

Exploring the impact of plant-based diets on environmental sustainability and human health

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ABSTRACT

Plant-based diets are at the forefront of promoting human health and environmental sustainability. In addition, they play a critical role in preventing the extinction of many species, safeguarding land and water resources that humans utilize on a global scale, and mitigating the effects of climate change by reducing greenhouse gas emissions. Whole food and plant-based diets have lower environmental footprints. As the world's population grows and the ecological consequences increase, more significant efforts are necessary to improve food system sustainability. Given these environmental advantages, plant-based goods are among the best ways to combat climate change and preserve natural resources while also contributing to the global sustainability goal. In public health, plant-based diets are associated with a lower incidence of chronic diseases such as heart disease, type 2 diabetes, and specific types of cancer. Focusing on nutrient-dense foods rather than calorie-controlled diets may assist in weight management and improve overall wellness. However, this initiative to consume more vegetables is not without obstacles. This review highlights the current understanding of how plant-based diets can significantly impact environmental and health consequences. The challenges of consuming the appropriate amount of nutrients are examined in this review, along with ways to lower costs and increase accessibility. Moreover, the possible mechanistic pathways through which plant-based diets affect health and the environment are critically discussed, underscoring the gaps where further research is needed.

INTRODUCTION

Human perceptions of food are changing in fascinating ways on a daily basis. Although ethical, health, and environmental sustainability problems are linked, plant-based diets are becoming increasingly popular among scientists, consumers, and legislators [1]. Despite the increasing adoption of plant-based diets, significant research gaps remain in comprehensive and comparative analyses of their environmental footprints and health outcomes across numerous varieties of plant-based dietary patterns, such as vegetarian, vegan, and flexitarian diets. Addressing this gap is critical for informing sustainable food systems and promoting healthier lifestyles [2].

Our eating habits and interactions with the intricate network of life that supports us could alter more than simply what we consume. The necessity for a nutrition and plant-based food revolution is becoming widely recognized owing to the growing worldwide burden of chronic illness, depletion of resources, and the need to slow down the rate of climate change [3]. The available data shows that a plant-based diet and our dependence on it may improve human health, save the planet, and transform our food systems significantly. Currently, two of the most complex problems all around the globe are human health and the long-term sustainability of the environment. It is



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commonly described in the scientific literature that animal agriculture underpins many of these issues with current modes of food production [3]. While a singular solution to these challenges remains elusive, adopting plant-based diets may significantly improve human health and reduce the demand for freshwater resources. Plant-based diets emphasize the consumption of plant-derived foods, such as fruits, vegetables, whole grains, legumes or pulses, beans, nuts, and seeds have substantially lower environmental footprints. These foods can be prepared in various ways; however, they typically limit oil intake and exclude fully processed animal products [4, 5].

The earth is seriously threatened by our industrial food system, which depends heavily on farm animals. According to the animal agricultural industry was responsible for 14.5% of the direct and indirect greenhouse gas emissions created by the land use/food chain on final emission effects [6]. Animal agriculture is a prominent contributor to climate change, with methane being one of the most concerning byproducts. However, enlarged livestock farming requires considerable land for grazing and feed production, leading to habitat degradation or deforestation [7]. In this case, a plant-based diet offers two impressive benefits. Numerous studies have shown that vegan diets have far less impact on the environment than diets containing animal-derived foods produced by animals. By substituting plant-based foods, we can both feed ourselves and preserve the delicate balance of our planet [8]. Plant-based diets have several benefits that go well beyond environmental sustainability. An increasing amount of research has indicated that they positively affect human health. Similarly, one of the issues from the World Health Organization European Region (2020) stated that plant-based diets could result in a lower risk of chronic diseases such as cardiovascular diseases (CVD), Type II diabetes, and several cancers [9]. A diet rich in fiber, vitamins, and minerals that also provides antioxidants is essential for good health and well-being. It is critical to understand that meticulous preparation is required for plant-based meals, especially vegan diets, to ensure sufficient consumption of vital minerals, such as iron, vitamin B12, and omega-3 fatty acids [10].

In addition to personal dietary preferences, plant-based diets are also being investigated. It examines the complex contexts (social, cultural, environmental, and economic) that shape not only what out-of-hand-like food is produced but also how it might be used. A recent study demonstrates that plant-based diets may contribute to various Sustainable Development Goals (SDGs), encompassing hunger, health, and environmental sustainability [11]. Business and innovation also benefit from the switch to plant-based diets. Plant-based meat alternatives are increasingly favoured since they fulfil health and sustainability objectives while preserving flavour and texture. This study dives thoroughly into the delicate relationship between plant-based diets, environmental sustainability, and human health. We sought to analyze the following key aims in order to provide a full explanation of various plant-based diets, including lenient, vegetarian, and vegan diet plans. A rigorous scoping evaluation analyzes animal and plant-based food production's environmental footprints [12]. In this review, we will look at how eating more plant-based foods could potentially reduce resource use and encourage ecosystem regeneration. The land, water, and greenhouse gas costs of animal farming are all taken into account in this analysis. Plant-based diet research and health effects were also assessed.

The present scientific study associates plant-based diets with a reduced risk of heart disease, the prevention of type 2 diabetes, and certain cancers. A range of techniques has been developed to address these challenges and support the development of healthy nutritional patterns. This review aims to deliver an impartial and thorough evaluation of plant-based diets and their diverse impacts on the environment and

public health. This review also aims to emphasize the possibility of adopting plant-centric dietary habits as a strategy for advancing sustainable development and enhancing global health outcomes.

ENVIRONMENTAL IMPACT OF PLANT-BASED DIETS

A plant-based diet significantly reduced natural greenhouse gas emissions compared with diets based on animal products. Livestock farming contributes to nitrous oxide and methane emissions. Moreover, both are greenhouse gases (GHGs). Therefore, reducing the consumption of animal-based diets also reduces the production of these gases [13]. A lean-based diet requires fewer resources, such as less land and water. Plant-based farming also helps to preserve biodiversity and natural habitats. Plant-based diets also help mitigate deforestation and soil degradation. This also promotes the development of a resilient and sustainable ecosystem [14]. A shift towards plant-centric eating patterns can substantially lower the overall carbon footprint of food systems, with studies indicating that vegetarian and vegan diets can reduce food-related greenhouse gas emissions by one-third to one-half, respectively, compared to omnivorous diets [15].

Reduction of greenhouse gas emissions

Greenhouse gases are the primary driver of climate change. Therefore, plant-based diets play a crucial role in reducing greenhouse gas emissions. Livestock farming is a significant source of GHG emissions, including carbon dioxide, methane, and nitrous oxide [6].

- i. Methane emissions: Methane is a potent greenhouse gas with a warming potential of 25 percent greater than carbon dioxide over ten years [16]. Ruminants such as cows, sheep, and goats produce methane during digestion through fermentation. Therefore, adopting a plant-based diet reduces the demand for animal-raised food. This reduces the methane emissions from enteric fermentation and manure [6].
- ii. Carbon Dioxide emission: This is the most significant contributor to global warming. Simultaneously, a large amount of fossil fuel is required to produce food for animals, such as feed production, transportation, and processing. Carbon dioxide levels also increase while cultivating feed crops and deforestation, as trees and vegetation remove carbon [17].
- iii. Nitrous oxide emission: Nitrous oxide is another potent greenhouse gas that causes global warming, approximately 298 times that of carbon dioxide over 100 years [16]. This gas is primarily released from agricultural soils by synthetic and organic fertilizers. Livestock farming significantly contributes to nitrogen monoxide emissions because of the use of nitrogen-based fertilizers in livestock production [18].
- iv. Life cycle emission: Activities such as animal rearing, slaughtering, processing, and transportation result in high GHG emissions compared to plant-based diets. Studies have shown that the life cycle stage of plant-based foods releases a lower carbon footprint than an animal-based diet. For example, one kilogram of beef produces 60 kilograms equivalent of carbon dioxide, whereas one kilogram of legume results in only 0.9 kilograms of carbon dioxide emissions [14].

Land use and deforestation

Plant-based diets have profound implications for land use and deforestation. Food production affects nature and the environment because it affects soil health, biodiversity, and carbon sequestration [6]. Animal agriculture requires intensive land to produce meat from cattle because land is needed for grazing, growing crops, and feeding crops. It takes 20 times more land to raise one calorie of beef than one calorie of vegetables [19]. In comparison, plant-based farming is more land-efficient. Unlike animal feed, crops are grown for direct human consumption. As a result, more people can be fed with less land and time. This will also help in reforestation and conservation by freeing up space [19].

Animal agriculture is a major cause of deforestation. Especially in tropical regions, forests are cleared to create space for livestock and crops, such as soy, which are used as animal feed [20]. Eighty percent of the deforestation in the Amazon rainforest is attributed to cattle ranching [21]. Deforestation threatens biodiversity and releases the carbon stored in trees and soil [22].

Water use

Water is an important agricultural resource. Water is used in food production, thereby affecting environmental sustainability. A plant-based diet offers more sustainable use of water resources than animal production [6]. Livestock farming is water-intensive because it requires significant amounts of water to grow feed crops, provide animals with drinking water, and maintain sanitary conditions. For example, one kg of beef requires approximately 15,000 liters of water, and one kilogram of chicken requires approximately 4,300 liters of water [23]. Water also grows livestock feed crops such as soy and corn [24].

A plant-based diet requires a significantly lower water footprint. Crops are grown for direct human consumption, which makes this process more water-efficient. Conversely, producing animal feed involves the extraction of water from rivers, lakes, and canals, leading to water depletion and affecting its availability for domestic and other agricultural uses [25].

PLANT-BASED FOODS AND THEIR ENVIRONMENTAL BENEFITS

In addition to the general environmental advantages of plant-based diets, specific types of plant-based food offer distinct benefits illustrated in Figure 1. The environmental impact of vegetarian and vegan diets, for instance, is considerably lower than that of omnivorous diets, primarily due to reduced greenhouse gas emissions and resource consumption [26]. For instance, legumes such as lentils and chickpeas improve soil nitrogen fixation, thereby reducing the need for synthetic fertilizers, which are energy-intensive to produce [27]. Whole grains require less energy and water compared to animal agriculture, making them a sustainable staple in plant-based diets. Conversely, the environmental footprint of highly processed plant-based meat substitutes, while still generally lower than animal products, warrants careful consideration regarding their land and water usage, and associated greenhouse gas emissions [28]. Nuts and seeds provide nutritional value with a smaller environmental impact. However, the cultivation of some nuts, particularly almonds, can be water-intensive, presenting a localized environmental concern [29]. Furthermore, fruits and vegetables contribute positively to biodiversity when cultivated using sustainable agricultural practices like

permaculture or agroforestry, which integrate trees and shrubs into crop and animal farming systems [19] and require fewer resources and promote ecological resilience [12]. The impact of plant-based diets on the environment is described below.

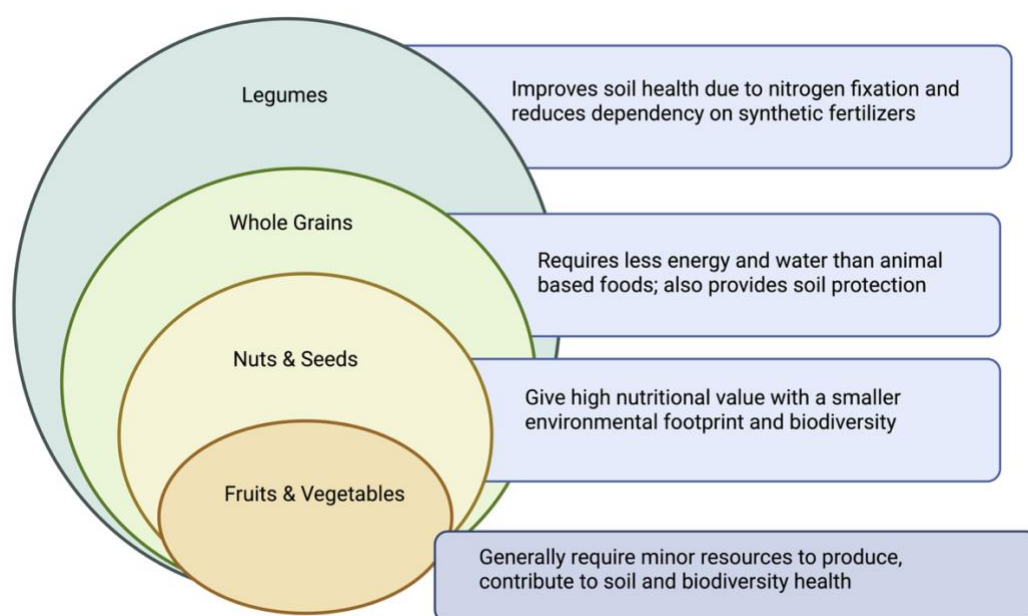


Figure 1. Some of the commonly consumed plant-based foods and their benefits. This figure highlights the environmental advantages of incorporating plant-based foods into the diet, supporting sustainable agriculture and resource conservation efforts [6, 17, 30].

Biodiversity conservation

Plant-based diets have a positive impact on biodiversity. The production and consumption of food directly impact ecosystems and wildlife. Animal agriculture is one of the major drivers of habitat destruction because large areas of forests and grasslands are cleared to produce feed crops for livestock [6]. Growing feed crops requires chemicals detrimental to the local ecosystem, affecting non-target species such as birds, aquatic life, and pollinators [18]. In contrast, plant-based methods require less chemical input. Sustainable plant-based farming enhances biodiversity by creating wildlife-friendly habitats [31].

Climate change

A plant-based diet can significantly impact climate change, which is a pressing global challenge. The relationship between diet and climate is both important and complex. Adopting a plant-based diet can benefit climate change mitigation by reducing greenhouse gas emissions, preserving forests and natural habitats, and conserving water [6]. People consuming fewer animal products will also help reduce methane emissions because plant-based food requires less energy to produce, resulting in lower carbon emissions [32]. A plant-based diet also requires less fertilizer during production, which reduces nitrous oxide emissions [18]. Deforestation is driven by intensive land use to produce feed. Animal food requires substantial energy, from growing feed to processing meat, and relies heavily on fossil fuels [17]. In contrast, plant-based foods require less energy and support renewable energy in agriculture, such as using wind energy for irrigation, which helps to reduce the carbon footprint [31].

Sustainable food systems

A sustainable food system ensures the well-being of the planet and future generations. Such a system encompasses economic viability, environment-friendly practices, and social equity [33]. A sustainable food system also supports efficient resource use, as plant-based foods are produced for direct human consumption, requiring less land and water than animal-based foods [6]. Plant-based food is more cost-effective than raising livestock because fewer production cycles are required, which reduces expenses [30]. Livestock production costs help to maintain a reasonable price and enhance food security by ensuring nutritious food for all [34]. Additionally, plant-based food systems create job opportunities in the agriculture, food processing, and retail sectors, which improves social sustainability and public health [31]. Plant-based diets have numerous health benefits, such as lowering the risk of heart disease, cancer, and diabetes [35]. Plant-based diets also reduce healthcare costs by decreasing diet-related diseases and promoting overall well-being [36]. This efficiency in agriculture increases food security and promotes a stable and resilient food supply that meets the nutritional needs of the global population [17].

HUMAN HEALTH BENEFITS OF PLANT-BASED DIETS

Plant-based diets help improve overall health and reduce the incidence of chronic diseases. When a person consumes various vegetables, fruits, nuts, and whole grains, they all provide fiber, nutrients, and antioxidants, which help in optimal health [37].

Obesity

Plant-based diets play a crucial role in reducing obesity. Plant-based diets are lower in calories but richer in nutrients than animal-based diets [38]. Plant-based products help maintain and reduce overall calorie intake while providing the necessary nutrients. Low-calorie rich foods, such as fruits, vegetables, legumes, and whole grains, contribute to this effect, as consuming these foods in large portions still results in fewer calories, which aids in weight management [39]. High-fiber foods, such as grains and fruits, are also prevalent in plant-based diets and help reduce hunger by slowing digestion and keeping individuals full for longer [40]. Additionally, plant-based foods are rich in vitamins, minerals, and antioxidants that support healthy metabolism, reduce inflammation, and ensure adequate nutrition [41].

Cardiovascular disease

Plant-based diets also help improve cardiovascular health by reducing the risk of diseases related to stroke, heart disease, and other cardiovascular conditions [42]. Plant-based foods typically have lower cholesterol levels than animal products [43]. Foods high in soluble fiber, such as fruits, beans, and oats, help reduce cholesterol by binding it to the digestive system and promoting its excretion [44]. This diet also improves blood pressure, which is a major risk factor for cardiovascular disease. Plant-based diets, enriched with potassium-rich foods such as vegetables and fruits, help regulate blood pressure levels, as potassium reduces blood vessel tension and lowers blood pressure [45, 46]. Additionally, a plant-based diet reduces inflammation due to its high content of anti-inflammatory foods, such as vegetables, nuts, and seeds, which reduce oxidative stress and protect against damage [47].

Diabetes

Plant-based diets play a positive role in the prevention and management of diabetes. A diet consisting of whole foods rich in nutrients and fiber helps maintain healthy blood sugar levels and improves insulin sensitivity [45]. Foods high in fiber slow the absorption of sugar into the bloodstream, which decreases glucose spikes and maintains steady sugar levels [40]. Complex carbohydrates take longer to break down than refined carbohydrates do, gradually releasing glucose [41]. A plant-based diet also improves insulin sensitivity, allowing the body to use insulin more effectively and reducing the risk of type 2 diabetes [48]. Numerous studies have indicated that a diet rich in whole and unprocessed foods helps prevent metabolic syndromes and chronic diseases [49].

Hypertension

Blood pressure and hypertension are common issues that can lead to various health problems, such as heart disease and stroke. A plant-based diet is helpful in managing and preventing health issues. Plant-based foods are rich in potassium, which helps balance sodium in the body, reducing strain on blood vessel walls and lowering blood pressure [45]. Foods, such as bananas, sweet potatoes, beans, spinach, and avocado, are excellent sources of potassium and assist in managing blood pressure by counteracting sodium [45, 49]. Additionally, plant-based diets are naturally lower in sodium than animal-based diets, which helps significantly reduce sodium intake [48]. Plant-based foods also contain high levels of antioxidants and healthy fats. Berries, leafy greens, and nuts provide antioxidants, which promote optimal blood flow. Simultaneously, healthy fats such as omega-3 fatty acids found in flaxseeds, walnuts, and chia seeds benefit cardiovascular health [42]. To visually summarize these benefits, refer to Figure 2, which depicts the key health benefits of plant-based diets, including hypertension regulation, cancer prevention, gut health, bone health, and longevity.

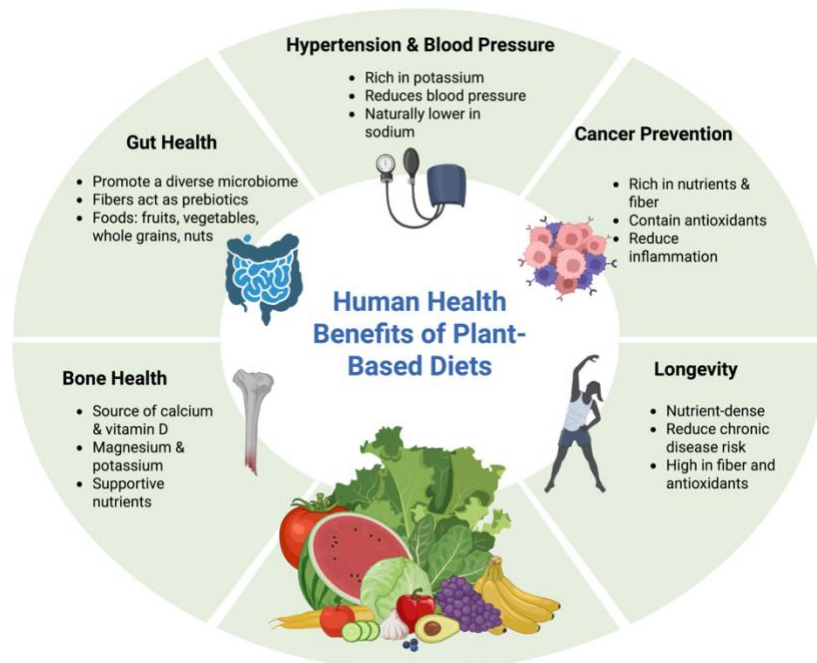


Figure 2. Human health benefits of plant-based diets. This figure highlights 5 major areas supported by plant-based eating patterns: hypertension & blood pressure regulation, cancer prevention, gut health, bone health, and longevity. Each branch outlines specific nutrient contributions and physiological effects associated with plant-derived foods.

Cancer

A plant-based diet is associated with a lower risk of developing different types of cancer. Whole-plant foods are rich in nutrients, fiber, and phytochemicals, which work together to help prevent cancer [50]. A balanced diet that includes antioxidants such as vitamin C helps protect cells from oxidative stress and damage caused by free radicals [45]. Plant phytochemicals have cancer-fighting properties, reduce inflammation, and enhance the immune system [51].

High-fiber foods and dietary fibers play crucial roles in cancer prevention by maintaining the digestive system and promoting regular bowel movements [40]. High fiber content also supports the gut microbiome, which helps lower the risk of cancer by facilitating a healthy gut environment [52]. Many plant-based foods, such as broccoli, cauliflower, and Brussels sprouts, help detoxify the body and activate detoxifying enzymes that neutralize carcinogens [49]. Thus, a balanced plant-based diet can significantly reduce the risk of cancer and promote overall well-being [53].

Gut microbiome

Good gut health affects overall well-being, making maintenance crucial [54]. Plant-based diets are highly beneficial for gut health. It supports a diverse gut microbiome consisting of trillions of bacteria and microorganisms that aid in digestion and overall bodily functions [52]. Fibers in plant-based foods play a vital role in gut health by acting as prebiotics and feeding beneficial bacteria [40]. Foods such as fruits, vegetables, whole grains, legumes, and nuts are fiber-rich and promote healthy gut microbiota [50]. Certain prebiotic foods, including garlic, onions, leeks, asparagus, and bananas, are particularly beneficial for maintaining beneficial gut bacteria [49].

Bone disease

A plant-based diet helps improve bone health by providing a variety of nutrients essential for maintaining bone density and preventing bone-related conditions, such as osteoporosis [45]. Calcium is crucial for bone health, and in a plant-based diet, it can be sourced from kale, bok choy, collard greens, fortified plant-based milks, tofu, almonds, and sesame seeds [42]. Vitamin D is essential for calcium absorption, and plant-based milk and cereals can help meet these vitamin D needs [50]. Mushrooms exposed to sunlight are a good source of vitamin D [51]. Additionally, magnesium and potassium are important for bone formation and regulating calcium levels; potassium helps neutralize bone-depleting acids [48]. Vitamin K, boron, silicon, and omega-3 fatty acids found in plant-based diets also contribute to improved bone health. The inclusion of a diverse array of plant-based nutrients supports bone health and promotes overall well-being [49].

Longevity

A plant-based diet is associated with many health benefits that improve quality of life and longevity [54]. People who consume nutrient-dense foods, rather than processed animal-based foods, have a reduced risk of chronic health conditions [49]. Chronic diseases, such as type 2 diabetes, hypertension, and certain cancer risks, can be mitigated by adopting a plant-based diet [50]. Plant-based foods with high fiber, antioxidant, and anti-inflammatory properties are crucial for reducing the risk [40]. Maintaining heart health is essential for longevity, and consuming nutritional foods,

such as fruits, vegetables, and seeds, supports cardiovascular well-being [42]. Additionally, plant-based diets improve metabolic health by regulating blood sugar levels and reducing the risk of diabetes, contributing to an increased lifespan [45]. Plant-based diets support heart and metabolic health, effective weight management, cancer prevention, and cognitive function [48].

TYPES OF PLANT-BASED FOODS AND THEIR NUTRITIONAL BENEFITS

Plant-based diets include a variety of foods rich in essential vitamins and nutritional value, including fruits, vegetables, legumes, whole grains, nuts, seeds, tofu, and plant-based milk, to ensure optimal health and well-being [54] illustrated in Figure 3.

- i. **Fruits:** Fruits are high in vitamins, minerals, antioxidants, and fiber, and low in calories. For instance, strawberries, blueberries, and raspberries are rich in antioxidants, vitamins C and K, and fiber, which help to reduce inflammation and oxidative stress [40]. Citrus fruits, such as oranges, lemons, and grapes, are abundant in vitamin C, boosting the immune system and enhancing skin health [45]. Bananas provide potassium and vitamin B6, which contribute to digestive health [46, 50].
- ii. **Vegetables:** Vegetables are packed with phytochemicals, minerals, and fibers that support health. Leafy greens, such as spinach, kale, and Swiss chard, are high in vitamins A, C, and K, reducing the risk of chronic diseases [48]. Cruciferous vegetables, such as broccoli, cauliflower, and Brussels sprouts, have cancer-preventive properties [42]. Root vegetables, such as sweet potatoes and carrots, are rich in beta-carotene and vitamin A, promote eye health, and boost immunity [49].
- iii. **Legumes:** Legumes are excellent sources of fiber, protein, and essential nutrients. Black beans, kidney beans, and chickpeas are high in protein, fiber, iron, and potassium, which are beneficial for regulating blood sugar and heart health [54]. Lentils are rich in protein, iron, folate, and fiber, whereas peas are high in vitamins A, C, and iron [40].
- iv. **Whole grains:** Whole grains, such as quinoa, brown rice, and oats, provide amino acids, fiber, and manganese, supporting overall health [45].
- v. **Nuts and seeds:** Nuts and seeds are nutrient-dense and offer fats, proteins, fibers, and minerals. For example, almonds are rich in vitamin E, which supports skin health and brain function [50]. Chia seeds are high in omega-3 fatty acids and calcium, whereas flaxseeds help reduce inflammation and support digestion [48].
- vi. **Tofu and tempeh:** Tofu provides amino acids, making it a complete protein rich in magnesium and iron [53]. Tempeh, which is rich in fiber, supports gut health [49].
- vii. **Plant-based milk:** Plant-based milk, such as almond, soy, and oats, offers various nutritional benefits and supports overall health [42].



Figure 3. Major categories of plant-based foods and their dietary benefits. The diagram classifies primary plant foods—namely fruits, vegetables, legumes, grains, nuts/seeds, tofu/tempeh, and plant-based milk—and emphasizes their vital nutrients, including vitamins, minerals, antioxidants, proteins, and healthy fats. This visual summary highlights the varied nutritional benefits of plant-based diets in enhancing overall health and well-being.

CHALLENGES AND CONSIDERATIONS

Different challenges are faced when adopting a plant-based diet. However, it is possible to overcome these challenges carefully if all the benefits of a plant-based diet are considered, such as planning and taking some consideration.

Nutrient considerations

Vitamin B12 is the primary vitamin in animal-based products, and its deficiency can cause anemia and damage to the nervous system. Consuming a B12 supplement and fortified foods such as plant-based milk, cereals, and nutritional yeast can solve this deficiency [55]. Plant-based iron is not absorbed as easily as animal-based products; therefore, plant-based diets can cause iron deficiency [56]. Iron-rich foods, such as chickpeas, lentils, and citrus fruits, enhance iron absorption from plant-based products. Maintaining protein intake while consuming a plant-based diet can be difficult, especially for people involved in high-intensity work [48]. Protein-rich foods, such as quinoa, tempeh, legumes, and plant protein powder, can help alleviate protein deficiency [57].

Nutrient requirements

Ensuring a balanced diet while consuming a plant-based diet is important because various foods cover all nutritional bases [36]. Planning meals and ensuring balanced nutrition helps individuals remain consistent and accountable [58]. Learning and

educating about plant-based diets from reliable sources and consulting dietitians can also be helpful in addressing nutritional deficiencies and enhancing overall health [59]. Additionally, it is advisable to consider supplements for vitamin B12, vitamin D, and omega-3s, which are challenging to obtain from plant-based foods [58-60]. Monitoring health and adjusting diet based on individual needs are also important measures for ensuring nutritional adequacy [61].

Accessibility and affordability

Adopting a plant-based diet is accessible and affordable, but there are also some challenges. Access to fresh fruits and vegetables can be difficult in rural locations, and plant-based options may be limited [62]. In this situation, supporting local farmers and community gardens, as well as taking initiatives to make freshly produced food more accessible, can be beneficial [63]. Online grocery service providers can expand their range of plant-based foods. Additionally, variety can be challenging, as not all stores have plant-based options, such as tofu, tempeh, and grains. Shopping at larger supermarkets, where these options are available, and exploring different cuisines and recipes can help diversify meal options [64].

Cultural and societal barriers

There can be different barriers to adopting a plant-based diet because people have been using it in traditional dietary practices for a long time. Animal-based products are easily accessible, widely available, and staple foods for many people and regions [7]. Practicing a respectful culture and introducing new plant-based versions of traditional dishes can help overcome these barriers [65]. Highlighting health and environmental benefits can change people's perspectives on their dietary plans [50].

People are accustomed to eating animal-based foods for festivals and celebrations, and plant-based options may be fewer. Adding more variation to celebratory foods and sharing delicious plant-based recipes can help raise awareness and demonstrate that plant-based foods can be enjoyable [27]. Certain religious beliefs also affect the consumption of animal-based foods [66].

Additionally, societal and peer pressure often favor meat consumption, and individuals may feel pressured to conform. Finding supportive communities with similar values and goals can be helpful [67]. Perceptions of plant-based foods include a lack of variety and concerns about nutritional adequacy. Sharing information regarding these misconceptions and demonstrating the diversity and availability of plant-based foods can address these concerns [53].

Nutritional education and awareness

Introducing topics on plant-based diets into the educational curriculum can create familiarity among many people. This approach helps individuals develop in-depth knowledge and understanding of plant-based diets [68]. School curricula can include classes on nutrition that inform students about the benefits of plant-based diets, and cooking classes can teach students how to prepare various plant-based dishes [68]. At the university level, nutrition, dietetics, and environmental science courses can provide the benefits of plant-based diets. Public seminars and workshops can raise awareness of plant-based diets. In healthcare facilities such as clinics, sessions on plant-based diets can be valuable for chronic disease prevention and management [69].

Policy and institutional support

Changes in the framework and institutional support are required for households to adopt a plant-based diet. Public and private institutions can ensure that plant-based foods are easily accessible to people [7]. Governments can create inclusive dietary guidelines that emphasize the importance of plant-based diets [17]. In addition, government programs such as public campaigns can educate and provide guidelines on plant-based diets [70].

Providing subsidies and incentives for plant-based agriculture can motivate farmers to grow more plant-based food [38]. Governments can also offer tax breaks to companies that work with plant-based products; these incentives can motivate businesses to produce more plant-based foods for general consumption [71]. The clear labeling of plant-based products makes it easier for consumers to identify and choose them. Including nutritional value and providing recipes in product descriptions can help consumers make informed decisions [72].

Although the adoption of plant-based diets poses certain challenges, they can be effectively managed. Ensuring adequate nutrient intake through thoughtful dietary planning and, if necessary, supplementation, enhancing the availability and affordability of plant-based foods, and addressing cultural and societal obstacles through targeted education and promotion are the key strategies [73]. Moreover, policy measures and institutional backing are vital for fostering a supportive environment for this dietary transition. With collaborative efforts from individuals, communities, healthcare providers, and policymakers, the shift towards plant-based diets can be encouraged, benefiting human health and environmental sustainability [74].

CONCLUSIONS

In conclusion, plant-based diets are becoming increasingly important for advancing human health and environmental sustainability. These diets considerably improve ecological balance by lowering greenhouse gas emissions and preserving resources [75]. These factors also contribute to improved general health and weight control by reducing the incidence of chronic diseases. Notwithstanding these advantages, problems still exist, such as ensuring that nutrients are consumed while overcoming past traditional food habits and practices [76]. To address these issues, inexpensive plant-based solutions, supportive guidelines, and public education are needed. To maximize these benefits, future studies should concentrate on long-term effects and scalable approaches [77]. Plant-based diets, but not a panacea, present a viable route to a better and more sustainable future with the potential to significantly improve health outcomes and preserve the environment.

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AUTHOR CONTRIBUTIONS

NKK wrote the manuscript. RBM reviewed and edited it. NZR conceptualized the study, developed the content structure, contributed to writing, reviewed and edited the manuscript, proofread it, prepared the figures, handled revisions, and managed correspondence related to the paper. All authors have approved the final version of the manuscript.

CONFLICTS OF INTEREST

There is no conflict of interest among the authors.

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