Cultured meat: new perspectives on the meat industry

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Abstract. This paper has the goal of analysing lab-grown meat, made from the extraction of animal cells. First, problems of the meat industry are debated. After that, a definition of lab-grown meat is sought, as well as clarifications about its synthetization. Subsequently, economic, environmental and market acceptance impacts are analysed, mainly on the context of the European Union and United Nations sustainability goals. The core of the debated proposed in this work is to examine if cultured meat products are able to be a solid alternative for traditional meat under three aspects: (i) environmental protection; (ii) economics and (iii) consumer acceptance. The paper uses concepts of environmental law; animals rights; green economics and sustainability for its development.

Keywords. Environmental Law; Lab-grown meat; Greenhouse effect; Food Law;

Sustainability.

1. Introduction

Since the most remote times, the consumption of proteins, especially of animal origin plays a central role in the human diet. It is estimated that humans consume around 350 million tons of meat per year [1]. On the first four months of 2022, around 100 million tons of meat have already been consumed [1].

This high-level consumption is not free of consequences for the planet. It is estimated that around 30% of the soil on Earth is used for meat production [2]. Moreover, the forementioned production is also responsible for the emission of 14.5% of greenhouse gases, in the amount of 7.1 gigatons of CO^2, according to a study conducted by the United Nations Food and Agriculture Organization (FAO) [3].

Analysing the forementioned data, it is possible to affirm that an alternate product should be considered for the duty of feeding the world population, which will only grow in the future years, demanding more and more natural resources.

On this context, the cultured meat (or lab-grown meat) might be the necessary alternative.

2. Concept and formation process

2.1 (In)Determination

Defining cultured meat is certainly not an easy task, mainly due to its disruptive characteristics. As it is a quite recent and innovative technology, many different definitions can be given to the product.

The first definition was given by Neil Stephens, who defines cultured meat as: "yet undefined ontological object" [4]. Jean-François Hocquette also tries to define cultured meat as: "artificial muscular proteins" [5].

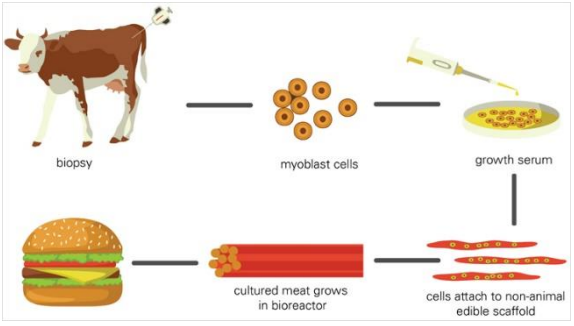
Other definitions that deserve being mentioned are the one given by Maastricht University and by the Good Food Institute. The Dutch university states that cultured meat is exactly the same product as the traditional meat, but free of animal slaughter [6].

Lastly, Good Food Institute states that cultured meat would be a "clean meat", in comparison with the traditional "dirty meat", due to its animal friendly trait [7].

2.2 Formation process

Cultured meat production is a very complex procedure, which involves many stages. The process can be summarized in the following picture [8]:

Figure 1 - Cultured meat production process



The process begins with a biopsy, in which a sample of muscle tissue is extracted from the animal. There is still some controversy on which type of cell should be used: muscle cells, stem cells, or myoblast cells

The next step is the most controversial of all, which is the weakest aspect of cultured meat. After extracting the cells, a serum is introduced for the cells to develop and become muscle cells. However, this serum is obtained from the blood of the foetus of an animal that will be slaughtered.

In other words, this step makes the "clean meat" not so clean, because it would involve animal slaughter, not for the meat offer itself, but to produce the lab-grown-meat.

The next step consists on the formation of a support for the cells to aggregate. and form three-dimensional flesh. The support must emulate the stretching of muscle cells and should be malleable and sensitive to variations in temperature and pH.

Currently, the most suitable substances for that process are alginate, chitosan, or collagen, all of non-animal origin.

Finally, the mentioned structure is placed in a bioreactor, which generates reactions biological factors that, at the end of the process, will lead to the formation of laboratory meat, similarly to the traditional meat.

2.3 Final considerations on the first topic

It is undisputable that the process of formation of the cultured meat is extremely complex and, to a certain extent, controversial, mainly due to the serum used for producing the meat.

This complexity has some regulatory implications, which make the production of cultured meat even harder.

3. Environmental Impact

One of the main advantages of the cultured meat would be a lower environmental impact, when compared with the traditional meat. In this section, those claims are analysed, based on a study conducted by Hanna L. Tuomisto, Marianne J. Ellis and Palle Haastrup (2014) [9].

3.1 Land usage

There is a certain consensus regarding that laboratory meat would present a considerable reduction in land use, especially when compared to production of beef, in an amount of up to 99%.

Such statement can even be considered intuitive, because while meat production, with the slaughter of animals, requires large spaces so that the animals can live, the artificial protein would, in principle, only need laboratory rooms.

Therefore, at least in this aspect, cultured meat is indeed superior to the traditional meat.

3.2 Water Usage

According to PETA (People for the Ethical Treatment of Animals), the production of a piece of beef demands around 9.085 litres of water [10].

On the other hand, cultured meat would demand roughly half of that amount. The result is superior to every meat, except for poultry.

Therefore, through the scope of water waste, it can be said that the transition to lab-grown meat would have a positive impact on the environment, except on a region in which the production is mainly of poultry, in which the introduction of laboratory protein should be assessed more carefully.

3.3 Energy Consumption

The consumption of energy is the greatest drawback of cultured meat, mainly due to the usage of a bioreactor for its production, as it consumes more energy than every other meat produced.

However, despite its high consumption rate, it is not possible to make any judgment about the environmental impact (of any meat) based only on these numbers, as the type of energy used in the process is more relevant to the environment.

In summary, if the energy used in the production of the cultured meat is renewable, its production could be advantageous, if not, its production would only increase the negative impact on the environment, more than any other meat type.

3.4 Greenhouse Effect

The greenhouse effect is one of the greatest concerns of Environmental studies since the second half of the 20th century, as its emission is directly related with a significant rise in temperature of Earth.

According to Tuomisto, Ellis and Haastrup [8], lab-grown meat would have a much smaller impact on the environment. However, differently from what happened in the previous criteria, there are strong opinions on the opposite direction.

In 2019, researchers John Lynch and Raymond Pierrehumbert [11], both from the University of Oxford, conducted a study on the emission of greenhouse gases on the production chain of lab-grown meat, addressing the emission of carbon dioxide, methane and nitrous oxide.

According to Lynch and Pierrehumbert, cultured meat does not present, *prima facie*, advantages over traditional meat, since previous studies (such as Tuomisto, Ellis and Haastrup) did not fully consider the different impacts of the various greenhouse gases.

From the forementioned study, the researchers conclude that laboratory meat could cause, in the long term, a greater buildup of carbon dioxide in the atmosphere than conventional meat, in case the process does not employ a solid method to

decarbonization.

It is concluded, therefore, that, in principle, the advantage of lab-grown meat in the emission of greenhouse gases can be identified as uncertain, depending on how the protein synthesis process will take place.

After the analysis developed in this topic, it can be said that cultured meat presents very positive results regarding the use of soil and water, with a drastic reduction compared to conventional meat production.

On the other hand, it does not present solid positive regarding energy use, as well as some degree of uncertainty regarding the emission of greenhouse gases. Therefore, possible implementation of artificial protein must be made with caution, using renewable energy and decarbonization, and must be constantly monitored

4. Economic Analysis

The economic analysis of cultured meat should comprehend two different scopes: (i) product price and (ii) unemployment on the traditional meat industry.

4.1 Product Price

The first lab-grown meat was produced in 2013 by Mark Post, co-founder of the Dutch start-up "Mosa Meat", with a total cost of 250,000 euros, which would be infeasible [12].

Despite the absurd price of the first cultured meat, technological advances enable a drastic drop in laboratory meat production costs. In 2019, European start-ups claimed that the cost of producing a piece of meat artificial price was around 100 dollars, or 93 euros, drop of almost 300,000% over the starting price [12].

In Singapore, the only country where some type of cultured meat has been approved by regulatory authorities, the 1880 private club serves a lab-grown chicken meal for 23 Singapore dollars, or 16 euros [13], which matches of 0,5 kg of chicken meat in Zurich, Switzerland [14], one of the most expensive cities in Europe.

Even though the price of cultured meat has been dropping, the viability of introducing it into the market with more affordable prices is still questionable.

At the end of 2020, in a study carried out by David Humbird [15], a researcher at the University of Berkeley, it was concluded that, in the current technological scenario, it would hardly be possible to lower the cost of laboratory meat to less than 25 dollars, or 23 euros, per kilo.

4.2 Unemployment

The impact of lab-frown meat on job creation cannot be ignored. According to data from the World Bank, agricultural activities employ 25% of the world population (although it has been using less and less, since it used 44% in 1991) [16].

Analysing the European scenario, the rate is drastically lower, with around 4.4% of the population employed in this area [16], which could indicate, in principle, a minor impact on the continent.

However, certain regions of the continent have higher rates than the medium, where the introduction of artificial protein would cause more impacts.

For example, in a study carried out by the Directorate-General for Internal Policies of the European Parliament in 2015, it was concluded that 11.6% of the jobs in the Azores Archipelago are generated by the agriculture sector, a much higher rate than the rest of the continent [17].

According to Christopher J. Bryant, a researcher at the University of Bath, the lab-grown meat industry will undoubtedly create new jobs [18]. However, it will hardly be possible to employ workers from the traditional industry meat, who will possibly lose their jobs, as the cultured meat industry requires skills that most workers in the agriculture and livestock do not possess.

4.3 Final thoughts on the topic

Cultured meat has still to overcome any economic obstacles, such as the price and the unemployment it might cause. Nonetheless, its production should be considered as a matter of public policy, offering an alternative for the possible unemployed workers.

5. Consumer acceptance

One of the great challenges that must be overcome by the cultured meat industry is the acceptance of consumers in the market. It should be noted, however, that research shows that there is, in general, a positive acceptance of lab-grown meat by the average consumer.

According to research carried out by Christopher Bryant and Julie Barnett, researchers from the University of Bath [19], at least 50% of the consumers in the United States, Italy and Germany would taste cultured meat.

However, the rates drop precipitously in underdeveloped countries. The same research shows that only 11.5% of Brazilian consumers would buy lab-grown meat, as well as only 15% in the Dominican Republic [19].

In the same way, rates drop when consumers are asked if they would consume cultured meat regularly, replacing traditional meat, even in developed countries (66.4% of consumers would try, 48.9% would eat regularly and 55.2% would replace traditional meat with lab-grown meat) [19].

Given these statistics, one must ask: what are the main barriers to the acceptance of cultured meat by the consumers? How is it possible to overcome them?

5.1 Lack of transparency regarding its production

According to the research carried out by Bryant and Barnett, one of the main factors for the rejection of cultured meat is the lack of clarity regarding its production. Many consumers do not trust meat-producing companies neither the regulatory authorities.

This lack of trust is expected, as the cultured meat represents a brand-new and disruptive technology, on a very traditional market sector. Therefore, the companies and the regulatory authorities should demystify the production processes of the lab-grown meat.

5.2 Ethical problems: foetal serum

As it was mentioned earlier in the article, one of the steps of the production of cultured meat is the appliance of a foetal serum to the meat cells, for its development.

However, the forementioned serum has animal components: it is extracted from the blood of foetus of female animals who are slaughtered in the meat industry. In other words, the cultured meat still relies on the traditional meat industry for its development.

This scenario would make impossible to call cultured meat a "clean meat", because it would still demand traditional animal slaughter. However, there are some initiatives who intend to remove this component from the production chain, replacing it by algae substances.

Moreover, recently, Mosa Meat was able to remove foetal serum from its production of cultured meat [20].

6. Conclusion

This paper intended to analyse the pros and cons of cultured meat, under economic, environmental, and social aspects. No one would dispute that cultured meat products have solid pros, but their cons should be analysed carefully.

Through the environmental scope, cultured meat could certainly promote a more sustainable food industry. However, the controversy regarding the greenhouse effect should be tackled with the necessary precautions.

Moreover, it is possible to state that the economic impacts of cultured meat should be assessed carefully, due to the potential unemployment that it might cause in the meat industry, as well as its high price.

Lastly, companies and regulatory authorities must make its production chain more transparent and trustworthy to the consumers.

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