites as source for pesticide information	3	2	0.918						0.185
Newsletters from public institutions "	3	2	0.866						0.259
Scientific periodicals "	3	2	0.853						0.270
I receive information on pesticides from Agronomists	4	3	0.712						0.428
Pesticides contribute to national income growth	4	1		0.836					0.383
Pesticides help increase food production	4	1		0.797					0.441
The use of agrochemicals is an unavoidable fact	4	2		0.719					0.470
The correct use of pesticides safeguards the user	4	2		0.697					0.418
The proper use of pesticides protects the consumer	4	2		0.652					0.411
My information sources about pesticides are TV/Radio	2	2			0.791				0.358
" Electronic Press	3	2			0.789				0.282
" Press	2	2			0.743				0.373

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Social Media	2	2			0.716				0.483
Labelling (traceability) reassures me	4	1				0.865			0.273
Safety of certified food products	4	1				0.843			0.303
Products from Integrated Crop Management are safe	4	1				0.819			0.310
I feel that my health has been at risk	3	1					0.820		0.288
I feel uncertain about the health of my own people	4	2					0.793		0.424
Pesticide residues in food make me concerned about my safety	5	1					0.787		0.347
Food of plant origin is generally safe to consume	4	2						0.893	0.295
The consumption of fruit and vegetables does not generally pose a risk to the consumer	3	2						0.733	0.345
Plant-based foods are tested for pesticide residues	3	2						0.636	0.450
Sum of the squared loadings			2.970	2.795	2.390	2.245	1.982	1.823	
Scale reliability (McDonald's ω)			0.865	0.796	0.774	0.795	0.720	0.698	
Explained variance %			13.502	12.706	10.863	10.205	9.008	8.288	
Cumulative variance %			13.502	26.208	37.071	47.275	56.283	64.571	
Bartlett's Test of Sphericity	$X^2 = 14{,}294.113$; df = 231; $p < 0.001$								
KMO Measure of Sampling Adequacy test	0.829								

(1): Median of the distribution of participants' answers to the 5-point Likert scale questions (1 = never to 5 = usually, or 1 = strongly disagree to 5 = strongly agree, whichever applies).

(2): Interquartile range

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[3]: Proportion of variance that is "unique" to the variable and not explained by the PCs. Uniqueness equals 1-communality. The lower the uniqueness, the higher the relevance of the variable in the PC model.

Note: "promax" rotation was used, variable loadings > 0.6 and uniqueness < 0.5 were selected.

Table A3. Results of binomial logistic regression analysis.

Model coefficients – Dependent variable: *Plant-food produced in Greece is as safe as in other EU member-States in term of pesticide residues*

				Wald test				95% Confidence Interval	
Predictor	**Estimate, b**	**Standard error**	**z**	**Statistic**	**df**	***p***	**Odds ratio**	**Lower**	**Upper**
Intercept	−0,637	0,145	−4,399	19,353	1	<0,001	0,529	0,398	0,702
SAFE (*Perceived plant-food safety*)	0,863	0,066	12,991	168,755	1	<0,001	2,369	2,080	2,698
Higher education	0,553	0,134	4,129	17,045	1	<0,001	1,738	1,337	2,260
Age group ≥45 years old	0,423	0,112	3,773	14,233	1	<0,001	1,527	1,226	1,903
OINF (*Official information sources)*	0,408	0,063	6,468	41,836	1	<0,001	1,504	1,329	1,701
Male gender	0,308	0,116	2,657	7,058	1	0,010	1,361	1,084	1,708
TRACE (*Confidence in traceability*)	0,231	0,062	3,702	13,707	1	<0,001	1,259	1,115	1,423
BENEFIT (*Perceived pesticides benefits*)	0,228	0,065	3,524	12,420	1	<0,001	1,256	1,106	1,426
RISK (*Perceived pesticides risk*)	−0,123	0,061	−2,006	4,024	1	0,045	0,884	0,784	0,997
Pesticides user status	−0,327	0,137	−2,395	5,736	1	0,020	0,721	0,551	0,942

Predictive measures: AUC = 0.790; Sensitivity = 0.709; Specificity = 0.736

Note: Estimates represent the log odds of "Plant-food produced in Greece is as safe as in other EU member-States = 1" vs. "Plant-food produced in Greece is as safe as in other EU member-States = 0"

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