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Research article

Cultured meat: A survey of awareness among Greek consumers

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Abstract: As the technology of cultured meat continues to evolve and reach the market, it is important to understand the dynamics of consumer attitudes and preferences in order to provide insights into the potential adoption of cultured meat in Europe. Our aim was to explore the attitudes of Greek consumers, via an online survey addressed to 1230 consumers. The results revealed that only 39.35% of participants in this survey were aware of the term "cultured meat", but 55.69% would be willing to try it with the group of young (18–25 years old) being more willing to try compared to >25 years old and also male and graduates. Among the perceived benefits, the first rated benefit was the contribution to animal welfare, followed by the lower environmental impact of cultured meat. The highest concerns about the potential negative consequences of cultured meat were about the unknown long-term adverse health effects and about a negative impact on the local livestock producers. Most of the respondents (80.73%) agreed that cultured meat is an artificial product. In conclusion, our results revealed a level of skepticism and reservations regarding cultured meat among Greek consumers and addressing public concerns might be especially important to increase public acceptance of cultured meat.

Key words: animal welfare; attitudes; cultured meat; environmental impact; preferences; survey

1. Introduction

Global meat production is expected to increase by nearly 44 Mt by 2030, reaching a total of 373 Mt, according to a report by the OECD-FAO [1]. This increase in meat demand, combined with an expected global increase in population by 11%, will exert enormous pressure on modern livestock farming which will face vital issues of sustainability, efficiency and environmental management of meat production systems. Another problematic aspect of conventional meat production in animal farms is the fact that it is considered responsible for 15%–24% of greenhouse gas production, as well as for the greater use of land and water per kg of protein produced. Furthermore, in recent years, a large part of the population, especially in developed countries has become more sensitive regarding intensive forms of animal husbandry, as well as the welfare and killing of animals in the meat production sector [2,3]. Consumers have also expressed awareness about food security in meat production systems, in terms of traceability and the use of antimicrobial agents in feed, and prefer antimicrobial-free meat due to the global risks associated with antimicrobial resistance [4].

These concerns highlight the need for the development of a new meat production method that may overcome the skepticism surrounding livestock meat production in farms. In this complex environment and to address all the modern problems of world meat production, new forms of protein food production are being sought that will be able to ensure the future needs of the population, while successfully addressing the challenges that threaten the sustainability and effectiveness of the system [5].

The technology for the production of meat through cell culture, in an artificial environment, without raising animals, is a relatively modern and innovative technology that promises to solve the problem of sustainability and ensure the satisfaction of global demand without consumers having to change their habits regarding their food choices [6,7]. The methodology involves selecting a small number of stem cells from an animal and then cultivating them externally in bioreactors, in order to multiply and differentiate into muscle fibers to create muscle tissue. The final product consists of a mass of muscle tissue, which can be processed in the same way as conventional meat to produce processed meat products [8]. Although the creation of cohesive pieces of meat, similar to the various pieces of conventional products, has not yet been achieved, the technology is at an early stage and there are prospects for further development and application.

The benefit of cultured meat is primarily that it does not require large-scale farming practices, there is no need for the slaughter of animals, and the impact of meat production on the environment is greatly reduced. Additionally, the constant supply of the population with high-quality and nutritionally safe protein is ensured [9].

Determinants of meat consumption are complex and factors such as demographics, urbanization, incomes, prices, tradition, religious beliefs, cultural norms, as well as environmental, ethical/animal welfare, and health concerns affect not only the level but also the type of meat consumption [10]. Although cultured meat is not available in the Greek market, on the EU market, where 40% of the global cultured meat companies are established [7], it is expected that the product will be introduced within the next few years. The global cultured meat market size reached US$ 184.4 million in 2022 and is expected to reach US$ 388.0 million by 2028, with a growth rate of 13.4% between 2023 and 2028 [11]. Consumer acceptance or resistance of cultured meat is of critical importance for the success of this new food technology. Although there is a trend observed in consumer preferences towards less meat consumption in high income countries, recent studies have revealed mixed attitudes

toward cultured meat. Levels of acceptance vary widely, with estimates ranging from around 25% to 65% [12,13].

As previous research on cultured meat showed that it is a novel food produced through an emerging technology, it is expected that consumer acceptance, related to product, health, psychological, and similar factors, will largely determine its way to market. The present investigation was undertaken to explore the responses of Greek consumers to cultured meat through their awareness of cultured meat (e.g., production, willingness to consume instead of meat consumption), views towards cultured meat (disadvantages or benefits, comparison to meat, taste, texture, health effects, "unnatural" product), and willingness to pay higher prices for cultured meat. By considering these factors, a contribution to a comprehensive understanding of consumer acceptance of cultured meat is made, and insights are developed to guide further developments in the field.

2. Materials and methods

2.1. Compilation of the online survey

The online consumer survey was designed and administered through the European electronic questionnaire compilation tool "EU survey" in the Greek language, protecting personal data and anonymity. Before being disseminated, a preliminary run was conducted. The questionnaire was approved by the Research Ethics Committee of the University of West Attica (number of approval 30575/22-03-2022). Participants were asked to consent to taking part in the study before answering any questions, and they were informed about the aim of the study. The distribution of the survey was conducted via electronic media invitations for participation. The recipients were a number of departments of Hellenic Universities, the Hellenic Association of Food Scientists and Technologists, consumer associations, retailer associations, and Hellenic associations of vegans, which distributed it to their members. Two invitations for participation were sent within a period of five months. The questionnaire was structured into five sections and was based on previous studies [12,14,15] with some adaptations.

2.2. Sociodemographic data

The first section of the questionnaire concerned the sociodemographic characteristics of the respondents through 4 closed-ended questions, regarding age, gender, level of education, and occupation.

2.3. Consumer behavior towards meat consumption

The second section of the questionnaire analyzed meat consumption and consumer purchasing behavior through 4 questions: a) Whether the respondents eat meat (yes/no), b) if yes, from where do they purchase meat, c) if yes, how often do they consume meat (every day, once a week, more than once per week, once a month, twice per month), and d) if no, which are the reasons for not eating meat (meat is expensive, animal ethics, meat is not healthy, protection of natural resources, do not like meat, meat contains antibiotics, other).

2.4. Consumer awareness about cultured meat

The third section initially explored the participants' awareness of cultured meat asking whether they had ever heard of the term "cultured meat" (yes/or no). Then, specific "neutral" information about the way the cultured meat is produced was given to the respondents as shown in Figure 1, in order to achieve a uniform level of awareness before assessing the next variables. The following text was also included: "Initially, stem cells are collected from cows and placed in a laboratory cell culture. The resulting muscle cells are placed in the bioreactor (phase 1) where they multiply. Then, the cells attach to a surface to be cultured in a healthy way, that is, in microcarriers. In the next step, the cells are followed modified in the bioreactor (phase 2) in order to form muscle mass. Finally, the muscle mass is collected and processed in order to create the final product (burger, steak etc.)".

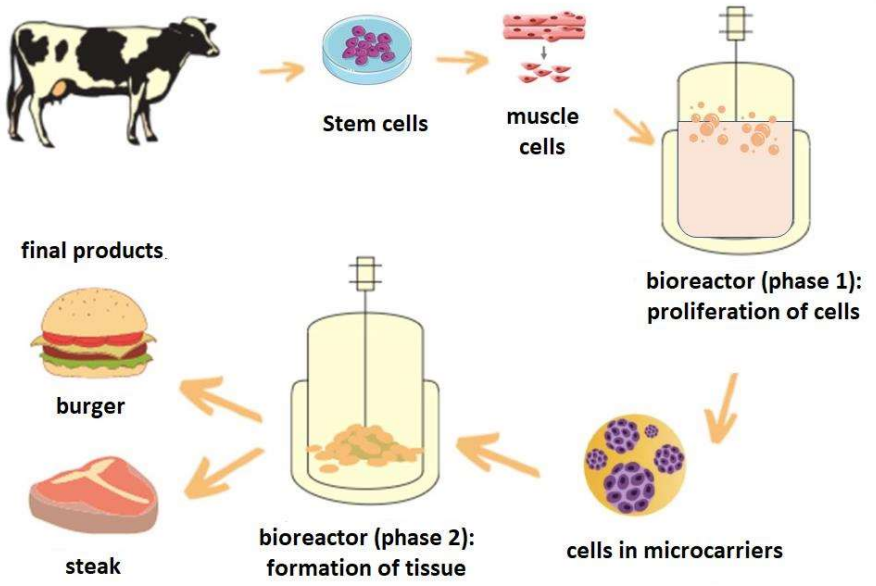

Figure 1. Simplified diagram of cultured meat production process presented to respondents (Figure edited by Aliki Papoutsi, MEng).

After the information was presented, two questions followed: a) A question aiming to assess the perception of respondents regarding the taste and texture of cultured meat compared to conventional meat and b) a 5-point scale (1 = totally disagree to 5 = totally agree) group of questions assessing the degree of perceived benefits of cultured meat compared to conventional meat (premium product, more healthy, tastier, better texture, more economic, more environmentally friendly). For each question a score was created by taking the average of points and a score > 3 was considered a positive response towards the statement, since level 3 of the scale was a neutral option (neither disagree nor agree). Besides the 5-point scale, the optional answer of "do not know" was also provided.

2.5. Consumer views towards cultured meat

The fourth section explored participants' general views, as well as perceived disadvantages or

benefits regarding cultured meat through three groups of 5-point scale questions (1 = totally disagree to 5 = totally agree) and the optional answer of "do not know". Similarly, as above, a score of > 3 was considered positive responses to a statement. The general views were investigated in the first group of questions assessing the belief whether: a) Cultured meat will be common in the future; b) science intervenes excessively in the food chain; c) cultured meat is a synthetic product; d) the respondents would be willing to try it; e) it is an appropriate choice for vegetarians; and f) it would be more ethical than conventional meat. The second group of questions assessed the perceived potential disadvantages from the production or consumption of cultured meat such as: a) Less nutritional value than conventional meat; b) unknown adverse health effects from the consumption; c) negative effects on livestock farmers; d) negative effects in the Greek meat industry; e) lack of traceability methods for cultured meat; and f) cultured meat is an unnatural product. The third group of questions investigated the perceived potential benefits of cultured meat such as: a) Better animal welfare (no death of animals); b) lower environmental print; c) free from antibiotics and hormones; d) nutritionally controlled; and e) contribution to meat global demand.

2.6. Willingness of consumers to pay more for cultured meat

In the last section of the questionnaire, the willingness of the respondents to buy the cultured meat and the price they would be willing to pay, are investigated through four closed-ended questions: a) "Would you be willing to pay the same price for cultured meat as conventional meat" (yes, no, maybe); b) "Would you be willing to pay a lower price for cultured meat than conventional meat?" (yes, no, maybe); c) "If you are willing to pay more for cultured meat and assuming that minced beef costs 8 euros/kilo, how much more would you be willing to pay?" (more than 10%, more than 20%, more than 30%, do not know); and d) "If you are not willing to pay more for cultured meat and assuming that minced beef costs 8 euros/kilo, how much would you be willing to pay?" (10% less, 20% less, 30% less, do not know).

2.7. Statistical analysis

A total of 1230 respondents took part in the survey. The data analysis was performed using the software package SPSS 29.0.0 ®. Pearson's chi-squared (χ^2) tests with crosstabs were carried out in order to assess statistical relationships among the responses concerning awareness, willingness to try and general opinions towards cultured meat versus the age, gender and level of education of respondents. The responses from the 5-point scale were treated as nominal variables since the answer "do not know" was included for Pearson's χ^2 tests (Ho, 2006). The statistical significance of the results was based on the probability value (p-value). Results with $p < 0.05$ were statistically significant, indicating a confidence level of 95 per cent. The hypotheses assessed were:

H0. There are no significant differences between age, gender, level of education vs. awareness, willingness to try and general opinions towards cultured meat.

H1. There are significant differences between age, gender, level of education vs. awareness, willingness to try and general opinions towards cultured meat.

The statistical strength was tested using the Cramér's V. Values between 0.06 and 0.17 indicate small statistical strength. A medium statistical strength is denoted by values V = 0.18 to 0.29.

3. Results

3.1. Sociodemographic results

The online survey was completed by 1230 participants, of whom 62.52% were women, almost half (48.6%) of the participants were 18–25 years old, and 82.28% were below 45 years of age. It should be noted that a very small sample of people over 65 years of age was collected probably due to the online nature of the survey, which constitutes a barrier for people with fewer digital skills. A total of 55.2% of respondents had university-level education and were either students (45.04%) or in the workforce (46.83%) (Table 1).

Table 1. Sociodemographic data of the on-line survey participants.

Demographic variable	Sample (%) (*n* = 1230)
Gender	
Male	36.34
Female	62.52
No answer	1.14
Age	
18–25	48.62
26–45	33.66
46–65	16.59
> 65	1.14
Education	
Primary	0.57
Secondary	10.49
University	55.2
Post graduate	33.74
Occupation	
Working	46.83
Student	45.04
Other	8.13

3.2. Consumer behavior towards meat consumption

The largest percentage (91.54%) of the respondents in this study consume meat, in a relatively frequent manner (75% of them consume meat more than once a week). Only a low percentage (8.46%) of the participants have stated that they do not eat meat (Table 2). This percentage indicates that vegetarianism is quite limited in Greece. Among the vegetarian respondents of this study, the strongest reason for not eating meat was “animal ethics” followed by “protection of natural resources”.

Table 2. Trends in meat consumption by participants of the survey.

Description	Sample (%)
Do you eat meat?	(*n* = 1230)
Yes	91.54
No	8.46
If yes, how often do you consume meat:	*(n* = 1124)
Every day	9
Once a week	13
More than once a week	75
Once a month	2
Twice a month	1
Where do you buy meat?	*(n* = 1124)
Super market	54
Butchery	76
Meat market	5
Family produce	9
Other	2
If no, reason for not eatingmeat:	*(n* = 104)
Animal ethics	91
Protection of natural resources	60
Meat not healthy	48
Meat contain antibiotics	35
Do not like meat	17
Meat is expensive	7
Other	52

3.3. Consumer awareness about cultured meat

The largest percentage (60.65%) of participants in this survey were not aware of the term "cultured meat" (Table 3). However, a statistical relationship with a small strength of association was found between awareness of cultured meat and age (p = 0.001), level of education (p = 0.000) and gender (p = 0.003), with respondents in the age group 18–25 years, graduates and males being more aware (Table 4). A simple figure (Figure 1) indicating how cultured meat is produced was shown to respondents at this point of the questionnaire before they answered the next questions. In spite of the information given, many respondents were uncertain about the general opinion questions that followed (Table 3). Regarding the willingness to try cultured meat, more than half of the respondents (55.69%) stated that they would be willing to try it, with a statistically significant (p = 0.000) relation of small strength to age, level of education (p = 0.003), gender (p = 0.033) (Table 4). Respondents aged 18–25 years old, university students or graduates and males were more willing to try. One of the strongest opinions stated was about the "artificiality" of cultured meat (80.73%), a variable that was also found to be statistically significant with gender (p = 0.003). The question of whether cultured meat would be a suitable choice for vegetarians was answered positively only by one fourth (24.72%) of the respondents. Awareness in general can lead to higher willingness to reduce meat consumption, which, consequently, positively influences willingness to engage [10].

Table 3. Awareness and general opinion about cultured meat.

Question	Responses (%)		
	Yes	No	Maybe
Have you ever heard of "cultured meat"	39.35	60.65	Non available
Do you believe cultured meat will have the sametaste and texture as conventional meat?	15.37	28.29	56.34
Cultured meat will becommon in the future	35.04	6.99	57.97
Science intervenes excessively in the food chain	54.72	23.50	21.79
Cultured meat will be anartificial product	80.73	6.50	12.76
I would be willing to try cultured meat	55.69	20.57	23.74
Cultured meat could be a good choice for vegetarians	24.72	38.37	36.91
Cultured meat would be more ethical than conventional meat	40.24	29.59	30.16

Table 4. Summary of Pearson x^2 results on age, gender and level of education vs awareness of cultured meat, willingness to try and general opinions about cultured meat.

Question	Age			Gender			Level of education		
	x^2	p-value	Cramér'sV	x^2	p-value	Cramér'sV	x^2	p-value	Cramér'sV
Have you ever heard of "cultured meat"	15.664	0.001	0.113	11.935	0.003	0.099	26.754	0.000	0.147
Culture meat has same taste and texture	4.618	0.594	0.061	21.820	0.000	0.094	8.587	0.198	0.084
Culture meat will be common in the future	15.761	0.015	0.080	16.692	0.002	0.082	14.610	0.024	0.077
Science intervenes excessively in the foodchain	33.642	0.000	0.117	14.407	0.006	0.077	13.635	0.034	0.074
Culture meat is an artificial product	7.978	0.240	0.057	16.388	0.003	0.082	8.682	0.192	0.059
Willingnessto try cultured meat	41.258	0.000	0.130	10.458	0.033	0.065	20.017	0.003	0.090
Cultured meat couldbe a good choice for vegetarians	23.171	0.001	0.097	1.407	0.843	0.024	10.813	0.094	0.066
Culturemeat is more ethical	23.411	0.001	0.098	15.184	0.004	0.079	12.406	0.053	0.071

Table 5. Comparison of cultured meat versus conventional meat and perceived advantages and disadvantages of cultured meat.

Question	Mean value (scale 1 = totally disagree to 5 = totally agree)	S.D.
Cultured meat will:		
be a premium product vs conventional meat	2.73 (n = 963)	1.30
be healthier vs conventional meat	2.59 (n = 1010)	1.26
be tastier vs conventional meat	2.25 (n = 982)	1.00
have better texture vs conventional meat	2.55 (n = 974)	1.12
be cheaper vs conventional meat	2.82 (n = 1066)	1.35
be more environmentally friendly vs conventional meat	3.75 (n = 1110)	1.28
Possible advantages of cultured meat:		
Contribution to animal welfare (no death of animals)	3.83 (n = 1159)	1.24
Lower environmental imprint	3.78 (n = 1101)	1.18
Free from antibiotics and hormones	2.98 (n = 976)	1.35
Nutritionally controlled	3.49 (n = 1060)	1.16
Contribution to global meat demands	3.60 (n = 1095)	1.25
Possible disadvantages of cultured meat:		
Lower nutritional value vs conventional meat	3.02 (n = 931)	1.24
Unknown long-term adverse health effects	4.06 (n = 1069)	1.09
Negative effects for livestock producers	3.85 (n = 1165)	1.06
Negative effects for the meat industry	3.75 (n = 1134)	1.10
Lack of effective methods for traceability of cultured meat	3.41 (n = 712)	1.12
Cultured meat is an unnatural product	3.69 (n = 1137)	1.21

3.4. Perceived advantages and disadvantages towards cultured meat

This section of the questionnaire revealed the participants' general views and attitudes, as well as the perceived disadvantages or benefits of cultured meat versus conventional meat. All questions were on a 5-point scale (1 = totally disagree, 5 = totally agree) and average scores above 3 were considered positive responses to a statement. The results are presented in Table 5.

Regarding the comparison of cultured meat vs. conventional meat, in terms of various properties such as taste, texture, healthiness, and cost, the respondents did not believe that cultured meat would outweigh conventional meat. The only characteristic of cultured meat that surpassed conventional meat was its "environmental friendliness" (score 3.75) which was also found to be statistically related to age (p = 0.000) and level of education (p = 0.023) (Table 6). The respondents' age group 18–25 university graduates and females were found to agree more that cultured meat would be environmentally friendly. Similarly, in the perceived benefits, the highest score (3.83) was attributed to the contribution to animal welfare since the production of meat by meat cultivation will not involve slaughtering of animals, followed by the lower environmental impact of cultured meat (score 3.78). However, in the questions that explored the potential disadvantages of cultured meat, all statements were rated higher than 3 (indicating agreement). The highest concern about the potential negative consequences of cultured meat was about "unknown long-term adverse health effects" (score 4.06),

which was found to be statistically related to age (p = 0.000). Strong feelings were also expressed about a negative impact on the livestock producers and Greek meat industry and both characteristics were statistically related to age (p = 0.002 and p = 0.042, respectively) (Table 6). This is in agreement with a study in Ireland that revealed similar skepticism among the respondents [14]. Moreover, the lack of effective methods for traceability of the cultured meat was also expressed as a disadvantage, as was the fact that cultured meat is an "unnatural" product. This statement was statistically related to age, education and gender, with respondents aged between 26–45 years old, post-graduates and females, agreeing more about the "unnaturalness" of cultured meat.

Table 6. Summary of Pearson x^2 results on age, gender and level of education vs attitudes towards cultured meat and perceived advantages and disadvantages.

Question	Age			Gender			Level of education		
	x^2	p- value	Cramér's V	x^2	p-value	Cramér's V	x^2	p-value	Cramér's V
Premium product	85.322	0.000	0.152	11.739	0.303	0.069	37.039	0.001	0.100
Healthier	57.551	0.000	0.125	9.402	0.494	0.062	18.766	0.225	0.071
Better taste	60.289	0.000	0.128	12.187	0.273	0.070	23.666	0.071	0.080
Better texture	48.549	0.000	0.115	11.717	0.304	0.069	16.011	0.381	0.066
Cheaper	86.132	0.000	0.153	48.890	0.000	0.141	31.673	0.007	0.093
Environmentally friendly	67.955	0.000	0.136	6.064	0.810	0.050	27.805	0.023	0.087
Contribution to animal welfare	52.102	0.000	0.119	21.878	0.016	0.094	34.907	0.003	0.097
Lower environmental imprint	35.384	0.002	0.098	5.063	0.887	0.045	25.351	0.045	0.083
Free of antibiotics	47.636	0.000	0.114	10.295	0.415	0.065	35.874	0.002	0.099
Nutritionally controlled	38.401	0.001	0.102	8.543	0.576	0.059	26.497	0.033	0.085
Contribution to global meat demand	22.943	0.085	0.079	7.509	0.677	0.055	16.296	0.363	0.066
Less nutritious	73.072	0.000	0.141	9.256	0.508	0.061	28.608	0.018	0.088
Unknown adverse health effects	41.408	0.000	0.106	8.957	0.536	0.060	18.321	0.246	0.070
Negative effects for livestock producers	35.117	0.002	0.098	9.299	0.504	0.061	13.146	0.591	0.060
Negative effects for the meat industry	25.667	0.042	0.083	15.537	0.114	0.079	8.529	0.901	0.048
No method of traceability	52.427	0.000	0.119	25.778	0.004	0.102	14.886	0.460	0.064
Unnatural product	66.686	0.000	0.134	15.544	0.113	0.079	32.629	0.005	0.094

3.5. Pricing of cultured meat

The final part of the questionnaire investigated the willingness of the respondents to buy the cultured meat and the price they would be willing to pay. The largest percentage of respondents (45.37%) were not willing to pay the same price as conventional meat (Table 7). The same conclusion was reached by the χ^2 crosstabs report, where a statistical relationship with a small strength of association was found between willingness to pay the same price and age (p = 0.000) and level of education (p = 0.023) (Table 8). Respondents aged 18-45 years old, graduates and postgraduates were not willing to pay the same price as conventional meat. Moreover, an even larger percentage (67.07%) were not willing to pay more for cultured meat. Only 7.89% of respondents stated that they would be willing to pay more for this product and 1.87% would pay more than 30%. However, about one-fourth of respondents have answered "maybe" in both questions (Table 7) regarding the price, indicating that there is a possibility of changing their minds in case there is more awareness about the benefits of cultured meat.

Table 7. Attitudes towards pricing of cultured meat.

Question	Responses (%)		
Attitude towards pricing of cultured meat	Yes	No	Maybe
Willing to pay same price for cultured meat as forconventional meat	28.94	45.37	25.69
Willing to pay higher price for cultured meat thanfor conventional meat	7.89	67.07	25.04
If you are willing to pay more for cultured meat and assuming thatminced beef costs 8 euro/kilo, how much more would you be willingto pay			
More than 10% (8,8 euro/kilo)	1.95		
More than 20% (9,6 euro/kilo)	2.6		
More than 30% (10,4 euro/kilo)	1.87		
Do not know	1.46		
No answer	92.11		
If you are not willing to pay less for cultured meat and assuming that minced beef costs 8 euro/kilo, how much would you be willing to pay			
10% less (7,2 euro/kilo)	9.92		
20% less (6,4 euro/kilo)	17.97		
30% less (5,6 euro/kilo)	35.04		
No answer	37.07		

4. Discussion

4.1. Demographic data

This survey was completed by 1230 participants. Statistically significant differences were revealed regarding age, gender and level of education. Similar surveys have revealed that the greatest acceptance is among young people in relation to the older [13], among men in relation to women [16,17] and among the most liberal in relation to the most conservative. Young people are generally characterized as being more open to new experiences and in addition they are more interested in personal benefits, while older people are more skeptical about the socio-political implications of their

choices. Women seem to be just as cautious about novel foods as men. Other parameters that seem to play a role in the acceptance of cultured meat are the origin of the population, as urban populations show a greater preference than rural ones [18] and educational attainment, since the higher level of education someone has received, the more likely they are to accept the new product [19,20].

4.2. Consumer behavior towards meat consumption

The results of this survey have shown that meat consumers prevail (91.54%) in Greece and patterns of consumption show regular meat eating more than once a week. The non-meat eaters in this study, considered as "vegetarians", were only 8.46%. In a recent study investigating the willingness to engage with cultured meat in four European countries, a similar percentage (8.3%, n = 484) was revealed for French citizens stating that they do not consume meat or animal products, whereas an even smaller percentage of only 3.3% of Spanish citizens (n = 210) claimed that they do not consume meat. These percentages were however much higher for more northern countries, such as the UK (17.5%, n = 366) and the Netherlands (16.5%, n = 231), indicating that vegetarianism and the quest for alternative proteins may be more common in these countries than in the southern European countries [10].

4.3. Awareness about cultured meat

Our results revealed that awareness about cultured meat is relatively low among the Greek respondents, since only 39.35% of participants in this survey were aware of the term "cultured meat". However, a statistical relationship was found between awareness of cultured meat and age (p = 0.001), level of education (p = 0.000) and gender (p = 0.003) (Table 2). An online survey from Croatia, Greece, and Spain, indicated that 47% of the participants had not heard of the term "cultured meat" before [21]. Regarding the willingness to try cultured meat, more than half of the respondents (55.69%), stated that they would be willing to try it, with a statistically significant relation to age (p = 0.000), level of education (p = 0.033), and gender (p = 0.033). This is in agreement with a similar study in Italy, in which more than half of the respondents (54%, n = 524) stated that they would be willing to try cultured meat, whereas the profile for a potential consumer of cultured meat was young, highly educated, relatively familiar with cultured meat, a meat consumer and willing to reduce meat consumption [15]. One of the strongest opinions stated was about the "artificiality" of cultured meat (80.73%), a variable that was also found to be related to gender (p = 0.003). The question of whether cultured meat would be a suitable choice for vegetarians was mostly answered negatively (38.37%) or skeptically (36.91%) by the respondents. Compared to other alternative protein products, such as plant-based protein and insect proteins, cultured meat seems to be preferred over insect consumption, but not over plant-based substitutes [16]. However, it is debatable if cultured meat should be targeted at the vegetarian public, as they make up a small percentage of the food market and strict vegetarians have developed an aversion to meat protein, regardless of origin. Rather, the goal is to replace conventional meat with the diet of people who enjoy eating meat.

4.4. Perceived advantages and disadvantages towards cultured food

This survey has highlighted that one of the major perceived benefits of cultured meat among

Greek consumers was the positive contribution to animal welfare by avoiding the torture and slaughter of animals. By highlighting the choice between cultured meat and conventional meat and by providing information on how to prepare the new product, consumers automatically raise questions, which they may not have thought about until then, about how conventional meat is produced. This works for the benefit of cultured meat, as the majority of consumers consider the slaughter of animals to be a bad thing [22,23]. The second biggest advantage, according to this survey, was the ecological parameter, thus the lower environmental imprint of cultured meat. Similar surveys have also resulted to positive feelings that the new meat production technology will address the problem of environmental footprint of conventional livestock farming [14,23–25]. In addition, better public awareness of the environmental benefits of new technology can contribute to further acceptance of the product [26]. However, it should be noted that scientists have expressed concerns that the current technology for producing cultured meat results in high CO_2 emissions from energy generation and that the technology will be environmentally superior only if decarbonized energy sources are used in the future [27]. In the area of nutritional value and health, while cultured meat could potentially prove superior to conventional meat, consumers do not identify it as such to a large extent, especially without motivation [16]. Similarly, in this study, consumers did not identify cultured meat as being healthier or more beneficial due to the absence of hormones or antibiotics. However, the contribution of cultured meat to global meat demands was perceived as a benefit in this survey.

As far as the perceived disadvantages are concerned, in this study, all the relevant statements received scores higher than 3 on the five-point scale, indicating that the respondents agreed to all the concerns raised regarding cultured meat. The strongest negative feeling about cultured meat was related to the safety of the product and the concern that it might have unknown long-term adverse health effects. This is linked to the feeling of food "neophobia" that consumers express, when a novel food product considered "unnatural" comes on the market. Indeed, in this study the majority of respondents agreed that cultured meat is an "unnatural product" (scale 3.69). In a similar survey, 57% of the respondents (from Croatia, Spain and Greece) described cultured meat as "unnatural" [21]. Neophobia might motivate such absolute opposition where fear prevents rational evaluation of outcomes and people perceive cultured meat negatively, regardless of the risks and benefits [12]. A second extension of the "unnatural" concept that characterizes cultured meat is the lack of confidence in its safety as a food [18]. Consumers appear concerned about the consequences that the consumption of the product may have on their health, either in the short or long term [14]. Furthermore, in the review of Tsvakirai et al., 2024, it was pointed out that many studies argue that root attitudes predetermine consumers' attitudes toward cultured meat to some extent and predict that some groups in society will be poised towards rejecting or accepting cultured meat [28]. However, this perception can be reversed, with the appropriate information of the public [29]. In this context, cultured meat is also treated as more unhealthy than conventional meat and nutritionally inferior [30,31]. Similar surveys have revealed that the most serious obstacle to the acceptance of cultured meat by consumers is found to be the feeling of "unnatural", [14,18,23,30,32]. Moreover, the attempt to convince consumers of the naturalness of the product does not seem to be working, even causing the opposite of the expected results. Participants in a survey who were presented with arguments about the naturalness of cultured meat showed a greater rejection of the product than those who were not given any argument [33]. It is the subjective view of the naturalness of a product that determines the public's attitude towards cultured meat and not the objective nature of the product itself [3]. In this light, the sense of the natural or unnatural differs between different social groups, with Europeans being more negative than

Americans [9]. The existence or not of naturalness is also associated with the feeling of disgust, although not absolutely. For example, eating insects may be associated with a greater aversion than eating cultured meat, even though insects are considered a more natural source of protein [31]. The aversion one feels to the idea of eating cultured meat is generally less than in the case of insects or genetically modified organisms [34,35], but greater than herbal substitutes and food additives. The tendency to aversion in general to new types of food, affects the final acceptance of cultured meat [34] and in addition, this feeling outweighs any other characteristic feature of the product, pre-occupying the consumer, even against to its obviously positive aspects [35]. However, it is important to explain cultured meat in a nontechnical way that emphasizes the final product, not the production method, to increase acceptance of this novel food [2]. The other strongly perceived disadvantage among the respondents in this survey was the potential negative economic impact that the new technology might have on livestock producers and the meat market. This can be explained by the fact that Greek market is characterized by the presence of many small farms that raise livestock animals, especially sheep, goats, and lambs [36] that could be affected by the new technology.

4.5. Paying premium price

The new technology used to produce cultured meat is continuously being improved, so it is difficult to be certain about the cost of the final product. Nevertheless, a recent study has estimated that 1 kg of cell-cultured meat would cost $63/kg to be produced in a large-scale facility [37]. Therefore, cultured meat is much more expensive than conventional meat. Many surveys have focused on evaluating the willingness to "pay more" for the new meat alternative, since this fact would be important for the profitability of the industry. However, the likely higher price at which cultured meat will be marketed could be an important obstacle to the acceptance of the product, as many consumers are not willing to pay more than for conventional meat [38]. In this survey, the largest percentage (67.07%) of Greek respondents were not willing to pay more for cultured meat, only 7.89% stated that they would be willing to pay more and 25.04% were uncertain. However, other surveys have shown higher percentages of willingness to pay more for cultured meat. In a survey in Italy, 23% of respondents would surely pay a premium in the range of 10%–30% over the conventional meat price, whereas 21% were uncertain [15]. In a study in the Netherlands, a relatively large percentage of 58% of the respondents were willing to pay a premium for cultured meat of, on average, 37% above the price of regular meat, after they were given positive information [39]. In a large sample (n = 3091) including many countries (China, US, UK, France, Spain, Netherlands, New Zealand, Brazil, and the Dominican Republic) food neophobia, having food allergies, being a locavore, and having concerns about food technology were found to be inhibiting factors towards willingness to try, buy, and pay a price premium for cultured meat [40]. In a US study, the respondents were willing to pay more than double for a cultured meat hamburger than they would for a traditional burger, as long as cultured meat hamburgers were framed as being equivalent in taste to conventional meat, and their environmental benefits were stressed [41]. From the preceding, it is derived that, an affordable cultured meat would be a step and/or might be contributing to its acceptance.

5. Conclusions

Our findings suggest that there is a significant level of skepticism and reservations regarding

cultured meat among Greek consumers. A large percentage of respondents expressed concerns related to the safety (score 4.06/5) of lab-grown meat and consider that there will be a negative impact for livestock producers (score 3.85/5). Moreover, the perception that cultured meat is a highly processed or artificial product (80.73% consider it is artificial) would be more likely to place a barrier to widespread acceptance. Cultural and ethical factors also play a role in shaping attitudes towards cultured meat. Europeans have diverse food cultures and traditions deeply rooted in their societies, which can influence their openness to adopting alternative food sources. However, one noteworthy aspect is the growing concern for environmental sustainability and animal welfare, which has piqued the interest of many Europeans in alternative protein sources such as cultured meat. In this survey, the two most important benefits of cultured meat were the contribution to animal welfare (score 3.78/5) and the lower environmental imprint (score 3.78/5). As awareness about the ecological impact of traditional animal agriculture increases, there is a willingness among some individuals to explore innovative solutions that can reduce the environmental footprint of meat production. As cultured meat technology continues to evolve and reach the market, further research is necessary to understand the dynamics of consumer attitudes and preferences. To foster greater acceptance of cultured meat, it is crucial to address public concerns through transparent communication, education, and engagement. Highlighting the potential benefits, including reduced environmental impact and improved animal welfare, while addressing safety and naturalness concerns, can help build trust and encourage consumers to consider cultured meat as a viable alternative. Long-term studies tracking changes in perceptions and behaviors can provide valuable insights into the potential adoption of cultured meat in Europe and help shape strategies to ensure a successful transition to a more sustainable and ethical food system.

Use of AI tools declaration

The authors declare that they have not used Artificial Intelligence (AI) tools in the creation of this article.

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Conflict of interest

The authors declare no conflicts of interest.

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