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The cultural construction of cellular agriculture food: through the lens of the whole-parts framework for meat

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This essay presents a critical perspective on the nature of what is referred to as "cultured meat" in the public sphere by revisiting the concept of meat in cultural practice. We propose a perspective that focuses on and further investigates whether cultured meat is meat, examining the interaction between the emergence of cellular agriculture technologies and cultural practices. First, we review the production processes of cellular agriculture for meat, comparing this to the processes used to produce conventional meat. Second, we discuss how meat has been embedded in cultural practices, focusing on meat-related activities, and propose that a whole-parts relationship is critical for constructing the meaning of meat in cultural contexts. Third, several key issues raised in the social debate on cultured meat are addressed within the whole-parts framework. Cultured meat requires a complete bottom-up process in producing objects, indicating that the concept of cultured meat is not necessarily aligned with the concept of existing meat, as previously suggested from the perspective of producing conventional meat. In this perspective, we proceed to further investigation the meaning of meat in cultural constructions, wherein the relationship between the whole body and meat as a part of it is important. Thus, cultured meat can be considered a nonmeat under the whole-parts framework for meat. This insight can provisionally and speculatively update some of the ethical, legal, and social issues of cultured meat as well as products based on cellular agriculture technologies.

KEYWORDS

cultured meat, cell agriculture, cultural practice, whole-parts framework, meat, social movement, governance

1 Introduction

Attention has been increasingly paid to cultured meat and cellular agriculture technologies in the context of global food security. This innovative approach involves producing food by amplifying a small number of cells extracted from animals in a laboratory setting, rather than relying on conventional livestock farming. Extensive resources are invested in research and development in university laboratories and corporate research institutions wherein various

types of cultured meat and their production methods have been devised (Ye et al., 2022; Good Food Institute, 2023). High expectations for cultured meat are contextualized in the growing global concern for climate change and animal welfare, and in the expansion of alternative protein markets. In this context, interest in the social impact of this technology in various fields—including political economy, institutional design, ethics, religious issues, and regional food and agricultural cultures—has been increasing (Van der Weele and Driessen, 2013; Stephens et al., 2018; Treich, 2021; Chriki et al., 2022; Newman et al., 2023). Many surveys on consumer attitudes towards cultured meat have attempted to clarify the determinants of consumer acceptance (Wilks and Phillips, 2017; Bryant and Barnett, 2020; Siegrist and Hartmann, 2020; Gousset et al., 2022; Hocquette et al., 2022; Pakseresht et al., 2022; Baune et al., 2023; Kouarfaté and Durif, 2023; Liu et al., 2023a). Although studies on the social impact of cultured meat have excessively focused on consumer acceptance (Stephens et al., 2018), the interaction between the emergence of cultured meat technology and cultural practices seems less controversial. In the context of consumer research, a few studies have investigated the perceived equivalence of cultured meat and conventional meat, but a growing body of research is now discussing whether cultured meat is meat (Chriki et al., 2022; Hocquette et al., 2022). It should be noted that there is no fixed terminology for "cultured meat" in 2023, and the FAO uses "cell-based food" as a working terminology (FAO and WHO, 2023). Experts in this area suggested studies before considering the international harmonization of the terminology were needed (FAO and WHO, 2023; *cf.* Hallman et al., 2023). This essay tentatively adapts the terminology "cultured meat," owing to its relatively wide use in the scientific literature (Chriki et al., 2020; FAO and WHO, 2023), but the terminology could change in the future.

This essay proposes a critical perspective on how cultured meat is viewed in the public sphere by examining the concept of meat in cultural practices. Previous arguments regarding the industrialization of cultured meat have premised that it is an alternative to conventional meat. Some of those engaged in the research and development of cultured meat seem to be aiming to make it an alternative to conventional meat, which is common in social controversies surrounding the promotion of cultured meat. Regardless of the positive or negative arguments pertaining to the issue, cultured meat will indubitably be incorporated into food culture at a status equivalent to that of conventional meat in the context of consumer research, with some exceptions (Stephens, 2010, 2013; Stephens et al., 2018; Gousset et al., 2022). What has been considered as "meat" by society? How has meat been embedded in cultural practices? Rethinking our assumptions about cultured meat as an alternative to conventional meat provides us the opportunity to consider what cultured meat really is and what we are trying to create. First, we briefly review the production processes of cultured meat currently reported from the field of research and development of this technology, and we compare this to the processes used to produce conventional meat, to confirm the basic technical background of cultured meat. Second, we discuss how meat has been embedded in cultural practices wherein a whole–parts relationship is critical for constructing the meaning of meat. Finally, several key issues raised in the social debate on cultured meat are addressed in the whole–parts framework. The perspective presented here may have implications for discussions on the social implementation of cellular agricultural food.

2 Production process of cultured meat

Cultured meat is a product of cellular agricultural technologies that use cell-based biotechnology to replicate various traditional animal-derived products other than meat, such as seafood, leather, and milk (Post et al., 2020). Noteworthily, a bottom-up process is required to produce objects during the scientific practice of developing cultured meats. The process for the production of cultured meat can be described as follows: a small piece of muscle is obtained from an animal, such as a cow, pig, or chicken, or theoretically any species, and isolated muscle cells are grown in larger quantities *in vitro*. Subsequently, proliferating cells are differentiated into muscle fibers in appropriate culture media and eventually grown into muscle tissue for certain applications (Stephens et al., 2018; Post et al., 2020; Takeuchi and Hibino, 2023).

Several instances of the operationalization of "meat" have occurred in scientific practices that attempt to produce the meat tissue artificially, which fuels the discussion on what the definition and measurement of objects produced through experiments should be. This clearly contrasts with the sense-making process of cultured meat in an industrial manner, whereby cultured meat is considered meat if the products are similar to the ordinary product of meat during the phase in which people consume them. Contrarily, scientists have often discussed the type of results obtained from experiments reproducing meat (tissue) that meets the requirements to be regarded as "real" meat (*cf.* Fraeye et al., 2020; Olenic and Thorrez, 2023). Different levels of cells or tissues exist, and several indicators can be used to assess whether an object is configured as the element of meat. For example, the quantity of muscle-specific proteins expressed could be used to indicate the proximity of a muscle, or the confirmation of a sarcoma structure could validate the muscle proximity. Several indicators exist, and the ontological boundary of "meat" is not fixed with respect to scientific practices for producing cultured meat (Stephens, 2010, 2013; Stephens et al., 2018).

We should note that the production processes used to produce cultured meat differ from the normal processes used to produce conventional meat. The process involved in converting muscle into meat is a complex process in which all the mechanisms responsible for developing meat qualities are very likely interdependent. For example, oxidation and proteolysis are two processes that are probably involved in the development of meat tenderness (Ouali et al., 2006). Additionally, it should be noted that meat results from the postmortem transformation of muscle tissue. This aging process activates various enzymes and softens the meat, increasing its flavor (Fraeye et al., 2020; Chriki et al., 2022). Meat is also associated with historical and cultural values that can depend on the species or breed of animal used by livestock farmers to produce meat. Beef varies in composition depending on the cattle breed and an understanding of fat distribution is required, whereas similar studies of the differences in cultured beef are still in progress. In summary, livestock farmers, butchers, and all the actors in the supply chain from the farm to the fork have defined the production processes used for existing meat. The American Meat Science Association (AMSA) defines meat as skeletal muscle and its associated tissues derived from mammalian, avian, reptilian, amphibian, and aquatic species commonly harvested for human consumption; consequently, this definition does not consider cultured meat to be "real" meat (Boler and Woerner, 2017; Ong et al., 2020; Chriki et al., 2022). European Union defined the foods that have not

been consumed by the EU population to a significant degree as novel foods, and defining cultured meat as a novel food has sparked debate in the European Commission (Chriki et al., 2022; Mancini and Antonioli, 2022). It is also debated that it is necessary to correctly label the product "cultured meat" so as not to mislead consumers (Chriki et al., 2022).

The social status of emerging cultured meat could be constrained by these previous definitions of conventional meat, by livestock farmers' historical perceptions, and the framework of cultural practices (to be described in the next section). However, another noteworthy point is that the historical and cultural meaning of meat has been defined by biological constraints. Further, the future development of a new meaning for reconstructed meat has the potential to transform the traditional meaning of meat, which has been defined from cultural and historical perspectives.

3 Meat is embedded in a whole–parts relationship in cultural practices

Meat, the flesh of animals, including fish and birds, is used as food in general; it has been deeply embedded in our history and culture. From a sociocultural perspective, meat-related activities in societies that have meat-eating habits have necessarily been accompanied by the whole–parts framework. Although it may be taken for granted in an English-speaking society, wherein meat is defined as a product derived from the animal, meat is part of an individual animal as a whole. The fact that we eat part of the whole implies that there was an entire body of an individual creature from which meat was derived, and the whole had to biologically die before the act of meat consumption. The framework addresses, in a physical sense, that the flesh is derived from and serves as an object of consuming all physical entities of animals. Moreover, in a symbolic sense, the premise of the whole (individual animal) is the source of attractiveness of the part (divided and segmented meat), as well as the source of power which people acquire by eating meat (Fiddes, 1991; Fessler and Navarrete, 2003). Similarly, rhinoceros' horns are considered a valuable ingredient in Chinese herbal medicine in Asia, and the utility of the horn as a food/medicine is established by presuming the entity of the whole rhinoceros rather than by only considering the nutritional elements of the horn.

This whole–parts framework implicitly assumes that meat is inextricably embedded within the norms, habits, and consolidation of the local community. During hunting in an African regional community, which was surveyed by the fourth author, the oldest person of the local community was the first to carve a piece of meat from the killed animal's body. Segmented meat is subsequently distributed in multiple steps to every member of the community (*cf.* Pilcher, 2005). The practice of cutting and sharing flesh as parts with members of the community may be aimed at increasing the sense of unity in the entire community. Although hunter–gatherer activities have not been implemented in many countries, the habit of carving meat at celebrations is still prevalent in East Asian countries, such as Japan and China. Meat-eating in China is associated with ceremonies wherein people serve roasted whole chickens or pigs. In modern Japanese cooking, customs such as sharing food are meaningful and involve the process of dividing the whole into parts. Based on the common understanding that the whole reappears by combining the divided parts, the act of eating, which is synonymous with receiving cuts of the meat, functions to unite a community.

The whole–parts meat framework can play a key role in providing an ethical basis for controlling excessive meat consumption. Death of the entire individual is necessary to obtain meat parts. The desire to eat meat to acquire the symbolic power of a living being arises owing to the intervention of sacrifice and the death of the whole (Fiddes, 1991), simultaneously, presuming the whole and its death restricts the excessive desire for meat consumption. In classical Japanese literature, some stories related to meat-eating depict the hesitation to kill animals, whereas other stories depict the punishment for excessive meat-eating (Watanabe, 2022).

In summary, in terms of sociocultural aspects, meat is invariably a segmented piece that accompanies its original whole. Considering this perspective, it is possible to recognize that cultured meat, which is formed from individual cells, is *not* meat, as it is *not* part of the original whole. This indicates that the concept of cultured meat is largely different from the concept of the existing meat in our society.

4 Implications

We investigate the meaning of meat in cultural constructions, wherein the relationship between the whole body and meat as a part of it is important, and cultured meat can be considered a nonmeat under this framework. Taking this perspective updates some of the ethical, legal, and social issues related to meat consumption and the relationship of these issues to cultured meat and cell agriculture technologies. More precisely, our perspective on the whole–parts framework of meat will rebuke some aspects of the social controversy regarding cultured meat. For example, an ethical challenge to cultured meat has been raised by discussions that cultured meat will open the door to consuming human flesh generated from human cells (Hopkins and Dacey, 2008; Schæfer and Savulescu, 2014; Treich, 2021). However, under such whole–parts framework, any food made from human cells using cell agriculture technology is not meat because it is not part of the whole. The issue of intellectual property of cells in the context of cell agriculture technology has a similar structure. Currently, competition is expected to accelerate the trading of the cells of certain good breeds of beef cattle; therefore, international and national legislation is required. However, as this essay has repeatedly emphasized, something constructed from a cell cannot be equal to an original individual from a sociocultural perspective.

The whole–part framework of meat remains open to three further theoretical examinations. First, this framework raises the question of scaling the "whole" and "parts" relations. In other words, further discussion is needed regarding the smallest unit in which the value of the whole animal is retained. Another point worth noting is how top-down from the "individual as a whole" can be shaped. Regarding cell differentiation and proliferation, the framework of "bottom-up" can be applied to the processes shaping both animal individuals derived from a fertilized egg cell and cultured meat created from single cell in the same manner. However, once the animal reaches maturity, the top-down framework can be used in to form the conventional meat in the whole-parts framework. In this regard, at least the phase of formation of an individual can play a key role in deciding the boundary between "top-down" and "bottom-up" frameworks.

Third, further consideration is whether the connection between the whole and parts of the food source, even in the current food industry system, has been increasingly lost (Buscemi, 2014), as this can cause uncertainty in the definition of food in cultural and social contexts. Fundamentally, we are gradually familiarized with the situation where we no longer know what we eat in modern society. Loss of connection between whole and parts may contradict some arguments in promoting cultured meat, such as the environmental impact and animal welfare. Such an issue of link loss is invisible but an essential challenge to address the future social implementation of cultured meat.

The whole–part framework of meat suggests new research perspectives in the studies on public perception of cultured meat. Previous social surveys have often focused on the acceptability of cultured meat as an alternative to traditional meat. However, some results indicate that consumers do not necessarily consider cultured meat as meat (Gousset et al., 2022). One critical investigation is, therefore, to examine to what extent people in modern society share the whole–parts concept regarding meat. By disconnecting the meat from the harvested animals, people eat meat without considering the moral or ethical consequences. This may explain why the receptiveness to cultured meat is more positive among people in urban areas than in rural areas, as indicated by the Irish survey (Shaw and Iomaire, 2019). A survey of Japanese public shows that some consumers view meat as merely a commercial commodity for consumption, while others perceive meat as connected to animals in dynamic ecosystems (Hibino et al., 2023). These findings imply that the whole–parts framework still retains a hold in modern society, at least among some consumers. However, the relationships between support for the whole–parts concept, judgments about whether cultured meat is meat, and acceptance of cultured meat are not simple. Further examination of this relationship is needed, based on empirical research and semantic analysis.

The new framing and the metaphor of cultured meat as something other than meat will affect the governance of cultured meat technology. Consumers' acceptance of cultured meat is important for the future industrialization of cultured meat and the provision of alternative protein in the broader sense; consequently, efforts to control the narrative and influence public perception have begun to emerge, particularly regarding the nomenclature of products derived from cell agriculture (Boler and Woerner, 2017; Simon, 2018; Ong et al., 2020; Chriki et al., 2022). The argument that cultured meat should not be called meat has already been put forward by the U.S. Cattlemen's Association (USCA) (2018), and the plural names for cultured meat and their competition can be interpreted in the context of a political struggle (Simon, 2018; Mancini and Antonioli, 2022). This argument of what defines "meat" will become further problematized with future regulations and the institutionalization of cell agriculture.

The whole–parts framework for meat cannot neutralize all the ethical, legal, and social issues related to cultured meat that are currently under discussion. An assessment of the environmental impact of cultured meat may remain important regardless of the definitions of meat and cultured meat (Rodríguez Escobar et al., 2021). Moreover, it can contribute to addressing ethical, legal, and social issues that were previously peripheral and neglected (Liu et al., 2023b). For example, this framework can influence gender issues pertaining to meat. If the symbolic value of meat is attached to hunting and controlling the whole individual animal and to the masculine value based on it, the meat would have a male-dominant value (*cf.* Adams, 2015). However, given the process of producing cultured meat, an analogy for it may be far removed from hunting, when the nurturing process of tissue formation from individual cells is highlighted. In this case, the appearance of what is developed from pieces provides an alternative image that neutralizes masculine values. The emergence of cultured meat has the potential to transform the social system into a relatively neutral one from the perspective of gender.

5 Conclusion

We propose a perspective that focuses on and further investigates whether cultured meat is meat from a perspective that is critical to discussions on the societal impact of cultured meat. The whole–parts framework can be used to interpret the cultural construction of meat and cultured meat, which aims to add the perspectives and enrich the discourse for discussing of cultured meat in the public arena, rather than to submit single verdict regarding whether cultured meat is meat.

The scope of this framework is not limited to the cognition of such meat but can be broadened to the understanding of relevant products created by cell agricultural technologies and various types of food applications. It is not restricted to the narrative of meat; every piece we take is part of a whole individual life, and the part is taken from the whole by killing the whole in the context of the animal. Currently, cell agriculture technologies are attempting to produce foods such as salmon, chicken, liquid eggs, eel, and foie gras. Like the debate over cultured meat, whether these artificial products can be described as "salmon" or "egg" because they lack the whole is debatable. The whole-parts framework also evokes the important issue of how the connection between the whole and parts of a food source has been lost in the current food system and how we can restore or reconstruct it — a topic that has become visible with the advent of cell agriculture technology.

Careful attention is necessary when developing studies on the cultural practices of eating meat and any international comparisons thereof. As mentioned above, the meanings of meat for farmers, butchers, and consumers are critical to the definition of meat, yet we can still find cultural diversity there. A major future challenge will be examining the processing of existing meat, as defined by farmers, butchers, and supply chain actors in the local context, while examining the interaction with the emerging cell agriculture industrial ecosystem. The definition of meat and cultured meat from religious perspectives, such as kosher and halal, will also be further considered in cultural practices (Chriki and Hocquette, 2020). How restrictions on producing conventional meat are imposed, based, for example, on religious traditions, and how these restrictions will affect emerging cell agricultural technology remain important considerations. For both aspects, our study sheds light on revisiting the correspondence between the definition of food, whole life, and food as a part. Noteworthily, the authors of this essay have a Japanese cultural background; therefore, the arguments herein are rooted in a combination of perspectives unique to Japanese culture, which may be both similar and different from other cultures. A prospect for the future is to conduct an empirical survey on cultural practices in various contexts as well as a detailed examination of the specific food area, as described above.

It is expected that the whole–parts framework proposed in this study will inspire further questions and amplify viewpoints from various angles of investigation, which would form the foundation of an institutional design.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

AH: Conceptualization, Project administration, Writing – original draft, Writing – review & editing. JM: Conceptualization, Supervision, Writing – review & editing. KT: Conceptualization, Writing – review & editing. YS: Conceptualization, Writing – review & editing. SK: Conceptualization, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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