



HAL
open science

The Challenges of Lab grown Meat

Sghaier Chriki, Marie-Pierre Ellies-Oury, Jean-François Hocquette

► **To cite this version:**

Sghaier Chriki, Marie-Pierre Ellies-Oury, Jean-François Hocquette. The Challenges of Lab grown Meat. International Meat Secretariat - Economics Workshop, International Meat Secretariat, Oct 2024, Paris, France. hal-04826658

HAL Id: hal-04826658

<https://isara.hal.science/hal-04826658v1>

Submitted on 9 Dec 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Public Domain

The Challenges of Lab-grown Meat



Sghaier Chriki

Marie-Pierre Ellies Oury

Jean-François Hocquette

Contact
Dr. Sghaier CHRIKI
schriki@isara.fr

The Challenges of Lab-grown Meat





The Challenges of **Lab-grown Meat**

What is Lab-grown meat?

❑ **Def.:** "Lab-grown meat refers to meat developed from animal cell culture, and not via traditional raising and slaughter of living animals". (Post et al. 2020)

❑ **Other terms:** Cultured meat, Cultivated meat, *In vitro* meat, Cell-based food...

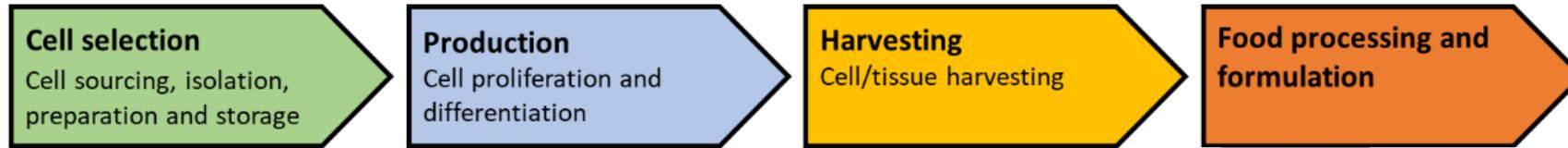
Lab-grown meat,
both used by:
- **Academia** and
- **Media**

Modifier term ^a	Sector			
	Authorities	Industry and developers	Academia	Media
animal-free			X	X
artificial			X	X
cell-based	X	X	X	X
cell-cultivated ^b			X	
cell-cultured	X	X	X	X
cellular			X	X
clean		X		X
cruelty-free				X
cultivated	X	X	X	X
cultured	X	X	X	X
fake			X	X
Frankenmeat				X
healthy		X		X
imitation				X
<i>in vitro</i>			X	X
lab-grown			X	X

FAO & WHO. 2023. *Food safety aspects of cell-based food*. Rome

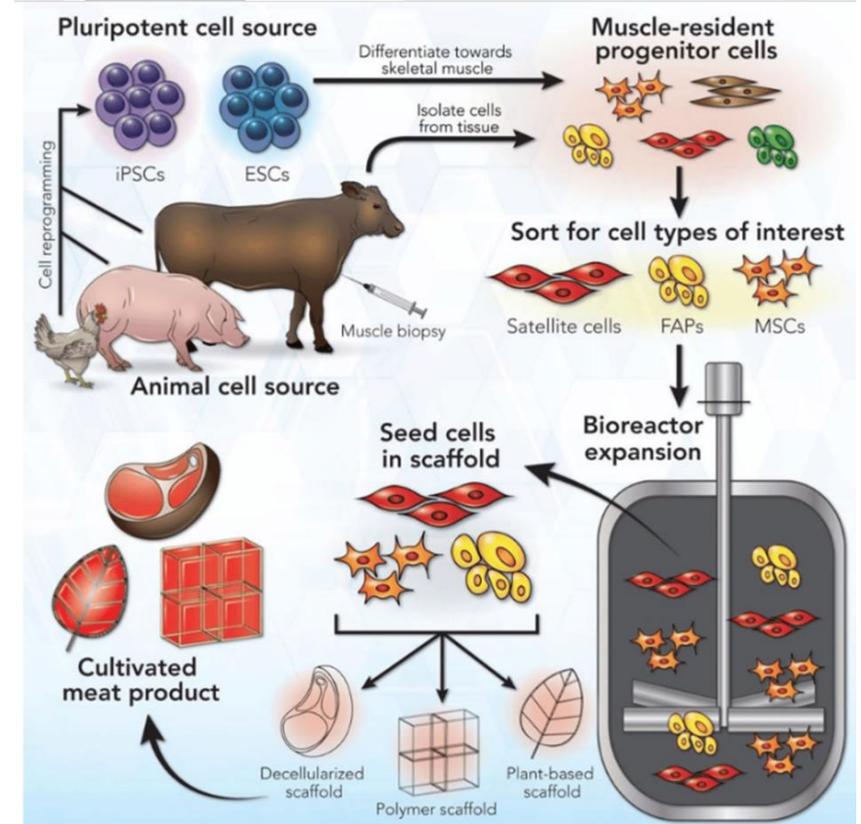
<https://doi.org/10.4060/cc4855en>

How is Lab-grown meat produced?



Lab-grown meat is produced through the following steps:

- (1) isolation of primary cells from animals or selection of cell lines
- (2) cell proliferation and differentiation for mass production of cells
- (3) cell and tissue harvesting, and
- (4) food processing and formulation



Kim, M., Jung, H., Ellies-Oury, M., Chriki, S., Hocquette, J. & Jo, C., (2024) "Technological Aspects of Bridging the Gap Between Cell-Based Food and Conventional Meat", *Meat and Muscle Biology* 8(1): 17645, 1-25. doi: <https://doi.org/10.22175/mmb.17645>

Todhunter et al. (2024) Artificial intelligence and machine learning applications for cultured meat. *Front. Artif. Intell.* 7:1424012. <https://doi.org/10.3389/frai.2024.1424012>



The Challenges of Lab-grown Meat

What is a challenge?

- ❑ **Def.:** Challenge: *“(the situation of being faced with) something that needs great mental or physical effort in order to be done successfully and therefore tests a person's ability”.*
- ❑ *We say: “Finding a solution to this problem is one of the greatest challenges faced by scientists today”*

What are the challenges that must be overcome before Lab-grown meat is available on a large scale?



Outline

1. Technological issues

2. Food safety

3. Social issues and consumer acceptance

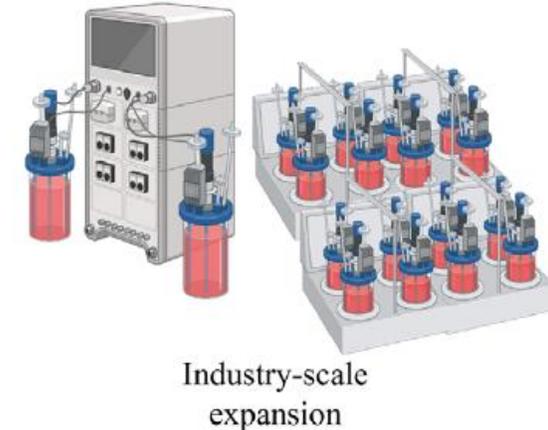
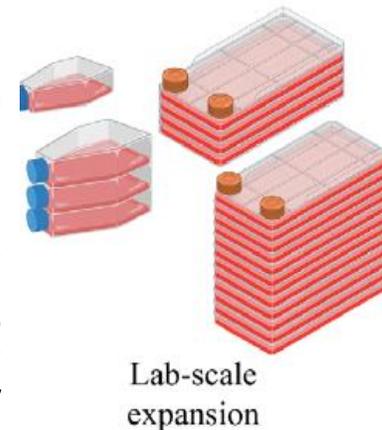
4. Regulatory aspects

5. Conclusions

Technological issues (1/2)

There are still many technical challenges to overcome in order to efficiently produce lab-grown meat on a large-scale:

- **obtaining seed cells and maintaining stable cell functions**
- the use of **large bioreactors** to produce cells at scale, likely introducing new challenges not encountered when producing cells using smaller bioreactors
- **using three-dimensional culture technologies** such as scaffold* culture or 3D printing to build the three-dimensional structure of cell-based food



Zheng et al. (2024)

<https://doi.org/10.1080/10408398.2024.2315447>

***Scaffolds:** aim to replicate *in vitro* the chemical, mechanical, and morphological characteristics of the extracellular matrix (ECM) found in living organisms (Kim et al. 2024 – Muscle and Meat Biology)

Technological issues (2/2)

There are still many technical challenges to overcome in order to efficiently produce lab-grown meat on a large-scale:

- reduce production costs by developing **animal-free medium** (without FBS, 99% of the cost), while maintaining good cell growth
- **high edible quality** similar or superior to that of conventional meat (taste, texture and nutritional value)



Adi et al. (2024). Designing cultivated meat: Overcoming challenges in the production process and developing sustainable packaging solutions. Trends in Food Science & Technology, 152 (2024) 104675.

<https://doi.org/10.1016/j.tifs.2024.104675>

Outline

1. Technological issues

2. Food safety

3. Social issues and consumer acceptance

4. Regulatory aspects

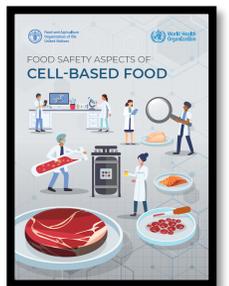
5. Conclusions

Food safety assurance first

Why should food safety come first?

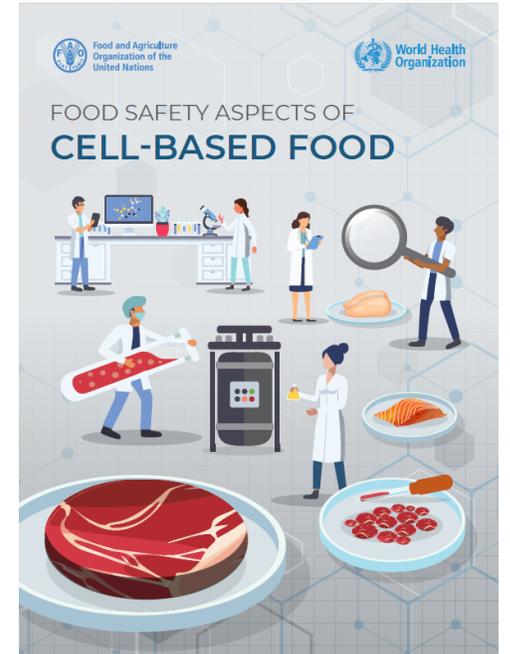
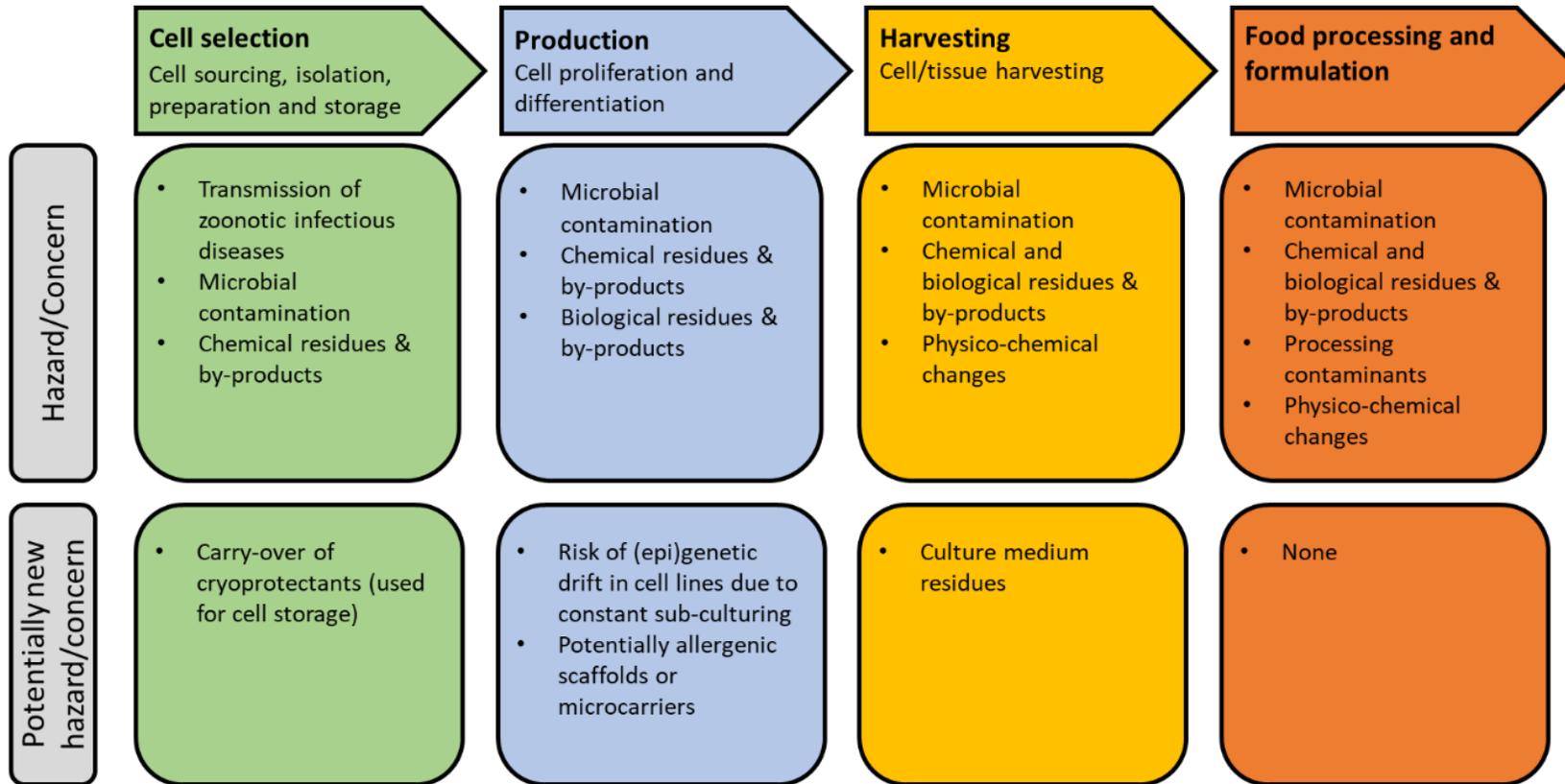
1. “If it isn’t safe, it isn’t food”
2. If **safety is not assured**, there is no point of discussing the potential benefits of the products
3. If **food safety is neglected** / underestimated, these products will not have a future

→ **FAO/WHO** have organized an expert consultation on the [food safety aspects of cell-based food](#) in **Singapore** in November 2022



Lab-grown meat safety research priorities (FAO-WHO)

Hazard identification based on 4 production phases



FAO & WHO. 2023. Food safety aspects of cell-based food. Rome. <https://doi.org/10.4060/cc4855en>

Conclusion of this report: most of the hazards identified are **like those found in conventionally produced foods**, including microbiological, physical, and chemical contaminants, additives, and residues.

Although some of the **materials, inputs, and equipment** used for cell-based food production **may be new**, the approaches to food safety assessment and risk mitigation necessary to produce safe cell-based foods are **very similar to those used for conventionally produced food**

Outline

1. Technological issues

2. Food safety

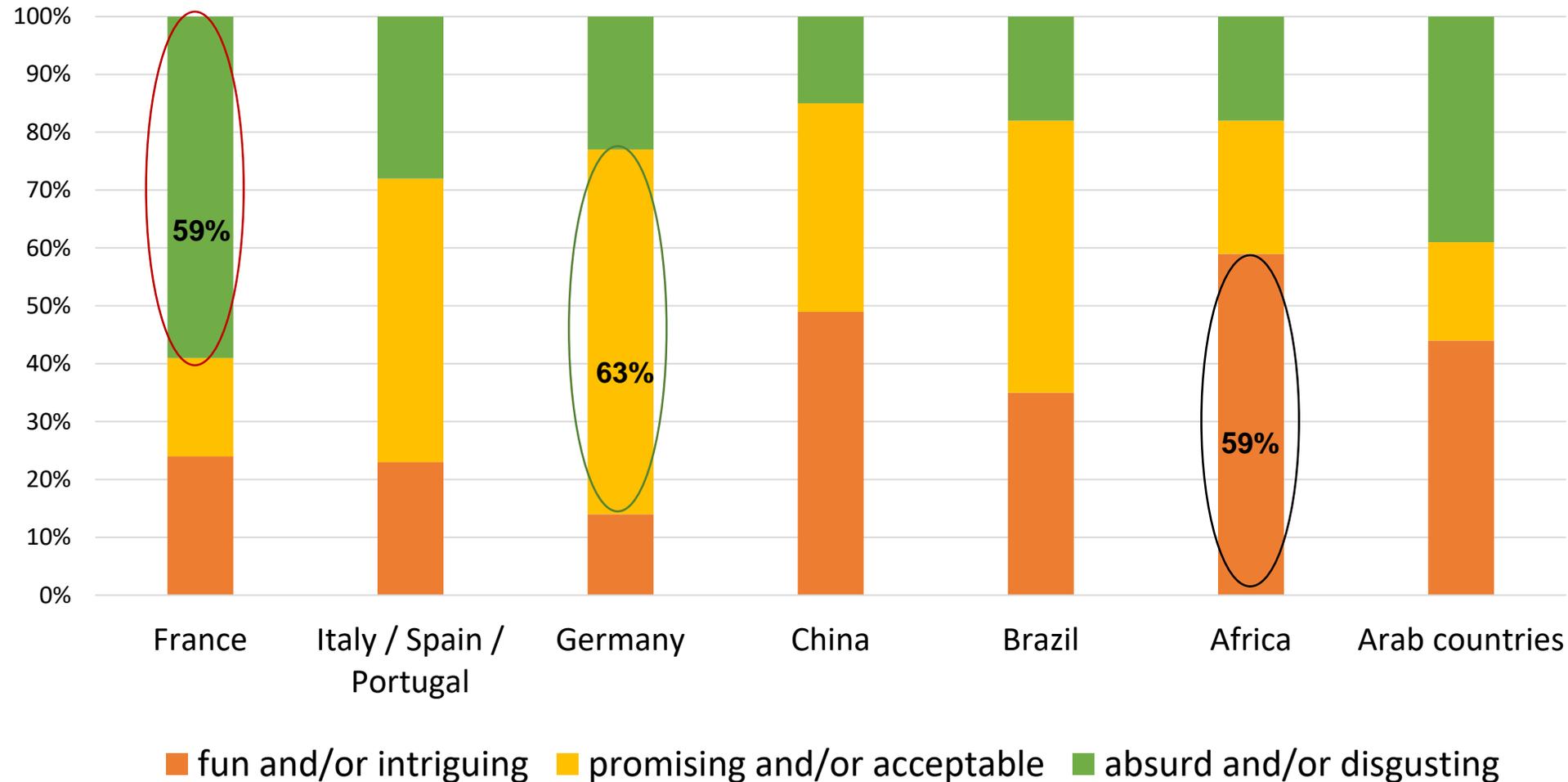
3. Social issues and consumer acceptance

4. Regulatory aspects

5. Conclusions

Consumer acceptance: variable from country to country

What do you think of lab-grown meat?



Same study
with the same Survey

Liu et al., Foods 2021
<https://doi.org/10.3390/foods10020353>

Chriki et al., Foods, 2021
<https://doi.org/10.3390/foods10112588>

Hocquette et al., Meat Science 2022
<https://doi.org/10.1016/j.meatsci.2022.108776>

Kombolo et al., Frontiers in Nutrition 2023
<https://doi.org/10.3389/fnut.2023.1127655>

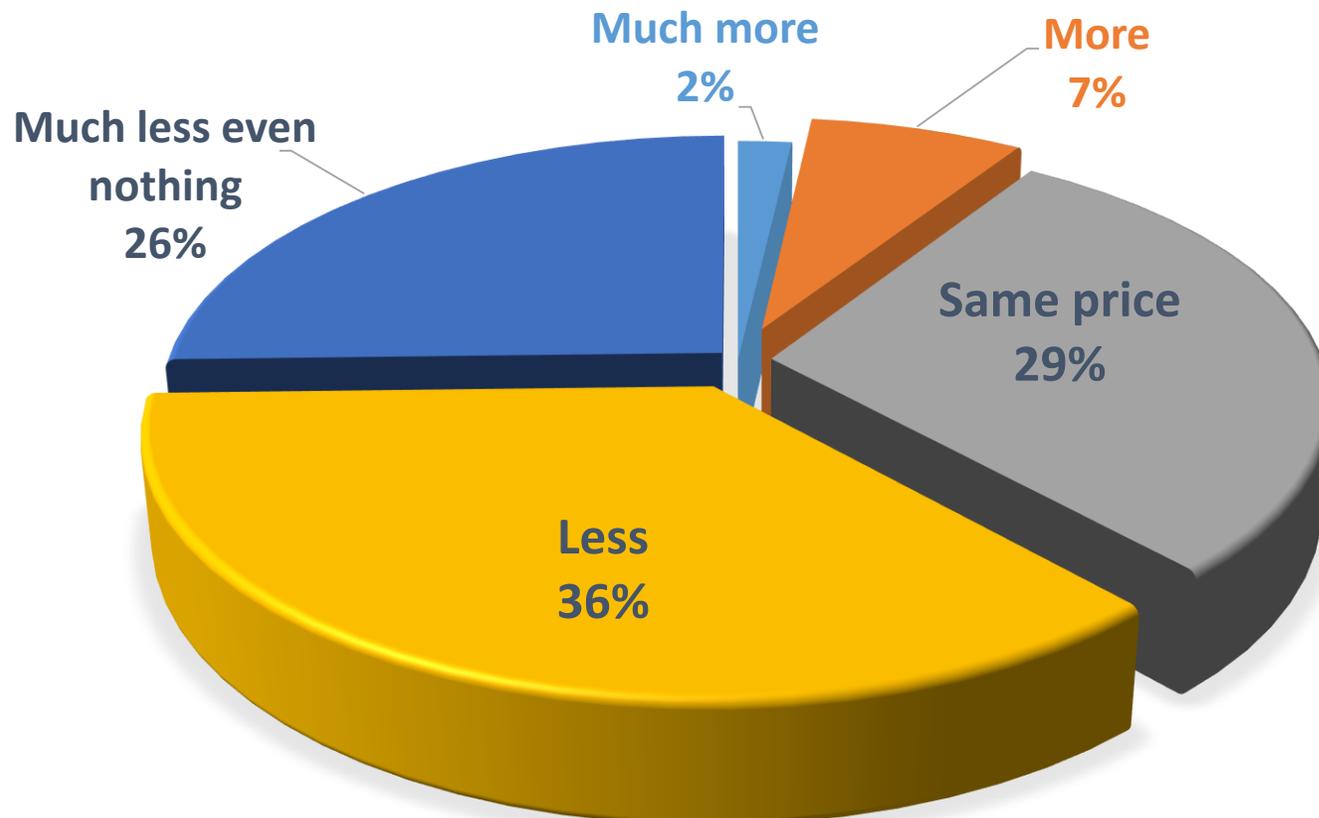
Liu et al., Frontiers in Nutrition 2023
<https://doi.org/10.3389/fnut.2023.1043618>

Jacobs et al., Frontiers in Nutrition 2024
<https://doi.org/10.3389/fnut.2024.1401715>

Chriki et al., JFS, under review

Majority of consumers don't want to pay more for lab-grown meat

How much would you be willing to pay for lab-grown meat compared to conventional meat?



Results from: France, Brazil, China...
> 15 000 answers

Liu et al., Foods 2021
<https://doi.org/10.3390/foods10020353>

Chriki et al., Foods, 2021
<https://doi.org/10.3390/foods10112588>

Hocquette et al., Meat Science 2022
<https://doi.org/10.1016/j.meatsci.2022.108776>

Kombolo et al., Frontiers in Nutrition 2023
<https://doi.org/10.3389/fnut.2023.1127655>

Potential profiles of lab-grown meat adopters

However, from the scientific literature we can define a potential profile of a lab-grown meat adopter:



- Young
- Women
- High-educated
- Familiar with the subject
- Meat-eaters
- Ready to reduce their consumption of conventional meat
- Low income (expectation of cheaper meat)

Wilks et Phillips, 2017; Mancini et Antonioli, 2019; Heidemann et al., 2020; Chriki et al., 2021; Gousset et al., 2022; Liu et al., 2023

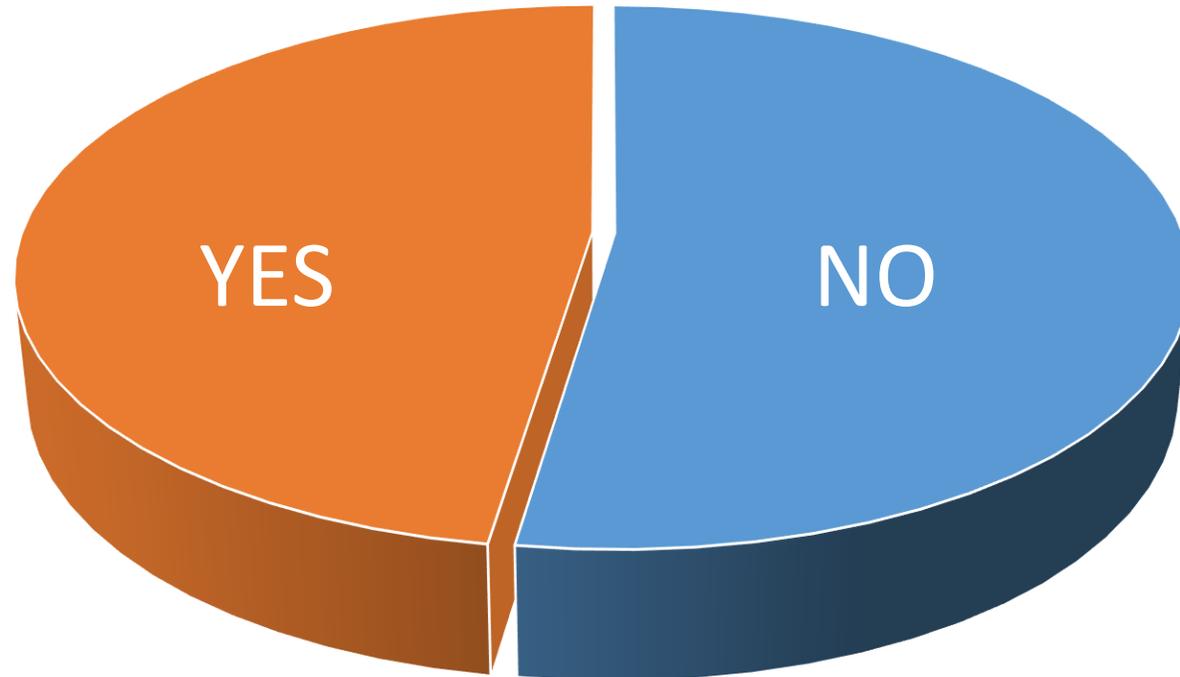
Outline

1. Technological issues
2. Food safety
3. Social issues and consumer acceptance
4. Regulatory aspects
5. Conclusions

Status of regulation worldwide

- ❑ **Progress in the lab-grown** meat industry requires overcoming another big challenge: regulatory approval
 - ❑ **2020**: Singapore was the first (2020) regulatory authority in the world to authorize the marketing of lab-grown meat
 - ❑ **2023**: the USDA granted approval for Upside Foods and Good Meat to sell their lab-grown chicken products in the United States
 - ❑ **2024**: Israel also granted approval for Aleph Farms
 - ❑ The Netherlands is the first country within the European Union (EU) to pass legislation allowing pre-approval tasting of lab-grown meat, even before receiving EU novel food approval
- It is expected that regulatory approvals will come on a country-by-country basis**

According to consumers, should this new product be called 'meat' when it is marketed?

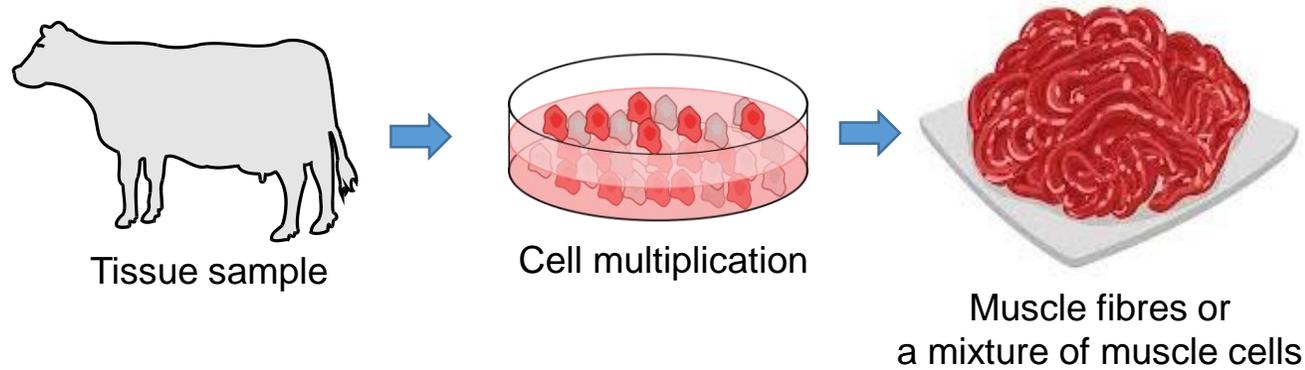


Average of more than 10,000 answers from Brazil (*Chriki et al., 2021. Foods, 10,11, 2588* <https://doi.org/10.3390/foods10112588>), European and American countries (unpublished results)

➔ The **product should be properly labelled**, so as not to mislead consumers

It is not meat on a biological point of view

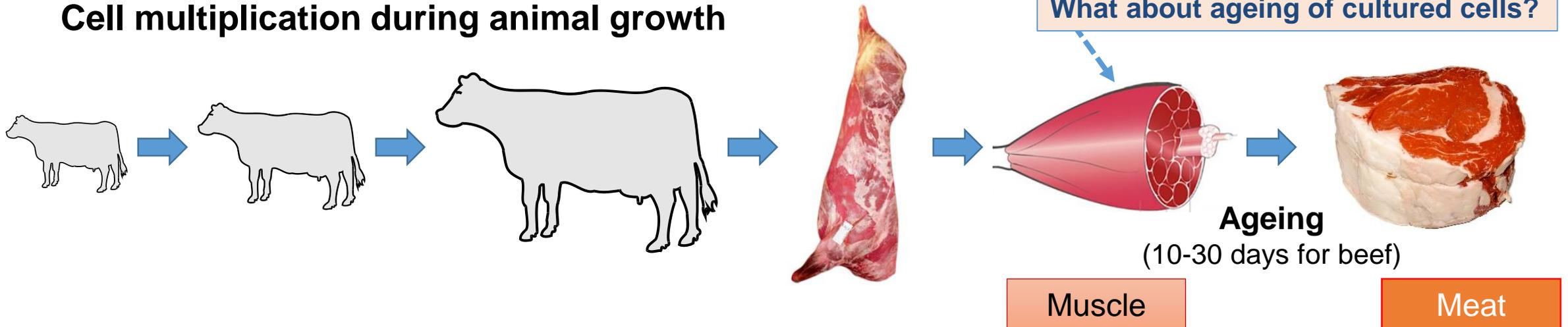
Cell-based food production



Addition of missing nutrients.
No study on digestibility

What about ageing of cultured cells?

Cell multiplication during animal growth



Outline

1. Technological issues
2. Food safety
3. Social issues and consumer acceptance
4. Regulatory aspects
5. Conclusions

Conclusions

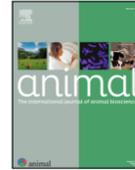
- ❑ There are numerous **technological** and **social challenges** to that must be overcome before Lab-grown meat is available on a large scale
- ❑ **Technical issues**: ex. animal-free medium, high edible quality...
- ❑ **Food safety**: need to assess the **health long-term effects** of consuming Lab-grown meat on health
- ❑ **Consumer acceptance**: low willingness to pay, moderate acceptance with a high country effect
- ❑ The **Regulatory** scenario is evolving slowly...



Contents lists available at [ScienceDirect](#)

Animal

The international journal of animal biosciences



Review: Will “cultured meat” transform our food system towards more sustainability?

Jean-François Hocquette^{a,*}, Sghaier Chriki^{a,b}, Dominique Fournier^c, Marie-Pierre Ellies-Oury^{a,d}

Feature Article

Is “cultured meat” a viable alternative to slaughtering animals and a good compromise between animal welfare and human expectations?

Sghaier Chriki,[†] Marie-Pierre Ellies-Oury,^{‡,||} and Jean-François Hocquette^{||}

[†]ISARA, Agroecology and Environment

[‡]Bordeaux Sciences Agro, Gradignan, Fr

^{||}INRAE, University of Clermont Auvergne

Analysis of Scientific and Press Articles Related to Cultured Meat for a Better Understanding of Its Perception

Sghaier Chriki^{1*}, Marie-Pierre Ellies-Oury^{2,3}, Dominique Fournier⁴, Jingjing Liu³ and Jean-François Hocquette^{3*}

¹ISARA, Agroecology and Environment Unit, Lyon, France, ²Bordeaux Sciences Agro, Gradignan, France, ³INRAE, Clermont-Ferrand, VetAgro Sup, Saint Genès Champanelle, France, ⁴INRAE, SDAR, Montpellier, France

Meat and Muscle Biology™



MEAT AND MUSCLE BIOLOGY

The Official Journal of the American Meat Science Association

Technological Aspects of Bridging the Gap Between Cell-Based Food and Conventional Meat

Minsu Kim^{1,2}, Hyun Young Jung¹, Marie-Pierre Ellies-Oury^{3,4}, Sghaier Chriki³, Jean-François Hocquette^{3*}, and Cheorun Jo^{1,2,6*}



Article

Brazilian Consumers’ Attitudes towards So-Called “Cell-Based Meat”

Sghaier Chriki^{1,*}, Vincent Payet¹, Sérgio Bertelli Pflanzler², Marie-Pierre Ellies-Oury^{3,4}, Jingjing Liu⁴, Élise Hocquette¹, Jonatã Henrique Rezende-de-Souza² and Jean-François Hocquette⁴

REVIEW
February 2020
2020.00007



Article

Chinese Consumers’ Attitudes and Potential Acceptance toward Artificial Meat

Jingjing Liu^{1,*}, Élise Hocquette², Marie-Pierre Ellies-Oury^{1,3}, Sghaier Chriki⁴ and Jean-François Hocquette^{1,*}



The Myth of Cultured Meat: A Review

Sghaier Chriki^{1*} and Jean-François Hocquette^{2*}

¹ISARA, Agroecology and Environment Unit, Lyon, France, ²INRAE, University of Clermont Auvergne, Vetagro Sup, UMR

At this stage: Lab-grown meat cannot contribute to a sustainable diet

Sustainable diets are defined as “nutritionally adequate, safe and healthy, culturally acceptable, financially affordable and with low environmental impacts” (FAO, WHO, 2019).

