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Plant-Powered: Understanding Vegan Food, Nutrition & Innovation

*S Minitha Chowdry and Bandari Jithender Reddy

Department of Food Process Engineering, Agricultural Engineering

College & Research Institute, TNAU, Coimbatore, India

*Corresponding Author's email: minithachowdary7@gmail.com

The UK Vegan Society defines a vegan as someone who tries to live without exploiting animals, eating a plant-based diet with nothing coming from animals (no meat, milk, eggs, or honey) and avoiding leather, wool, silk, or other animal products for clothing or any other purpose. Vegans are described as strict vegetarians who, beyond not eating meat, fish, or fowl, also do not consume animal products such as dairy and eggs.

History of Vegan Foods

The roots of veganism can be traced to ancient Eastern religions such as Jainism, Hinduism, and Buddhism, which promoted ahimsa (non-violence towards all living beings). In the Western world, Pythagoras was one of the earliest supporters of a meat-free lifestyle, followed by Percy Shelley, Leo Tolstoy, and Mahatma Gandhi, who viewed it as a path to moral purity. In the United States, the Natural Hygiene Movement encouraged plant-based eating for spiritual well-being. The term "vegan" was coined in 1944 by Donald Watson, who founded The Vegan Society to promote a lifestyle free from all forms of animal exploitation. The society aimed to end the use of animals for food, clothing, work, and research. In 1975, Peter Singer's book *Animal Liberation* strengthened the animal rights movement by introducing the concept of speciesism. By the 1980s, the Humane Society of the United States (HSUS) reported that farmed animals accounted for 99% of animals killed by humans each year.

Why the World Is Choosing Vegan Foods

The number of people identifying as vegans in the United States increased from 1% in 2012 to 3% in 2018, representing around 10 million people. In addition, 23% of Americans report eating less meat, while one-third consume plant-based products. Semi-vegetarian or eating meat only occasionally, is most common among Millennials, Gen X, and Gen Z. People choose vegetarian or vegan diets for ethical, health, environmental, and personal reasons, as well as family and cultural traditions. Health vegetarians mainly follow the diet to prevent disease and manage body weight. Many people also stop eating meat to prevent cruelty to animals, with feelings of disgust toward animal suffering influencing their decision. The exposure of animal suffering in industrial meat and dairy production, along with concerns about environmental damage and human health, has become a major reason for adopting ethical veganism.

The difference between vegan and vegetarian

Vegan: consumes no animal products at all (no meat, fish, dairy, or eggs)

Vegetarian: does not consume meat or fish, but may still consume dairy/eggs.

Nutritional Science of Vegan Foods

A well-planned vegan diet is rich in dietary fibre, magnesium, folic acid, vitamins C and E, antioxidants, and phytochemicals. However, it may be low in protein, omega-3 fatty acids (n-

3 PUFA), calcium, zinc, iron, and vitamins B12 and D, making proper meal planning important. Compared with omnivores, vegetarians have a lower risk of death from non-communicable diseases, including heart disease, stroke, type 2 diabetes, and most types of cancer. A vegan diet also increases the intake of nutrients that help protect against chronic diseases while reducing harmful dietary factors. Studies on bone mineral density have shown mixed results, with some reporting higher values in vegetarians and others finding no significant difference. Research suggests that semi-vegetarians may have a greater risk of disordered eating patterns than full vegetarians or vegans. Vegans and true vegetarians also showed healthier eating behaviours and a more positive relationship with food. To maintain good health, a balanced vegan diet should include vitamin D, vitamin B12, calcium, DHA-fortified foods, and iodized salt to meet nutritional requirements.

Nutrient Intake Differences

Nutrient	Vegans	Vegetarians
Total energy	2383 kcal	2722 kcal
Total fat	68 g	96 g
Saturated fat	21 g	41 g
Cholesterol	149 mg	275 mg
Protein	82 g	93 g
Fiber	41 g	34 g
Alcohol	7 g	13 g
Sodium	1316 mg	2228 mg
Calcium	738 mg	1465 mg
Iron	23 mg	20 mg

Plant Proteins: Sources, Benefits and Daily Requirements

Common sources of plant protein include **legumes, soybeans and soy products, and seitan**. Although **algae** is not a plant, it is sometimes included among alternative protein sources. Plant proteins generally contain lower amounts of essential amino acids and are less efficiently utilized by the body than animal proteins. Therefore, vegetarians who consume little or no animal protein may need an additional 12–15 g of protein per day (about 1.0 g per kg of body weight) to meet their daily protein requirements.

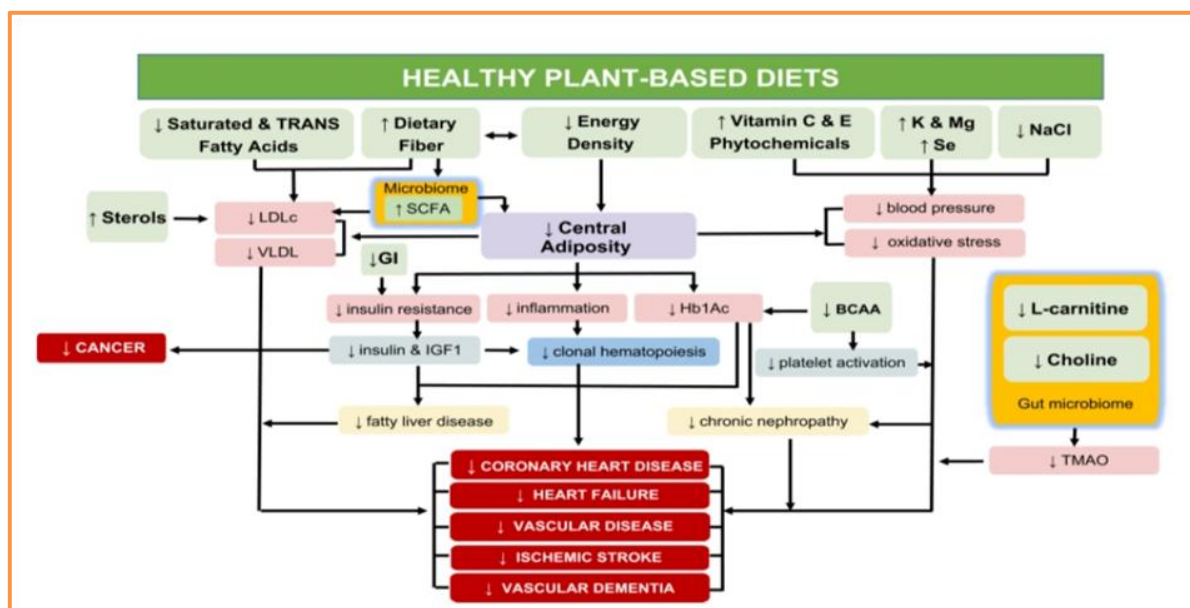


Fig 1. Health benefits of healthy plant-based diets through multiple biological pathways

Innovative Food Technologies in Plant-Based Protein Production

Modern food technology has greatly improved the quality, nutrition, and texture of plant-based protein foods. The major technologies include:

1. **Protein Extraction and Modification:** Techniques such as extrusion, fermentation, high-pressure processing, and heat treatment improve the functionality, digestibility, and texture of plant proteins.
2. **Structural Analysis:** Advanced tools like low-field Nuclear Magnetic Resonance (NMR) and Raman spectroscopy are used to study moisture content and structural changes in plant proteins.
3. **Texture Engineering:** By controlling the swelling properties of proteins, manufacturers can produce meat alternatives with the desired firmness, chewiness, water-holding capacity, and texture.
4. **Fermentation Technology:** Fermentation enhances the stability, flavour, and nutritional quality of plant-based ingredients while reducing harsh processing conditions.
5. **Legume Protein Processing:** Alkaline extraction, heat treatment, ultrafiltration, and gel filtration are used to improve the functional properties of proteins from legumes and reduce anti-nutritional compounds.
6. **Textured Vegetable Protein (TVP) Production:** TVP is widely used to manufacture plant-based burgers, sausages, nuggets, and other meat alternatives with a meat-like texture.
7. **Soy-Based Product Processing:** Technologies such as UHT sterilization, enzyme coagulation, and soybean fermentation are used to produce soy milk, soy yoghurt, tofu, tempeh, and soy cheese.
8. **Emerging Technologies:** New developments, including 3D food printing, are creating innovative, protein-rich plant-based foods with improved quality and consumer appeal.

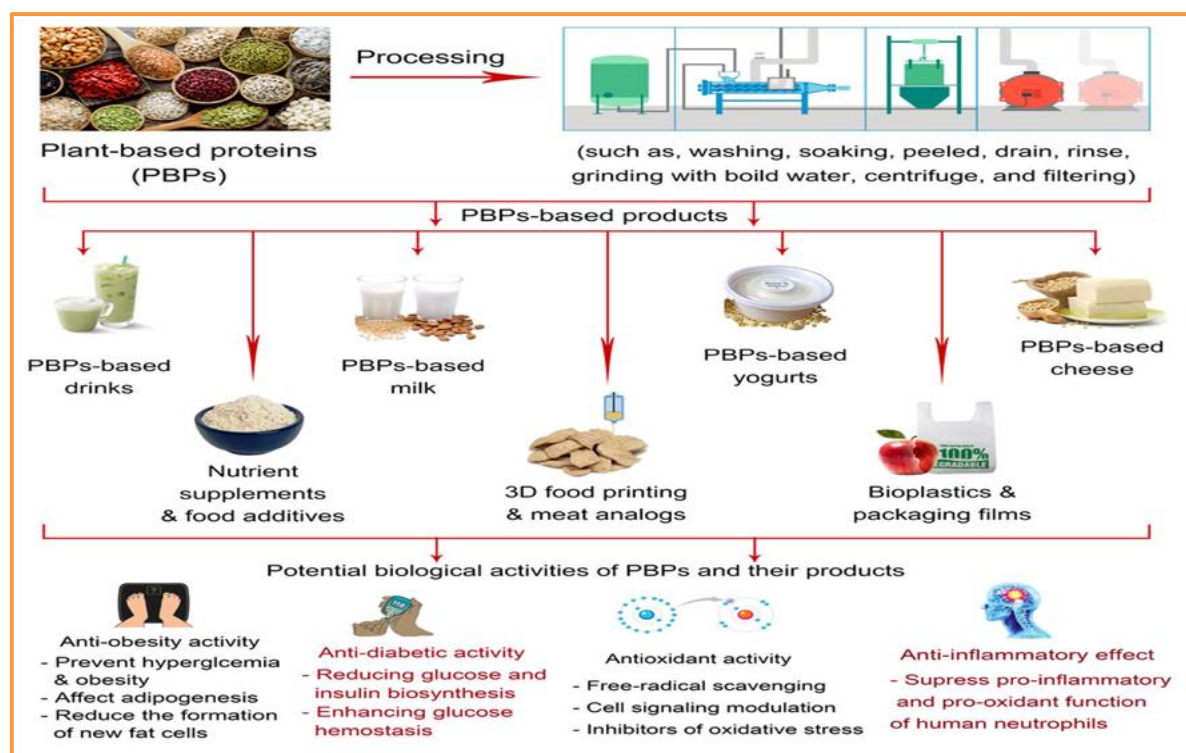


Fig 2. From Plant to Plate: Processing and Innovative Applications of Plant-Based Proteins

Global Market Trends

The plant-based food market has grown rapidly in recent years. In 2018, retail sales of plant-based foods in the United States increased by **11%**, compared to **2% growth** in the overall retail food market, with the market reaching a value of \$4.5 billion. During the COVID-19 pandemic, sales of plant-based meat products grew faster than those of conventional meat products, even during periods of panic buying. Industry reports now describe veganism as a mainstream food trend rather than a niche lifestyle. This shift has been driven not only by social activists but also by athletes, doctors, entrepreneurs, investors, and celebrities, who have helped make veganism more widely accepted and popular.

Conclusion

Vegan foods have evolved from an ethical lifestyle choice into a widely accepted dietary pattern supported by advances in food technology and growing consumer awareness. A well-planned vegan diet can provide important health benefits when nutritional requirements are properly met. Innovations in plant-based protein processing have improved the quality and acceptability of vegan foods. The continued growth of the global plant-based food market reflects the increasing popularity and acceptance of veganism worldwide.

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