

Key Attributes for Success of Plant-based Meat Alternative - Nutritional Values, Functional Properties, Suitability for Diverse Use and Price Parity

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Review Article

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Abstract

There is an unmet need, but still a growing demand from the consumers for the meat alternatives derived from plant sources, that is acceptable to all, safe for consumer, safe for the environment, easily available and price wise affordable. Global concerns on decline of animal protein resources, animal diseases, environmental, economical and few religious concerns are believed to be the reasons for the increasing demand for the meat alternatives from plant resources for human consumption. Soybean proteins, wheat gluten, pea proteins, mycoproteins and other plant proteins are being used as the source material for manufacturing of the plant meat alternatives. The final plant meat product would resemble meat in taste and texture. The coming decade would find improved formulations with enhanced nutrition, taste and texture akin to meat products.

In changing lifestyle scenario, consumers demand for meat alternatives is increasing day by day and plant meat becomes one of the best alternatives for the consumers. Plant meat, also known as Vegan meat, Vegetarian meat, Meat analogue is the Meat alternative containing the meat mimicking substances derived from plant sources, typically having the taste, texture, flavor and appearance like a meat. Plant meat is a fast-growing market, targeting vegetarians, vegans, those wanted to reduce meat consumption for health reasons and those follow religious dietary laws. Many of the consumers, once non vegetarians are shifting to plant based diet for varieties of reasons., viz., Taste preference, protection of animals, environmental concerns and general health concerns [1].

Health concerns and environmental concerns are the two major reasons for the innovation of plant proteins-based meat analogue. The environmental challenge and depletion of natural resources for the sustainable meat production by Live Stock Industry which requires an estimated 40% land, 29% fresh water 36% Crop Calories and 14.5% green house gas emission trigger veganism due to environmental concern [2-4]. The flexitarians, also known as semi – vegetarians occasionally include meat in their diet are rapidly increasing for the above reasons. Veganism is rapidly growing in Australia since 2018 followed by United Kingdom and New Zealand. A fivefold increase of Veganism was reported in USA from 2014 to 2017 [5] .

The plant based meat products are made from vegetarian ingredients, mainly soya based, gluten based or from pea proteins. Mycoprotein also is a less commonly used ingredient in plant meat products. The final product of plant meat tastes and textures like chicken/beef/lamb/sausage/sea food etc. Global food industries concentrating on meat alternatives that

deliver taste, flavor and texture to catch the fast growing market on meat analogues. Although plant based proteins mainly rely on Soy and wheat protein, the global market is expanding for non soy gluten free plant based proteins projected to be \$1.5 billion by 2022. There are varieties of plant meat products available in the market which include, earlier formats like Tofu, Tempeh, Seitan, Veg Burgars, Patties and current improved formats like Sausages, Deli Slices, Crumbles and Nuggets, targeting mainly those working to reduce meat consumption in their diet. The next decade would see that this plant meat market would continue develop with more newer formats of products with much improved flavors, textures and mouth feel experience.

A Plant Derived Beef Substitute by Impossible Foods claimed to offer taste, cooking and appearance similar to beef. It is claimed that the product, when cooked is virtually indistinguishable from beef.

Beyond Meat, a California based meat analogue producer uses soy protein for its ‘Beyond Chicken’ which tastes like chicken strips. Other meat like products of Beyond Meat include that mimic beef and pork sausage.

With introduction of plant based ‘Awesome Bargar’, Nestle also entered the meat analogue market. Awesome Bargar is designed to look, cook and taste like a real beef burger when tapped with onion, tomato, lettuce and condiments.

It is an established fact that it would be more challenging to mimic meat through plant protein as they contain insufficient essential amino acids and trace elements that imitates nutritional value of the animal meat products. The meat analogues currently available in the market may not be able

to equal the essential fortified elements [6]. Chemically synthesized essential components to mimic meat analogue or extraction from plant sources through various processes are raising debate among eco-friendly consumers [6].

The major challenge for the plant meat industry is developing the quality attributes of acceptable standards of the plant meat to its counterparts, which solely depends on the characteristics of the ingredients used [7, 8]. For Plant meat manufacturing either pilot scale or large scale, its protein must be unfolded, cross linked to align the protein in to fibers and texturize the proteins via techniques like extrusion, shear flow and spinning, followed by solidification through heating, cooling and drying [6, 9].

One of the major characteristics of manufacturing plant meat products is the texture resembling the meat and the other attribute is its fibrous like structure. The texture of Plant meat product is typically produced by Extrusion Technique, in earlier days using Low Moisture Extrusion Technique, later replaced with High Moisture Extrusion Technique. Although both the methods have their own advantages as well as the disadvantages, High Moisture Extrusion Technique is better preferred for meat like products [10]. High moisture extrusion technology is a boon for vegan products, offering a better potential for meat and plant meat industries. The technology offers generation of texture of vegetarian proteins that mimics meat [11]. Typical products of extrusion technology includes snacks, breakfast cereals, flat breads, noodles, chewing gum and crumbs. Plant meat products manufactured by high moisture extrusion technique, texture wise resembles muscle meat. The high protein content, texture and palatability are similar to cooked meat high with nutritional values [12]. Another major challenge in the manufacture of plant meat product is the efficient generation of fibrous appearance. This can be effectively generated by a well-defined Shear Flow. The Shear induced anisotropic biopolymer structuring is the result of elongated protein filaments oriented along the direction of the Shear flow, entrapped in a continuous protein phase [13].

Most of the plant meat products available in the market contain isolates of soy protein, a highly pure form of soy protein with a minimum protein content of 90%. Soy protein isolates are typically extracted by dehulling or decortication of the seeds of soy beans followed by treating them with solvents to extract the oil substances, treated with alkali to dissolve the protein, leaving behind the carbohydrates, further treated with acidic substances to precipitate the protein, washed, dried and purified. The protein isolate is considered as a complete protein containing all the essential amino acids and it is free from fats and carbohydrates and relatively has a neutral flavor. To mimic the meat and to increase the palatability, lipids are added in semi liquid glyceride or in liquid form. Usually plant based lipid sources, viz., olive oil, soybean oil or canola oil is used. The finished products contain flavor compound, coloring agents, leavening agents and emulsifiers.

Filamentous mycoprotein which is naturally low in fats, high

fiber content and high quality protein with an excellent amino acids profile is also used for plant meat production, because it offers fibrous texture akin to meat in the final product. The technology involves fermentation of the soil fungus *Fusarium* to isolate the mycoprotein. The filamentous fungus is produced in bioreactors under controlled conditions and further processed by forming, steaming and texturizing. Plant meat-mycoprotein are commercially available as Chunks, Sausages and Burgars [14-16].

Shandi's Plant Chicken

Shandi's Plant Meat product claimed to provide an affordable plant based chicken meat alternate free from artificial additives and has naturally built chicken taste. The product is shown to exhibit the same nutritional functions, digestibility and anyone can consume it without compromising on taste and nutrition of everyday food. The product strategy includes synergizing amino acids and nutrients similar to meat at molecular level derived from plants and delivering functional proteins naturally



The product is claimed to be advantageous as it is

1. Affordable, priced at 1 USD per 100gm v/s min. 4 USD per 100gm
2. Easily digestible with faster absorption and Can be consumed three times a day
3. Available in Boiled and roasted formulation,
4. Clean Label – Free from artificial ingredients.

Plant Meat Market

As consumers prefer meat alternatives and sustainable food, there is an increasing demand for plant meat, notably in Western Countries with Europe dominates the market for meat alternatives. Big companies are expanding their market share due to the increasing demand on meat alternative. There is a market prediction of \$1.4 Trillion based on the sales of meat alternatives in Western Countries. Small players and startup companies also enters in plant meat market due to its demand. Increasing acceptance level in Asian countries is also predicted as consumers become more familiar with plant meat [17]. A survey on consumer preference for meat alternatives revealed that China with 95.6% and India with 94.5% dominates the USA with 74.7% preference level [17]. Plant meat market according to FAO [18] continues to grow in developing countries and expected to reach up to 73% by 2050, thus Asian countries could also be a potential market for meat alternatives by plant proteins.

Regulations on plant meat alternatives

Food Safety Standards are the statutory documents enforced by law and implemented by authorities, to safeguard human health containing the safety requirements of food and its manufacturers to comply with. The national regulatory agencies are responsible for enforcement of these standards and ensuring compliance by manufacturers.

In order to ensure good practices on plant meat market, it is essential to revisit and upgrade food laws and regulations in the public interest. The three basic principles of EU in food regulation, viz., i) Consumer Safety ii) Appropriate Labeling to avoid misleading the consumers and iii) Intended replacement by novel food should not be by any means nutritionally disadvantages to consumers and should be strictly under regulation in plant meat market [19].

According to World Health Organization (WHO), five key elements to ensure food safety, viz.,

1. Keep Clean
2. Separate raw and cooked
3. Cook Thoroughly
4. Keep the food at safe temperature
5. Use safe water and raw materials

These key elements, describing handling, preparation and storage of food to prevent food borne illness and to avoid potential health hazards through food processing, have been translated in 40 languages and spread across the world (www.who.int/food_safety/consumer/5_keys/en/index.html)

ISO 22000 is the standard, developed by International Standard Organization (ISO) which specifies the requirements of food safety management system to provide safety standards for end products that is as far as safe from pathogens and other contaminants. ISO standards are reviewed every five years to ensure that the set standards remain relevant and useful to business practices and to determine whether a revision is necessary.

The main concern is that the manufactured food products in terms of ensuring safety in manufacturing and delivery should be safe in the market for consumers.

Food contamination could be possible in production process, storage condition, packaging process, transportation and unhygienic condition while cooking. The contaminants are classified in to:

Physical Contamination, i.e., sources of contamination through objects like hair, nails, glass or other small particles, metals, stones, etc.

Chemical Contamination, i.e., sources of contamination through chemical substances, which include unapproved food additives, adulterants, residues of pesticides, herbicides, inclusion of over the limit preservatives etc.

Biological Contamination is caused through microbes, pests,

rodents, remnants of human wastes through unhygienic practices, like saliva, sweat, blood components, etc.

Safe manufacturing, following Good Manufacturing Practices (GMP), and safe handling procedures from industry to consumers ensures food safety.

Under safe manufacturing practices, food adulteration/food poisoning is 100% preventable, however, the fact that the pathogens could be introduced in to food products, no matter how much precautions are taken. It is the acceptable fact that food products serve as a growth medium as well as reproductive medium for the pathogens (Bacteria, Virus, Mold, Fungus etc.) to multiply at faster rate which can cause morbidity and some cases mortality in animals as well as human. Water used in production process is also a critical point in causing contamination. There are intricate standards enforced in developed countries for food industry, however, in developing countries or lesser developed countries, these regulations are much relaxed and its enforcement is relatively poor.

Conclusion

In the coming years, with the improved technology and resources, it is feasible to meet the growing demand in manufacturing the meat alternatives from plant sources having ethical, cost effective, high nutritional value and low environmental impact. High Moisture extrusion and shear flow technology make the production process easier, affordable at large scale and texture like muscle proteins. The appearance eating sensation and mouth feel experience of the final product would be similar to cooked meat and its high protein contents offer nutritional value. Safe manufacturing practices, large scale production, shelf life and safe handling procedures free of contamination are few of the concerns to be taken care of to ensure food safety for consumers.

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