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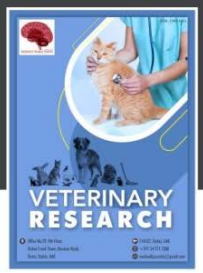

Identification of Lab Grown Meat and its Nutritional Impacts on Human Health

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Abstract: Meat is indeed a vital source of nutrition as it contains a healthy balance of proteins, nutrients and vitamins. Because of its value, its production cannot be stopped, so, cultivated meat has also been developed as a food that is free of animal abuse and uses fewer capital than cattle. Other things such as the color of the meat, the flavour of the meat, the texture of the meat and the quality of the meat do have to be improved. One of it's big problems with the launch of lab-grown meat were ethical problems and market approval.

INTRODUCTION

Cultured meat is animal protein meat that has been processed in a laboratory utilizing different tissue engineered technologies in a growth media. This meat has a numerous advantage over traditional meat, like being more environmentally friendly being healthier and being free of food borne and nutrition-related disorders. Industrial *in vitro* meat processing will also minimise the number of animals sacrificed as well as the amount of soil, water and energy consumed[1]. Considering people's continuing appetite to consume meat, it would seem that changing attitudes would not be enough to overcome the issues regarding the consumption instead, they must be approached from a certain angle: modifying the commodity. The production of a food from cultured animal-derived stem cells in the laboratory (*in vitro* meat, IVM) has been studied by researchers in the Netherlands. They cooked and ate the world's first laboratory-grown meat patty, an *in vitro* hamburger, in

April of 2013 and are now working to make this food a viable non-farming option for potential meat processing. They hope to answer several of the ethical and environmental issues about agricultural activities as well as the growing global appetite for meat, by doing so[2]. Such constrained narrative limits the scope of national conversations and arguments regarding the production of lab-grown meat. Such prohibitions run counter to the claimed intention of transparency of lab-grown meat proponents and they cloud a few of their moral statements[3].

Market acceptance of cultured meat is likely to be influenced by a diverse range of factors, varying through technological preferences to product-specific desires as well as broader social context such as media attention, consumer participation and confidence in research, politics and community[4]. The concept of producing meat from mammalian cells positions itself with a new innovative means to access meat by eliminating livestock processing at the start of the meat process of production. During hunting and raising livestock, this transition has also been called "the third phase of meat development"[4]. CM has the potential to revolutionize meat processing by offering a more eco-friendly and nutritious compared to conventional meat. New technologies can help to shorten the time required for CM product to reach the market[5].

PRODUCTION

Muscle cells: As a standard "*in vitro*" form of stem cell culture, muscle cells can indeed be conveniently developed on plastics. This technique has been used for years and is a well-recognized paradigm for studying the molecular pathways of muscle growth and deterioration. This method has now become a suitable option to livestock farming as a meat source. Muscle cells can be cultivated and regulated at all stages of their development and differentiation (pros). Muscle cell thin film, therefore, varies significantly from muscle tissue which is an extremely complex structure (cons). Adipose and connective tissues and also a vascular bed are all represented in skeletal muscle (11).

Stem cell: Detection, collection and alteration of stem cells has come a long way over the last 2 phases. Some many stem cell forms seem to be of importance for meat culturing. The myoblasts, also known as satellite cells, are first and foremost[6]. This tissue-derived adolescent stem cell is the real deal when it comes to muscle recovery after a trauma. Maintaining its proliferative condition in cultured cells, therefore, has proven to be difficult. The satellite cell, on the other hand, quickly distinguishes into myotubes and much more mature myofibrils when cultured long enough and as a result, it was chosen as the chosen stem cells for skeletal muscle engineering. Recent research on ageing satellite cell populations indicates that a subclass of satellite cells could have even greater regenerative ability[7]. However, at time, embryonic stem cells are already a potential option since the struggle for pig and cow embryonic stem cells is also still underway. While keeping these both from the inner cell mass of bovine or porcine epiblasts in an undifferentiated state is likely only a matter of time and effort, so far the attempts have not been entirely successful. Induced pluripotent porcine stem cells (iPSC) have recently been developed and may be a viable substitute for *in vitro* meat production. iPSCs are differentiated cells such as fibroblasts, that have been made pluripotent by stable transfection with a series of four distinct transcription factors that control embryonic gene expression programmed in the cell.

While iPSC-derived myotubes are functional for myogenic segregation and *in vivo* muscular injury recovery, no bio-artificial muscles have been created so far. Certain meat ingredients such as visceral fat, can be generated using a variety of cell source materials. We chose another adult tissue-resident stem cell for this: the adipose tissue-derived stem cell (ADC), that have shown the ability to form preadipocytes and then divide into mature adipocytes. These cells have been used in the tissue-engineered of adipose tissue in the past.

NUTRITIONAL QUALITY AND SAFETY ASPECTS

Meat has a strong protein concentration and a balanced composition of amino acids, mineral and vitamins, making it a nutrient-dense meal. However, producing culture meat which closely resembles fresh meat is much more difficult since cultured meat lacks a blood stream, limiting the amount of nutrients and oxygen delivered as well as the diffusion mechanism. As a result, only some cell layers may be generated utilizing culture techniques, potentially limiting the nutritional content of culture meat. Different methods are studied by Fraeye *et al*.[8] in order to match the dietary structure of culture meat against conventional meat.

The hydrogel of naturally occurring polymers is often used in scaffold methods to improve tissue joining forces and cell-induced contraction. Scaffold content has an effect on the nutritional quality of the substance. Collagen and fibrin protein have been used in various muscle tissue engineering techniques. Collagens are mostly made up of non-essential amino acids, although, they do contain certain lysine which is post-transcribed into the hydroxylysine type, that can be used in protein synthesis. The scaffold content extracted from algae, plants and fungi to substitute alginate, cellulose or chitosan will increase the amount of health benefits and act as a source of dietary fiber, respectively.

Co-culture of adipocytes which can then be generated from different saturated and unsaturated fatty acids to shape adipose stem cell is used to maximize the fatty content of cultured meat. However, further study is needed in this area, since, certain basic amino acids such as alpha-linolenic acids and linolenic acids as well as some nutritionally important compounds are still missing from this co-culture method. It can be done by applying important amino acids directly to the medium or by including plant-based fats in culture meat items. In addition to the fat content of the medium, the saturated-to-unsaturated fat ratio is easily preserved or regulated.

The myoglobin content of meat is linked to a number of dietary parameters. Since, myoglobin is stifled at atmospheric oxygen concentrations, cultured meat is usually light yellow in color. As a result, increasing the myoglobin content improves nutritional properties while also adding color and taste. There are two types of iron used in muscle tissues. The heme group of myoglobin is the first and the non-heme form is the second (it made a complex with ferritin). It is recommended that iron be consumed in heme form because heme iron is readily absorbed in our digestive tract and chelating agents should not interact with its absorption. Different methods to increasing myoglobin content are included in the Fraeye *et al*.[8] report. Muscle fibers are cultured in a low-oxygen environment in the first approach. Under hypoxic conditions, glucose intake and lactic acid synthesis improve, increasing cultured productivity while causing cell harm due to mild acidification; instead by using a media addition, myoglobin development is facilitated. This method necessitates further thought in evaluating myoglobin whose expression rises in hypoxic conditions. The myoglobin content or iron are explicitly applied to the culture medium in the second solution, however still this method does not match the myoglobin content of conventional meet.

Vitamins may be added into tissue engineering in order to increase cellular proliferation, although, it is unclear if adding vitamins to the culture will increase the amount of vitamin in cultured meat. Further research is being conducted to determine the nutrient content of cultured meat. Taurine is a free amino acid and a bioactive product that is applied to culture media to aid in the development process and some tests have shown that Taurine can help reduce cardiovascular diseases.

Safety aspects: The preservation and consistency of culture meat are two of the most pressing concerns. According to safety experts, lab-grown meat is safer than traditional meat, since, it is grown in a fully controlled environment. There is no need to use antibiotics, steroids, or growth hormones in the processing of cultured meat which are often given to livestock to reduce the risk of illness and increase the cost-effectiveness of rapid growth. However, the usage of such antibiotics raises the amount of bacteria that are resistant to antibiotics and causing damage to humans. The possibility of infection with intestinal bacteria is minimal in culture meat, reducing the risk of an infection.

LAB GROWN MEAT'S IMPACT ON ENVIRONMENT

Since, lab-grown meat has not yet been processed on a large-scale industrial scale, although that it's being introduced and study is being done on it, it is difficult to determine the precise environmental impact. Until now, all analyses have been speculative. Cattle meat processing has the greatest environmental impact of all the meats, so, lab-grown meat production is often related to it. When compared to lab-grown beef, cattle meat contains higher methane and therefore less carbon dioxide (CO_2). Methane gas is abundant in the digestive system of cattle but it is less potent than CO_2, since, methane lasts 12 years in the environment while CO_2 lasts 1000 years. As a result, when we consider its long-term environmental effects, lab-grown meat is more effective than cattle meat processing. Since, lab-grown meat does not emit the same amount of methane as actual cows, it may result in less warming in the short term. In the long run, though, the pattern reverses. Cattle is a kind of animal that offers far more than just beef. Its different parts are used to produce leather. Candles and lubricants may be made from gelatin, pet food and its fat. Lab-grown meat processing cannot produce these ingredients or by-products. As a result, lab-grown meat cannot replace natural meat. Food raised in a lab would only be used as a source of protein but livestock are far more than that; they are also laborer's. In certain ways, lab-grown meat has a positive impact on the climate because it does not consume the same amount of soil, feed or water as livestock do, resulting in a reduction in property, water and feed scarcity.

LAB GROWN MEAT HALAL/HARAM STATUS

Muslims have a halal food requirement, similar to just how Jewish people and Hindus all had their own food requirements. Muslims have their very own dietary requirements, halal food which is a component of their faith that protects them religiously and physically. Until now, food that was once considered haram has been shown to be harmful to human consumption.

We therefore, need take cells from an animal, whether dead or alive, to produce lab meat and that's where the problem begins; the cell of a haram organism would render the meat haram, so, understanding which animal's cell was used to make lab meat is a significant criterion to review but it's only the beginning. The next

concern is there are appropriate procedures directed to Muslims to slaughtered the animal according to natural law (fitrah) and Sunnah such as draining the blood and reciting the duaa right while the butcher is butchering the animal but lab meat cannot be slaughtered nor can it hear more, causing an issue over its haram or halal status. It really doesn't follow Tayibbah's requirements. The holy Quran says in regards to lab meat processing it is against the law of nature (fitrah) which Satan has guaranteed:

"I will deceive them and impart false wishes in them; I will command them to cut the ear of cattle and deface Allah's (fair) creation. That whoever abandons Allah and accepts Satan as a comrade has undoubtedly endured a significant loss."30.

This is why consuming laboratory meat is against nature. Due to all these questions, these items are labelled as mushbooh which means uncertain, when it is unknown if the product is haram or halal. But it's best to stop it. According to al-Bukhari and Muslim, there's a hadith that says: "On the authority Abi Abdillahi al-Nu'man ibn Basheer (R.A) who said: I heard the Messenger of Allah (Peace Be Upon Him) say: "There is no question regarding what is legal and what is illegal but there are certain doubtful [or ambiguous] issues about which few citizens are informed. As a result, he who refuses these dubious issues clears himself in terms of his faith and honor. Yet, as the shepherd who pastures around a refuge, all but grazing therein, whoever falls into questionable matter enters into that which is unlawful. Every king has a safe haven and Allah's safe haven is His prohibition. There is a crumb of meat in the body that, if sound, makes the whole body strong and if diseased, makes the entire body diseased. The heart is a function of the core."31.

MERITS/ADVANTAGES OF LAB GROWN MEAT

Nutrition-related disorders, food-borne allergies, antibiotic-resistant pathogen strains, resource use and farm animal welfare and environmental repercussions of farming animals such as emissions from their faeces and significant methane emissions causing global warming, are only a few of the severe implications compared with standard meat production systems and customers have conveyed their dissatisfaction.

In view of the significant detrimental impacts of current meat processing on the ecosystem and human well-being, *in vitro* meat production, a technology that has the potential to revolutionize human life, is a promising option. One of the proposals being suggested to minimize the negative impacts of modern meat processing processes is *in vitro* meat production. *In vitro* meat processing can provide health and environmental benefits by eliminating waste, water usage and land use correlated with existing meat production systems.

As a result, *in vitro* meat processing systems carry a lot of potential for the ecosystem. *In vitro* meat has the ability to significantly minimize animal cruelty and eliminate the need to feed animals, in addition to meeting many of the dietary and hedonic needs of meat eaters. It has the ability to be a much more reliable solution, since, a bio-reactor commodity is free of the vicissitudes of livestock, is not tied to soil or place and opens up opportunities for new development sites or alternative land usage. Furthermore, animals are notoriously inefficient as a raw material for meat production from a commercial standpoint due to disease, stress and inconsistent development.

Functional and designer meat: By modifying the structure of the broth culture, the fat content and the fatty acid profile of the cultured meat, *in vitro* may be designed to also be healthier and more usable than traditional meat. Supplementing fats during processing will also help regulate fat content and the proportion of saturated to polyunsaturated fatty acids may be best managed. Good fats such as omega-3, may be used to supplement harmful saturated fats. Furthermore, by applying elements to the broth culture that could have a beneficial impact on the health such as some kinds of vitamins, the effects on health of the meat may be improved.

Animal welfare: Through harvesting cells from either the donor animal by biopsy as well as cultivating them in medium containing extract solution rather than animal blood plasma, *in vitro* meat, named "victimless meat" by animal activists and meat conservation researchers, removes the moral ramifications of conventional beef farming. As a result, use of livestock would be limited and a single farm animal may potentially provide the entire nation's meat supplies. Ten cells will produce 50,000 metric tonnes of meat if they replicate and multiply continuously for two months. Since, embryonic cells have an almost unparalleled potential for self-renewal, cultivating them would've been perfect for such a reason. A single cell line of this kind could theoretically feed the entire planet.

Reduction in zoonotic and food borne diseases: Strict quality control regulations such as Quality Standards can help to reduce the incidence of food borne viral microorganisms by lowering the risk of meat poisoning due to the absence of a possibly infectious organism. In addition, the effects of pesticides, arsenic, dioxins and hormones, all of which are supported by previous meat processing processes, may be considerably reduced.

Quick production: The present meat processing methods are inefficient of energy and nutrient utilisation and they take a lot of time to convert including chickens taking

longer and cows and pigs taking years until the meat can indeed be processed and readily accessible. In a fractions of the time, the meat is cultivated in an *in vitro* setting and it can be harvested in week rather than month (for chickens) or years (for pigs and cows). Since, the tissue must be preserved for a shorter period of time, the total energy and labour needed per kg of *in vitro* meat is much lower.

Reduction in resource use and ecological foot print: Compared to traditional industrial farming, *in vitro* meat processing is much more environmentally sustainable and cost consuming. This will decrease the carbon emissions of meat products while also lowering energy needs, so, unlike conventional meat where 76-94% of the food supplied to an animal is wasted due to oxidation and undigested structures such as the backbone or neuronal tissue, all of the nutrition shall be used in the processing of the lean protein only[9].

DRAWBACKS /DISADVANTAGES OF LAB GROWN MEAT

Whereas many people are supporting *in vitro* meat because of its possible climatic and ecological advantages and animal welfare campaigners support it, it has also sparked concerns and controversy[10].

Sensorial characteristics: *In vitro* meat can get some difficulty comparing against standard meat in terms of color and texture. The colorless cultured meat developed and tested by a sensory panel in London's Riverside Studios in 2013 was published. Adding a little red beetroot juice and saffron to the meat enhanced the color. New meat processing technologies must be introduced to enhance the appearance and quality of the introduced *in vitro* meat products. In the beginning, yolk-like chunks of self-assembling muscle cells and tissue monolayers were created *in vitro* using scaffolds for the production of comminuted beef products. Many technologies are being tried such as scaffolds filled with muscle cells that can solidify the resulting beef, to create more attractive meat goods using tissue regeneration techniques[11]. Scaffolds made from natural and edible biomaterials including collagen have also been suggested and tried to allow for 3-D tissue culture and complex meat structuring.

Alienation to nature: Another issue with an *in vitro* livestock production scheme is that it has the potential to risk alienating us against nature and wildlife and be a step toward our separation from nature to live in the city. Cultured meat blends in with a growing reliance on technology and the concern is that it is accompanied by a growing disconnect from nature. In the lack of livestock-based cultivation, human activity will harm less areas of soil which is positive for biodiversity but could also alienate us from it.

Cost of production and economic disturbances: *In vitro* meat production would undoubtedly have an effect on the economies of countries that engage in large-scale traditional meat production and rely on meat export to other countries. In countries where cultured meat processing is being introduced on a wide scale, this technology would have an effect on agricultural jobs. These manufacturing centres can decrease noise by being close to towns to minimise transportation costs but this may not be ideal for the landscape[4].

Social acceptance: One of the most significant obstacles to community acceptance is cultured meat. Consumers are increasingly concerned about the artificial nature of *in vitro* meat but as Hopkins and Dacey point out, "Just because anything is organic does not imply it is safe for you." Unnatural ideas, on the other hand, seem to be a big part of a lot of opposition to modern food technology, at least in Europe. Regardless to whether a compelling case may be presented about the unnaturalness of cultivated meat, those perceptions must be taken seriously. Furthermore, people could perceive *in vitro* meat as artificial rather than natural meat, losing value its worth in the same way that they would artificial flowers or synthetic gems. Many opponents of *in vitro* meat processing are concerned that the capacity to cultivate human muscle tissue could lead to victimless cannibalism[6].

People are paying attention to disgusting reactions while attempting to determine if a modern, particularly biotechnological, method is ethically good and therefore, should be legalised. Another common criticism of ethical vegetarianism is that, paradoxically, animal's lives would be healthier in a society with anything like the current meat industry than in a world of universal or extensive vegetarianism.

CONCLUSION

Several lab techniques may be used to make lab farmed meat or cultured meat and yet none of them can fully replicate meat; it may look like meat, however, the nutritional content, color and taste cannot be the same. It needs further research for the development before it can be accepted as a meat by customers[12]. It is a commodity that has not yet been commercialised because this is still being produced and large-scale production is not yet

feasible. Typically, every modern groundbreaking product does have its own set of benefits and drawbacks and lab meat is no different. Natural meat cannot be readily substituted and cultured meat cannot supply the nutrition that traditional meat does. For example, iron absorption in the body is critical but iron absorption in cultured meat is lower than in conventional meat due to the lack of a heme community. Since, conventional meat has much greater nutritious benefit than cultured meat, a diet-conscious person will consume traditional meat rather than cultured meat. There are other advantages such as the fact that cultured meat does not require water, soil, labour or feed, since, it is neither alive nor dead. Ethical questions exist, since as Stephens points out, "there is no animal to kill for *in vitro* livestock which requires no inefficient natural resource intake preparing the animal to slaughter." As a result of the religious questions, Muslims can consume halal meat. Since, halal slaughtering operations cannot be carried out, blood cannot be extracted and we cannot be certain if the animal cell used to produce the meat was a pig (which is a haram animal in Islam) or a sheep/meat/chicken cell, cultured meat raises a number of questions about whether it can be halal or haram.

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