The willingness of Turkish consumers in different sociodemographic groups to try and consume in-vitro meat

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ABSTRACT

This study was conducted to determine the willingness of Turkish consumers in various socio-demographic groups to try, consume, and pay for in-vitro meat. The study was applied to potential participants through social media via Google Forms in the form of a questionnaire, and 989 responses were collected. Males were more willing than females to try in-vitro meat, consume it regularly, and try it when recommended. People who have master's and doctoral degrees are more willing to try in-vitro meat compared to those with other education levels. Related professionals, students, and health workers are more willing to try in-vitro meat directly and even more willing to try it, if recommended, than other occupational groups. The willingness to try, to consume regularly, and to try on recommendations were higher in the Mediterranean, Aegean, and Central Anatolia regions compared to others. Compared to individuals with one or two children, those without children and those with three or more children were found to be more willing to try in-vitro meat and to try if recommended. In-vitro meat is not yet commercially marketed in TürkiyeTurkey, and this study addresses the perceptions and opinions of consumer groups in different socio-economic statuses about in-vitro meat.

Introduction

Due to environmental, animal welfare, food safety, and public health issues, the rapid increase of the world population, and limited arable land and water resources, it is claimed that it will not be possible to meet the increasing demand for meat in the future by conventional meat production which is obtained from livestock (1, 12, 21, 39).

Therefore, despite advances in traditional breeding and production systems, researchers and private companies have been driven to develop alternatives for vegetarian meat substitutes (18).

In this context, researchers have focused on a new meat alternative derived from the living stem cells of farm animals (26). Various names have been used for this new product, such as cell-based meat or, more commonly, artificial meat, cultured meat, in-vitro meat, slaughter-free meat, or lab-grown meat (6). It has been hypothesised that conventional meat production will not be sufficient to solve issues such as ethics, environment, health, and hunger. Based on this hypothesis, the issue of in-vitro meat tends to be a current issue in industrial, political, social, and scientific terms (7). This new food product is also called clean meat because it is claimed to use fewer hormones and fewer resources, as well as being less harmful and less polluting to the environment. It is also proposed that this product will contribute to meeting the daily protein requirement (21).

Bioartificial muscles are produced from skeletal muscle stem cells, also known as satellite cells (10, 33). In-vitro meat is obtained from embryonic stem cells or embryonic myoblasts taken by biopsy from a living animal. These cells are developed in a culture medium with appropriate laboratory conditions for their

proliferation. In this context, Chriki and Hocquette (9), Hocquette et al. (17) and Post (27) reported that many cells proliferate, fuse and form muscle fibre clusters. After that, it's ready to be eaten like a burger (9, 23). This biotechnology came out in 2013 for the first time, and it awakened a strong interest in both scientific and mediatic areas (8, 13). Many surveys have been conducted in various countries to investigate consumers' attitudes on this issue and to assess their perceptions and consent to purchase and consume such a product. The common view in these surveys is that while many consumers have shown a willingness to taste "in-vitro meat" once, they are not yet ready to consume it regularly; however, a large section of them do not really know anything about in-vitro meat (16, 17, 22, 36, 37).

Animal origined food sources are valuable for nutrition because of their high protein contents. A large proportion (85%) of the daily calories consumed per capita in Türkiye are herbal. In recent years, the demand for red meat has increased. In 2022, red meat consumption per capita was 23.9 kg for Türkiye. Of this consumption, 18.44 kg was met from cattle and 5.5 kg from small ruminants. On the other hand, 4413 tonnes of red meat were imported in 2023 because the red meat production in Türkiye had not been enough to meet the need (14). There is no production or sale of artificial meat in Türkiye. Meat consumption preferences may differ in various countries depending on socioeconomic factors, ethics, religious beliefs, or traditions (11).

Similarly, it is observed that there are differences between the results of studies conducted in various countries in terms of the approach to in-vitro meat (17). Considering this information, this study aimed to determine the willingness of Turkish consumers of various socio-demographic groups to try, consume, and pay for in-vitro meat.

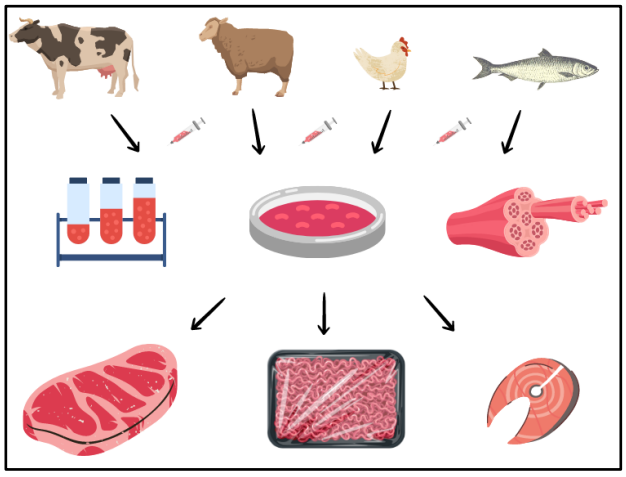
Materials and Methods

The procedures of the study were submitted to Çanakkale Onsekiz Mart University Graduate Education Institute Ethics Committee, and the project was approved by the Scientific Research Ethics Committee (Approval No: 2023-YÖNP-0498, Acceptance date: 21/06/2023, Decision number: 08/07).

Design of the Questionnaire: This study was conducted from July to September 2023. The target group of the questionnaire was people over the age of 18 years living in Türkiye. The questionnaire was administered in Turkish. The questionnaire consisted of 4 parts. The main headings of these sections are i. Sociodemographic information, ii. A brief introduction to in-vitro meat, iii. Questions about the willingness to try, consume, and purchase in-vitro meat, and iv. The extent of which respondents agree with various opinions presented about in-vitro meat.

The first part of the questionnaire is about the sociodemographic information of the participants. In this section, the participants were asked about their age, gender, education level, province of residence, number of children, income status, meat consumption habits, frequency of meat consumption, and whether they had heard of the concept of in-vitro meat before. The professions of the participants were grouped as follows: civil servants, healthcare professionals, housewives, related professions, retired, self-employed, skilled worker/service professionals, small business owners, students, unemployed, and white collars. Veterinarians, agricultural engineers, and food engineers who have received training on the biochemical properties of meat are categorised under "Related Professions". While determining the subgroups of household monthly income, the minimum wage in Türkiye was used as a base for the period when the survey was conducted.

Since in-vitro meat is not available in markets in Türkiye and considering that consumers may have limited knowledge about this product, the definition and visual expression of in-vitro meat were included in the second part of the questionnaire (Figure 1). In the second part of the questionnaire, a security question (Please tick "yes" in this question so that we can evaluate data security) was also asked to determine its security. Those who did not answer “yes” were excluded from the evaluation.



Artificial meat is a meat product produced in a laboratory using muscle stem cells that are never part of a living animal. This product is also called "cultured meat, cell-based meat, in-vitro meat, laboratory meat, clean meat, or synthetic meat." Stem cells are taken without causing any discomfort to living animals and turned into tissue in a controlled laboratory environment. Artificial meat is bioidentical to meat tissue derived from animals. Artificial meat products are not yet available for retail sale in Turkey.

Figure 1. Brief introductory information about artificial meat presented to participants.

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There were two parts in the third section of the questionnaire. In the first part, participants were asked about their willingness to try in-vitro meat, whether they would consider consuming it regularly, and whether they would be willing to try it if it was recommended. Participants were asked to answer this section on a Likert scale of 1-5 (1: Absoutely no, 2: No, 3: Not sure, 4: Yes, 5: Absolutely yes). In the second part, they were asked how much they would be willing to pay for in-vitro meat compared with farmed meat. Respondents were asked to answer 1: Much less, 2: Somewhat less, 3: Similar, 4: Somewhat more, 5: Much more

In the fourth part of the questionnaire, 32 different opinions about in-vitro meat were presented, and the participants marked this section, which was prepared to determine the perception levels, with a Likert scale of 1-5 (1: Strongly disagree, 2: Disagree, 3: Undecided, 4: Agree, 5: Strongly agree). Since the perceptions of the participants and their willingness to consume are intended to be discussed in different articles, the part of the study related to the fourth section is not interpreted and evaluated in this article.

Before the questionnaire was applied, a pilot survey was conducted to evaluate the comprehensibility, applicability, and usability of the questions, and 27 people participated in this survey online. As a result of the pilot survey, corrections were made to the Turkish wording and the fourth part of the questionnaire in line with the evaluations and comments of the participants.

Participants and Data Collection: The questionnaire form was prepared via Google Forms and delivered to potential participants via social media. "Informed voluntary consent text" was presented to the participants to inform them before participating in the survey and the consent text was expressed as follows, “We invite you to the research titled "Determination of Perceptions and Attitudes of Consumers in Türkiye on Artificial Meat (In-vitro Meat). The aim of this research is to analyse the knowledge, attitudes, and approaches of consumers in Türkiye regarding the concept of in-vitro meat and their perspectives on in-vitro meat. Participation in this study is completely voluntary. For the study to achieve its purpose, you are expected to answer all the questions completely, without being under any pressure or suggestion from anyone, and sincerely give the answers that suit you best. Reading and approving this form will mean that you agree to participate in the study. However, you also have the right not to participate in the study or to leave the study at any time after participation. The information obtained from this study will be used entirely for research." In addition, in the informed consent text, the e-mail address of the project coordinator was also provided so that the participants could reach the project coordinator.

A total of 1009 people participated in the questionnaire. Of these people, six people under the age of 18 were excluded from the evaluation. 9 people clicked on the link and answered "no" to the question "I agree to participate in the research". 5 people did not answer the security question. After cleaning, the data of 989 participants were evaluated.

***Statistical Analyses*:** Distribution of participants according to subgroups of demographic characteristics and descriptive statistics were determined using the Jamovi 2.3.21 programme (32). The Kruskall - Wallis test was applied in the Jamovi 2.3.21 programme to determine the effect of demographic characteristics on the participants' willingness to try in-vitro meat, to consume it regularly, to consume it instead of conventional meat, and to consume it if it is recommended by a friend and how much they are willing to pay compared to meat from farm animals. In case of significance for a sociodemographic characteristic, the Dwass-Steel-Critchlow-Fligner pairwise comparison test was performed (32).

Results

In the study, 989 responses were collected through an online survey. Regardless of sociodemographic characteristics, the general results related to the willingness of the participants to try, consume and pay for in-vitro meat are presented in Table 1. The mean scores given by participants for willingness to try in-vitro meat, consume it regularly, consume it instead of farmed animal meat, try it if recommended by friends, and pay for it compared to farmed animal meat were 2.44, 1.96, 2.03, 2.52, and 1.49, respectively.

Table 1. Mean, standard deviation (SD) and median values for the willingness of the respondents to try, consume, and pay for in-vitro meat.

Question	Mean	SD	Median
Would you be willing to try "in-vitro meat"?	2.44	1.27	2
Would you be willing to consume "in-vitro meat" regularly?	1.96	0.95	2
Would you be willing to consume "in-vitro meat" instead of meat from farmed animals?	2.03	1.09	2
Would you be willing to try "in-vitro meat" if it was recommended by your friends?	2.52	1.26	2
How much would you be willing to pay for in-vitro meat compared to meat from farmed animals?	1.49	0.82	1

The significance of the sociodemographic factors affecting the participants' willingness to try, consume, and pay for in-vitro meat is given in Table 2. Except for the frequency of meat consumption and familiarity with in-vitro meat, the effect of other factors on the willingness of the participants to try in-vitro meat and to try if recommended by their friends was found to be significant. The effect of education level on the willingness to regularly consume in-vitro meat was found to be insignificant (P>0.05). Sociodemographic factors other than gender, geographical region, and familiarity with in-vitro meat were also reported to have a significant effect on the willingness to consume in-vitro meat. On the other hand, the effects of age group (P<0.001), geographical region (P<0.01), number of children (P<0.001), dietary habits (P<0.001) and frequency of meat consumption (P<0.001) on how much participants were willing to pay for in-vitro meat were found to be important when compared with conventional meat.

The effect of gender, age group, and education level of the participants on their willingness to try, consume, and pay for in-vitro meat is presented in Table 3. In general, males were more willing than females to try in-vitro meat, consume it regularly, and try it when recommended. The differences between male and female participants in terms of willingness to consume and pay for in-vitro meat compared with meat from farm animals were found to be insignificant (P>0.05). The difference between the 18-25 and 26-35 age groups in terms of participants' willingness to try in-vitro meat, consume it regularly, consume it instead of traditional meat and willingness to pay was found to be insignificant. However, it was determined that the willingness of the participants aged 36-45 years and above to consume, try, and pay for in-vitro meat decreased (Table 3).

It is seen that people who have master's and doctoral degrees are more willing to try in-vitro meat compared to those ğ with other education levels. Those with technical school and bachelor's degrees were more willing to try in-vitro meat than those with primary and high school degrees. The willingness to try in-vitro meat if recommended by a friend was lower in primary, secondary, and high school graduates than in the other groups. In terms of willingness to consume in-vitro meat instead of meat obtained from farm animals, the ones with master's and doctoral degrees gave highest scores, yet the difference between them and highschool and technical school graduates were not significant. However, primary and middle school graduates had lower willingness to consume the in vitro meat when compared to ones which has higher educatation degrees (Table 3).

The effects of occupational groups and geographical regions on the willingness to try in-vitro meat, consume it regularly, consume it instead of farm animal meat, consume it if recommended, and willingness to pay are presented in Table 4. When compared with the occupational groups, it is seen that related professionals, students, and health workers are more willing to try in-vitro meat directly and even more willing to try it if it is recommended than other occupational groups. In terms of regular consumption and willingness to consume instead of conventional meat, it is seen that professionals and students are more willing. In terms of willingness to pay, the difference between occupational groups was found to be insignificant (Table 4). Regionally, it was found that the willingness to try, to consume regularly, and to try on recommendations were higher in the Mediterranean, Aegean, and Central Anatolia regions compared to other regions. There was no significant difference between the regions in terms of willingness to consume instead of livestock meat.

The effects of having children and monthly income on the willingness to try in-vitro meat, consume it regularly, consume it as a substitute for farm animal meat, consume it if recommended, and willingness to pay are presented in Table 5. Compared to people with one or two children, those without children and those with 3 or more children were found to be more willing to try in-vitro meat and to try it if recommended. People without children were found to be more willing to consume in-vitro meat instead of conventional meat (Table 5). People with a monthly income of 80.501 TL and above, 69.001-80.500 TL, and 57.501-69.000 TL had a higher willingness to try in-vitro meat, consume it regularly, consume it instead of conventional meat, and try it if recommended compared with other groups. There was no significant difference between the income groups in terms of willingness to pay (Table 5).

The effects of meat consumption habits, frequency of meat consumption, and familiarity with in-vitro meat on the willingness to try in-vitro meat, consume it regularly, consume it as a substitute for farm animal meat, consume it if recommended, and pay for it are presented in Table 6. White meat and seafood consumers and vegans were found to be more willing to try, to consume instead of traditional farmed meat, and to try if recommended compared with other groups. The willingness to consume regularly was higher in white meat and seafood consumers than in the other groups, while the willingness to pay was higher in vegans than in the other groups (Table 6).

In terms of frequency of meat consumption, the willingness to consume and pay for in-vitro meat instead of farm animal meat was found to be higher in those who never consumed meat. The effect of familiarity with in-vitro meat on the willingness to try, consume, and pay for in-vitro meat was found to be insignificant (P>0.05; Table 6).

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Table 2. Significance levels of investigated factors on the willingness of the respondents to try, consume and pay for in-vitro meat (IVM).

Factor		Willing to try IVM		Willing to consume IVM regularly		Willing to consume IVM instead of meat from farmed animals		Willing to try IVM if it was recommended by friends		Willing to pay for IVM compared to meat from farmed animals	
	df	χ^2	P	χ^2	P	χ^2	P	χ^2	P	χ^2	P
Gender	2	14.81	<0.001	9.24	0.010	1.66	0.436	8.13	0.017	5.68	0.058
Age group	4	41.20	<0.001	24.60	<0.001	24.60	<0.001	46.50	<0.001	22.00	<0.001
Education Level	3	29.41	<0.001	7.11	0.068	7.90	0.048	19.79	<0.001	4.14	0.246
Occupation	10	74.90	<0.001	45.10	<0.001	36.20	<0.001	69.70	<0.001	16.20	0.093
Geographic Region	5	14.02	0.015	12.52	0.028	9.15	0.103	14.59	0.012	18.96	0.002
Number of Children	3	23.52	<0.001	8.27	0.041	22.89	<0.001	21.83	<0.001	25.59	<0.001
Household monthly income	7	30.30	<0.001	23.80	0.001	20.80	0.004	27.00	<0.001	10.10	0.183
Eating habits	3	16.40	<0.001	12.60	0.006	33.10	<0.001	15.10	0.002	98.20	<0.001
Meat consumption frequency	3	0.925	0.819	3.122	0.373	17.12	<0.001	0.838	0.840	88.37	<0.001
Familiarity with "in-vitro meat"	2	2.04	0.361	4.37	0.112	1.07	0.584	2.86	0.239	3.61	0.165

Table 3. The effects of gender, age group and education level of the respondents on willingness to try, consume and pay for in-vitro meat.

Factor		Willing to try		Willing to consume regularly		Willing to consume instead of conventional meats		Willing to try if recommended		Willing to pay	
	N	Mean (SD)	Med	Mean (SD)	Med	Mean (SD)	Med	Mean (SD)	Med	Mean (SD)	Med
Gender											
Female	557	2.30 ^{b} (1.19)	2	1.88 ^{b} (0.92)	2	2.02 (1.13)	2	2.43 ^{b} (1.24)	2	1.54 (0.86)	1
Male	419	2.64 ^{a} (1.35)	2	2.07 ^{a} (0.99)	2	2.06 (1.05)	2	2.65 ^{a} (1.29)	3	1.43 (0.74)	1
No wish to answer	13	2.31 ^{ab} (1.11)	2	1.77 ^{ab} (0.60)	2	1.85 (0.80)	2	2.08 ^{ab} (0.95)	3	1.23 (0.83)	1
Age group (years)											
18-25	163	2.85 ^{a} (1.25)	3	2.13 ^{a} (0.91)	2	2.18 ^{a} (1.05)	2	2.91 ^{a} (1.16)	3	1.62 ^{a} (0.85)	1
26-35	213	2.69 ^{a} (1.35)	3	2.15 ^{ab} (1.08)	2	2.27 ^{a} (1.20)	2	2.80 ^{a} (1.33)	3	1.61 ^{ab} (0.89)	1
36-45	274	2.30 ^{b} (1.27)	2	1.90 ^{bc} (0.94)	2	2.01 ^{ab} (1.20)	2	2.42 ^{b} (1.28)	2	1.47^{abc} (0.86)	1
46-55	210	2.27 ^{b} (1.16)	2	1.82 ^{c} (0.84)	2	1.86 ^{b} (0.95)	2	2.29 ^{b} (1.18)	2	1.40 ^{bc} (0.71)	1
>56	129	2.09 ^{b} (1.11)	2	1.77 ^{c} (0.87)	2	1.78 ^{b} (0.92)	2	2.14 ^{b} (1.14)	2	1.29 ^{c} (0.64)	1
Education Level											
Primary & Middle School	31	1.74 ^{c} (0.73)	2	1.71 (0.64)	2	1.68 ^{b} (0.70)	2	2.06 ^{b} (0.89)	2	1.26 (0.58)	1
High School	99	2.00 ^{c} (1.01)	2	1.77 (0.78)	2	1.80 ^{ab} (0.87)	2	2.08 ^{b} (1.08)	2	1.40 (0.71)	1
Technical college & Undergraduate degree	587	2.44 ^{b} (1.27)	2	1.95 (0.95)	2	2.03 ^{ab} (1.09)	2	2.54 ^{a} (1.25)	3	1.49 (0.83)	1
Master's & PhD degrees	272	2.69 ^{a} (1.33)	3	2.07 (1.01)	2	2.16 ^{a} (1.17)	2	2.69 ^{a} (1.33)	3	1.53 (0.85)	1

^{a,b,c} The differences between subgroups that do not have a common letter in the same column are significant (P<0.05). SD: Standard deviation, Med: Median.

Table 4. The effects of occupation and geographic region of the respondents on willingness to try, consume and pay for in-vitro meat.

Factor		Willing to try		Willing to consume regularly		Willing to consume instead of conventional meats		Willing to try if recommended		Willing to pay	
	n	Mean (SD)	Med	Mean (SD)	Med	Mean (SD)	Med	Mean (SD)	Med	Mean (SD)	Med
Occupation											
Civil servants	154	2.14 ^{c} (1.20)	2	1.82 ^{cd} (0.92)	2	1.90 ^{bc} (1.06)	2	2.29 ^{cd} (1.28)	2	1.38 (0.75)	1
Healthcare professionals	66	2.50 ^{b} (1.18)	3	2.11 ^{ab} (0.90)	2	2.23 ^{ab} (1.06)	2	2.61 ^{bc} (1.20)	3	1.55 (0.79)	1
Housewifes	45	1.71 ^{d} (0.90)	1	1.62 ^{d} (0.81)	1	1.64 ^{c} (0.83)	1	1.93 ^{d} (1.03)	2	1.47 (0.87)	1
Related professions[1]	72	3.18 ^{a} (1.35)	3	2.38 ^{a} (1.07)	2	2.42 ^{a} (1.24)	2	3.21 ^{a} (1.22)	3	1.54 (0.77)	1
Retired people	65	2.05 ^{cd} (1.11)	2	1.71 ^{d} (0.81)	2	1.78 ^{c} (0.93)	2	1.92 ^{d} (1.01)	2	1.23 (0.52)	1
Self-employed	30	1.90 ^{cd} (1.09)	2	1.57 ^{d} (0.73)	1	1.77 ^{c} (0.90)	1.5	2.07 ^{cd} (1.17)	2	1.43 (0.77)	1
Skilled worker/service professionals	79	2.43 ^{bc} (1.25)	2	2.01 ^{bc} (0.90)	2	1.91 ^{bc} (0.93)	2	2.46 ^{c} (1.14)	2	1.44 (0.71)	1
Small business owners	40	2.27 ^{bc} (1.06)	2	1.95 ^{bc} (0.88)	2	1.93 ^{abc} (0.97)	2	2.40 ^{cd} (1.19)	2	1.50 (1.01)	1
Students	97	2.93 ^{a} (1.26)	3	2.21 ^{ab} (0.97)	2	2.31 ^{a} (1.08)	2	2.97 ^{ab} (1.16)	3	1.55 (0.76)	1
Unemployed people	15	2.27 ^{bc} (1.28)	2	1.53 ^{d} (0.52)	2	1.53 ^{c} (0.92)	1	2.60 ^{bc} (1.12)	3	1.40 (0.63)	1
White collars	326	2.52 ^{b} (1.29)	2	1.97 ^{bc} (0.99)	2	2.08 ^{b} (1.16)	2	2.60 ^{bc} (1.31)	3	1.56 (0.91)	1
Geographic Region											
Aegean	85	2.71 ^{a} (1.36)	3	2.07 ^{ab} (0.96)	2	2.18 (1.15)	2	2.80 ^{a} (1.28)	3	1.66 ^{a} (0.85)	1
Black Sea	57	2.28 ^{bc} (1.36)	2	1.77 ^{c} (1.00)	1	1.82 (1.07)	1	2.37 ^{bc} (1.35)	2	1.42 ^{bc} (0.89)	1
Central Anatolia	106	2.62 ^{ab} (1.24)	2	2.04 ^{ab} (0.89)	2	2.04 (1.03)	2	2.68 ^{ab} (1.22)	3	1.54 ^{ab} (0.71)	1
Eastern and Southeastern Anatolia	33	2.03 ^{c} (1.08)	2	1.73 ^{bc} (0.76)	2	1.82 (0.95)	2	2.03 ^{c} (0.95)	2	1.18 ^{c} (0.64)	1
Marmara	659	2.39 ^{bc} (1.25)	2	1.94 ^{bc} (0.96)	2	2.02 (1.09)	2	2.48 ^{bc} (1.27)	2	1.47 ^{bc} (0.83)	1
Mediterranean	49	2.73 ^{a} (1.29)	3	2.22 ^{a} (0.99)	2	2.31 (1.14)	2	2.76 ^{ab} (1.22)	3	1.59 ^{ab} (0.81)	1

^{a,b,c} The differences between subgroups that do not have a common letter in the same column are significant (P<0.05).
SD: Standard deviation, Med: Median.

Table 5. The effects of number of children and household monthly income of the respondents on willingness to try, consume and pay for in-vitro meat.

Factor		Willing to try		Willing to consume regularly		Willing to consume instead of conventional meats		Willing to try if recommended		Willing to pay	
	n	Mean (SD)	Med	Mean (SD)	Med	Mean (SD)	Med	Mean (SD)	Med	Mean (SD)	Med
Number of Children											
0	415	2.67 ^{a} (1.33)	3	2.06^{a} (1.12)	2	2.24 ^{a} (1.20)	2	2.74 ^{a} (1.31)	3	1.64 ^{a} (0.93)	1
1	270	2.32 ^{b} (1.20)	2	1.90^{ab} (0.88)	2	1.89 ^{b} (0.98)	2	2.40 ^{b} (1.19)	2	1.43 ^{b} (0.73)	1
2	229	2.20 ^{b} (1.239	2	1.84 ^{b} (0.93)	2	1.83 ^{b} (0.98)	2	2.29 ^{b} (1.22)	2	1.34 ^{b} (0.69)	1
≥3	75	2.35 ^{ab} (1.11)	2	1.96^{ab} (0.83)	2	2.01 ^{ab} (0.99)	2	2.41 ^{ab} (1.19)	2	1.27 ^{b} (0.58)	1
Household monthly income (TL)											
≤11 500 TL	105	2.37 ^{c} (1.33)	2	1.96 ^{bc} (1.01)	2	2.10 ^{ab} (1.19)	2	2.45^{c} (1.28)	2	1.53 (0.87)	1
11 501 – 23 000 TL	246	2.28 ^{c} (1.19)	2	1.87 ^{bc} (0.89)	2	1.90 ^{b} (0.99)	2	2.40 ^{c} (1.19)	2	1.42 (0.74)	1
23 001 – 34 500 TL	206	2.29 ^{c} (1.24)	2	1.83 ^{c} (0.93)	2	1.90 ^{b} (1.10)	2	2.34 ^{c} (1.22)	2	1.51 (0.78)	1
34 501 – 46 000 TL	155	2.52 ^{bc} (1.28)	2	2.01 ^{ab} (0.92)	2	2.09 ^{ab} (1.08)	2	2.59 ^{bc} (1.25)	3	1.45 (0.86)	1
46 001 – 57 500 TL	101	2.29 ^{c} (1.11)	2	1.86 ^{bc} (0.91)	2	1.97 ^{b} (1.01)	2	2.39 ^{c} (1.14)	2	1.44 (0.78)	1
57 501 – 69 000 TL	58	2.81 ^{ab} (1.36)	3	2.21 ^{a} (1.01)	2	2.16 ^{ab} (1.09)	2	2.83 ^{ab} (1.33)	3	1.41 (0.80)	1
69 001 – 80 500 TL	45	2.89 ^{ab} (1.50)	3	2.36 ^{a} (1.13)	2	2.49 ^{a} (1.27)	3	3.02 ^{ab} (1.56)	4	1.53 (0.79)	1
≥ 80 501 TL	73	2.99 ^{a} (1.26)	3	2.19 ^{a} (0.97)	2	2.32 ^{a} (1.15)	2	3.01 ^{a} (1.30)	3	1.73 (1.02)	1

^{a,b,c} The differences between subgroups that do not have a common letter in the same column are significant (P<0.05). SD: Standard deviation, Med: Median.

Table 6. The effects of eating habits, meat consumption frequency and familiarity with IVM of the respondents on willingness to try, consume and pay for in-vitro meat.

Factor		Willing to try		Willing to consume regularly		Willing to consume instead of conventional meats		Willing to try if recommended		Willing to pay	
	n	Mean (SD)	Med	Mean (SD)	Med	Mean (SD)	Med	Mean (SD)	Med	Mean (SD)	Med
Eating habits											
Meat eating	879	2.41^{b} (1.26)	2	1.94^{b} (0.94)	2	1.95^{b} (1.02)	2	2.48^{b} (1.25)	2	1.39^{c} (0.71)	1
White meat only & Pescatarian	38	3.05^{a} (1.25)	3	2.47^{a} (1.03)	2	2.68^{a} (1.28)	2	3.18^{a} (1.25)	3	1.84^{b} (0.89)	2
Vegan	44	2.86^{a} (1.37)	3	2.00^{b} (0.99)	2	2.98^{a} (1.49)	3	2.86^{ab} (1.39)	3	2.64^{a} (1.20)	3
Vegetarian	28	2.07^{b} (1.22)	2	1.75^{b} (0.93)	1.5	2.11^{b} (1.34)	2	2.25^{b} (1.24)	2	2.29^{ab} (1.18)	2.5
Meat consumption frequency											
Never	77	2.60 (1.41)	2	1.94 (1.02)	2	2.66^{a} (1.15)	2	2.66 (1.40)	3	2.47^{a} (1.18)	3
Rarely	305	2.39 (1.20)	2	1.98 (0.96)	2	2.06^{b} (1.08)	2	2.52 (1.21)	2	1.45^{b} (0.78)	1
Regularly	564	2.44 (1.28)	2	1.96 (0.93)	2	1.96^{bc} (1.01)	2	2.50 (1.27)	2	1.38^{b} (0.67)	1
Everyday	43	2.51 (1.37)	2	1.77 (0.97)	2	1.70^{c} (0.86)	2	2.53 (1.26	3	1.33^{b} (0.89)	1
Familiarity with “in-vitro meat”											
Heard and know	256	2.51 (1.49)	2	1.93 (1.11)	2	2.08 (1.30)	2	2.45 (1.46)	2	1.63 (1.01)	1
Heard but not know	530	2.47 (1.22)	2	1.96 (0.92)	2	2.05 (1.06)	2	2.56 (1.21)	3	1.44 (0.74)	1
Never heard before	203	2.29 (1.06)	2	1.98 (0.80)	2	1.94 (0.85)	2	2.49 (1.11)	2	1.42 (0.69)	1

^{a,b,c} The differences between subgroups that do not have a common letter in the same column are significant (P<0.05). SD: Standard deviation, Med: Median.

Discussion and Conclusion

In this study, participants responded to willingness questions on a scale of 1 (Definitely No) to 5 (Definitely Yes). The average scores were 2.44 for willingness to try in-vitro meat, 1.96 for willingness to consume in-vitro meat regularly, and 2.52 for willingness to try in-vitro meat if recommended by friends. In a study conducted in the UK with 1010 male and 1072 female participants, it was emphasised that the reaction to the idea of in-vitro meat was predominantly negative; half of the consumers clearly rejected it and only 16% stated that they would buy it, while 33% were not sure (35). Baybars et al. (5), in a similar study, reported that the participants did not have a positive attitude towards regular consumption of in-vitro meat, experimentation, and recommendations. Zhang et al. (40) reported that 84.72% of 1004 participants were willing to try in-vitro meat. These reports indicate that there are differences among countries in approach to in-vitro meat. However, the results obtained in our study show that Turkish consumers are more distant from in-vitro meat than the studies listed above.

Another notable finding of the study is that nearly all participants responded with 'Much less' or 'Somewhat less' to the question, 'How much would you be willing to pay for in-vitro meat compared to meat from farmed animals?' The average score for this question was 1.49. Van Loo et al. (34), in a survey of more than 1800 consumers in the USA, presented the choice between farm-raised beef and in-vitro meat, holding the price constant, and reported that 72% of the respondents chose beef and 5% chose in-vitro meat, and that even if the price of in-vitro meat decreased, the market shares of farm-raised beef was higher. In a study conducted in India, it was reported that participants tended to pay less for in-vitro meat compared with conventional meat (3). Liu et al. (20) reported that 94% of the participants in their study stated that they were not willing to pay more for in-vitro meat than for conventional meat.

In our study, compared with women, men were more willing to try in-vitro meat (mean score: 2.64 vs. 2.30), to consume it regularly (mean score: 2.07 vs. 1.88) and to try it if recommended (mean score: 2.65 vs. 2.43). In a similar study, Shaw and Iomaire (29) reported that 63% of men reported that they were willing to try cultured meat, whereas this rate was only 46% for women. Also, in a study conducted in the USA, it was stated that men are more willing to consume in-vitro meat (37). According to the studies, it can be concluded that men are more open to trying in-vitro meat. While women tend to turn to vegetables and fruits as meat alternatives, it is also seen that men may prefer in-vitro meat with high similarity to meat as a meat alternative.

In our study, when the relationship between the willingness to try in-vitro meat and age groups was

examined, it was determined that the willingness of the participants to try in-vitro meat, to consume it regularly, to consume it instead of traditional meat, to try it if recommended, and to pay was generally higher in participants aged 18-25 and 26-35 years, whereas the willingness decreased in participants older than this age. Shaw and Iomaire (29) reported that there was a statistically significant relationship between the age of the participants and their willingness to try cultured meat, and that those under the age of 35 were more willing to try cultured meat than those over the age of 55. In a study conducted in the UK, it was reported that consumers over the age of 55 were the least likely to purchase in-vitro meat (35). In a study conducted in Italy, it was reported that those who wanted to try in-vitro meat were 71% of participants under the age of 25, 56% of participants between the ages of 25 and 45, 47% of participants between the ages of 46 and 65, and 40% of participants over the age of 65 (22). The finding obtained in our study that "Younger age participants are more willing to try, consume, and pay for in-vitro meat, and as the age of the participants increases, the level of willingness to try and consume decreases" is generally compatible with the results previously reported in other countries (22, 29, 35).

When evaluating education levels in our study, it was determined that people with master's and doctorate degrees were more willing to try in-vitro meat and consume it instead of conventional meat compared with people with other education levels. In a study conducted in Italy, it was reported that participants with a higher level of education had a more favourable attitude towards in-vitro meat, with 62% of highly educated participants willing to try in-vitro meat when compared with less educated participants**,** who were only 36% (22). Supporting the results of the present study, it has been reported in many previous studies that highly educated individuals have a more positive view of in-vitro meat (22, 31, 38, 40). Sikora and Rzymski (30) stated that education level did not play a role in accepting of in-vitro meat. On the other hand, the difference between educational level groups in terms of willingness to consume in-vitro meat regularly and willingness to pay for in-vitro meat was found to be insignificant. This result indicates that although highly educated Turkish consumers are more willing to try in-vitro meat than other education groups, they have not yet adopted the idea of regular consumption and purchase. Weinrich et al. (36) reported that highly educated people have a more positive attitude towards the willingness to try in-vitro meat, to consume it regularly, and to recommend it. Kombolo et al. (19) stated that higher education level has a significant effect on the willingness to consume in-vitro meat regularly and willingness to pay. Hocquette et al. (16) reported that educated consumers were skeptical about in-vitro meat consumption. In our study, it is seen that professional workers, students, health workers, and white-collar workers who have knowledge about meat biochemistry are more willing to try in-vitro meat compared with other occupational groups. The more favourable view of students towards in-vitro meat may be related to the fact that most of them are also young. In a previous study, non-scientists and scientists reported the lowest level of willingness to consume compared with participants who were not familiar with the meat sector (17). In another study, it was reported that scientists not working in the meat sector had a higher willingness to try and consume in-vitro meat than non-scientists and people working in the meat sector; also, the participants who were dealing with meat science were 1.6 times more likely to consume in-vitro meat than non-scientists but working in the meat sector, while non-scientists and people not working in the meat sector were 2.7 times more likely to consume in-vitro meat (20). In the study, as the monthly household income of the participants increased, their willingness to try in-vitro meat, consume it regularly, consume it instead of conventional meat, and try it when recommended by a friend increased. Wilks and Phillps (37) determined that low-income participants were more willing to try in-vitro meat than high-income participants. On the other hand, the effect of income level on willingness to pay for in-vitro meat was found to be insignificant.

When the eating habits of the participants were evaluated in our study, it was found that only white meat-fish consumers and vegans had a higher willingness to try in-vitro meat and consume it instead of conventional meat compared with meat consumers. In addition, it is seen that the willingness of white meat and fish consumers to consume in-vitro meat regularly is higher than that of other groups. It is seen that vegans are willing to pay more for in-vitro meat compared with individuals who consume red meat, white meat, and fish regularly. In a study conducted in Brazil with 408 participants, it was reported that 65.2% frequently consumed meat, 66.4% could try in-vitro meat, and 24% of vegetarians and vegans could eat in-vitro meat (19). Wilks and Phillips (37) similarly reported more favourable perceptions among vegetarians and vegans but a lower willingness to try. Except for a recent study by Anonymous (2), which is more accepted among vegans, it shows that individuals with high meat consumption compared to vegetarians are more open to trying cultured meat (19, 25, 28). In another study, it was reported that participants following a vegan or vegetarian diet were less likely to accept in-vitro meat compared with those consuming meat (15). This contradictory behaviour of non-meat eaters may be explained by the fact that they are not only against cultured meat but are also not interested in consuming it.

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In our study, in terms of frequency of meat consumption, people who never consumed meat were found to be more willing to consume and pay for in-vitro meat instead of conventional meat. In a study, it was found that participants under and over 31 years of age who ate meat every day had a lower willingness to try in-vitro meat than participants of the same age who rarely or never ate meat. In the same study, the willingness to try in-vitro meat was found to be lower in non-scientist participants who regularly/every day eat meat and know/do not know the meat sector than in scientists who do not know the meat sector or know the meat sector but never eat meat (17).

When our study was evaluated in terms of familiarity with in-vitro meat, it was found that 25.9% of the participants had heard of in-vitro meat and knew what it was, 53.6% had heard of it but had no knowledge, and 20.5% had never heard of it before. In a study conducted in two different regions of Brazil, it was reported that 81.6% and 82.6% of the participants had little or no knowledge about in-vitro meat (19). In another study, it was reported that 86.3% of the participants were familiar with in-vitro meat and 16.7% had not heard of it (17). Heidmeier and Teuber (15) stated that 62% of 526 participants had heard of in-vitro meat and 54% of those familiar with in-vitro meat were willing to purchase it. Asioli et al. (4) also reported that consumers who had heard of in-vitro meat were willing to pay more than those who had not heard of the term. Min et al. (24) reported that participants with knowledge about in-vitro meat had a higher willingness to try and consume in-vitro meat compared with other groups. In our study, the effect of familiarity with in-vitro meat on the willingness to try, consume, and pay for in-vitro meat was also found to be insignificant.

In this study, Turkish consumers' willingness to try, consume, and pay for in-vitro meat was analysed by matching the sociodemographic characteristics of the participants. The results of the study show that Turkish consumers are distant to in-vitro meat. The willingness to try, consume, and especially pay for in-vitro meat was found to be quite low for all sociodemographic groups in general. On the other hand, the fact that the vegan, vegetarian, only white meat, and pescatarian consumption groups are willing to pay more for in-vitro meat indicates that in-vitro meat can be considered as an alternative product for these people in Türkiye.

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Ethical Statement

This study was carried out after the project was approved by Çanakkale Onsekiz Mart University Graduate Education Institute Ethics Committee, Scientific Research Ethics Committee (Approval No: 2023-YÖNP-0498, Acceptance date: 21/06/2023, Decision number: 08/07).

Conflict of Interest

The authors declared that there is no conflict of interest.

Author Contributions

AGE; conceptualization, methodology, project administration, investigation, writing-original draft. PDK; investigation, formal analysis, writing-review & editing. FYE; investigation, writing-review & editing. BE: conceptualization, data curation, methodology, project administration, formal analysis, supervision, writing-review & editing.

Data Availability Statement

The data supporting this study's findings are available from the corresponding author upon reasonable request.

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