

T.C.
YEDİTEPE UNIVERSITY
FACULTY OF HEALTH SCIENCE
DEPARTMENT OF NUTRITION AND DIETETICS

**INVESTIGATION OF ACCEPTABILITY OF
CULTURED MEAT IN UNIVERSITY STUDENT**

MASTER THESIS

MERVE KUMRU

İSTANBUL,2023

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APPROVAL

This thesis has been deemed by the jury in accordance with the relevant articles of Yeditepe University Graduate Education and Examinations Regulation and has been approved by Administrative Board of Institute with decision dated and numbered

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DECLARATION

I hereby declare that this thesis is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree except where due acknowledgement has been made in the text.

01.02.2023

Merve Kumru



DEDICATION

I would like to dedicate my thesis to my family, friends and to my advisor Assoc. Prof. Dr. Hülya Demir.



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First of all, I am thankful to my advisor Assoc. Prof. Dr. Hülya Demir who helped me at every stage of my thesis. I would like to express my endless thanks to my family and friends who always there for me.



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LIST OF SYMBOLS AND ABBREVIATIONS

| | |
|------------------|---|
| USDA | U.S. Department of Agriculture's |
| FSIS | Food Safety and Inspection Service |
| HHS | U.S. Department of Health and Human Services' |
| FDA | Food and Drug Administration |
| EFSA | The European Food Safety Authority |
| JECFA | Food Additives |
| ADI | Acceptable Daily Intake |
| WHO | World Health Organization |
| IMF | Intramuscular Fat |
| SPSS | Statistical Package for the Social Sciences |
| YCMPS | Young People's Cultured Meat Perception Survey |
| ECM | Extra Cellular Matrix |
| GG | Greenhouse Gases |
| N ₂ O | Nitrous oxide |
| CH ₄ | Methane |
| CO ₂ | Carbon dioxide |
| ITCS | Item Total Correlation Score |
| FAO | Food and Agricultural Organization |
| AHA | The American Heart Association |
| IARC | The International Agency for Research on Cancer |
| FBS | Fetal Bovine Serum |
| HACCP | Hazard Analysis Critical Control Point |

ABSTRACT

Kumru, M. (2023). Investigation of the Acceptability of Cultured Meat in University Students. Yeditepe University, Institute of Health Sciences, Department of Nutrition and Dietetics, Master Thesis, Istanbul.

This study was conducted to investigate the consumer acceptance and willingness to pay of cultured meat among students in Turkey. The sample of the research consists of 371 university student who voluntarily agreed to answer questionnaire and demographic information form. The survey questions were obtained by compiling questions from other studies on the acceptability of cultured meat. While evaluating the findings of the study, SPSS (Statistical Package for the Social Sciences) version 25.0 program was used for statistical analysis. According to the findings obtained, most of the participants were female, has omnivore dietary habits. In this study, there was no statistically significant differences between the survey mean score of the students and gender, dietary choices of the students ($p>0.05$). According to the occupational group, there was a statistically significant difference in the mean scores of the consuming culture meat section ($p=0.002$). The result of the bonferroni correction test, students who received business and economics education much more intended to consume and purchase cultured meat. In addition, statistically significant difference between the mean score of the all factor in the survey of the students and education type of the students was found in this study. Student who has two years education time were higher total score of the survey than students who has four years of education time in the university ($p<0.05$). Also it is found that negative correlation between the age of the participants and their Factor 2 (being an alternative of industrial meat) section points ($r=-0.109$, $p=0.036$), Factor 3 (consume and purchase cultured meat) section points ($r=-0.121$, $p=0.019$). In conclusion, there were statistically significant results between variables (the type of education, groups of education, age of students) and their opinions about cultured meat. In general university students in Hakkari University, has negative perspective on aspect of health, being and alternative, consuming of cultured meat.

Key words: Cultured meat, Acceptance of Cultured Meat, University Students

ABSTRACT (Turkish)

Kumru, M. (2023). Üniversite Öğrencilerinde Kültür Etinin Kabul Edilebilirliğinin İncelenmesi. Yeditepe Üniversitesi, Sağlık Bilimleri Enstitüsü, Beslenme ve Diyetetik Departmanı, Master Tezi, İstanbul.

Bu çalışma Türkiye'deki üniversite öğrencileri arasında kültür etini satın alma davranışı ve kültür etine yönelik öğrencilerin bakış açısını saptanmayı amaçlamaktadır. Çalışmanın örneklemini yapılan ankete gönüllü katılım sağlayan 371 üniversite öğrencisi oluşturmaktadır. Verileri toplamak için kullanılan anket soruları, kültür etinin kabul edilebilirliği üzerine çalışan diğer araştırmalardaki anket sorularının derlenmesi ile elde edilmiştir. Çalışmanın istatistiksel analizi için SPSS 25.0 versiyonu kullanılmıştır. Yapılan analiz sonucunda elde edilen bulgulara göre katılımcıların çoğunun kadın olduğu ve katılımcıların ağırlıklı olarak hepçil bir beslenme alışkanlığına sahip oldukları görülmektedir. Anketin puan ortalamaları ile öğrencilerin cinsiyetleri ve beslenme biçimleri arasında istatistiksel olarak anlamlı bir bulguya rastlanılmamıştır ($p>0.05$). Meslek grupları açısından incelendiğinde ise anketin kültür etini satın alma bölümü puanları ile meslek grupları arasında istatistiksel olarak anlamlı bir sonuç elde edilmiştir. Bonferroni düzeltme testinin uygulanmasıyla istatistiksel farklılığın işletme ve ekonomi meslek grubuna mensup öğrenciler ile eğitim meslek grubuna dahil olan öğrenciler arasında olduğu tespit edilmiştir. İşletme ve ekonomi eğitimi alan öğrencilerin kültür etini tüketme ve satın alma bölüm puanları eğitim meslek grubundakilere göre daha yüksek bulunmuştur ($p=0.002$). Ek olarak iki yıl eğitim alacak olan öğrenciler ile dört yıllık öğrenim göreceği olan öğrenciler arasında iki yıllık ön lisans öğrencilerinin anket toplam puanları ve satın alma bölümünün puanları dört yıllık eğitim süresine sahip öğrencilerden istatistiksel olarak anlamlı olacak şekilde daha yüksektir ($p<0.05$). Ayrıca öğrencilerin yaşları ile anketin kültür etinin endüstriyel ete alternatif olmasını inceleyen Faktör 2 bölüm puanları ($r=-109$, $p=0.036$), ve kültür etini satın alma eğilimini irdeleyen faktör 3 puanları ($r=-0.121$, $p=0.019$). arasında negatif bir ilişki saptanmıştır. Sonuç olarak öğrencilerin öğrenim tipleri, meslek grupları, yaşları gibi değişkenler ile kültür eti ile ilgili görüşleri arasında istatistiksel olarak önemli bulgular elde edilmiştir. Genel olarak Hakkari Üniversitesi'nde öğrenim gören öğrencilerin, kültür etini sağlık, alternatif olma, tüketim açılarından incelediğinde olumsuz bir tutum sergiledikleri çalışmamızca ortaya konmuştur.

Key words: Kültürleşmiş Et, Kültürleşmiş Etin Kabul Edilebilirliği, Üniversite Öğrencileri

1. INTRODUCTION AND PURPOSE

Cultured meat is defined as new novel food obtained by proliferating and differentiating stem cells taken by biopsy from live animals under anesthesia in the laboratory environment (1). They are also named as artificial meat, cell culture meat, in vitro meat, lab meat, synthetic meat, and clean meat (2). This innovative method requiring few or without any animals to produce muscle fibre. Therefore this technique eliminates the slaughter of animal (1). In addition, according to FAO (Food and Agricultural Organization), the need for food of the human population, which will reach approximately 9 billion people in 2050, is expected to increase by 70% and 2 billion people are expected to add to the 815 million people who are at the hunger limit (3). Industrial livestock production, on the other hand, is insufficient to meet the increasing population and food consumption needs, contradicting the principle of sustainability due to its inefficient use of resources like lands, energy, water (4). Two-thirds of agricultural areas and one-third of the land on earth are devoted to industrial livestock (5). 40% of the grains in the world are harvested to feed animals and it is known that even half of this rate is sufficient to solve the hunger problem (6). Moreover, it is observed that the area destruction caused not only reduces biodiversity, but also causes threaten wild life habitat (7). Livestock industry significant contribution to environmental issue, depletion of natural sources, leading to habitat loss and decrease biodiversity. On the other hand, cultured meat technology has potential to bring solution to this livestock issues (8). It is known that approximately 22% of pathogens that cause many diseases originate from meat, and this poses a health threat in traditional livestock farming (9). It is predicted that cultured meat can reduce the risk of zoonosis and other animal diseases, due to the fact that the production system is controlled and human-animal interaction is limited (10). Unfortunately, it is known that because cultured meat is a new product, which means that it is difficult to make definite conclusions about its health consequences. There may be unexpected biological mechanisms in the culture process like uncontrolled cell proliferation (11). This situation needs to be controlled by regulatory institutions in order to reassure the consumer about guarantee of safety of cultured meat (12).

Cultured meat is a novel subject in cellular agriculture, gaining public attention in the last two decades (13). The spread of cultured meat to the masses is largely attributed to the attitude of the consumer towards this product. It is known that the price of the product, the taste of the product, the perception of naturalness on the product, and the concept of food neophobia (who have a fear of or aversion to new foods) are effective factors in the consumer's acceptance of

the product (14). Another way to achieve success in the consumption of cultured meat is to imitate real meat in terms of structure, appearance, nutritional value and taste (15).

To the best of our knowledge, no other study concerning consumers' perceptions of cultured meat in university students in Turkey has been conducted. Thus, this study aimed to fill this gap by analyzing the perception of a sample of Turkey student consumers and their willingness to try, to pay and to buy for cultured meat.

2. LITERATURE REVIEW

2.1. Current Problems of Livestock

The current animal husbandry system has problems such as inefficiency in terms of the use of natural resources, not caring about animal welfare, causing the spread of zoonotic diseases, and threatening public health due to antibiotic and pesticide residues. One of the alternative ways developed to respond to these problems is cultured meat (15).

2.1.1. Consumption of naturel resources

2.1.1.1. Land use

Livestock production is the largest user of land in the world. It is also responsible for the consumption of 40 per cent of what is produced in agriculture. The livestock sector has occupied three quarters of the earth's land area, using it for grazing animals. This brings with it a range of problems, from deforestation and soil degradation to habitat destruction and biodiversity decline. Intensive and expansionist agriculture on the fertile land needed to produce food for animals is also negatively affecting the Amazon region (16). The Amazon, the world's largest tropical forest, provides an example of biodiversity being destroyed by livestock. Three quarters of the area is used for crop cultivation and grazing, leading to deforestation (17). Cultivated meat production can prevent deforestation through vertical production without the need for grazing (18). Unlike today's livestock farming, which opens forest areas to grazing for meat production, cultured meat significantly reduces the use of forest resources. In this way, it can support the ecosystem here and pave the way for the re-establishment of wildlife. It can make it possible to prevent the hunting of exotic animals (19). Because another problem created by anthropogenic land use is the negative impact on species richness. Meat production with the use of land for grazing or agriculture affects biodiversity. Apart from soil erosion caused by reduced vegetation cover, the decrease in plant diversity threatens the food chain of wild herbivores (20). When habitats dominated by humans are compared with habitats that remain natural, it is noteworthy that there are fewer species in habitats dominated by humans (21).

Land use in food production plays a key role in the decline of biodiversity. 60% of the decline in global and terrestrial biodiversity is associated with the food sector (22). Biodiversity is decreasing with the livestock sector and 52 per cent of the world's wildlife has disappeared in the past four decades. The main causes of this situation are grazing, deforestation and desertification. With increasing and intensifying agricultural activities, 62% of 5,407 species are under threat (23). Africa's cheetah (*Acinonyx jubatus*), Asia's hairy-nosed otter (*Lutra sumatrana*) and South America's huemul deer (*Hippocamelus bisulcus*) are among the 2,300 species that are negatively affected by the livestock-dependent agricultural sector (7).

2.1.1.2. Water use

Water is not only essential for humans but also for agriculture and animal husbandry. The fact that the use of water waiting for hundreds of years in the underground water is out of control and approaching depletion shows that water is no longer an edible resource (24). Water resources are being depleted due to the uncontrolled withdrawal of water from the ground due to increasing population and agriculture, which is faster than the recharge of water with precipitation (25). Agriculture uses approximately 70 per cent of the water and livestock husbandry uses approximately 30 per cent (3). Approximately 15,415 litres of water must be consumed for one kg of beef production and 1440 litres of water for one kg of chicken. The amount of water required to obtain animal proteins is much higher than vegetable proteins (26). It is thought that cultured meat technology will use 82%-96% less water compared to traditional animal husbandry (27).

2.1.1.3. Energy use

The skin of animals regulates temperature, the internal organs are responsible for digestion and the distribution of nutrients and oxygen, and the immune system is responsible for fighting pathogens. The fulfilment of the same tasks when meat is produced in the laboratory makes this technological development energy-dependent (28). Cultured meat production is energy dependent due to the production of ingredients used for the medium and bioreactors used to provide suitable environmental conditions. It is also shown that the energy consumption required for cultured meat production is higher than that currently used in animal husbandry (29). The data obtained from laboratory-scale experiments may not coincide with the data of the industrialised system. Regulations on medium and bioreactors, which have an important place in determining the energy load of cultured meat in factory production, can affect energy efficiency. For example, large-scale bioreactors have not yet been tested. Alternative ingredients developed to replace Dulbecco's modified Eagle medium (DMEM) medium, which

is frequently used in production and requires high amounts of energy, can reduce energy consumption (30). Growth factors and vitamins to be used as a source in cultured meat production can also affect the amount of energy utilisation. Although energy consumption for the production of cultured meat is still based on estimates, it is thought to be 46% less than beef production and 38% more than chicken production (31). The processing of food to improve the structural properties of meat can also impose an extra energy burden (27). The use of renewable energy sources such as solar and wind is among the options to reduce energy consumption in cultured meat production (32).

2.1.2. Environmental impact

The proportion of greenhouse gases (GG), produced directly by the livestock sector and indirectly such as deforestation, fertilisation, production and transport is 14.5% of total production (33). Nitrous oxide (N_2O) emitted from manure in livestock, methane (CH_4) released as a result of animal digestion, carbon dioxide (CO_2) emitted from the area used in feed production or animal feeding and/or due to fossil fuel use during transport contribute to GG emissions (34). The low transport and storage costs of cultured meat and the low amount of possible waste can be an environmental improvement. It is also expected to have a longer shelf life compared to today's meat (35). Cultured meat performs an important job by reducing CH_4 gas emissions emitted in traditional livestock farming. However, due to the energy dependence of cultured meat production, CO_2 is produced during production. The long life of CO_2 compared to CH_4 may affect the environmental burden of cultured meat. Since there is no production on a global scale yet, it is difficult to answer this question (1). According to Lynch and Pierrehumbert's study, cultured meat production may worsen the climate crisis in the long term due to the shorter accumulation of CH_4 in the atmosphere compared to CO_2 . Therefore, the advantageous position of cultured meat in terms of greenhouse gas production is uncertain (34). In a study comparing the environmental burdens of meat analogues such as soy, insect, chicken and cultured meat, it was concluded that cultured meat can create an environmental problem compared to its alternatives due to its dependence on non-renewable energy sources (36).

One of the environmental benefits of cultured meat is that it can revitalise dead areas with low oxygen in the ocean. The increase in nitrogen and phosphorus in the water with agricultural wastes causes the proliferation of algae and causes eutrophication. The deoxygenation caused by this situation results in the death of aquatic life. Cultivated meat, which requires less agricultural inputs, has the potential to reduce eutrophication (28).

Cultured meat production is also advantageous in terms of food safety as it is grown under indoor conditions. Food safety is threatened by the climate crisis in regions struggling with high temperatures and drought. Cultured meat production can improve food safety by providing a more optimal product yield (30).

2.1.3. Health concern

The livestock system is characterised by a number of health issues affecting society, such as animal diseases, the risk of diet-related non-communicable diseases, antibiotic resistance and pesticide residues (37).

2.1.3.1. Livestock disease

Zoonotic diseases, which are caused by the transmission of pathogens through the interaction between animals and humans, are extremely common in livestock and threaten public health and safety. Pathogens from domestic animals such as goats, pigs, sheep and horses can be transmitted to humans directly or through food and can cause diseases such as anthrax, rabies, tuberculosis, brucellosis, pustular stomatitis, rotavirus infection (38). Food-borne diseases, mostly caused by zoonotic pathogens, are a public health problem responsible for adult and child morbidity worldwide, in addition to economic losses (39).

Modern agricultural practices and habitat loss for grazing or crop production bring wild animals and domestic animals into a common space, facilitating the spread of zoonotic agents and exacerbating existing conditions (40).

2.1.3.2. Pesticides and antibiotic use

Pesticides, which were introduced into modern agriculture with the green revolution, are easy-to-apply and cheap chemical agents that increase productivity by removing pests and weeds in agriculture. Although pesticides, which have a wide history, took place in the agriculture of the Romans, Sumerians, Greeks as plant extracts, copper, sulfur, it is known that they could not get the efficiency of pesticides today due to inadequate application strategies (41). Pesticide residues can accumulate in animal tissue indirectly as a result of agricultural activities through water or feed or by direct application to the area where the animal lives. Pesticides that enter the body through skin contact, respiration and digestion can be metabolized and stored in the edible tissues of animals, causing residues to be seen in animal products such as meat, milk and eggs (42). It is thought that pesticide residues, which are transferred to humans with consumption, are associated with neural diseases and cognitive abnormalities depending on the

duration of exposure, and may trigger cancer formation by affecting the endocrine and immune system in the human body (43).

Antibiotics widely used livestock animals to improve growth and prevent infection related disease. It is known that 30% of antibiotics are used for growth promotion in the industry (44). 83% of antibiotics taken by United State are used in animal husbandry for promote growth or prevent illnesses (45). The use of the majority of antibiotics in animals accounts for the largest share in the development of antibiotic resistance (46). The presence of antibiotics and resistant bacteria in soil, rivers, groundwater and drinking water creates environmental pollution and raises a major health concern as a means of introducing antibiotics into the food chain (47). It is known that antibiotics are excreted through urine and feces after the detoxification process after entering the animal body, and some of them remain as residues in the edible parts for a certain period of time (48). Since residues in milk can suppress the starter bacteria that initiate yogurt production, problems can also be encountered industrially (49). The contamination of vegetables and fruits with antibiotic residues, which are mostly ingested through animal foods, is thought to be caused by animal fertilizers in agricultural practices (50). Another problem is that antibiotic residues reaching humans through the food chain cause resistance, reducing the effectiveness of the treatment used in infectious diseases, resulting in the death of at least 700 thousand people every year and damaging the effectiveness of antibiotics applied to animals. (46). The fact that antibiotic-resistant bacteria are not only transferred from animals to humans but also from humans to humans imposes a responsibility on people in the resistance crisis, as one person has the right to influence the use of antibiotics by another person (51). Considering the environmental and health consequences of uncontrolled antibiotic use, it is recommended that farmers should stop improper practices, wait for the purification period in the tissue after antibiotic application and comply with the upper residue limit, and carry out vaccinations to prevent diseases (52).

2.1.3.3. Meat consumption related disease

Apart from containing essential amino acids and being a good source of B12 and iron, meat is considered to be responsible for the emergence of non-communicable diseases, especially cancer and heart diseases, due to the excess of saturated fatty acids, salt, heterocyclic amines, polycyclic aromatic hydrocarbons and nitrazo compounds in its content (53,54). According to the American guidelines, dietary pattern has the power to reduce the risk of disease causing death from any cause by 17-26%. Excessive meat and processed meat consumption results in high cholesterol and increases the risk of vascular infarction compared to a plant-based diet.

However, when compared with a normal diet, it is seen that there is no difference between them (55). The American Heart Association (AHA) recommends limited consumption of processed meat and a preference for lean meat to reduce the risk of heart disease. The International Agency for Research on Cancer (IARC), in a report based on a review of more than 800 reviews, classified processed meat as carcinogenic and fresh meat as probable carcinogenic, noting that there is a strong association with colorectal cancer, which ranks third in the world in terms of prevalence, and that the risk increases by 12% for every 100 g of red meat consumption (56). The American Cancer Society recommends a shift from red meat and processed meat to chicken and fish to reduce risk (57). In a meta-analysis study examining the relationship between chicken consumption and cardiovascular disease, it was found that there was an inverse relationship between chicken consumption and causes of death and a negative relationship with cardiovascular events. So, it is said that it may be an alternative to red meat (58). In the cohort study obtained by secondary analysis of 6 cohort studies, consumption of more than two servings of processed meat and chicken per week was associated with increased incidence of CVD, while the association of fish consumption was found to be statistically insignificant. For all causes of death, red and processed meat were associated with a high risk, while chicken and fish were not. Although it is not possible to establish a direct relationship between excessive intake of a food group and the risk of cardiovascular disease, since the occurrence of these diseases depends on multiple factors such as physical activity, smoking and alcohol consumption, it is not correct to reduce it to a single cause (59). In a systematic review, a low level of evidence showed that reducing lean meat in the diet had a low effect on reducing cardiometabolic and cancer outcomes. Apart from the environmental and ethical aspects of meat consumption, the members of the panel suggested that current consumption can be continued when evaluated from a health perspective (60). Since conflicting results were obtained in the systematic review conducted to determine the relationship between myocardial ischemia and excess meat consumption, it does not seem possible to reveal a clear information in the light of the literature (61).

2.1.4. Animal welfare

Animal welfare refers to a state in which the animal is healthy, well-fed, free from pain and fear and can exhibit its natural behaviour. The fact that diseases, mortality, stress, behavioural disorders can occur in bad conditions and that vertebrates are emotional beings. They can experience pleasure and happiness in addition to their capacity to taste pain reveals the ethical side of animal welfare apart from its economic return (62). Although animal welfare is thought

to be a new issue, it is actually possible to trace its traces back to the past. In Mesopotamian clay tablets such as the Laws of Hammurabi, the Laws of Eshnunna (1920 B.C.), and the Lipit-Ishtar Law (900 B.C.), there are provisions on offences committed against animals, the responsibilities of humans on animals, and ancient texts revealing the human-animal relationship (63). Although this issue, which started to gain importance with civilised societies, became widespread by expanding to individual and social institutions of other countries with the establishment of British animal protection laws in the early 19th century. The absence of legal regulations on animal welfare in places such as Brazil and China, which are the leading countries of animal production, points to a great contradiction. The fact that animals suffer from negative emotions such as fear and stress reveals the urgency of this discipline, not with the thought that animal welfare will create an economic loss by losing the health of animals in adverse conditions (64).

Practices that cause animals to suffer and the place of lives that end in death on our plates are elements that cannot be separated from the current animal husbandry system (32). In industrial animal husbandry, the presence of implementation such as beak trimming, tail docking, practices before, during and after transportation, inability to exhibit normal behaviour in an overcrowded environment are practices that ignore animal welfare (65). The processes in which physical and biochemical changes occur intensively in animals are experienced at the time of loading and unloading. Due to the stress experienced by the animals, their attempts to escape or lie down can cause bruises, injuries and overloading of animals can worsen the situation (66). The fact that the transfer times are very long and that food and water are not provided during the waiting period after being unloaded for the slaughterhouse are among the major problems experienced in transportation. Another problem experienced in the slaughterhouse is that the stunning process cannot be performed properly due to electrodes placed in the wrong area due to the thought that the animal will die anyway (67). Although the practice of tail docking is banned in Turkey, but it is known that it is still continued in some farms. Due to this practice, problems such as dermatitis, chronic pain and wounds, and the inability of animals to repel flies arise (68). In the poultry sector, it is known that beak trimming, which is a similar practice to prevent animals from attacking each other and plucking feathers due to the stress they experience, causes chronic pain and stress. The main reason for this cannibalism is that chickens are put in cages, which are too small to exhibit their natural behaviours such as digging, pecking and exercise, which resulted in the banning of the traditional cage system by the European Union (EU) after 2012 (69). In Turkey, which is trying to comply with EU criteria, cages are

planned to be banned as of 1 January 2023 (70). Apart from being kept in cages, it is known that hens kept on litter in overcrowded environments have difficulty in accessing food and water, suffer from leg pains and heat stress, and close contact facilitates the spread of diseases. Prolonged exposure to ammonia due to poor litter quality can lead to conjunctivitis disease in chickens, decline in growth and decrease in feed consumption. Apart from that, another problem is that the application of 23 hours of light and 1 hour of darkness in order to ensure the rapid growth of chickens may result in eye diseases and sudden death (71).

Cultured meat, which offers the opportunity to present an animal-centred point of view in a realistic way by not performing the act of killing, is also referred to as "slaughter-free meat", victimless meat, cruelty-free meat (72). If cultured meat replaced with conventional animal system, there is no need to animals kept and slaughtered. Cultured meat can be produced in laboratories and may lead to animal suffering through cultured meat produce method (73). However, it is underlined that cultured meat technology is still animal dependent and it is known that taking cells by biopsy frequently in a certain animal cluster is subject to criticism that it may raise other ethical problems (1).

2.1.5. Growth population and endless demand of meat

In the modern world, farm animals are seen as machines that provide eggs and milk and do not have emotional values. Ignoring the social and emotional needs of these animals, whose food, medical support and accommodation are provided, causes them to suffer. Emotions are not only a spiritual expression but also a biochemical mechanism that develops among animals through natural selection over the years and enables them to survive by solving problems. Mammals, birds, some reptiles and fish are known to be emotional beings. With the agricultural revolution, the dairy industry ignores the bond between mother and child, separating the baby immediately after the birth of the mother and ignoring the basic emotional bond. Not only the industry, but also humans eat one of the cows and dogs with the same emotional capacity, but not the other, due to the difference in perspective we produce with our thoughts and emotions while consuming meat. We do not construct the relationship between the steak on our plate and the animal and consume it as if it were a dish independent of the animal (74). Both loving animals and consuming their meat creates the paradox of meat (75). The first option is to stop consuming meat in order to get rid of ethical incompatibility. The second option is to try to align attitudes and behaviours by developing psychological mechanisms. Considering that a large population still consumes meat, it is seen that the secondary option is predominantly engaged (76). In order to solve the dilemma and justify themselves, people have developed categories. The first of the

3Ns, normal, says that eating meat is a normal and customary action. Natural indicates that it belongs to human nature. Necessary, on the other hand, indicates that without meat, it is impossible to get the necessary nutrients and achieve a healthy diet (74). The fourth N, which was later added by Piazza et al., represents nice and associates the taste of meat with pleasure (77). According to Rothgerber, there are some basic mechanisms to reduce discomfort when the animal is eaten and to cope with this situation. Avoiding the relationship between the animal and the food, denying the animal's pain and mind, or ignoring that they are responsible for this pain also facilitate coping with the dilemma (78). Since many consumers cannot give up the flavour of meat, they place it at the basis of their diets and continue to consume it (79).

Although meat consumption is directly related to income, the amount of meat per capita per year varies between 80-130 kg in developed countries. An increase in meat consumption has also been observed in developing countries over the past two decades (5). With a favourable economic base and a growing population, meat consumption is expected to increase in the future (80). The increasing demand for animal resources increases the pressure on the ecosystem and causes livestock producers to compete for various resources. The current situation, in which 815 million people worldwide are undernourished, one in every nine people is tested by hunger, and one in every eight people lives in extreme poverty, is an urgent call for the global food system. How industrial animal husbandry will feed the human population, which is expected to reach 9.8 billion in 2050, is a matter of great debate (3). In order to meet the food need in 2050, it is estimated that the global crop supply should increase by 25%-70% (81). It is a matter of concern how and in what way industrial animal husbandry will meet the need for sufficient food in quality and quantity for the growing population. Cultivated meat claims to be able to respond to the needs of the growing population by producing more meat with fewer animals compared to industrial livestock (12). There are different views on the role of cultured meat in managing increasing global poverty and hunger.

There are those who believe that cultured meat has the potential to end hunger by providing cheaper protein to those who struggle to make ends meet. Opposing views are that hunger is caused by the distribution of food, not its production, and that cultured meat will have no effect on distribution. In addition, another argument of those in this view is that cultured meat will not prevent global hunger and poverty because it will not be at a price that poor people can afford (29).

2.1.6. Productivity

Raising animals for human consumption is an inefficient process in many respects. In modern animal husbandry, animal breeding depends on grain. Forty per cent of the world's harvested grain is reserved for feeding animals. Even half of this amount of grain is enough to feed all hungry people (82). Protein efficiency, which is expressed as the percentage of the feed given to the animal to be transformed into body tissue, also varies according to animal species. When the same amount of feed is given, a conversion of 12 units in insects, 6 units in chickens, 3 units in pigs and 1 unit in cattle is realised (83).

In addition, not all parts of the animals raised are consumable. Edibility rates vary according to the type of animal (84). The feed given to the animal is spent 75%-95% of the animal's metabolism and the growth of inedible parts such as tail, skin and horn. It is thought that renewable tissue will be obtained with a high conversion rate with cultured meat. Since it does not constitute the whole animal, it is thought that the nutrient requirement to be spent per kilogram in cultured meat will be less (85). According to a study, 14.1% of cows and 11% of pigs are wasted. However, the leftovers are used in the pet industry, cosmetics and pharmaceuticals (86). There is no waste or by-product formation in cultured meat. One of the reasons why cultured meat is more efficient than industrial livestock production is that it does not need to form the skin, organs or other biological structures of the animal (28). Since it does not use the whole animal, cultured meat also offers an opportunity to solve the problem of food waste in the meat industry (87). Since the part of the animal, not the whole animal, will be transported and the production sites are closer to the consumer, it can be beneficial in terms of access to cultured meat. Since the animal does not have excesses such as bone, adipose tissue, etc., the need for refrigeration may also decrease (27). In addition, the cultured meat obtained by culturing stem cells reaches the amount of meat obtained in industrial animal husbandry faster since it does not need to wait for the animal to be slaughtered (18).

2.2. Historical Development of Cultured Meat

Although cultured meat seems to be a current development, its maturation in terms of idea dates back to 1912 (88). In 1912, Alexis Carrel managed to keep the culture of chicken heart tissue alive for 34 years and inspired Churchill 'Fifty Years Hence' essay to argue that since we only consume certain parts of the chicken, we do not need to produce all of it (89). Although the realisation of the idea took a long time due to the lack of technological possibilities, the discovery that stem cells could be transformed into muscle cells was a step beyond the idea. In 1999, Dutch scientist Willem Frederik Van Eelen became the first person to patent industrial

production cultured meat suitable for human consumption with cell culture technique (85). Three years later, a group of scientists cultured golden fish cells in a petri dish to provide an alternative food source for long space journeys (90). In 2008, the first international conference on in vitro meat was held in Norway. In 2013, Mark Post's hamburger, the first cultured meat, which took three months to produce and cost more than 330 thousand dollars, was evaluated by dietician Hanni Rutzler and gourmet Josh Schonwald, author of "The Taste of Tomorrow", and the panel concluded that the hamburger was almost similar to the taste of real meat (91). In 2016, Memphis Meat Company followed this development by producing the first meatball and expanded its production by adding duck and chicken (92). The Aleph Farm company, which overcame the obstacle of producing meat such as steak, which has a complex structure with cell culture method, using 3D bioprinting technology method in 2018, managed to produce the first in vitro steak (93). Looking at the distribution of diversification, it is known that at least a quarter of the companies focus on beef, 22 per cent on duck and chicken, the rest on pork and seafood, and two companies are interested in producing rat meat as a pet food (94). When the amount of money invested is analysed, it is seen that over 460 million funding was made for in vitro meat between 2016 and 2020 and Memphis Meat, which took the lead with 200 million, was followed by Mosa Meat with 85 million (95).

2.3. Production Stage of Cultured Meat

The muscle cell culture model based on the growth of muscle cells in vitro has been used and accepted for many years. This approach appears as an alternative model for animal meat production (96). Roughly summarised, stem cells are first obtained from the donor animal by biopsy. Stem cells proliferate and differentiate into myoblasts and myoblasts fuse into myotubes. Myotubes differentiate and form myofibres. When the matured muscle fibres are harvested and combined, the culture meat takes its final form (12). The stem cells grow and differentiate in the bioreactor with growth medium on the scaffold (97). The production stages and the biomaterials used are explained in the sub-headings.

2.3.1. Cell selection and biopsy

The cells to be used in the production of cultured meat are expected to have the capacity to renew themselves, proliferate and differentiate into mature cells. At the same time, it is desired that the cell line to be formed should be consumable in terms of food safety and provide sufficient amount of product at low cost. Since the ability of the cells to culture with each other and the ability of the cells to take the necessary substances from the medium and contain them

in the product will affect the nutritional content of the cultured meat, cell selection is important in the cell line to be formed (98).

There are two basic stem cell types, adult stem cells and pluripotent cells, which can meet these needs. Adult stem cells have the ability to differentiate into some cell types and are widely preferred in cultured meat production. Satellite and mesenchymal stem cells are included in this group and can differentiate into different cell types (99). Mesenchymal stem cells can be obtained mostly from bone marrow, but are also found in areas such as dental pulp, adipose tissue, skeletal muscle. These cells differentiate into preadipocytes and provide the formation of white and brown adipogenic lines by binding to each other (100). In addition, mesenchymal stem cells have the ability to differentiate into chondrocytes, and fibroblasts. Satellite cells are responsible for myogenesis.

Pluripotent stem cells have the power to differentiate into almost all cell types except placenta with their superior and unlimited differentiation ability. In order to obtain muscle fibres from these cells, they must first differentiate into myogenic progenitor cells, but it may be difficult to prevent the formation of different lines. However, since satellite cells from adult stem cells are already programmed to become muscle fibres, they differentiate into myogenic progenitor cells and provide skeletal muscle reconstruction (101). Satellite cells are passive between the basal lamina and sarcomere. In case of muscle damage, injury and trauma, they are activated and start to perform muscle fibre formation stages (102). Myogenesis is a process that starts in the formation of the embryo, continues in the development of the foetus and ends with birth (96). In these cases, the ability of satellite cells to form muscle cells indicates the potential for use in cultured meat production. In order to achieve success in the production of cultured meat, it is necessary to obtain easily and cheaply, with sufficient reproductive capacity. Pluripotent cells require more time and resources to mature. Obtaining these cells is costly and culturing processes are more complex than adult cells. Although their proliferation capacity is better, adult stem cells with limited proliferation capacity can also form the cell population required for culture (103). In addition, pluripotent cells are located in the lower layer of blastocysts. Damage to embryos while isolating from the tissue raises another ethical concern in the use of these cells (104). Many cell types have potential for cultured meat production and are being investigated. It can be said that satellite stem cells are promising in this regard (97). A heterogeneous cell population can be created by using more than one cell type in the production process. Considering the structure of meat, the presence of satellites and adipocytes is inevitable (105).

After the selection of the appropriate stem cell, the stage of isolating the cell and making it suitable for use is started. In order to remove the cell, a biopsy must first be performed on the donor animal. Needle or small incision methods are used for tissue biopsy, which is a standard procedure in veterinary science. Although incision is a more painful procedure than using a needle, it is an advantageous method in cultured meat production as it allows easier control of the donor animal and allows the sample to be taken in large quantities. In both techniques, it is necessary to anaesthetise the animal and minimise the pain and stress it will experience with local anaesthesia. All these procedures should be performed under veterinary control (106).

Anaesthetising donor animals for the procedure and trying to ensure that they remain immobile in the cage may limit animal welfare. Considering this situation, it is recommended to increase the number of biopsies per session instead of frequent sessions. According to a protocol that can be applied for this purpose, two or at most four needle biopsies can be performed in a quarterly session and about 500 mg of tissue can be obtained from each of them. It is recommended to optimise this protocol with different studies (107).

In order to obtain a large number of stem cells from the donor animal to be biopsied, it is necessary to pay attention to factors such as the age and sex of the animal. Satellite stem cells decrease with increasing age, indicating that the age of the animal is a significant parameter (108). Gender factor can also affect the selection of the donor animal. Although the mechanism is not yet known, it has been shown that androgen hormone can increase satellitic stem cell growth and differentiation (109). In this case, taking into account the gender as well as the age of the animal in the procedure may affect the number of stem cells to be obtained from the procedure.

After the biopsy, unnecessary components such as connective and adipose tissue are removed with the help of scale and scissors in order to isolate the cell. The cell is washed repeatedly with Dulbecco's phosphate buffered saline (DPBS) mixed with antibiotics to remove foreign substances. Environmental hygiene is observed to prevent contamination. Then, the process is completed by breaking peptide bonds by means of previously prepared proteolytic enzymes (110).

2.3.2. Medium culture

One of the most important elements in cell culture technology is undoubtedly culture medium. It is essential for the maintenance of cellular functions, cell proliferation, adhesion and differentiation (111). Nutrients and components used for cell growth can be combined in

different ratios and combinations. Although it varies according to the cell type and line to be used, in general, medium contains essential and non-essential amino acids, carbohydrates, inorganic salts, minerals, vitamins, growth factors, serum and antibiotics (112).

In cell culture applications, serum can be preferred as a supplement in terms of harbouring growth factors, nutrients and proteins. The percentage of FBS (Fetal Bovine Serum), which is the most widely used serum, varies between 2-20 in the media. In academia and industrial areas, the development of mediums that can replace serum is being fought (113). The use of FBS as serum creates an ethical dilemma. Although a standardised medium has not yet been found, in order for cultured meat to survive and preserve its existence, the medium should not contain animal sources, can be placed in food and should be cheap (114). In addition, cultured meat should proceed in parallel with sustainability goals by using resources well. By removing FBS from the culture medium, cultured meat can only be accepted in terms of sustainability (115). The use of serum-independent media is considered as a more realistic option both to prevent serum-borne infections and to reduce production costs. It is important for industrial production to meet these conditions (116). The high cost of mediums is an obstacle to the production of cultured meat on an industrial scale. Apart from the cost, the amount of medium required for industrial scale production has not yet been reached (32).

Serum-free media are obtained by enriching basal media such as Alpha-Minimum Essential Medium, Dulbecco's Modified Eagle's Medium, Iscove's Modified Dulbecco's Medium with hormones, growth factors, carrier elements, vitamins and minerals. Basal medias basically contain inorganic and organic salts, amino acids, carbohydrates and they need additional nutritional support to ensure cellular growth and development. Deficiencies in basal media are eliminated by adding substances such as antioxidants, carrier molecules, hormones and growth factors, fatty acids (113).

2.3.3. Scaffold

Myoblasts need to be attached to something in order to perform the contractile movement. The scaffold mimics the ECM (Extra cellular matrix) and acts as a biochemical trigger as well as a desired mechanical support. Myblasts need a scaffold to contract, proliferate and differentiate into multinucleated muscle fibres (117). It is very important for myotubes to form a straight cell line on the scaffold for differentiation. Because the formation of branches with incorrect structuring may cause a decrease in the contractility of the cells and disruptions in protein production (118). At the same time, the scaffold must have a flexible structure for contraction and diffusion of the medium. A scaffold with a large surface area should be preferred for cells

to adhere and grow. Another feature sought in the scaffold is that it should be edible or easily separable from the product since it will be found in the final product (18).

The main purpose of the scaffold is to facilitate the development of muscle and adipose tissue. It should provide continuous perfusion by mimicking the vascularisation in normal tissue with a porous structure (119). The three-dimensional networked structure formed by interconnected pores manages the flow of nutrients and the transport of wastes (120). Apart from the transport of oxygen and nutrients, it has a major role in the shaping of the final product by controlling the distribution and geometric structure of the cells. It affects the sensory properties of cultured meat such as structure, firmness and nutritional value of the product (121). It should also be non-allergenic and non-toxic and it is recommended to control this (122).

ECM has functions such as realising intercellular communication, providing structural support and producing response against injuries. ECM consists of proteins such as collagen, fibrinectin, laminin and polysaccharides such as glycosaminoglucon. The three-dimensional scaffold should also stabilise the cell and resemble the ECM as much as possible (123, 124). The use of animal-derived collagen is recognised as the gold standard in achieving this similarity. The potential of non-animal source preferences is increasing in terms of consumer acceptance and suitability for large-scale production. Non-animal-derived polymers such as chitin, cellulose and recombinant collagens are used in tissue engineering as they are low-cost, versatile, compatible, biomaterials already consumed by consumers (125).

Biomaterials derived from plants or fungi are an alternative and promising approach. The fact that plant tissue has a porous and vascular structure may provide an advantage in application by facilitating oxygen and nutrient transport (126). In addition to plants, cellulose scaffolds obtained from bacteria may also be suitable for scaffolds to be used in cultured meat (127).

2.3.4. Bioreactor

Bioreactors try to create biological conditions suitable for cells and medium by creating a controlled environment. Apart from creating an aseptic environment, it is responsible for controlling values such as temperature and pH. Another function is to help transport oxygen and nutrients (116). Stirred tanks and wave bioreactors are widely used (128). When the cells multiply and reach approximately 10^{13} , they are placed in the bioreactor to increase the number of cells per medium (129). The ratio of the surface area to the volume of the scaffold, which is considered as the internal part of the design in the culture meat production process, directly affects the size of the bioreactor to be used. The need for large bioreactors with high efficiency

in order to produce large amounts of cultured meat is a challenge for the cultured meat industry (124).

2.3.5. Harvest

Three weeks after the production of contractile proteins, muscle fibres are mature and reach 2-3 cm in length. Muscle fibres that are suitable for harvesting then proceed to the stages of processing, cooking and presentation to the consumer (11).

2.4. Technics of Production

The production methods used in culture meat technology can be basically reduced to two groups. These methods are self-organising technique known as tissue culture technique and scaffold-based technique also called cell culture technique (130). The scaffold method is based on the reproduction and growth of the animal cell taken by biopsy by attaching to the scaffold in the bioreactor in a culture where the appropriate medium is provided (131). While boneless meat production can be realised with this method, it is not possible to produce high structured meats such as steak. However, a more rigid product can be obtained with a self-organising structure in suitable substrates (132). Benjaminson et al., goldfish muscle explants were cultured in vitro. After separating the fish tissue into very small pieces, they centrifuged it. They waited for seven days in the culture medium in a Petri dish. When the culture containing dissociated golden fish skeletal muscle cells was used, 79% proliferation was observed on the surface and the new tissues looked like fresh fish fillets. The fish marinated with olive oil and garlic was fried and presented to the panellists. Although it was not tasted by the panellists, comments were received that it looked and smelled good (90). It is known that the self-organising technique can bring together the correct composition of the tissues that make up the meat and produce a realistic three-dimensional meat by mimicking the in vivo environment (132). However, cells that remain away from nutritional support for a long time may undergo necrosis (133).

2.5. Health Aspect of Cultured Meat

2.5.1. Nutritional value

Cultured meat should be able to imitate traditional meat in terms of appearance, structure and nutrient content (134). Cultured meat, which can be an alternative to meat, which offers a rich source of amino acids, vitamins and minerals, should aim for a nutritional composition close to meat (135). In terms of protein, the protein content of cultured meat depends on the type of scaffold used and the cytoplasmic proteins produced by myotubes in culture. Most of the

cytoskeletal proteins of myoblast cells are actin, myosin and titin. The nutrition and structure of meat is affected by the amount and composition of these dominant proteins (136). It takes 3-5 days for myoblasts to differentiate into myotubes with the differentiation and growth of cells during the culturing process. After myotubes are formed, they start to synthesise sarcomeric proteins. Therefore, the protein content of cultured meat depends primarily on the cytoplasmic proteins they produce (137). Another factor is the scaffold, which has an important place in tissue culture technology. The scaffold provides cell growth and proliferation by mimicking the three-dimensional structure of the cell in the laboratory environment during the formation process of muscle tissue. Apart from the mechanical support it provides, it also supports the management of metabolic events in the cell by controlling the nutrient and oxygen input to the cell thanks to its porous structure (88). Since the scaffold, which has a great place in cell culturing, is a part of the final product, it must be edible. Being edible shows that it can affect the nutritional value of the product. Edible biomaterials selected for cultured meat can contribute to the taste and appearance as well as change the nutritional value of the product (138).

When the scaffold is protein-based, this directly affects the amino acid content of the product (139). Collagen or gelatin is widely used in the food industry to create extracellular matrix due to its biodegradabilities, and low antigenicities (140). Collagen is a triple helix protein formed by the formation of covalent bonds of its three chains with glycine. Due to the large side chains, essential amino acids such as valine and isoleucine cannot be included in the alpha-helix structure (141). It is weak in terms of nutritional value due to its high amount of glycine amino acids and predominantly non-essential amino acid content (142). The amino acid content of meat is inversely related to the amount of connective tissue it contains. Isoleucine, valine, arginine, methionine amino acids decrease in the presence of connective tissue and this reduces the nutritional value of meat (143). In cases where connective tissue is used as a scaffold, the nutritional value of artificial meat may be insufficient in terms of amino acid content.

Alternatives are considered to prevent the dependence of cultured meat on animal-derived materials. This situation increases the interest in plant derived biomaterials. Soy, zen and pea proteins are preferred due to their low cost and rich protein content. Chien et al., found that the scaffold produced from soy has the potential to be used in tissue engineering technology (144). Ben-Arye et al., revealed that the scaffold they developed with textured soy protein is cheap, does not need further modification and has the potential to be used in the culturing process (122). There is no commercialised plant-based scaffold yet. Apart from this, it is recommended

that scaffolds obtained from soy and peanut proteins should be labelled against the risk of allergy (138).

Carbohydrates are a very important element for the extracellular matrix as they affect mechanical properties and functions (145). Scaffolds consisting of polysaccharides provide cell adhesion and proliferation. Although materials obtained from animals are often used in the scaffold, the material here can also be preferred from algae or plant origin (139). Plant-based polysaccharides such as alginate, cellulose, pectin have a high acceptance (135). The fact that indigestible polysaccharides are rich in dietary fibre can enrich cultured meat in terms of nutritional values.

The nutritional characteristics of cultured meat obtained by genetic modifications can be optimised. In this study, which provides an example of nutritional modifications in tissue culture engineering, endogenous production of carotenoids was achieved. With this application, not only the nutritional characteristics of the meat, but also the shelf life of the meat can be extended by reducing lipid oxidation levels (146).

The content of traditional meat has a distribution in which saturated fat is high and unsaturated fat is low (147). Due to the fact that the production stages of cultured meat are open to modification, a special and healthy product can be produced. It is possible to reach the desired fatty acid profile by regulating the culture medium. A meat with a profile rich in ω -3 instead of low-fat or saturated fatty acids can be produced (148). Epidemiological studies draw attention to the relationship between meat consumption and heart disease and colon cancer. If this relationship is due to components that are not produced from muscle and fat cells of meat, a healthier product can be obtained by removing these factors. Cultured cells cannot synthesise minerals such as zinc, selenium and vitamin B12. Vitamins and minerals need to be supplemented to the culture with binding proteins that carry vitamins and minerals to the cells (11). Vitamin B12 supplementation is an extremely vital application for cultured meat to be similar to traditional meat. Whether the tissue contains enough vitamin B12 is also a subject of future research (134).

Currently, there is not enough information about the protein, carbohydrate content and amino acid composition of cultured meat (149). The hypothetical information is waiting to be verified by comparing it with today's meat in terms of nutritional values when cultured meat is commercialised. In addition, there is a need for the contributions of researches on the effect of

cooking methods to be applied to cultured meat at the consumption stage such as cooking, smoking, baking, fermenting on nutritional values (150).

2.5.2. Antibiotic use

It is common practice to use antibiotics to prevent microbial contamination when culturing cells. The presence of microorganisms in the culture can inhibit cell growth or cause cell death. The addition of antibiotics to the medium is vital, contributing to the creation of a sterile environment. A contaminated cell line can be corrected with a combination of various antibiotics (151). Antibiotics frequently used in culturing are penicillin and streptomycin. In some studies, streptomycin is not recommended to be used as medium because it reduces the effect of mechanical stimulation and negatively affects cultured muscle (152). Currently, it does not seem possible to grow large amounts of cells without the use of antibiotics. Technological developments are expected to replace antibiotics for a healthier and safer way. L-glutamine, an amino acid, has the potential to replace antibiotics or be used in combination (110). As another alternative, the addition of sodium benzoate to the medium is thought to inhibit the growth of yeasts and fungi in culture (153). Sodium benzoate is a preservative that is frequently used in the industry due to its ability to prevent microbial growth and prolong the shelf life of foods by preserving nutritional values, in addition to preventing the growth of yeast, bacteria and mold. Sodium and potassium benzoate have genotoxic effects on human lymphocytes in vitro (154). Another study found that a mixture of sodium benzoate and potassium sorbate increased micronucleus frequency in human lymphocytes. Attention should be paid to the use of these substances as food preservatives (155). Joint FAO and World Health Organization (WHO) on Food Additives (JECFA) set the Acceptable Daily Intake (ADI) for sodium benzoate as 0-5 mg/kg body weight (154). If sodium benzoate is used in cultured meat as an alternative to antibiotics, the consumer's attention to the daily intake limits is a factor to be considered in terms of health.

Adding the antibiotic to the medium can reduce the risk of contamination. However, there is a possibility that the antibiotic, which is criticized in industrial animal husbandry and causes resistance, may resist until the end product of the culturing process. It is important to document the type and amount of antibiotic in order to clear suspicions about human health and to prevent antibiotic resistance (156). The presence of antibiotics in long-term cell cultures creates resistant microbes, which contradicts the benefits of cultured meat for industrial animal husbandry (157). It is seen that the amount of antibiotics used in the procedure to prevent contamination is less than the amount used in industrial animal husbandry (158). This can be

explained by the elimination of the necessity to keep cultured meat in an area for a long time as in industrial livestock farming and the reduced need for antibiotics (10). It is also thought that this process can occur without antibiotics (159). However, antibiotic use is currently part of routine practice (153).

2.5.3. Contamination risk

The production of cultured meat is constantly monitored and intervened when contamination is necessary (160). The harvesting process from the proliferation of stem cells takes place under sterile conditions. Due to its small size, the presence of microorganisms can be easily recognized (11). As an advantage of being produced in a sterile environment, it is thought that cultured meat can reduce the incidence of diseases arising from human and animal interaction (10). Pathogens can be managed more easily in the production of cultured meat (161). In industrial livestock farming, animals raised under inappropriate and inadequate conditions increase the risk of viral outbreaks (avian and swine flu). Stress in animals brought together in confined spaces in industrial animal husbandry suppresses their immune systems and increases the spread of pathogens. Insufficient exposure to sunlight and inappropriate ventilation conditions lead to prolonged survival of the virus (162). With animal agriculture, the possibilities of viral transmission between humans and animals are expanding. In addition, this situation facilitates the spread of harmful pathogens such as E.coli and Salmonella in meat (163). It is thought that sterile and controlled cultivation of meat can prevent these problems and will be beneficial for public health (164). The fact that animals are not raised or slaughtered in the same environment in the production of cultured meat reduces the risk of epidemics and eliminates the cost of vaccines developed accordingly (165). Another advantage of cultured meat compared to conventional meat is that it can be grown under sterile conditions, extending its shelf life and reducing food losses (166). It is recommended to develop a suitable packaging method for cultured meat, which becomes vulnerable to bacterial contamination during transportation or distribution, to show the benefits it will provide on shelf life and food loss (167). Another advantage of cultured meat over industrial animal husbandry is that it will significantly reduce the use of pesticides, environmental pollutants and hormones in industrial animal husbandry (85).

Cultured meat, which in theory is free from microbial contamination resulting from animal slaughter and can reduce the possibility of foodborne disease and outbreaks, needs to be considered for contamination risk during cell culture production (156). It is generally accepted that cultured meat produced in the laboratory reduces the risk of zoonotic diseases. However,

there are some gaps regarding the health effects of cultured meat (168). Cell bank activities and the development of a straight cell line require manual manipulation and are vulnerable to environmental and personnel exposure (169). There is a risk of mycoplasma contamination during cell retrieval and storage (170). Mycoplasma, which is considered a type of bacteria, is difficult to detect and remove in cell culture due to its unique characteristics. The difference from other bacteria is that it has no cell wall and has a flexible cell membrane. This flexibility allows mycoplasma to take different shapes, making it difficult to recognize in culture (169). For mycoplasma, laboratory materials, personnel and the environment are intermediary sources of contamination (171). Observation and monitoring of the production environment has a major role in preventing mycoplasma transmission (170). Raw materials derived from plants or animals pose a distinct risk as they are a source for mycoplasma to feed on. This risk is known to be reduced when using media devoid of animal ingredients (172).

Another potential hazard for culture medium comes from the animal serum used for the media. Culture medium has an indisputable place in cell culture technology because it provides cell growth and proliferation. FBS is the serum commonly used in media due to its rich nutrient content, hormones and proteins necessary for adhesion (173). It has the necessary qualities for cell adhesion, growth and proliferation. However, when analyzed in terms of biosafety, the fact that it may contain endotoxin, mycoplasma, prion, virus causes concern (174). Detection of the virus during the production of the material and prevention of contamination is a challenging process. There is a possibility of encountering broad-spectrum viruses in a culture in the presence of FBS (175). The presence of pestiviruses (especially bovine viral diarrhoea virus), which are widespread in the cattle population, also poses a threat in the use of FBS. The ability of the viruses to cross the placental barrier of the cow and infect the fetus means that FBS is also contaminated and not suitable for culture (173).

2.5.4. High rate of proliferation

Another concern for cultured meat is the possibility of uncontrolled cell proliferation. The rapid proliferation of stem cells can lead to genetic dysregulation and the formation of cancer cells. It is possible for carcinogenic cells to hide and multiply. These cells are considered harmless because they will be dead when the meat is finished. In case they are still alive, they will be destroyed by the stomach or small intestine when our digestive system is activated (11). Chromosomal abnormalities can also be seen in myblasts during their growth. Their genetic instability poses a risk in clinical use (176). In order to reassure the consumer that there will be

no health problems, this situation needs to be controlled by the authorities and monitored with a HACCP (Hazard Analysis Critical Control Point) plan (12).

There is a need for regulatory institutions to guarantee the quality and health of cultured meat. Health concerns can be addressed with a system that advances with technological developments in parallel with the discourse of regulatory bodies (107).

2.5.5. Health regulatory institution

Due to the limited production and non-commercialization of cultured meat, safety standards have not yet been clarified. It is estimated that the practices will vary from country to country. The fact that cultured meat is a food product gives food authorities the right to speak instead of medical authorities (32). At a recent meeting, the U.S. Department of Agriculture's (USDA) Food Safety and Inspection Service (FSIS) and the U.S. Department of Health and Human Services' (HHS) Food and Drug Administration (FDA) announced that they will play a role in the safety of this new technology. While the FDA will handle the growth, proliferation and development of the cell, the final product ready for harvesting and labeling will be regulated by the USDA-FSIS (128). The European Food Safety Authority (EFSA) has prepared a detailed list addressing the commercial aspects of cultured meat. The list, which provides guidance from the cells that produce cultured meat to the culturing process, can help businesses (177).

In order for cultured meat to reach the consumer in a healthy and safe way, it must pass certain inspections. In order to replace today's meat, it must meet the same safety standards. However, it is thought that extra safety measures will be needed for the culture media and scaffolds involved in its production (160). HACCP system is considered to be applied in order to ensure the necessary hygiene conditions of cultured meat and not to pose a danger. HACCP is a system built on preventing or reducing biological, physical, chemical hazards that may occur in the product in order to guarantee the safety of the product. It enables to identify risks contaminated with food. HACCP was initially created to ensure a proper and safe diet for astronauts and its basic principles were developed in a laboratory context (178). This can be considered as a factor that can facilitate the application of HACCP criteria to cultured meat produced in a laboratory environment (179). The development of an inclusive monitoring program and an appropriate flow of authorities represent the prerequisites for ensuring the safety of cultured meat (32).

2.6. Challenges of Acceptance

2.6.1. Consumer acceptance

The existence of an audience that does not find technological interventions in food production natural and does not trust them is a challenge for the acceptability of cultured meat (180). Consumer rejection or acceptance of the product may be directly related to the technology. Scientific data or uncertainties on the subject, the controllability of the process or the perception of naturalness towards the product are effective in the evaluation of a technological product. Although the advantages of cultured meat compared to traditional animal husbandry in the press may be attractive to the consumer at first, the frequent coverage of technological details may confuse the public. The fact that a product obtained by technological means is not perceived as natural by the consumer causes a negative attitude towards cultured meat. The artificial meat or synthetic meat names used for cultured meat may also reinforce the perception of unnatural (14). In fact, a product produced in an unnatural way should be considered natural, just as children born through an unnatural way such as in vitro fertilisation can be considered natural (73). Our life starts with a cell and undoubtedly refers to a natural process. From this point of view, consuming cultured meat is also a natural act (181). In order for artificial meat to be accepted by the society as a natural product, some marketing methods may need to be developed (182). In order to improve the consumption of cultured meat, labelling that includes the benefits of cultured meat for the environment, animal rights and public health can be counted among these strategies (167). Apart from the perception of naturalness, food neophobia may develop in consumers due to the fact that cultured meat is a new and foreign concept. The state of being reluctant to eat a foreign, new food is called food neophobia (183). Consumers are more likely to consume food groups they are familiar with (88). Considering that cultured meat is also included in the new food category, the development of food neophobia in consumers may create a negative situation regarding purchasing. Individuals with food neophobia may tend to see the benefits of cultured meat less (184). Another issue that draws attention while deciding whether to consume the product is product-related health concerns. The safety and nutritional values of the product affect the perspective. It has been observed that when consumers are given positive information, their willingness to consume increases (185). Perceptions may change with the intervention of regulatory organisations or in the event of awareness of the technology of the product at the level of society and consumers. This is not yet the case for cultured meat (14).

2.6.2. Aspect of economy

The first hamburger made of cultured meat weighing 141.75 g produced by Mark Post cost \$325,000 (186). In order for cultured meat to compete with today's meat in the market, its costs should be reduced. Medium culture is the most costly element in the industrial production of

meat (187). The growth factors in the medium are the primary reason that makes the medium expensive. In order to reduce the cost here, new approaches such as genetically modified microbes and fungi are promising (188). In cultured meat production, apart from culture medium and bioreactors, the tools used during the process and employment also constitute major expenses. Employment costs can be reduced with increasing mechanisation. In order for cultured meat to remain in the market, it is essential to reduce the costs of medium, bioreactor and employment costs (189). Cultured meat production on an industrial scale will only be feasible if a cost-effective process is created. If cultured meat is more expensive to produce than today's meat, its consumption may be limited to a special group such as vegetarians (190). If cultured meat production is realised, the economies of countries producing or exporting traditional meat will be affected. If industrialised, it is thought to affect employment in the agricultural sector (85). Smallholder livestock farming is largely based on family agriculture and provides food, income and hot money to households (191). The livestock sector has a significant role in poverty alleviation. It is known that the livelihoods of 1.3 billion people worldwide depend directly and indirectly on the livestock sector (192). Cultured meat can create new working areas. However, it may require different employment criteria than the skills and knowledge of individuals working in the agricultural sector (193). Cultured meat may not completely eliminate the livestock sector, but it may affect the sustainability of farmers. If entrepreneurs in the cultured meat sector manage the export of traditional meat to other countries, this may lead to inflation and economic disruption in some countries (148).

2.6.3. Aspect of religion

The consumption of cultured meat has also become a subject of debate in religious areas. Ideas have been put forward about whether cultured meat belongs to the categories of Kosher foods, which are religiously permitted to be eaten in Jews, and halal foods in Islam (165).

In addition to the reliability of the food consumed by Muslims and Jews, it is of particular importance that it is religiously appropriate. Halal food in Islam is defined as foods that are allowed to be eaten and drunk by the religion of Islam. Pork, shed blood, animals not slaughtered in the name of Allah, dead animals are not accepted as halal food (194). Whether or not cultured meat will fall into this class is a new issue for the Islamic community. According to Islamic thought, culture meat can be considered halal with the regulation to be made in the cell source in culture meat and the content of the medium used. The fact that the serum used in the culture medium does not fall into the category of clean because it is obtained from blood does not make the culture meat clean according to Islamic thought. If different alternatives such

as chemical, plant-based or fungal-based media are used for the medium and an assurance is given that this is not harmful, the meat is considered halal. Another condition is that the stem cells must be taken from a non-living animal slaughtered in accordance with Islamic procedures. It is forbidden to eat cultured meat produced by taking stem cells from a living animal (195). Stem cells can also be taken from freshly slaughtered animal tissue (107). If these conditions are met, cultured meat can take place in the Muslim market as an alternative to halal and traditional meat.

There is a debate among Jewish rabbis as to whether cultured meat is kosher or not. According to some rabbis, cultured meat is classified as meat and is considered kosher if it is slaughtered in accordance with kosher procedures. According to some rabbis, cultured meat has severed its connection with meat. There is no harm in consuming pork, which is normally prohibited, even as cultured meat (196). In a survey conducted with Jewish individuals, the vast majority reported that they could eat cultured pork (197).

The fact that animal cruelty is not included in the basic principles of Hinduism may encourage the consumption of cultured meat (29). However, even if cultured meat prevents the killing of animals, it is criticised for being considered unethical in terms of taking the cells of the creature to be used for meat production (198).

2.6.4. Simirlarity of livestock meat

Muscle consists of muscle cells, fat cells, connective tissue cells such as fibroblasts and vascular tissue (99). It is a heterogeneous and complex organ. Meat consists of skeletal muscles located in different parts of the body. The complexity of its composition determines the taste and quality of the product. Fat cells are aroma and flavouring agents. The stroma consisting of connective tissue provides the structure of meat (96). The different components that occur as a result of the maillard reaction with the cooking of meat constitute the aromatic richness of meat (1).

Cultured meat is also expected to replicate meat as much as possible by containing sensory components such as structure, colour, aroma or volatile molecules that provide the formation of these components, such as the presence of myoglobin (134). One of the criteria for achieving success in cultured meat production is that the cultured meat achieves a high level of acceptability by having a similar taste, structure and appearance to today's meat (199).

2.6.4.1. Texture

A system without vascularisation and blood leads to disruption of nutrient and oxygen transfer, making it difficult to create the normal thickness in cultured meat. Cultured meat is built on a thin and porous structure (200). The fat content of cultured meat and the ability to create larger muscle fibres are features that need to be studied. Co-culturing with adipocytes is essential for structural similarity to traditional meat (115). The limited size of skeletal muscle due to the lack of vascular network can be overcome by co-culturing myoblasts and muscle precursor cells (201). However, co-culturing can be problematic considering the different medium requirements of each cell type to differentiate and grow (134). For this reason, it may be considered to combine two different cells later. Stem cells can be taken with the same biopsy procedure and grown separately from adipose tissue muscle and then brought together during the preparation of meat (115). Instead of co-culture, proteins such as collagen or elastin used in edible scaffolds can also support the creation of connective tissue (134).

2.6.4.2. Flavour

There are over a hundred substances that give meat its flavour and many of them change during cooking or storage. With heat treatment, flavours are formed in meat due to the Maillard reaction. The glycosamines formed in the Maillard reaction are dehydrated to form furfural, furfural by-products and dicarbonyl products. All these products form the flavour (202). The mixture of heterosilicic compounds containing sulphur, nitrogen and oxygen also contributes to meat flavour (203). The addition of free amino acids and peptides, which are flavouring agents formed in the Maillard reaction, during production can increase the flavour of cultured meat. The same purpose can be served by enriching with various flavours and spices (204). Apart from aromatic substances, fatty acid content also creates the unique flavour of meat (205). Intramuscular fat (IMF) consists of fat droplets stored in muscle fibres and muscle fat. It contributes to properties such as juiciness, taste, odour, appearance and nutritional value, which indicate the sensory quality of meat (206). The consumption of low-fat meat products is limited due to their inability to capture the social taste and lack of flavour. For acceptability, the product must meet structure, flavour and other sensory characteristics (207). The ability of cultured meat to develop intramuscular fat is important for structure, mouthfeel and flavour (208). In order to increase the fat content of cultured meat, fats of animal and vegetable sources can be added to the medium at the last step of the culturing process (19). Co-culturing adipocytes and muscle cells in a suitable medium can also increase fat mass (10). Another way to create adipose tissue in cultured meat is to use stem cells. After culturing pluripotent stem cells, they are

expected to differentiate into mature adipocytes. Mesenchymal stem cells can also be preferred as another option to obtain adipocytes (209). While the formation of muscle tissue takes three weeks, the maturation of adipose tissue can take 2-3 months. Although the maturation interval is longer, muscle fibre is easier to form in vitro (116). To improve the flavour of cultured meat, the heme component found in myoglobin and haemoglobin can be added (208).

2.6.4.3. Tenderness and water capacity

A complex biochemical process begins with the slaughter of the animal. In the absence of oxygen, anaerobic metabolism is initiated and intramuscular glycogen is broken down to lactate. With the release of calcium from the sarcoplasmic reticulum, the muscle contracts and a permanent actin myosin complex is formed (210). As the intracellular pH decreases, many enzymes are activated to break down muscle proteins and soften the meat. A few days after the slaughter of the animal, the meat becomes suitable for consumption when it reaches a soft consistency (12). This process ensures the realisation of flavour precursors and tenderisation. After harvesting, it is necessary to investigate the similarity of cultured meat to today's meat regarding glycogen content and pH change. The fact that the isoforms of actin and myosin in cultured meat are of neonatal or embryonic origin instead of adult may change the protein response (15). However, if the actomyosin complex developed in rigor mortis is not formed in cultured meat, this may increase the softness and water holding capacity of the product (134). Tenderness and juiciness are two important sensory components that provide appreciation of meat products (204). The tenderness and water holding capacity of cultured meat can be improved by the properties of the scaffold used. For example, bacterial celluloses have high water retention ability and high polymerisation and crystallisation levels (211). Due to these properties, they are already used as thickener and texturiser in the food industry (212). Gelling and emulsifying properties are associated with the proteins in meat. In cases of insufficiency, the structure of cultured meat can be strengthened by providing support with starch, fibre and proteins (200).

2.6.4.4. Color

The yellow colour of the muscle fibres in cultured meat is incompatible with today's meat. This is because ambient oxygen conditions suppress myoglobin synthesis, which provides the red colour to meat (12). To overcome this problem, there are approaches to increase the amount of myoglobin in cultured meat. The first approach involves inducing myoglobin synthesis by adapting muscle fibres to low oxygen levels (213). The expression of myoglobin is influenced by media selection, hypoxic conditions in the bioreactor, and supportive substances added to

the media (199). Although hypoxic conditions have been shown to stimulate the differentiation and growth of myostaline cells, further research is needed to unravel the mechanism (214). A secondary approach is to add myoglobin directly into the medium (134). Using natural extracts or myoglobin analogue to mimic the colour is also considered as an option. For example, Beyond Burger uses beet juice as a natural extract (204).

2.7. Idea About Future of Cultured Meat

Cultured meat has the potential to create a world where there is a meat production factory in every block instead of large farms (215). It has a revolutionary quality that allows more production using less space (28). Although this journey from laboratories to factories requires time and much research, it is thought that this transition is possible (216). With the development of technology and the necessary investments, it is predicted that cultured meat will soon take its place on the plates (217). Cultured meat has the potential to be an alternative to traditional animal husbandry and is a candidate to become one of our daily food habits. However, the long-term consequences of its impact on the environment and human health need to be observed (218). Its economic dimension, which is an obstacle for it to enter the market shelves and for its fabrication, also needs to be improved (85). It is thought that cultured meat technology will continue to develop and increase consumer acceptance (167). Even if this technology cannot reduce the price in economic terms and will never catch up with large-scale production, it is a fact that intensive animal farming must end (196).

3. MATERIALS AND METHODS

3.1.Type of Research

This study was conducted as an descriptive and cross sectional study.

3.2.Time and Place of Research

This study was conducted with the participation of university students in Hakkari. After ethics committee approval, data collection was initiated in March 2022 and completed in April 2022. The study was concluded in June 2022 with the processing and analysis of the data.

3.3.The Subjects and Sample of the Research

This study was carried out to students at Hakkari University in Hakkari. In order to determine the sample size of the study, the calculation (d-value) method developed by Cohen was used to calculate the effect size. To determine the effect size index d, Mancini MC. and Antonioli F. in 2019, the findings of the study investigating the attitudes of consumers towards cultured meat in Italy were used (219). In this study, the rate of willingness to consume cultured meat was

determined as 46%. In the calculation we made for this consumption demand difference, the effect size was found to be $d=0.146$ (small effect). In this context, Chi-Square tests to be used to determine the difference in meat consumption desire between groups (χ^2) for; $d=0.146$ (small effect size), $\alpha=0.05$ (margin of error), $1-\beta=0.80$ (power), accompanied by the specified criteria *G-power (version 3.1)*. With the help of the package program, a total of 369 participants was calculated.

3.4. Data Collection Tools

Participants signed a consent form before participating in the study. In the voluntary consent form, the purpose of the research was explained and the participants were informed about the research. It was also stated that participation is completely voluntary and participant information would be kept confidential. The data were obtained through a questionnaire. Data collection was carried out face to face. The survey questions were obtained by compiling questions from other studies on the acceptability of cultured meat (2, 220, 221, 222). With this questionnaire, it was aimed to determine the level of knowledge, perspectives, attitudes and purchasing tendencies of the participants regarding cultured meat. The questionnaire were consisted of 5 sections and 23 items. It was a Likert-type questionnaire that was expected to be scored from 1 (least) to 5 (most) except for the first part. In the first section, the participants were asked to share their demographic information such as age, gender, education level, dietary habits, etc. In the second part, the level of knowledge about cultured meat was questioned. Afterwards, the participants were informed verbally and in writing in order to answer the other parts properly. The third part includes questions on the comparison of industrial animal husbandry and cultured meat, and aims to analyse the participants' perspective on cultured meat. In the fourth part, they were expected to answer questions about the possibility of trying cultured meat or replacing traditional meat in their diet with cultured meat. In the last part, the purchasing behaviour of cultured meat was examined.

3.5. Data Assessment

While evaluating the findings of the study, SPSS version 25.0 (IBM Corp., Armonk, NY, USA) program was used for statistical analysis. Descriptive statistical methods (mean, standard deviation, number, percentage, etc.) were used while evaluating the study data. Normal distribution of data was evaluated by using Kolmogorov Smirnov test. The data was not normally distributed according to Kolmogorov Smirnov test, so the comparisons between the two groups in quantitative data were determined by Mann-Whitney U test. In comparisons of more than two groups, Kruskal-Wallis test was used. Bonferroni test was used to determine

which groups the difference originates from. Spearson test was used for determining relation between descriptive factors. Significance in the 95% confidence interval was evaluated significant.

3.6. Ethical Approval

There was no objection to the conduct of this study by the scientific publication and ethics committee of the University of Hakkari. The study was approved by the board dated 21.02.2022, session number 2022/28.

3.7. Limitations of Research

This study had some limitations. The study sample includes only university students in the city of Hakkari. For this reason, the inability to generalise the results constitutes the limitation of the present study.

4. RESULTS

This section presents the results obtained as a result of the statistical analysis of the collected data.

4.1. Demographic Features of Participants

The sample of the Young People's Cultured Meat Perception Survey (YCMPS) consisted of a total of 371 students from the Republic of Turkey (TC) studying in different fields at a public university. The mean age of the students included in the study was 22.35 ± 2.71 and the age range was 18-34 years. 62.5% (N=232) of the participants were female and 37.5% (N=139) were male. 35% (n=130) of the students were studying in associate degree programmes and 65% (n=241) in undergraduate programmes. When the distribution of the occupational groups in which the students receive education was examined, 66.8% (n=248) of the students receive education in education, 20.2% (n=75) in health, 8.1% (n=30) in business-economics and 4.9% (n=18) in engineering or technical occupations. In terms of dietary habits, 93.3% (n=346) of the students were omnivores, 2.7% (n=10) were semi-vegetarians, 2.7% (n=10) were vegetarians and 1.3% (n=5) were vegan (Table 4.1).

1

Tablo 4.1. Demografic characteristic of participants

| Features | N | % | Mean±SD | Min.-Max. |
|--------------|-----|-----|------------|-----------|
| Age | 371 | 100 | 22.35±2.71 | 18-34 |
| Group of Age | | | | |

| | | | | |
|--------------------------|-----|------|--|--|
| 18-20 | 81 | 21.8 | | |
| 21-24 | 239 | 64.4 | | |
| ≥25 | 51 | 13.7 | | |
| Sex | | | | |
| Female | 232 | 62.5 | | |
| Male | 139 | 37.5 | | |
| Type of Education | | | | |
| Two years | 130 | 35.0 | | |
| Four years | 241 | 65.0 | | |
| Occupation Groups | | | | |
| Education | 248 | 66.8 | | |
| Health | 75 | 20.2 | | |
| Business- economy | 30 | 8.1 | | |
| Engineering | 18 | 4.9 | | |
| Dietary Habbits | | | | |
| Omnivore | 346 | 93.3 | | |
| Semi vegetarian | 10 | 2.7 | | |
| Vegetarian | 10 | 2.7 | | |
| Vegan | 5 | 1.3 | | |

4.2. Findings Related to Item Analysis and Factor Structure of YCMPS

In order to determine the factor structure of the questionnaire, principal components factor analysis method was applied to the scores obtained from the answers of 371 students to the 5-point Likert-type items using varimax rotation method. Kaiser-Meyer-Olkin (KMO) for sampling adequacy and Barlett's test values for sample size were calculated. Kaiser-Meyer Olkin (KMO) value was calculated as 0.913 in principal components factor analysis and this value was found to be at an acceptable level. Bartlett's Test of Sphericity (Bartlett's Test of Sphericity Test) analysis showed that $\chi^2=3266.556$ and highly significant ($p<0.001$). In order to reach the appropriate factor analysis model, for the 23 items in the questionnaire, 7 items with an item-total correlation value below 0.30, a factor loading value less than 0.45 or an overlapping item were removed from the scale. As a result of the factor analysis performed with items 3,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,14,15,16,20,21,22 and 23, 3 factors were obtained under which 16 items with eigenvalues greater than 1 were collected. When the line graph of the eigenvalues were analysed, it was seen that the questionnaire was grouped under 3 factors

(Figure 4.1). In the graph, the first factor explained 45.404% of the survey variance, the second factor explained 10.898% of the survey variance and the third factor explained 8.219% of the survey variance. After the third factor, the course of the graph was generally horizontal and no significant downward trend was observed.

When the data in Table 2 were analysed, 3 factors in the final questionnaire explained 64.521% of the questionnaire variance. This ratio was considered sufficient since it was above 50%. The item correlations of the questionnaire took values between 0.52 and 0.76. The factor loadings of the items in the questionnaire were ranged between 0.57 and 0.95. The item numbering of the 16-item scale was re-numbered and given as "scale item number" in Table 1. As a result of the reordered items, items 1-7 were grouped under factor 1, items 8-12 under factor 2 and items 13-16 under factor 3. When the items collected under the factors were analysed in detail; it was determined that the items collected under the 1st factor were related to "Health-Flavour", the 2nd factor was related to "Being an Alternative" and the 3rd factor was related to "Consumption". The total reliability value of the questionnaire was found to be 0.92 (Table 4.2).

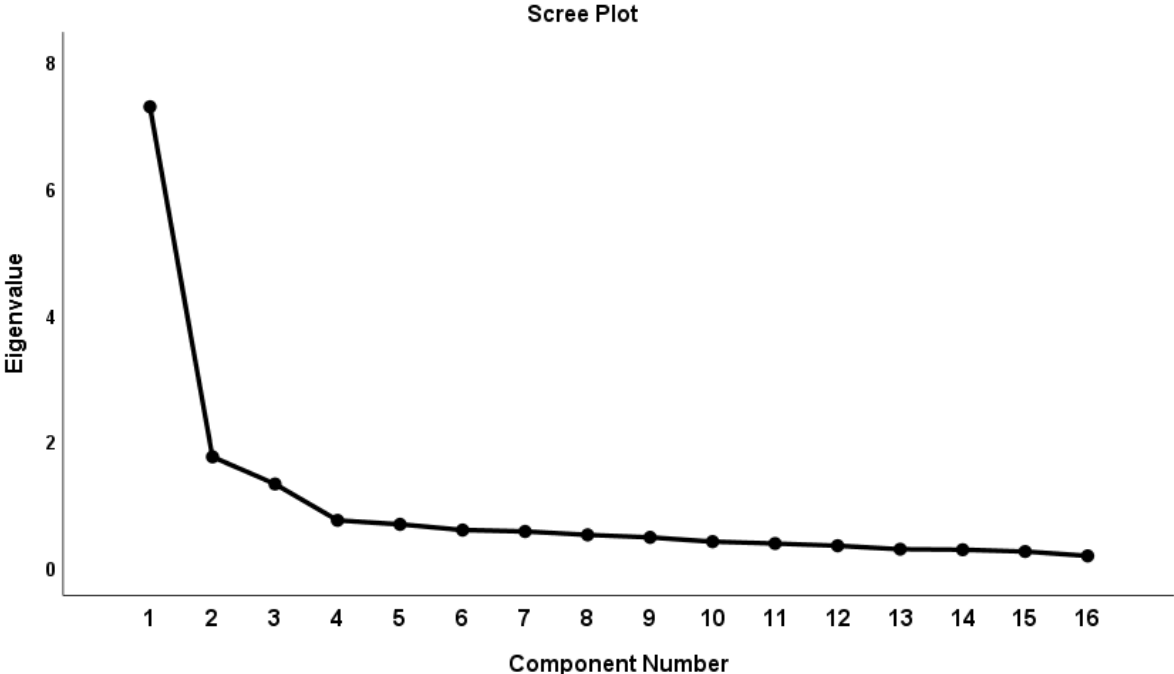


Figure 4.1. Scree Plot

Tablo 4.2. Results of Factor Analysis of YCMPS

| Subdimension | Item No | Item Survey No | Survey Items | ITCS* | Factor Load | Cronbach Alpha(α) | Explained Variance (%) |
|---|---------|----------------|--|----------|-------------|----------------------------|------------------------|
| Health-Taste (1st Factor) | 3 | 1 | Cultured meat is healthier than industrial meat. | 0.647 | 0.946 | 0.898 | 45.404 |
| | 4 | 2 | Cultured meat is more natural than industrial meat. | 0.628 | 0.919 | | |
| | 5 | 3 | Cultured meat is more environmental-friendly than meat. | 0.707 | 0.709 | | |
| | 7 | 4 | Cultured meat is ethical than industrial meat. | 0.731 | 0.656 | | |
| | 9 | 5 | Cultured meat is ethically right than industrial meat. | 0.760 | 0.643 | | |
| | 8 | 6 | Cultured meat is more tasty than industrial meat. | 0.638 | 0.636 | | |
| | 6 | 7 | Cultured meat could reduce GG emission from agriculture. | 0.614 | 0.567 | | |
| Being an Alternative (2st Factor) | 15 | 8 | Cultured meat may be an alternative industrial meat. | 0.551 | 0.868 | 0.819 | 10.898 |
| | 14 | 9 | Cultured meat may be a solution to scarcity. | 0.542 | 0.862 | | |
| | 16 | 10 | Cultured meat replace with industrial meat in the future. | 0.557 | 0.746 | | |
| | 11 | 11 | Cultured meat has less risk transmitted disease animal to human compared to industrial meat. | 0.517 | 0.617 | | |
| | 10 | 12 | Eating cultured meat improve animal welfare. | 0.633 | 0.588 | | |
| Consumption (3st Factor) | 23 | 13 | I buy cultured meat regularly. | 0.536 | 0.831 | 0.843 | 8.219 |
| | 22 | 14 | I intend to pay more money than industrial meat in order to consume cultured meat. | 0.519 | 0.815 | | |
| | 20 | 15 | I eat cultured meat instead of industrial meat. | 0.598 | 0.745 | | |
| | 21 | 16 | I suggest to omnivore person to eat cultured meat | 0.656 | 0.711 | | |
| Sum | | | | - | - | 0.919 | 64.521 |
| Kaiser-Meyer-Olkin (KMO) | | | | 0.913 | | | |
| Barlett's Sphericity Test Chi-Square Value (χ^2) | | | | 3266.556 | | | |
| Significany (Sig.) | | | | <0.001 | | | |

*ITCS: Item Total Correlation Score

Table 3 shows the level of participation of the students according to the items of the YCMPQ. The lowest score of the students was "*I regularly buy cultured meat*" (Mean=2.03±1.01) and the highest score was "*In the future, cultured meat may be an alternative to industrial meat*" (Mean=3.27±1.15). Only 7% of the participants stated that they were willing to purchase cultured meat regularly. It is seen that a large majority of 64.9% disagree with paying more money to buy cultured meat than industrial meat. Only 15% of the participants selected the options of agree and strongly agree with the statement that cultured meat is more natural than industrial meat. This statement was found to have the lowest mean score in factor 1.

When the total scores obtained from the factors are analysed; 1st factor mean score 17.69±6.55 (range=7-35), reliability coefficient $\alpha=0.90$; 2nd factor mean score 15.63±4.62 (range=5-25), reliability coefficient $\alpha=0.82$; mean score of the 3rd factor was 8.94±3.60 (range=4-20), reliability coefficient $\alpha=0.84$; and mean total score of the questionnaire was 42.26±12.59 (16-79), reliability coefficient $\alpha=0.92$ (Table 4.3).

Tablo 4.3. Participants' Participation Rates and Mean Scores for the Statements of the YCMPS

| | YCMPS | I strongly disagree | I disagree | Undecided | I agree | I strongly agree | |
|-------------|--|------------------------|------------------------|----------------------|--------------------------|------------------|-----------------|
| | ITEMS | n (%) | n (%) | n (%) | n (%) | n (%) | $\bar{X}\pm SD$ |
| 1st Factor | Cultured meat is healthier than industrial meat. | 119(32.1) | 111(29.9) | 85(22.9) | 40(10.8) | 16(4.3) | 2.25±1.14 |
| | Cultured meat is more natural than industrial meat. | 150(40.4) | 90(24.3) | 75(20.2) | 43(11.6) | 13(3.5) | 2.13±1.17 |
| | Cultured meat is more environmental-friendly than meat. | 82(22.1) | 58(15.6) | 98(26.4) | 93(25.1) | 40(10.8) | 2.87±1.31 |
| | Cultured meat is ethical than industrial meat. | 94(25.3) | 75(20.2) | 108(29.1) | 62(16.7) | 32(8.6) | 2.63±1.26 |
| | Cultured meat is ethically right than industrial meat. | 99(26.7) | 83(22.4) | 104(28.0) | 62(16.7) | 23(6.2) | 2.53±1.22 |
| | Cultured meat is more tasty than industrial meat. | 120(32.3) | 70(18.9) | 140(37.7) | 32(8.6) | 9(2.4) | 2.30±1.09 |
| | Cultured meat could reduce GG emission from agriculture. | 52(14.0) | 49(13.2) | 149(40.2) | 99(26.7) | 22(5.9) | 2.97±1.10 |
| 2. Factor | Cultured meat may be an alternative industrial meat. | 42(11.3) | 38(10.2) | 113(30.5) | 134(36.1) | 44(11.9) | 3.27±1.15 |
| | Cultured meat may be a solution to scarcity. | 43(11.6) | 44(11.9) | 119(32.1) | 117(31.5) | 48(12.9) | 3.22±1.17 |
| | Cultured meat replace with industrial meat in the future. | 56(15.1) | 54(14.6) | 113(30.5) | 104(28.0) | 44(11.9) | 3.07±1.23 |
| | Cultured meat has less risk transmitted disease animal to human compared to industrial meat. | 59(15.9) | 56(15.1) | 116(31.3) | 91(24.5) | 49(13.2) | 3.04±1.25 |
| | Eating cultured meat improve animal welfare. | 63(17.0) | 58(15.6) | 101(27.2) | 103(27.8) | 46(12.4) | 3.03±1.27 |
| 3 st Factor | I buy cultured meat regularly. | 148(39.9) | 95(25.6) | 102(27.5) | 21(5.7) | 5(1.3) | 2.03±1.01 |
| | I intend to pay more money than industrial meat in order to consume cultured meat. | 134(36.1) | 107(28.8) | 91(24.5) | 34(9.2) | 5(1.3) | 2.11±1.04 |
| | I eat cultured meat instead of industrial meat. | 120(32.3) | 84(22.6) | 118(31.8) | 30(8.1) | 19(5.1) | 2.31±1.15 |
| | I suggest to omnivore person to eat cultured meat. | 97(26.1) | 81(21.8) | 126(34.0) | 49(13.2) | 18(4.9) | 2.49±1.15 |
| | | 1st factor | 2 st factor | 3st factor | Sum | | |
| | $\bar{X}\pm SD$ Median (Min.-Max.) | 17.69±6.55 18(7-35) | 15.63±4.62 16(5-25) | 8.94±3.60 9(4-20) | 42.26±12.59 43(16-79) | | |

4.3. YCMPS Scores According to Students' Descriptive Characteristics

There was a statistically significant negative correlation between the age of the students and their Factor 2 scores ($r=-.109$, $p=0.036$) and Factor 3 scores ($r=-0.121$, $p=0.019$).

The mean scores of the students who received two year education were statistically significantly higher than the students who received four years university education ($p<0.05$).

It was found that there was a statistically significant difference in the mean scores of the 3rd factor according to the occupational group ($K-W_{\chi^2}= 14.881$, $p=0.002$). According to the bonferroni correction test, this difference was found to be between the groups of students who received education for business and economics professions.

There was no statistically significant difference ($p>0.05$) in the YCMPQ scores of the students according to gender and dietary styles (Table 4.4).

Tablo 4.4. Total and Subscale Score Averages of YCMPS According to Participants' Descriptive Characteristics

| | | | YCMPS | | | Sum |
|----------------------|-------------------------|-----|------------|---------------|---------------|---------------|
| | | | 1st Factor | 2st Factor | 3st Factor | |
| Features | Category | N | Mean±SD | Mean±SD | Mean±SD | Mean±SD |
| Age | <i>R</i> | | -0.046 | -0.109 | -0.121 | -0.033 |
| | <i>P</i> | | 0.381 | 0.036* | 0.019* | 0.527 |
| Groups of Age | 18-20 | 81 | 18.36±6.19 | 16.22±4.34 | 8.14±3.39 | 42.72±10.79 |
| | 21-24 | 239 | 17.61±6.17 | 15.56±4.53 | 9.06±3.49 | 42.23±12.22 |
| | ≥25 | 51 | 17.02±8.56 | 15.04±5.43 | 9.61±4.25 | 41.67±16.57 |
| | <i>K-W_{χ²}</i> | | 1.561 | 1.653 | 5.652 | 0.470 |
| | <i>P</i> | | 0.458 | 0.438 | 0.059 | 0.791 |
| Sex | Male | 232 | 17.89±6.48 | 15.58±4.43 | 8.99±3.54 | 42.46±12.06 |
| | Female | 139 | 17.36±6.67 | 15.72±4.94 | 8.85±3.71 | 41.93±13.45 |
| | <i>Z</i> | | -1.008 | -0.590 | -0.491 | -0.469 |
| | <i>P</i> | | 0.313 | 0.555 | 0.623 | 0.639 |
| Type of Education | Two Years | 130 | 18.47±6.15 | 15.93±4.14 | 9.74±3.44 | 44.14±11.39 |
| | Four Years | 241 | 17.27±6.73 | 15.47±4.87 | 8.50±3.62 | 41.25±13.10 |
| | <i>Z</i> | | -1.856 | -0.483 | -3.289 | -1.978 |
| | <i>P</i> | | 0.063 | 0.629 | 0.001* | 0.048* |
| Groups of Occupation | Education | 248 | 17.21±6.63 | 15.42±4.84 | 8.50±3.62 | 41.13±12.88 |
| | Health | 75 | 18.01±6.45 | 16.03±4.20 | 9.45±3.33 | 43.49±11.85 |

| | | | | | | |
|------------------------|------------------------------------|-----|------------|------------|---------------|-------------|
| | Business | 30 | 19.83±5.62 | 15.80±3.98 | 10.27±3.07 | 45.90±10.04 |
| | Engineering | 18 | 19.44±6.65 | 16.67±4.24 | 10.61±4.19 | 46.72±13.59 |
| | K-W_{χ²} | | 7.217 | 0.785 | 14.881 | 6.928 |
| | P | | 0.065 | 0.853 | 0.002* | 0.074 |
| Dietary Habbits | Omnivores | 346 | 17.67±6.54 | 15.63±4.60 | 8.90±3.57 | 42.21±12.63 |
| | Others | 25 | 17.96±6.79 | 15.72±5.03 | 9.36±4.13 | 43.04±12.23 |
| | Z | | -0.091 | -0.074 | -0.258 | -0.053 |
| | P | | 0.928 | 0.941 | 0.796 | 0.958 |

5. DISCUSSION AND CONCLUSION

Cultured meat is a new concept for consumers in Turkey. Although there are many studies examining consumer perspectives on cultured meat (2, 219-229), the lack of a study in this field in Turkey creates a gap in the literature. This study is likely to contribute to the literature by representing a first. In our study, it is aimed to reveal the approach of university students in a province of Turkey towards the consumption of cultured meat and to determine the factors affecting the decision-making stages of students about consuming this kind of meat.

The statement "Cultured meat is more natural than industrial meat" in the first factor of our questionnaire was calculated as the statement with the lowest score within its factor. In food technologies, the product is evaluated by the consumer by considering the naturalness criterion. The approval of cultured meat by the consumer is closely related to the perception of naturalness (230). It was observed that only 15% of the 371 participants in our study ticked the "agree" and "strongly agree" options. This shows that the majority of the participants think that cultured meat is not natural. In the study of Segrist et al. (2018), it was stated that the results of the study may differ depending on whether the definition of cultured meat in the questionnaire for the perception of natural consumption of cultured meat is technical or not. In this direction, it was stated that with the use of technical expressions while defining culture meat, the perception of the naturalness of culture meat changed and the willingness to consume decreased. It was concluded that with a non-technical definition of cultured meat with positive outputs, the perception of naturalness in the consumer may change and the consumer's willingness to purchase the product may increase (231). The negative opinion that cultured meat is not natural reported in this study may be related to the fact that the definition of cultured meat in the questionnaire used included technical expressions. It is thought that the students' perspectives on cultured meat may have changed and their perception of naturalness may have

been affected due to the presence of explanations about the production method in the definition of cultured meat.

When the willingness to purchase cultured meat is analysed, it is seen that the majority (64.9%) in this study do not intend to pay more money than industrial meat in order to consume cultured meat. At the same time, the statement "I buy cultured meat regularly" has the lowest mean among all statements. Only 7 per cent of the participants stated that they were willing to buy cultured meat regularly. In a study conducted with participants in the USA (Wilks, 2017), it is seen that while those who want to try cultured meat constitute two-thirds of the participants, this rate decreases to one-third in regular purchase. The participants' reluctance to pay more money for cultured meat is similar to our finding (220). In a study conducted in France (Hocquette, 2022), 50.6% of the participants were willing to try cultured meat, but 79.7% of the participants did not want to buy cultured meat regularly. Only 8.7% of the participants stated that they would pay more money to consume cultured meat than today's meat (224). The findings of our study in terms of the percentage of intention to pay more money to buy cultured meat than industrial meat are consistent with Hacquette et al. (2022).

According to Slade (2018), when participants were asked about their consumer preferences in a situation where a burger made of beef and cultured meat were sold at the same price, two-thirds of the participants stated that they would prefer a beef burger. The percentage of respondents favouring cultured meat among the cultured meat and beef burger options was limited to 17. It is thought that by reducing the prices, cultured meat can compete in the market and the purchasing rates of individuals may increase (225). In the study of Palmieri (2020), it was found that the segment willing to try cultured meat could pay the same or more for a hamburger made of cultured meat than a traditional hamburger. In the related study, it was observed that the participants who did not want to taste cultured meat stated that they could consume a hamburger made of cultured meat when it was sold cheaper than a traditional hamburger (222). However, the popularity of the product is a strong reason for preference. Popularity also indicates the quality of the product in the eyes of the consumer. With the entry of cultured meat into the market at affordable prices, it is expected that the purchasing tendency arising from scientific results will differ from that in practice (232).

It is also seen that thinking that cultured meat is not natural creates ethical problems for the consumer. From the consumer's point of view, what is unnatural can also be considered unethical. Depending on the pricing of cultured meat, there are consumer opinions that it may

increase inequality and injustice between poor and rich individuals. There is also a group of people who think that cultured meat may lead to the exclusion of farmers by destroying farm animal husbandry (233). In the study of Verbeke et al. (2015), it was found that the participants had concerns about the disappearance of farm animals, the end of rural life and the change in culinary culture (234). In this thesis study, it was determined that 49% of 371 participants did not find cultured meat ethically inappropriate compared to the meat consumed today and 28% were undecided in terms of ethics. This can be explained by the fact that the people of the region have similar concerns. The Eastern Anatolian provinces, in which Hakkari is located, contribute greatly to animal husbandry activities. The goat population of the province, which is mainly a part of the ovine husbandry, constitutes approximately 12.79% of the Eastern Anatolia Region and 1.81% of the goat population in Turkey (235). In Hakkari province, which has a pasture-based animal husbandry system, animal husbandry occupies a central place socially and economically (236). Participants' perspectives on animal husbandry, which are related to many cultural, economic and social factors, may cause them to consider cultured meat as ethically inadequate. The potential of cultured meat to replace traditional animal husbandry may also cause a concern among the participants. Because in the present study, the percentage of the participants who agree with the idea that cultured meat may replace traditional animal husbandry in the future is higher than those who disagree. In addition, 39.9% of the participants think that cultured meat may be an alternative to traditional meat in the future. The statement of being an alternative to cultured meat in the future is the statement with the highest average among all statements in the questionnaire. In line with the findings of our study, Hocquette et al (2015) reported that the participants found the cultured meat technology feasible and realistic. Another finding in the study of Hocquette et al (2015) is that most of the participants who are aware of the negativities of the meat industry believe that cultured meat cannot bring a final solution to ethical issues (237). According to Tucker's study (2014), most of the participants (69.7%) stated that they would reduce their meat consumption in order to help the environmental problems created by the meat industry. 55% of the participants had a negative attitude towards the consumption of cultured meat (229). In Wang's (2022) study, it was reported that participants with social concerns such as environmental problems were willing to consume cultured meat and to pay more to purchase cultured meat (Wang, 2022). In another study conducted in Sri Lanka (Chandimala, 2022), it was revealed that consumers believe that cultured meat can protect the well-being of the animal and improve the use of natural resources. It was also observed that consumers had a high acceptance (75%) towards consuming cultured meat (226). In our study, 35.9% of university students were of the opinion that cultured meat

was environmentally friendly, while 37.7% were of the opinion that it was not environmentally friendly. According to this finding, the majority think that cultured meat is not environmentally friendly and do not see cultured meat as capable of solving environmental problems. It is thought that participants who do not interpret cultured meat as a solution to environmental problems may approach cultured meat more negatively and this may lead to a decrease in the acceptability of cultured meat.

Another important factor in consumption is flavour and health. In the study conducted by Hocquette et al. (2015), most of the participants evaluated the cultured meat as tasteless and unhealthy and reported that they would not accept the consumption of the meat (237). Wilks et al. (2017) found that the primary factor that has the potential to prevent the acceptance of cultured meat is the perception of flavour (220). In our survey, only 11% of the participants thought that cultured meat would be tastier than traditional meat. 15.1% stated that they found cultured meat healthy. The consumer's doubts about the nutritional value of the product and the destructive effect of perceiving the product as unnatural on health can be counted as the reasons why consumers do not favour the health dimension of cultured meat. For this reason, safety and health controls should be carried out before the cultured meat enters the market (234). Zhang et al (2020) found a relationship between consumer satisfaction and acceptance of cultured meat, which will be experienced with the involvement of regulatory institutions for the safety of food (223). It is seen that the consumer's perception of the health dimension of the product may change with the involvement of food authorities.

The hypothesis that 1) gender, 2) age, 3) education type, 4) occupational group and 5) dietary choices has no effect on students' approach to cultured meat is the H_0 hypothesis of our research.

In our study, no statistically significant difference was found between the gender of the students and the total scores of the questionnaire ($p>0.05$). For this reason, our first hypothesis H_0 , which states that gender has no effect on students' approach to cultured meat, is accepted. It is thought that gender, one of the sociodemographic factors, may have an effect on the tendency to purchase cultured meat. There are many studies showing that male individuals are more positive towards cultured meat (228;220;225). There are also studies indicating that men are more willing to consume genetically modified foods than women (238;239). This has been explained by the fact that men are more open to trying new foods than women (240). Apart from openness to new experiences, the fact that women are more neophobic than men can also be shown as a reason (241). In our study, no statistically significant difference was found between the gender

of the students and the total scores of the questionnaire, which contradicts the literature ($p > 0.05$). The study of Bryant et al. (2020), in which they found no relationship between gender and willingness to consume cultured meat, supports the results of the present study (242).

In the present study, there was a statistically significant negative correlation between the age groups of the students and their Factor 2 scores ($r = -0.109$, $p = 0.036$) and Factor 3 scores ($r = -0.121$, $p = 0.019$) ($p < 0.05$). Therefore, our second hypothesis H_0 , which states that the age of the students has no effect on their positive and negative attitudes towards culture and meat, is rejected. In many studies, it has been found that younger groups have a more positive attitude towards cultured meat and this finding is consistent with the finding in this study (229;225;223;219;243). In studies conducted on genetically modified foods, it was found that young groups were more willing to consume such foods (244;245;239). This may be explained by the fact that the age factor has an inverse relationship with being open to new experiences. Older people may be more attached to their habits (246). It is also known that young people are closely interested in and concerned about issues such as climate crisis and environmental problems (247). These concerns of young people may cause them to approach biotechnological foods positively and to have a strong tendency to consume these foods.

In the present study, the total mean score of the questionnaire and the mean score of the 3rd factor were found to be statistically significantly higher in students who continue their two-year education at the university ($p < 0.05$). For this reason, our third hypothesis H_0 , which states that there is no effect on students' education types and their positive and negative attitudes towards culture meat, is rejected.

Many studies indicate that there is a positive relationship between biotechnological acceptance and education level. In a study comparing participants at primary, secondary and university levels, it was found that acceptance of cultured meat in consumers was associated with increasing educational level after regression analysis (226). In a study conducted in China (Wang, 2022), participants with high school or below and university degrees were included. It was found that people with a positive attitude towards cultured meat had a high level of education (227). In another study conducted in China (Zhang, 2020), junior school and below, high school, university degree, graduate degree education levels were included. The finding in this study supports the positive judgement regarding the level of education and attitude towards culture meat in other studies mentioned in this study (223). In Slade's (2018) study, which has a wider range of education levels such as elementary school, high school, high school,

university, master's or PhD degree, it was revealed that being more educated increases the likelihood of preferring cultured meat (225). In the study of Grasso et al. (2019), it is seen that among the elderly with education levels determined as tertiary level and below, those with higher education accept to consume an alternative or sustainable protein source at a rate of 33-41% (228). In the studies conducted on genetically modified foods, there are also studies in which positive relationships were found between the educational levels of individuals and their tendency to purchase the product (239;245). In a study conducted by Hossain et al. (2004) with university and non-university students, it was found that people with a basic or intermediate level of knowledge about biotechnology were more willing to buy biotechnological foods (239). In another study (Han, 2007), which consisted of people below high school, high school graduates, technical school and university students, it was observed that university level students were prone to purchase genetically modified foods (245).

The study of Hocquette et al. (2015), which reveals that the acceptability of cultured meat by educated people is low, contradicts other findings in the literature. According to this study, the educated consumer has the belief that cultured meat cannot be found in environmental analyses and does not attach much hope to this product (237). It was found that students who continue their two-year education at the university are more favorable to the consumption of cultured meat and are more likely to purchase it than those who will receive four-year education.

In a study examining student attitudes towards genetically modified foods, which are considered among biotechnological products (Oğur, 2017), a relationship was found between the rate of agreement with the statement "I think the society is sufficiently informed about genetically modified foods" and the education levels of the participants. When undergraduate students and associate degree students were compared, it was observed that the rate of disagreement with this statement was higher among undergraduate students (238). This situation can be interpreted as a more skeptical approach of undergraduate students towards biotechnological products and less reliability. From this point of view, it can be understood that the tendency to purchase the product increases in associate degree students and they have a positive approach in terms of health, consumption and alternative dimensions of cultured meat. In addition, the fact that associate degree students are open to innovations can be counted among the reasons for the positive attitude towards culture meat. In a study examining the individual innovativeness levels of associate degree students (Alagöz, 2019), it is seen that 60% of associate degree students studying in child development fall into the category of pioneers who

are willing to try innovations, like to take risks, and inform other individuals about innovations (248).

In our study, it was found that there was a statistically significant difference in the mean scores of the 3rd factor according to the occupational group of the students ($K-W_{\chi^2} = 14.881, p = 0.002$). For this reason, our fourth hypothesis H_0 , which states that there is no effect on students' occupational groups and their positive and negative attitudes towards culture meat, was rejected. According to the bonferroni correction test, this difference was found to be between the groups of students who received education for business and economics professions. It is thought that the fact that people in the business and economics occupational group have a more positive view of the factors for purchasing cultured meat is a result of the increasing interest and market interest in the cultured meat industry. Since the first hamburger from cultured meat was made, the number of companies producing cultured meat has rapidly increased and is increasing as cultured meat technology has attracted the attention of the media and investors. Between 2015 and 2020, cultured meat companies were financed approximately 320 million USD (94). Between 2018 and 2019, the number of cultured meat start-ups quadrupled. Public agencies, which usually rarely fund research, supported the stages that enabled Post to create hamburgers (249). In 2013, after the first hamburger produced with cultured meat technology, a large number of companies turned to this field and expanded their fields with the production of many species such as chicken, beef, pork and fish. Among these companies, Memphis Meat and Mosa Meat account for more than half of the money reservoir in the cultured meat industry. Memphis Meat has reached \$200 million, followed by Mosa Meat with \$85 million (95). While the value of the cultured meat market was \$1.64 million in 2021, it is estimated to reach \$2788.1 million in 2025-2030 (250).

In our study, no statistically significant difference was found between the diet of the students and the total scores of the questionnaire ($p > 0.05$). For this reason, our fifth hypothesis H_0 , which states that there is no effect on students' diet and their positive and negative attitudes towards cultured meat, is accepted. It is thought that this situation is due to the fact that there are very few vegetarians among the respondents.

This study has some limitations. Since the sample used in the study consists of university students in one province of Turkey, the results of the study cannot be generalized on a national basis. Another limitation of the study is that only associate and undergraduate students were included in the study as education type and participants with different education levels were not

included. It is thought that this situation may have prevented the emergence of the relationship between educational levels. In addition, the small number of vegetarian participants may have concealed the effect of diet type on the view of cultured meat. It is recommended by the authors of the study to conduct multicentred studies in future studies and to obtain nationwide data by working with a sample including subjects from different education levels.

5.1. Conclusion

Within the limitations of this study, the following results were obtained;

- 1) As the age increases, the belief that cultured meat can be an alternative to traditional meat and the tendency to purchase cultured meat decreases.
- 2) Students who continue their two-year education at the university have a more positive approach to cultured meat in terms of health, being an alternative and consumption compared to students who continue their four-year education at the university.
- 3) It was found that students in the business and economics occupational group were more inclined to purchase cultured meat.
- 4) It has been observed that university students generally do not intend to pay more than the price paid for today's meat when purchasing cultured meat.
- 5) University students generally think that cultured meat is not natural, healthy, tasty and ethical.

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7. APPENDICES

7.1.Ethical Approval

Evrak Tarih ve Sayısı: 26.12.2021-19160

T.C
HAKKARİ ÜNİVERSİTESİ REKTÖRLÜĞÜ
BİLİMSEL ARAŞTIRMA VE YAYIN ETİĞİ KURULU KURUL
KARARI

Oturum Tarihi
24.12.2021

Oturum Saati
11:00

Oturum Sayısı
2021/79

Kurul Karar No
1

24.12.2021 tarihinde saat 11:00'da Prof.Dr. Erdoğan BADA başkanlığında, aşağıda imzaları bulunan üyelerin katılımlarıyla toplanarak gündemdeki konu/konuları görüşmüş ve aşağıdaki karar/kararları almıştır.

Doçent Hülya DEMİR'in "ÜNİVERSİTE ÖĞRENCİLERİNDE KÜLTÜR ETİNİN KABUL EDİLEBİLİRLİĞİNİN İNCELENMESİ" başlıklı çalışmasının etik açıdan uygun bulunmasına ve konunun Rektörlük Makamına arzına;

Oy birliği ile karar verilmiştir.

Kurul Üyeleri:

Prof.Dr. Erdoğan BADA
Başkan

Prof.Dr. Erdoğan BADA
Başkan

Dr. Öğr. Üyesi Ayhan GÜLER
Üye

Doç.Dr. Habip DEMİRHAN
Üye

Dr. Öğr. Üyesi Neşe ATAMAN BOR
Üye

Doç.Dr. Mehmet BULUT
Üye

Raportör:
Nurcan ÖNEN
Bilgisayar İşletmeni

7.2.Questionnaire Form

KÜLTÜR ETİ ANKETİ

Demografik Bilgiler

| | | | | |
|-------------------|---|--------------------------------|-----------|--------------------------|
| Cinsiyetiniz | <input type="checkbox"/> Kadın | <input type="checkbox"/> Erkek | Bölümünüz | <input type="checkbox"/> |
| Yaşınız | <input type="checkbox"/> | | | |
| Eğitim seviyeniz | <input type="checkbox"/> Ön Lisans (sınıf belirtiniz) | | | |
| Beslenme Tarzınız | <input type="checkbox"/> Lisans | | | |
| | <input type="checkbox"/> Lisansüstü (sınıf belirtiniz) | | | |
| | <input type="checkbox"/> Omnivor (hayvansal ve bitkisel gıdaların her ikisini de tüketirim) | | | |
| | <input type="checkbox"/> Semi vejetaryen (Yalnızca kırmızı et tüketmem) | | | |
| | <input type="checkbox"/> Pesketaryen (Balık ve deniz ürünleri dışında et grubu tüketmem) | | | |
| | <input type="checkbox"/> Vejetaryen(Herhangi bir et grubunu tüketmem) | | | |
| | <input type="checkbox"/> Vegan (Et grubu ve yumurta, süt vb hayvandan elde edilebilecek ürünleri tüketmem) | | | |

İfade: (1) Kesinlikle katılmıyorum (2) Katılmıyorum (3) Fikri yok (4) Katılıyorum (5) Kesinlikle katılıyorum

| Kültür Etinin Bilgi Boyutu | İfade | | | | |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| | 1 | 2 | 3 | 4 | 5 |
| | Kesinlikle katılmıyorum | Katılmıyorum | Kararsızım | Katılıyorum | Kesinlikle katılıyorum |
| Kültür eti kavramını daha önce duymuştum. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Kültür etinin ne olduğunu biliyorum. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

LÜTFEN TANIMI OKUYUNUZ

Kültür eti, biyopsi işlemiyle hayvandan alınan stem hücrelerinin besin çözeltisi içerisinde çoğaltılmasıyla elde edilerek laboratuvar ortamında üretilen bir üründür. Yapay et, hücresel et ve laboratuvar eti olarak da tanımlanmaktadır. Kültür etinin, hayvan ölümüne yol açmamasıyla hayvan refahının iyileştirilmesi ve endüstriyel hayvancılıktaki etik kaygıları ortadan kaldırması beklenmektedir. Bu üretimin amacı endüstriyel ete görünüş, tat, koku açısından birebir bir ürün elde etmektir. Kültür etinden yapılan ilk hamburger 2013 yılında Londra'da yapılmıştır. Ticari olarak kültür eti marketlerde vs mevcut olmasa bile geleceğin et üretim sistemlerinde yerini almak için potansiyel barındıran bir yöntemdir.

| | Kesinlikle katılmıyorum | Katılmıyorum | Kararsızım | Katılıyorum | Kesinlikle katılıyorum |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Kültür Etine Bakış Açısı | | | | | |
| Kültür eti, endüstriyel ete göre daha sağlıklıdır. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Kültür eti, endüstriyel ete göre daha doğaldır. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Kültür eti, endüstriyel ete göre daha çevre dostudur. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Kültür eti, tarıma ilişkin sera gazı salınımını azaltabilir. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Kültür eti, endüstriyel hayvancılığa göre daha etikdir. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Kültür eti, endüstriyel ete göre daha lezzetlidir. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Kültür eti, endüstriyel ete göre etik olarak daha doğrudur. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Kültür etini tüketmek hayvanların yaşam standartlarını iyileştirecektir. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Kültür eti, endüstriyel ete göre hayvandan insana geçebilen hastalıklar açısından daha az risk barındırır. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Kültür eti doğal değildir. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Kültür eti güvenilirdir. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Kültür eti dünyadaki kıtlık sorununa bir çözüm olabilir. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Gelecekte kültür eti endüstriyel ete bir alternatif olabilir. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Gelecekte kültür eti endüstriyel etin yerini alabilir. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Yeni gıda teknolojilerinin insan sağlığındaki potansiyel etkileri hakkında endişe duyarım. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

İfade: (1) Kesinlikle katılmıyorum (2) Katılmıyorum
(3) Fikri yok (4) Katılıyorum (5) Kesinlikle katılıyorum

İfade
1 2 3 4 5

| | Kesinlikle katılmıyorum | Katılmıyorum | Kararsızım | Katılıyorum | Kesinlikle katılıyorum |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Kültür Etinin Tutum Boyutu | | | | | |
| Et tüketimimi azaltmayı isterim. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Kültür etini denemek isterim. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Endüstriyel et yerine kültür etini tüketirim. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Etçil insanlara, endüstriyel et yerine kültür etini yemelerini tavsiye ederim. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

| | Kesinlikle katılmıyorum | Katılmıyorum | Kararsızım | Katılıyorum | Kesinlikle katılıyorum |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Kültür Etinin Satın Alma Boyutu | | | | | |
| Kültür etini satın almak için endüstriyel ete oranla daha fazla para ödeyebilirim. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Kültür etini düzenli olarak satın alırım. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

8. CURRICULUM VITAE

Kişisel Bilgiler

| | | | |
|------------|-------|---------------|-------|
| Adı | Merve | Soyadı | Kumru |
| Doğum Yeri | - | Doğum Tarihi | - |
| Uyruğu | TC | T.C Kimlik No | - |
| E-mail | - | Tel | - |

Öğrenim Durumu

| Derece | Alan | Mezun Olduğu Kurumun Adı | Mezuniyet Yılı |
|---------------|-----------------------|--------------------------|----------------|
| Doktora | - | - | - |
| Yüksek Lisans | Beslenme ve Diyetetik | Yeditepe Üniversitesi | 2023 |
| Lisans | Beslenme ve Diyetetik | Yeditepe Üniversitesi | 2020 |
| Lise | - | - | - |

Yabancı Dil Bilgisi

| Bildiği Yabancı Dilleri | Yabancı Dil Sınav Notu |
|-------------------------|------------------------|
| İngilizce | Yökdil (88) |

İş deneyimi

| Görevi | Kurum | Süre (Yıl) |
|---------------------|----------------------|------------|
| Araştırma Görevlisi | Hakkari Üniversitesi | 2 |

Yayımları

| |
|--|
| Investigation of Green Eating Behaviour in University Student- Sürdürülebilir Çevre Dergisi (2022) |
| Beslenme ve Değer İlişkisi- Farklı Disiplinler Perspektifinden Değerler Kitap Bölümü |