



FABRICATED CUTS: IS CULTURED MEAT A MORE SUSTAINABLE MEAT ALTERNATIVE?

Emma Uderski

ABSTRACT: Cultured meat is an innovative protein alternative that is just hitting the markets in Asia and the Middle East. Produced by harvesting cells from young animals and culturing them on a scaffold, cultured meat theoretically provides a cruelty-free meat alternative that mimics the taste and texture of meat. Preliminary research suggests that cultured meat production could be more environmentally friendly than producing meat and meat alternatives and could reduce our environmental impact - notably land use and greenhouse gas emissions. However, since cultured meat is a relatively new area of study, there needs to be more definitive research in some areas, such as how energy consumption would affect environmental impact. This paper analyzes current research to explore the possibility of cultured meat as an environmentally friendly protein alternative.

Section I: What I Know, Assume, or Imagine

I chose to do my research on the risks and rewards of producing and consuming cultured meat (more commonly known as cell-based meat). With a quick Google search on this topic, I found that the terms for cultured meat have been changed several times throughout their development - it has been called healthy meat, slaughter-free meat, clean meat, synthetic meat, cell-based meat, and many other names before the industry settled on the neutral term “cultured meat.” I first heard of cultured meat in the news from a National Geographic Kids article I read in my science class in 5th grade. Since then, it has become a personal fascination of mine to find out how someone would grow meat in a lab without killing an animal. I was immediately enamored with the implications of lab-grown meat and wanted to see how it measured up to “natural” meat in terms of taste and texture, but also with the implications that a new way to produce food may have on the existing production chain. On top of this, in a health and wellness class I took in my freshman year of high school, we did a unit on nutrition.

It included a lot of information about the meat industry—we learned that the livestock industry produces a very large chunk of the world’s greenhouse gases, which in turn contributes heavily to global climate change.

Right now, most people who are environmentally conscious adopt dietary changes such as switching out animal products for plant-based alternatives, but cultured meat has the potential to offer consumers another choice. Through some baseline Google searches, I gathered that the commercial sale of cultured meat is not yet widely available, but Israel, Singapore, and the United States have already approved cultured meat to be sold to the public. Producing cultured meat on a large scale may help to mitigate some of these greenhouse gas emissions so other efforts to alleviate the effects of climate change may see some results. Climate change is one of the biggest concerns for the future, and in trying to build the best future possible for our planet, we should be considering every possibility that may ease the pressure on future generations. Finding new and innovative ways to address the negative



Uderski

environmental impacts of the meat industry is one of the most significant ways that we can do this and create hope for the future. However, I imagine that producing cultured meat may have some drawbacks - perhaps it produces a lot of waste or is very energy-intensive, which would make it unviable as an environmentally friendly alternative to traditional farmed meat. Through my research to write this paper, I hope to find out more about the environmental impacts that the production of cultured meat may have.

Section II: The Search Process and Discoveries

Part A: The Search Methodology

I started my research with the keywords “in-vitro meat,” “risks,” “rewards,” and “effects” while searching for a reference source on Gale Virtual Reference Library and Academic Search Complete. These search terms were ineffective and provided me with a lot of reference sources that were outdated or had little to no information about cultured meat. Instead, they largely focused on the effects of the meat industry in general and glossed over cultured meat as a potential solution due to most reference sources having a publishing date preceding the year 2010. I found one reference source that gave me some different terms for cultured meat and reviewed my keywords from what little I found, narrowing my search terms to “cultured meat and environmental impacts.” I also decided to search in subject databases specifically dedicated to the environmental sciences. I found that the Agricultural & Environmental Science Collection and Environment Complete were the most helpful databases for increasing my knowledge about the process of making cultured meat and the current conversation about its potential effects on the environment. After familiarizing myself with what is well-known about cultured meat and its impacts, I refined my search terms to explore areas that are not as certain and incorporated keywords like “energy use,” “land use,” and “plant-based meat

alternatives.” I found the majority of relevant information on my topic from these search terms in the specified databases — other databases yielded reference sources or articles that were not peer-reviewed. On top of that, I noticed that two specific academic journals, *Foods* and *Trends in Biotechnology*, have continued to come up in both databases independently and contain the bulk of the information I have collected in my research. Overall, I have had the most success when using the search terms “cultured meat and environmental impacts” while searching in databases that primarily focus on environmental studies.

Part B: Discoveries and New Information

Cultured meat is still a relatively new topic of study, and therefore there are not very many definitives when it comes to its impact, especially on environmental factors. One of the most significant factors to pay attention to is that the production of cultured meat requires far less land than the more traditional “farmed meat.” Nicolas Treich, an environmental economist, indicates that “[...] animal products in the form of meat, aquaculture, eggs, and dairy use about 83% of the world’s farmland and contribute about 57% of foods’ different [greenhouse gas] emissions while providing only 37% of our protein and 18% of our calories” (35). Compared to the amount of land that producing farmed meat requires, it contributes very little to the world’s collective diet. It could be argued that this use of resources is wasteful and that the vast amount of land being used for livestock production should be repurposed for something more environmentally friendly - such as producing more sustainable protein alternatives like cultured meat and various plant-based proteins. To this point, studies have found that cultured meat has been found to require significantly less land than farmed meat. Jennifer Penn, a Master of Law in international and environmental policy, states “Lab-grown meat, also known as cultured meat, provides an alternative that may address many of the



environmental harms stemming from livestock production. Cultured meat requires 99 percent less land [...]” (104). Such a large reduction in land use poses a solution to the meat industry’s inefficient use of space - if cultured meat were to rise in popularity, it becomes feasible that demand for farmed meat could reduce, which would allow much of the land that is currently being used to produce farmed meat to be used for more sustainable purposes. Since the production of cultured meat can be produced using very little land, cultured meat can free up a lot of land to be used for other purposes, thereby providing a new meat alternative that is more sustainable in the long run than farmed meat.

Another factor to consider as research is conducted is that the production of cultured meat has been shown to yield less greenhouse gases than farmed meat. Karoline Wowra, a researcher at Dechema Research Institute’s biotechnology division, states: “Based on different scenarios, [cultured meat] production was benchmarked against conventional protein products. The study revealed that [cultured meat] in a baseline scenario has a lower carbon footprint compared with dairy and cattle beef” (1207). Though Wowra’s findings are from a preliminary study and cannot account for real-world factors (like replacing or converting existing infrastructure), they still indicate that cultured meat has a reasonable potential to reduce the planet’s carbon emissions. Since cultured meat could potentially reduce greenhouse gas emissions from meat production, it addresses one of the largest sustainability concerns about the meat industry. This reduction could ease concerns about worldwide sustainability practices since the meat industry is such a huge contributor to greenhouse gas emissions worldwide. Additionally, the process of producing cultured meat can be further improved in order to make it more sustainable. A study done on the possible environmental impacts of cultured meat by Tuomisto and M. Joost Teixeira de Mattos, researchers in the life sciences at the University of Oxford and the University of Amsterdam

respectively, asserts: “As the majority of GHG emissions during the production of cultured meat are associated with the use of fuel and electricity, the emissions could be reduced by using renewable energy sources” (6121). Instead of using nonrenewable energy sources, such as natural gas or coal, the energy required to produce cultured meat could be sourced from wind, solar, water, or any other source of renewable energy - which would reduce its greenhouse gas emissions even further. Not only does this mean that cultured meat will continue to improve alongside research on renewable energy, but the production of cultured meat can also be altered to fit the infrastructure of any country, allowing those that are lacking in natural resources to become more self-sustaining. Cultured meat produces less greenhouse gas emissions than farmed meat and its emissions can be improved by utilizing a variety of renewable energy sources - which means that popularizing cultured meat could vastly reduce global carbon emissions for the vast majority of the globe, given the right infrastructure.

In addition to producing less greenhouse gas than farmed meat, cultured meat has also been shown to significantly reduce the yield of greenhouse gas emissions when compared to plant-based meat alternatives. Diana Bogueva and David McClements, researchers in alternative proteins and plant-based foods (respectively) state: “Embracing a plant-centric diet in the wealthiest nations, despite representing just 16 percent of the world’s population, has the potential to reduce greenhouse gas emissions by approximately 61 percent” (1). If most people adopted a plant-based diet, the planet’s carbon emissions could be reduced to over half of what it is today. A reduction in greenhouse gas emissions of that magnitude would be considered a monumental victory in environmental science, as fewer greenhouse gases in the atmosphere would lead the symptoms of climate change to be far less pronounced and allow climate scientists



Uderski

to focus on other solutions for climate change. However, even though plant-based proteins could reduce greenhouse gas emissions by a significant margin, cultured meat could further reduce emissions from farmed meat production and consumption. Tuomisto and Teixeira de Mattos' study on the environmental impacts of cultured meat also found that cultured meat yields 78-96% less greenhouse gas emissions than farmed meat per 1000kg produced (6117). This means that while consuming plant-based proteins over farmed meat could reduce greenhouse gas emissions by about 61 percent, prioritizing cultured meat over farmed meat may be able to lower greenhouse gas emissions by an additional 17-35 percent. Although plant-based proteins are already a huge improvement in reducing carbon emissions through the meat industry, cultured meat has the potential to further innovate in the field of meat alternatives and lower the planet's greenhouse gas emissions significantly. Decreasing greenhouse gas emissions so significantly may lead to a climate victory similar to closing the hole in the ozone layer - proving that taking action against climate change has definite positive impacts. Cultured meat yields far less greenhouse gas emissions than plant-based meat alternatives, making it a more sustainable alternative to farmed meat.

However, there is still much about cultured meat that is not certain. Researchers are still determining how energy-efficient the production of cultured meat is. While the study done by Tuomisto and Teixeira de Mattos found many beneficial things about producing cultured meat, it also found that "Energy requirements of cultured meat production are lower compared to beef, sheep, and pork, but higher compared to poultry" (6120). Since producing different kinds of cultured meat or cultured animal products requires different levels of energy, estimating whether or not producing cultured meat requires less energy than farmed meat is difficult. The amount of energy required to produce enough cultured meat for consumers may fluctuate with demand or availability of resources - if

consumers prefer a product that is particularly high in terms of energy consumption, cultured meat could potentially require much more energy than farmed meat. Additionally, the demand for certain products may fluctuate, so the energy required to produce cultured meat nationally and globally may be inconsistent and hard to predict. Not only may the energy consumption of cultured meat be hard to predict, but there may also be a high baseline energy cost to producing enough cultured meat for consumers. Robert Goodland, an environmental advisor to the World Bank Group and tropical ecologist, asserts that "Cell culture in modern laboratories is incredibly energy-intensive, [...] it requires constant control of temperature and humidity, unlike outdoor livestock production" (35). Attempting to create a synthetic meat product with all the qualities of naturally grown meat is a highly intensive process, which may require a lot of energy. If researchers were to compromise on the quality of cultured meat to minimize its energy requirements, consumers may end up with a subpar product, but if researchers prioritize the quality of cultured meat, there is a strong possibility that cultured meat production will require much more energy to produce than traditional meat or other meat alternatives. This would disqualify cultured meat as a viable eco-friendly meat alternative since producing plant-based proteins already requires less energy than farmed meat. However, there is no consensus in the research on cultured meat's energy requirements, so it is difficult to draw any quantitative conclusions. There is still much to be researched about cultured meat and how it could impact the world's infrastructure, particularly how much energy large-scale production of cultured meat would require.

Section III: Conclusions About What I Discovered

In the process of researching the environmental impacts of cultured meat, I realized how little definitive research there was on cultured meat in general. Before I did my research, I had assumed



that there would have been more research and some major developments in the field since cultured meat was proposed as a potential product. However, I found that researchers are still looking into a lot of the effects of cultured meat, such as how much energy the large-scale production of cultured meat is going to take. Even the positive effects that most people agree on (like the reduction in greenhouse gas emissions) are still only supported by preliminary research and theory. Most sources that I read, namely the study done by Tuomisto and Teixeira de Mattos and the article written by Nicolas Treich, conclude that cultured meat needs far more research for any findings to be concrete. Nonetheless, theory and preliminary studies indicate that the effects that I imagined cultured meat would have on the environment are still possibilities - it has been shown to greatly reduce greenhouse gas emissions as opposed to farmed meat, as well as current meat alternatives. I was also correct in assuming that a big concern around producing cultured meat is around how much energy it may or may not use, even though I did not predict that it would be highly debated. On top of this, an unexpected possible benefit of cultured meat is that it requires much less land than farmed meat, which is beneficial for the environment because it allows livestock farmland to be repurposed into farmland for environmentally friendly meat alternatives and/or biodiverse ecosystems. Overall, my new perspective is that there are many possible benefits to shifting our focus to cultured meat in the future, however, there is still a lot of conflicting data being reported, which does not make me confident that cultured meat is ready to be on the market. For me as a consumer to feel comfortable in purchasing cultured meat as a sustainable choice, I would need to definitively know the environmental impact that cultured meat has and not just consider the potential positives and negatives. More research needs to be done and published on this subject - particularly any research that could confirm or deny the amount of energy that

cultured meat requires to produce. However, confirming the findings of the preliminary studies that showed other possible benefits (such as reducing greenhouse gas emissions and land use) through more research would also be highly beneficial, as it would cause cultured meat to be more appealing to consumers if researchers find that the production of cultured meat does come with a high energy cost. Cultured meat needs far more research and development over a broad range of factors before it is ready to be a viable substitute for farmed meat.

Works Cited

- Bogueva, Diana, and McClements, David J. "Safety and Nutritional Risks Associated with Plant-Based Meat Alternatives." *Sustainability*, vol. 15, no. 19, 2023, N.PAG. ProQuest, doi:<https://doi.org/10.3390/su151914336>.
- Goodland, Robert. "A Fresh Look at Livestock Greenhouse Gas Emissions and Mitigation." *Impact of Meat Consumption on Health and Environmental Sustainability*, edited by Talia Raphaely and Dora Marinova, Information Science Reference, 2016, pp. 27-42. *Practice, Progress, and Proficiency in Sustainability*. Gale eBooks, link.gale.com/apps/doc/CX7424900014/GVRL?u=wash_main&sid=bookmark-GVRL&xid=5431a9b7. Accessed 7 Dec. 2023.
- Penn, Jennifer. "Cultured Meat": Lab-Grown Beef and Regulating the Future Meat Market." *UCLA Journal of Environmental Law & Policy*, vol. 36, no. 1, 2018, pp. 104-126. *EBSCOhost*. doi:<https://doi.org/10.5070/L5361039902>.
- Treich, Nicolas. "Cultured Meat: Promises and Challenges." *Environmental & Resource Economics*, vol. 79, no. 1, May 2021, pp. 33-61. *EBSCOhost*. doi:<https://doi-org.offcampus.lib.washington.edu/10.1007/s10640-021-00551-3>.
- Tuomisto, Hanna L., and M. J. de Mattos. "Environmental Impacts of Cultured Meat Production." *Environmental Science & Technology*, vol. 45, no. 14, 2011, pp. 6117-6123. ProQuest, doi:<https://doi.org/10.1021/es200130u>.



Uderski

Wowra, Karoline, et al. "Estimating environmental impacts of early-stage bioprocesses." *Trends in biotechnology*, vol. 41, no. 9, 2023, pp. 1199-1212. ProQuest, doi:<https://doi.org/10.1016/j.tibtech.2023.03.011>.