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In Vitro Meat: An Ethical Solution to an Unsustainable Practice

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Abstract

In vitro meat, also recognized as test tube meat, cultured meat or cloned meat, refers to an animal flesh product, which has never been a component of a complete and living animal (Martin, Wendt, & Heberer, 2004). It is among the emerging technologies that are under research. The current research into this form of food resulted from a NASA experiment that attempted to find improved forms of long-term food for astronauts in space. NASA has been at the forefront of trying to find an in vitro meat, since 2001, by producing it from turkey cells. With constant increases in the costs of farming conventional meat and demand from the world population, in vitro meat might be one of the various new technologies necessary in maintaining the food supply by the year 2050. In vitro meat will have some profound effects on human daily life. The production of conventional meat might become too costly for the normal consumers to facilitate, especially when the world's population reaches about 8.9 billion people (Bhat & Bhat, 2011). In light of this, the paper discusses the impacts of in vitro meat as an emerging technology.

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Introduction

In the world today, humanity is facing major cataclysmic events such as water shortages, insufficient resources, sparse habitable lands, paucity of food, human health issues, humanitarian ethical issues, destruction of ecosystems, and exponential climate change, that will only exasperate the aforementioned issues. Left untreated, any one of these issues will decimate the human populace within the century, as the population is estimated to increase by 1.2% annually and resources and land will become unavailable (Smolinski, Mark S., et al.). To prevent our current lives from becoming mythology for future generations, we must simply deal with one problem: Meat. Or rather, how we harvest it. Modern methods require exorbitant amounts of resources just to produce a ton of meat; high consumption of energy, water, land, and antibiotics, all for a low yield rate when compared to that of agriculture. However, with stem cell research comes the advent of in vitro meat. The following will discuss the limitations of current methods, the process of obtaining in vitro meat, and the advantages and drawbacks of this new technique.

Current Issues with meat production

According to a report conducted by US Environmental Protection Agency, currently, grazing livestock takes up 26% of the Earth's total land, while the crop used to feed the livestock takes up 33% of the land; of the arable land used to feed them, only 15 grams of meat food is produced for every 100 grams of vegetable matter fed. Since 29% of the Earth is land, that leaves only 11.89% left for humans, homes, businesses, agriculture, wildlife, rainforests, and

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uninhabitable zones to occupy. Besides the squandered land use, excessive fresh water is used to sustain the beasts; an average of 16,726 m3 of fresh water is required for 1 ton of beef, compared to sustainable agricultural crops such as rice or potatoes. Livestock around the world are also the number one contributor to greenhouse gases. In 2013 alone, cattle were responsible for depositing 162.8 metric tonnes of methane into the atmosphere, releasing 27 kg of CO2 per 1 kg of consumable food, making cattle the largest contributor to greenhouse gases. However, that does not mean we should kill off every cow on the planet; in fact, many would abhor animal cruelty. In 2007, the United States alone sent 10 billion land livestock to the slaughterhouses, greater than the number of humans on the planet. A swift death would be ideal for these beings; however, from the time of their birth they are subject to overcrowded and filthy conditions. Conditions that require heavy use of antibiotics to keep the livestock alive long enough to reach the slaughterhouse, and pumped with hormones to produce the most amount of meat. Chemicals that remain in the meat to be digested by the consumer, known to have repercussions such as diseases and increased rates of cancer. In Vitro Meat is the solution, since a high use of land and freshwater use is needed for meat production. Growing crops for animal feed entails a highly efficient use of water, and places a strain on diminishing freshwater reserves. Animal agriculture generates a significant amount of greenhouse gases that contribute to climate change. Greenhouse gases are impacting our environment, while antibiotics are bad for our health. It affects the health of our consumers. By some estimates, global food production would need to double by 2050 if we expect to feed the growing population.

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In vitro meat is the solution

The ability to create food out of a test tube has always been the product of science fiction and the discussion of disgust among people who lack an understanding of the underlying process. The technique requires no harsh chemical mixture, nor does it involve the use of genetic modification or employ other Genetically Modified Organisms. The process requires a few muscle or stem cells extracted from a healthy animal via biopsy, a painless procedure that leaves the cattle blissfully unaware. The donor cells are then placed in a growth medium, the core of it consisting of fetal bovine serum, which are able to deliver nutrients to the donor cells and induce a natural propagation by coercing the stem cells to initiate the muscle repair process, and therefore create more cells. Once the serum is depleted and the donor cells are fasted, the newly formed muscle cells begin contracting and forming along any substrate placed in the medium. From here, they continue to grow in size and continuously contract via electrical stimuli & chemical stimuli, effectively "exercising" the muscle (Chen, Fa-Ming, and Xiaohua Liu). The strips are then placed into bioreactors, large containers that allow the muscle concentration to expand. Once the sheets of muscle have reached fruition and enough sheets are cultivated, they can then be cut and pressed into patties.

Limitations on Research

The research is limited by consumer hesitancy to purchase a meat product that does not look or taste like meat. In 2013, the first patty was available for an official taste test, where it

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was met with mixed reactions due to the muscle being extremely lean and discolouration due to the lack of myoglobin that usually colours the meat pink. Even though the meat lacked this, all three judges agreed that the taste was passable for slaughterhouse meat. The price tag of such a patty? Approximately $385,000.00, contributed by Google co-founder Sergey Brin. In March 2015, Dutch Professor Mark Post made an announcement that it is viable to produce lab-grown beef for "$80 a kilo", translating to a measly $6.80 for a 3 ounce hamburger patty; a price that will fail to compete with conventional meat. In vitro meat will eventually outcompete the butcher meat market when the prices are more reasonable. Another issue, is the inability to create highly structured goods such as steaks and the like; the only passable meat products that would be available would be ground meats and processed meats.

Another important issue hailing from vegans and animal-rights advocacy groups is that in vitro cultured meat is a harmful way to produce meat, and they are right. The use of fetal bovine serum involves extracting the blood from the hearts of fetal calves within a pregnant cow by mean of puncture, unfortunately killing the fetus. However, those advances make such acts obsolete, as a medium made from an extract from the maitake mushroom, is both animal-cruelty free and is shown to have higher growth rates than fetal bovine serum. In vitro meat is the solution due to the positive impact it has on the consumers. Contrary to the production of conventional meat, in vitro meat does not require the use of antibiotics. Growth hormones will decrease and there will be a reduction in climate change. In vitro meat could eliminate the supposed lack of well-being of livestock, reduce energy consumption and has the potential to

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free up cultivable land. The future of food production will lead to healthier meat sources, and prevent negative impacts on our environment. The new technology will provide its consumers a lab-grown meat that is produced in sterile environments. The lab-grown meat will be free of bacteria and prevent the use of pathogens in conventional meat that causes fatal food-related infections.

Positive impact of In Vitro Meat

For every negative in vitro meat can bring, it will also bring exponential good that butcher meat cannot compare to. Alternative meats do not have to undergo heavy use of antibiotics, which in the United States accounts for more than 80% of all antibiotic sales. So much antibiotic use paired with unsanitary conditions creates an optimal environment for breeding superbugs and will only increase as we encourage more antibiotic resistant bacteria. If kept in sterile environment such as a bioreactor, illnesses such as salmonella and mad cow disease can be kept to a minimum in these highly controlled environments. Also, use of growth hormones that have been known to affect humans after consumption of slaughter meat will drastically decrease, as the natural cell division of the muscle stem cells can multiply near-indefinitely. Instead, healthier additives to fortify foods such as omega fatty acids and β-carotene could be infused into the meat. Use of labs will also decrease the amount of land used to raise livestock and let livestock graze upon, as well as arable land used to create feed, by a whopping 99%. Energy used to produce the cultured meat will decrease by 45% when

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compared to modern methods of raising livestock. Also, the amount of greenhouse gases emitted by raising livestock, feeding livestock, transporting livestock, and processing livestock will decrease by 96% when switched to in vitro means (MeatFree). The already diminishing fresh water supply will be conserved, and lands that were once used to sustain livestock can then be used to cultivate agricultural crops or returned to let the wildlife thrive upon it once more. Optimistically, if most of the meat production were converted to in vitro methods, we can reduce the rate that the climate is changing due to greenhouse gases. Most importantly, animals that were once caged in confined crippling spaces, locked in disgusting over populated environments, doped up on hormones, filled to the brim with antibiotics, tortured, and slaughtered can now roam free, liberated from a cycle of death, allowing the cow to enjoy its life and not just be used for meals.

Conclusion

Cultured meat is only a decade away from being commercially available, economically sustainable, and morally conscientious. Leaps in bioengineering and tissue manufacturing, has given humanity the tools to fight global events; such as, the hunger epidemic and climate change, that were once thought to be insurmountable. The concept of harvesting, reproducing and eating desirable cells, in a clean environment would drastically undercut the requirements of native beef. Not to mention this could be produced in local communities without the petroleum output currently required to transport meat from where it is grown to where it is processed to where it is

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sold. Over 50 calories of petroleum go into producing/selling every calorie of meat. That is simply not sustainable considering we are facing a bigger demand for this product on less available oil reserves. If the society cannot be concerned to cut down their meat consumption, the government cannot be concerned to cut farming subsidies, which would allow the consumers to feel the real cost of these commodities, then we might have to face a future with in vitro grown muscle protein. Rather than waiting for this to happen it is better to collect more data on this research. It will be beneficial to be able to figure out how to culture in vitro meat on a larger scale. As to the antibiotic argument - this would control the release of antibiotics from entering our water systems. An overall reduction of antibiotic use, will produce safe and viable protein. Different methods of how to grow cultured meat and the machinery used in creating in vitro meat, are continuously being developed. There is still a lot of effort remaining in figuring out the creation of in vitro meat. The first trial of in vitro meat was a success in America. It is a new technology that will develop over time, but it is important for each and every household in America to have this fast form of meat production in their homes. It is important that this new technology is introduced to the American households since it leaves a future impact on the new generation and it is significant to introduce in vitro meat to consumers. It will take some time for this new technology to pick up in the market for consumers to purchase. But, it will also take some time for consumers to afford this product. It also depends on how in vitro meat is grown in lab and if there are consumers that are willing to buy this product. Since, the consumers will determine the future use of this product, it will be left in the hands of the consumers to determine

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how this new technology will be used in the future. This new technology has a long way to go before it is economically feasible.

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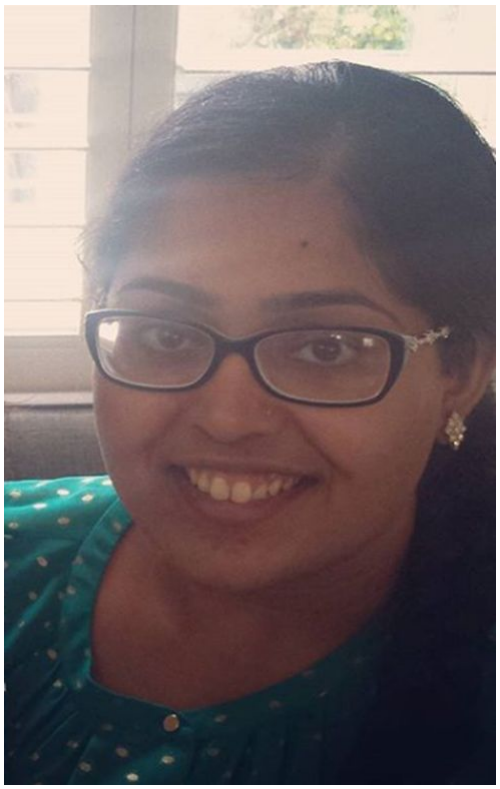

My name is Manpreet Takhar, I am a senior at UC Merced and I am majoring in Mechanical Engineering. I am interested in going to graduate school in the near future to pursue a PhD in Mechanical Engineering. My interest in engineering started as a result of taking engineering courses at the beginning of my college career. I aim to work in an Aerospace field in the near future.