Progression of plant-based nourishment: – A replacement of meat

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Abstract—Opting vegetarianism can save millions of animals which in turn will help our environment to grow efficiently. Plants have now become a boon to the food industries. They are a lead for us to make our future lifestyle healthier There are many disadvantages of consuming meat extracted from animals. It poses a major influence on our surroundings. Livestock slaughtering is one of the reasons for greenhouse emissions. On the other hand, meat alternatives are more ecologically approachable. Though the invention of meat alternatives is somewhat complicated and costly but it does not affect our surroundings. A large number of meat alternative producers are advancing to transform their invention. By generating competences, the food manufacturing corporations are looking forward to serve more and more customers. Mainly extrusion techniques are used for producing the plant-based meats. The flavour, texture and appearance play an important role in the food. Various innovations are done for replicating the taste, texture and quality of meat. The chief ingredients of the plant-based meats are proteins and fats. The Americans and the Europeans have started shifting towards the plant-based meats but Indians have just taken an initiative to develop plant-based meats. India being a developing country would require many more years to completely shift from animal meat to plant-based meat. These new developments of inventing plant-based meats will also have an enormous influence on the GDP growth of our country.

Index Terms—Healthier, Ecological, Extrusion, Innovations, Meat.

I. INTRODUCTION

It appears like a contradiction, doesn’t it: “Meats derived from plants”. The identical characterization of meat is that it is impossible to be plant-based, still rising alertness in the populace about healthy and supportable diets has directed to a mounting curiosity in plant protein-based meat substitutions across the globe. Meat is essentially made by means of traditional knowledge and skills. It is exclusively intended and prepared in such a way that it looks same, have same taste and flavour and also cooked similar to conventional meat. Various forms of plant-based meat are observed such as burgers, patties, nuggets, and also crumbles and sausages because of its popularity. There is a drastic change in meat industry due to these meat substitutions. There are several companies in the market who are focusing on this. For instance, two of the most renowned establishments – Impossible Burger and Beyond Meat have taken an initiative to design some plant-based meats such as sausages and crumbles. Both the products are planned in such a way that it replicates the ground meat. There are some further establishments like Garden Protein International, Morningstar Farms, Quorn Foods, Amy’s Kitchen, Maple Leaf Foods, Vegetarian Butcher, Tofurky, V Bites etc. who are evolving various plant-based food products for benefiting customers. Through the commencement of the coronavirus epidemic, the meat manufacturing was crashed via cautions of lack of meat due to unoperated plants. Submit your manuscript electronically for review.

II. INGREDIENTS

Proteins are big, composite compounds which are helpful in performing various functions in our body. They are responsible for building and repairing cells in our body and also regulates the tissues and organs present in our body. They comprise of long and short chains of amino acids. Whereas, the meat has various cons such as they are not good for our health. People consuming meat are at a high risk of developing tumours, heart ailment, overweightness. Due to the presence of high fat content the fat deposits leading to obstructions in the arteries. Therefore, there is a shift from meat to plant-based meat as a healthier option. This leads to a chance for sellers to grasp a large assembly by apprehensions associated with well-being of the individuals. The various ingredients of the meat alternatives are listed below:

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Ingredient Listed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>Soy protein, pea protein, soy beans, hydrolysed vegetable protein, soybeans, salmon</td>
</tr>
<tr>
<td>Fat/Saturated Fat</td>
<td>Vegetable oil, canola oil, sunflower oil, sunflower kernels, rice bran oil, cocon</td>
</tr>
<tr>
<td>Carbohydrate/Sugars</td>
<td>Potatoes, tapioca, rice flour, sweet potato, corn starch, potato starch, sugar, fructose, apple, tomato paste, wheat flour</td>
</tr>
<tr>
<td>Dietary Fibre</td>
<td>Brown rice, lentils, black beans, wheat flour, chickpeas, quinoa, red lentil, locust bean gum, buckwheat, jackfruit bean, split peas, green peas, whole wheat flour, soy flour, soy bean, mung beans, carrots, pumpkin</td>
</tr>
<tr>
<td>Vitamins and Minerals</td>
<td>Iron was added to 3/3137 products; (via supplemental iron or fortified flour), vitamin B12 was added to 28/137 products; zinc was added to 25/137 products</td>
</tr>
</tbody>
</table>

Figure:- Ingredients in plant-based meats contributing to key nutrients

The main component of these meat alternatives is proteins. Mainly proteins are extracted from soy, pea, soy beans and legumes because of rich protein content. Carbohydrates stands second as the primary ingredient. They are mostly extracted from wheat grains and potatoes because of high content of carbohydrates. Dietary fibres giving ingredients like lentils, chickpeas, quinoa brown rice etc. helps in proper digestion of the food. Mostly saturated fats are present which includes vegetable oil, coconut oil, peanuts, canola oil etc. Lastly, but an essential part comes from vitamins and minerals like iron, vitamin B12 and zinc are added. Vitamins
and minerals play an important role by enhancing the immune system, helps in healing the wounds and is also required by our body for repairing damaged cells. All these ingredients make the plant-based food healthier and tastier.

III. METHOD
Mainly two methods are used for making plant-based meats. These two methods affect the quality of meat produced.

A. Technique of extruding the materials
It is a combination of operating numerous units. High-temperature short-time (HTST) method and a high level of moisture content is being used for this purpose. This is helpful in reducing bacteriological infection and also deactivates the enzymatic activity. This technique contributes in making the surface of meat alternatives. Throughout this procedure the long and short chains of amino acids experiences both thermic pressure and pressure by the machineries due to the heat generated by the containers and clipping of bolts. Therefore, assembly of the amino acids are changed which leads to the development of solvable and unsolvable masses. Firstly, the chains of amino acids are heated then quickly the temperature is brought down for cooling. When cooling of proteins takes place, its aggregates passes by the narrow slit which helps in transforming the proteins and gives it a flexibility. If an extended chilling die is attributed at the termination point of the extruder machine, the long and short chains of amino acids will be united and go along in the same direction resulting in the formation of aeolotropic protein link. Many features in the output of the produces can be attained if we change the surroundings of the procedure. There are various specifications like container calefaction, rapidity of the bolt and shape which can be changed in the bolt segment through which the circumstances of the procedure are changed. Other specifications in die segment like the frequency of chilling and configuration of die can also be changed resulting in a change in the surrounding of technique. This helps in improving the elasticity of the procedure. The process of extrusion multivariable composite procedure and all the segments are connected. If there is a variation in one unit, the variation in another unit will also be seen. Thermic and mechanic conduct in extruding disturbs the atomic assembly and the assets of produce during the extrusion. Numerous output foodstuffs can be attained if there is a change in process surroundings while the product is being extruded in the environment of high moisture content. Newly, wet texturization is developed by means of twin screw extruding process in a fusion of a sequence of biochemical and physical methods to yield an additional stringy construction and imitating meat quality of the subsequent foodstuff. If the product is suitably pre-treated then higher range of protein molecules and additional constituents like extracts, thickeners and fibres can be used. Further if a stage in process is added, extruded form is treated additionally by means of established parts. At this point the product is cooled, united, surfaced and transformed to burgers, and other desired food products. The proteins having high moisture content are generally treated and packed in cold conditions. Most commonly cans and pouches are used for packaging these food products.

B. Technique of using shear cell
It is an innovative development. Higher degree and sheared-generated assembly development of combination of proteins can be attained by means of cone shaped trim compartment with high temperature. The perks of using this technique is that it can produce bigger fragments of stringy meat equivalents. It is reasonable in cost, easy and gentle to use.

IV. CHANGES OBSERVED IN QUALITY OF MEAT ALTERNATIVES

A. Texture
The proteins which are obtained by animals are elastic in nature and it helps in binding the meat. It’s hard to imitate the proteins of animals by means of plants. The reason for this is the vital variance among the muscular structure of animals and the plants as the basic requirement is flexibility and sponginess. For movement of the body the animals should transform their figure and pressurize the skin without any destruction. The cells of the plants are comparatively firm and inelastic. The taste of plant product is crispy and meat is stringy. The solution of this is to make the surface of meat alternative by using proteins extracted from wheat grains and peas. The most important aspect of beef meat is the fat extracted from the animal. This gives the meat is juicy flavour and makes it tempting. At high temperature range the beef meat gradually melts. The gradual melting of fat moistens the meat which lasts till masticating. This is somewhat tough for the fats derived from plants. The point at which the fat melts is related to the saturation level- the amount of single bonded lipids contrasted with double bonded lipids. The fats derived from animals are found to be more saturated as compared to the fats derived from plants. This is one of the reasons that animal fats are firm at normal degrees and oils derived from corn tends to be fluid excluding the oil obtained from the coconut which have high level of saturation. Due to this property of oil derived from coconut it is being used as prime source of fat in plant-based meat products so that it produces a tempting surface quality of the product. There is a disadvantage of coconut oil that it has the ability to melt at a lesser degree and at a rapid rate as compared to animal fat. So, this is able to provide the juiciness and good flavour of food product in the mouth but it vanishes at a faster rate. The food industries are still looking for different ways to improve this.

B. Appearance-

The plant-based meats have also developed different techniques to imitate the colour of the animal meat specifically focusing on red colour. In animal meats the myoglobin plays an important role which gives a red colour to the meat. It helps in transmitting the oxygen to cells of muscles from arteries and veins. There is a protein named haem which is responsible for surface quality and biological responses of the meat. Since we are focusing on extracting each and every component to make plant-based meats the red colour can be extracted from beets. Deoxyribonucleic acid is extracted from the roots of soy as it contains an iron composite which is helpful in transporting oxygen. This compound is known as leghaemoglobin. Genetic modifications in yeast and then the fermentation of the yeast is done for the production of leghaemoglobin. Coconut oil is included in very less quantity so as to replicate the surfacing of original meat.
C. Flavour-

The food companies have directly not revealed the extracts which they use for flavouring the plant-based meat products. Flavours which are extracted from the nature and the unnatural flavouring agents both are allowed but the specifications must be properly done irrespective of the processing and refining methods used. Since fats derived from plants melts at faster rate therefore the lipid-soluble flavouring components dissolve at a rapid rate during mastication.

V. DATA AND ANALYSIS

According to the studies, approximately a small fraction of the American populace of Americans are dynamically decreasing the ingestion of actual animal produced products. Whereas, a minor fraction of American populace eats vegetarian food and some eat large variety of foodstuffs but almost negligible amount of food that comes from animal sources. Most of the population has shifted towards consuming foods that come from plant source. In United States the meat alternatives are sold much more than actual meat products. The meat alternatives group are worth $939 million. In 2019, the sale of meat alternatives were approximately 208 million units. It is also observed that in 2019 meat alternative industry sales were increased by 18%. Whereas, in 2018 its sales increased by 20%.

The youngsters are focusing on their lifestyle and shifting towards plant -based sources for a healthy lifestyle. The ecological aspect and well -being of an animal are the influencing prospects for the population.

In United States the meat alternatives are observed to be lower than 1% of total meat sold in the country. Though this appears to be almost insignificant, but the industry is rising as the year passes by, signifying the fact that there is a chance of a great revolution in the production and consumption of food products. The customers of the United States purchased around 157 million units of meat alternatives in 2019, leading to around 23% growth of the industry in comparison to 2018. This type of growth will persist the standard over the coming years. According to the Global Food Institute by the year 2025, the meat alternatives will increase to 6.5 billion dollars. The meat alternative industry nurtures, it has the capability to support the biosphere and evade the long-lasting food uncertainty. According to the United Nations, by 2050, around 815 million individuals worldwide are malnourished and further 2 billion individuals are projected to link these levels. As weather modifies, it reduces agronomic productivity throughout the globe, the United Nations boosts nations to make their food invention organizations extra supportable by increasing additional nourishing harvests as a substitute of producing the meat products.

For the year 2019 and 2015 the predictable market rate section of plant-based products as per the various district are shown. In the last year 2019, approximately 42% of the market portion for plant-based products was constituted by North America. It is being predicted that till year 2025 North America market worth will increase till 44.37%. The market share of rest of the world in 2019 only constitute about 5.22% and in future it is being predicted that it will decrease from 5.22% to 3.86%. From the year 2018 to 2026 the predictable market worth of meat alternatives globally has tended to increase. In the year 2018, the market price of plant-based products in United States is projected to be around 10.1 billion $ and is estimated to increase till 30.92 billion $ by 2026.

Covid leaves an outstanding a focus for customers to assess their personal food selections and giving them an option whether they should purchase animal- based meat or switch to plant -based products. After Covid-19, there are several explanations which emphasises on the fact that meat alternatives should be adopted. Aspects such as urbanism, populace development, and an increasing worldwide
intermediate economy group accompany more ingestion of animal-based products. According to United Nation, around 55% of the global populace exists in built-up areas. In future it is predictable that it till 2050 it will reach 68%. In the meantime, the global populace is predictable to flow till 9.7B by the year 2050. This will lead to an enormous manufacture of food products. Evolving marketplaces are lashing with this development. China stands out to be the highest customer of meat products with approximately 4% increase in protein ingestion every year because of the mounting intermediate economy group. As per Plant Based Foods Association, in 2019 the yearly trade food market was elevated by 2.2% but plant-based food products increased by 11.4%.

![Market value of plant-based meat worldwide from 2018 to 2026](image)

**VI. CHALLENGES FACED**

Besides working on such innovative technique to develop meat substitutions for benefiting a lot of vegans there are some obstacles faced by the establishments. These obstacles are as followed:

- **Sense of taste is of paramount importance** - This is the utmost quoted barricade for designing plant-based meat. The clients who consume these products are still not satisfied with the taste of this. At initial stages they found it tasteless. As times passed though the sense of taste has been improved but till now it has not reached up to that level of actual meat. The alternatives of proteins do not replicate the sense of taste of the actual meat. People demand for best sense of taste at low price.
- **Emphasis on nutritional content** —Since there is an increase in the health issues and the diseases are hitting hard to humans’ people are bending towards more nutritious food. Around 83% of the people said that plant-based meats are the correct option if anyone is looking for a nutritious diet. The emphasis on substituting the meat products with much better sense of taste leads to a developed analysis on labelling of nutrients like the amount of salt present in plant-based meat. People challenges the company for a healthier option. They wish for healthy diets with satisfactory and efficient constituents with existence of deliciousness. The producers reflect in enriching the nutritious aura of these foodstuffs, framing with less sodium levels, superlative fat content, with amino acids and proteins as an addition.

  - Labelling of constituents present in the food: Generating produce with distinction in a progressively inexpensive group with hygienic tag on foodstuffs is a chance to make a stand in market. Hygienic tag on foodstuffs marks the plant-based meat trade, by customers questioning about the invention of the product and its constituents. Confirming a hygienic and nutritious tag on the produce, without any unnatural -additives, flavours and colours are the basic need of customer.

- **Distinction of protein rich foods** - Plant-based meat customers do not wish to compromise with the hight protein content which they usually get from the actual meat. Approximately 40% of the customers nominated protein rich food as the significant characteristic while selecting a plant-based meat substitute. Protein content can mark a great change in the sense of taste, firmness, uniformity and the cooking method of the product. This is a great obstacle for the manufacturers to make sure that the output of the product is possible to be made at both home and cafeterias. Though the customers practical information on protein gambled to be nominal, the customers still embrace the view of protein substitution. According to the studies approximately 62% of the pulses, 55% of the nuts and 48% mushrooms are referred to as rich alternative sources of proteins.

- **Innovative arrangements indicate type of development** - Presenting a wide-ranging assortment of plant-based aids will eradicate desirability-biasness and raise customer acceptance of plant-based meat. Still, when framing a plant-based resolution, it has been observed that seeing the assembly, sense of taste, and consistency of the alternative meat is important in bringing a complete good sense of taste.

- **Rate of plant-based meat**- It is a great obstacle for the manufacturers to design a product whose cost is equal to or less than the cost of actual meat. It all depends on the manufacturers how well they can copy the actual meat. Consumer demands for safe and nutritious food at nominal price.

  - The problem faced by populace who faces allergic reactions due to plant- based meat bases like soy and wheat.

**VII. GLIMPSE OF THE FUTURE**

In past ages, the custom of substituting the meat with plant-based meat was inspired by means of financial and spiritual motives. Another inspiration for this was animal’s well-being. Lately this innovation has gained a place in market because people want to remain fit and maintain a good suitable nutritious diet. Also, customers demand for innovative foodstuffs. Currently there is a drift in sponsoring numerous cultured foodstuffs from several uncooked ingredients. There are many protein sources which we get from plant like - legumes and grains which vegans include in their diet. These sources are easily accessible, inexpensive and can be kept in normal conditions. The other products like tofu, tempeh is also rich in proteins. They can easily stand out in competition with meat and fish products with respect to the nutritive value which serve the purpose of good nutritive mechanism. Concurrently, meat substitutions are fetching the accessibility in cafeterias and marketplace. According to the
research studies, there are chances of swiftly rising of the meat substitution sections among the target groups. In the coming years we can expect the decline in the price of plant-based meat. Continuous developments in the genomic technology and lab grown inventions will improve the product quality to stimulate feeding. These advancements will be able to endure to increase the intact meat and seafood groups like pork, and duck. We will be able to see straight competition among the obligatory meat products. Amidst Covid-19 create scarcities and the increased customer emphasis on decent ingesting and substitutive meat foodstuffs are sighted in mounting awareness, seizing stakeholder and communal considerations. Numerous start-ups have been coming up with new ideas and contributing in plant-based dairy, poultry and meats products. The motive of these start-ups is increasing investments and growing their manufacture and making money throughout the year. They are an asset to the globe contributing to GDP. Product assignment have a huge influence on market sales. When the hypermarkets will take an initiative to bring plant-based foodstuffs there will be a rise in the sales. With an increasing rise in the plant-based industry the long-lasting food uncertainty will get diminished. Plant based industry also impacts our environment. To produce 1 calorie meat, we need a lot of capitals from harvests, aquatic life and terrestrial property. Correspondingly meat manufacture results in erosion, terrestrial deprivation, and aquatic pollution. Offering a little of its terrestrial property to plant-based foodstuffs would decrease the quantity of yield essential to provender the world and permit agriculturalists to cultivate produces that renew lands.

Conclusion

There are many countries facing obstructions in creating plant-based meats. A step to sustainable surroundings and healthy lifestyle is not so easy but the new innovations of the food processing industries will make it possible soon. This drift in new developments will have a huge impact on the country’s GDP growth. Plant based meats are costly not because of the ingredients used but because of the techniques used to make it. Food industries are trying their best to exactly replicate the quality of the original meat that is being sold in market. Due to the coronavirus pandemic people are getting more conscious about their lifestyle. They are trying to opt vegetarian foods. Vegetarian foods are much more nutritious than meats as it comprises of all plant sources. According to the caloric content, meat substitutions are like to actual meat. Advantage of meat substitutions are that they are low in cholesterol, contains a small amount of fibre in addition which original meat lacks. Plant sources are inexpensive and affordable. As people will get aware of this and the advantages of consuming plant-based meat, the consumption of meat substitutions will dramatically increase.

REFERENCES
