



FOOD PROCESSING

Towards Sustainable Growth Opportunities

A close-up photograph of a hand holding a bunch of fresh, vibrant green leafy vegetables, likely lettuce, in a hydroponic system. The background is a blurred field of similar plants, suggesting a large-scale agricultural or food production setting.

**A FOCUS PAPER ON
PLANT BASED PROTEINS**



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TABLE OF CONTENT

01	Introduction	01-06
02	Plant-based proteins - challenges and opportunities	07
03	From Plants to Protein: The Art and Science of Plant-Based Meat Processing	08-09
04	Understanding the Bioavailability of Plant-Based Proteins	10-12
05	Benefits of Plant-Based products and Meat Alternatives	13
06	Plant-Based Protein Industry Regulations and Compliance	14-15
07	Market Overview	16-17
08	Market Analysis	18-19
09	Conclusion	18-19

ABSTRACT

The popularity of plant-based proteins and meat alternatives is on the rise, driven by recognized health advantages, sustainability concerns, and ethical considerations. This focus paper explores the opportunities and challenges in the Indian plant-based protein market and the meat alternatives industry. The paper discusses the various sources of plant proteins, including amaranth, quinoa, millets, tofu, soy, tempeh, and pulses, and highlights the potential of seaweeds as a comprehensive amino acid source. It emphasizes the need to incorporate plant proteins into the diet to mitigate the negative environmental impact of animal protein production.

The challenges in the plant-based protein market are addressed, including the replication of meat-like taste, texture, and sensory aspects, the bioavailability of plant-based proteins, and consumer perception barriers. The paper explores processing techniques such as thermoplastic extrusion and fibre spinning, which play a vital role in the production of plant-based meat analogues. It also discusses the strategies to enhance the bioavailability and digestibility of plant-based proteins through processing techniques and combinations of different protein sources.

The benefits of plant-based products and meat alternatives are highlighted, including their lower environmental impact, reduced saturated fat and cholesterol content, and potential health benefits. The paper examines the sustainability aspects of the meat industry, including deforestation, greenhouse gas emissions, and water pollution, and explains how plant-based meat alternatives address these concerns.

Regulatory compliance and guidelines for the labelling and display of plant-based food products are discussed, with a focus on the regulations governing vegan foods in India. The market overview highlights the growing demand for plant-based proteins, both domestically and globally, and the potential for India to become a major exporter of plant-based goods and ingredients.

The paper concludes by discussing the emerging trend of cell-cultured meat as a novel alternative to conventional meat. Although facing regulatory challenges, cell-cultured meat offers ecological benefits and is perceived positively by consumers.

Overall, this focus paper provides insights into the current landscape and future prospects of the Indian plant-based protein and meat alternatives industry, offering valuable information for entrepreneurs, investors, and consumers interested in this growing sector.

01.

PLANT-BASED PROTEINS INTRODUCTION

Plant protein serves as a substantial protein source in the human diet, originating from diverse plant species, such as amaranth, quinoa, millets, tofu, soy, tempeh, seitan, nuts, seeds, specific grains, and peas¹. Additionally, the residual material derived from oil extraction from oilseeds, commonly referred to as oilcake or meal, represents a significant reservoir of plant protein. Groundnut cake demonstrates the highest protein content (45–50%) among the various types, followed by soybean, cottonseed, rapeseed, sesame, sunflower, palm oil, and olive oilcake². Seaweeds exhibit a comprehensive spectrum of amino acids essential for human nutrition, with a notable presence of glycine, alanine, arginine, proline, glutamic acid, aspartic acid, and nearly all indispensable amino acids. Furthermore, pulses, including chickpeas, lentils, various bean types (e.g., black, kidney, adzuki), and split peas, constitute another abundant source of proteins.

The popularity of plant-based proteins is rising steadily, driven by their recognized health advantages, sustainability, and ethical considerations. The demand for protein, both from plant and animal sources, has witnessed a notable increase. However, the escalating demand for animal protein has raised concerns regarding its negative impact on environmental resources

¹ Gayathri Balakrishna and Renée Goodrich Schneider, The Role of Amaranth, Quinoa, and Millets for the Development of Healthy, Sustainable Food Products—A Concise Review

² Renu Singh^{1*}, Sapna Langyan^{2*}, Seema Sangwan³, Bharti Rohtagi³, Ashish Khandelwal¹ and Manoj Shrivastava¹, Protein for Human Consumption from Oilseed Cakes: A Review



Source: European Food Research and Technology ¹⁰

However, the escalating demand for animal protein has raised concerns regarding its negative impact on environmental resources. A growing body of clinical evidence supports the health benefits associated with protein intake, particularly for older adults, as well as adolescent, vegetarian, and malnourished populations³. These benefits include enhancements in lean body mass, functional improvements such as increased leg power and gait speed, and enhanced bone density^{4 5 6 7 8}. Despite the market push for protein-rich options, concerns persist regarding the environmental sustainability of scaling up high-quality animal protein production, as it necessitates substantial amounts of plant protein and can have detrimental effects on land and water resources, as well as greenhouse gas emissions⁹. To address these concerns, incorporating plant proteins into the diet can provide sufficient high-quality protein while mitigating potential adverse environmental consequences.

³ Henchion M., Hayes M., Mullen A.M., Fenelon M., Tiwari B. Future Protein Supply and Demand: Strategies and Factors Influencing a Sustainable Equilibrium

⁴ Hudson J.L., Wang Y., Bergia Iii R.E., Campbell W.W. Protein Intake Greater than the RDA Differentially Influences Whole-Body Lean Mass Responses to Purposeful Catabolic and Anabolic Stressors: A Systematic Review and Meta-analysis

⁵ Houston D.K., Nicklas B.J., Ding J., Harris T.B., Tylavsky F.A., Newman A.B., Lee J.S., Sahyoun N.R., Visser M., Kritchevsky S.B. Dietary protein intake is associated with lean mass change in older, community-dwelling adults: The Health, Aging, and Body Composition (Health ABC) study

⁶ Mitchell C.J., Milan A.M., Mitchell S.M., Zeng N., Ramzan F., Sharma P., Knowles S.O., Roy N.C., Sjodin A., Wagner K.H., et al. The effects of dietary protein intake on appendicular lean mass and muscle function in elderly men: A 10-wk randomized controlled trial

⁷ Oikawa S.Y., McGlory C., D'Souza L.K., Morgan A.K., Saddler N.I., Baker S.K., Parise G., Phillips S.M. A randomized controlled trial of the impact of protein supplementation on leg lean mass and integrated muscle protein synthesis during inactivity and energy restriction in older persons

⁸ Park Y., Choi J.E., Hwang H.S. Protein supplementation improves muscle mass and physical performance in undernourished prefrail and frail elderly subjects: A randomized, double-blind, placebo-controlled trial

⁹ Pimentel D., Pimentel M. Sustainability of meat-based and plant-based diets and the environment

¹⁰ Singh, Meenakshi & Trivedi, Nitin & Enamala, Manoj & Kuppam, Chandrasekhar & Parikh, Punita & Nikolova, Maria & CHAVALI, Murthy. (2021). Plant-based meat analogue (PBMA) as a sustainable food: a concise review. European Food Research and Technology. 247.

10.1007/s00217-021-03810-1.



02.

PLANT-BASED PROTEINS: CHALLENGES AND OPPORTUNITIES

Plant-based proteins present multiple prospects for food companies, entrepreneurs, and consumers, including alternative food choices, health advantages, and the potential for innovative product development. However, the plant-based protein industry also poses several obstacles, such as regulatory obstacles, taste and texture restrictions, and competition from traditional animal-based protein products.

2.1 CHALLENGES

One of the primary obstacles in developing plant-based meat alternatives lies in successfully replicating the appearance, texture, flavour, and mouthfeel of conventional meat products. While vegetarian and vegan consumers may be more accepting of plant-based alternatives that do not closely resemble meat, omnivorous and flexitarian consumers prefer alternatives that closely mimic meat properties^{11 12}.

Taste emerges as the most significant factor, with some consumers refusing to purchase protein alternatives due to concerns about taste¹³. Additionally, consumers frequently associate taste with regular meat in contrast to meat alternatives¹⁴. This highlights taste as a crucial driver favouring conventional meat, presenting a challenge for the food industry to match the flavour of meat alternatives with that of regular meat.

¹¹ Michel, F.; Hartmann, C.; Siegrist, M. Consumers' Associations, Perceptions and Acceptance of Meat and Plant-Based Meat Alternatives

¹² Reipurth, M.F.S.; Hørby, L.; Gregersen, C.G.; Bonke, A.; Perez Cueto, F.J.A. Barriers and Facilitators towards Adopting a More Plant-Based Diet in a Sample of Danish Consumers

¹³ Michel, F.; Hartmann, C.; Siegrist, M. Consumers' Associations, Perceptions and Acceptance of Meat and Plant-Based Meat Alternatives

¹⁴ Ibid

Interestingly, consumers find plant-based alternatives more convincing when they imitate processed meat products such as hamburgers, sausages, and nuggets, compared to imitating unprocessed meats like steak¹⁵. This distinction is likely due to the ease of replicating the texture of processed meats compared to the intricate composition of unprocessed meat. Consequently, meat alternatives have a higher chance of acceptance when presented in formats resembling processed meat products, such as burgers and sausages.

Another challenge associated with plant-based proteins is their bioavailability and amino acid profiles. Certain plant-based proteins, such as soy, exhibit similarities to those found in eggs. However, the presence of anti-nutrients like phytates, tannins, and saponins can impact protein absorption. Studies have reported lower consumption of certain amino acids, such as lysine and methionine, in vegetarians compared to omnivore^{16 17}. Other research has indicated that plant-based protein sources generally have lower concentrations of amino acids like methionine, lysine, tryptophan, and threonine¹⁸. Nevertheless, a well-planned and balanced plant-based diet, combining and complementing different amino acids through a variety of plant-based foods, does not lead to protein deficiency^{19 20}.

Furthermore, various mechanical and thermal pre-processing techniques can be used to mitigate the presence of anti-nutrients and improve the sensory aspects of plant-based proteins.

Techniques, such as roasting, dehulling, blanching, soaking, cooking, and sprouting, can be employed to mitigate the presence of anti-nutrients like protease inhibitors and improve sensory aspects such as off-flavour, mouthfeel, and colour. However, certain anti-nutrients exhibit high resistance to such treatments. For instance, phytates cannot be completely eliminated even through heating at 100 °C, and a fermentation process that generates phytases capable of hydrolysing phytates into myoinositol and phosphate may offer greater efficacy²¹. Consequently, there is a necessity to develop plant-based food products that encompass all essential amino acids or at least the majority of them, while also minimizing the presence of anti-nutrients that impede their bioavailability. Moreover, the application of the concept of complementarity, considering the amino acid composition of different plant protein sources (such as combining grains and legumes in a meal or throughout the day), holds potential for the development of novel food products and meat analogues with optimized nutritional and sensory qualities.

¹⁵ Ibid

¹⁶ Tangyu, M.; Muller, J.; Bolten, C.J.; Wittmann, C. Fermentation of Plant-Based Milk Alternatives for Improved Flavour and Nutritional Value

¹⁷ García-Maldonado, E.; Gallego-Narbón, A.; Vaquero, M.P. ¿Son las dietas vegetarianas nutricionalmente adecuadas? Una revisión de la evidencia científica

¹⁸ Chardigny, J.-M.; Walrand, S. Plant Protein for Food: Opportunities and Bottlenecks

¹⁹ Ibid

²⁰ García-Maldonado, E.; Gallego-Narbón, A.; Vaquero, M.P. ¿Son las dietas vegetarianas nutricionalmente adecuadas? Una revisión de la evidencia científica

²¹ Tangyu, M.; Muller, J.; Bolten, C.J.; Wittmann, C. Fermentation of Plant-Based Milk Alternatives for Improved Flavour and Nutritional Value

²² Aschemann-Witzel, J.; Gantriis, R.F.; Fraga, P.; Perez-Cueto, F.J.A. Plant-Based Food and Protein Trend from a Business Perspective: Markets, Consumers, and the Challenges and Opportunities in the Future.

²³ Corrin, T.; Papadopoulos, A. Understanding the Attitudes and Perceptions of Vegetarian and Plant-Based Diets to Shape Future Health Promotion Programs

²⁴ Bryant, C.J. We Can't Keep Meating Like This: Attitudes towards Vegetarian and Vegan Diets in the United Kingdom

Research consistently highlights the perception that vegetarian and vegan diets are deemed inconvenient, requiring complex cooking or preparation methods, and often facing limited availability of ingredients in stores^{22 23}. While many meat-eaters acknowledge the advantages of transitioning to a more plant-based diet, they find vegetarianism and veganism inconvenient, costly, or lacking in enjoyment²⁴.

These factors hinder the acquisition and consumption of vegetarian and vegan products, even when individuals are aware of their environmental and health benefits.

Established meat and dairy industries possess a well-established infrastructure and supply chain, which may compete with the plant-based industry as these industries begin producing their own plant-based alternatives. Additionally, lab-grown meat and dairy products are creating buzz and may also pose a threat to the plant-based protein market.

Additionally, the higher cost, limited variety, and distribution of plant-based protein can present barriers for some consumers. Processing facilities and infrastructure for locally sourced raw materials are inadequate, leading to start-ups depending on expensive imports. The technical challenges of taste, texture, processing, functionality, and digestibility of some plant-based foods also limit their adaptability and acceptability. Moreover, there are supply chain issues, limited availability of high-quality ingredients, and a lack of suitable supply chain arrangements that pose significant challenges for the plant-based food market.



2.2 EMERGING OPPORTUNITIES IN THE PLANT-BASED PROTEIN MARKET

In the Indian market, there is a notable presence of more than 56 brands, 300 SKUs (Stock Keeping Units), and 30+ formats across all three technology categories: plant-based, fermentation-derived, and grown²⁵. During the previous years, a considerable number of companies have surfaced in India, introducing and assessing their plant-based food products, indicating unparalleled growth. Entrepreneurs are actively exploring innovative protein sources, including indigenous crops like millets and pulses, as well as microalgae and seaweed, capitalizing on India's agricultural diversity and extensive coastline.

Furthermore, India currently accommodates a substantial number of businesses, specifically focusing on deep-tech innovations like cultured meat and precision fermentation. The country not only holds promise as a significant market for smart protein but also has the potential to become a major exporter of plant-based goods and ingredients. According to a study, the projected export potential for plant-based meat in 2030 ranges from Rs 2,194 crore to Rs 6,824 crore. Similarly, the estimated export potential for plant-based dairy falls within the range of Rs 459 crore to Rs 1,889 crore. As for plant-based eggs, the export potential in 2030 is projected to be between Rs 266 crore to Rs 631 crore²⁶.

²⁵ Nuf Foods Spectrum. Smart protein sector is poised to create 4 lakh jobs in India by 2030

²⁶ Ibid

India's plant-based food industry presents numerous flourishing opportunities, which are supported by the following factors:



RISING HEALTH CONSCIOUSNESS:

The surge in plant-based diets in India is primarily propelled by the escalating health consciousness among consumers, who actively seek sustainable and nutritionally rich food alternatives.



EXPANDING VEGETARIAN DEMOGRAPHIC:

India boasts a sizable and expanding vegetarian population, establishing a substantial market potential for the plant-based food industry to cater to the preferences and needs of this consumer segment.



GOVERNMENT BACKING:

The Indian government has demonstrated a growing inclination to support the development of the plant-based food industry. Recognizing the industry's potential for growth and job creation, the government has undertaken initiatives and policies to facilitate its progress.



EXPORT OPPORTUNITIES:

India possesses a substantial and burgeoning export market for plant-based products, particularly in countries that have a significant vegetarian population. This opens up lucrative opportunities for Indian plant-based food producers to tap into these markets and expand their reach beyond domestic borders.



INCREASING FOOD SERVICE SECTOR DEMAND:

The growth of the plant-based food industry in India is propelled by the escalating demand for vegetarian and vegan options in the food service sector, including restaurants and other food service outlets.

**INVESTMENT PROSPECTS:**

The increasing demand for plant-based products creates diverse investment opportunities across various stages of the industry, including production, processing, distribution, and retail. These opportunities offer potential for entrepreneurs and investors to participate in the expanding plant-based food market.

In conclusion, the plant-based food industry in India presents a wide range of prospects for entrepreneurs, investors, and consumers, driven by the rising demand for healthier and more sustainable food options. At the national level, the production of plant-based foods can contribute to and benefit from the growing global market for plant protein crops, processed protein ingredients, and manufactured goods. The surge in demand for plant-based meals in North America, Europe, and Asia creates opportunities to bridge supply gaps and leverage evolving technologies. Establishing a global market for India's domestic agricultural products would yield significant benefits for the country.



03.

FROM PLANTS TO PROTEIN: THE ART AND SCIENCE OF PLANT-BASED MEAT PROCESSING

The present study explores two primary processing techniques for plant-based meat analogues, namely thermoplastic extrusion and fibre spinning. Thermoplastic extrusion is a cost-efficient method suitable for large-scale production, while fibre spinning is less commonly employed due to its intricate nature and high production costs, which negate the cost advantage of producing affordable plant-based meat.

3.1 THERMOPLASTIC EXTRUSION

The production of PBMA involves a series of steps that begin with the extraction of raw plant materials. The extracted proteins are then processed using extrusion techniques that employ heat and agitation to achieve a desirable texture. Flavour, aroma, and taste are then added to simulate the characteristics of real meat. For instance, red beet extracts are used in beef substitutes to create a red colour, while caramel is added to produce the final brown hue. To replicate the taste and smell of real meat, volatile and nonvolatile molecules are isolated and incorporated. Once the final product is ready, it is packaged and shipped to retailers and grocery stores.



3.2 FIBER SPINNING

Fibre spinning is a widely used processing technique in the production of plant-based meat products. The process involves using a spinneret machine to produce slender fibres from a protein-rich liquid mixture. These fibres possess a meat-like texture and can be utilized to manufacture different plant-based meat items, such as sausages and burgers. The resulting fibres are further processed by cutting, shaping, and seasoning to mimic the texture and flavour of real meat. The use of fibre spinning in the production of plant-based meat products enables manufacturers to offer a diverse range of alternatives to conventional meat products that appeal to consumers. Moreover, fibre spinning can also aid in increasing the protein content of plant-based meat products, thereby rendering them a healthier choice for consumers.

MEAT

GROUNDS AND BURGERS

BURGERS AND MINCE

GROUND BEEF

PREPARED BEEF

STRIPS AND STEAKS

GROUNDS AND CUTLETS

PLANT BASED MEAT ALTERNATIVE (PBMA)

BEANS, LENTILS, PEAS

MUSHROOMS

NUTS

PLANT BASED MEATS

SEITAN

TOFU

04.

UNDERSTANDING THE BIOAVAILABILITY OF PLANT-BASED PROTEIN

Processing techniques can enhance the absorbability of plant-based proteins by overcoming the effects of anti-nutritional factors such as fibre and polyphenolic tannins. Various research-based methods, including dehulling of beans, protein extraction techniques such as Aqueous two-phase extraction, Solid-phase extraction (SPE), as well as purification of proteins to produce plant-derived isolates or concentrates, and the application of heat treatment and hydrolyzation, collectively contribute to enhancing the absorption and digestibility of plant-based proteins²⁷. To compensate for lower protein quality in some plant-based proteins, increasing the protein dosage can enhance the post-prandial protein synthetic response. However, this may not be practical for whole plant-based foods with lower protein density. Combining different protein types or sources creates a balanced amino acid profile and boosts the anabolic potential while blending proteins with complementary amino acid profiles helps fulfill overall amino acid requirements²⁸.

²⁷ Shixiang Liu^{a,1}, Zhihua Li^{a,1}, Bing Yu^{a,b}, Song Wang^a, Youqing Shen^{a,c}, Hailin Cong^{a,b,*}. Recent advances on protein separation and purification methods

²⁸ Steven R. Hertzler,* Jacqueline C. Lieblein-Boff, Mary Weiler, and Courtney Allgeier, Plant Proteins: Assessing Their Nutritional Quality and Effects on Health and Physical Function, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7760812/>

05.

BENEFITS OF PLANT BASED PRODUCTS AND MEAT ALTERNATIVES

Plant-based products and meat alternatives are becoming increasingly popular due to the health and environmental concerns associated with traditional meat products. While meat is a rich source of essential nutrients such as protein, iron, and zinc, it can also be high in saturated fat and cholesterol. The production and consumption of meat have been linked to environmental and health issues, prompting the rise of plant-based meat alternatives (PBMA's) that are typically made from plant proteins, oils, and other ingredients. The average nutritional value of meat (per 100 gm) is Calories 143; Protein 26 g; Total fat 3.5 g; Saturated Fat 1.2 g; Cholesterol 73 mg; Iron 6 %; Vitamin B6 35 %; Magnesium 7 %; Vitamin D 2 % and Cobalamin 10%.²⁹

PBMA's can be shaped and cooked like traditional meat and are often used in recipes such as burgers, sausages, and tacos. The average nutritional value of PBMA's per 100 g is typically lower in saturated fat and cholesterol compared to traditional meat products, and they also require fewer resources to produce, making them a more sustainable and healthier alternative³⁰.

This paper explains the sustainability of the meat industry and the benefits of plant-based meat alternatives in addressing the environmental issues associated with meat production.

²⁹ USDA, <https://fdc.nal.usda.gov/fdc-app.html#/food-details/168250/nutrients>

³⁰ Roberta Alessandrini,* Mhairi K. Brown, Sonia Pombo-Rodrigues, Sheena Bhageerutty, Feng J. He, and Graham A. MacGregor, Nutritional Quality of Plant-Based Meat Products Available in the UK: A Cross-Sectional Survey, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8709452/>

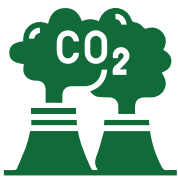
5.1 SUSTAINABILITY ANALYSIS

India's plant-based food industry presents numerous flourishing opportunities, which are supported by the following factors:



DEFORESTATION:

Approximately 20% of the total land area of India is occupied by livestock grazing, which has contributed to deforestation. The expansion of the meat industry has led to the clearing of forests to create grazing land and to cultivate animal feed crops such as soy and corn³¹.



GREENHOUSE GAS EMISSIONS:

The production of meat is responsible for 18% of global greenhouse gas emissions. These emissions are caused by methane produced during animal digestion, deforestation of carbon-rich trees, and the use of large amounts of artificial fertilizers required to feed cattle that are housed in highly concentrated numbers³².



WATER POLLUTION:

Animal products have a larger water footprint compared to crop products and account for approximately 29% of water pollution³³.

³¹ <https://www.indiawaterportal.org/articles/land-use-map-india-national-institute-hydrology>

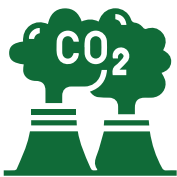
³² <https://indiabioscience.org/columns/indian-scenario/meating-the-needs-of-the-future#%3A~%3Atext%3DRuminants%20such%20as%20buffalo%20and%20Cby%20Indian%20livestock%20each%20year>

³³ Susanne Stoll-Kleemann & Tim O'Riordan (2015) The Sustainability Challenges of Our Meat and Dairy Diets, Environment: Science and Policy for Sustainable Development, 57:3, 34-48, DOI: 10.1080/00139157.2015.1025644

India's plant-based food industry presents numerous flourishing opportunities, which are supported by the following factors:

**LAND USE:**

A 2018 study found that producing a plant-based burger requires approximately 95% less land than producing a beef burger.

**GREENHOUSE GAS EMISSIONS:**

Production of plant-based meat generates approximately 90% less greenhouse gases than similar meat products, indicating that plant-based meat substitutes have a smaller carbon footprint than traditional meat.

**WATER POLLUTION:**

Plant-based meat, being produced primarily from plant-based ingredients, generates a significantly lower amount of waste compared to traditional meat. Consequently, it has a lesser contribution to water pollution compared to the meat industry.

06.

PLANT-BASED PROTEIN INDUSTRY REGULATIONS AND COMPLIANCE

At present, there are no established standard rules and regulations specifically governing plant-based meat products in India. However, it is worth noting that there are regulations in place for vegan foods. These regulations pertain to the labelling, composition, and safety requirements for food products labelled as “vegan”. According to these regulations, the term “vegan food” refers to food or food ingredients, which include additives, flavourings, enzymes, carriers, or processing aids that are not derived from animals. It is crucial to note that throughout the entire production and processing stages, no ingredients, including additives, flavourings, enzymes, carriers, or processing aids of animal origin, have been utilized.

6.1 GENERAL REQUIREMENTS:

6.1.1

Compliance with these regulations is mandatory for any person involved in the manufacturing, packaging, sale, offering for sale, marketing, distribution, or import of food labelled as vegan.

6.1.2

Vegan foods are not allowed to undergo animal testing unless it is deemed necessary by a Regulatory Authority.

6.1.3

Packaging materials utilized for vegan food must meet the prescribed packaging regulations.

6.1.4

It is essential to implement precautions at every stage of production, processing, and distribution to prevent the inclusion of non-vegan substances.

6.1.5

Before the production of vegan products on shared production lines, thorough cleaning or equivalent measures must be undertaken

6.1.6

The preparation, production, and packaging of vegan products should adhere to Good Manufacturing Practices

6.1.7

Maintaining the vegan integrity of the food requires traceability up to the manufacturer level, along with fulfilling any additional requirements specified by the Food Authority.

6.1.8

Vegan food must adhere to the relevant provisions outlined in the Act, rules, and regulations.



6.2 GUIDELINES FOR PRODUCT LABELLING AND DISPLAY

6.2.1

Retailers are required to store and showcase vegan food separately from non-vegan food items

6.2.2

Packages of vegan food that have received approval must prominently display the designated logo.

6.2.3

Vegan foods must adhere to the packaging and labelling requirements outlined in the Food Safety and Standards (Labelling and Display) Regulations, 2020, with the exception of clause (b) of sub-regulation (4) of regulation 5.

6.3 REGULATORY COMPLIANCE FOR VEGAN FOOD

6.3.1

The Food Business Operator is required to submit an application containing all the requisite details to the licensing authority designated by the Food Authority in order to ensure compliance with vegan food regulations.

6.3.2

The Food Authority has the authority to issue guidelines pertaining to the approval process for the vegan logo.

6.3.3

Imported vegan food products must be accompanied by a certificate in the specified format accepted by the Authority, which is issued by recognized authorities of the exporting countries.

07.

MARKET OVERVIEW

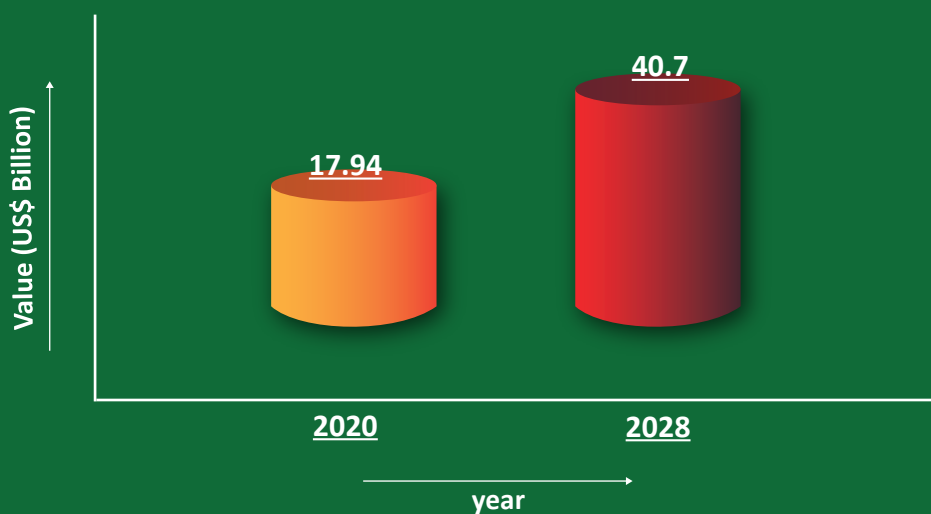


The growing urbanization and wealth in India are expected to contribute to the growth of the plant-based food industry in the country, making it a promising market for such products. Studies suggest that the younger generation of Indians is more open to experimenting with plant-based foods and meat alternatives, and the increasing availability of these products in the market is expected to make them more accessible to a wider audience.

According to industry estimates, the global plant-based protein market is expected to grow significantly, reaching a value of US\$26.71 billion by 2030 from US\$11.10 billion in 2020, with a compound annual growth rate (CAGR) of 9.1% from 2020 to 2030³⁴. North America currently holds the largest market share for plant-based protein, followed by Europe and Asia-Pacific. Meanwhile, the market for plant-based meat substitutes was valued at US\$9.9 billion in 2020 and is projected to expand at a CAGR of 42.1% from 2020 to 2030³⁵.

The demand for plant-based proteins is predicted to increase further as consumers become more interested in healthier and alternative food options. The growth of the plant-based protein market can be aided by innovations in ingredients, increased capital investment, the democratization of technology, and the establishment of support systems for entrepreneurial development.

GLOBAL PLANT-BASED FOOD AND BEVERAGE MARKET



³⁴ Report by Markets and Markets, global market research and consulting firm with HQ in India

³⁵ Grand view research report "Meat Substitute Market Size, Share & Trends Analysis", 2022 - 2030

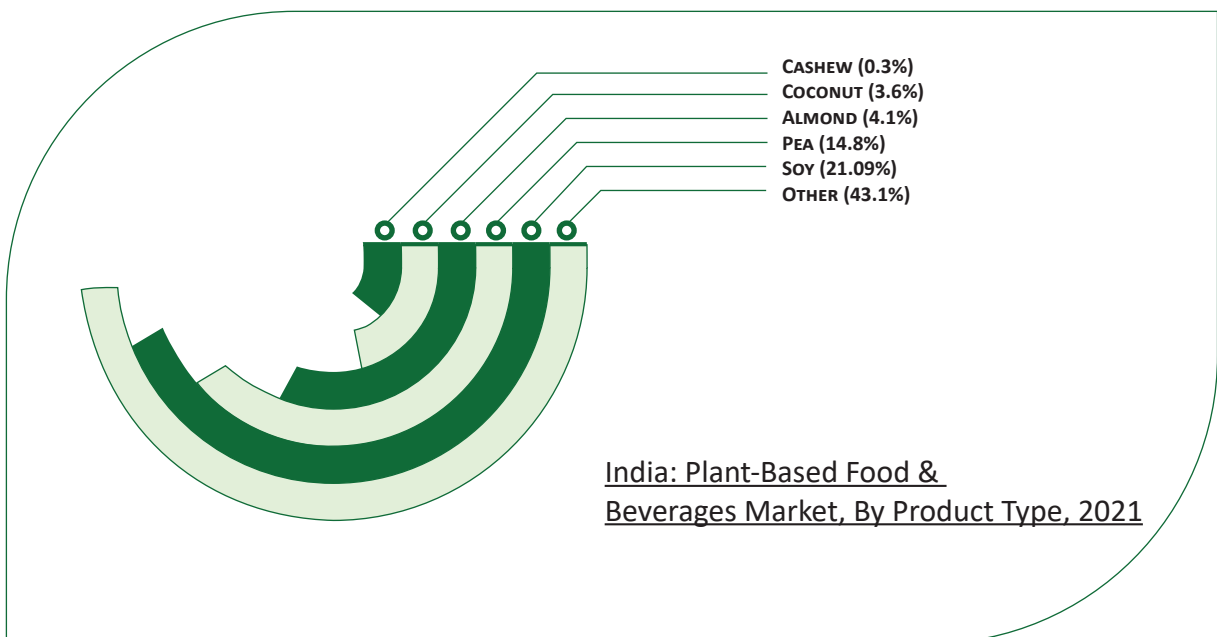
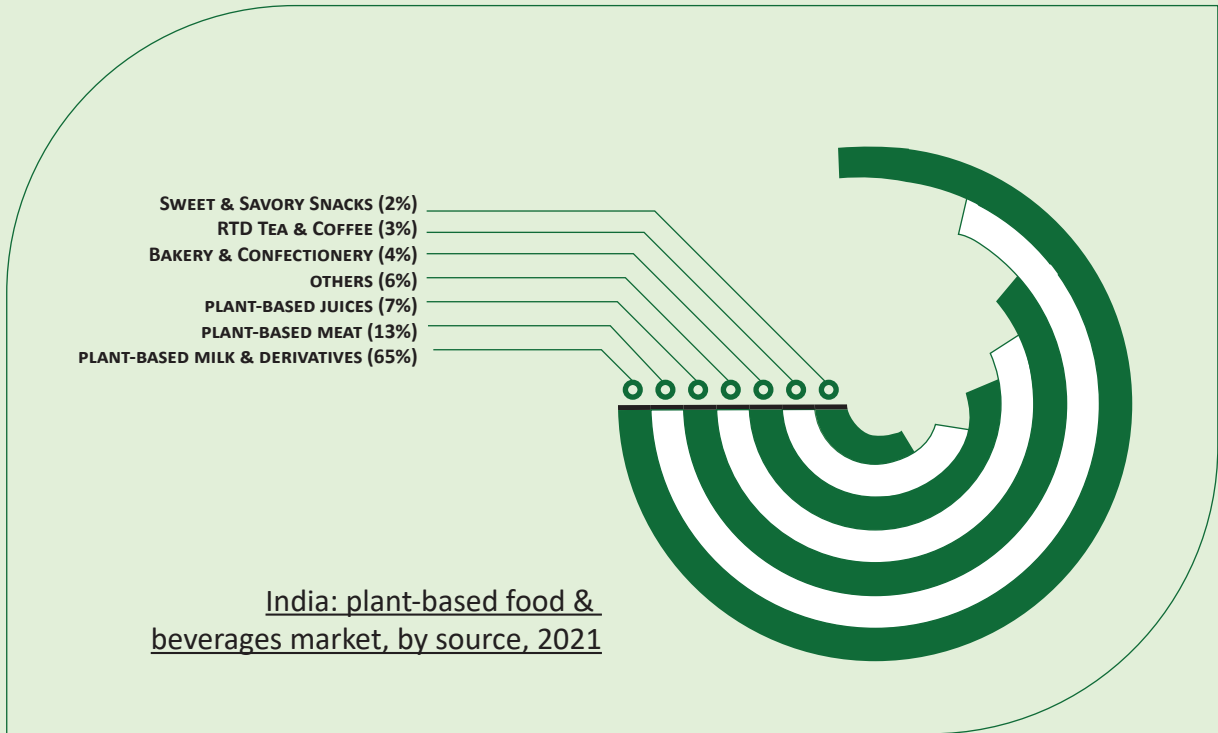
08.

MARKET ANALYSIS

Since 2020, the plant-based protein industry has experienced significant sales growth due to the favourable conditions for grocery purchases during the Covid-19 pandemic. The industry saw the launch of eight alternate meat start-ups during 2019-20, and five domestic and international players entered the market in 2020-2021. However, the growth of plant-based meat has decreased due to supply chain issues and inflation, and consumers tend to prefer lower-priced conventional meat or other plant-based food options. Nevertheless, this trend is expected to reverse, and the market is projected to accelerate sales by 2024. India is the largest consumer base, with 63% of the population expressing a willingness to purchase plant-based meat. The "Eat Right India" campaign launched by the Indian government promotes a healthy lifestyle and plant-based diets³⁶.

Factors that will drive the growth of the PBMA industry in India include health and wellness, sustainability, taste, religious and cultural factors, and innovation and startups. A 2021 Nielsen study found that about 70% of Indians are willing to pay more for healthier food options. Additionally, plant-based meat is seen as a more sustainable option due to its lower carbon footprint and reduced environmental impact. Taste is a crucial factor in consumer choices, and plant-based meat must have a similar taste and texture to real meat. Religious and cultural factors are also significant, as many Indian consumers prefer plant-based meat due to cultural and religious reasons or concerns about animal welfare. Finally, innovation and the emergence of startups in the industry are expected to lead to a double-digit increase in market growth, with Indian plant-based startups offering a range of plant-based meat products, such as burgers, sausages, and kebabs.

³⁶<https://www.mordorintelligence.com/industry-reports>



¹⁰ Ministry of Food Processing Industries, Press Release, 05 AUG 2022 6:02PM by PIB Delhi

¹¹ <https://www.statista.com/statistics/1266811/india-export-value-food-processing-machinery/>

8.1 CELL-CULTURED MEAT: A NOVEL ALTERNATIVE TO CONVENTIONAL MEAT

Also known as lab-grown or cultured meat. This alternative meat is produced by taking a small sample of animal cells and growing and multiplying them in a suitable environment. It has potential ecological benefits as it uses fewer resources, including land, water, and feed, than traditional meat production and does not require animal killing. However, regulatory challenges in the USA are preventing its commercial release, while Singapore is the only country to grant regulatory approval to cultured meat products. Moreover, the cultured meat market is facing issues in economies of scale to make it more commercially feasible. Despite this, consumers perceive it positively as it does not contain preservatives and additives like plant-based meat, making it a more natural and healthy option. In India, the plant-based meat industry is competitive, with leading players such as Good Dot and Veggie Champ providing a range of products at affordable prices.



09. CONCLUSION

The focus paper on plant-based proteins and meat alternatives in India reveals a positive outlook for this emerging industry. Plant-based proteins extracted from plants, oil seeds, and other ingredients, offer numerous advantages over traditional meat proteins, including enhanced sustainability, reduced environmental impact and lower saturated fat and cholesterol content in the plant-based foods. The plant-based meat analogue industry has experienced double-digit growth rates since 2020, driven by factors such as health consciousness, sustainability concerns, taste preferences, innovation, and religious and cultural considerations.

The plant-based protein market in India presents a range of opportunities for entrepreneurs, investors, and consumers alike. The country boasts a significant number of businesses focusing on deep-tech innovations like cultured meat and precision fermentation. Furthermore, India has the potential to be a major exporter of plant-based goods and ingredients, offering lucrative prospects in the global market.

Challenges in the plant-based meat industry include replicating the taste, texture, and sensory aspects of conventional meat, addressing bioavailability and amino acid profiles, overcoming consumer perception barriers, and competition from established meat and dairy industries. However, with technological advancements, innovative processing techniques, and strategic investments, these challenges can be mitigated.

To realize the full potential of the plant-based meat market, it is crucial to establish regulatory frameworks that ensure compliance, consumer trust, and consistent product quality. The Indian government's support for the industry, coupled with increasing health consciousness, growing vegetarian demographics, and the rising demand from the food service sector, creates a favourable environment for market growth.

In addition, the study highlights the potential of cell-cultured meat as a novel alternative to conventional meat. Although still in the early stages and facing regulatory challenges, cell-cultured meat holds promise in addressing environmental and health issues associated with traditional meat production.

In conclusion, the research findings indicate a promising future for the plant-based protein and meat alternatives industry in India. By addressing challenges, capitalizing on emerging opportunities, and aligning with consumer preferences, this industry has the potential to revolutionize the food landscape, promote sustainability, and cater to the increasing demand for healthier and more environmentally friendly food options.



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