

## The Rise of Clean Meat: Revolutionizing the Food Industry

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By the development of technology and increasing awareness about healthier alternatives in food among consumers, their demand and interest is always changing in sustainable and natural food. The recent trend in this is, consumers opting for less processed food and more fresh food, one among them are clean meat (Foods Free Full-Text Preserving Ready-to-Eat Meals Using Microwave Technology, n.d.). Clean meat is a type of meat that uses cell culture to grow meat, unlike other meat which is from an animal's body. The meat is named clean since it does not undergo slaughtering to produce meat, rather than stem cells are removed from an animal by a biopsy, and then cultivated *in vitro* to form muscle fibers. It is also called as lab grown, *invitro*, or cultured meat. Benefits including animal welfare, sustainability, environmental friendliness, novelty, and food safety.

The idea of growing parts like breast or wing separately under a suitable medium instead of growing a whole chicken was a thought given by Winston Churchill in 1932. By using the growing technology, clean meat can be produced which has benefits for environment, animal welfare, and food safety by satisfying the demand for plants grown protein. According to United Nations Food and Agriculture Organization (FAO) of 2011 report about 72 % of meat consumption will increase worldwide by 2050. Due to the increase in population and meat consumption as well as lack of land availability for growing meat, there is need of substitution of plant-based meat or lab grown meat. There is a failed attempt of vegetarian meat like veggie burgers, and meatballs in satisfying the complex flavour and textural profile of animal meat. Hence, clean meat is an alternative to animal meat without compromising in protein. Although clean meat has many benefits, it also has few negatives including unnaturalness, taste, feeling disgust cost, and safety.



Fig. 1 clean meat (Cassiday, L. (2018). Clean meat. *inform*, 29(2), 6-14)

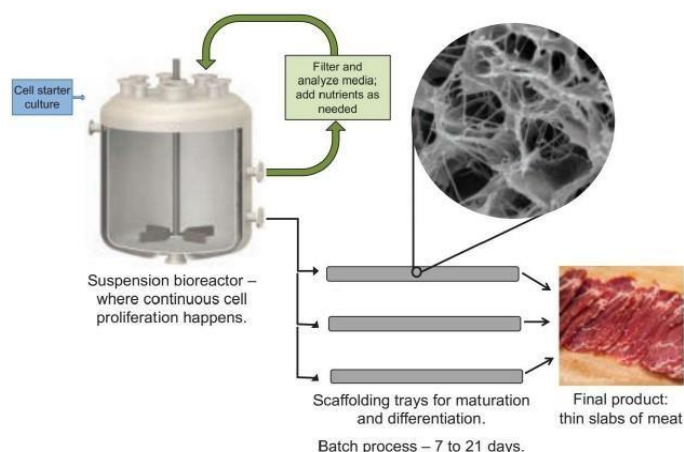
### Techniques for producing clean meat

Some successfully used techniques to produce clean meat is scaffold method and self-organizing method which are discussed below:

#### 1. Scaffold method

This is one of the successful methods in culturing meat *in vitro* condition which has the ability to mimic the natural growing environment; additionally, it also helps differentiation and proliferation of the cultured tissue. Scaffold is a medium which gives the mechanical support to the tissue for their growth and multiplication. Majorly used scaffold for clean meat is collagen other than that hyaluronic acid and fibrin are also used. Collagen is used because they used to mimic the biological properties of meat. Since collagen is the most common protein in the body, it is frequently employed in tissue engineering. The extracellular matrix of muscles is rich in fibrous collagens I and III. They stimulate cell migration and tissue development, act as anchors for cell adhesion and play structural roles in the tissues. For the purpose of providing the right arrangement of

lipids, connective tissues, and muscles, the scaffold material should be biodegradable. In order to produce a clean meat, firstly a cell of the desired animal is taken and isolated. The isolated cells are grown in an appropriate *in vitro* condition. After generation of myotubes, the cell is transferred to the scaffold. Large-scale production of cultured meat is done in the bioreactor. In the final stages, scaffold is removed and 3D-like structure is formed which mimics clean meat (Sruteet *et al.*, 2022).



**Fig. 2: Clean meat production technique (Cassiday, L. (2018). Clean meat. *inform*, 29(2), 6-14)**

### Types of scaffolds

As previously discussed, scaffolds are the supporting material which are used in the tissue engineering process. There are many types of scaffolds which are used currently, i.e., microcarriers, porous, hydrogels, or fibre scaffolds. Each of them has different functions.

**Microcarriers:** Microcarriers are easy to produce and these microcarriers are composed of gelatin, cellulose which is coated with collagen. This type of scaffold will give good adherence to the cell. Myoblasts have been grown in microcarriers.

**Porous scaffolds:** This type of scaffolds contains tiny pore-like structure which gives mechanical stability to the cells. The size varies from 10 to 100 microns depending on the scaffold.

**Hydrogel scaffolds:** Hydrogel scaffolds are three-dimensional network of hydrophilic chain which has high water-holding capacity. This type of scaffolds mimics the extracellular matrix (ECM) and provides suitable environment for the cell to proliferate, differentiate, and adherence. Hydrogels are non-toxic.

They have porous structure which allows the diffusion of nutrients, minerals, and oxygen for the growing cell *in vitro*.

**Fibre scaffolds:** The main function of this scaffold is that they provide cell adhesion and diffusion of nitrogen and oxygen. They are produced by electrospinning.

## 2 Self-organizing method

Another method of producing the cultured meat *in vitro* is to take the stem cells of animals and arrange them in a structured framework. Co-culturing of cells is another important process which is done during the *in vitro* production of cells often. The method of co-culturing in an appropriate medium preserves the existing tissue. This method is one of the emerging techniques to produce meat *in vitro* without availing the scaffolds. However, a major disadvantage of this approach is that when it is growing without the supply of nutrients, the cells may undergo necrosis ultimately the growth of the culture will retard (Sruteet *et al.*, 2022).

### Benefits of clean meat

#### Food safety

Since food-borne viruses like Salmonella and E. coli are found in the digestive tract of the livestock, they might directly infect humans during slaughtering. So considering these, few scientists say that clean meat or lab-grown meat would be safer for human consumption rather than conventional animal meat which is the better alternative. As it is cultivated in a sterile bioreactor tank, the contamination caused by microorganisms can be detected easily and prevented. In the view of the fact that lab-grown meat is produced in a sterile environment without the use of any antibiotics, it can lessen the resistance of bacteria toward antibiotics.

#### Novel foods

When it comes to novelty clean meat can be made healthier by altering cell culture, types of cells or fortification of fatty acids like omega-3 fatty acids which are found in fatty fishlike salmons, maceral, sardines, and cold-water fish. Polyunsaturated fatty acids are an excellent substitute to saturated fatty acids. Texture and nutritional profiles can be improved by combining different species of cells.

### Environmental impact

It lessens the negative environmental effects brought by the life cycle analysis of the animals, from their rearing to their killing. Cultured meat is thought to require 7–45% less energy than meat that is produced traditionally.

### Contamination

Contamination is eliminated *in vitro* cultivation of lab-grown meat. In the traditional approach, a variety of tranquilizers, additives, and steroids are administered to the animals before they are killed. The purpose of making more money is by producing more. Occasionally, will be diseased if their bodies are not properly cleansed. On the other hand, none of these issues arise with lab meat.

### Animal Welfare

The benefit of clean meat in the context of animal welfare could be the most obvious. Large number of animals wouldn't need to be grown and raised often in unhygienic conditions before being out to death through processes that could or might not be unpleasant. Alternatively, a limited number of companion animals may be maintained as live sources of stem cells. Supporters of clean meat, People for the Ethical Treatment of Animals (PETA), offered a \$ 1 million prize in 2008 to the first firm to introduce lab-grown chicken meat to the market by 2012. Animals raised for meat are typically subjected to crowded and stressful conditions, as well as practices such as castration, debeaking, and confinement. Therefore, animals are not slaughtered cruelly.

### Conclusion

Clean meat represents a promising solution to the many challenges facing the traditional meat industry. With its potential to mitigate environmental impact, improve animal welfare, and enhance public health, clean meat has garnered increasing attention from scientists and consumers. As the global

population continues to grow, clean meat could help meet increasing food demand without overburdening natural resources. By using this method, it allows for greater control over the meat's composition, potentially reducing risks associated with antibiotics, hormones, and contamination found in conventional meat. Herewith, it reduces the carbon footprint that is it is projected to generate significantly lower greenhouse gas emissions, helping to combat climate change. As the global population continues to rise, clean meat could help meet the growing demand for protein without overburdening natural resources, contributing to global food security. While there are still technological and regulatory hurdles to overcome, continued research and development in this field could lead to a more sustainable and ethical future for meat production.

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