

# Eating pattern of vegetarian diet

## Padrão alimentar da dieta vegetariana

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### ABSTRACT

This literature review examines several studies that evaluated the factors that influence the adoption of vegetarianism, as well as the eating pattern and recommendations of the vegetarian food guide. A search on databases such as Medline (National Library of Medicine, USA) and Lilacs (Bireme, Brazil) allowed us to find scientific studies published in Portuguese and/or English that had the following keywords: vegetarian, vegetarian diet and vegetarianism. Vegetarianism has been disseminated for centuries and many respected physicians, scientists and philosophers followed this practice based on different reasons. The increasing number of individuals that adopt the vegetarian diet impute to Health professionals, particularly nutritionists, the responsibility of knowing the principles of vegetarianism, in expectation of their proper management and adjustment of the vegetarian feeding behavior to the nutritional requirements of the individual.

**Keywords:** Diet, vegetarian; Food guide; Feeding behavior; Food consumption

### RESUMO

Esta revisão reúne diversos estudos que avaliam os fatores que influenciam a adesão ao vegetarianismo, bem como o padrão alimentar e recomendações do guia vegetariano. Para tanto, foi realizado um levantamento bibliográfico mediante consulta às bases de dados Medline (National Library of Medicine, USA) e Lilacs (Bireme, Brasil), nas quais foram selecionadas publicações científicas em português e inglês, a partir dos seguintes termos: vegetariano, dieta vegetariana e vegetarianismo. Durante séculos o vegetarianismo tem sido difundido. Ao longo da história, grandes médicos, cientistas e filósofos seguiram a prática da alimentação vegetariana fundamentada em diferentes concepções. O crescente número de vegetarianos atribui aos profissionais da Saúde, sobretudo nutricionistas, a responsabilidade de conhecer os princípios da dieta vegetariana na expectativa de que, com base em evidências científicas, eles possam direcionar adequadamente sua

conduta com respeito a essa dieta, bem como adequar esse padrão alimentar às necessidades nutricionais do indivíduo.

**Descritores:** Dieta vegetariana; Guias alimentares; Padrões alimentares; Consumo de alimentos

### INTRODUCTION

The interest and adoption of vegetarian diets have been increasing. A survey conducted in 1994 reported that approximately 12.4 million individuals of the United States considered themselves vegetarians. This corresponds to approximately 7% of the population and to double the number of vegetarians described in the last eight years<sup>(1)</sup>.

There are many reasons that lead individuals to adopting the vegetarian diet. The main reasons are related to health, to ethics and animal rights, to the environment, to hunger, to economics and religion. According to Melina<sup>(2)</sup>, the majority of people that follow this eating pattern base their choice on a healthy lifestyle.

Over the last decades, epidemiological studies have indicated significant benefits of vegetarian and other vegetable-based diets to human health<sup>(3)</sup>. Part of this evidence comes from studies conducted on the health status of the Seventh-Day Adventists, for this group presents an homogeneity in lifestyle, such as tobacco and alcohol abstinence and a vegetarian or ovo-lacto-vegetarian diet. More than 205 papers have been already published based on researches carried out, mainly by scientists of Loma Linda University, about Californian Adventists<sup>(4)</sup>.

The vegetarian diet differs from the egg-based diet in aspects that go beyond the mere suppression of meat products. Vegetarians have a high intake of

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vegetables, fruits, cereals, legumes and nuts, besides the fact that this diet presents a lower content of saturated fat and a relatively higher content of unsaturated fat, carbohydrates and fibers<sup>(5)</sup>.

The term 'vegetarian' encompasses a broad range of eating patterns with potential different implications in health<sup>(1)</sup>. It is not uncommon that individuals who claim to be vegetarian eventually eat meat. The different eating patterns result in different nutrition intake and that is why health professionals need to verify what is actually eaten instead of relying on how people name their diets. Unfortunately, there is no exact definition of the term 'vegetarian' on several scientific studies, although researchers might classify individuals based on their reported dietary intake and not on how people would call themselves or their diets<sup>(6)</sup>.

Basically, vegetarians are individuals who do not eat any type of meat. The nomenclature used to define the different vegetarian diets depends on what animal products are included in the diet. Therefore, the vegan, or pure or strict vegetarian, does not include any products of animal origin. The lacto-vegetarian includes dairy products in his/her diet and the ovo-lacto vegetarians include eggs and dairy products. All of them are vegetarians.

Cereals, fruits, vegetables, legumes, nuts and seeds are the base of vegetarian diets, with variable amount of dairy products, with or without eggs<sup>(1)</sup>.

There are few studies about vegetarian diets in Brazil<sup>(7)</sup>. Because of the scarce number of Brazilian studies, it is important to address the theme.

## OBJECTIVE

This review aims to discuss the recommendations of the current vegetarian guide, as well as the nutritional aspects related to this type of diet.

## METHODS

This literature review was conducted through a bibliographical survey based on Medline (National Library of Medicine, USA) and Lilacs (Bireme, Brazil), and on books. Scientific papers were selected, both in Portuguese and English. The keywords searched were vegetarian, vegetarian diet and vegetarianism. Comparative, retrospective, prospective studies and meta-analyses were assessed.

## RESULTS

### Emergence of vegetarianism

According to Melina<sup>(2)</sup>, vegetarianism has been a nutritional option since the beginning. According to

creationists, its origin comes from the creation of man and one of the most well known records of this is found in the Old Testament, in which God tells Adam and Eve about how their diet should be<sup>(8)</sup>:

“Behold, I have given you every plant yielding seed that is on the surface of all the earth, and every tree which has fruit yielding seed; it shall be food for you.”  
(Genesis 1:29)

Throughout history, vegetarianism blended with culture all over the world. Many of the great philosophers and thinkers chose not to eat meat at times in which this choice did not fit the legislation set by the ruling class. Among those who have advocated and promoted vegetarianism, Pythagoras was the first in the East and was considered to be the “father of vegetarianism”. His influence was so impressive that at the end of the 19<sup>th</sup> century, when the word “vegetarianism” was coined, those who followed a diet without meat were called “pythagoric”<sup>(2)</sup>. Just as Pythagoras, many other great men followed vegetarianism over the centuries, such as Leonardo da Vinci (1452-1519); Benjamin Franklin (1706-1790); Dr. J.H. Kellogg (1869-1948); Mahatma Gandhi (1869-1948) and Albert Einstein (1879-1955).

Vegetarianism presented a slow, but constant growth. According to Melina<sup>(2)</sup>, during the first half of the 20<sup>th</sup> century, vegetarianism was fed by the ideals of Health reformers and by those who defended the ethical principles of a vegetarian diet.

### Reasons for adopting a vegetarian diet

Nowadays, there are several reasons for the adoption of vegetarianism, including rational and emotional factors. Many people believe that a vegetarian diet is healthier, others claim that there is a relation between the diet chosen and the environment, world hunger and economics. Some of the most common reasons are discussed below.

- health: this is the key reason outside Brazil for people to adopt a vegetarian diet. There is a strong consensus that the vegetarian diet is healthier than a diet that includes food of animal origin<sup>(2)</sup>. Over the last 20 years, epidemiological studies have documented important and significant benefits of vegetarianism and other diets based on vegetables, which reduce the risk of many non-communicable chronic diseases as well as the total risk of mortality<sup>(3)</sup>.

While meat intake has been related to a increased risk of diverse non-communicable chronic diseases, such as the ischemic heart disease and some types of

cancer, the abundant consumption of essential food of vegetarian diet, such as fruits, vegetables, pulses, non-refined food and nuts, has been consistently associated with a lower risk of developing many of these diseases and, sometimes, an increase in life expectancy<sup>(5)</sup>. According to Sabaté<sup>(3)</sup>, people who have followed this diet, especially Adventist vegetarians, have presented a remarkable health status.

These benefits may occur because of the abstinence to meat in the diet, or because of the increased amount and diversity of vegetables that contain biologically active substances, in addition to nutrients, vitamins and minerals.

With the increase of scientific evidence supporting the benefit of a vegetable-based diet, scientists and Health professionals should encourage more effectively this type of diet, which would help to refrain the strong economic power that discourage vegetarianism<sup>(9)</sup>.

According to Melina<sup>(2)</sup>, there are other reasons for adopting vegetarianism:

- ethics and animal rights: many people think that vegetarianism is a statement against violence and cruelty. They affirm that killing another creature is essentially wrong. Every year, more than seven billion animals (except for fish) are slaughtered and consumed as food in the United States. In Brazil, according to the Brazilian Vegetarian Society, approximately 50% of individuals become vegetarian for this reason;
- environment: the response of our society to the environmental status is unprecedented. Many individuals think that the decision of becoming vegetarian is a means of reducing the damage caused to the environment, since industrial animal raising has a great impact on the environment specially related to deforestation and contamination of groundwater, among others;
- hunger: world hunger is an issue of enormous proportions. Almost one fourth of the world population does not have enough to eat. In spite of that, 40 to 60 million individuals starve to death or die from other diseases as a consequence of hunger. Many people choose a vegetarian diet in order to somehow contribute to reducing world hunger, since to produce two pounds of meat, ten pounds of grains are necessary;
- economics: a major part of the world population subsists on vegetarian or almost vegetarian diets simply because they cannot afford meat. Economics can shape political decisions and force the choice of food. Some people think that economics is

another strength that compels them to adopting a vegetarian diet;

- religion: although it is important to mention religion as one of the reasons that lead people to becoming vegetarian, most often the reasons that lead a religious institution to recommend this kind of diet are based on health issues or on the belief that killing is strongly wrong.

### **Adventists and vegetarianism**

One group of vegetarians that has been exhaustively studied is the Seventh-Day Adventists. At the beginning of the 1950s, the physicians Hardinge and Stare, from Harvard University, were the first two to conduct a comprehensive study about the nutritional status of this group. Approximately half of the participants of the study were high risk individuals, such as pregnant women and adolescents. The study provided the necessary evidence to the statement that adopting and planning well a vegetarian diet bring indisputable benefits<sup>(10)</sup>. Since then, numerous studies closely examined the health status of vegetarian Adventists.

The Seventh-Day Adventists are also known for disseminating concepts about healthy life by following vegetarianism, and have been subject of studies over the last 45 years because of the unique features of their lifestyle<sup>(11)</sup>. They are a conservative religious group with more than 13 million members around the world<sup>(9)</sup>. Their first general conference that actually formed the Seventh-Day Adventist Church took place in 1863 in the United States. In the same year, a small group of Adventists started to stress the role of lifestyle in health promotion.

Since then Adventists have strongly recommended their unique lifestyle for 140 years, although only the use of alcohol and tobacco and the consumption of foods considered impure in the Bible, such as pork, are currently prohibited. In addition to it, the church also recommends Adventists to avoid the consumption of other types of meat (beef, chicken and fish), coffee, black tea and other drinks that contain caffeine, refined and spicy food. Following these recommendations, nowadays, half of Californian Adventists are ovolactovegetarians or eat meat less than once a week, but they also follow other specific recommendations with regard to their lifestyle<sup>(9)</sup>.

Ellen G. White played a key role in the first years of the Adventist church. As author of several papers about health, she encouraged the adoption of the recommendations of this lifestyle. Furthermore, Adventists have been concerned with establishing institutions that promote this healthy lifestyle, such as

hospitals, rehabilitation clinics and schools, from the very beginning. Probably the most well known out of these institutions, that has been the *locus* of many studies on vegetarianism, is the Medical Center of Loma Linda University in California.

### Eating pattern in vegetarian diet

The eating pattern of vegetarians presents a considerable variation. The diet of ovo-lacto vegetarians is based on grains, legumes, vegetables, fruits, nuts, dairy products and eggs while it excludes beef, fish and poultry. The eating pattern of strict vegetarians is similar to ovo-lacto vegetarians except for the additional exclusion of eggs, dairy products and other foods of animal origin. Within each pattern, there might be considerable variation with regard to the extent in which animal products are excluded. Therefore, an individual approach is necessary to accurately assess the nutritional quality of the dietary intake of a vegetarian<sup>(12)</sup>.

However, there is a new group of individuals called semi-vegetarians by some authors. According to Fraser<sup>(11)</sup>, semi-vegetarians are those who eat fish and meat less than once a week.

According to The American Dietetic Association (ADA)<sup>(13)</sup>, the vegetarian diet is defined as the one that does not include meat, fish and seafood. The position of the ADA is that when properly planned, vegetarian diets are health and nutritionally fit, bringing benefits to the prevention and treatment of certain diseases.

The first food guide was developed by the United States Department of Agriculture (USDA) in 1916; however, it did not include enough information to plan vegetarian diets<sup>(14)</sup>.

Throughout the decades, many other tools for planning meals especially to vegetarians have been developed. One of these tools is the vegetarian guide, that started to be developed by the Loma Linda University in 1995 by a group of scientists, lecturers and physicians, which should represent the diverse vegetarian traditions and practices. This pyramid has been used by a large number of ovo-lacto vegetarians, although it does not often include recommendations on frequency<sup>(15)</sup>. According to the same author, several facts contributed to the development of a vegetarian food guide: when properly planned, vegetarian diets promote adequate growth and development and supply the nutritional needs of healthy individuals.

Evidence based on studies of the eating habits of vegetarians have been observed and described. This data is available in the scientific literature.

Results of clinical and epidemiological studies indicate that high consumption of food of vegetable origin has reduced the risk of several chronic diseases whereas the consumption of meat has increased it.

### Groups of the vegetarian food pyramid

The nine food groups that comprise the Food Guide of the Loma Linda University for Vegetarians are described by Sabaté<sup>(15)</sup> and shown on Figure 1. The groups are: whole grains, legumes, vegetables, fruits, seeds, vegetable oils, dairy products, eggs and sweets. The five major food groups (whole grains, legumes, vegetables, fruits, pulses) make up the trapezoid base of food that is characteristic of strict vegetarian diet. At the top of the pyramid there are the four optional food groups that include vegetable oils, dairy products, eggs and sweets.

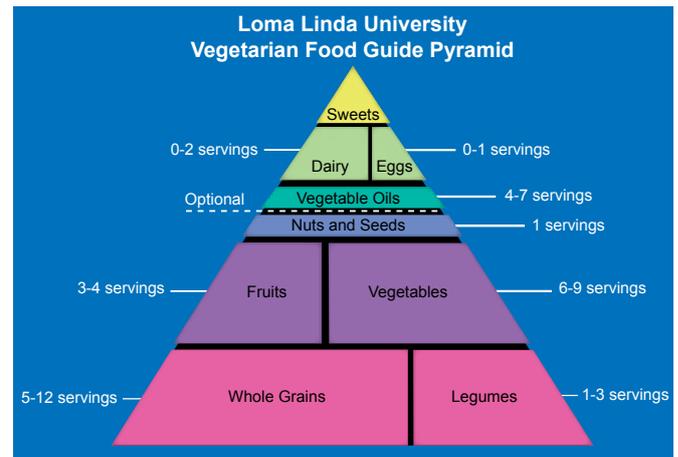


Figure 1. Food guide of the vegetarian pyramid

The vegetarian guide also makes other recommendations, such as water consumption, physical activities, exposure to sunlight and consumption of vitamin B12 (recommended to strict vegetarians).

Next, a description of each food group is presented:

- Group 1 (whole grains): the consumption of whole grains (whole wheat, whole rice and cereals) has been recommended all over the world. This group consists of grains produced under minimal processing. The best whole food choices are bread, grains and rice. Some vegetarians eat grains as beef analogues such as gluten, which is a part of wheat rich in protein.
- Group 2 (pulses, lentils, peas): in vegetarian diets, pulses are on the same level of whole grains. This

group also comprises a variety of processed foods based on soybean and others.

- Group 3 (vegetables): many vegetables have very little carbohydrates and are rich in vitamins, minerals, antioxidants and phytochemicals. Vegetarians usually eat the amount of vegetables recommended by the food guide.
- Group 4 (fruits): this group includes fresh, frozen, dried and canned fruits. Fruits are a good source of fibers, and of several minerals, vitamins and phytochemicals. By and large vegetarians consume the recommended amounts of fruits.
- Group 5 (nuts, cashews and oily seeds): rich sources of nutrients such as fat, fibers, B-complex vitamins, vitamin E, vitamin A, minerals and phytochemicals. Vegetarians eat more nuts, cashews and oily seeds than omnivorous.
- Group 6 (fat/vegetable oils): fat can come from animals (butter, mayonnaise, margarines) and vegetal (avocado, olives, coconut, vegetable oil, hydrogenated vegetal oils). Considering the eating pattern of vegetarians, it is recommended that vegetable sources of fat, particularly food that are rich in polyunsaturated (mainly omega 3) and monounsaturated fats.
- Group 7 (dairy products): some vegetarians might consume a larger amount of protein from milk (cheese and yogurt), without including any meat sources. Other vegetarians consume little or no protein of animal origin. However, food of vegetable origin fortified with calcium (water-soluble soybean extract fortified with calcium) has been launched in Brazil and consumers may choose these products to replace dairy products and, therefore, consume smaller amounts of foods of animal origin.
- Group 8 (eggs): because of their nutrients, eggs are consumed as meat substitutes. The separation of this group helps us distinguish the different categories of vegetarianism (ovovegetarians, lactovegetarians and ovolactovegetarian).
- Group 9 (sweets): it is usually the combination of two or more groups of foods. The majority of sweets contain sugar, refined flour, margarine, butter or oils, eggs and a variety of other ingredients. Processed food contains hydrogenated oils. This group should be consumed with moderation and be limited for weight management or loss programs.

### Risks of vegetarian diets and the existing potential controversies

Studies about vegetarianism focus mainly on the characteristics of diets, the motivation to adopt this practice and its nutritional benefits and implications.

Nowadays, nutrient bioavailability is considered highly important in Nutrition science. This concept has been developed since 1960 and its applicability in vegetarian diets is very important because of its special characteristics, such as the interaction of different nutrients<sup>(16)</sup>. The nutrients of which bioavailability are considered to be very important for vegetarian diets are protein and minerals (iron, calcium and zinc), as well as omega-3 fatty acids and vitamin B12.

### Protein

In 1991, the Food and Drug Administration (FDA) and the World Health Organization (WHO)<sup>(17)</sup> adopted the Protein Digestibility Corrected Amino Acid Score (PDCAAS) which revealed that the biological value of soy protein is similar to animal protein. Thirty grams of soybean protein isolate (SPI) contains 26.4 g of proteins and can be added to ready-to-eat foods; 113 g of tofu provide 8 to 12 g of protein and 100 Kcal; two cups of soy milk and a meal with a meat analogue provide 30 g of soy protein per day, which shows that soybean and soybean products provide high protein content. However, there are some challenges in regards to soy consumption by Brazilians because several people never used it (only in processed foods) and do not know how to prepare it.

The recommended method, named PDCAAS, was adopted by FDA to evaluating protein quality and labeling products for children aged over two years and adults.

The PDCAAS is based on a method to score amino acids, comparing the amino acid profile of the protein of the test food to the essential amino acid requirements of the pre-school children, adopted by the FAO/WHO as amino acid standard. This standard is used because it exceeds the standard amino acid need of older children and adults. The most limiting amino acid is used to determine the non-corrected amino acid score, which is multiplied by the digestibility of the test food to establish the PDCAAS. Based on this method, soy protein isolated has the highest score (1.0) that can be attained for the corrected protein score. No protein can have a PDCAAS higher than 1.0. The digestibility of soy proteins is highly and completely digestible, containing all essential amino acids in the reference pattern and at the right ratio.

PDCAAS (for Soy Protein Isolate):

- soy protein digestibility = 97%;
- non-corrected amino acid score = 26 divided by 25 = 1.04;
- amino acid score corrected by protein digestibility =  $0.972 \times 1.04 = 1.00$ .

As for biological value, the ovolactovegetarians consume the protein of the egg white that presents the best biological value. The biological values of milk and meat proteins are also high<sup>(16)</sup>.

Studies indicate that the availability of vegetable foods eaten throughout a day can provide all essential amino acids and ensure appropriate nitrogen retention in healthy adults. Therefore, protein supplement is not required on the same meal<sup>(18)</sup>. On the other hand, based on the low digestibility of vegetal proteins, some authors admit that the protein requirements of vegans can be increased by 30 to 35% for children aged up to two years, 20 to 30% for children aged from two to six years, and 15 to 20% to children older than six years of age compared to the non-vegetarian ones<sup>(19)</sup>.

Young and Pellett<sup>(20)</sup> verified that protein deficiencies in vegetarian populations are not confirmed in population studies or in groups with a small number of individuals. Old concepts of protein need based on animal models caused misinterpretations of the theoretical need of proteins for human beings. Vegans tend to present serum albumin levels significantly higher than omnivorous and the protein intake of vegetarians usually attains from 12 to 13% of total energy<sup>(21)</sup>.

## Zinc

Solomons<sup>(22)</sup> gives examples of some dietetic and non-dietetic factors that affect zinc bioavailability. Dietetic factors are subdivided into intrinsic and extrinsic factors. Intrinsic factors are related to the chemical nature of zinc itself; extrinsic factors include nonheme iron (milk, egg and vegetable iron), ethylenediaminetetraacetic acid (EDTA), dietetic fiber, phytic acid, calcium, copper and specific foods such as cow milk, cheese, coffee, eggs, lime and celery, which reduce zinc bioavailability.

Phytic acid is a chelating agent that binds to zinc producing an insoluble compound in normal intestinal pH. Phytate affects the absorption of zinc from the diet and of endogenously secreted zinc<sup>(16)</sup>.

Phytic acid is also an organic acid that can affect the nutritional value of the food in which it is found as well as of the food that does not contain it, but which is eaten with it in the diet. This acid is found in all proteins of seeds and several roots. This substance is not destroyed during normal processing of proteins (cooking) nor affected while it goes through the gastrointestinal tract<sup>(16)</sup>.

Excessive calcium in the diet in the presence of phytate has adverse effects on zinc absorption. This fact may occur in ovolactovegetarian diets<sup>(23)</sup>.

Erdman et al.<sup>(24)</sup> studied zinc bioavailability in soy processed foods and found negative effects of phytic acid, calcium and other factors on zinc bioavailability. These results are important for vegetarian diets since soy products are largely consumed by its followers. The interaction of these factors in complex diet systems, such as vegetarian diet, and its effect on nutritional status in human beings are not clearly understood yet.

Santos and Cozzolino<sup>(23)</sup> conducted a study in which the nutritional status, particularly related to zinc, was affected in vegetarians when compared to non-vegetarians, using saliva and blood plasma as clinical parameters. Results indicated that, in average, vegetarians had lower zinc levels in the supernatant saliva fraction (24.9 + 12.9 mg/L) when compared to non-vegetarians (34.1 + 18.3 mg/L). The same study indicated significant negative association between the intake of dietetic fiber and zinc in the saliva of vegetarians. However, according to Hunt, zinc intake of vegetarians is virtually the same of omnivorous. This study did not detect any clinical or laboratory deficiency of zinc in the studied populations<sup>(25)</sup>.

## Iron

The absorption of iron (Fe) is not only determined by dietetic factors, but also by the iron nutritional status of individuals. Some studies state that more iron is absorbed by individuals with iron deficiency than by individuals who are iron replete.

The major facts that affect dietetic iron absorption are:

- amounts of heme and non-heme iron;
- dietetic factors that affect the bioavailability of the mineral;
- iron nutritional status of individuals.

Some studies conducted with vegetarians identified few individuals with iron deficiency. Therefore, it is assumed that dietetic factors, such as vitamin C and the iron available in soy and other foods, compensate for lower absorption of iron from vegetable foods<sup>(26)</sup>.

In a controlled study conducted in a laboratory, Kies and McEndree found that vegetarians use iron from a lactovegetarian diet better than omnivorous who consume the same diet<sup>(27)</sup>. These results support the theory that the absorption of iron is partly mediated by the individual nutritional needs.

Vegetarians usually consume more iron (particularly vegans) than omnivorous individuals, and it is also associated with vitamin C intake, which is usually doubled by vegetarians. Hunt demonstrated that

vegetarians have the same prevalence of anemia due to iron deficiency as omnivorous populations<sup>(28)</sup>.

### Calcium

Milk is the food with the highest concentration and bioavailability of calcium, vegetarian diets are separated in two groups with regard to this mineral: those that include and those that do not include milk and dairy products in the diet.

Most calcium from foods of vegetal origin is combined with compounds that inhibit absorption, including oxalic and phytic acid, phosphate and fibers.

A good cooking practice that can partially eliminate the oxalic acid present in foods is boiling vegetables rich in this substance followed by the disposal of the water in which they were cooked. However, not all vegetables rich in oxalic acid are prepared according to this cooking method. Therefore, a diet rich in oxalic acid should be compensated with an increased intake of food rich in calcium<sup>(29)</sup>.

Vegetarians can avoid potential issues related to their mineral nutritional status by adjusting the intake of fibers, phytates and oxalates to a reasonable level.

According to Weaver et al.<sup>(30)</sup>, calcium intaken by vegetarians that take milk and dairy products is usually appropriate. Vegans tend to eat from 500 to 700 mg of calcium per day (daily recommendation is 1,000 mg). Nutritional counseling, including more foods with good calcium bioavailability and those with lower oxalic acid, can correct this difference. As for calcium and bone health, vegetarians tend to produce more vitamin D2, increased intake of phytoestrogen, more appropriate consumption of proteins and food with alkaline ashes that can be beneficial to bone health<sup>(31)</sup>. There are no specific calcium recommendations to vegetarians<sup>(32)</sup>. New demonstrated that the bone health of vegetarians is similar to that of omnivorous populations<sup>(33)</sup>.

### Omega-3

Vegetarians should consume a larger amount of omega-3 fatty acids because it should be converted in eicosapentaenoic acid (EPA) and docosaexanoic acid (DHA), forms that are already present in animal origin food. As the conversion of this fatty acid is low in human beings, its intake should be optimized<sup>(34)</sup>.

The other nutrients do not tend to be an issue in vegetarian diets. A study conducted in the United Kingdom with 33,883 omnivorous and 31,546 vegetarian individuals found that, when compared to omnivorous, vegetarians tend to eat fewer calories but with the same, or even increased, intake of micronutrients,

which reflects the choice of foods with richer nutritional content<sup>(35)</sup>.

### B12 vitamin

Ovolactovegetarians might attain and exceed the RDA of vitamin B12 if the consumption of eggs or dairy products is regular, because this vitamin is found in these kind of food. However, according to Koebnick et al.<sup>(36)</sup>, vegans that eat no supplement or enriched food do not have a proper intake of this vitamin, which might cause long term deficiencies since liver B12 stock can last many years. B12 vitamin should be offered as supplement to all vegans, including children and pregnant women<sup>(37)</sup>.

### DISCUSSION

One of the reasons for the popularity of vegetarian diets are the recent studies that indicate a lower morbidity and mortality ratio by degenerative chronic conditions in vegetarians compared non-vegetarians.

De Biase et al.<sup>(38)</sup> studied 76 Brazilian vegetarians with regard to their total cholesterol (TC), LDL cholesterol (LDL) and triglycerides (TG). The results indicated significant differences between the samples. The highest values were found in omnivorous whereas vegetarians had lower values according to the level of restriction of animal origin products, and the lowest level was found in vegans. The mean and standard deviation of total cholesterol are  $208.09 \pm 49.09$  mg/dl for omnivorous and  $141.06 \pm 30.56$  mg/dl for vegans ( $p < 0.001$ ). LDL levels were  $123.43 \pm 42.67$  mg/dl and  $69.28 \pm 29.53$  mg/dl ( $p < 0.001$ ) for omnivorous and vegans, respectively. Triglycerides values were  $155.68 \pm 119.84$  mg/dl and  $81.67 \pm 81.90$  mg/dl ( $p < 0.01$ ) for omnivorous and vegans respectively. There were no differences between the two groups with regard to HDL levels, but the HDL/TC ratio was significantly higher for vegans ( $p = 0.01$ ). The authors concluded that the vegetarian diet was associated to lower TG, TC and LDL values in comparison to the omnivorous diet.

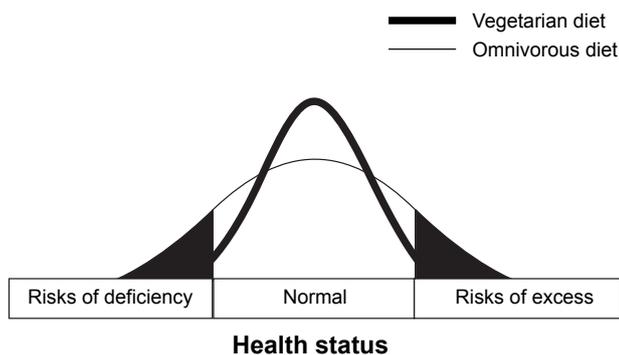
Scientific literature has found several benefits for preventing or treating chronic degenerative conditions with a vegetarian diet. Some studies indicate associations between vegetarianism and arterial pressure<sup>(39)</sup>, weight management<sup>(40)</sup> and all causes of mortality<sup>(41)</sup>. Seeds, whole grains and legumes provide a broad variety of phytochemicals and antioxidants that reduce the risk of cardiovascular diseases, hypertension and cancer<sup>(5)</sup>.

A new paradigm is emerging. Over the last ten to 20 years, epidemiological and clinical studies about the

impact of different vegetables on human health have increased scientists' understanding about the important role of this kind of food on human nutrition and health.

The high risk of cancer and cardiovascular diseases in omnivorous populations compared with vegetarians might be explained not only by excess energy, total saturated fat and other nutrients, but also by deficiency or poor consumption of phytochemicals and other nutrients found in vegetables.

Thus the contribution of diets based mostly on animal origin food might be related to increased frequency of diseases related to excess, unbalance, nutrient deficiency or deficiency of other compounds found in the vegetable origin food. Sabaté<sup>(3)</sup> gives exemplifies this new model proposed in Figure 2, which expresses the new understanding of the role played by diets based on food of vegetal and animal origin in human health. In this new model, the relative contribution of excess or deficient nutrients is clearly contrasted between the two diets, with more favorable risk-benefit for vegetarian diets. Recent scientific progresses seem to promote a paradigm shift: diets based on vegetable food are more balanced and improve health, unlike the diets based on animal origin food<sup>(3)</sup>.



**Figure 2.** The model proposed reveals the risk-benefit of vegetarian and omnivorous diets. The area under each curve represents the ratio of individuals of the population according to their eating pattern. Both ends of continuing health are divided in risks for diseases caused by deficiency or excess nutrients or food compounds to health status. The central area represents the ratio of individuals with optimal or beneficial diet.

According to the studies examined in this paper, population studies indicate that out of all nutrients taken by vegetarian populations, without the use of supplements, only vitamin B12 can be really inadequate<sup>(3)</sup>.

Although the intake of all the other nutrients might be appropriate in vegetarian diets, it is necessary to observe the intake of iron, zinc, calcium and omega-3 provided by the diet. Therefore, vegetarians need an appropriate planning and selection of the foods that will be part of their regular diet.

In order to attain that, the following recommendations are made to optimize the bioavailability of nutrients in vegetarian diets<sup>(16)</sup>.

### Recommendations for optimizing the bioavailability of nutrients in vegetarian diets

1. Reinforce the importance of diverse foods in the diet, particularly of foods with high micronutrient density.
2. Include a broad range of legumes, even as sprouts.
3. Include the consumption of fermented soy products.
4. Select dry fruits as desserts.
5. Reinforce the consumption of fresh fruit and green leafy vegetables.
6. Avoid the consumption of foods rich in calcium and iron in the same meal.
7. Reinforce the consumption of foods rich in vitamin C at meals.
8. Regularly assess the intake of iron, zinc, calcium and phytates with the help of a food composition table.
9. Use fortified foods with iron and zinc when recommended by a professional specialized in Nutrition.

### CONCLUSIONS

The different reasons to adopt vegetarianism and the diverse eating pattern among vegetarians are important facts that should be considered by health professionals when these are responsible for providing nutrition orientations to the public. This issue implies a judicious and customized approach to make the individual follow a balanced and healthy diet.

Furthermore, with the growth of vegetarianism, it is essential that health professionals, particularly nutritionists, know which foods and how many servings should be part of a vegetarian diet based on the recommendations of food guides. Therefore, diet prescription combined to monitoring nutrients from the diet, such as iron, zinc, calcium and omega-3 fatty acids, allow individuals to have a healthy and nutritionally complete diet.

Another important fact to be considered is the need of having further epidemiological studies in Brazil, using methodologies that meet the standards of scientific research. Such studies would not only allow comparison with international studies, but also promote the development of specific food guides to Brazilian vegetarians.

“Nothing will benefit human health and increase chances for survival of life on Earth as much as the evolution to a vegetarian diet”

Albert Einstein

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