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# Cultured Meat, An Alternative for Conventional Meat

Gabriel POPESCU
The Bucharest University of Economic Studies, Bucharest, Romania,
Email:popescug2004@yahoo.co.uk

Dorin MARTIN
Ph.D. student Economic II The Bucharest University of Economic Studies, Romania
Email: dorin.martin@gmail.com

Maria GIRIP
Ph.D. student Economic II The Bucharest University of Economic Studies, Romania
Email: maria.girip@gmail.com

Correspondence should be addressed to: Gabriel POPESCU; popescug2004@yahoo.co.uk

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## Abstract

Lately, the increase in the number of inhabitants of the planet has generated a greater demand for food and more specific products based on animal proteins, which has led to many debates regarding the livestock sector and meat consumption. All these debates refer to the environmental problems caused by animal farms and the advantages of artificial meat production; there is a growing demand and support for this type of meat, created in the laboratory, from several opinion leaders from outside the farming community. This type of meat is presented as a real solution to our environmental challenges and the growing demand for meat on the market. Artificial meat production is now increasingly promoted by leading technology leaders, who are making strong statements in favor of artificial meat with substantial investment in this sector. This vision of high technologies for meat production, which is receiving more and more attention in recent years, is very little explained and analyzed without knowing all the social, environmental, economic, and public health effects. The claim that a diet without "real meat" and a Europe without animal husbandry are the answers to the challenges posed by climate change is incorrect. It could lead to a catastrophe for our nutrition, territories, environment, diversity, and culture.

**Keywords:** Artificial Meat, Livestock, Sustainability.

## Introduction

The scope of this article is to analyze the environmental, social, and market impact of conventional animal husbandry compared to the impact of the elements mentioned on artificial meat production. The question that this paper is planning to respond to is: If artificial meat is an alternative for meat consumption in Europe.

The current problem presented by FAO states that the demand for food will be a challenge by 2050 since the population is expected to be at almost 10 billion (FAO, 2017).

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This will present as a big challenge since the resources are limited. Nevertheless, meat is still an important part of our diet. Although meat consumption has a decreasing trend in developed countries, the overall trend is ascending mostly since developing countries like India, China, and Russia are not on a descending trend. The above middle population is also considering more gourmet products that are meat-based or animal-based (Sghaer et al., 2021).

The meat production industry did create some concerns regarding water demand, pollution, and CO2 (greenhouse gas emissions). This comes from the fact that the productions are focused on maximal output with the minimum of investment; this leaves out the care for the environment, climate change, artificial growth hormones, antibiotics, animal welfare, and overall sustainability (Steinfeld H. et al., 2006).

European Union has issued several decisions to regulate the meat industry to have fewer antibiotics and better living conditions for the animals. The scope of those decisions was to improve animal welfare and to meet the consumers' expectations (ECA, 2018).

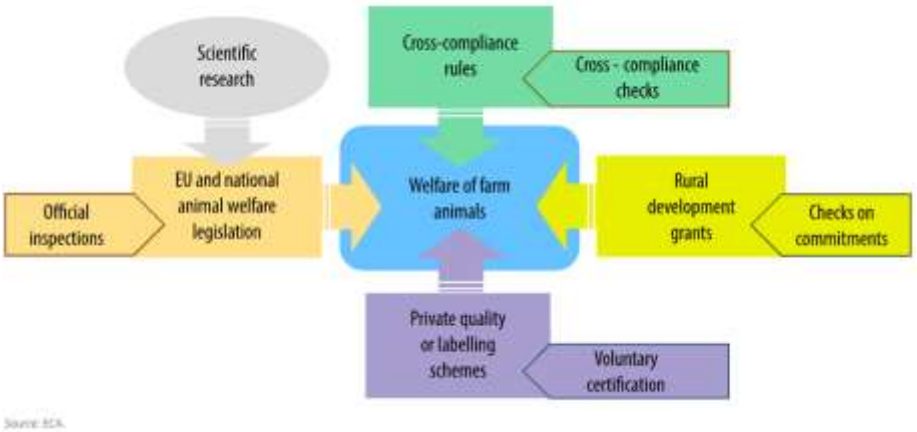


**Figure 1: Actions in the EU with an impact on animal welfare**

*Source: (ECA, 2018)*

In the figure 1 above, it can be seen the traceability of the EU's actions regarding animal welfare.

As the report mentions, the EU has the world's highest standards for this matter. The first legislation was appointed almost 40 years ago and was amended numerous times, with more state members adopting additional measures regarding slaughter, as the European Court of Auditors mentions in their report. Nevertheless, the good animal welfare is not always connected to monetary interest. The higher profits require an intensive production system where the animal can manifest a somewhat unnatural behavior due to artificial conditions of life like feather pecking in hens, cannibalism, and biting in pigs. The practices to prevent this are rather painful for animals, e.g., beak trimming, tail docking, castration, and teeth clipping. The issues are addressed by EU legislation, with one of the imposed rules being the minimum space requirement (ECA, 2018).

The one statement made by Harry Aiking (2014) for The American Journal of Clinical Nutrition states that access to food is not equitable for the whole population, with almost one billion people being obese and one billion going hungry. Furthermore, these figures will grow considering the developing trends of demographics.

Aiking addresses the problem of food security and sustainability by concluding that the current path of consumption it is not the option because the decrease of demand for animal protein will be price related, and the poor will suffer, increasing the already present world hunger (Aiking, 2014).

## Problem statement

Considering the above, the pros for artificial meat research come in handy since the above statement – the economic interest is not always close to animal welfare, and synthetic meat can provide an alternative to this without the cons of an intensive system. The cultivated meat or cultured meat is animal meat that is solely produced by cultivating animal cells. This type of production has the advantage over the need to raise animals and therefore eliminates the animal welfare dilemma. The process consists in extracting the stem cells, then arranging the cells similar or identical to animal tissue, thus the nutritional profile being replicated (Swartz E., 2019).

Animal agriculture is responsible for 14,5% of the world's greenhouse gas emissions, and it is projected to account for almost 81% of the remaining carbon budget under the Paris Agreement by 2050 at this pace. Another critical issue

stated by Swartz Elliot (2019) is that 77% percent of the habitable land on Earth is currently being used to raise and feed livestock while being accountable for only 17% of the world's caloric supply. Also, industrial animal agriculture is the leading cause of biodiversity loss and climate change. Another alarming thing is the number of antibiotics used to produce livestock and farmed fish that is nearly the same as the number used for humans (Swartz E., 2019)

## Methodology

This paper will analyze the specialty literature written about the subject among with data observation. First, Hamdan et al. describes the history of cultured meat and how it can impact the customers on philosophical, religious, and ethical issues (Hamdan et al., 2018). Next, Fernandes et al. provides an insight into the bibliometric analysis regarding cultured meat (Fernandes et al., 2019). Regarding the actual production of the meat, the first hamburger that was made from cultured meat was cooked and tasted on a television program in August 2013. The burger was created by Professor Mark Post from Maastricht University and was made by lab-grown cells (BBC, 2013).

*Definition of artificial meat or cultured meat – What is cultured meat?*

Artificial meat is a product that is grown in the laboratory can have several other names, synthetic meat, in vitro meat, cultured meat. This type of meat is produced by harvesting stem cells from animals and preserving them, and then the cells are grown into bioreactors. The process tries to mimic the natural process of cell growth; therefore, the cells are fed with a rich oxygen lcm consisting of glucose, amino acids, vitamins, and inorganic salts, and enriched with proteins and other growth factors (Good Food Institute, 2020).

## Environmental effects of conventional animal husbandry compared to artificial meat production.

Tuomisto et al. 1 affirm that the manufacturing of vitro meat is eco-friendly since it is expected to set off fewer greenhouse gases( the fact is still disputed) using their hypothesized system (Tuomisto et al., 2011). Lyncth et al. (2019) communicates in their paper that the process would need a smaller amount of water and need not as much land compared with the standard production of meat, from ruminants especially. A significant proportion of GHG comes from livestock, mainly ruminants, since the digestive tract of herbivores releases methane. One of the potential advantages of artificial meat compared with animal husbandry is methane reduction (known to be a potent GHG). The emanation of carbon dioxide ($CO_2$), methane ($CH_4$), and nitrogen oxide ($N_2O$) are known to be linked with cattle breeding.

There is no agreement regarding the GHG emission, in the carbon equivalent case, for cultured meat and standard meat; the study from Tuomisto et al. (2019) provided an advantage for cultured meat while the study from Mattick et al. (2015) did not reach a conclusion. The study conducted by Lynch et al. (2019) concluded that artificial meat would have an initial positive impact on global warming but is not a long-term plan. This is backed up by the fact that $CH_4$ is not accumulating as much in the atmosphere if compared with to $CO_2$.

Nevertheless, the heating that comes from the $CO_2$ produced by artificial meat manufacturing will persist. In their study, Lynch et al. (2019) concluded that there is no clear positive in comparing cultivated meat and cattle for GHC (Lynch et al., 2019). In their study, Doreau et al. (2012) said that to produce 1 kg of beef it will be needed 15 000 L of water, just for consumption, 95% of it is necessary for the field crops that will be used later to produce the fodder or to feed the animals. If farm animals are taken out to graze, this water consumption decreases significantly

Both studies by Corson et al. (2013) and Doreau et al. (2012) do agree that for delivering 1 kg of beef, between 550-700 L of water will be required.

A crucial aspect can be the quality of the water resulting from the production of artificial meat, which can contain various substances, materials resulting from synthetic meat laboratories; if we take into account the indirect activities in the chemical industry, that will have to produce growth factors and hormones in ultrasounds of cell culture.

There is a possibility of producing waste or discharges of chemicals, and these products are found in the water as a waste eliminated from the laboratories that produce artificial meat. Still, in a controlled environment, the possibility can be drastically reduced. When analyzing the land area necessary to produce artificial meat, it becomes clear that the vitro meat requires less land than a standard meat production, compared to the breeding of ruminants that need pastures. Even though this could come up as an advantage for cultured meat, the manure produced by livestock contributes to the fertility of the soil.

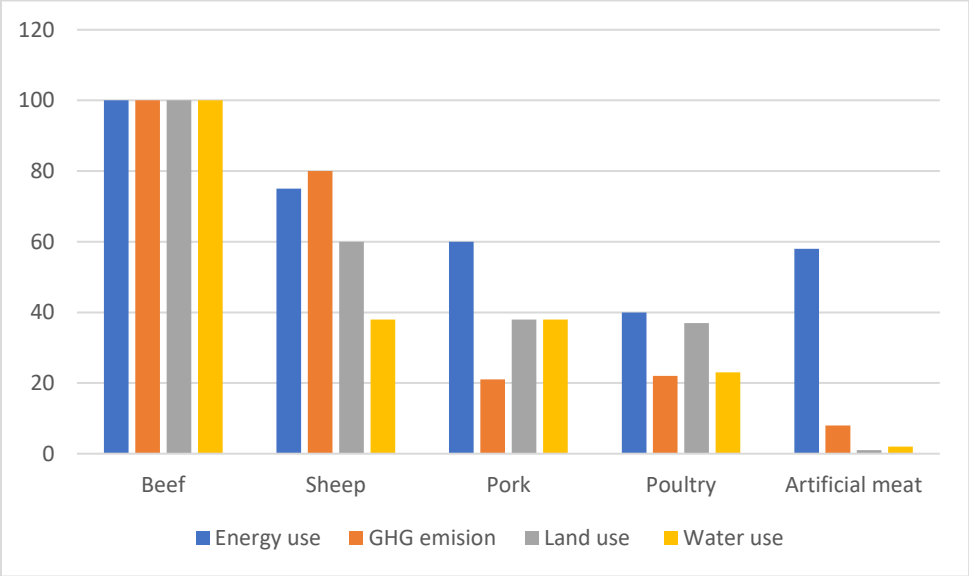


**Figure 2. Environmental impacts of conventional animal husbandry vs. production of artificial meat**
*Source: Author's work based on (Tuomisto Hanna L., et al.,2011)*

In their study, Chriki et al. (2020) state that the production of food for animals requires about 2.5 billion ha of land (the land corresponds with 50% of Earth's agricultural area), out of 2.5 a 1.3 billion is dedicated to non-arable grassland, function only for domestic animals.

## Animal Welfare

The one concern of our society refers to animal welfare, which is also one of the main arguments to produce artificial meat—stopping the ruthless practices by animals sometimes enclosed in small spaces and slaughtered in inhumane conditions. How animals are raised in intensive and super-intensive systems can often lead to illness, infection, developmental issues, and suffering (ECA, 2018).

The cultivated cells do not have a nervous system, and the resulting product, the artificial meat, should not suffer any kind of pain. However, the biopsies that will be made on animals with the purpose of collecting cells may raise some problems related to animal welfare. In the end, the number of animals needed for the purpose of obtaining artificial meat will decrease significantly (Sebo, 2018; Chauvet.,2018).

Nowadays, animal welfare issues related to industrial pig and poultry production units. Indeed, due to a large number of livestock bred, such industrial units compete vigorously with small farms, which are declining at the European level.

There are other aspects that need to be considered. For the way in which artificial meat is currently produced, animals are needed to produce cultivated meat, in a smaller number only for the collection of muscle samples. Regardless of the pain, animals must be raised so that portions of their tissue can be harvested to produce artificial meat. Lab-grown or cultured meat does involve the exploitation of animals, which should be the one thing that alternative meat is (Alvaro, 2019).

With artificial meat replacing livestock comes to attention the rural dynamic of all the other services and areas in which livestock was the main occupation. Many people from the rural area have animal husbandry as their only source of income, not to mention that lots of other animal products that are primarily sold would disappear too. Some of the examples might be – DOC cheeses, milk, and other protected products like prosciutto (Dumont et al., 2017; Ryschawy et al., 2019).

## Food Safety and Ethical Concerns

According to various studies artificial meat is considered safer than conventional meat. The lab-grown meat is produced with controlled conditions by researchers. There is also a low contamination risk because of the lack of contact with the external environment. Even though regulated conditions, research cannot assure that the risk is nonexistent due to biological systems. Large-scale replication of a significant number of cells can lead to some irregularity in some lines of cells, and this can be avoided by removing them (Hocquette, 2014).

The lead specialist does have the theory that lab-grown meat can be adjusted by controlling the quantitative components from the production. A good example could be replacing saturated fats with good types of fats, such as omega 3 ( Scollan et al., 2014).

## Consumer Perception Regarding Artificial Meat

In 2013 Professor Mark Post from Maastricht University created the first artificial meat hamburger and reached 30,000 USD. The cost is explained by the high usage of components that are typically used in medicine manufacturing. The initiative received additional funding, and the start-up called Mosa Meat was created. The cost of an artificial burger went down to 9 USD, which is nine times more than a regular meat burger that goes up to 1 USD. Moreover, Mosa Meat recently announced the cultivation of meat in a serum-free environment, according to the FAQ of the website (Mosa Meat, 2019). In Israel, the first artificial industrial meat factory was open with the ability to produce 500 kilograms per day or the equivalent of 5,000 hamburgers. The company – Future Meat Technologies makes it achievable to reach supermarket shelves in 2022 (CISION, 2021).

The artificial meat industry has now more than 75 companies; since the first prototypes, startups have reduced costs by 99%. Meanwhile, there is an opening to this type of industry. According to Mc Kinsey's publication, if the demand grows, the cultured meat market could reach almost 25 billion USD by 2030. Furthermore, while the USA has announced arrangements in the scope of product regulation, in European Union, there was awarded a multimillion-euro research grant (Mc Kinsey, 2021).

Among many discussions about this subject, one that really influences the consumer's perception is the name, and the "artificial meat" has the probability to appear to consumers as fake, hence the lack of demand from the market. The demand is the one indicator that also influences the decision for investment in a business or not; the fluctuations of demand are controlled by consumers. Therefore, consumers' opinion regarding this is rather important, even more than the actual scientific breakthroughs; the absence of demand or refusal of the product could mean that the research effort was in vain (Siegrist et al., 2018).

A study conducted by Provoke Insights and Future Meat Technologies surveyed 2,016 US citizens and came to the conclusion that cultured meat is the a favorite term than cell-based meat or cell-cultured meat (CISION, 2021; Bryant et al., 2019; ABC News, 2018). The studies also back up the future name issue since consumers lack acceptance for artificial food; the study conducted by Verbeke et al. in three European countries showed that the first reaction was rejection and disgust for lab-grown meat. Although they considered the greater benefit of the society, the feeling of uncertainty and unknown was still present among respondents (Verbeke et al., 2015).

If and when the perception will change, the artificial meat industry still requires regulations and controls to be set in place since this is a breakthrough production system. Regarding alternative proteins, there is a growing interest manifested by UK consumers, as an Informa Agribusiness Intelligence estimates, milk alternative having a 43% more demand and meat alternative 25% (Stephens et al., 2018). This breakthrough is also an opportunity for small farms to produce their own kind of lab-grown meat, also recreating the taste and characteristics provided by their livestock. This can provide new jobs and still protect the traditional products (Stephens et al., 2018). The price competitiveness can also be an advantage if the characteristics of alternative products, like the smell, taste, etc., are precisely the same as the conventional meat (Hartmann et al., 2017; Tan et al., 2016).

## European legislation for artificial meat

In the EU, the body that approves products is the European Food Safety Authority; they published in March 2021 a guidance for the approval process regarding new foods. At present, after the application has been submitted, the approval can take up to 18 months, and with further changes, it will reach 24 to 30 months, states the publication Food Navigator (Food Navigator, 2021). Therefore, to further prospect on this matter, a probable minimum for cultured meat in Europe could be late 2022, since the first guideline was published in 2021.

## Findings

The greenhouse emission will not significantly drop solely from reducing meat consumption. Moreover, the mass production of artificial meat is still new and cannot be yet perceived as an alternative. Livestock growth is an integral part of Europe's identity.

Livestock production is still the only source of income for a big part of the population. Also, Europe has many countries that are famous for their pastures and alpine grazing cows. In 2019 half of the European Union's meat production was from pork. Furthermore, poultry production reached 13,3 million tonnes (Eurostat, 2020).

The data from Eurostat also shows that in 2021 in Q2 there were actively engaged 379.4 thousand people employed in agriculture.

The current costs for producing cultured meat are still large, and the demand for it is not that high since the food itself does not seem appealing to the large public, as a study concluded (Whithing, 2020).

In December 2020, Singapore Food Authority was approved the first facility that sells cultured meat, making Singapore the first country that approved cultured meat dishes for consumption; in July, another company also got approval to manufacture the meat (Tan, 2020). The Good Food company states that producing cultured meat will make land usage from up to 300% more efficient than poultry and going to even 4000% more efficient for beef. This will allow the decrease of antibiotics, better welfare, need not require animals to be confined in small spaces. The risk of animal-related pandemics will also decrease significantly. In 2020 there were invested 3.1 billion dollars in the industry for alternative proteins (Good Food Institute, 2020).

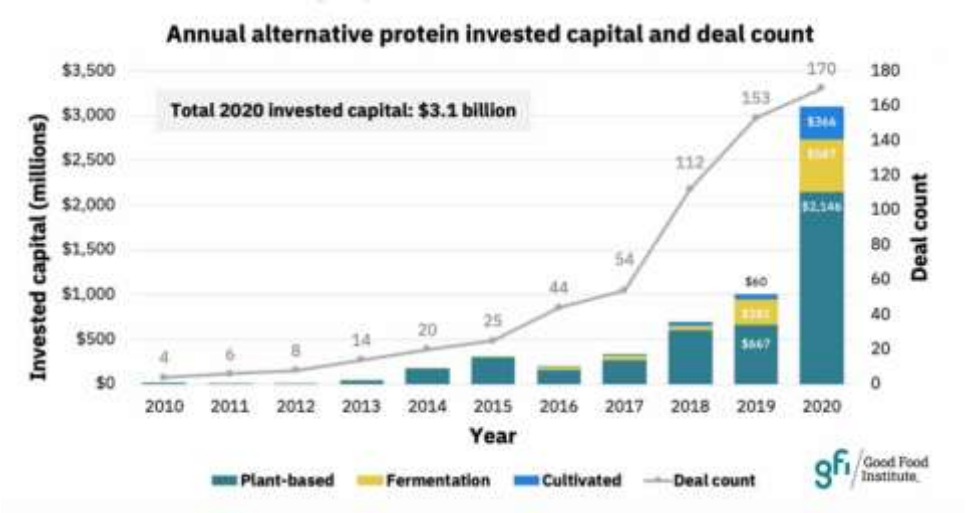


**Figure 3: Annual alternative protein invested capital and deal count**

*Source : (Good Food Institute, 2020)*

## Conclusions

Although consumers' attitude is yet unsure about lab-grown meat consumption, the reticence comes mainly from the unknown and not the trustfulness of the process. With a change regarding the name, the cultured meat can be more appealing for consumers.

The alternative meat along with the alternative proteins industry, can supply where is low food availability, providing a more affordable alternative to conventional sources among with creating a new set of jobs and opportunities in the field.

There is yet progress to be made at least regarding culture meat, but the path has been paved, people already replacing animal-based milk with vegetal-based milk like almond, oat, coconut, soy, and others. So, the question arises - Can artificial meat replace conventional meat? Unfortunately, at current times this is not likely since the cost of production is too high and the new character of the industry lacks regulatory bodies worldwide.

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