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Meat substitutes: a comparative study on cultured meat narratives

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ABSTRACT

The food industry is undergoing a significant transformation driven by escalating concerns regarding environmental sustainability and animal welfare. Cultured meat, an innovative alternative protein, presents a promising avenue for mitigating environmental impact and confronting ethical challenges associated with conventional livestock farming. Cultivated from animal cells in laboratories, it has sparked widespread public discourse often influenced by its portrayal in the media.

This research aims to analyse how Italian traditional and social media treat the narrative and language related to the technological process of cultured meat production, highlighting the differences between the two platforms. Through a qualitative content analysis of journalistic articles and social media posts published between 2023 and 2024, the study explores the communication strategies adopted and the effect these may have on public perception. The methodology includes the collection and coding of texts to identify dominant keywords and themes in the media discourse on cultured meat.

The work is organized into four chapters. The first chapter presents a comprehensive overview of cultured meat, including its origins, scientific achievements, and possibilities for widespread adoption. This introduction lays the foundation for the second chapter, which provides a critical literature review centered on customer perception and media coverage of cultured meat. The relationship between public opinion and the role of the media is clarified here, clearing the way for the third chapter, which describes the qualitative analysis methodology. This chapter describes how content from traditional and social media sources was collected and compared. Finally, the fourth chapter discusses the findings of this thesis, emphasizing the disparities in narratives and their implications for communication tactics and public acceptance of cultured meat. With this approach, this thesis aims to provide an in-depth insight into how information about cultured meat is mediated and received in Italy, offering insights to improve communication strategies related to emerging food technologies and promote their wider acceptance.

CHAPTER 1
CULTURED MEAT LANDSCAPE

For centuries, meat has played a vital role in human diets, offering crucial nourishment and serving as a cultural cornerstone in countless communities. Yet, the methods we use to both produce and consume meat have undergone significant changes throughout history, spurred on by factors such as population expansion, technological advancements, environmental consciousness, and shifts in dietary choices. In modern times, the global desire for meat has skyrocketed. The determinants influencing meat consumption exhibit a complex interplay of factors including demographics, urbanization, income levels, pricing dynamics, cultural traditions, religious affiliations, and considerations regarding environmental sustainability, ethical treatment of animals, and health implications. Notably, population growth emerges as the primary catalyst for heightened meat consumption, and the projected global increase of 11% will underpin a projected increase of 14% in global meat consumption by 2030 (OECD/FAO, 2021).

According to scientific research, the amount of meat consumed per capita has nearly doubled in the past 50 years. In 2020, the world produced a staggering 337 million tonnes of meat, which marks a substantial 45% increase - or 104 million tonnes - in comparison to the levels recorded in 2000. Although there are various animal species raised for meat, the three primary types - chicken, pig, and cattle - have dominated production, contributing almost 90% to the global output between the years 2000 and 2020 (FAO, 2022c). Furthermore, the Chatham House report posits that meat consumption could potentially increase by a significant 75% by the year 2050 (Wellesley et al., 2015). This amplified demand has placed tremendous stress on conventional livestock farming practices, sparking apprehension over their long-term viability, ethical implications, and environmental effects.

In response to the burgeoning challenges posed by conventional livestock farming practices, the global food industry has witnessed a notable surge in interest and investment towards the development and utilization of alternative protein sources. These

alternatives, including plant-based meat substitutes, cultured meat, and insect-based protein products, offer potential solutions to meet growing protein demand while addressing environmental, ethical, and resource constraints associated with traditional meat production.

Plant-based meat substitutes have gained attention for their ability to mimic the taste, texture, and nutritional profile of traditional meat without the environmental costs and ethical concerns of animal agriculture. Advancements in food technology have enabled the creation of various plant-based analogues, providing consumers with sustainable and cruelty-free alternatives. Cultured meat, produced through the cultivation of animal cells in a controlled laboratory setting, offers a groundbreaking solution to traditional meat production methods. By bypassing the need for animal rearing and slaughter, cultured meat holds promise for revolutionizing the meat industry while offering a sustainable and ethical alternative. Insect-based protein, though less mainstream, has emerged as another viable alternative to conventional meat. Insects such as crickets, mealworms, and black soldier flies are rich in protein, vitamins, and minerals, making them a nutritious and sustainable source of dietary protein.

The following chapter will provide an introduction to the landscape of cultured meat. It will begin by exploring its inception, technological advancements to date, production processes, and its environmental and ethical advantages. The final two paragraphs will address the challenges hindering the widespread adoption of this innovative food and will also examine the current status of cultured meat in Italy.

1.1 **Origins and technological advancements in cultured meat production**

Cultivated meat, also known as cultured meat, is genuine animal meat, including seafood and organ meats, that is produced through the direct cultivation of animal cells. This innovative production method eliminates the need for animal farming and raising for food. Cultivated meat consists of similar cell types that can be arranged in the same or similar structure as animal tissues, resulting in a product that replicates both the sensory and nutritional profiles of conventional meat (Stephens et al., 2018).

1.1.1 *History of early research and key innovations*

The concept of lab-grown meat, also known as cultured meat, has traversed a long and intricate journey since its inception in the early 20th century. The pioneering experiments that laid the foundation for the development of tissue culture techniques can be attributed to Nobel laureate Alexis Carrel. In 1912, he accomplished the successful cultivation of a small piece of chicken heart muscle in a solution that sustained its viability for several years at the Rockefeller Institute (Bhat et al., 2015).

Winston Churchill had written about the concept of *in vitro* meat for human consumption in his essay 'Fifty Years Hence', which was later published in his book 'Thoughts and Adventures' in 1932. He had predicted that "Fifty years hence we shall escape the absurdity of growing a whole chicken in order to eat the breast or wing by growing these parts separately under a suitable medium" (Bhat et al., 2015).

Later on, in 1998, Jon Vein acquired a patent pertaining to the manufacturing of lab-grown meat tissue designated for human consumption. This seminal event marked the inception of a paradigm shift in the culinary landscape, laying the groundwork for subsequent advancements in cellular agriculture (A.Shaji, 2020).

In 2001, the National Aeronautics and Space Administration (NASA) embarked on trials to create cultured meats utilizing starter cells derived from turkeys. Concurrently, a consortium comprising businessman Willem van Kooten, medical doctor Willem van Eelen, and dermatologist Wiete Westerhof filed a patent outlining their method for producing cultured meat, signifying a concerted effort to explore innovative approaches to sustainable food production. The year 2002 witnessed a significant breakthrough with the production of the first edible lab-grown meat sample, a fish fillet derived from cultured goldfish cells. Further advancements ensued in 2003 when Harvard Medical School and the Tissue Culture and Art Project utilized stem cells obtained from frogs to fabricate tissue resembling a steak. In 2008, the People for the Ethical Treatment of Animals (PETA) catalyzed efforts in the realm of lab-grown meat by offering a substantial monetary incentive to the initial company capable of introducing lab-grown chicken into the food industry. This incentivization mechanism galvanized research endeavors, fostering innovation in sustainable protein production (A.Shaji, 2020).

The seminal moment arrived in 2013 when Dr. Mark Post of Maastricht University in the Netherlands unveiled the world's first lab-grown beef hamburger, worth more than

$330,000, during a press event in London, England. This milestone event garnered widespread media attention and underscored the technological feasibility of producing cultured meat on a commercial scale (Bhat et al., 2015).

Figure 1 - World's first lab-grown hamburger held by researcher Mark Post, The New York Times, 2013

In subsequent years following the inception of lab-grown meat technology, significant advancements and initiatives propelled the field forward. The year 2016 marked the emergence of startups like Memphis Meats and SuperMeat, showcasing prototypes of lab-grown meat products, reflecting a growing entrepreneurial drive towards sustainable food production. In 2017, Finless Foods announced plans to introduce lab-grown seafood, expanding the scope of cultured meat beyond traditional livestock. The year 2018 saw a breakthrough with Meatable's innovative use of stem cells derived from animal umbilical cords, addressing ethical concerns surrounding starter cell procurement in cultured meat production (A.Shaji, 2020).

A significant milestone occurred on December 2, 2020, wherein the state of Singapore approved the sale of a cultivated meat product, specifically chicken produced by the Californian company Eat Just. For the first time globally, cultivated meat was served at a restaurant in Singapore, notably at a substantially lower cost compared to the hamburger offered in 2013. In June 2023, the Food and Drug Administration (FDA) and the U.S. Department of Agriculture (USDA) granted approval for the marketing of lab-grown meat in the United States of America. This marks the first time that lab-grown meat has been approved for sale in the country. Good Meat and Upside Foods are the two

companies that have been authorized to bring lab-grown chicken to the market. Finally, in January 2024, Israel's Ministry of Health rendered an important decision, authorizing for the first time globally the commercialization of meat grown from beef cells, developed by start-up Aleph Farms.

1.1.2 *Pioneering companies in cultured meat production*

The Good Food Institute reports that the number of companies involved in producing synthetic meat or fish has steadily increased, reaching 156 globally as of 2022. This growth trend continues, with approximately 70 new companies joining the sector through partnerships, bringing additional expertise and resources to accelerate development. While the majority of these companies are based in the United States, Israel, and the United Kingdom, not all handle the entire production process. Instead, some specialize in specific stages such as scaffolding or cell growth. Most synthetic meat farms operate vertically, managing all or nearly all aspects of production (Good Food Institute, 2022).

Groundbreaking research in the cultivated meat industry is primarily conducted by startup companies, often with limited public disclosure of their processes. Leading the charge are notable companies such as Mosa Meat, founded by Mark Post's Maastricht group, who famously created the first cultured burger, and Memphis Meats, a US-based company that showcases cultured meat products such as meatballs, beef fajitas, chicken, and duck. In addition, Israeli companies such as Aleph Farms, SuperMeat, and Future Meat have been active in this field, with recent collaborations potentially influenced by a trade deal with China (Stephens et al., 2018).

In the increasingly dynamic and evolving landscape of synthetic meat production, three other companies stand out as pioneers and leaders in the industry: Eat Just with its GOOD Meat division, Upside Foods and Meatable.

In 2021, Eat Just, headquartered in California and established in 2011, made headlines by securing the first-ever marketing authorization for its lab-grown chicken in Singapore. Bolstered by an impressive $400 million in funding and the FDA's approval of its product's safety, GOOD Meat is leading the charge towards commercializing synthetic meat products in the US.

Upside Foods, founded in California in 2015, has garnered the attention of influential figures like Bill Gates since its inception. A trailblazer in the industry, the company

pioneered the production of lab-grown meatballs in 2016 and is now expanding its offerings to include other animal-derived items such as eggs and milk. With FDA approval for its synthetic meat's safety, Upside Foods has solidified its status as a leader in the field.

Meatable, a Dutch startup founded in 2018, has disrupted the production process by eliminating the need for bovine serum, thereby reducing the impact on animals. With substantial funding and a mission to significantly reduce production time and costs, Meatable is poised to become another major player in the race towards sustainable synthetic meat production.

These are just some of the companies involved in the production of synthetic meat. It's important to note that some start-ups are not yet publicly known, while others specialize in certain stages of production and are not considered pioneers in creating the final product.

1.1.3 *Technologies and methodologies for the production of cultivated meat*

Generating meat without having to start with the entire animal is the concept that underlies the creation of cultured meat. This process entails replicating the cells and tissues of the desired meat piece within a laboratory environment. Various methods exist for designing *in vitro* meat production systems, spanning from established approaches such as scaffold/cell culture-based and self-organizing/tissue culture-based techniques to more experimental concepts like organ printing, biophotonics, and nanotechnology.

1- Scaffolding technique

Cultured meat production using the scaffold technique consists of three main stages:

- **Cell Isolation and Expansion**

  The process begins by obtaining a small sample of stem cells from either the muscle tissue of an animal or embryos through a biopsy. These isolated stem cells are then placed in a medium that is rich in nutrients, where they are allowed to multiply and proliferate. This stage is known as cell expansion, and it involves providing the necessary nutrients, growth factors, and hormones to encourage the cells to grow rapidly (Audino et al., 2020).

- **Cell Culture in Bioreactor**

  After obtaining a sufficient number of muscle cells, they are transferred to a bioreactor. This is a controlled environment designed to imitate the conditions found inside a living organism. The muscle cells are submerged in a culture medium containing nutrients, amino acids, and growth factors required for their continuous growth and maturation. The bioreactor provides the muscle cells with optimal growth conditions, including controlled temperature, pH, oxygen levels, and agitation. This favourable environment allows the cells to rapidly proliferate and form small clusters of muscle tissue (Treich, 2021).

- **Tissue Maturation on Scaffold**

  During the final stage of production, cultured muscle cells are transferred to a scaffold. This scaffold is a three-dimensional structure that provides support and structure for the cells to grow into larger tissue. The scaffold acts as a framework for the cells to organize and align themselves, mimicking the natural structure of muscle tissue. As the cells grow and multiply on the scaffold, they gradually form muscle fibers and integrate with each other to create larger tissue structures. This process continues until the desired texture and consistency of the cultured meat is achieved (Treich, 2021).

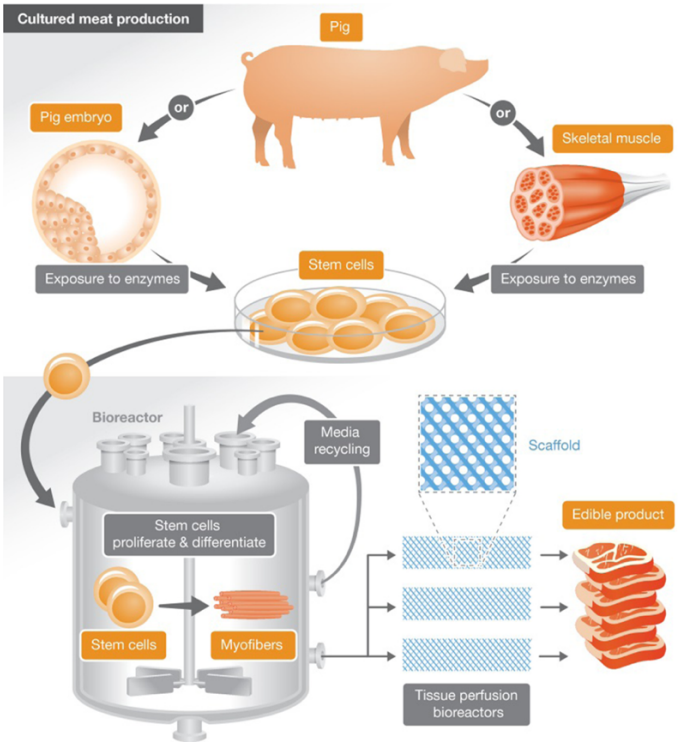

Figure 2 - The production process of cultured meat, Tuomisto H., 2018.[1]

Although progress has been made in cell culture methods, identifying the optimal composition of the growth medium is essential for the efficient growth and differentiation of muscle cells (Mateti et al., 2022). Another challenge lies in designing a large-scale bioreactor capable of mass culturing meat, which would ideally include a circulatory system to supply nutrients and oxygen to the developing cells (Mateti et al., 2022).

While scaffold-based techniques are not capable of producing structured meats like steaks, they can be used to produce ground and boneless meats with a soft consistency (Bhat et al., 2015).

2- Self-organizing technique

Another approach to creating *in vitro* meat is by using explanted animal muscle tissue. This is a more ambitious approach that involves creating highly structured meats by proliferating existing muscle tissue *in vitro* or creating structured muscle tissue as self-

[1] Tuomisto H., 2018. The eco-friendly burger: Could cultured meat improve the environmental sustainability of meat products? Retrieved on 26/03/2024, https://www.embopress.org/doi/full/10.15252/embr.201847395.

organizing constructs (Bhat et al., 2015). The tissue that is produced has comparable amounts of muscle, adipose, and other cells to traditional meat. Additionally, it possesses improved sensory characteristics (Ramani et al., 2021). Although in vitro meat production using self-organizing techniques shows potential for creating intricately structured meats, the absence of blood circulation in these ex-plants makes significant growth unattainable (Bhat et al., 2015).

3- 3D/4D Organ or Bioprinting

Three-dimensional (3D) and four-dimensional (4D) organ or bioprinting is a process that operates on conventional printing principles. Computer-aided design (CAD) software is used to generate prototypes of bio-products. Then, cells are sprayed onto gels according to CAD specifications. After culturing, the cells fuse together to form the bio-product, potentially possessing basic cellular structure and vascularization to facilitate blood delivery (Mateti et al., 2022).

In 2021, Aleph Farms, in partnership with The Technion, Israel Institute of Technology, achieved a significant milestone by cultivating the world's first rib-eye steak using 3D bioprinting technology.

4- Biophotonics and Nanotechnology

Biophotonics and nanotechnology represent groundbreaking avenues in the realm of meat production and preservation. Biophotonics, harnessing the unique properties of laser light to bind particles and create structures, offers a promising alternative to traditional scaffolding methods for cell manipulation. This technology has already demonstrated success in generating red blood cells and even complex tissues like hamster ovaries. Meanwhile, nanotechnology, with its capability to manipulate matter at the molecular level, presents opportunities for creating novel meat substitutes and enhancing meat preservation techniques (Benny et al., 2022). However, further research and development are necessary to overcome existing limitations and make these technologies more accessible and cost-effective for widespread adoption.

1.2 **Motivations for the development of protein alternatives**

In recent years, there has been a significant increase in the search for protein alternatives. This surge is driven by a combination of compelling factors that highlight the need for sustainable and diverse food sources. The following paragraphs delve into the intricate exploration of the multifaceted reasons behind the development of protein alternatives. This exploration weaves through the intersecting realms of environmental, ethical, and economic concerns.

1.2.1 *Environmental impact of traditional livestock farming*

The impact of livestock on the environment is a matter of great concern owing to its exponential growth and dynamic nature. The global demand for meat, milk and eggs is on an upward trajectory, primarily due to the rise in income levels, burgeoning populations and urbanization. As previously mentioned, meat production worldwide rose by 45% between 2000 and 2020, reaching 337 Mt in 2020, and it is projected to expand by nearly 44 Mt by 2030 (FAO, 2022c; OECD/FAO, 2021). As shown in figure 3, chicken meat exhibited the most significant growth in both absolute and relative terms since the year 2000, representing 35% of the global production in 2020 (FAO, 2022c).

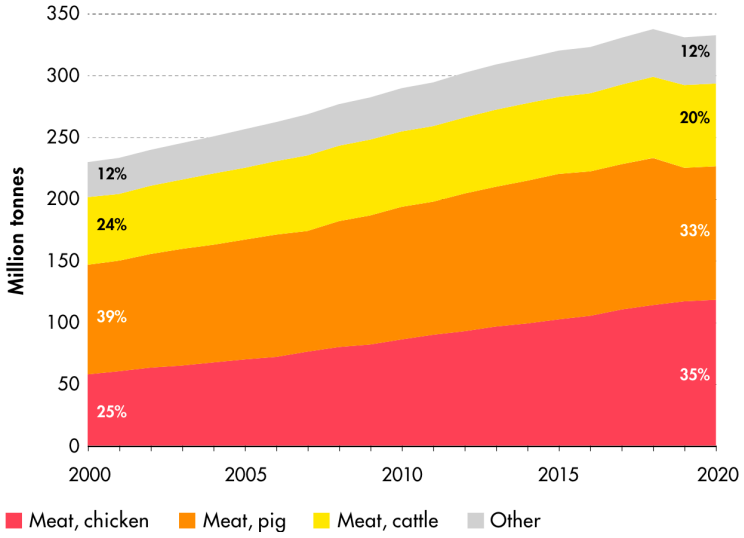

Figure 3 - World production of meat evolution 2000-2020. FAO, 2022.[2]

[2] FAO. 2022. World Food and Agriculture – Statistical Yearbook 2022. Rome. Retrieved on 02/04/2024, https://doi.org/10.4060/cc2211en

Notably, China and the United States of America are among the top producers for each type of meat, with China producing 38% of the world's pig meat and the United States accounting for 17 to 18% of global chicken and cattle meat production (FAO, 2022c).

The livestock industry is experiencing a multifaceted transformation in terms of technology and location. The research findings suggest that livestock production is undergoing a geographic shift, with a gradual move away from rural areas towards urban and peri-urban regions to cater to the demands of the consumers. Moreover, this trend is further reinforced by the shift towards the sources of feedstuff, which includes feedcrop regions as well as transport and trade hubs where feed is imported (FAO, 2006). This has led to a situation where the sector must contend with direct competition for limited land, water, and other natural resources, further exacerbating the already complex challenges facing the industry. Livestock significantly impact the world's water, land, and biodiversity resources while contributing to climate change (FAO, 2006).

Climate change and air pollution

Climate change constitutes a global phenomenon characterized by the alteration of Earth's meteorological patterns, primarily ascribed to heightened anthropogenic discharge of greenhouse gases (GHGs).

The livestock sector holds significant responsibility in driving climate change, emitting approximately 6.2 gigatonnes of CO_2-equivalent annually, it constitutes around 12% of total anthropogenic greenhouse gas emissions in 2015 (FAO, 2022a). This means that greenhouse gas emissions of the sector are higher than those produced by all cars, planes and other forms of transportation combined (FAO, 2022a).

Regarding the main sources of gas emissions, methane emissions stemming from enteric fermentation, manure management, and rice production for feed represent the most significant contributors to total emissions. Methane possesses a global warming potential 28 times higher than carbon dioxide when considered over a 100-year timescale, and 84 times more potent over a 20-year timescale. Cows alone produce a staggering 150 billion gallons of methane each day (FAO, 2006). Approximately 54% of all emissions from livestock are attributed to methane, while carbon dioxide (CO2) and nitrous oxide (N2O) constitute smaller portions, accounting for 31% and 15% respectively (FAO, 2023).

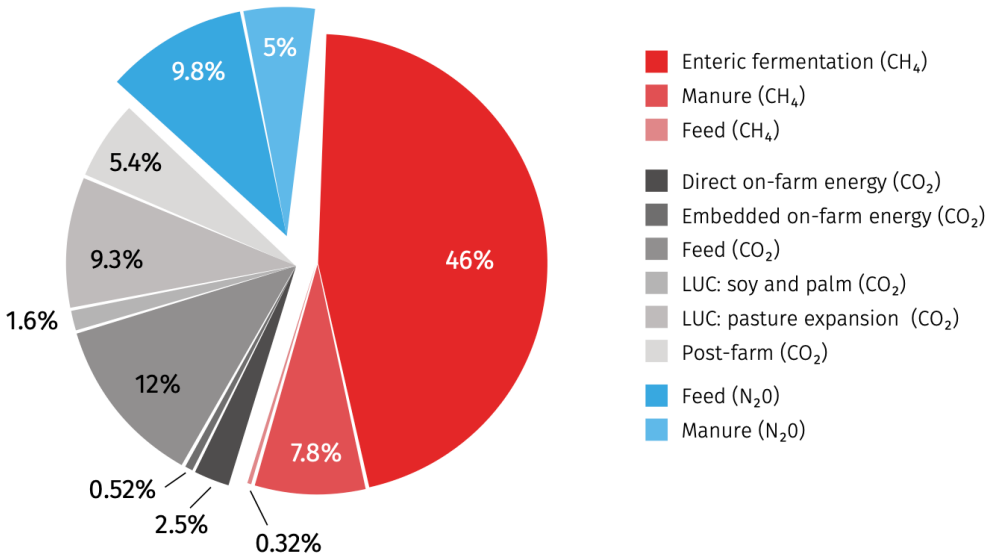

Figure 4 - Total emissions by sources calculated with GLEAM 3[3]. FAO, 2023.[4]

Livestock production represents also a significant driver for deforestation, leading to consequential carbon dioxide emissions through direct and indirect means. Directly, forests are cleared for pasture establishment or degraded through livestock grazing activities. Indirectly, the surge in demand for animal feed prompts the expansion of cropland into forested areas, further exacerbating CO_2 emissions (Bailey et al., 2014). Alarmingly, projections suggest that by 2030, emissions from livestock rearing alone will surpass the 565 gigatonnes CO_2e limit, even without factoring in emissions from fossil fuels. This underscores the urgent need for mitigation measures within the sector to address its substantial contribution to greenhouse gas emissions.

[3] Global Livestock Environmental Assessment Model is a tool developed by the Food and Agriculture Organization of the United Nations (FAO) to quantify the GHGs from the livestock sector. The model aims to provide a comprehensive assessment of the environmental impact of livestock production systems globally. As of 2022, GLEAM has undergone several iterations, with GLEAM 3 being one of the latest versions.

[4] FAO. 2023. Pathways towards lower emissions – A global assessment of the greenhouse gas emissions and mitigation options from livestock agrifood systems. Retrieved on 02/04/2024, https://doi.org/10.4060/cc9029en

Land use and degradation

The livestock industry is a significant land user, as it encompasses an area of over 3.9 billion hectares. This vast expanse of land represents around 30% of the total surface area of our planet and about 80% of agricultural land (Gerber et al., 2007). It has been suggested that without the consumption of meat and dairy products, global agricultural land use could be reduced by more than 75%, which is equivalent to the total area of the United States, China, and Australia combined (Poore & Nemecek, 2018).

The drive for enhanced feed supply is clearly steering intensification efforts within the agricultural sector, culminating in a notable upsurge in global productivity levels. This surge owes much to the growing emphasis on mono-gastric species and the refinement of dietary practices. Nonetheless, this burgeoning demand is paradoxically poised against a potential decline in pasture and feedcrop expanses, as the push for intensification eclipses expansionary endeavors. Regional dynamics further complicate the picture: while OECD nations are leveraging efficiency gains and increased imports to mitigate land use, regions such as South America and East/Southeast Asia are witnessing robust growth, propelled by amplified feed imports and intensified farming practices (Gerber et al., 2007).

Transitioning to plant-based diets can lead to significant land conservation, as grazing land and croplands for animal feed can be reduced. Also, relinquishing biofuels would release land currently designated for growing cereals, vegetable oils, and other feedstocks. Furthermore, enhancing land productivity, be it through more efficient grazing lands or higher crop yields, can pave the way for producing more food with less land.

Water depletion and pollution

The consumption of livestock has an immense impact on global water resources, affecting its quality, hydrology, and aquatic ecosystems. The industry is responsible for utilizing over 8% of the world's human water consumption, with the majority being diverted towards livestock feed production, which accounts for 7% of global water usage (FAO, 2006).

Globally, 70% of freshwater withdrawals are used for agriculture. However, the amount of water required for different food types varies significantly (Poore & Nemecek, 2018). Figure 5 displays the average freshwater withdrawals[5] in liters per kilogram of food product worldwide. It has been estimated that producing half kilogram of meat requires 5,9 kilograms of grain and around 9464 liters of water. This means that abstaining from consuming around half kilogram of meat would conserve a greater volume of water compared to refraining from showering for six months (*Cowspiracy*, 2014).

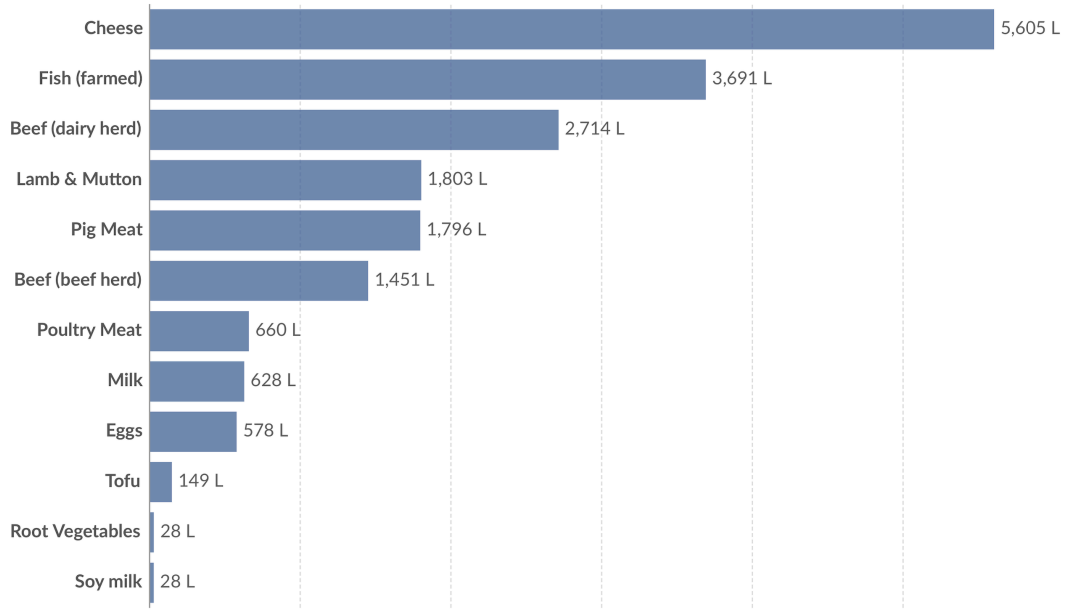

Figure 5 - Global average freshwater withdrawals per kilogram of food product. Poore, J., & Nemecek, T., 2018.[6]

To determine the livestock sector's exact role in water depletion is a challenging task, given its complex nature. However, the amount of water depleted is significantly high. Around 15% of the annual water depletion is attributed to the evapotranspiration of crops designated for livestock feed. The primary mechanisms responsible for water depletion are land use and management practices within the livestock sector (FAO, 2006).

[5] Water withdrawals refer to the extraction of freshwater from either underground or surface water reservoirs, including rivers or lakes, on a temporary or permanent basis, for various purposes such as agriculture, industry, or municipal (domestic) applications.

[6] Poore, J., & Nemecek, T., 2018. Reducing food's environmental impacts through producers and consumers. Retrieved on 09/04/2024, https://globalsalmoninitiative.org/files/documents/Reducing-food's-environmental-impacts-through-producers-and-consumers.pdf.

The production of feed and forage, along with manure application on crops and extensive land use, all contribute to an unsustainable amount of nutrients, pesticides, and sediments in global water resources. The adverse effects of pollution on ecosystems are often insidious and gradual in nature, yet the consequences can be dire. Unfortunately, mitigating the pollution process can prove to be a formidable challenge, especially in areas where poverty is prevalent (FAO, 2006).

Biodiversity loss

Food production creates 32% of global terrestrial acidification and 78% of eutrophication. These emissions can fundamentally alter the species composition of natural ecosystems, reducing biodiversity and ecological resilience. The farm stage dominates, representing 61% of food's GHG emissions (81% including deforestation), 79% of acidification, and 95% of eutrophication (Poore & Nemecek, 2018).

According to the 2005 Millennium Ecosystem Assessment Report, biodiversity loss and ecosystem service changes are driven by habitat change, climate change, invasive alien species, overexploitation, and pollution. The livestock sector is a significant contributor to these mechanisms, particularly through habitat change, climate change, and pollution. While extensive livestock systems have historically caused substantial biodiversity loss, intensive systems are increasingly contributing to future losses, particularly through habitat pollution (FAO, 2006).

Despite the livestock sector's significant impact on biodiversity, conservation organizations such as WWF, Conservation International, and IUCN have gathered extensive data highlighting livestock's role in biodiversity erosion. Livestock-related threats are widespread across various biomes and biogeographical realms, affecting a substantial number of terrestrial ecoregions and biodiversity hotspots. The livestock sector's influence extends to habitat loss for a significant portion of species facing extinction risk, particularly terrestrial species (FAO, 2006). The most widespread danger to land-dwelling animals is the loss of their habitats due to grazing livestock and feed crops. This threat adversely affects 86% of all mammals, 88% of amphibians, and 86% of all birds (*Cowspiracy*, 2014).

1.2.2 *Ethical concerns related to intensive animal husbandry and animal welfare*

The consumption of animal-based protein has always been a significant part of human diets, influenced by cultural, economic, and nutritional factors. As developing nations become more prosperous, there is an observable increase in demand for animal protein. However, in wealthy regions, there is growing ethical scrutiny around meat consumption, leading to heated debates. The discussions revolve around ethical concerns surrounding the rearing and slaughtering of animals for food, the welfare standards within modern large-scale farming systems, and the consequential environmental and human health impacts. Numerous traditional farming techniques involve confining animals in intensive farming systems where they often experience overcrowding and restricted conditions, leading to considerable stress and compromised welfare. Moreover, the methods employed for slaughtering animals raise ethical questions regarding the pain and distress they undergo. While several studies have attempted to identify approaches to minimize animal suffering from rearing to death, it remains impossible to avoid negative states entirely. Furthermore, the environmental impact of meat consumption is a crucial ethical consideration, given the substantial resource requirements and greenhouse gas emissions associated with animal agriculture, as discussed in the previous section.

With the increase in consumer awareness about ethical concerns, it has become imperative for businesses to adopt more transparent and humane farming practices that prioritize animal welfare and environmental sustainability. As a result, there is a growing demand for such practices to be implemented across the industry.

1.3 **Perspectives for large-scale adoption of cultured meat**

1.3.1 *Environmental impact of cultivated meat production*

Cultured meat has garnered attention as a potential solution to mitigate the environmental and ethical concerns associated with conventional meat production.

A comprehensive study utilizing Life Cycle Assessment (LCA) methodology examined the ecological impact of large-scale cultured meat production (Tuomisto & Teixeira de Mattos, 2011). The nutrient and energy source for muscle cell growth was assumed to be Cyanobacteria hydrolysate. The investigation demonstrated that the production of 1,000 kg of cultured meat necessitates between 26 and 33 GJ of energy,

between 367 and 521 m^3 of water, and between 190 and 230 m^2 of land, with emissions ranging from 1900 to 2240 kg CO_2-eq (Tuomisto & Teixeira de Mattos, 2011). These numbers were matched up against conventional meat production in Europe. The findings indicated that cultured meat has substantial environmental benefits over conventional European meat. Specifically, cultured meat consumes around 7-45% less energy than conventional meat, with the exception of poultry meat, which requires less energy. Greenhouse gas emissions are 78-96% lower, while land use is reduced by 99% and water use by 82-96%, contingent on the product type being compared (Tuomisto & Teixeira de Mattos, 2011).

A recent preprint study conducted by researchers at the University of California, Davis, presents contrasting findings to previous research on the environmental benefits of cultured meat production. The study conducted a comprehensive LCA to evaluate the energy consumption and GHGs associated with various stages of cultivated meat production, juxtaposed with traditional beef production methods. One key challenge identified in the cultivation of meat in laboratories is the reliance on highly refined growth media, which resembles the biotechnological processes employed in pharmaceutical manufacturing. The authors investigated the potential environmental impact of cultured meat production using two distinct scenarios. The first scenario involved the use of production processes similar to those commonly employed in the pharmaceutical sector, while the second scenario utilized methods more commonly used in the food market. The findings of the study demonstrated a significant difference between the two scenarios. When utilizing the production processes employed in the pharmaceutical sector, the climate impact of cultured meat production was found to be up to 25 times greater than that of conventional farmed meat production. However, when using the methods more commonly used in the food market, emissions ranged from 80 percent less to 25 percent more than those of conventional meat production (Risner et al., 2023).

Numerous studies have been conducted in recent years to evaluate the environmental impact of cultivated meat production. The ultimate objective is to determine if this emerging technology offers genuine sustainability benefits when compared to traditional meat production methods. However, conflicting results have emerged from such research, and authors have emphasized that their conclusions cannot be considered entirely reliable. This is because a comprehensive understanding of all aspects of the production chain is

crucial to accurately assess the impact of cultivated meat production, and such information has not yet been disclosed. It is also important to note that since this technology is still in its early stages, there are many areas that require extensive research to minimize emissions and energy consumption, contributing to the uncertainty in the calculations (Treich, 2021).

1.3.2 *Regulatory approval and safety concerns*

The viability of lab-grown meat in the market hinges on multiple crucial elements that include sizeable funding, efficient regulations, and public trust. Safety testing is a critical component in ensuring the safety of lab-grown meat products for consumers, workers, and the ecosystem. Beyond meeting regulatory standards, safety testing establishes public trust, meets investor expectations, and satisfies consumer demands (Ong et al., 2021).

One of the most important considerations when introducing new technology into food production processes is ensuring safety. For lab-grown meat to be approved for human consumption, regulatory agencies such as the U.S. Food and Drug Administration (FDA) and the European Food Safety Authority (EFSA) must ensure that it is both safe and high-quality. These agencies are responsible for assessing the safety of novel food products, including lab-grown meat, by evaluating the production process, identifying potential hazards, and establishing rigorous safety standards to minimize risks to consumers. This can be done by examining the production methodologies and steps for cell-based food production, which can vary depending on factors such as the company, the final product, and the manufacturing facilities and equipment (FAO, 2022b).

Unlike traditional meat production, which faces a significant challenge from pathogenic contamination, *in vitro* meat production raises apprehensions about the safety of the added substrates and components in the culture medium (Bhat et al., 2015). The use of cell culture techniques necessitates the provision of essential nutrients, hormones, and growth factors to promote cell growth, generating uncertainties about their potential health impacts in the short and long term (Benny et al., 2022).

The FAO and a WHO expert panel recently conducted a comprehensive analysis of potential health hazards associated with cell-based food production. The study identified 53 hazards across the four stages of production: cell procurement, growth and production, harvesting, and food processing. These hazards include heavy metal contamination,

microplastics, nanoplastics, allergens, chemical contaminants, toxic components, antibiotics, and prions. While many of these hazards are not new and are already addressed in conventional food production, the unique aspects of cell-based food production require focused attention. Experts emphasize the importance of scrutinizing materials, inputs, ingredients, potential allergens, and equipment specific to cell-based production (FAO & WHO, 2023).

Particular attention needs to be paid to the mechanisms involved in cell proliferation within bioreactors. Biological components such as growth factors and hormones, sourced from animal serum or non-animal origins, are used to initiate and expedite cell cultivation. However, these biologically active molecules have the potential to interfere with metabolism and have been associated with the development of certain cancers. As such, the carcinogenic effects of these products pose significant risks to human health and warrant careful consideration (FAO & WHO, 2023).

To mitigate these risks, experts advocate for the implementation of risk mitigation tools such as good hygiene practices, manufacturing protocols, hazard analysis, critical control points (HACCP), and comprehensive assessments of the safety of the final product. By addressing these hazards systematically, stakeholders can work towards ensuring the safety and integrity of cell-based foods for consumers (FAO & WHO, 2023).

1.3.3 *Consumer acceptance*

Studies conducted on the adoption of lab-grown meat have revealed interesting insights into the factors that influence individuals' openness towards innovation. According to existing literature, younger individuals, those with higher levels of education, and those who hold progressive values are more likely to exhibit a higher degree of openness towards innovation, including the adoption of lab-grown meat (Treich, 2021). When it comes to lab-grown meat, aesthetic factors such as its flavor, texture, and appearance play a crucial role in its adoption. In addition to this, studies have shown that skepticism towards cultured meat is often rooted in concerns about its ‘unnaturalness’, ‘disgust’, ‘safety’, ‘healthiness’, and price. These factors may influence individuals to hesitate in embracing this innovative technology (Treich, 2021).

One of the major obstacles in public acceptance of cultured meat is its perceived unnaturalness (Bhat et al., 2015). This perception is rooted in the naturalistic heuristic,

which suggests that "what is natural is good". This heuristic poses a serious barrier to consumer adoption of genetically modified foods (Macdonald & Vivalt, 2017).

One of the main challenges facing cultivated meat is replicating the taste and texture of traditional meat that consumers have come to expect and love. The early versions of cultivated meat have been criticized for not matching the rich and complex flavors of traditional meat, which could make it difficult for people to accept it as a viable alternative, and often even generating a sense of disgust. The feeling of disgust is largely tied to emotions and varies based on the cultural associations and preconceived notions of what is considered an acceptable food. This element of rejection or acceptance may therefore be positively influenced by the information provided about the novel food, particularly if the novel food is highly technological (Rolland et al., 2020).

Another significant factor that hinders consumer acceptance of laboratory-grown meat is safety concerns. Given the novelty of the technology, people are understandably skeptical about the safety of consuming cultivated meat and worry about potential health risks.

Cost is another major obstacle to the adoption of cultivated meat by consumers. Currently, the production of cultivated meat is more expensive than traditional meat farming methods, which makes it less accessible to the average consumer. However, as technology advances and production processes become more efficient, the production cost of cultivated meat is expected to decrease, making it more affordable and accessible to a larger number of people.

1.3.4 *Technological challenges*

The primary challenge in cultured meat production is to emulate the complex musculature development observed in traditional livestock within controlled laboratory or industrial settings. Muscle growth, a process honed over millions of years of evolution, operates synergistically with various bodily functions, rendering it inherently efficient within biological contexts. Tissue engineering endeavors to replicate this intricate process by amalgamating insights from biological tissue development with biochemical engineering methodologies to mimic *in vivo* conditions. Historically, tissue engineering has predominantly concentrated on medical applications, including regenerative medicine and the creation of non-animal *in vitro* models for drug testing and toxicological studies.

While the fundamental technical principles remain consistent, the transition to cultured meat production necessitates a scale-up of operations to meet demands akin to traditional meat production, all while ensuring cost-effectiveness to establish the product as a viable commodity in the market (Stephens et al., 2018). This results in several technological challenges that hinder the large-scale commercialization of lab-grown meat. The production process of cultivated meat is complex and optimizing it requires a multidisciplinary effort, thus collaboration across various domains such as biological, chemical, technical and industrial is necessary for its commercial scale-up. The research involves key areas such as the development and improvement of cell lines, culture media, bioreactors, scaffolding, and biofabrication techniques (Benny et al., 2022).

One of the primary obstacles to achieving affordable cultivated meat production is the need to optimize cell culture media and exchange protocols. In this regard, it is important to reduce the reliance on expensive serum supplements or recombinant proteins, and to explore alternative, sustainable sources of nutrients and bioactive compounds to support cell growth and differentiation (Kirsch et al., 2023). Currently, the ingredients used for cultured media are primarily obtained from animals, such as chicken embryo extract, fetal calf serum, and horse serum, instead of plant-based or microbial sources. To uphold the principles of cell-based meat production, which strives to eradicate animal farming and slaughter, it is crucial to remove all animal-derived components from the manufacturing process.All of these considerations must be taken into account while addressing ethical concerns and cost constraints.

An additional concern involves the composition of the Scaffolds, which must achieve a delicate balance in terms of factors such as surface area, flexibility, cell affinity, and edibility, while also ensuring that degradation does not impede cell growth in the production of cell-based meat. This presents several challenges, such as determining the appropriate timing for scaffold degradation, guaranteeing that the texture, taste, and nutritional profile meet industry standards for meat, and devising efficient methods for scaffold disassembly that do not harm the cells (Benny et al., 2022).

Developing intelligent bioreactors for cell-based meat production poses another significant technical challenge in mammalian cell culture. Achieving the staggering scale necessary, which involves using approximately 1014 cells to produce just one ton of cell-

based meat[7], requires innovative approaches. Thanks to technological advancements, it is currently possible to produce bioreactors with a capacity of 2,000 liters. However, this size is not sufficient to meet the demands of large-scale production, for which it would be necessary to develop bioreactors that are as large as 5,000 liters (Benny et al., 2022). Alternative designs, such as fluidized bed and hollow fiber membrane bioreactors, have potential for higher cell densities, but they lack widespread adoption for cell expansion. Additionally, determining the optimal approach to scale-up (few large bioreactors) versus scale-out (many smaller bioreactors) presents a challenge while ensuring the final product matches or exceeds the sensory and nutritional qualities of conventional meat, meeting consumer expectations for color, flavor, texture, and nutrition.

1.4 **Italy and Cultured Meat**

The theme of cultured meat, in a country with deep-rooted culinary traditions like Italy, is a complex and controversial issue. To fully understand the aversion shown by both politicians and Italian citizens, it is essential to analyse the importance of the meat sector in Italy. According to the Qualivita Report 2023, the fresh meat segment reached a production value of 103 million euros, registering a growth of +5.3%. Added to this is the 2.271 billion euros (+7.5%) from meat products, such as hams, cold cuts and sausages. At European level, Italy ranks as the fifth largest meat producer, preceded by Spain, Germany, France and Poland. According to Eurostat data, in 2022 Italy accounted for 11.6% of the EU's beef production (the third largest producer country behind France and Germany), 9.3% of poultry meat production and 9.2% of veal production.

In light of this, the advent of cultured meat was perceived, especially in the economic sphere, as a potential threat to a sector of fundamental importance to the national economy. Meat production in Italy is not only an important component of the production fabric, but also represents an essential part of the country's gastronomic and cultural heritage, which makes the acceptance of alternatives such as cultured meat particularly difficult.

[7] Benny, A., Pandi, K., & Upadhyay, R. (2022). Techniques, challenges and future prospects for cell-based meat. *Food Science and Biotechnology, 31*(7), pp. 1-15.

Although Italy does not yet have any companies directly producing cultured meat, the country plays an important role in some key steps of the process, particularly in bioreactor technology and research funding. Several Italian universities and research centres are making significant progress in this area. One important example is the development of a fish cell line at the University of Tuscia, which has aroused interest among European producers of cultured meat. This demonstrates the impact of Italian research and its potential contribution to industry. In addition, Italy has some of the most advanced bioreactor technologies in the world, which are essential for bringing cultured meat production to a large scale. An example of excellence in this field is Solaris Biotech, founded in 2002, which produces fermenters, bioreactors and filtration systems used worldwide. Thanks to its products, Solaris directly supports companies involved in the production of cultured meat, making Italy a significant player in the global supply chain of cultured meat. Another important player is Bruno Cell, founded in 2019, which operates with a B2B model, offering financial support for research into large-scale production of cultured meat. Bruno Cell has also started commercialising cell lines, which are essential for the development of cultured meat products.

Despite significant scientific and technological progress, the Italian political landscape has consistently resisted the development of cultured meat. In early 2023, under the leadership of Prime Minister Giorgia Meloni, the Italian government introduced a legislative proposal aimed at banning the production, commercialization, and sale of cultured meat and other lab-grown food products. This initiative, promoted by Agriculture Minister Francesco Lollobrigida, was presented as a means of safeguarding Italy's traditional agricultural sectors and protecting its rich culinary heritage, deeply rooted in animal husbandry. Lollobrigida claimed that the proposed law was necessary to protect Italian farmers and producers from the perceived economic threat posed by lab-grown alternatives, which many consider to be at odds with long-standing Italian food traditions. The decree gained then approval in the Italian Senate and its restrictions had significant repercussions on research and development in Italy, stifling innovation in a rapidly growing field. The effects were immediate: research projects and collaborations focused on cultured meat were forced to either stop or pivot, as the new legal framework created uncertainty and challenges for continued investment and progress in this area. However, the law quickly encountered significant legal challenges at the European level,

as it was found to be incompatible with EU regulations. According to the European Union's Technical Regulations Information System (TRIS), member states are required to notify the European Commission of any legislative proposals that could affect the marketing and distribution of goods. This system is designed to prevent the creation of trade barriers within the EU single market. Under EU law, once novel foods, such as cultured meat, receive approval from the European Food Safety Authority (EFSA), they must be allowed to circulate freely across the single market. Any national legislation attempting to restrict this would be overridden by EU regulations. As a result, the Italian decree was found to be in conflict with both EU food safety standards and competition laws, which prohibit member states from creating unfair barriers to market entry. By October 2023, it became clear that the bill would not hold up under legal scrutiny at the European level and, on October 13, 2023, the Italian government quietly withdrew the proposal, with little public announcement.

Thus, it is undeniable that italy has demonstrated a highly conflicting attitude towards the development of cultured meat. while this attitude is justified by the desire to preserve the country's strong culinary and economic traditions, it is inevitable that it raises concerns about the success and growth of research and also about the possibility that sustainable food alternatives such as cultured meat might take hold in the country.

CHAPTER 2
LITERATURE REVIEW AND RESEARCH QUESTIONS

Currently, emerging food technologies are a widely discussed and contentious topic, sparking curiosity and debate about future developments. However, despite increased media coverage, little is known among the general public about these alternative concepts for food. The media play a key role in informing and educating the public about these issues and it is essential, before continuing with the research, to analyse the dynamics through which the media can influence consumer acceptance and perceptions towards emerging technologies and thus also laboratory-grown meat.

This section will conduct an analysis of existing literature concerning the relationship between the media and emerging food technologies, in particular cultured meat, and the influence of media framing on public comprehension of emerging technologies.

2.1 **Consumer Perception of Emerging Food Technologies**

In recent decades, technology has radically transformed the food sector, influencing every stage of the supply chain, from production to distribution to consumption. Technological innovation has introduced new farming methods such as precision agriculture and hydroponics, improved traceability and food safety through blockchain systems, and revolutionised the consumer experience with 3D food printing and artificial intelligence-based home delivery platforms. However, consumer acceptance of these emerging technologies is not always immediate or uniform. Understanding how consumers form their opinions about these innovations is crucial to promote wider adoption and trust in these technologies. This section will review the existing literature on psychological and social theories that explain the cognitive and behavioural processes underlying the formation of consumer opinions towards emerging technologies in the food sector.

2.1.1 Role of heuristics

Most average people have limited knowledge about nutrition, lack in-depth knowledge about the environmental impact of different foods and above all do not know the production processes behind the foods they buy and consume. Consequently, the evaluation of food technologies by the non-specialist public tends to be based on heuristic processes rather than an in-depth analysis of the available information. Heuristics are generally defined as cognitive shortcuts or rules of thumb that simplify decision-making, especially under conditions of uncertainty. They represent a method for replacing a complex question with a simpler one, which may lead to cognitive biases (Kahneman, 2003). In fact, relying on heuristics when deciding on food hazards can lead to distorted perceptions. The heuristics used by people to make decisions are numerous, however, the main ones that are used in food technology and that are worth exploring in this discussion are: affect heuristic, trust heuristic and 'natural-is-better' heuristic.

Affect heuristics holds that people rely on the affective meaning they associate with an image or the associations aroused by an object when they are asked to evaluate its risks or benefits. Emotions in this case significantly influence people's perception and judgement of risks. In other words, hazards that arouse intense feelings of fear or dread are often considered more dangerous than those that do not arouse such emotions (Slovic, 1987). This explains why the general public may be more concerned about some food hazards than others and why their perception of risk may differ from that of experts, who tend to rely on analytical systems due to their knowledge.

Trust is also a heuristic that people use to evaluate food technologies by replacing specific attributes, such as improved yields, with trustworthy cues, such as similarity of values. For example, when a consumer buys an organic food, he does not check the production methods himself, as this would require significant effort, so he trusts the honesty of the producers' label. Therefore, trust plays an important role in food acceptance and has been shown to influence the perception of risks and benefits of new food technologies (Siegrist, 2000).

Finally, the 'natural is better' heuristic is a mental shortcut whereby consumers automatically perceive natural foods as healthier, tastier and better for the environment due to the positive emotions associated with naturalness in Western countries. One of the main characteristics that make a product perceived as 'natural' is the absence of human

processing. Relying on this heuristic can lead to bias, as the addition of elements or the processing of a food does not necessarily result in a loss of wholesomeness. This heuristic is particularly relevant in the case of cultured meat, as it has been shown that the perception of naturalness is one of the most incisive factors in consumer acceptance (Lusk et al., 2014).

2.1.2 Impact of individual differences

Consumer acceptance of emerging food technologies depends on a number of factors that differ from individual to individual. A first factor found in some individuals is the so-called 'neophobia' for food technologies. It consists of a personality trait that influences consumers' readiness to embrace new technologies. It has been observed that people with greater food knowledge tend to have lower neophobia scores towards food technologies than those with more limited knowledge (Lusk et al., 2014).

There is a second individual factor that influences the perception of food technologies: disgust sensitivity, an evolved mechanism to avoid pathogens and ensure disease-preventing behaviour. this variable influences various aspects of daily life, including the selection of food to be consumed. Increased disgust sensitivity leads to the rejection of foods perceived as contaminated or unnatural, such as genetically modified foods or artificial meat.

2.1.3 Media framing

The media act as an essential bridge through which information is transmitted to the public. During this transfer process, news is processed and conveyed in the form of text, images or video. This step is crucial, as the same news can be presented in different ways, significantly influencing the opinions and perceptions of the end users. The way news is formulated by the media not only informs, but also orients and shapes the reactions of the audience. The framing effect occurs when different representations of the same information lead to different conclusions because of the context or the way the information is framed (Tversky & Kahneman, 1981). Media frames provide audiences with cognitive shortcuts or heuristics to quickly process new information, especially for topics with which members of the public are not very familiar (Scheufele & Lewenstein, 2005). Narrative frames of stories can incorporate cognitive elements, which provide specific details on certain aspects of the technology, or affective elements, which infuse

a positive or negative tone into the overall representation of the technology (McCluskey et al., 2016).

Over the years, numerous studies have examined media articles for the presence of affective and cognitive elements through textual or content analysis, which have shown that the media, through the adoption of specific frames, exert a significant impact in shaping the public's opinions regarding emerging food technologies.

In a study on the perception of nanotechnology, it was found that a positive narrative of nanotechnology in the media positively influences the public's perception of this emerging technology (Scheufele & Lewenstein, 2005). Participants who stated that they frequently read scientific media showed a more favourable attitude towards nanotechnologies than those who did not follow such sources. This link has been attributed to the framing effect: scientific media tend to emphasise the potential benefits of nanotechnologies more than other media, which could explain their readers' greater propensity to support them. Similarly, Bauer (2005) conducted a study on the impact of media coverage on public attitudes towards biotechnology in 12 European countries from 1996 to 1999 (Bauer, 2005). Using large-scale surveys, the study observed changes in the public perception of medical and agricultural biotechnology in a context of increasing negative media coverage. The results indicated that media representation, thus the tone employed, significantly influenced public opinion, with media readers adopting views consistent with the prevailing media discourse, a trend not found among non-readers (Bauer, 2005).

In the context of cultured meat, Siegrist et al. conducted two experiments to explore how perceptions of naturalness and disgust influence the acceptance of this product among consumers (Siegrist et al., 2018). Their research shows that the description of cultured meat plays a critical role in public perception. In particular, consumers show low acceptance of cultured meat due to the perception of its unnaturalness. It has been shown that to increase acceptance of this emerging food, it is crucial to present it in a non-technical way, emphasising the end product rather than the production method. Informing participants about the technologies used in the production of cultured meat and its benefits has the paradoxical effect of increasing the acceptance of traditional meat at the expense of cultured meat. Conversely, emphasising the similarities between the two types of meat led to a greater propensity to accept cultured meat (Siegrist et al., 2018).

McCluskey et al. (2016) conducted an in-depth analysis of the existing literature on the role of the media in shaping consumer perceptions and behaviour regarding new food technologies. The analysis revealed much empirical evidence of how extensive, often negative, media coverage of new food technologies, particularly biotechnology and genetically modified foods, has influenced public perceptions, increasing awareness but also fuelling fears and mistrust. In this sense, the authors demonstrated how the media can act as so-called 'amplifier stations', focusing on potential risks. This theory is known as the risk amplification theory (Kasperson et al., 2010). Further support for this theory was provided by research by Frewer et al. (2002) in the context of media coverage of GM foods in the UK. By collecting data on attitudes before, during and after the rise of news stories about the potential risks of GM foods in the UK in the spring of 1999, Frewer et al. showed that the public's perception of risk varied in conjunction with the media coverage and the dominant narrative of the period (Frewer et al., 2002).

It is also important to consider another aspect of consumer psychology, the so-called negativity bias, i.e. the tendency of consumers to give more weight to negative information than to positive information. This concept can be better understood by considering Prospect Theory. Prospect theory posits that individuals evaluate potential losses and gains differently, with losses typically exerting a greater psychological impact than equivalent gains (Kahneman & Tversky, 1979). According to this theory, consumers tend to favor risk aversion when faced with choices involving certain gains and exhibit risk-seeking behavior when confronted with choices involving certain losses (Kahneman & Tversky, 1979). Gains and losses are assessed relative to a reference point, which can be altered by changing the labeling of outcomes (Li, 1998). This means that consumer reactions to objectively equivalent information can be significantly influenced by the semantic presentation of the options. In the context of cultivated meat, media framing that emphasizes potential risks and negative outcomes is likely to have a stronger impact on consumer perceptions than frames highlighting positive benefits. This is because people are generally more sensitive to potential losses than to equivalent gains.

Another important aspect to consider within this framework is terminology. According to recent studies, the terminology utilized by media outlets has a substantial impact on shaping consumer perceptions of novel technologies such as cultivated meat. Extensive research has been conducted on how the use of different terminologies, such as "lab-

grown meat", "cultured meat", "clean meat", "*in vitro* meat", "synthethic meat" or "artificial meat" can substantially influence public acceptance and attitudes.

In their study, Bryant and Barnett (2019) investigated how the naming of in vitro meat (IVM) affects consumer acceptance. The research involved 185 participants who were split into four groups, with each group presented with a different name for IVM: 'clean meat', 'cultured meat', 'animal free meat', or 'lab-grown meat'. Although other terms are also used, the researchers decided to test names that are conceptually distinct. They did not, for example, test either 'artificial meat' or 'synthetic meat', as these terms are likely to be perceived as very similar by consumers. The participants were asked to provide word associations and rate their attitudes and behavioral intentions toward the product. The findings revealed that terms like "clean meat" or "cultured meat" tended to elicit more positive responses by emphasizing the health and environmental benefits. In contrast, terms such as "lab-grown meat" or "synthetic meat" could lead to skepticism or discomfort due to their associations with unnatural processes (Bryant & Barnett, 2019).

2.2 **Coverage of Cultured Meat in Traditional and New Media**

The latter half of the 20th century witnessed an unprecedented acceleration in technological progress. The Internet, mobile phones, and a host of other digital technologies changed everything about human life in ways never thought imaginable. In this respect, the world of mass communication, typically known for the one-way or centralised transmission of information to a large audience, is rapidly entering an era of great change, characterized by the rise of "new media." These new tools of communication, based on advanced technical capabilities, offer greater reach, interactivity, and potentially a greater impact than traditional methods. Resulting from this new technology, traditional media forms, such as print publications, begin to find their readership numbers dwindling and respond with integration with this new technology to survive. This is in accord with previous research, wherein traditional and new media are not considered mutually exclusive, but rather complementary to each other. There are advantages and disadvantages associated with each type of medium. In the case of social media, the benefits that can be provided include services being less costly, highly interactive, data-driven insight, real-time results, the potential for global reach, targeted audiences, and that the content will go viral.

Conversely, traditional media remains valuable for its reliability, credibility, and accuracy. By integrating both types of media, their combined strengths can offset their individual weaknesses, leading to more effective content distribution and increased audience outreach (Al-Quran, 2022).

Cultured meat is one of several emerging technologies that the media often touts as meaningful solutions to a range of pressing public problems, despite the fact that their potential remains largely unproven. From the early 2000s onward, the investigation into cultured meat was primarily conducted within the realm of biomedical academia. The launch of a high-profile lab-grown burger back in 2013 changed the landscape. It marked a turning point, featuring a surge of start-ups, each flush with several streams of venture capital. Since 2015 in particular, this sector has started recording a very different set of acceleration in innovation and private investment, thus throwing the cultured meat industry into high gear. These episodes, taken in conjunction, captured public and media imagination, firmly marking the cornerstone of cultured meat's journey from being an esoteric academic subject to one of mainstream discussion.

Only a handful of studies have looked into how the traditional media has covered the topic of cultured meat. Recent analyses on this issue have uncovered a predominantly positive narrative, focused on its potential environmental and ethical benefits while often overlooking the technical and economic challenges associated with its production. Goodwin and Shoulders (2013) conducted an analysis of how cultured meat was portrayed in the early print media of the US and EU, to gain insight into how consumers may have formed their opinions about cultured meat based on this media coverage. The study identified recurring themes in the articles, such as discussions on the challenges associated with traditional livestock production and the potential advantages of cultured meat as a more sustainable and ethical alternative. Additionally, the media explored the background and production process of cultured meat, potentially overwhelming consumers with technical information. Notably, the sources cited within the articles preponderantly supported cultured meat production, with academics and PETA being the most frequently quoted. The lack of opposing viewpoints, particularly from the agricultural industry, has been considered as a possible bias in the early media coverage of cultured meat (Goodwin & Shoulders, 2013). Subsequent analyses, such as Painter et al. (2020), confirmed the continuation of this optimistic narrative in traditional media.

They once again discovered that the coverage was largely positive, with a strong emphasis on the environmental benefits, such as reductions in greenhouse gas emissions, land use, and water consumption (Painter et al., 2020). The media also spotlighted ethical advantages, including reduced animal suffering and health benefits due to the absence of antibiotics in production. However, the analysis revealed that technical and economic challenges, such as production scalability and affordability, were not frequently discussed (Painter et al., 2020). This optimistic portrayal, influenced mainly by industry sources, indicates a media narrative that may surpass the current scientific and technical realities of cultured meat.

Alongside traditional media, social media platforms have played a pivotal role in disseminating information about cultured meat. The rapid dissemination of news and the direct interaction between companies and consumers have facilitated a more dynamic and interactive public discourse. Influencers and prominent figures within the sustainability and tech communities have also bolstered the conversation, reaching diverse audiences and nurturing a sense of community around the cultured meat movement.

Hopkins (2015) examined the media coverage of the cultured meat tasting event in London in 2013, focusing in particular on online media in the US, Canada and the UK. The findings indicate that online coverage placed significant emphasis on several key aspects such as the reactions to the taste, the high cost of production and the potential environmental and ethical benefits (Hopkins, 2015).

The rise of social media has changed how people shape their understanding of the world. In the past, those in power controlled the narrative by choosing which information to share and what to leave out. Social media has disrupted this by giving regular people a platform to share their perspectives and spread information. This shift could mean that everyday people now have more influence over public opinion than those in power, marking a change in the way news and information are presented.

Even regarding the coverage of cultured meat in social media there are only a few studies available. One study revealed that user comments, whether in agreement with or in opposition to traditional media perspectives, wielded substantial influence over public opinion and decision-making (Leong, 2022). It was also found that the emphasis on either environmental or health-related aspects did not impact attitudes and decision-making. This indicates that social media users may base their opinions more on the consensus

reached between ordinary individuals and those in positions of authority, rather than on the specific arguments presented in online discussions (Leong, 2022).

A second study has examined social media (Twitter) discussions surrounding the topic of cultured meat in the United States. The study found 3,114 mentions on Twitter over a six-month period (August 1, 2018 - January 31, 2019), with notable increases during specific events such as the joint meeting of the USDA and FDA (Specht et al., 2020). Among these mentions, 45.2% were original tweets, 20.8% were replies, and 34% were retweets. The engagement came from 68.6% male users and 31.4% female users, while key themes included "meat," "cultured," "lab-grown meat," and "future" (Specht et al., 2020).

2.3 **Research Questions and Relevance of the Study**

Drawing from the discussion above, this thesis aims to provide insights into these three research questions:

RQ0: *How does the representation of technological evolution in the field of cultured meat vary among consumers depending on the communication strategy employed?*

RQ1: *How is the technological process of cultured meat production portrayed in Italian traditional media and social media?*

RQ2: *What are the similarities and differences in the portrayal of cultured meat production processes by Italian traditional media and social media?*

The issue of cultured meat represents a significant innovation in the field of sustainable food and biotechnology. Its production involves advanced scientific processes that require a clear and understandable explanation for the general public. The objective of this study is to comprehensively analyze the portrayal of technologies employed in the production processes of cultured meat within the Italian press and social media platforms. The study aims to identify and compare the thematic treatment used by traditional journalistic sources versus new media channels. By doing so, the study seeks to uncover potential discrepancies or congruencies in how these two media spheres inform the public regarding the technological advancements in cultured meat production.

Comparing newspapers and social media is crucial for several reasons. Social media platforms have become pivotal in disseminating information and shaping public discourse, especially among young people. Unlike traditional media, social media offers real-time, interactive, and user-generated content, allowing for a more dynamic and participatory form of communication. This environment can rapidly amplify diverse opinions, including both supportive and critical perspectives on emerging technologies like cultured meat. For instance, Leong (2022) study on social media interactions revealed the significant influence of user comments and the consensus among ordinary individuals on shaping public opinion.

Traditional media, such as newspapers, are known for their reliability, credibility, and thorough fact-checking processes, which often lend authority and perceived objectivity to their narratives (Al-Quran, 2022). However, they tend to have a one-way communication model with less interaction from the audience. In contrast, social media platforms enable real-time, interactive, and user-generated content, creating a more dynamic and participatory form of communication. This environment can rapidly amplify diverse opinions, including both supportive and critical perspectives on emerging technologies like cultured meat. Many studies suggest further investigation into the portrayal of cultured meat on social media to understand how this evolving topic is addressed in the dynamic landscape of new media. Bryant and Dillard (2019) believe that: "social media may lead to a variety of personalized frames which are outside the control of producers and traditional media outlets. Such an environment could lead to further insights about important narratives about cultured meat as they develop".

Furthermore, by focusing on the Italian context, which presents a complex landscape in terms of cultured meat acceptance, this research can provide localized insights for policymakers, media practitioners, and industry stakeholders. Italy's cultural, gastronomic, and regulatory environment makes it a unique case study for understanding public perception and media portrayal of cultured meat. This research will aid in crafting effective communication strategies regarding the technologies and processes involved in cultured meat production, ensuring they are culturally sensitive and resonate with Italian consumers. Additionally, these insights could help address the broader societal and ethical considerations, paving the way for more informed and balanced public discourse on this innovative food technology.

CHAPTER 3
METHODOLOGY AND DATA ANALYSIS

3.1 **Methodology**

To address the research questions, a qualitative content analysis approach was employed, examining a selection of newspaper articles and social media posts. Qualitative content analysis (QCA) is "*a method for systematically describing the meaning of qualitative material. It is done by classifying material as instances of the categories of a coding frame. The method is suitable for all material that requires some degree of interpretation. This can be verbal or visual, and it can be material that you generated for your research, or material that you sampled from other sources*" (Schreier, 2012). Qualitative analysis is an essential component in the evaluation of scientific communication through the media, as it allows to assess not only the accuracy and completeness of the information provided, but also how this information is perceived by the public (Schreier, 2012).

3.1.1 Data Collection

In the data collection phase of this study, twenty texts were carefully chosen, with an equal division between newspaper articles and social media posts. To maintain consistency and relevance in the research, it has been set a specific time frame, including all texts published from January 2023 to the current date, July 2024. The ten newspaper articles were carefully chosen from prominent Italian news sources, while excluding publications that primarily focus on topics unrelated to the subject matter, such as La Gazzetta dello Sport. The selected newspapers include Il Sole 24 Ore, Corriere della Sera, La Repubblica, and Il Messaggero in order to capture a diverse range of political perspectives and editorial priorities. The articles were searched using the Factiva database with the Boolean search string: 'Carne AND (Sintetica OR Coltivata OR Artificiale)'. The terms 'coltivata' and 'artificiale' were selected due to their frequent use in academic literature on mainstream media (Goodwin & Shoulders, 2013; Hopkins, 2015). The term

'sintetica' was included in the search criteria due to its significant usage in the Italian press. Initially, the term 'prodotta in laboratorio' was also part of the search string; however, its inclusion did not lead to a substantial increase in the number of relevant results. The initial search yielded 314 articles from the four Italian publications, which were subsequently narrowed down to 42 after excluding irrelevant articles (with no mention of the cultivated meat production process) and duplicates. From these 42 articles, the ten most relevant to the description of cultivated meat production processes were selected. Regarding the selection of the posts included in the research, only public and/or specialized information channels with notable relevance in terms of the validity of the published information and audience following were considered (at least 200 thousand followers). Some of the sources from which the posts were selected are: "geopop", "torcha", "la_stampa" e "essereanimali".

3.1.2 Data Analysis

The analysis involved a thorough review of the gathered data, followed by a systematic coding of the texts to identify the keywords used in describing the production process of cultivated meat. According to the literature, identifying principal keywords is a fundamental unit of measurement in content analysis studies, enabling researchers to determine the prominence of specific topics or concepts within media texts (Krippendorff, 2018). The identified keywords were analyzed for frequency of occurrence and distribution within the texts under review. This process of analysing and coding the data was done manually, the keywords were then recorded and counted using Microsoft Excel. This approach allows for the identification of the most commonly used words and concepts, offering a comprehensive overview of how cultured meat is portrayed on different media.

The research then continues with a comparative analysis of the narratives adopted by newspapers and those present in social media. To conduct a rigorous comparative analysis between the narratives present in newspapers and those in social media, this study will employ an analytical framework grounded in narrative theory as delineated by Dahlstrom (2014). This framework provides a systematic approach to evaluate and compare the use of narratives versus logical-scientific communication, the level of emotional engagement, and the verisimilitude within the representations of cultured meat production. These

dimensions form the core metrics (yardstick) for this study's evaluation of media representations.

Dahlstrom's study, entitled 'Using Narratives and Storytelling to Communicate Science with Nonexpert Audiences', explores the use of narratives in science communication towards non-expert audiences. The research emphasises that narratives are a powerful and accessible method of communication that can surpass traditional logical-scientific communication in terms of comprehensibility and involvement (Dahlstrom, 2014).

The dichotomy between narratives and logical-scientific communication serves as the primary axis for our analysis. Narratives, as identified by Dahlstrom (2014), are distinguished by their ability to weave together elements such as causality, temporality, and characters. This narrative structure facilitates inductive reasoning, enabling audiences to derive broader understandings from specific instances. In contrast, logical-scientific communication typically follows a more expository style, utilizing deductive reasoning to convey general principles and factual data. This thesis will assess the extent to which each medium - newspapers and social media - employs narrative techniques versus traditional logical-scientific exposition. The analysis will focus on identifying the presence of character-driven stories, temporal sequences, and causal linkages, as opposed to straightforward presentation of scientific facts and data.

Emotional engagement is another crucial dimension of the analytical framework. Narratives are particularly effective at eliciting emotional responses, which can enhance audience involvement and retention of information. According to Dahlstrom (2014), the engaging nature of narratives stems from their ability to connect with audiences on a personal and emotional level. This thesis will evaluate the degree of emotional engagement by examining the tone, language, and stylistic choices in both newspapers and social media. Factors such as the use of emotionally charged language, personal anecdotes, and appeals to ethical considerations will be considered in the analysis. The presence and intensity of these elements will be used to gauge the level of emotional engagement aimed at by each medium.

The concept of verisimilitude, or the appearance of being true or real, is vital in assessing the credibility and trustworthiness of the information presented. Dahlstrom (2014) highlights that narratives, while powerful, must maintain a certain degree of

verisimilitude to be effective in science communication. This thesis will evaluate the accuracy and reliability of the representations of cultured meat production in newspapers and social media. This involves scrutinizing the consistency of the narratives with established scientific knowledge and assessing the sources and evidence provided to support the claims made. Special attention will be given to identifying potential misinformation or exaggeration, particularly in how each medium balances storytelling with factual accuracy.

CHAPTER 4
RESULTS AND DISCUSSION

4.1 **Qualitative Content Analysis of Cultured Meat Production Process Narratives in Social Media**

This section delves into the presentation of the results obtained through a qualitative analysis conducted on the online posts sample selected for the present study. The analysis focused on the description of the cultivated meat production process, with the aim of identifying recurring keywords, analysing their frequency of use and the narratives adopted. Identifying recurring keywords makes it possible to outline the main themes and narrative techniques used to explain the cultivated meat production process. This methodological approach allows a deeper understanding of the language used and the level of detail offered to the public on a complex scientific topic such as cultured meat.

As part of the qualitative analysis of the ten examined posts, several relevant keywords were identified to describe the cultivated meat production process. These terms recur frequently in the texts and represent the fundamental concepts of the technology used. The main keywords identified included '*cells', 'laboratory', 'bioreactors', 'muscle tissue', 'nutrient broth', 'tissue engineering', 'stem cells', 'cell culture', 'gelatine', 'enzyme'* and *'biopsy*'. For example, the word '*cells'* is often used to refer to the basic element from which one starts to produce cultured meat, as evidenced in statements such as '*Cells are cultured in the laboratory to create edible meat*'. The word '*laboratory'* frequently occurs to describe the controlled environment in which cell cultivation takes place: '*Cells are grown in the laboratory to ensure a sterile and controlled environment.' 'Bioreactors'* are mentioned in relation to their function in supporting cell growth, as in '*Bioreactors provide the necessary environment for cell growth*', emphasising the importance of these devices in the production process. The '*nutrient broth'*, which refers to the cultivation medium, is another essential element for cell growth which was referred to in the posts. Other terms, such as '*tissue engineering', 'stem cell', 'cell culture',*

'gelatin' and *'enzyme*' are used to describe further technical aspects of the process, such as the use of stem cells, tissue structure and the use of enzymes to facilitate cell growth.

Keyword	Total occurrencies	Number of posts
cells	24	9
laboratory	15	8
bioreactor	6	4
tissue	6	4
stem cells	6	4
nutrient broth/culture broth	5	3
nutrients	2	2
scaffold	2	2
fish gelatine	2	2
cell culture	2	2
protein	2	2
contaminants	2	2
cultivation	1	1
food additive	1	1
culture medium	1	1
tissue engineering	1	1
antibiotics	1	1
foetal bovine serum	1	1
biopsy	1	1
flavourings	1	1
hormones	1	1
enzyme	1	1

Figure 6 - Frequency of keywords related to cell culture in online posts. Source: author's elaboration.

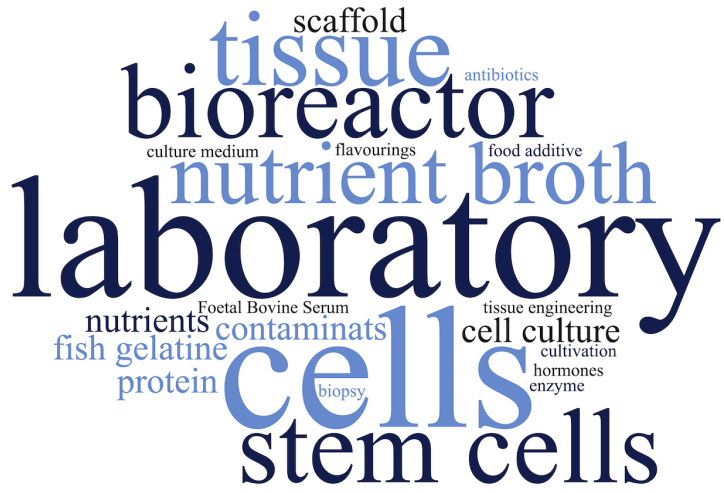

Figure 7 – Wordcloud map of social media keywords. Source: author's elaboration.

The narrative techniques employed in social media posts often aim to simplify and clarify the complex scientific concepts involved in the production of cultured meat. One of the primary methods used is breaking down intricate processes into more digestible steps for the audience. For instance, many posts describe the production of cultured meat in clear, sequential stages. Examples from the data set include statements such as:

- "*The production starts with a biopsy to obtain cells, which are then cultured in a nutrient broth within bioreactors*"
- "*How cultured meat is obtained?*

  1- Animal biopsy: Stem cells are extracted from animal tissue.

  2 - Bioreactor: The cells are fed and multiply.

  3 - Transformation: Stem cells become muscle tissue".

This step-by-step approach helps readers grasp the entire process without feeling overwhelmed by scientific jargon. In the posts analyzed, this technique is consistently applied, with detailed scientific processes broken down into easy-to-follow narratives that maintain accuracy while being accessible. The use of simplified language and structure is a common strategy in science communication, enhancing accessibility for non-expert audiences. This is complemented by the adoption of a narrative style and storytelling, which engage readers and facilitate understanding (Dahlstrom, 2014). Indeed, another powerful narrative technique used is storytelling. Storytelling involves crafting a

narrative that not only conveys information but also engages the audience emotionally, making the scientific concepts more relatable and memorable. For example, a post might narrate the journey of cultured meat from its inception to its potential impact on the future:

- "*Synthetic meat is no longer taboo. The Food and Drug Administration,..., has declared the synthetic chicken created by Californian start-up Upside Foods 'safe for human consumption'* "
- "*The numbers and the production process are however astounding: a sample the size of a peppercorn, weighing approximately 0.5 grams, is taken from the animal. From this sample, around 33,000 cells are selected, the best, the healthiest, which can produce up to 80,000 hamburgers*"

This technique transforms dry, technical details into compelling stories that capture the reader's attention. Storytelling also incorporates human elements, such as the ethical motivations behind cultured meat production, making the science more relatableBy combining clear, step-by-step explanations with engaging storytelling, social media posts effectively demystify the cultured meat production process while appealing to the audience's values and emotions. This dual strategy of clarity and narrative richness ensures that the information is both accessible and compelling, fostering a deeper understanding and interest in cultured meat technology.

4.2 **Qualitative Content Analysis of Cultured Meat Production Process Narratives in Newspaper Articles**

Following the analysis of cultured meat narratives, this section provides an exploration of how the cultivated meat production process is presented and how the technologies involved are portrayed in newspaper articles. The analysis aims to identify recurring themes and keywords, so as to examine the narratives adopted by journalists.

In the analysis of the ten selected articles, certain keywords emerge repeatedly, outlining the primary aspects of the cultivated meat production process (Figure 8).

Keyword	Total occurrencies	Number of articles
cells	25	9
bioreactor	10	2
laboratory	10	5
stem cells	8	7
tissues	4	4
differentiation	3	2
proliferation	3	2
animal cell	3	3
biopsy	3	3
cell multiplication	2	2
bio-technology	2	2
bioreactors for expansion	2	1
antibiotics	2	1
cultures	2	2
tube	1	1
protein serum	1	1
in vitro	1	1
nutrients	1	1
silos	1	1
tissue engineering	1	1
fermenter	1	1

Figure 8 - Frequency of keywords related to cell culture in newspaper articles. Source: author's elaboration.

The primary keywords identified include '*cells', 'bioreactor', 'laboratory', 'stem cells', 'tissues', 'differentiation', 'proliferation'* and '*biopsy*'. The term '*cells*' is frequently used, appearing 25 times, indicating its central role in the production of cultivated meat. Similarly, '*bioreactor*' is mentioned 10 times in the context of supporting cell growth and scaling up the production process. In particular, there are two articles that refer to the use of the bioreactor, described as "*a metal silo with a helix capable of accelerating cell multiplication*". In addition to providing a description, the articles also highlight ongoing technological developments aimed at further improving

the efficiency and effectiveness of bioreactors: "*The second project concerns the development of a bioreactor that provides physical stimuli to cells, to reproduce the texture and consistency of meat*". The word *'laboratory'* also appears multiple times, underscoring the controlled setting where cells are cultivated and reinforcing the image of meat being created in an 'artificial' environment such as the laboratory.

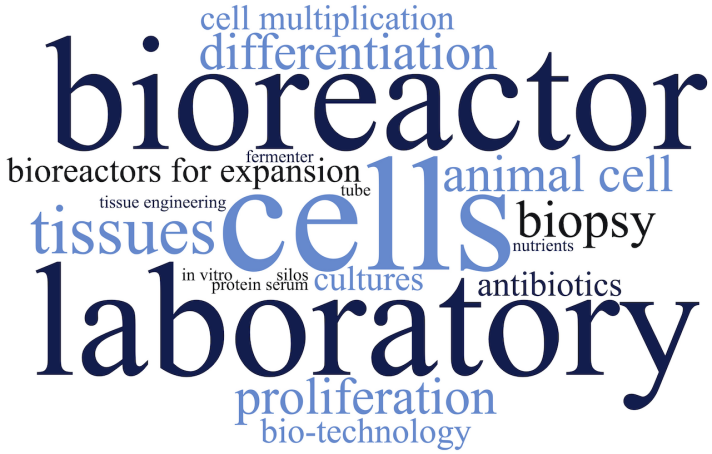

Figure 9 – Wordcloud map of newspaper keywords. Source: author's elaboration.

The qualitative analysis conducted on the articles revealed that the approach taken by Italian journalists is predominantly scientific and didactic. There is a clear intent to inform and educate readers on the technological advances and scientific principles behind cultured meat production. The articles frequently utilize detailed descriptions of the technological and biological components involved in cultivated meat production:

- "*…produced from a few cells taken from animals and grown using tissue engineering techniques. To achieve this on a large scale, expansion bioreactors are used, devices that provide a suitable environment for stem cells to proliferate."*
- "*…produced from stem cells grown in a protein serum in vitro (from plants, animals or insects), replicates the DNA of the starting cell until the 'steak' is obtained*."

The use of terms like '*stem cells'*, '*protein serum'*, '*in vitro'* or '*expansion bioreactors'* indicate a high level of technical detail and specificity in the articles. Furthermore, in the articles are often present analogies and comparisons, which consist of associating more

technical parts of the proceedings with processes that are more easily known to the public, with the aim of making the information conveyed more comprehensible:

- "*The bioreactor reproduces the conditions existing within the animal organism. The same equipment has already been used in the production of beer and yoghurt."*

In this article the process of cell cultivation in a bioreactor is compared to the production of beer and yogurt, illustrating how the principles of fermentation and cell growth are applied in different contexts. Such comparisons help readers relate unfamiliar scientific processes to everyday experiences, thereby making the information more relatable and easier to grasp.

4.3 **Similarities and Differences in the Portrayal of Cultured Meat Production Processes by Newspapers and Social Media**

4.3.1 Narratives vs. Logical-Scientific Communication

In the analysis of newspaper articles and social media posts, a notable variation emerges in the utilization of narrative techniques as opposed to logical-scientific communication.

The newspaper articles analyzed predominantly adopt a traditional expository style, focusing on the presentation of facts and data. Nevertheless, some narrative characteristics are evident, such as the introduction of key figures and the chronological recounting of events. For instance, one article highlights the contributions of Mark Post, a prominent figure in the development of cultured meat, stating, "Prof. Mark Post unveiled the world's first cultured meat hamburger in 2013, a milestone in food science". This personalization serves to humanize the narrative, making complex scientific developments more relatable and accessible to the reader. Gli articoli di giornale, pur contenendo elementi narrativi, tendono a fare uso di un linguaggio più formale e strutturato rispetto ai post sui social media. Articles frequently provide detailed explanations of the cultured meat production process, including specific technical terms such as 'bioreactors', 'differentiation', and 'tissue engineering'. Moreover, the temporal structure is often employed to trace the evolution of cultured meat technology from its inception to its current applications. Such a narrative allows readers to follow the progress and future potential of this innovation in a linear and engaging manner. The causal

relationships are also clearly delineated, with articles frequently linking causes and effects. For example, they explore how cultured meat could potentially alleviate the environmental and ethical issues associated with traditional livestock farming, thus providing a logical argument in favor of this emerging technology.

In contrast, social media posts, by nature of the platform and audience engagement strategies, frequently employ more vibrant and immediate narrative techniques. These posts are crafted to capture attention quickly and provoke an emotional response, leveraging concise, impactful language and visual elements. The use of prominent public figures and celebrities is a common tactic; their involvement in the topic adds a layer of credibility and relatability. For instance, he mention of Leonardo DiCaprio as an investor in cultured meat not only piques interest due to his celebrity status but also positions the issue within a broader context of environmental activism and sustainability, which he is known to support. This strategic use of celebrity endorsements helps to frame the narrative in a way that is not only informative but also aspirational, encouraging audiences to align themselves with the positive values associated with these figures. The brevity and immediacy of social media posts also allow for real-time engagement and rapid dissemination of information. This immediacy fosters a dynamic interaction with audiences, who can instantly react, comment, and share these posts, thereby amplifying the message's reach and impact. The use of visuals, such as images or short videos, further enhances the storytelling aspect, providing a quick and compelling visual narrative that complements the written content.

4.3.2 Emotional Engagement

In newspaper articles, emotional involvement is often achieved through a meticulous tone and the strategic use of evocative language. These publications aim to balance the need to inform and educate with the subtle use of emotional resonance to increase reader involvement. The emotional tone of newspaper articles tends to be subtle, often embedded in a larger narrative that maintains a formal, factual style. This subtlety is intentional and reflects the medium's role in providing reliable and authoritative content. However, despite the predominantly factual tone, articles sometimes incorporate emotionally charged phrases to emphasise the importance or urgency of the topic. For example, when discussing the environmental benefits of cultured meat, terms such as 'sustainable future'

and 'ethical consumption' are often used. These terms not only emphasise the positive potential of farmed meat, but also appeal to the reader's sense of ethical responsibility and moral duty. By framing the discussion in the context of a broader social and environmental impact, these phrases invite readers to consider the implications of their consumption choices. Furthermore, newspaper articles often increase emotional involvement through the inclusion of personal anecdotes or human interest elements. This is done through interviews with key figures, such as scientists, activists or industry leaders, who are directly involved in the development and promotion of cultured meat. These narratives add a personal dimension to the scientific discourse, making it more relatable and emotionally engaging for the reader.

On the other hand, social media posts employ a more direct and overtly emotional narrative approach, taking advantage of the interactive and visually rich nature of the platform. Unlike the measured and exhaustive tone of newspaper articles, narratives on social media are crafted to provoke immediate emotional responses and are often designed to be shareable and attention-grabbing. They often highlight the ethical and environmental benefits of cultured meat in an accessible and emotionally resonant way. For example, posts may use persuasive phrases such as 'sustainable food future' or 'ethical alternative to traditional farming'. These phrases are deliberately chosen to evoke a sense of urgency and moral responsibility, effectively tapping into the values and concerns of the audience. The aim is to create a strong emotional connection with the audience, encouraging them to reflect on their values and potentially change their consumption behaviour. Social media posts often amplify their emotional impact through the use of visual and multimedia elements, such as impactful images, videos and infographics. Frequently, the same technical information is presented through images, placing text alongside graphics or images that provide a visual representation of what is explained in the post.

Figure 10 – Social media emotional engagement through images and videos. Source: Instagram.

4.3.3 Verisimilitude

Representations of cultured meat in newspapers and on social media show a wide range of opinions and information. In newspapers, the emphasis is often on the environmental, ethical and economic benefits of cultured meat. However, there are also doubts about energy sustainability and cost competitiveness compared to conventional meat. For example, some articles emphasise the potential of cultured meat in reducing greenhouse gas emissions and resource consumption, while others highlight the high energy consumption associated with laboratory production.

On social media, discussions are equally varied. One finds posts extolling the advantages of cultured meat, such as the reduction of animal suffering and the positive impact on the environment. At the same time, concerns are raised about public perception and misinformation. Some posts report that cultured meat could solve many problems related to intensive livestock farming, but there are also those who express scepticism and resistance, partly fuelled by misinformation campaigns by livestock lobbies.

Analysis of the narratives revealed that while much of the information shared is consistent with scientific knowledge, there are also exaggerations and occasional misinformation. In newspapers, the description of the production process of cultured meat, which involves the growth of animal stem cells in bioreactors, is generally accurate. However, the presentation of environmental costs and benefits sometimes lacks accuracy, with some claims not being fully supported by empirical data.

In social media posts, the situation is similar. Many posts provide detailed and accurate explanations of the production process and the potential benefits of cultured meat. However, there is some confusion among the public regarding the terms used and technical details, which can lead to misunderstandings and misinformation. For example, terminology such as 'synthetic meat' is often misused, creating negative prejudices.

The reliability of the narratives, as seen above, is closely linked to the quality of the sources cited and the evidence presented. In terms of sources cited, newspapers tend to cite experts in the field and academic institutions to support their claims; this helps to lend credibility to the information presented. In social media, on the other hand, sources vary widely in quality and reliability and are not always present. Indeed, while some posts cite recognised authorities, such as the FDA, or experts in the field, such as Prof. Mark Post, others rely on personal opinions or unverified information, increasing the risk of misinformation.

CONCLUSIONS

This thesis analysed and compared the representation of cultured meat in Italian media, both traditional and digital, through a qualitative content analysis. The main objective was to examine the narrative strategies adopted by the media and their impact on public perception, with particular reference to the narrative of technological challenges related to cultured meat. Through the analysis of the three proposed research questions, significant results emerged that contributed to an in-depth understanding of communication strategies and their implications on consumer acceptance. The conclusions drawn from the results obtained for each research question are discussed in detail below.

RQ0: *How does the representation of technological evolution in the field of cultured meat vary among consumers depending on the communication strategy employed?*

The results show how communication strategy exerts a decisive influence on consumer perception of cultured meat. In particular, as the literature shows, the choice of terminology plays a crucial role. Expressions such as 'cultured meat' or 'clean meat' generally elicit more favourable reactions, as they evoke positive associations related to sustainability and health. Conversely, terms such as 'synthetic meat' or 'artificial meat' tend to generate mistrust and scepticism, underlining the importance of a correct lexical choice to favour or hinder public acceptance.

Besides terminology, the framing of the production process plays an essential role in consumer perception. When technical and scientific aspects of the process are emphasised, such as the use of stem cells or bioreactors, the perception of 'unnaturalness' is accentuated. Conversely, simplified narratives that focus on the ultimate benefits of the technology, such as environmental sustainability and reduced animal suffering, encourage a greater openness towards cultured meat. In particular, social media prove particularly effective in conveying emotionally engaging content, establishing a more personal connection with the audience. Narratives that make ethical appeals, such as the

protection of animal welfare or positive environmental impact, prove to be effective tools for shaping consumers' opinions and attitudes. This highlights the need to develop communication strategies that not only inform but also emotionally engage consumers, making the message more accessible and increasing the chances of acceptance of cultured meat as a sustainable alternative.

RQ1: *How is the technological process of cultured meat production portrayed in Italian traditional media and social media?*

The portrayal of cultivated meat in traditional and social media varies widely in terms of tone, content and depth of information. In traditional media, such as newspapers, the narrative tends to be more measured and factual. Reports are typically expository in style and focus on the scientific and technological aspects of cultured meat production. Detailed descriptions of processes such as cell culture and the use of bioreactors are common, as mainstream media aim to convey the technical credibility of this innovation. Moreover, these media often emphasise the broader societal implications of cultured meat, underlining its potential in addressing global challenges such as climate change and food security.

Social media, on the other hand, take a more dynamic and interactive approach. Posts on platforms such as Instagram and Twitter often rely on visual storytelling and simplified messages to quickly grab attention. These posts tend to focus on emotional and ethical appeals rather than detailed scientific explanations. For example, influencers often leverage sustainability, framing cultured meat as the ‘food of the future’ that can solve pressing environmental problems. However, this medium also allows for a more polarised discourse, with user-generated content occasionally amplifying concerns about unnaturalness and potential health risks.

RQ2: *What are the similarities and differences in the portrayal of cultured meat production processes by Italian traditional media and social media?*

Both traditional and social media cover recurring topics such as environmental sustainability, animal welfare and innovation, but there are significant differences in the way these topics are presented. Traditional media tend to offer a balanced and technically grounded narrative, often relying on testimonies from experts, scientists and industry

professionals. This approach helps to reinforce the image of cultured meat as a relevant technological innovation, albeit still in an experimental phase. However, the economic and regulatory issues surrounding cultured meat are sometimes overshadowed by a narrative more focused on environmental and ethical benefits.

On the other hand, social media offer a more accessible narrative with a strong emotional component. Through the use of influencers, multimedia content and short formats, these channels tend to simplify the message, favouring immediacy and sharing. Although this approach encourages greater audience engagement, it can lead to oversimplification or a distorted portrayal of complex issues. For example, while the advantages of cultured meat are often emphasised, the technical difficulties related to production scalability or cost reduction tend to be overlooked or downplayed. This divergence of approach may lead to conflicting perceptions among different segments of the population.

The results of this study suggest several directions for future research. First, it would be useful to investigate the long-term effects of communication strategies on consumer behaviour, with longitudinal studies analysing how narratives, especially on social media, influence public opinion over time. Furthermore, future research could focus on analysing consumer perceptions in different demographic segments, exploring how factors such as age, education level and personal values influence the acceptance of cultured meat. A better understanding of these aspects would make it possible to develop more effective and personalised communication strategies that address the specific needs and concerns of different social groups. Finally, it would be useful to conduct empirical studies to assess the impact of narratives that emphasise the ‘naturalness’ or ‘unnaturalness’ of cultured meat on consumer acceptance by testing different framing techniques to overcome prejudices towards traditional food products.

In conclusion, as cultured meat production technologies advance, it will be crucial to continue monitoring how narratives evolve and how they may influence public understanding and acceptance. Only through clear, balanced and scientifically sound communication will it be possible to promote widespread awareness of the benefits and challenges of cultured meat, fostering informed discussion and contributing to a more sustainable food system.

REFERENCES

Al-Quran, M. (2022). Traditional media versus social media: Challenges and opportunities. *Technium: Romanian Journal of Applied Sciences and Technology*, *4*, 145–160.

A.Shaji, G. (2020). The development of lab-grown meat which will lead to the next farming revolution. *Proteus (Shippensburg, Pa.)*, *11*, 1–25.

Audino, A., Bakudila, A., & Milano, S. (2020). *I sostituti della carne*. Slow Food. https://www.slowfood.it/wp-content/uploads/2020/11/ITA_carne_in_vitro_def.pdf

Bailey, R., Froggatt, A., & Wellesley, L. (2014). Livestock – Climate Change's Forgotten Sector. *Climate Change*, 6–28.

Bauer, M. (2005). Public Perceptions and Mass Media in the Biotechnology Controversy. *International Journal of Public Opinion Research*, *17*.

Benny, A., Pandi, K., & Upadhyay, R. (2022). Techniques, challenges and future prospects for cell-based meat. *Food Science and Biotechnology*, *31*(10), 1–18.

Bhat, Z., Kumar, S., & Bhat, H. (2015). In vitro meat production: Challenges and benefits over conventional meat production. *Journal of Integrative Agriculture*, *14*, 2–9.

Bryant, C. J., & Barnett, J. C. (2019). What's in a name? Consumer perceptions of in vitro meat under different names. *Appetite*, *137*, 104–113.

Cowspiracy: The Sustainability Secret. (2014). Cowspiracy. https://www.cowspiracy.com/facts

Dahlstrom, M. (2014). Using narratives and storytelling to communicate science with nonexpert audiences. *Proceedings of the National Academy of Sciences of the United States of America*, *111*.

FAO. (2006). *Livestock's long shadow—Environmental issues and options*. FAO.

FAO. (2022a). *Greenhouse gas emissions from agrifood systems. Global, regional and country trends, 2000-2020.* (pp. 1–12). FAO.

FAO. (2022b). *Thinking about the future of food safety*. FAO.

FAO. (2022c). *World Food and Agriculture – Statistical Yearbook 2022*. FAO.

FAO. (2023). *Pathways towards lower emissions*. FAO.

FAO, & WHO. (2023). *Food safety aspects of cell-based food*. World Health Organization & Food and Agriculture Organization of the United Nations.

Frewer, L., Miles, S., & Marsh, R. (2002). The Media and Genetically Modified Foods: Evidence in Support of Social Amplification of Risk. *Risk Analysis : An Official Publication of the Society for Risk Analysis*, *22*, 701–711.

Gerber, P., Wassenaar, T., Rosales, M., Castel, V., & Steinfeld, H. (2007). Environmental impacts of a changing livestock production: Overview and discussion for a comparative assessment with other food production sectors. *FAO*, 37–54.

Good Food Institute. (2022). *2022 State of The Industry Report—Cultivated Meat and Seafood*.

Goodwin, J. N., & Shoulders, C. W. (2013). The future of meat: A qualitative analysis of cultured meat media coverage. *Meat Science*, *95*(3), 445–450.

Hopkins, P. D. (2015). Cultured meat in western media: The disproportionate coverage of vegetarian reactions, demographic realities, and implications for cultured meat marketing. *Journal of Integrative Agriculture*, *14*(2), 264–272.

Kahneman, D. (2003). A Perspective on Judgment and Choice: Mapping Bounded

Rationality. *The American Psychologist*, *58*, 697–720.

Kahneman, D., & Tversky, A. (1979). Prospect Theory: An Analysis of Decision under Risk. *Econometrica*, *47*(2), 263–291.

Kasperson, R., Renn, O., Slovic, P., Brown, H., Emel, J., Goble, R., Kasperson, J., & Ratick, S. (2010). *The social amplification of risk*. 176–188.

Kirsch, M., Morales-Dalmau, J., & Lavrentieva, A. (2023). Cultivated meat manufacturing: Technology, trends, and challenges. *Engineering in Life Sciences*, *23*(12), 6–12.

Krippendorff, K. (2018). *Content analysis: An introduction to its methodology* (2. ed.). Sage Publ.

Leong, A. D. (2022). Framing in the social media era: Socio-psychological mechanisms underlying online public opinion of cultured meat. *New Media & Society*, 1–16.

Li, S. (1998). Can the conditions governing the framing effect be determined? *Journal of Economic Psychology*, *19*(1), 133–153.

Lusk, J. L., Roosen, J., & Bieberstein, A. (2014). Consumer Acceptance of New Food Technologies: Causes and Roots of Controversies. *Annual Review of Resource Economics*, *6*, 381–405.

Macdonald, B., & Vivalt, E. (2017). Effective strategies for overcoming the naturalistic heuristic: Experimental evidence on consumer acceptance of "clean" meat. *OSF Preprints*.

Mateti, T., Laha, A., & Shenoy, P. (2022). Artificial Meat Industry: Production Methodology, Challenges, and Future. *JOM*, *74*(9), 7–13.

McCluskey, J. J., Kalaitzandonakes, N., & Swinnen, J. (2016). Media Coverage, Public Perceptions, and Consumer Behavior: Insights from New Food Technologies. *Annual Review of Resource Economics*, *8*, 467–486.

OECD/FAO. (2021). *OECD-FAO Agricultural Outlook 2021-2030*. OECD/FAO.

Ong, K., Johnston, J., Datar, I., Sewalt, V., Holmes, D., & Shatkin, J. A. (2021). Food safety considerations and research priorities for the cultured meat and seafood industry. *Comprehensive Reviews in Food Science and Food Safety*, *2021*, 1–28.

Painter, J., Brennen, J. S., & Kristiansen, S. (2020). The coverage of cultured meat in the US and UK traditional media, 2013–2019: Drivers, sources, and competing narratives. *Climatic Change*, *162*(4), 2380–2394.

Poore, J., & Nemecek, T. (2018). Reducing food's environmental impacts through producers and consumers. *Science*, 1–7.

Ramani, S., Ko, D., Kim, B., Cho, C., Kim, W., Jo, C., Lee, C.-K., Kang, J., Hur, S., & Park, S. (2021). Technical requirements for cultured meat production: A review. *Journal of Animal Science and Technology*, *63*, 2–15.

Risner, D., Kim, Y., Nguyen, C., Siegel, J. B., & Spang, E. S. (2023). *Environmental impacts of cultured meat: A cradle-to-gate life cycle assessment*.

Rolland, N. C. M., Markus, C. R., & Post, M. J. (2020). The effect of information content on acceptance of cultured meat in a tasting context. *PLOS ONE*, *15*(4), 1–17.

Scheufele, D. A., & Lewenstein, B. V. (2005). The Public and Nanotechnology: How Citizens Make Sense of Emerging Technologies. *Journal of Nanoparticle Research*, *7*(6), 659–667.

Schreier, M. (2012). *Qualitative Content Analysis in Practice*. SAGE.

Siegrist, M. (2000). The influence of trust and perceptions of risks and benefits on the acceptance of gene technology. *Risk Analysis: An Official Publication of the Society for*

Risk Analysis, *20*(2), 195–203.

Siegrist, M., Sütterlin, B., & Hartmann, C. (2018). Perceived naturalness and evoked disgust influence acceptance of cultured meat. *Meat Science*, *139*, 213–219.

Slovic, P. (1987). Perception of Risk. *Science*, *236*, 280–285.

Specht, A., Rumble, J., & Buck, E. (2020). "You Call that Meat?" Investigating Social Media Conversations and Influencers Surrounding Cultured Meat. *Journal of Applied Communications*, *104*(1), 1–15.

Stephens, N., Di Silvio, L., Dunsford, I., Ellis, M., Glencross, A., & Sexton, A. (2018). Bringing cultured meat to market: Technical, socio-political, and regulatory challenges in cellular agriculture. *Trends in Food Science & Technology*, *78*, 155–166.

Treich, N. (2021). Cultured Meat: Promises and Challenges. *Environmental and Resource Economics*, *79*(1), 33–61.

Tuomisto, H. L., & Teixeira de Mattos, M. J. (2011). Environmental Impacts of Cultured Meat Production. *Environmental Science & Technology*, *45*(14).

Tversky, A., & Kahneman, D. (1981). The framing of decisions and the psychology of choice. *Science*, *211*(4481), 453–458.

Wellesley, L., Happer, C., & Froggatt, A. (2015). Changing Climate, Changing Diets. *Chatham House*.