CULTIVATED MEAT: BIOMASS HYPE OR REALITY?

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Bioprocessing is the new way forward to produce meat without intensive livestock farming. In the future, many high-value ingredients and products will be bio-manufactured, along with cell-free methodologies for developing more sustainable food for everyday life to overcome the limitations of traditional products that significantly need more water, energy, and land space. Innovative food technologies such as molecular agriculture, regenerative agriculture and precision fermentation have a good chance of becoming a second pilar for meeting the growing demand for cultivated meat and -fish without adding further to ecological and environmental degradation.

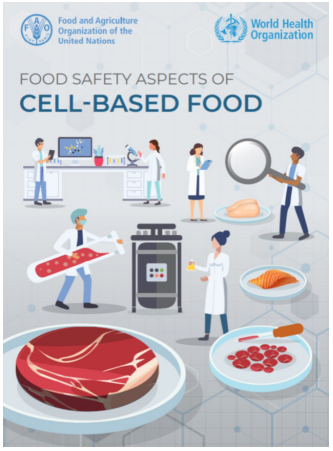
The new age of commercialized cultivated consumer meat and cultivated seafood runs in parallel to other emerging food science advancements, such as non-animal precision fermentation and molecular bioscience or -farming, like the Moolec Science's cultivation of pork protein embedded in soybeans.

Cultivated meat are real animal tissue products produced directly by growing animal cells in a bioreactor without the need to raise and slaughter livestock. The colossal global meat industry is increasingly facing multiple challenges ranging from interrelated ethical, environmental, and business concerns. In the future, the words "meat" and "animal" will be decoupled. Meat without animals is the new notion of cellular biotechnology using stem cells and bioreactors as the basic platform to grow healthy and nutritious cultured meat. A major advantage of cell-cultured food is that the manufacturing companies will only produce the parts of meat that consumers eat. In other words, they effectively reduce food waste while providing supply chain security.

For companies to stay relevant, it will be essential to diversify outside of conventional product portfolios to assemble nutritious and affordable food products. Bio-manufactured products should preferably be bio-identical, using methods such as "precision-fermentation-made-animal-free" with the same taste, functionality, and nutritive profile as the traditional products.

The Approval Hurrah

The time has finally arrived for the burgeoning cultivated meat industry to see how the affluent consumers react to eating whole-textured meat that never has been part of a living animal. Initially, cell-cultivated chicken will be available at select restaurants. The commercial introduction of cultivated meat is anyone's guess but likely not happening before 2030-2035 at the earliest.



Cell-Cultivated Meat Hiccups

The production of conventional meat in modern times is far from natural. "Meat producing "consumption animals" are routinely given antibiotics and hormones so that they grow much faster and larger than they naturally would. In addition, unsanitary outgrow farming and slaughtering conditions may increase the risk of contamination from feces, as well as a host of other unwanted bacteria and viruses.

The use of contaminants and antibiotics in cultivated meat products is still debated. It is well-known that antimicrobial resistance builds up or occurs under the influence of antibiotics. Preferably, cultivated meat should avoid all those issues: it has many benefits for human health, ethical, religious, and environmental advantages, including "no-animal-to-food" conversion, as well as huge savings on clean water and animal feed.

Yet, the use of antimicrobial properties of cultured meat are important to ensure the safety of these products. Antibiotics may be used in cultured meat to prevent bacterial contamination and thus will improve safety and prolong shelf life. However, antibiotics usage in meat products triggers concerns about potential residues in relation to antibiotic resistance in humans. A possible answer is the development of non-antibiotic antimicrobial support agents, able to eliminate bacterial contamination. Such a solution is using antimicrobial peptide mixtures like leucine and lysine. These synthetic "peptide blends" show potential in cultured meat production without harming stem cells or promoting antibiotic resistance. The latter is a major concern for medical health advocates, as well as for regulatory compliance and environmental sustainability.

Global Challenges

Growing meat without using animals is a rapidly emerging highly innovative technology. The goal is to remove the animal from meat production. The time has come for the world to move past the need to slaughter animals and instead embrace new food platforms such as "plant meat" and cell-cultured meat. The true benchmark for cultivated meat -and cultivated fish for that matter- lies in high output quantities at a cost-efficient scale. In all fairness, it is likely that the competitive cost benchmarks will only be reached if cultured meat is blended with plant protein components into true nutritious and tasty hybrid foods.

The animal cells, which are the building blocks of the meat, are grown in a stainless-steel vessel -also termed bioreactor or cultivator- and fed with the right blend of media nutrients. After about 20 days, the tiny meat strands are ready for harvest and can be further processed for human consumption. For cultivated meat, the top economic challenges are product quality, costs, and scalability. To be cost-effective, it is projected that the scale of the production of bio-fermenters needs a minimum capacity of 250,0000 liters.

Cultivated meat can become a mass-market product capable of augmenting the traditionally grown animal meat. It will help to balance the needs of a growing global population and reduce the stress levels of traditional agriculture, including animal stress and feed requirements. Human food consumption is projected to almost double by 2050 and demand is growing exponentially. Cultivated meat products are an "and", not an "or" solution, and is the latest in a long history of optimizing food production methods. Meeting the world's protein needs will require contributions from large-scale production methods, including new types of protein regeneration, all the way to small-scale animal farming. If consumers embrace cultivated meat, it will play an important role to ease possible

food shortages as well as improving global sustainability issues.

The Movers & Shakers of Change

Currently, more than 150 startups are working on developing cultivated meat and seafood. Many of these startups are in Europe, US, Canada, and Israel, while China is rapidly catching up. It seems that multinational life science companies, as well as the legacy food and meat processing industries, have now acknowledged the potential of this emerging technology.

Even the world's largest legacy food company, Nestle, has announced plans to enter this rapidly emerging industry. Singapore has become the first country to approve the commercialization of cultivated meat and -fish. Local player Umami Bioworks has introduced a cell-based crustacean and launched small quantities of cultivated minced shrimp product in 2024. To be fair and balanced, quantities are extremely limited, and the products are hybrid formulated, i.e., there is also soy or pea protein included. Some of the few cultivated meat or fish products sold in Singapore restaurants are in fact, 5 percent bioreactor grown meat or fish cells blended with 95 percent plant protein components. History is repeating itself now that the Japanese biotech giants like Ajinomoto Co and Mitsubishi Co are teaming up with cultivated meat startups to accelerate their proprietary technology and fermentation expertise to fast-track market commercialization.

The speed of cultivated meat patent filing is increasing notably in Korea. Also, Mosa Meat (Netherlands), Upside Foods (US), and Aleph Farms (Israel) rank among the heavy patent filers. Both the University of Yonsei (Korea) and Tufts College (US) rank in the top five filers. It is likely that the number of patent filings will increase, especially since Aleph Farms (Israel) has teamed up with BioRaptor on implementing Artificial Intelligence to further optimize production know how and efficiency.

More Ways than One

Most, if not all, cultured meat products will likely to be novel when commercially available and as such will require pre-market safety and legislative assessment to obtain authorization for sale. Most probably, these pre-market assessments will be based on the CODEX principles including molecular characterization, contaminant analysis (both chemical and microbial) and a clear description of the manufacturing process. In addition, questions may be asked about allergenicity, including dietary exposure assessment studies.

What Will Vegans Do?

The unanswered question is: Will vegans buy-in to eat cultivated meat since these have no animals involved? Food is emotion, and this is especially true for meat. All emotional, ethical, and environmental credentials will disappear if the staunch vegans no longer can play the "animal-suffering" card. The answer is still unknown and only time can tell if vegans will embrace cultivated meat as part of their dietary intake.

Better and More

Human civilization was largely enabled by the domestication of livestock animals. In the future, cellular biotechnology is going to be the second domestication not only in producing large quantities of cell-cultivated meat and -fish, but also in growing leather, silk, perfumes, as well as vaccines and organs.

Traditional animal agriculture has almost reached its maximum capacity, hence new technologies like cultivated meat and bioengineered proteins and synthetic fat such as coconut and even avocado oil, are needed to lower both environmental impact and to avoid food insecurity. As the global meat demand continues to grow with approximately 2 percent each year, deforestation and wildlife habitat remain the focus of public outcry. Especially the Amazon rainforest gets destroyed to free up thousands of hectares to grow soy crops which mostly ends up as animal feed. Smarter ways to produce food and meat for the global population is urgently needed to alleviate some of these ecological pressures.