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TO WHAT EXTENT CAN LAB-GROWN MEAT REPLACE TRADITIONAL ANIMAL FARMING IN TERMS OF SUSTAINABILITY, NUTRITION, AND CONSUMER ACCEPTANCE IN THE ROMANIAN URBAN SOCIETY?

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ABSTRACT

Throughout human history, meat consumption has served as a critical driver of evolutionary encephalization, providing dense, highly bioavailable essential amino acids and micronutrients vital for human physiology. However, modern global livestock production faces mounting environmental and ethical challenges, accelerating academic and industrial interest in lab-grown (cultured) meat as a cellular agriculture alternative. This paper investigates the viability of cultured meat across nutritional, historical, technical, and consumer dimensions, complemented by a quantitative cross-sectional survey (N = 132) examining consumer attitudes, perceptions, and behavioral intent within Romania. Comprehensive desk research reveals major technical and economic bottlenecks; despite promises of land reduction, industrial growth media purification currently generates significant global warming potential while maintaining non-competitive production costs (17–38/kg). Furthermore, nutritional profiling of in-vitro tissue demonstrates key compositional disparities, including reduced indispensable amino acid density alongside elevated sodium and saturated fatty acids. Empirical survey results gathered in 2026 indicate a strong initial openness among a predominantly younger demographic, with 67.4% expressing a willingness to purchase cultured meat. Nonetheless, substantial psychological and perceptual barriers persist: 81.1% of respondents view cultured meat as inherently unnatural, 69.7% harbor severe concerns regarding long-term health risks, and 70.5% remain skeptical that cellular agriculture can replace conventional livestock farming within the next 50 years. Evaluated via five-point Likert scales, environmental sustainability (4.06/5.00) and animal welfare (3.97/5.00) emerged as the primary drivers of adoption, whereas health uncertainties (3.73/5.00) and retail pricing (3.57/5.00) remain significant deterrents. Ultimately, while conditional consumer openness exists, successful commercial transition requires key biotechnological enhancements, transition to renewable energy inputs, transparent ingredient disclosures, and proactive regulatory frameworks to address deep-seated consumer anxieties regarding food naturalness and long-term safety.

KEY WORDS: *Cultured meat viability, Cellular agriculture sustainability, Consumer acceptance barriers, In-vitro nutritional profiling*

INTRODUCTION

Throughout recent history, meat consumption has been a debate from multiple perspectives: ethically, sustainability and nutritionally. Extensive empirical evidence suggests meat is an important source of nutrition for people worldwide providing highly bioavailable and dense nutrients that are difficult to fully replace with plant-based options. Humans are physiologically wired to require the complex nutrient formation and density of meat, which elucidates why plant-based diets are difficult to adopt. This suggests continued research in cellular agriculture and innovative technological interventions are essential in order to fully understand the phenomena.

From an evolutionary perspective, it has been an essential cornerstone for human nutrition for over 3 million years and is essential for enhancing brain development and overall health (Leroy et al., 2023). Meat provides indispensable amino acids (IAA), as well as a large variety of micronutrients such as zinc, vitamin B12, iron, omega-3 fatty acids, crucial for the human brain, synthesis of proteins, blood health, immunity and prevention of chronic health outcomes (Beal and Ortenzi, 2022). Although these minerals and nutrients may be found in micronutrient-rich plants as well, they are bound to compounds which reduce their absorption and are generally more bioavailable in meat. Methods such as anthropometry, the analysis of fossil records and mathematical modeling have allowed us to create links between the diet of humans and our hormin ancestors. Compared to other mammals, humans have a much larger brain size when compared to their body size as a result of a process of encephalization, consequently the need for a much larger intake of energy. As a result, our gastrointestinal tract is much smaller to compensate for the metabolic cost of the larger brain, suggesting the need for a shift, from a bulky plant diet to an energy and protein focused alimentation requiring less digestive processing. (Leroy et al., 2023)

Mathematical modeling techniques such as optimal foraging theory reveal the importance of meat in evolution, as in order to maintain the daily energy balance, energy intake minus cost of foraging, hunter gatherer patterns migrated from ingesting plants, seeds

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and fruit (500-6,000 kcal) to meat sources ranging from squirrels, snakes, antelope and peccary (5,000-65,000 kcal). (Cordain et al., 2002)

From a historical perspective meat consumption was mainly influenced by the climate and geography of the region, which was then propelled by the Industrial Revolution, but limited by mechanical refrigeration and transportation channels. Before the industrial revolution, diets in Europe fell into two distinct categories, Northwestern Europe and Southern Europe.(Flandrin & Montanari, 1999)

Spain, Italy and Greece had a Mediterranean baseline consuming and producing wheat, olives, and grapes for bread, oil, and wine, due to their distinct climate type, characterized by hot, dry summers, wet winters and a landscape characterized by rough, mountainous terrain. In this region, meat was considered a luxury and the main sources of protein consisted of cheeses, legumes and coastal fish. Britain, France and Germany, had an Anglo-Saxon baseline consuming and producing oatmeal, wheat bread, beer and dairy products as a result of their climate characterized by cool summers and consistent rainfall while the terrain architecture of rolling hills and vast grazing land allowed the centering of their diet around livestock and grain agriculture. Though meat was still expensive in the Northwest they consistently consumed more meat than the South of Europe. (Braudel, 1992)

During the British Industrial Revolution, diet initially worsened and factory workers relied on sugar and bread, cheap fuels providing immediate caloric energy, however this caused a decline in the average height of British workers known as the Anthropometric decline. This phenomenon was labelled by economic historians as “Antebellum Paradox”. (Komlos, 1998)

As the industrialization model matured in the late 19th century, meat consumption worldwide was attributed to the advancements in technology and growth in disposable income. Mechanical refrigeration, transportation links and steamships allowed massive quantities of grains and refrigerated meat to be cheaply imported from Argentina, Uruguay and Australia into Europe, while rising incomes created the purchasing power for the historical status symbol of wealth: meat. (Delgado, 2025)

The Industrial Revolution and advancements in technology and global trade democratized meat, however its success created an unprecedented and unsustainable global demand.

Over the past 50 years meat production has more than tripled with 86-90% of people consuming roughly 46 kilograms of meat (per person) annually (Faunalytics, 2023) creating a huge economy where over 373 million tonnes of poultry, pig, beef, buffalo being sold in stores globally.

On the other hand, concerns regarding CO2 emissions, animal welfare, water and land usage have sparked the creation of lab grown meat, otherwise known as cultured meat. Essentially it is a form of cellular agriculture where meat is produced by culturing animal cells in a vitro environment; therefore replicating them.(Food Standards Agency, 2023) Stem cells are harvested from muscles of livestock through non-invasive procedures then cultured to facilitate their growth to muscle tissue in a lab environment. Despite its seemingly harmless formation, could it compare to traditional meat that’s been around for centuries, rise to the standards, or even replace it?

LITERATURE REVIEW

In order to set the context for this paper, a desk research was conducted between the dates of April 1st 2026 to May 30th 2026 using the academic search engine Google Scholar, filtering between 2020 and 2026, with some exceptions consisting of papers from 1992, 1998 and 2011 in order to set the context as a core literature point. The key words that were used to perform this research were: ”lab grown meat”, which led to 16.900 results, ”cultured meat production”, which led to 16.800, ”historical perspective of eating”, which led to 19.800 results, ”north-west vs southern dietary baseline”, which led to 17.700 results. From all of these results, 10 most cited were selected based on their notoriety and impact on the field, as well as after a themed analysis was conducted on their abstracts. After a second theme analysis, the desk research kept the remaining 46 scientific sources that were used to draft both the context as well as the methodology of the quantitative research. The themes that were used in the analysis were the difference between eating cultures of different countries, the human perception on meat products, sustainability, laws and regulations of alternative meat products. The limitations of this type of research are represented by the open access criteria, since the study focused only on open access sources, as well as the amount of sources that were analysed. The simplest way to decipher this information is by looking into the three main viewpoints of the main research question of the study, which is ”to what extent can lab-grown meat replace traditional meat?”, starting with sustainability and production viability.

Cultured meat is promised to offer a more environmentally friendly approach to meat production, focusing on efficient scalability, cost-effectiveness and reduced greenhouse gas emissions. Studies on the effect of lab-grown meat on our environment date back to 2011 where one of the first major studies estimated that cultured meat had the potential of reducing gas emissions by 78-96%, use of land by 99% and 45% less energy.(Tuomisto & Teixeira de Mattos, 2011)

On a different perspective, further studies challenge previous assumptions, such as the 2023 Environmental Impacts of Cultured Meat Considering Pharmaceutical-Grade Growth Media study conducted at the University of California showing that the current process of creating cultured meat (growth media, similar to those used in pharmaceuticals) releases 4 to 25 times more CO2 than regular meat.

“Companies having to purify growth media to pharmaceutical levels use more resources, which then increases global warming potential,” said Derrick Risner, a US-Davis doctoral graduate and lead researcher.(Risnel et al., 2023)

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A further issue presented is the cost-effectiveness: many studies show that major cost contributors include, culture media which account for up to 80% of costs, bioreactor design adding millions in infrastructure and energy and highly skilled labour including bio tech engineers and lab technicians. A techno-economic analysis (TEA), modeled a full scale cultured meat facility comparing the overall costs between both alternatives (Humbird, 2021) . The results show that lab-grown meat had an overall cost of 17-38$+ even at large scale while conventional beef was only 4-6$ per kilogram, retail.

Cost-effectiveness and scalability go hand in hand, aiming to address many critical factors before reaching production viability, which require extensive capital investments and infrastructure, specialised and scalable technology, and high-purity inputs. An analysis reports that despite future technological advancements cultured meat will not be able to reach cost parity and scalability in the near future without revolutionary breakthroughs in the scientific community. (Negulescu et al., 2023)

Now that the sustainability factor has been established, another viewpoint to examine would be the nutrition aspect of cultured meat: meat is one of the main sources of highly digestible protein,with a complete amino acid profile, containing essential vitamins(B12, niacin,riboflavin), important minerals (iron,zinc,selenium) and bioactive compounds (creatine, carnosine, taurine) which derive from animal feed components synthesized by other organs. (Sharma & Thind, 2023) Research examines the uncertainties of the nutrient profile found in vitro meat since only the minority of cells may be generated using culture techniques because it lacks a blood stream and a diffusion mechanism. (Fraeye et al., 2020)

Therefore, novel solutions for micronutrient supplementation are continuously explored ,including: scaffold integration, media incorporation and metabolic and cell engineering which are thoroughly explained in the article Helikon Consulting: Nutritional Enhancement of Cultivated Meat (2022)

The most straightforward and traditional method of nutritional enhancement is media incorporation, which involves mimicking the role of the bloodstream by enriching the cell culture medium.

Not just intended for structural support of cell growth, scaffolds are materials intended to degrade during the culturing process that remain as nutrient reservoirs, leading to a slow release of supplements without frequent replenishing of media, enhancing shelf life. Non-degrading implementations of scaffolds are engineered so that they become part of the final product contributing to plant-based protein content, dietary fiber and phytochemicals or antioxidants. An advanced strategy is metabolic engineering where genetic modification is used to produce additional or novel nutrients.(Bomkamp et.al, 2021)

As these techniques promise the incorporation of: amino/fatty acids, vitamins, minerals, creatine, taurine, phytochemicals, fiber, bioactive compounds and more studies have been conducted revealing that while there is a lack in some critical nutrients, it can exceed in others. (Sikora & Rzymski,2024) This revealed that cultured chicken meat had lower content of protein (14.8–18% compared to 22.5% in conventional chicken, showing a 20–34% reduction), and a corresponding 20–40% reduction in the majority of indispensable amino acid contents, Mg (13mg/100g vs 28mg/100g), and vitamin B3 (0.51mg/100g vs 11.2mg/100g), but higher levels of total fat (3–6% vs 1.2%), saturated fatty acids (up to 280% higher), cholesterol (64.8mg/100g vs 59mg/100g), vitamins B5 (up to 500% higher), B6 (0.61mg/100g vs 0.55mg/100g), and A (11.4µg/100g vs traces), and minerals Ca (187mg/100g vs 11mg/100g), Cu (0.13mg/100g vs 0.04mg/100g), Fe (1.16mg/100g vs 0.72mg/100g), K (421mg/100g vs 334mg/100g), Mn (0.16mg/100g vs 0.01mg/100g), Na (394mg/100g vs 65mg/100g, a 500% increase), P (261mg/100g vs 196mg/100g), Se (24.4µg/100g vs 17.8µg/100g), and Zn (1.48mg/100g vs 0.81mg/100g (Trevisan et al., 2024)

Lower content of proteins and amino acids often go together and they lead to muscle loss and weakness, slower wound healing, weakened immune system, fatigue and poor concentration and in severe cases: edema, hair loss and brittle nails. (National Library of Medicine, 2023). Lower contents of magnesium can lead to muscle cramps and spasms, anxiety, irritability, poor sleep, irregular heartbeat, headaches or migraines, bone weakness over time. Lower contents of vitamin B3 can lead to fatigue and weakness, poor concentration and depression, skin problems while severe deficiency causes pellagra: dermatitis, diarrhea, dementia (National Institutes of Health, Office of Dietary Supplements, 2023).

The higher levels of fat,saturated fatty acids,cholesterol,vitamin B5, B6 and A, minerals Ca, Cu, Fe, K, Mn, Na, P, Se and Zn presented in cultured meat can also have a significant impact. Excess fat, saturated fatty acids and cholesterol can lead to increased risk of cardiovascular disease, higher LDL, arterial plaque buildup (atherosclerosis), increased stroke and heart attack risk, weight gain and obesity (American Heart Association, 2023). Higher levels of the vitamins are generally safe but in excess can cause digestive issues, nerve damage (peripheral neuropathy), numbness/tingling, liver damage, bone pain, hair loss, blurred vision and birth defects in pregnancy. Higher levels of minerals Ca causes kidney stones, calcification of tissues, Cu causes liver damage, nausea, neurological issues, Fe causes organ damage, oxidative stress, K causes irregular heartbeat (hyperkalemia) Mn causes neurotoxicity (similar to Parkinson's symptoms), Na causes high blood pressure, fluid retention, kidney strain, P disrupts calcium balance, bone issues, Se causes selenosis , hair loss, nail brittleness, neurological damage and Zn suppresses immune function, copper deficiency (National Institutes of Health, Office of Dietary Supplements, 2023).

Lastly, the ultimate success of lab grown meat depends on consumer acceptance, a critical factor in the implementation of this evolving product on the market. Despite clear research showing the potential of higher levels of certain nutrient groups, safety concerning the ingredients have increased the ethical risk perception, this being partly attributed to the lack of transparency surrounding

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ingredients and regulations.

A survey was conducted online on consumers from a nationally representative group assessing how consumers perceive cultured meat versus plant based meat, 2.6 million, internet users receiving the questionnaire, 1766 users completing it. (Liu et al., 2022). It revealed concerns regarding its technological complexity, lab grown nature and the unclear long-term effects, with 62.4% agreeing that cultured meat is more ethically questionable than plant based alternatives. The results suggest a need to provide verifiable information regarding the substances used as well as clear and regulated standards. These findings were further reinforced by a study where"Participants from both groups were concerned about the long-term impact cultured meat could have on people's personal health." (Ho et al., 2023)

Multiple surveys showcase similar results, but from a legal point of view, countries seem to try distancing themselves from cultured meat. BBC reports Italian MPs have voted to back a law banning the production,consumption, sale or import of cultivated meat with an overwhelming 159 votes to 53, setting a 60,000 dollar fine if violated. Legge 1 dicembre 2023, n. 172 (Gazzetta Ufficiale). "Disposizioni in materia di divieto di produzione e di immissione sul mercato di alimenti e mangimi costituiti, isolati o prodotti a partire da colture cellulari o di tessuti derivanti da animali vertebrati." (Post & Stephens, 2024)

Other EU countries share similar views ; Austria, Greece, Slovenia, Bulgaria, Ireland, France, Spain, Portugal and Hungary have expressed their concerns, some in the process or attempting to ban. Regulation (EU) 2015/2283 of the European Parliament and of the Council of 25 November 2015 on novel foods (European Parliament & Council of the European Union, 2015). Despite apprehension, Singapore was the first country to approve the sale of cultivated meat when the SFA ruled in favour of lab grown chicken meat.

The U.S while having the approval of federal agencies (FDA and USDA) has multiple states imposing their own restrictions on lab grown meat, such as Florida, Alabama , Mississippi , Montana , Indiana and Iowa with legislators currently introducing bills aiming to ban cultured meat in Arizona, Kentucky, Tennessee and West Virginia as of 2024-2025. The Romanian Senate also banned the commercialization, production and consumption of vitro meat and passed " Proiect de lege privind interzicerea comercializării cărnii sintetice în România (L584/2023)" on October 18, 2023, with the Senate decision published in Monitorul Oficial No. 953/2023. (Romanian Senate. (2023). "Proiect de lege privind interzicerea comercializării cărnii sintetice în România [Draft law on banning the sale of synthetic meat in Romania] (L584/2023). Monitorul Oficial, No. 953/2023.) "

Part of these concerns are attributed to health and safety uncertainties as the regulatory frameworks are still evolving with no clear guidelines and ingredient disclosure. Ingredients such as FBS (fetal bovine serum) and porcine gelatin are particularly driving unease as well as the potential allergens and contaminants, requiring further controlled and approved research.(Vergeer & Chriki, 2024)

Though each of the given arguments could be seen from multiple perspectives, shifting the views on the limitations posed by these arguments, the first being sustainability. As of today, the majority of equipment utilises fossil fuels which leads to an exponentially greater release of carbon dioxide. Therefore, the sustainability of cultivated meat relies on the energy mix used, even if energy consumption is optimized. Researchers are working on implementing renewable energy as it is estimated to reduce over 92% of greenhouse gas emissions just by sourcing it at their production facilities, claims the article "The science of cultivated meat"(Good Food Institute, 2021).

Countries such as Israel, South Korea and the Netherlands are partnering with ENGIE Impact, TissenBioFarm and Mosa Meat sustainability firms in an effort to achieving net-zero carbon emissions by 2030, actively working towards using 100% renewable energy. However, from an economic and scalability point of view, things are not looking as promising as it is currently very challenging. As previously mentioned the cost of creating cultured meat is already high base, the possibility of adding solar panels, wind turbines or energy storage systems will require heavy investments from the governments. Most small scaled organisations are barely recovering expenses, therefore going "green" remains unfeasible. (EIT Food Protein Diversification Think Tank, 2023)

Regarding the nutrient profile, despite exceeding certain nutrients, cultivated meat has no way of fully replicating the nutritional complexity of traditional meat. Common misconceptions include the healthiness of lab-grown meat. As it's expected that antibiotics will not be used in the production likely resulting in fewer foodborne illnesses, recent studies have highlighted that cultured meat may contain higher levels of cholesterol and fat. While these levels may vary, increased consumption of saturated fats are linked with cardiovascular diseases. Luckily, with biotechnologically improving, there is a possibility of modifying the fat composition of cultured meat such as by adding omega 3 fatty acids. From a different perspective, a review states that the over modification using bioengineering techniques could introduce novel compounds changing nutrient pathways leading to health risks.(Food Standards Agency, 2023).

From a global point of view people distancing themselves from cultured meat could not only be a result of the uncertainty surrounding the ingredients or clear guidelines but from a psychological point of view. As with many novel foods, there is a greater hesitation regarding consumer acceptance such as moral concerns with the "unnaturalness" while emotional discomfort outweighs the potential benefits of lab-grown meat. A literature review of 43 articles addressing the factors that influence cultured meat acceptance (Pakseresht et al., 2022) proves how ethical or emotional reactions exceed rational and science-based conclusions. "Studies show that a food's perceived 'naturalness' may influence consumer acceptance" or "Many consumers believe cultured meat lacks any direct health benefits, instead viewing it as unsafe for human consumption." (Pakseresht et al., 2022) This highlights how deeply rooted emotions could overrule objective assessments. Not only that, there is a risk of the regulatory domino effect where one country's ban or person's

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opinion legitimizes others to follow without concrete evidence backing that decision further supported by the observation that "Consumers who lack prior knowledge about a novel food also frequently rely on heuristics, such as seeking out new information to confirm their existing opinion" (Pakseresht et al., 2022)

METHODOLOGY

The methodology of the research is based on a quantitative, cross-sectional approach to investigate consumer behavior and attitudes (Stan, 2026) within the specific context of meat substitutes, focusing primarily on cultured, lab-grown, or in-vitro meat. The main research objective is to determine the precise extent to which the average Romanian meat consumer is willing to transition from conventional meat to lab-grown meat or other viable market alternatives.

Data collection is conducted via a primary online survey utilizing the Google Forms platform, which allows for the collection of a specific targeted number of complete responses over a determined multi-week time period in 2026. The survey design is strictly structured into two sequential phases to optimize data integrity and isolate the target demographic profile. The first phase consists of a selection questionnaire containing a total of eight questions designed to filter participants based on explicit inclusion criteria. These criteria require that participants currently reside geographically within Romania and maintain omnivorous or flexitarian dietary habits, thereby excluding strict vegetarians or vegans whose baseline motivations differ fundamentally from the average meat consumer. This initial phase also captures vital demographic descriptive data including gender, age group, net monthly income level, highest level of education achieved, and broad professional background to allow for later cross-tabulation and statistical correlation.(Momeni et.al, 2017) The second phase represents the main psychometric body of the survey, which integrates a balanced combination of closed-ended binary questions and structured ordinal scaling. Binary questions requiring a definitive yes or no response are utilized to establish clear behavioral baselines, explicit consumer intent, and primary driving motivations. A standard five-point Likert scale, ranging from strongly disagree to strongly agree, is implemented to capture the subtle nuances of consumer perceptions (Stan, 2026), abstract attitudes, institutional trust, and emotional responses. Each of the five core hypotheses is operationalized through multiple distinct items to ensure internal consistency and construct validity. Unnaturalness perceptions are evaluated through conceptualizations of food artificiality, while emotional discomfort is measured using affective variables that capture visceral hesitation or anxiety. The regulatory domino-effect is isolated by measuring the direct influence of institutional approvals and international market trends on personal trust.(Chandra et.al., 2022) Potential health risks and sustainability drivers are explicitly weighed against alternative motivations to determine if they constitute the primary factors governing consumer acceptance or rejection. The resulting dataset will be analyzed using statistical software to perform descriptive frequency distributions and inferential analyses, such as chi-square tests for the binary metrics(Stan & Botoncea, 2026) and analysis of variance for the Likert scale averages, to formally accept or reject the five proposed hypotheses. The selection questionnaire contained a total of 8 questions, while the survey contains 3 main sections, each one aiming at questioning the subject on the themes of the hypotheses, first section containing 8 likert-scale questions, the second section containing 8 likert-scale questions, while last section was focused on uni-lateral analysis type questions, closed ended, containing a number of 6 items. Hypotheses that were fundamental for the research H1: Lab grown meat is perceived as unnatural, H2: The consumers experience emotional discomfort when considering consuming vitro meat, H3: The regulatory domino-effect influences consumer choice regarding vitro meat, H4: The main motive for people being against cultured meat is that it may have health potential risks, H5: The main motive for people being in favour of lab grown meat is sustainability.

The limitations or the research consists in the quantitative approach that limits the extent of the answers given structured based on a closed design with elements specific to the likert-scale and validation questions. Another limitation consists in the sample size chosen due to operations, which is representative to some extent to the general population can still be considered low in numbers 132, which can limit the understanding of the problem, suggesting the need of conducting a future research on a higher sample.

DATA ANALYSIS

The analysis is based on responses collected from 132 participants and aims to evaluate the attitudes, perceptions and behavioural intentions of consumers regarding cultured meat. Descriptive statistics were first used to examine demographic characteristics of the sample as well as the distribution of responses. Subsequently, inferential statistical techniques were employed to test the proposed hypotheses and determine whether significant relationships exist between key variables influencing consumer acceptance of cultured meat. The demographic profile of the respondents demonstrate that the sample consists primarily of younger individuals. Among the 132 participants, 54.5% identified as male, 44.7% identified as female, and 0.8% identified as non-binary. In terms of age distribution, the largest group of respondents fell within the 19 - 15 year age category, representing 37.1% of the sample. Participants aged between 14 and 18 years accounted for 23.5% of respondents, while those aged between 26 and 30 years represented 20.5%. Individuals aged between 31 and 40 years constituted 8.3% of the sample, and respondents over the age of 40 accounted for 11.4%. The predominance of younger participants is consistent with the increasing interest of younger generations in innovative food technologies, environmental sustainability, and alternative protein sources.

One of the primary objectives of the study was to assess consumer willingness to purchase cultured meat if it became

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commercially available in Romanian supermarkets. The results indicate a generally favourable attitude toward the product. Out of the 132 respondents, 89 individuals representing 67.4% of the sample, reported that they would be willing to purchase cultured meat, while 43 respondents, equivalent to 32.6%, indicated that they would not buy it. These findings suggest that although cultured meat remains a relatively novel concept, a substantial proportion of Romanian urban consumers are open to considering it as part of their future dietary choices. This level of acceptance is particularly noteworthy given the fact that cultured meat has not yet become widely available within the Romanian market and remains unfamiliar to many consumers.

Despite the relatively high willingness to purchase cultured meat, respondents expressed considerable reservations regarding the nature of the product. When asked whether they perceived cultured meat as unnatural, 107 respondents, corresponding to 81.1% of the sample, answered affirmatively, while only 25 respondents, or 18.9%, indicated that they did not consider cultured meat to be unnatural. This finding highlights one of the most significant challenges facing the cultured meat industry.

Although consumers may acknowledge the potential benefits associated with cultured meat production, many continue to associate food produced through laboratory techniques with artificiality and technological intervention. Such perceptions have been widely documented in previous research examining public attitudes toward food innovations and biotechnology. The survey also examined concerts regarding the potential health implications of consuming cultured meat. The results revealed that 92 respondents, representing 69.7% of the sample, believed that cultured meat could potentially create health problems, while 40 respondents, 30.3% did not share this concern. These findings indicate that uncertainty regarding the long-term health effects of cultured meat remains widespread among consumers. Given that cultured meat is relatively recent technological development, many individuals may perceive a lack of sufficient scientific evidence regarding its safety, nutritional composition, and long-terms effects on human health. Such concerns may serve as an important barrier to consumer adoption and market expansion.

Another important aspect investigated in the study concerned perceptions regarding the future role of cultured meat within the broader food system. Respondents were asked whether they believed that cellular agriculture could replace traditional livestock farming within the next fifty years. The results showed that only 39 respondents, accounting for 29.5% of the sample, believed such a transition was likely to occur. In contrast, 93 respondents representing 70.5% expressed skepticism regarding the possibility of cultured meat replacing conventional animal agriculture suggesting that while respondents may be willing to purchase cultured meat on an individual level, they remain doubtful about its ability to achieve widespread societal adoption or completely transform the existing agricultural system.

Conducting an average analysis on the likert-scale items, it has been proven that the main concern of the potential consumers regarding cultured meat is represented by environmental sustainability, with a score of 4.06 out of 5. Following it we have seen that the second highest concern of the subjects of this quantitative study was animal welfare, with a score of 3.97 out of 5. The third option was represented by poor taste with a score of 3.76 out of 5. The fourth option was represented by the concern of the respondents with long-term health risks, with a score of 3.73 out of 5. The fifth was high retail price, accounted for a score of 3.57 out of 5. The sixth was represented by ethical concerns with 3.50 out of 5. The seventh and eight were global food security, respectively loss of traditional farming jobs, with scores of 3.43 for the first, while 2.97 for the second.

To further investigate the factors influencing consumer acceptance, hypothesis testing was conducted using chi-square tests of independence. The chi-square test was selected because variables examined were categorical in nature and the objective was to determine whether statistically significant associations existed between respondents attitudes and their willingness to purchase cultured meat.

The first hypothesis examined the relationship between perceptions of unnaturalness and consumer willingness to purchase cultured meat. The alternative hypothesis proposed that perceiving cultured meat as unnatural negatively influences purchase intention, while the null hypothesis stated that no significant relationship exists between these variables. Analysis of the cross-tabulated data revealed a notable difference between respondents who viewed cultured meat as unnatural and those who did not. Among respondents who did not perceive cultured meat as unnatural, all indicated willingness to purchase the product. In contrast, among respondents who considered cultured meat unnatural, a considerably larger proportion expressed reluctance of refusal to purchase it.

$$X^2 = \sum \frac{(\text{Observed value} - \text{Expected value})^2}{\text{Expected value}}$$

Using the formula the data collected was analyzed resulting in: $x^2 = 13.13$, with a p-value of 0.00029. Since the p-value is substantially lower that the conventional significance threshold of 0.05, the null hypothesis was rejected. The findings therefore indicate a statistically significant relationship between perceptions of unnaturalness and willingness to purchase cultured meat. In practical terms, respondents who perceive cultured meat as unnatural are significantly less likely to express an intention to purchase it compared with those who do not hold such perceptions. The result aligns closely with existing literature on food technology acceptance. Research has consistently demonstrated that perceptions of naturalness play a crucial role in shaping consumer attitudes toward novel food products. Foods perceived as highly processed or technologically manipulated are often viewed with suspicion, regardless of their objective nutritional values or environmental benefits. In the context of cultured meat, the production process takes place in controlled laboratory environments rather than on conventional farms, which may contribute to consumer perceptions that the product is fundamentally

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different from traditional meat. Consequently, even consumers who recognize the environmental advantages of cultured meat may remain hesitant to incorporate it into their diets if they perceive it as unnatural. The findings therefore provide empirical support for the argument that increasing public understanding of cultured meat production processes may be necessary to reduce perceptions of artificiality and improve consumer acceptance.

Taken together, the hypothesis-testing results reveal that both perceived unnaturalness and health concerns represent significant determinants of consumer acceptance. While respondents generally expressed openness toward the concept of cultured meat, recognizing the advantages it holds, such as environmental sustainability and animal welfare as the key points, acceptance was strongly influenced by psychological and perceptual factors rather than solely by consideration of the advantages or innovation. These findings support previous studies indicating that technological acceptance within the food sector depends not only on objective product characteristics, but also on subjective consumer beliefs and attitudes.

The results further reveal an interesting contradiction within consumer attitudes. Although a majority of respondents (67.7%) indicate that they would be willing to purchase cultured meat, most simultaneously viewed it as unnatural (81.2%) and potentially harmful to health (69.9%). This apparent inconsistency suggests that consumers may be willing to experiment with cultured meat despite harbouring concerns regarding its characteristics. Such behaviour is not uncommon in the adoption of innovative technologies, where curiosity, perceived benefits, and social trends may encourage trial even in the presence of uncertainty. However, long-term adoption and regular consumption are likely to depend on whether these concerns can be effectively addressed through marketing, education and scientific validation. As for the price, the majority (72.2%) of the subjects stated that this factor will influence the decision. As expected with new technology, the price at the release and initial phases will be high, making it less affordable for most of the potential buyers; but with better production processes, the costs, as in any novelty, will decrease with time, leading to lower prices that will eventually attract more customers. The findings also have important implications for sustainability objectives. One of the main arguments supporting cultured meat is its potential to reduce the environmental impacts associated with traditional livestock farming, including greenhouse gas emissions, land use, water consumption and biodiversity loss. Although sustainability considerations were not directly examined through hypothesis testing in this study, the relatively high level of willingness to purchase cultured meat suggests that consumers may be receptive to environmentally friendly alternatives. In regards to the replaceability factor of traditional meat being substituted with in-vitro product, the majority of respondents (70.7%) do not think it could be a possibility, since traditional livestock farming within the next 50 years will remain the main production method. This skepticism may reflect broader social attitudes regarding food traditions, cultural preferences, and perceived importance of traditional agriculture (2.97 on average on a scale from 1-5). Meat consumption is deeply embedded within many cultural and social practices, especially in Romanian society, a study analyzing the trends in the meat consumption for the average consumers in Romania between 2023 and 2024 has unveiled the following aspects: increases in the average annual consumption of poultry meat and poultry products, and of ovine-caprine meat and ovine-caprine products, decreases in the average annual consumption of pork and pork products, of beef and beef products, and of edible offal, an increase in the average annual consumption of milk and milk products; an upward trend in the average annual consumption of eggs, a slight decrease in the average annual consumption of fish and fish products, the average annual consumption of animal fats (gross weight) has increased. (INS, 2026) In the year 2024, the average consumption of meat per capita was: 79.9 kg, from which 38.2 kg porcine meat, 30.5 kg poultry meat, 4.9 kg bovine meat, 0.7 kg other types of meat and 2.8 ovine and caprine and last but not least, 2.8 kg of edible offal. (INS, 2026). Consumers finding it very difficult to envision a future in which conventional animal farming is substantially replaced or eliminated, since also it is presented in a study with the sample size was approximately 44.200 agricultural holdings, of which 40.533 were agricultural holdings without legal personality that there are a total of 1809 bovine holdings, 1.357 porcine holdings, 11.869 ovine holdings. (INS, 2025).

Furthermore, respondents may be aware of the economic, technological and regulatory challenges associated with scaling cultured meat production in order to meet global demand. As a result, consumers may perceive cultured meat as a supplementary product rather than a complete replacement for traditional meat.

CONCLUSIONS

This paper explored lab-grown meat benefits and drawbacks from sustainability, nutrition and consumer acceptance. As of today, the production of cultivated meat requires significantly more energy input, releasing exponentially greater amounts of CO2, while shifting to renewable energy would require larger funds and evolutionary technology advancements.With little to no possibility of reaching scalability or cost parity between cultivated meat and traditional meat.

While there is no way of completely replicating the complexity of real meat due to the lack of a whole body system, through media incorporation, scaffolds and metabolic engineering there is a nutrient imbalance with certain being over and others undersaturated, however the lowering of these fatty and cholesterol levels could lead to the over bioengineering of the meat posing unknown health risks. Not to mention the concerns regarding long-term effects and nutrient transparency are continuing to increase.

Lastly, a critical factor is consumer acceptance, where the majority of countries are trying to ban and impose restrictions regarding cultured meat with emphasis on the unclear and unregulated standards. Several surveys on vast proportions of the population seem to

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agree uninformed consumers are hesitant about the "unnaturalness" of cultured meat, which could be partly attributed to the regulatory domino effect but also the lack of assessments and regulated processes.

The negative effects of the agriculture of regular meat on the environment demands change on a local, national and international scale. The main objectives would be to inform the population, provide alternatives along with behavioral support and to implement measures that help maintain healthy habits.

The RE-MAP clinical trial in the UK offered free meat-alternatives along with behavioral support, to investigate the effect on the quantity of meat intake among frequent meat eaters. The results of the investigation show a 63g reduction by week 4, no significant change in protein, energy intake and sodium levels, and decreased intentions to eat meat while participants claimed to feel more control over their diet (Bianchi et al., 2022). To understand why and how external factors influence the adoption of these changes a study was done using Argumentation Networks methods and Agents Based Modelling (AMB). Findings suggested that encouraging a second nutrition transition requires counteracting agribusiness PR, aid in maintaining formed habit, as well as providing clear, scientific information. (Thomopoulos et al., 2021).

By using this information we can conclude that in order to sway the public towards reducing their meat intake the following has to happen:

1. Counter advertising and awareness campaigns providing nutritional and environmental information need to be implemented or increased, these can also come in the form of aiding materials (plant-based recipes, articles, leaflets).
2. Reduced costs for the meat alternatives such as soybean, distributing free samples of such ingredients or offering vouchers.
3. Incentivization of habit maintenance through strategic product placing, free-meat options in public canteens and through the creation of social support networks for meat reducers.

Ultimately, further research must continue in this area so we can determine if continuing the development of cellular agriculture is sustainable in the future and viable, or if resources would be better utilized optimizing existing plant-based alternatives.

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