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Healthy Supply of the Body with Nutrients through Vegetarian Diets

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Received: December 06, 2021; **Published:** December 31, 2021

Abstract

Vegetarian and vegan diets are receiving more and more attention and their popularity in the world is growing. These diets eliminate a variety of animal products whose nutrients are to be replaced by plant-based ones. In some cases, the use of these diets may increase the risk of nutrient deficiencies. The research aimed to evaluate the diet of individuals who are proceeding vegetarian and vegan diets and to provide recommendations for proper nutrition. To achieve the aim of the research, the peculiarities of vegetarian and vegan diets in the context of scientific literature were examined, and the nutrition of persons applying vegetarian and vegan diets was analyzed. The research object - nutrition of vegetarians and vegans. Two hundred and twelve (212) respondents who were at least 18-year-old and proceeding lacto-vegetarian, lacto-ovovegetarian, ovo-vegetarian, and strict vegetarian (vegan) diets participated in the study.

A questionnaire was used to complete the mixed quantitative study. Statistical analysis was performed using the statistical program SPSS (IBM SPSS Statistics 24), statistically significant differences considering different types of vegetarian diets' representatives were determined under chosen significance levels $\alpha = 0,01$ and $\alpha = 0,05$. Most vegetarian and vegan diets are proceeded by women and they are more common among younger individuals for ethical, health improvement, and environmental protection reasons.

Vegetarians and vegans frequently consume various products rich in proteins. Meanwhile, vegetarians and vegans consume polyunsaturated omega-3 fatty acids, selenium, iodine-rich products less frequently. Most of the participants take vitamin B12, vitamin D, iron, omega-3 fatty acid dietary supplements. The majority of the participants are consuming recommended daily amounts of vegetables, fruits, and berries. Participants rarely consume less healthy foods - most often 2-5 times per month or never. The majority of the participants have an optimal body mass index. Vegetarian and vegan diets can ensure an adequate supply of nutrients to the body, when additional attention is given to nutrients which risk of deficiency development in these diets is higher.

Keywords: *Nutrition; Antinutrients; Macronutrients; Micronutrients; Nutrient Uptake; Body Intake; Vegetarian Diet; Polyunsaturated Fatty Acids (PFAs)*

Introduction

Vegetarians do not consume meat and poultry, fish, or seafood. Vegetable products make up a large part of their diet. A vegetarian diet can be broadly classified according to which animal products are eliminated from the diet. A vegan diet can be considered a strict vegetarian diet, as vegans refuse to consume animal products completely [41]. The vegan diet is characterized by high consumption of cereals, fruits, vegetables, legumes, seeds, nuts, vegetable oils [28].

Vegetarianism and veganism are rapidly gaining popularity around the world. The reduction in the consumption of animal products is being driven by various projects and initiatives, which are receiving increasing attention. According to a literature source [26], 500,000 people joined the annual "Veganuary Challenge" in 2021 during which the participants ate vegan food throughout January (it was twice as many participants as in 2019). The "Meatless Monday" project, which has already been adopted by more than 40 countries [44], encourages the abandonment of meat one day a week. The growing demand for plant-based foods has also led to changes in the food industry. Alternatives to vegetarian and vegan food are on the rise in supermarkets and restaurants.

Early research was focused on vegetarian diets and the possible deficiency of nutrients, but recently the approach to these diets has expanded to explore the potential benefits of this diet [5]. A well-balanced vegetarian and vegan diet can meet the needs of the body's nutrients, be healthy, and can prevent some diseases [2]. People around the world have used a plant-based diet or vegetarian diet since ancient times. Nutrition on these diets was motivated by a variety of reasons, including health benefits, ethical and religious considerations [5].

Vegetarians, and vegans, in particular, do not make up a large portion of the world's population. Accurate data are not available to determine the vegetarian and vegan populations in the world, but it's known that most vegetarians are in India. According to the census data released by the Indian government in 2014, India had about 30% of vegetarians [40]. Germany has the highest number of vegetarians compared to other European countries, and the number of vegans is also increasing [17].

People who follow vegetarian diets are more likely to have a higher socioeconomic status, lead a healthier lifestyle, are more physically active, and have no harmful habits more often than those who are eating a mixed/varied diet [21]. Several scientific sources show lower alcohol consumption among vegans and vegetarians compared to all foods consumers [12,31]. There has been found a higher rate of physical activity (hours per week) among vegans compared to those eating vegetable and animal products [1]. Vegetarians and vegans are more likely to have a lower body mass index than all foods users [1,9,31].

There are a variety of reasons to become a vegetarian or vegan. An international survey was conducted to find out why people choose to become vegans in 2018. More than 12 thousand people from 97 countries took part in the survey. The main motives behind the choice of veganism are ethical reasons related to animal safety, health promotion, environmental and religious aspects. The survey also revealed that the majority of those who choose veganism are women (82%). At the same time, this diet is more common among the younger generation (persons were at least 18-year-old), with most vegans in the 18 - 34 age group [36].

Environmental issues are receiving increasing attention as the agrifood system has a direct impact on the environment. The livestock sector is naturally resource-intensive and contributes significantly to global emissions of greenhouse gases such as methane and nitrous oxide all over the world [32]. There are currently 7,8 billion people in the world, 940 million of them do not have enough food to live a full, active life [46,48]. Population growth is projected in the coming decades, leading to an increasing problem of human food security [49]. Strategies to reduce emissions from this sector are needed to meet the growing demand for livestock products due to the growing population. One strategy may be related to dietary changes. The World Health Organization recommends a sustainable diet that reduces the negative impact on the environment [47]. In such a diet, the emphasis is on vegetable, local, home-cooked food, sustainably sourced fish and seafood, the consumption of moderate amounts of milk and its products or substitutes, and low levels of fat, mainly from vegetable sources. Such a diet also limits the amount of meat, especially red. Vegetarianism or veganism may be more environmentally friendly, as such diets contain limited or no consumption of animal products. It's observed that the reasons for choosing these diets are more often determined by animal welfare or health.

A plant-based diet is often equated with a vegetarian diet, but the nutritional habits of those who promote these diets are different [7]. The plant-based diet focuses on plant products, including not only vegetables, fruits, but also seeds, nuts, whole grains, legumes, and oils. Such a diet does not necessarily reflect vegetarianism or veganism, as it may contain small amounts of animal products [37]. There are the main types of vegetarian diets that do not contain meat, poultry, fish, and seafood [2]. Vegetarian diets can use eggs, milk, and dairy prod-

ucts, while vegan diets do not contain animal products (Table 1). Vegans can be classified as strict vegetarians [16,19]. Raw vegans feed on 75 100% unprocessed foods and this diet is based on vegetables, fruits, nuts, seeds, sprouted cereals [2]. Vegetarians often include other types, such as pesco vegetarians, who consume fish, milk and dairy products, eggs, and semi-vegetarians, who also include small amounts of meat (mainly poultry) and fish in their diet [42].

Type of vegetarian diet	Consumed/Not consumed foods in the vegetarian diet			
	Plant products	Milk and Dairy products	Eggs	Honey
Lacto vegetarian	Consumed	Consumed	Not consumed	Consumed
Ovo vegetarian	Consumed	Not consumed	Consumed	Consumed
Lacto-ovo vegetarian	Consumed	Consumed	Consumed	Consumed
Vegan	Consumed	Not consumed	Not consumed	Can be consumed
Green vegan	Consumed, however 75 100% - unprocessed food	Not consumed	Not consumed	

Table 1: *Classification of vegetarian diets. Source: compiled by the authors according to literature [2].*

The sources of some micronutrients in vegetarian, especially vegan, diets are lower than in diets with animal products, and it may be difficult or even impossible to obtain several micronutrients naturally with food (vitamins B12, B2, B3, D, A, minerals iron, zinc, calcium, selenium, iodine) [11,13,15,24,27,30,33,34,43].

Objects and Methods of Research

Research problem: Is it possible to provide the body with nutrients through vegetarian diets?

Goal of the research: To assess the nutrition of individuals on vegetarian and vegan diets.

Objectives of the research:

1. Examine the peculiarities of vegetarian and vegan diets in the context of scientific literature.
2. Assess the nutrition of vegetarians and vegans and compare the research results with the scientific literature data.

Respondents, their selection criteria

respondents who were 18+ years old and proceeding lacto-vegetarian, lacto-ovo vegetarian, ovo-vegetarian and strict vegetarian (vegan) diets took part in the study.

Methods of the research

Electronic databases of scientific publications - EBSCOhost, MDPI, Oxford Academic, PubMed, ScienceDirect, SpringerLink, Taylor & Francis - were chosen to collect data from the scientific literature.

The instrument chosen for the research was a questionnaire. The questionnaire was prepared to take into account the goal and objectives of the research. The electronic survey system Apklausa.lt was used to create the questionnaire. The questionnaire was publicly distributed to the target groups through the social network Facebook: Lithuanian Vegans (33,2 thousand members), Lithuanian Vegetarians (5,2 thousand members).

The survey was conducted and obtained results were systematized and analyzed with IBM SPSS Statistics 24 program, statistically significant differences considering different types of vegetarian diets' representatives were determined under chosen significance levels $\alpha = 0,01$ and $\alpha = 0,05$. Research results were discussed to assess the nutrition of vegetarians and vegans and compared with data obtained from scientific publications.

Results and Discussion

Distribution of vegetarian and vegan diets and general demographics of respondents

The research included 212 vegetarians and vegans, mostly women (91%). Half of all respondents (50%) are vegans (88% women and 12% men). More than a third of the respondents (37%) are a lacto-ovo vegetarians (95% women and 5% men). There are the fewest people who use the lactovegetarian diet (10%) and the ovovegetarian diet (3%), only women apply the ovovegetarian diet (Table 2).

Most of the respondents (88%) live in cities (88% of women and 84% of men). Only more than a tenth (12%) live in rural areas (16% men and 12% women).

Half of all respondents (50%) (53% men and 49% women) have an academic university degree. Slightly more than a quarter of all respondents (27%) have secondary education (37% men and 26% women). Less than a fifth of respondents (18%) have graduated from universities of applied sciences (19% women and 11% men). Only a small proportion of respondents have incomplete secondary and special secondary education.

Nearly a half of all respondents belong to the 18-25 year age group (49%) (51% women and 32% men). One-third of the respondents (32%) belong to the 26-32 year age group (47% men and 31% women. In other age groups, the distribution of respondents is insignificant (Table 2).

Characteristics	Women (n = 193)	Men (n = 19)
Type of Vegetarian Diet		
LactoVegetarian Diet	90 (n = 19)	10 (n = 2)
LactoOvoVegetarian Diet	95 (n = 74)	5 (n = 4)
OvoVegetarian Diet	100 (n = 7)	0 (n = 0)
Vegan (strict vegetarian) Diet	88 (n = 93)	12 (n = 13)
Age Group		
18 - 25 year	51 (n = 98)	32 (n = 6)
26 - 32 year	30 (n = 59)	47 (n = 9)
33 - 39 year	13 (n = 25)	16 (n = 3)
40 - 46 year	3 (n = 5)	0,0 (n = 0)
47 - 53 year	2 (n = 4)	5 (n = 1)
≥ 54	1 (n = 2)	0,0 (n = 0)

Table 2: *Characteristics of the respondents, per cent.*

In summary, the majority of vegetarians and vegans who took part in the study are women. The most common diet is vegan, to a lesser extent - lacto-ovo vegetarian and lacto-vegetarian, the least popular diet among respondents - ovo vegetarian, which is used only by women. Vegetarian and vegan diets are most common among urban residents. The use of vegetarian and vegan diets is more common among younger individuals. Most of the respondents have an academic university degree.

Duration of vegetarian and vegan diets' application, reasons for the choice

The analysis of the duration of vegetarian and vegan diets' application by respondents showed that more than a third of the respondents (35%) have applied vegetarian and vegan diets for 1 to 3 years (Figure 1). This duration was most often reported by close to half of strict vegetarian (vegan) diet's proponents (43%) and a third by those on a lacto-ovo vegetarian diet (28%)). There are no respondents on the ovovegetarian diet who have been on the diet for less than a year. Nearly one-fifth of respondents (19%) use vegetarian meals for 3-5 years (29% ovovegetarians and 22% lacto-ovovegetarians). Less than a fifth of respondents (18%) apply vegetarian and vegan diets for more than 7 years (43% lacto-vegetarians and 29% ovovegetarians).

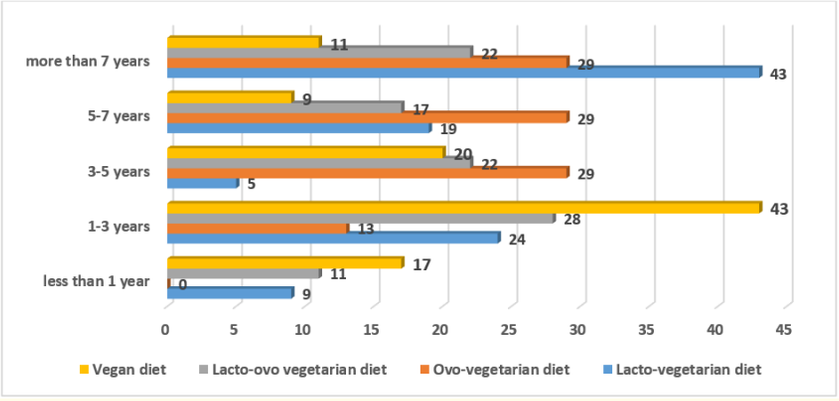

Figure 1: *Distribution of respondents by duration of diet's application according to different types of vegetarian diet (per cent).*

A statistically significant difference (α = 0,05) was found between the duration of chosen vegetarian diet and different vegetarian diets (p0,015).

The research found that more than a third of respondents (37%) chose a vegetarian diet for ethical reasons, including the vast majority of lactovegetarians (80%) and vegans (70%) (Figure 2). One-third of respondents (29%) chose a vegetarian diet to improve their health (65% of vegans and 52% of lactovegetarians). A quarter of all respondents (25%) chose a vegetarian diet for environmental issues, more than half of them were vegans (56%) and close to half - lactoovovegetarians (47%). As many as a third of respondents (33%) chose a lacto-vegetarian diet for religious reasons. Nearly a half of an ovovegetarian diet's proponents (43%) chose other own causes, such as clinical diagnoses, globalization issues, and personal choices.

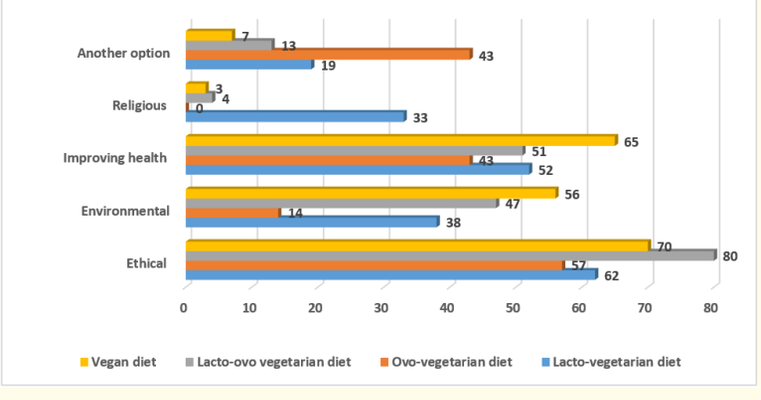

Figure 2: *Distribution of respondents by reasons for choosing a vegetarian diet, taking into account different types of vegetarian diet (per cent).*

Statistically significant differences (α = 0,05) between the reasons for choosing individual types of vegetarian diets (religious (p0,000), environmental (p0,041), and other (own) reasons (p0,013)) and representatives of different vegetarian diets were found.

In summary, most of the respondents who are vegans and lacto-ovo-vegetarians apply these diets for 1-3 years. Almost half of all lacto-vegetarian diet proponents have been on this diet for 5 to 7 years. The least number of respondents follow vegetarian and vegan diets for less than a year and 5 to 7 years. The analysis of the reasons that led to the choice of a particular diet revealed that the most common reasons are ethical, health, environmental, and only a small part of respondents apply these diets for religious reasons (mostly lacto-vegetarian diet proponents).

Consumption of macronutrients, micronutrients, honey, and food supplements in vegetarian and vegan diets

Proteins and amino acids are involved in the regulation of most processes in the body (muscle synthesis, body composition, bone status, glucose homeostasis, satiety, cellular signaling, gastrointestinal function, and microbiota) [3]. The analysis of research data showed that the most frequent consumption of milk and dairy products by respondents on a lactovegetarian and lactoovovegetarian diets was 1-3 times a week (29% and 40% respectively) and 1 time a day (24% and 19% respectively). Proponents of the ovovegetarian diet do not consume dairy products. A couple of vegans (2%) consume milk and dairy products 2 to 5 times a month.

Eggs are most often consumed 1 - 3 times a week by ovovegetarians and lactoovovegetarians (57% and 40%) respectively. Respondents on a lactovegetarian diet sometimes eat eggs, but the majority (91%) do not use eggs in their diets. Respondents on a vegan diet do not eat eggs at all.

Leguminous vegetables are most often consumed daily by proponents of the vegan diet and those on a lactovegetarian diet (29%). Vegans (13%) consume legumes several times a day. All respondents usually consume legumes 4-6 times a week. Those who eat legumes less than 2-5 times a month or never eat them make only a small part of all respondents.

Soy products are usually consumed 1-3 times a week and 2-5 times a month by the respondents, and the smallest number of respondents consume soy products several times a day. Slightly more than a fifth of vegans (21%) consume soy products on a daily basis. Compared to other plant products, soy products are consumed less frequently by the respondents.

Nuts are usually consumed 1-3 times a week and 2-5 times a month by all respondents. One-third of vegans (29%) consume nuts daily.

The respondents most often consume whole grain products 4-6 and 1-3 times a week (24%), and a large part of the respondents consume whole grain products daily (22%). These products are most commonly used by vegans (38%). There is only a small part (3%) of those who use whole grain products less than 2-5 times a month or never use them.

Statistically significant differences (α = 0,05) between the consumption of protein products (nuts (p0,01), soy products (p0,023), eggs (p0,000), milk, and dairy products (p0,000)) and representatives of different vegetarian diets were found.

The results obtained by the research are in line with literature data. Vegetarian and vegan diets can provide adequate amounts of protein unless energy requirements are not met or protein-containing products are avoided for some reason [35]. Due to poorer plant protein digestibility, vegetarians and vegans should consume more protein than recommended for the general population [4].

A study on honey consumption among respondents found that slightly more than half of the respondents (54%) consume honey: one-third of vegans (31%), majority of lacto-ovo-vegetarians (73%), ovo vegetarians and lactovegetarians (86%).

A statistically significant difference (α = 0,01) between honey consumption (p0,000) and representatives of different vegetarian diets was found.

Research findings reflect scientific literature data: most sources emphasize that vegans do not consume honey [16,19]. Vegan diets may not contain honey, but this is not strictly defined [2].

Several scientific sources note that vegans consume less saturated fat than vegetarians and significantly less than those with all food diet [10,12,45]. To find out whether respondents get enough polyunsaturated omega-3 fatty acids in their vegetarian and vegan diets, the frequency of consumption of products containing omega-3 fatty acids was examined. After analysis, it was found that the most commonly used products, containing omega-3 fatty acids, were hemp and Spanish sage seeds, walnuts, and seaweed. Proponents of vegetarian and vegan diets mostly consume these products 1 - 3 times a week and 2-5 times a month. However, there was a significant part of respondents who use these products even less often or never. Vegans tend to consume these products more often than proponents of other types of vegetarian diets. Quite a large part of respondents consumes soybeans, wheat germ, flaxseed, and rapeseed oil seldom, 2 - 5 times a month and less or never.

Statistically significant differences ($\alpha = 0,05$) between the consumption of polyunsaturated omega-3 fatty acids (hemp seeds (p0.02), seaweed (p0,012)) and representatives of different vegetarian diets were found.

According to scientific literature data [4], vegetarians and vegans can improve their intake of omega-3 PFAs by regular consumption of products with high-α-linolenic acid content (walnuts, flaxseed, Spanish sage seeds, and their oils) and by limiting the consumption of linoleic acid-containing products (sunflower oil, corn oil).

In summary, the proponents of vegetarian and vegan diets consume protein-rich products quite often. Vegans are more likely to consume such products than other proponents of vegetarian diet types. Most respondents often consume different protein-containing products. Analyzing the consumption of honey among the representatives of different types of vegetarian diets, it was observed that slightly more than half of the respondents consume honey: one-third of vegans, and the majority of lacto-ovo-vegetarians, ovo-vegetarians and lactovegetarians. After determining the frequency of consumption of foods with polyunsaturated omega-3 fatty acids among vegetarians and vegans, it was found that the most frequently consumed foods containing omega-3 polyunsaturated fatty acids are Spanish sage seeds, walnuts, cannabis seeds, and algae. However, a significant part of respondents uses these products 2-5 times a month, less or never. The research revealed that such omega-3 fatty acids-containing products as soybeans oil and wheat germ oil are particularly rarely consumed by respondents.

Plant foods are the only source of nutrient fiber, vitamin C, flavonoids, and are also rich in vitamin B1 (thiamine), folic acid, potassium, and magnesium. Plant foods are lower in saturated fat and completely free of cholesterol [20]. However, vegetarian and vegan diets may be at risk to supply the body with some micronutrients (vitamins: B12, B2, B3, D, A, and minerals: iron, zinc, calcium, selenium, iodine) [4,8,14,23,28,29].

After analysis of the respondents' opinion on which nutrients (vit. B12, vit. B2, vit. B3, vit. D, vit. A, zinc, selenium, iodine, iron, omega-3 fatty acids, proteins) in vegetarian and vegan diets additional attention needs to be paid, it was found that the majority of respondents believe that additional attention should be paid to vitamin B12 (85%), iron (60%) and omega-3 PFAs (59%). Almost half of the individuals (46%) believe that more attention should be paid to vitamin D in these diets. Almost a third of respondents (30%) are convinced that additional attention should be paid to proteins. A minority of respondents think that it's important to pay more attention to selenium (9%) and vitamin A (8%) in their diet. However, a small part of respondents (9%) still believe that nutrients in vegetarian and vegan diets should not be given extra attention. Respondents were also able to indicate their preferred option: it was stated that nutrients should be addressed regardless of diet type, and that biochemical blood tests are also of great importance.

Statistically significant differences ($\alpha = 0,05$) between indicating nutrients that should be given extra attention in vegetarian diets (iron (p0,019), proteins (p0,004)) and representatives of different vegetarian diets were found.

After analysis of the respondents' knowledge about nutrients for which extra attention should be given in vegetarian and vegan diets, the frequency in consumption of food supplements among respondents according to different types of vegetarian diets was determined. Respondents most often took the following dietary supplements: vitamin B12 and vitamin D, iron, omega-3 fatty acids. An analysis of the study data found that dietary supplements were more consumed by proponents of lacto-ovovegetarian and vegan diets compared to those on lactovegetarian and ovovegetarian diets. A higher proportion of vegans use vitamin B12 (63%) and omega-3 PFAs (28%) supplements compared to other types of vegetarian diets. More people on a lacto-ovovegetarian diet are taking iron supplements (46%) compared to vegans (26%). Fewer respondents consume zinc, vitamin B3, vitamin B2, and vitamin A in the form of food supplements. The lowest number of respondents indicated that they use selenium and iodine supplements. One-fifth of all vegans (21%) do not take the listed dietary supplements at all.

Statistically significant differences ($\alpha = 0,05$) between consumption of dietary supplements (vit. B12 (p0,003); vit. A (p0,008); iron (p0,018); "not taking dietary supplements at all" (p0,036) and representatives of different vegetarian diets were found.

The obtained research results are substantiated by scientific literature data: it was found that vegans who received only small amounts of vitamin B12 with food and took dietary supplements had similar levels of vitamin B12 intake among those who consumed all foods diet [1]. If the diet contains a small number of animal-origin products or does not contain such products, it's necessary to take dietary supplements or foods enriched with vitamin B12 [22].

Micronutrients are one of the main groups of nutrients needed by the body, which include vitamins and minerals. Plant foods have a high nutrient density, which means they are high in nutrients, but usually have fewer calories. Plant foods are the only source of nutrient fiber, vitamin C, flavonoids, and are also rich in vitamin B1 (thiamine), folic acid, potassium, and magnesium [20]. To assess whether respondents receive a sufficient amount of vitamins and minerals from food, the deficiency risk of which in vegetarian and vegan diets is higher, the frequency of consumption of certain foods was determined. The study revealed that the most commonly used products of all respondents (several times a day, every day and 4 - 6 times a week) are yellow-orange vegetables, fruits, onions, garlic, dark green leafy vegetables, and fruits. Vegans are more likely to consume yellow-orange vegetables several times a day (14%) compared to proponents of other types of vegetarian diets. Respondents usually take broccoli 4 - 6 times a week and 1-3 times a week, most of whom are on a lacto-vegetarian diet. Rarely (2 - 5 times a month or less and never) do all respondents have Brazil nuts, mushrooms (slightly more often these products are consumed by vegans and lacto-ovo vegetarians). Foods fortified with vitamins and minerals are more commonly consumed by ovo-vegetarians and vegans.

Statistically significant differences ($\alpha = 0,05$) between the consumption of foods containing vitamins and minerals (foods enriched with vitamins and minerals (p0,035); dark green leafy vegetables (p0,031); yellow-orange vegetables, fruits (p0,009); mushrooms (p0,019); onions, garlic (p0,018)) and representatives of different vegetarian diets were found.

An analysis of the results obtained for salt consumption revealed that a higher part of respondents uses Himalayan (45%) and marine (24%) salt. Iodized salt is consumed only by one-fifth of respondents (20%). There is also a small part of individuals who do not consume salt at all (5%). According to scientific literature, vegetable iodine sources are iodized salt, seaweed, although the latter (especially brown algae) consumed in large quantities may exceed the maximum level [1,19,30].

In summary, the majority of the respondents consent that in the vegetarian and vegan diets additional attention should be paid to vitamin B12, iron, omega-3 fatty acids. Nearly a half of respondents are convinced that more attention should be paid to vitamin D in vegetarian and vegan diets, and almost a third of them consider that more attention should be paid to proteins. The analysis of food supplements' usage revealed that most of the respondents use food supplements of vitamin B12, vitamin D, iron, omega-3 fatty acids. Lacto-ovo vegetarians and vegans are taking more dietary supplements than lacto-vegetarians and ovo-vegetarians. The majority of vegans consume vitamin B12, omega-3 fatty acid supplements, compared to those who promote other types of vegetarian diets. More lacto-ovo vegetarians

use iron supplements compared to vegans. Fewer respondents use zinc, vitamins B3 and B2, vitamin A supplements, and the smallest part of respondents use selenium and iodine in the form of dietary supplements. A fifth of vegans does not consume food supplements at all.

In summary, considering the frequency of consumption of products containing vitamins and minerals, most respondents usually consume yellow-orange vegetables, fruits, onions, garlic, green leafy vegetables several times a day or daily and 4-6 times a week. These products contain provitamin A, iron, calcium, selenium, vitamin B2. The study found that respondents often consume protein-containing products - legumes, whole grains, lacto-vegetarians and lacto-ovo vegetarians - milk and dairy products. These products also contain calcium, vitamin B3, zinc, in milk, and its products - vitamin B12. Respondents rarely consume Brazil nuts, which are higher in selenium (depending on the soil), and mushrooms that contain vitamin D2. Foods fortified with vitamins and minerals are more commonly consumed by ovo-vegetarians and vegans. Iodized salt is consumed by almost a fifth of the respondents, the majority consume Himalayan salt.

Nutrient uptake in vegetarian and vegan diets

Various compounds (antinutrients) in plant foods, such as phytates, tannins, trypsin inhibitors, lectins, contribute to the poorer digestibility of plant proteins [25]. Some treatments of vegetable protein sources can improve their digestibility by reducing the effects of antinutrients, such as soaking, germination, fermentation, cooking, sterilization under high vapor pressure (autoclave) [39].

The uptake of nutrients in vegetarian and vegan diets can be hindered by a variety of antinutrients. Some food preparation methods can improve the absorption of plant foods. A study on how often respondents consume foods that have been prepared in certain ways (fermentation, germination, soaking before heat treatment, tanning, heat treatment) showed that the majority of respondents (77%) consume heat-treated products most often, vegans - several times a day (42%). Respondents also often use soaked foods before heat treatment (33% 1 - 3 times a week) and fermented foods (31% 1 - 3 times a week). Proponents of a lacto-ovovegetarian diet are more likely to consume fermented products than other types of vegetarian diets; the main reason could be lacto-ovovegetarians consume fermented dairy products (yogurt, kefir) daily. Respondents consume fermented cereal products (28% 1 - 3 times a week) less often and sprouted products (28% 2 - 5 times a month) are consumed less frequently. In summary, respondents are quite often consuming foods prepared in certain ways that can reduce the number of antinutrients in plant foods. Respondents most often use cooked, soaked before cooking, and fermented food.

After conducting a survey and finding out when the respondents use polyphenol-containing drinks (coffee, black, herbal teas) that may act as inhibitors of iron absorption, it was determined that quite a large part of respondents do not use these drinks at all (herbal tea - 22%, coffee - 37%, black tea - 54%). A considerable part of respondents uses these drinks correctly - later than an hour after a meal or more than an hour left before a meal (herbal tea - 42%, coffee - 27%, black tea - 22%). At the same time, quite a large proportion of individuals use these drinks during meals, less than an hour after a meal or less than an hour before a meal (herbal tea - 36%, coffee - 36%, black tea - 24%). This may contribute to the inhibition of iron absorption in the body.

A statistically significant difference ($\alpha = 0,01$) between the using way of polyphenol-containing drinks (herbal tea (p0,004)) and representatives of different vegetarian diets was found.

Scientific literature suggests that polyphenol-containing beverages (black, herbal tea, coffee, etc.) may reduce the absorption of non-haem iron [38]. The study carried out in the UK found that a 1-hour interval between eating and tea attenuates the inhibitory effect of non-haem iron absorption, resulting in increased uptake of non-haem iron [6].

In summary, the respondents quite often consume foods that are prepared in certain ways and contain reduced amounts of antinutrients in plant foods. Respondents most often consume heat-treated foods, soaked before heat-treatment foods and fermented foods. The majority of respondents consume polyphenol-containing beverages that may inhibit iron absorption correctly, but some respondents drink these beverages with meals, less than an hour before or after a meal, which may contribute to the inhibition of iron absorption.

General data on the diet of vegetarians and vegans

To assess whether respondents' diet is healthy, the number of servings of vegetables, fruits, and berries consumed per day was examined. After analysis of results, it was noticed that most respondents consume 3 servings of vegetables per day (30%) and 1 serving of fruits per day (31%). Slightly more than half of the respondents (51%) consume one serving of berries per day. It's recommended to consume 400-500 g or 5 servings of vegetables, fruits, or berries, of which at least 300 g are vegetables (excluding potatoes) and 150 - 200 g - fruits and berries. Thus, the majority of respondents consume the recommended amount of vegetables, fruits, and berries per day.

A statistically significant difference ($\alpha = 0,05$) between the number of servings of (vegetables (p0,023)) consumed per day and representatives of different vegetarian diets was found.

To find out how often respondents consume less healthy products (confectionery, sweets, semi-finished products, fatty dairy products or vegetable alternatives to dairy products, refined grains, sugary drinks, fast food), it was determined that a higher proportion of respondents consume confectioners and refined grains 1-3 times a week (32 and 37% respectively), semi-finished and fatty dairy products or vegetable alternatives to fatty dairy products - 2-5 times a month (38% and 32% respectively), beverages with added sugar - slightly more than a half of respondents (52%) consume less than 2-5 times a month or do not consume at all, most persons (45%) consume fast food 2-5 times a month. It can be concluded that unhealthy or less favorable foods are rarely consumed by respondents, 25 times a month or not at all.

Statistically significant differences ($\alpha = 0,01$) between the consumption of less healthy products (confectionery, sweets (p0,006); fatty dairy products (p0,009)) and representatives of different vegetarian diets were found.

To assess whether respondents sustainably prepare food, it was examined which cooking methods are most commonly used by the respondents. Analyzing the obtained data, it was found that the majority of persons prepare food by boiling in water (85%), frying in a pan (79%), and baking in the oven (74%). Only a small proportion of individuals use the frying method (1%). Respondents were also able to record their option, in which they usually indicated that they were frying food in a hot air fryer, stewing. Thus, although a large part of the respondents prepares food in a pan, a larger proportion of respondents still prepare food in a sustainable way - cooking and baking in the oven.

A statistically significant difference ($\alpha = 0,05$) between sustainable food preparation method (boiling in water (p0,013) and representatives of different vegetarian diets was found.

Recommended number of meals for individuals - 3 - 5 times a day. After analysis of data, it was determined that the majority of the respondents have meals 3 - 4 times a day: proponents of the lactoovovegetarian diet (49%) and proponents of the lactovegetarian diet (43%). A higher portion of vegans eats 4 - 5 times a day compared to other types of vegetarian diets. Only a small portion of respondents eat 1 - 2 times, 5 - 6 times, and more than 6 times a day. Proponents of the ovovegetarian diet (57%) and vegans (25%) are the most likely to eat 2 - 3 times a day. Thus, the majority of respondents' meals per day are in line with the recommendations.

Eating regimen is regular eating no more than every 2,5 to 3 hours and at least every 4 hours. Assessing the regularity of eating was aimed at finding out whether the respondents follow a regular eating regime. It was found that the majority of representatives of all vegetarian diets' types do not follow a regular eating regime - they eat at different times. A higher portion of individuals (26%) who eat at different times are vegans.

In summary, most of the respondents consume the recommended amount of vegetables, fruits, and berries per day. Unhealthy or less favorable foods are rarely consumed by respondents 2 to 5 times a month or not at all. The majority of persons prepare food by boiling in water, frying in a pan, and baking in the oven. The nutrition mode of most respondents is in line with the recommendations for a healthy

diet (3 - 5 times a day). Most respondents eat 3 - 4 times a day, most often lacto-ovovegetarians and lacto-vegetarians. A higher portion of vegans eats 4 - 5 times a day compared to representatives of other vegetarian diets. Analysis of data on the regularity of nutrition showed that the majority of respondents do not follow a regular diet and eat at different times.

Body intake and lifestyle of individuals on vegetarian and vegan diets

To calculate the respondents' body mass index (BMI) and to estimate body intake, respondents were asked to indicate their height and body weight. The obtained data shows that the majority of the respondents are of optimal body weight (BMI - 18,5 - 24,9 kg/m^2). Optimal body weight is more common in vegans (37%) compared to other types of vegetarian diets. Some people are underweight (12%, BMI - < 18,5 kg/m^2), of whom there are more vegans (8%) and are overweight (13%, BMI - 25,0 - 29,9 kg/m^2), of whom more people are on the lactoovovegetarian diet (7%).

Assessing the physical activity of the respondents according to the type of vegetarian diet, it was found that the majority of the respondents have low and moderate physical activity (43% and 40% respectively), most of the vegans (43%). A relatively small portion of respondents have very low physical activity (11%) and an even smaller proportion of respondents (6%) are engaged in high-intensity physical activity.

To find out more about respondents' lifestyles, it was assessed in the study, how often respondents consume alcohol. The obtained results distinguish the frequency of alcohol consumption by the type of vegetarian diet. It was found that the majority of respondents (35%) do not consume alcohol at all, but a similar proportion (34%) consume alcohol several times a month. Most non-alcoholic drinkers are among proponents of a lactovegetarian (57%) and vegan (41%) diet. The lowest number of individuals consume alcohol daily (1%) and several times a week (9%).

After analyzing the results obtained about the respondents' smoking and taking into account the type of vegetarian diet, it was found that the majority of the respondents (76%) do not smoke. The lowest number of smokers is among vegans (20%), and the highest number of smokers is among lactovegetarians (33%).

In summary, the majority of the respondents have optimal body weight. A small proportion of respondents, most of whom are vegans, are underweight. A quite similar proportion of respondents are overweight, most of whom are lacto-ovovegetarians. The analysis of the data on the respondents' lifestyle habits revealed that the physical activity of respondents is low. A large portion of the respondents, mostly vegans, have physical activity of moderate intensity. Very low and high intensity physical activity is characteristic for only a small portion of respondents. Onethird of respondents do not consume alcoholic beverages, and a similar portion consumes these beverages rarely, several times a month. Lacto-vegetarians and vegans are the most common non-drinkers. Most respondents do not smoke, with the least number of smokers among vegans. The majority of smokers are lacto-vegetarians.

Conclusion

1. Research carried out using questionnaire and assessing vegetarians' nutrition have shown that respondents are quite likely to consume protein-rich foods prepared in certain ways that reduce the number of antinutrients in plant foods, consume polyphenol-containing beverages properly. The need for omega-3 polyunsaturated fatty acids is ensured by consuming Spanish sage, hemp seeds, walnuts, algae. Most respondents who take vitamin B12, vitamin D, iron, omega-3 fatty acid supplements, and lacto-ovovegetarians are more likely to take iron supplements than vegans. Most respondents consume the recommended amounts of vegetables, fruits, and berries per day. The number of meals of respondents is in line with the recommendations for healthy nutrition, but more than half of the respondents (55%) do not follow a regular diet and eat at different times. Unhealthy or less favorable foods are rarely consumed by the respondents, the majority of respondents do not consume alcoholic beverages or consume them very rarely, and most of the respondents do not smoke.

2. Comparative analysis of the research results and scientific literature has revealed coincidences of the respondents' characteristics. Women and younger people more often practice vegetarian diets for ethical, health, environmental and religious reasons. To meet the need for proteins and essential amino acids in nutrition vegetarians need to consume more protein than the general population due to antinutrients in plant products, the effect of which can be reduced by applying certain food processing methods (thermal, soaking, fermentation, tanning) that adjust the factors inhibiting and activating the absorption of nutrients. Respondents consume products with more α-linolenic acid and less linoleic acid, food supplements, which are emphasized in scientific sources, to ensure the supply with macro- and micronutrients.

3. Statistical analysis of the research data emphasizing the nutrients lacking in an unbalanced vegetarian diet has revealed that vegetarians and vegans, maintaining the diversity of nutrition, applying health-friendly and sustainable food preparation methods and principles, can ensure a healthy and comprehensive supply with nutrients.

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