ARTIFICIAL MEAT MANUFACTURING AND ITS FUTURE PERSPECTIVES

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Abstract

The world population is continuously increasing and it is expected that it will increase up to 7 billion by the year 2050. Hence the increasing population requires extra resources likewise the meat industry is unable to respond to this increasing demand for protein. Thus industries must find an alternative to meet the needs of people and solve the problems related to the welfare of animal life, health, and sustainability. Modern meat or the novel meat commonly known as "artificial meat" is utilizing modern and groundbreaking technologies and techniques to tackle problems faced by the traditional meat industry. Artificial meat, in-vitro meat, and GMO meat (Meat produced from genetically modified organisms) have no capacity to fight with traditional meat production in the current environment. Although, meat replacement plans including proteins obtained from plant and myco proteins are serving the best competitors and are also wiping their hurdles in the market. Cultured meat can push traditional meat to the premium end of the market. If the expense rate on traditional meat did not lessen, the manufactured meat will provide the less expensive and palatable meat. The livestock industry has considered agroecology and ecology concepts to create sustainable systems for animal production. The traditional meat industry can increase the output, quality and variety in meat from innovative technologies like GMO (genetically modified organisms) and cloning. By using these technologies the meat industry can produce the best substitute for conventional meat and meet the need for resources and environmental changes.

Keywords: Meat industry, Culture meat, Consumer satisfaction, In-vitro meat, Sustainable product, Artificial meat.
Introduction

According to the FAO (Food and agriculture) the food demand will be increase by 70% in 2050 to meet the needs of the masses and complete the demand of populous regions only. This estimated figure does not give much hope as restricted resources and arable limitations of the land are big hurdle. Although developed countries have given up on meal consumption, the global consumption is evaluating day by day particularly this practice is adopted in developing countries like China, India, and Russia (Toble, 2011). The alarming situation of worldwide food and nutrition security is triggered by livestock systems (Willett, 2019).

The factory farming model is contributing in producing very well proportion of livestock. In contrast to extensive agriculture, the model is also fruitful for water usage. Factory farming contributes very less in greenhouse gases (GHG).

The efficient target of this model is to produce more quantity of milk and meat in spite of other services including animal welfare, interaction with environment, a minimum usage of environment or sustainability (Steinfeld, 2006). Consequently, more effective methods of protein production are now introduced to meet the needs of increasing global population and other modern challenges such as animal welfare and environmental crisis (Aiking, 2014). After considering the solutions, artificial meat is considered as a sustainable substitute for people who do not want to change the composition of their diet but want to become more responsible (Shapiro, 2018).

Numerous possible ways are using to help the industry in fulfilling rising demands for protein (Henchion, 2017). The meat industry has modern solutions to these problems which are very useful in increasing the production of meat. They have included genetic innovations and upgraded agro-ecological systems (Dumont, 2013). Among them, it is a process that majorly concerns with the current environment and utilizes common processes to minimize the input, waste, and maximize the efficiency of meat (Dumont, 2013).

There is less chance that the above technologies are considered artificial for consumers because they want to modify the current livestock production system to make it more effective. There are some techniques including genetic technologies such as animal cloning,
genetic modification and genotype based on selective breeding which are currently incorporated into traditional meat production (McColl, 2013). In contrast, plants, fungi, algae, and insects are also used as a resource for substituting protein in meat. Products that are acquiring the proteins obtained from plants and mycoproteins are already available in the market whereas the products which are specifying the algal proteins and insect proteins are not so common (van der Spiegel, 2013).

**Artificial Meat and Meat Industry**

Apart from the conventional ways, many other ways are available to aid the industry in fulfilling the world demand for protein as well as the demand of the market (Henchion, 2017) stated that, the meat industry considers many options for increasing the efficiency of meat. It includes genetic innovations and upgraded agroecological systems. Agroecology is a type of process which prefers the usage of the local environment and extracts the advantages to reduce the input, waste, and maximize the efficiency of meat (Dumont, 2013). This technique is attractive for the consumers who mainly focus on external qualities such as sustainability and animal welfare and this technique also attracts premium prices. Particularly the states like the European “Nations” favor this type of production as it concerns shifting the environmental priorities of administering bodies. However, there are certain types of agroecological methods that are very moderate to spread through the industry as they need a specification of a paradigm shift by producers. It includes livestock production to pasture and by-products as they will require the farmers to consider animal nutrition from a unique perspective (Roos, 2016). There are many types of artificial meat protein that do not possess cholesterol and also very less amount saturated fats. It includes soya meats fabricated from protein obtained from plants which holds maximum nutritional values and also matches with meat in flavor and texture.

Quoron is manufacture from fungal protein, it is very unique as it can serve as a meat alternative to make steaks, sliced meats, chicken breast and burgers (Jnshi, 2015). Cultured meat can also be produced using the same tissue engineering techniques which is conventionally used in regenerative medicines (Post, 2013). Alternatively, plants, fungi, algae, or insects are the sources of producing protein. This kind of protein serves as a good substitution of meat proteins. The products obtained from plant proteins and mycoproteins
are already available in the market. But the protein products constituting of algae and insect are still emerging (Van der Spiegel, 2013). Synthetic meat system is a technique that is specific in using *in-vitro* culture and 3D (three dimensional) printing techniques. This technique is a favorable option to produce meat proteins as it includes groundbreaking technologies. Artificial meat or *in-vitro* meat does not grow in the living organisms rather originated from the cells or tissues which are grown in the laboratory.

The cultured meat can be extracted from a basic broth culture of myocytes or they can slowly grow on a lattice or frame to produce a muscle-like end product. But currently, there are currently no commercially available *in-vitro* meats in the market. The three-dimensional printing technique is a specific technology that is used in the manufacturing industries. It is used for manufacturing physical objects from 3D digital models. It can be done by depositing continuous thin layers of a material consecutively. Inkjet printing and soft-material-extrusion are the most relevant techniques for meat products. These techniques are specific for making "structure-less" meat products such as burger patties or innovative meat paste items (Post, 2012). For manufacturing, the *in-vitro* meat industry would require the advancement of a modern manufacturing facility utilizing various untested technologies. It would impact a major jeopardy for marketable organizations. Conversely, the media coverage of *in-vitro* meat gives a positive impact (Hopkins, 2015). Agroecological farming possesses is a great nutritional value as compared to the products which are derived from traditional farming systems. Furthermore, meat produced via this technique carries greater amount of polyunsaturated fat (PUFA), especially of n-3 PUFA, in comparison of traditionally created meats (Srednicka & Tober, 2016).

**Cell structure of artificial meat**

The piece of muscle which is extracted from a living animal is called a biopsy. This is cut to extract the stem cells that can multiply but it can also alter them into specific kind of cells like muscle and fat cells. When these cells are brought to culture in a specific medium they start dividing and provide growth factors, hormones and nutrients. The culture medium considers the best medium to grow the cells containing fetal bovine serum (FBS). This specific serum is prepared from calf’s blood which is rate-limiting and is not acceptable for vegetarians nor vegans. The growth of one trillion cells is possible which ultimately form
myotubes naturally and its length is not more than 0.3 mm. These myotubes are then kept in a ring growing into a small cut of muscle tissue as elaborated in different reviews (Ben & Arye, 2019).

Bhat (2014) stated that the piece of muscle will be divided into more than a trillion strands. This grown fiber is coupled with a rough sponge-like scaffold enriches the fibers with essential nutrients and enlarges them mechanically by stretching or "exercising" the muscle cells. It increases their protein value and size. During this mechanism, the cells are placed in a specific environment that replicates the temperature inside the body of a cow. For instance, this process is used to increase the production of lab-grown meat (Ben & Arye, 2019). These stages are involved in the production of artificial meat including treatment of growth medium, selection of the starter cells. Muscle tissue is obtained from the growth medium and then organized in a 3D structure by scaffold which is necessary for the final product. The cells are grown on the scaffold to culture the three-dimensional meat that directs its structure and order. The ideal scaffold can be eaten so there is no need to remove the meat and periodically moves it to enlarge the developing muscle, by stretching. It stimulates the animal body during normal development. Furthermore, the scaffold must maintain flexibility so that it could not be detached from the myotubes (early muscle fibers). For the normal development of the muscle tissue, the scaffold must allow vascularization (creation of blood vessels) (Edelman, 2005).

It is exceptionally critical to regulate the blood pressure in mammals, the renin-angiotensin system serves as one of the worthy vasodilator and vasoconstrictor mechanisms that direct the blood pressure in mammals. Angiotensin-1 converting enzyme (ACE, peptidyl dipeptide hydrolase, EC 3.4.15.1) is very specific as it creates a vasoconstrictor angiotensin-11 (Asp-Arg-Val-iles-ProPhe) by eliminating the C-terminal dipeptide via a precursor decapeptide angiotensin-1 (Asp-Arg-Tyr-iles-His- pro-PheHis-Len) and it also degrades a vasodilator named bradykinin (ArgPro- Pro-Gly- Phe- Ser- Pro-Phe-Arg). ACE includes in a class of zinc proteases that needs zinc along with chloride for their activation possess a good biological technique. Thus, ACE inhibitors like enalapril and captopril have been applied to hypertensive patients and hypertensive animals for lowering the blood pressure (Edelman, 2005).
For non-peptide ACE inhibitory drugs, inhibitory peptides against the angiotensin-1 converting enzyme act as the natural substitute biofunctional peptides. Many ACE inhibitory peptides are separated from the food proteins like the collagen and hydrolysate of gelatin (Jeon, 2000).

Enzymatic digestion of proteins is very crucial in potent bio-functional peptides and producing better nutritional values. Biotechnological researches from protein hydrolysates mainly concerned with the design and advancement of bio-functional peptide production (Jeon, 2000). Hypertension in animals can be treated by the administration of peptides with ACE inhibitory effects and considered as a vital auxiliary therapeutic approach for the treatment (Schiffrin, 2011). Thus, we have mainly concerned with the ACE inhibitory peptide (PTHIKWGD) which is revealed by Kohama et al. is originated from the thermal hydrolysate of tuna meat.

The use of specialized sires and dam lines in selection for the production of meat

It is very important to improve the value of progeny as well as performance hence cross-breeding systems are applied in beef cattle production so that prominent results of heterosis (non-additive effects) can be achieved. It is also vital to exploit the contrasts in the breed so that particular characteristics would merge. Crossbreeding proves very beneficial to successfully coordinate the maternal biological type with their significant nutritive and climatic environment as well as requirements of the market. This technique can also take advantage of significant variances. It can be used as an additive in determining genetic merit for growth rate and carcass quality of special terminal sire breeds. A breeding program cannot function in isolation since it requires a mating scheme, breeding goal, a suitable technique of extracting selection candidates, a method to access the program design and an appropriate method of genetic improvement (MacNeil, 1994). The first and most important stage in evaluating a well-organized breeding programme is to establish a breeding goal (Harris, 1994).

The base production herd is formed by the two-strain rotational cross of M1 and M4. Crossbred replacement females were produced as a result of this rotation, and surplus steers
and heifers were sold. Crossbred replacement heifers were bred to M3 bulls, and the entire crop was sold. The expression of driving variables affected by breed and heterosis. A supposed balanced breed composition of 1/2 (M1 M4) was observed in the two strain rotation of all calves which are produced by multiparous females. Whereas calves from primiparous females showed an assumed breed composition of 1/2M3 1/4(M1 M4). The expression of strain-specific direct and maternal additive effects has a proportion value in the breed composition. 100% of direct heterosis effects are expressed in the calves sired by M3 bulls but the remaining individuals expressed only two-thirds of maternal and direct heterosis.

The base cow herd is generated by the rotation of three strain M1, M2, and M4. This kind of rotation is produced by replacement heifers. Along with heifer’s surplus, steers were marketed. The breed composition of 1/3 (M1 M2 M4) was assumed in the three-strain rotation produced by all calves. The breed constituents of the individual and its dam was directly proportional to the maternal effects and expression of strain-specific direct. Those calves which were produced in three-stain rotation showed 86% of both i.e. maternal heterosis and individual direct. M3 or TX bulls have absolute (100%) direct heterosis expression and 86% maternal heterosis expression (MacNeil, 1994).

**Future benefits of artificial meat**

It was announced by the manufactures of lab-grown burgers that the usage of *in-vitro* meat drops the price of burgers from $325,000 to $11.36 or $80 per kilogram of cultured meat (Crew, 2015). Whereas the current rates of natural protein per kilogram looks like this; the rate of ground beef per kg $ 5.6, boneless bead for $9, pork on the bone costs $7.4, and the price of whole chicken meat is $ 2.6. Considering the results of greenhouse gas emissions of livestock, swiss management has even discussed a possible "meat tax" (Lerner, 2013).

The course of technological innovation is strongly influenced by the regulatory systems (Bruce, 2013). The demand for meat is continuously increasing which influences the availability of resources as they are continuously decreasing. The traditional way of meat production is creating complexity and is likely to incur maximum costs, which ultimately increase the cost of meat.
Whereas consumers are concerned about the treatment given to livestock and they also demand ethical justifications of slaughtering animals to fulfill human food requirements (Croney, 2012). Despite this, artificial meat is concerned with these issues in different ways and provides a solution. Consumers are also confident in buying the product which is similar to traditional meat (Richardson, 1994). The Swiss government has also debated a specific "meat tax" in response to the implications related to greenhouse gas emissions of livestock (Lerner, 2013). When the demand for meat increases it results in decreasing the availability of resources and the regulatory environment becomes difficult. Traditional meat products will endure great costs, which makes the meat more expensive. Commercialization is an important parameter and it includes modern technologies such as cloning technology, cultured in-vitro meats, and genetically modified organisms (GMO). These technologies have a prominent technological and regulatory barrier to commercialization. In-Vitro has some specific barriers to cross before entering the market. Some scientists claim that this technology will revolutionize the meat industry while some argue that it will never compete with commercialization (Chiles, 2013).

**Animal biotechnology and quality of meat production**

Animal biotechnology is a modern technology that emphasizes the specific fields and covers a broad spectrum including the polarities of basic and applied research, vaccines, gene manipulation, and development of molecular and diagnostics modelling. These fields are benefitted from innovative technologies like molecular markers, biotechnology tools, stem cells, and tissue engineering. The continuously increasing world population requires the more reliable and efficient quality of animal products, unfortunately, the numbers of farms are not increasing as the number of animals where they need good farms habitat. Furthermore, livestock production problems are also increasing (Thornton, 2010). Multidisciplinary studies such as animal biotechnology provide the solution to these problems. It is impossible for the common industries to provide the expected performance without the aid of innovation. The modern dairy farms execute data monitoring and thus enable the proceeding control of health, production and welfare of animals. Effective methods are required to genetically improve the livestock effective methods are necessary for exploiting this variation. Environmental changes are controlled with a buffer that includes genetic diversity. It has a
major role in selection and breeding for adaptability. The desirable traits are merged from the specific genes and these genes are selected and identified by using molecular markers. The selection of superior germ plasma is now possible and it can even be disseminated by artificial insemination, embryo transfer, and other reproductive methods. These innovations are valuable in the genetic modification of animals. Transgenes are beneficial for advances in the field of medicine and agriculture. The desirable characteristics in the livestock are also economically favorable such as fecundity, immunity to tolerate environmental stresses obtained by inserting new genes. It represents a breakthrough in the production of commercially vital stock. The transgenic technology also provides us the important proteins like insulin and clotting factors in the milk of livestock (Thornton, 2010).

**Conclusion**

The conventional meat industry is dealing with variable market place. Many customers need modifications in the traditional meat production industry. It would be destructive to the organization to take no notice of any of these pressures. Regulating authorities are adding up the novel, environmental rectification which can change the economical state of production. Whereas artificial meat innovations are using the modern technologies and techniques to fulfill the continuously increasing demands of the market, that has health concerns, animal welfare and sustainability of environment. Though, there are many challenges confronting these artificial meat products introduced in market at huge scale. Various products depending on untested technology, which is not ready to be introduced commercially and struggling with the environment yet they have to develop their place in the market. The market place has diversity and it demands distinct products for different consumers. The artificially manufactured products which are currently accessible to the customers are manufactured from mycoproteins and proteins obtained from plant. It is very difficult to diminish the conventional production of meat utilizing animals not least due to the ruminant's unique ability to digest cellulose. The company will confront challenges from a difficult market and regulatory climate, which will cause the industry to change as a whole. To have “market pull” gains in proficiency and quality, traditional broad livestock systems (pasture-based beef and sheep) will need to start improved mechanisms for transparent financial transaction and feedback.
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