Plant-Based Diet

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In recent decades, the food industry has been faced with new challenges and it has had to develop new types of diets and produce new types of foods that can slow down the spread of chronic diseases. The aim of our research is to identify the characteristics of plant-based nutrition based on international and Hungarian literature. The comprehensive analysis has been performed based on the theoretical model called Theory of Planned Behavior, in the course of which the perceived and objective benefits of and barriers to the conversion to a plant-based diet have been examined. According to our results, the main benefits of plant-based nutrition are its many factors associated with a reduction in risk of developing numerous chronic diseases. This is followed by benefits of well-being and satisfaction, followed by ethical and environmental benefits. The most commonly reported inhibitory factor of a vegetarian diet is the enjoyment of eating meat and the difficulty in giving up meat consumption. This is followed by health considerations, e.g., lack of various ingredients in foods. Convenience and taste factors are also important disincentives as well as the irrelevant nature of some plant-based nutrition information sources. Besides, social barriers, negative discrimination and negative effect of mental health associated with them can also be a hindrance, as can financial barriers. The classification developed during our analysis can serve as a relevant guideline for decision-makers, and also as a basis for further primary qualitative and quantitative research.

Keywords: plant-based diet ; benefits and barriers ; vegan ; vegetarian ; consumer attitudes ; Theory of Planned Behavior ; comprehensive review

1. Introduction

1.1. Plant-Based Diets and Influencing Factors

In nutritional science, there are two ways to differentiate the so-called special diets. One approach includes special diets that are adopted because of a particular illness, such as a food intolerance or a food allergy. These diets are beyond the scope of the present study and are not discussed here in detail. The other differentiation is based on special diets adopted by individuals on their own initiative (a plant-based vegetarian diet and its specific forms).

A plant-based diet has already been defined above; however, it is worth adding that it can be considered a collective term, including diets ranging from a strict plant based one to semi-vegetarian or pesco-vegetarian. Plant-based diets consist of vegetables, fruit, legumes, oilseeds, and whole grain cereals. These components may be supplemented with milk, dairy products, and eggs in some alternative vegetarian diets or in rare cases by poultry and fish. It is also important to stress that those following a vegetarian diet mostly prefer their meals with ingredients which have been changed as little as possible and which have undergone only minimal industrial preprocessing as compared to their original form. In this way, phytonutrients (compounds in plants having a positive effect on health) can be more efficiently preserved ^[1]. The general recommendations for a plant-based diet regarding the food categories above are shown in Table 1.

Groups of Ingredients	Recommended Daily Allowances	
Vegetables (with the exception of starchy vegetables)	"Ad libitum", aiming at diversity	
Fruit	2–4 portions (1 portion = 1 medium-sized piece or 1/2 cup)	
Whole grain cereals (e.g., oat, brown rice, quinoa)	6–11 portions (1 portion = 1/2 cup of cooked cereals or one slice of whole wheat bread)	
Legumes (lentils, peas, beans, soybean)	2–3 portions (1 portion = 1/2 cup of cooked legumes)	

 Table 1. General recommendations for a plant-based diet.

Groups of Ingredients	Recommended Daily Allowances	
Leaf vegetables (e.g., broccoli, lettuce, kale)	At least 2–3 portions (1 portion = 1 cup raw or 1/2 cup of cooked leaf vegetables)	
Oilseeds (e.g., pistachio, almond, walnut)	30–55 g	
Seeds (e.g., chia, linseed, hempseed)	1–3 tablespoons	
Vegetable milk (e.g., cashew, soy, almond)	2–3 cups	
Fresh herbs	"Ad libitum"	

Source: Authors' own editing, based on Hever $^{[2]}$ and Szabó et al. $^{[1]}$

The ability to sustain plant-based dietary habits is influenced by several factors. Personal factors (habits and physical feedback) and the characteristics of the social network (vegetarian relatives or acquaintances, organized groups of animal rights supporters, those active in environmental protection, and those interested in healthcare) play a crucial role in this respect. The availability of the ingredients of a plant-based diet is also considered essential (in shops and in restaurants) [3][4].

Overall, it can be concluded that a vegetarian way of life is appropriate for all kinds of activities (intellectual and physical work, and sport) and suitable for all ages, as long as it is well planned in advance and properly sustained later on ^{[5][6]}.

1.2. The Emergence and History of the Plant-Based Diet

Research by Kökény ^[5] shows that plant-based diets are long-established dietary practices, as vegetarianism in the East has existed since the beginning of history. In India, cows and other animals are considered sacred, and their protection has always been taken for granted (Ahimszá); thus, India has always represented the strongest base of vegetarian diets. The Egyptians had a predominantly plant-based diet and consumed mainly grain crops ^[Z]. In ancient Persia, priests used a vegetarian diet ^[8]. The plant-based diet of the Western world can be traced back to the Ancient Greek culture (Socrates and Hippocrates). Given the above factors, several religious trends (e.g., Judaism, Brahmanism, Adventism, and Hinduism) prefer meat-free or mostly meat-free diets ^[1].

The first official organization was the Vegetarian Society, which was established in Great Britain in 1847, and the word "vegetarian" originates from the name of this society [9][10]. Scientific research into vegetarianism started in the 1950s and was mainly aimed at examining the adverse effects of this type of diet. Due to the positive findings, in the 1960s and 1970s, research focused more on the health benefits. It was around the turn of the millennium that the first studies on the preventive and therapeutic objectives of plant-based diets appeared, and these were concerned with the different physiological and pathological conditions of individuals [1][5][11][12].

The history of vegetarianism in Hungary dates back to 1883, when the Vegetarian Society of Hungary was established (later renamed the Hungarian Vegetarian Association). The society was formed with the aim of developing action plans and contributing to maintaining and improving people's health, with a healthy way of life. The first vegetarian restaurant was opened in 1991, in Budapest ^{[5][13]}. The 1980s saw a new boost in the emergence of plant-based diets in Hungary and it was then that new trends toward a natural lifestyle and 'reformed' diets started to develop. The "esoteric boom" in the 1990s prompted the government of the time to issue legal regulations. As a result, vegetarianism, naturopathic medicine, esotericism, and the 'reformed' lifestyle evolved into an increasingly profitable business and an important element in the economy ^[6]. The next most important change was the separation of naturopathic medicine and vegetarianism. Naturopathic medicine was able to gather more support from the very beginning, and it had political influence as well, while the followers of vegetarianism formed separate associations and societies ^[5].

1.3. Benefits of the Plant-Based Diet

Research shows that the most important benefits of vegetarian diets can be associated with positive health factors ^{[14][15]} ^{[16][17][18]}. The findings of a representative survey carried out in the USA suggest that the prevalence, patterns, and other related factors of vegetarian and vegan diets, are more significant among Americans when they make these dietary changes to protect their health ^[19]. Dyett et al. ^[20] questioned 100 people in the USA about how their health beliefs motivate them toward a switch in their lifestyle behavior and in changing their dietary patterns. Nutrient intake was assessed based on "Dietary Reference Intakes". Health (47%) proved to be the main reason for making a dietary change. The second most significant reason for a switch to a plant-based diet can be linked to well-being and satisfaction. Compared to these, connections to animal welfare and environmental sustainability were factors less-frequently preferred

and reported ^{[16][21][22]}. Jabs and Devine ^[23] looked at the preferences of vegetarians related to health and animal welfare. They conducted personal interviews with 19 vegetarians. They subdivided vegetarians into two categories. The main motivation for health-oriented vegetarians is associated with the health benefits of the diet and, through these, the avoidance of health risks. The key considerations of ethical vegetarians are moral ones and connected to maintaining animal welfare. Hoek et al. ^[24] carried out a nationally representative survey and interviewed Dutch consumers over the age of 18 in their research entitled the "National Food Consumption Survey". It was revealed that, besides health-related and social factors vegetarian consumers had a positive attitude toward the importance of product information, specialty shops, novelties, and ecological products. A detailed analysis of factors mostly supporting plant-based diets are presented below. The analysis is based on the classification given by Corrin and Papadopoulos ^[25], Rosenfeld ^[26], and Ruby ^[27]. Factors supporting the plant-based diet are shown in Table 2.

Benefits	Types of Benefits ^{1,2}	Author(s), Year of Publication				
Factors Beneficial to Health						
May reduce body fat and thus the degree of obesity	Objective	Berkow and Barnard, 2006; CJDPR, 2003; Cummings et al., 2002; Friedewald et al., 2011; Szabó et al., 2016				
Decreased intake of saturated fat	Perceived	Lea and Worsley, 2003a; Lea et al., 2006a				
	Objective	Kökény, 2009				
Having levels of serum albumin with a more favorable effect on balanced nutritional status	Objective	Benzie and Wachtel-Galor, 2009				
The essential nutritional ingredients can be found in a greater amount	Objective	Antal, 2005; CJDPR, 2003; Dwyer, 1988; Pomerleau et al., 2002				
Reduces the risk factors for developing chronic diseases	Perceived	Graça et al., 2015; Knutsen, 1994; Melina et al., 2016; Lea and Worsley, 2002; Lea and Worsley, 2003a; Lea et al., 2006a; Weinrich, 2019				
	Objective	Berkow and Barnard, 2005; Barnard et al., 2009; Dwyer, 1988; Leroy and Cofnas, 2019; Micha et al., 2010; O'Connor et al., 2017				
Reduces the likelihood of developing cancer	Objective	IARC, 2015; Nechuta et al., 2012; Pérez-Cueto and Verbeke, 2012; Richman et al., 2010; Szabó et al., 2016				
Benefits Linked to Well-Being and Contentment						
Has a positive effect on the development of well-being and on achieving peace and contentment	Perceived	Kökény, 2005; Lea and Worsley, 2002; Lea et al., 2006b				
May contribute to a decrease in social dysfunction	Perceived	Judge and Wilson, 2015				
Improves the quality of life	Objective	Kökény, 2009; Meyer et al., 2006				
Et	hical and Enviro	onmental Benefits				
May result in more effective exploitation of	Perceived	Weinrich, 2019				
economic resources	Objective	Candy et al., 2019; Oláh et al., 1985; Sabaté, 2001				
Reduces the effect of global warming and	Perceived	Mylan, 2018; Schenk et al., 2018				
environmental pollution	Objective	Candy et al., 2019; Kökény, 2009; Leitzmann, 2003				
More favorable results concerning indicators	Perceived	Mullee et al., 2017; Vanhonacker et al., 2013				
measuring environmental impacts	Objective	Castané and Anton 2017; Goldstein et al., 2016; Könczey and Nagy, 1997;				
Prioritizing the protection of animals as individuals and as species	Perceived	Janssen et al., 2016; Kenyon and Barker, 1998; PADADC, 2003; Schenk, 2018; Weinrich, 2019				
Increased willingness to contribute to animal welfare organizations	Perceived	Backer and Hudders, 2015				

Table 2. A comprehensive overview of perceived and objective benefits of plant-based diets.

¹The perceived or objective assessment of the benefits shown in the Table may be subjective, depending on the individual.

²Perceived benefits were based on consumer surveys, objective benefits were based on objective measurements (e.g. laboratory and clinical studies).

1.3.1. Factors Beneficial to Health

A plant-based diet may reduce body fat and thus the degree of obesity [6][28]. It must be added, however, that if total body mass is lower as well, one might have lower total fat mass, but the degree of adiposity is not necessarily lower. This has been stated by a research study conducted by Berkow and Barnard ^[29], who assessed the body weight of vegetarians and that of non-vegetarians. Evidence suggests that vegetarian men weighed 4.6-12.6 kg less and vegetarian women weighed 2.9-10.6 kg less than their non-vegetarian peers. By using a well-constructed diet, cardiovascular diseases, which mainly develop as a result of obesity or risk factors leading to obesity, could be prevented [1][30]. Decreased intake of saturated fat is also considered an important health benefit of vegetarian diets ^{[5][14][16]}. By conducting human trials, researchers demonstrated that individuals using a plant-based diet had levels of serum albumin with a more favorable effect on their balanced nutritional status than those using a mixed diet [31]. The quantity of important nutritional components such as magnesium, potassium, folic acid, fibers, antioxidants including vitamins C and E, and phytochemicals is higher in people with a plant-based diet [6][32][33]. The absorption of iron of plant origin can be facilitated with a proper amount of vitamins [34]. Plant-based diets are able to reduce risk factors leading to the development of diseases, which is an outstanding health benefit [35]. Fewer people have been found to die of heart diseases, and the occurrence of type 2 diabetes, dementia, gallstones, kidney diseases, rheumatoid arthritis, and different types of allergies has decreased [14][32][36]. In addition to the above, it should be emphasized that a number of nutrition guidelines stress the risk factors of consuming red and processed meat in the development of primarily cardiovascular diseases. However, it has been suggested by an increasing number of research studies, that it is only excessive meat consumption that can be considered a real risk factor [37][38][39]. Even so, the overall negative view in relation to meat consumption supports the opinion of those who have chosen plant-based nutrition, which is considered healthier [37][38][39]. The cholesterol level and blood pressure in most vegetarians are found at the lower end of the normal range [14][16][17][21][32][40][41][42]. Reducing meat consumption and the preference for plant-based diets can be effective methods for reducing the likelihood of developing some (not all) types of cancer. According to the International Agency for Research on Cancer (IARC), red meat is "probably carcinogenic to humans", while processed meat products are "carcinogenic to humans" [1][43][44][45][46].

1.3.2. Benefits Linked to Well-Being and Contentment

It has previously been elaborated that the improvement in the health condition of the individual is the main driving force in the changes in dietary patterns and in the shift to a plant-based diet. Thus, the individual seeks to reduce health risks and seeks well-being, which makes the feeling of maximum contentment attainable. Well-being and contentment, in turn, are associated with the increased amount of time devoted to physical activity and recreation. Consequently, a plant-based diet has a positive effect on well-being, enabling the achievement of peace and contentment [3][21][22]. Judge and Wilson [47] carried out a questionnaire-based survey with a sample of 506 New Zealand university students. They presented a vision which symbolized a society in 2050, where consumers predominantly followed plant-based, i.e., vegetarian or vegan diets. The findings suggested that vegetarianism could promote a decrease in social dysfunction. Individuals adopting a plant-based diet usually spend less money on health and health care, and at the same time, the quality of their lives improves [5][48].

1.3.3. Ethical and Environmental Benefits

Evidence suggests that a plant-based diet may result in more effective exploitation of economic resources, which may reduce environmental impacts ^{[13][35][49][50]}. Concerning environmental protection, the ameliorating effects on global warming and environmental pollution are mostly reported by researchers ^{[5][49][51][52][53]}. It has been confirmed by a growing number of studies that excessive meat production and meat consumption and factory farm conditions impose an unreasonable burden on the natural environment ^{[13][54][55]}. Indicators measuring environmental impacts were found to show more favorable results concerning all the factors in the case of plant-based products than in the case of Mediterranean diets (meat-based products and fish) ^[56]. In Denmark, so-called life-cycle assessments (LCA) were used to compare traditional diets with vegetarian and vegan diets, based on factors related to environmental impact. The two plant-based diets (vegetarian and vegan) turned out to produce significantly better results than the mixed diet. However, there were no notable differences between the two plant-based diets ^[57]. The protection of life is of particular importance; this is understood as prioritizing the protection of animals as individuals and as species ^{[35][52]}. With the aim of protecting animals, for moral reasons, individuals are reluctant to contribute to the existence of factory farm conditions that torture animals and then kill them (the ahimsa principle) ^{[58][59]}. Backer and Hudders ^[60] examined the relationships between

animal and human well-being attitudes and the willingness to donate, and the connections between moral issues and the choice of diets among meat consumers, flexitarians, and vegetarians. Donating behavior was assessed by examining the respondents' willingness to contribute to charitable organizations working for the protection of animals and humans. Their studies revealed that vegetarians showed more willingness to donate to animal protection organizations than those using a mixed diet. In their research, Janssen et al. ^[61] identified a vegetarian consumer group, which may also be open to the processing of products of animal origin, where the aspects of the well-being of animals are taken into consideration.

1.4. Barriers to Consuming Plant-Based Diets

The enjoyment of eating meat and the immense difficulty in giving it up are suggested by surveys to be the biggest barriers to the switch to a plant-based diet $\frac{14|[17][22][62]}{12}$. Compared to the popularity of eating meat, factors associated with health and convenience have been found to be less important $\frac{15|[16][17][22][62][63]}{12}$. Similar to the previous section, the following analysis was based on the classification made by Corrin and Papadopoulos $\frac{[25]}{2}$, Rosenfeld $\frac{[26]}{2}$, and Ruby $\frac{[27]}{2}$. The barriers to consuming plant-based diets are summarized in Table 3.

Barriers	Types of Barriers ^{1,2}	Author(s), Year of Publication				
The Enjoyment of Eating Meat						
Excessive commitment to eating meat and the difficulty in abandoning it	Perceived	Graça et al., 2015; Kenyon and Barker, 1998; Lea and Worsley, 2003a; Lea and Worsley, 2003b; Pohjolainen et al., 2015				
Essential-	Nutrient-Deficie	ncy Risks				
	Perceived	Lea and Worsley, 2001; Lea et al., 2006b				
RISK OF IOW Protein Intake	Objective	Dwyer, 1988; Kökény, 2009; Szabó et al., 2016				
Low intake of micronutrients for example, vitamin B12 and vitamin D, as well as that of riboflavin, iron, calcium and zinc	Objective	Balk et al., 2005; Candy et al., 2019; Dwyer, 1988; Kökény, 2009; Watanabe, 2007				
Convenience and Taste Factors						
The preparation of meals is too complicated	Perceived	Lea et al., 2006b; Pohjolainen et al., 2015				
The availability of meals to choose from is limited in restaurants	Perceived	Lea and Worsley, 2001; Lea et al., 2006a; Lea et al., 2006b; Vanhonacker et al., 2013				
It easily becomes boring and tasteless	Perceived	Lea and Worsley, 2001; Povey et al., 2001				
Difficulty in Obtaining Information						
The range of relevant and available information is very limited	Perceived	Lea and Worsley, 2001; Lea and Worsley, 2003a; Lea et al., 2006a				
Social Constra	aints, Negative I	Discrimination				
It may load to opting disorders	Perceived	Povey et al., 2001				
it may lead to eating disorders	Objective	Dwyer, 1988; Glasauer and Leitzmann, 2005				
Negative associations, stereotypes	Objective	Szabó et al., 2016				
The preservative effect of family habits	Perceived	Kenyon and Barker, 1998; Lea and Worsley, 2003a; Lea et al., 2006b; Taren and Wiseman, 2003				
	Objective	Kökény, 2005;				
	Perceived	Hodson and Earle, 2018				
Motivation based on initiation	Objective	Kökény, 2005				
Negative Effects on Mental Health						
Vegetarians are more neurotic and depressed than omnivores, causing them poorer mental health	Perceived	Baines et al., 2007; Forestell and Nezlek, 2018				
Financial Constraints						

Table 3. A comprehensive overview of perceived and objective barriers to plant-based diets.

Barriers	Types of Barriers ^{1,2}	Author(s), Year of Publication
Daily meals and raw materials are too costly to obtain	Perceived	Kenyon and Barker, 1998; Lea et al., 2006b; Povey et al., 2001; Taren and Wiseman, 2003

¹The perceived or objective assessment of the barriers shown in the Table may be subjective, depending on the individual.

²Perceived barriers were based on consumer surveys, objective barriers were based on objective measurements (e.g. laboratory and clinical studies).

1.4.1. Enjoyment of Eating Meat

Graça et al. [12] examined the decline in meat-based diets and the growth in the proportion of plant-based diets, which, in their view, represent a positive step forward in increasing sustainability, in developing public health, and in minimizing the suffering of animals. They conducted a questionnaire-based research study among a sample of 410 meat consumers, with the aim of assessing the potential conversion to a plant-based diet. During the analysis, the sample was broken up into three clusters, and one major cluster included those supporting meat consumption. It has been confirmed by numerous studies that excessive commitment to eating meat and the difficulty in giving it up are of prime importance among the potential barriers to changing dietary patterns [14][15][59][63].

1.4.2. Essential Nutrient Deficiency Risks

Opponents of plant-based diets often argue that these diets run the risk of low protein intake. It must be noted that experts are divided on the protein content of plant-based diets. Researchers claim in several studies that no significant difference can be found between plant-based diets and diets of animal origin in terms of protein supply [36][64]. However, nowadays there is a wide range of new alternatives available to address this problem. There is a considerable selection of plant-based protein-rich foods such as soy products, tofu, seitan, and tempeh [1][5][22][32][62]. The low intake of micronutrients, for example, vitamin B12 and vitamin D, as well as that of riboflavin, iron, calcium, and zinc, may easily lead to nutrient deficiency in vegetarians [49]. Vitamin B12 is of particular importance since it can be introduced to the body with water-soluble foods of mostly animal origin (e.g., liver, meat, milk and dairy products, and eggs) [5][32][65]. However, according to the findings of a research study in 2014, nori sheets made of dried algae, which are very popular in Japan, may function as a source of vitamin B12, to a considerable degree. Other functional foods of a similar type or dietary supplements can also contribute to vitamin B12 intake [1][66].

1.4.3. Convenience and Taste Factors

A potential barrier to vegetarian diets may be associated with the fact that they are too complicated to prepare $\frac{[22][63]}{R}$. Restaurants do not provide good opportunities for vegetarian diets, because the availability of meals to choose from on the menu is limited and the preparation of meals is not appropriate $\frac{[16][22][55][62]}{R}$. A vegetarian diet may easily become boring and tasteless $\frac{[62][67]}{R}$. Mullee et al. $\frac{[18]}{R}$ conducted an online questionnaire-based survey among Belgian consumers (N = 2436), with the aim of exploring attitudes and beliefs associated with vegetarianism and meat consumption. The sample included only 38 vegetarians, 288 semi-vegetarians, and 2031 omnivores. The most important reasons for rejecting a vegetarian diet were the following: lack of interest and willingness, bad taste, and a lack of cooking skills.

1.4.4. Difficulty in Obtaining Information

There is little relevant and available information about what dishes are worth preparing and about how to prepare them in a vegetarian diet, and about which types of food are mostly suitable for replacing meat ^{[14][16][62]}.

1.4.5. Social Constraints, Negative Discrimination

Individuals try to keep their body mass balanced by using a plant-based diet; however, this carries the risk of developing eating disorders and may lead to various illnesses [32][67]. For this reason, vegetarians may suffer from certain deficiency diseases [68]. The negative associations, stereotypes (malnourishment, vitamin or mineral deficiency, poor nutrition, and protein deficiency) previously established in relation to vegetarian diets are still persistent among the public nowadays [1]. Another barrier is that the family of the individual adopting a plant-based diet is reluctant to follow this type of diet [22]. Owing to the already established dietary habits and attitudes, the preservative effect of family habits can be a barrier, mainly for women and the elderly, during conversion to a plant-based diet [59][69]. Dietary attitudes are largely determined by different personal habits and by habits arising from close social relationships and family ties. These relationships become more pronounced with age [3][14]. Motivation based on imitation is strongly evident in connection with plant-based diets. If a popular actor or media personality adopts a vegetarian diet, his or her fans are likely to find it an example to be

followed. In this way, the health and ethical considerations of the change in the dietary pattern are overshadowed by an external control ^[3]. The consumer habits of former and current vegans were examined in a largely representative US community sample involving 1313 people in a questionnaire-based survey. A conservative attitude was considered an important issue. Findings revealed that the adoption of a vegan diet was less incited by justice concerns (animal rights, environment issues, and the starvation of the poor) ^[70].

1.4.6. Negative Effect on Mental Health

Baines et al. ^[71] compared the health status of vegetarian and omnivorous young Australian women. Their findings indicate that vegetarians experienced poorer mental health at their own discretion. Forestell and Nezlek ^[72] also reached a similar conclusion; according to their results, people following a plant-based diet are more open to novelties; however, they are also more prone to depression. It should be emphasized, however, that scientific views on the impact of plant-based nutrition on mental health are divided. In addition to the negative effects presented above, several researchers believe that, in a number of cases, plant-based nutrition can also have a positive effect on the individual's mood ^{[73][74][75]}.

1.4.7. Financial Constraints

A further perceived barrier to a plant-based diet may be the fact that the daily meals of vegetarians are too expensive and, in addition to this, the accessibility to food ingredients of plant origin is difficult $\frac{[22][67]}{1}$. Similar research also examined the perceived barriers to the conversion to a plant-based diet, and beside the change in taste and convenience, price was also found to be a potential barrier $\frac{[59][69]}{10}$. We believe that meat prices have a clear impact on the willingness to convert to a plant-based diet.

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