NUTRITIONAL GUIDE FOR ADULT VEGETARIAN DIETS

MEDICINE AND NUTRITION DEPARTMENT

BRAZILIAN VEGETARIAN SOCIETY

2012

BRAZILIAN VEGETARIAN SOCIETY (SVB)

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Introduction

This **FOOD GUIDE FOR ADULT VEGETARIANS** is designed to support nutrition professionals who see vegetarian clients as well as clients who wish to adopt a vegetarian diet. A vegetarian diet, if well-planned (as any diet should be), can perfectly support human growth and development and can be adopted by people at any stage in life and with any lifestyle, including by athletes, pregnant women, children and elderly people.

A number of renowned international organizations, including the American Heart Association (AHA), the US Food and Drug Administration (FDA), the US Department of Agriculture (USDA), Kids Health (Nemours Foundation), the College of Family and Consumer Sciences (University of Georgia),and the American Dietetic Association (ADA) have all taken a favorable stance regarding vegetarianism. The ADA even says that it is the duty of nutrition professionals to encourage those who express their intention to become vegetarians to actually do so.

Vegetarian diets deliver beneficial effects in the prevention and treatment of several non-communicable chronic and degenerative diseases. No study has shown increased incidence of diseases in vegetarian groups. Vegetarian populations are at a lower risk for heart conditions, cancer, diabetes, obesity, gall bladder disorders and high blood pressure. Studies show that vegetarian populations have 31% fewer heart conditions, 50% less diabetes, and lower incidence of several cancers, including 88% less colon cancer and 54% less prostate cancer [1].

The **FOOD GUIDE FOR ADULT VEGETARIANS** expands on materials previously developed by Dr. Eric Slywitch and that were used as a basic reference for the official opinion on vegetarianism published by Brazil's Regional Nutritionist Board in January 2012.

According to IBOPE (a market survey organization in Brazil), of people aged 18 or older in Brazil, 10% of men and 9% of women say they are vegetarians. We believe that this Guide, and its 180+ scientific references, can provide healthcare professionals with important information to support this expanding community.

Marly Winckler

President, Brazilian Vegetarian Society

TECHNICAL OPINION CRN-3[1]

Vegetarianism

The Regional Nutritionists 'Board – 3rd Chapter (CRN-3), in concert with the "Point & Counterpoint" project for discussion of controversial topics that are relevant to the work of nutritionists, publishes the outcomes of the discussions regarding Vegetarianism, discussions in which nutritional, social and cultural issues associated to this diet were addressed.

In this discussion, the following considerations stood out:

– human beings are omnivore animals and can eat both animal and plant foods. By their nature, they can eat whatever they want. Environmental vicissitudes have led to evolutionary changes in diet habits;

– vegetarians are individuals who exclude all types of meat, poultry, fish and their byproducts from their diet; some vegetarians eat dairy and/or eggs, some do not;

– today, a number of reasons motivate people to become vegetarian, including scientific, environmental, religious, philosophical and ethical. Scientific studies show that it is possible to achieve nutritional balance and suitability with vegetarian diets, be they ovo-lacto vegetarian, lacto vegetarian, ovovegetarian or vegan, provided the diets are well planned and, if necessary, supplemented;

– a strict vegetarian diet (vegan) has no sources of vitamin B12, which must be supplied by fortified foods or supplements. The elements that require greater care in an ovo-lacto vegetarian diet are iron, zinc and omega-3. In the strict vegetarian diet, care must also be given, in addition to vitamin B12, to calcium and protein;

Given such considerations, the CRN-3 RECOMMENDS that nutritionists should pay attention to the following points:

1) Any poorly planned diet, be it vegetarian or omnivore, can be detrimental to one's health and lead to nutritional deficiencies.

2) Vegetarian diets that meet individual nutritional requirements can promote proper growth, development and maintenance and can be adopted at any stage in life.

3) Individuals with eating disorders (anorexia nervosa, bulimia, orthorexia or others), during the course of their disease, may adopt different types of restrictive diets – vegetarian or otherwise – and should be assessed within this context.

4) It is harder to achieve nutritional balance in strict vegetarian (vegan) diets, which therefore require careful planning and guidance and include specific supplementation.

Nutritionists should guide their clients' diet plans, aiming to promote their clients' health and, at the same time, respecting their individual characteristics and personal diet choices. In the dietetic care process, biological, psychological and socio-cultural aspects of the relation between individuals and food should always be taken into account.

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FOOD GUIDE FOR ADULT VEGETARIAN DIETS

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1. SUMMARY

Vegetarian diets are safe, provided they are properly planned – just like any diet should be, irrespective of whether or not it includes meat.

Most people adopt a vegetarian diet because of ethical reasons. In Brazil, a survey conducted by the IBOPE estimated that 10% of men and 9% of women are vegetarians.

If properly planned, just like any diet should be, vegetarian diets promote proper growth and development and can be adopted at any stage in life, including by pregnant women and children.

Vegetarian diets are beneficial in the prevention and treatment of several non-communicable chronic and degenerative diseases. No study has shown increased incidence of disease among vegetarians.

The ovo-lacto vegetarian diet and the lacto vegetarian diet provide human beings with all the nutrients required by the human body. The strict vegetarian diet does not include any nutritional sources of vitamin B12, and therefore enriched food items or supplements must be used.

Nutrients that require greater care when an ovo-lacto vegetarian diet is being prescribed are: iron, zinc, and omega-3. For strict vegetarian diets, attention must also be paid to vitamin B12and calcium.

Protein is not usually a point of concern in vegetarian diets. In the strict vegetarian diet, the recommended lysine intake can be achieved by eating 4 tablespoons of any type of cooked beans or vegetables.

In a healthy omnivore diet, meat intake is limited and, therefore, one needs to eat plant foods to achieve the recommended daily intake of nutrients such iron and zinc. Thus, care with the bioavailability of these nutrients should be adopted both for vegetarian and omnivore diets.

The recommended intake of iron, zinc and omega-3 (DRIs) is higher for vegetarians because of theoretical reasons and not because of any data of observed deficiencies in this population.

To increase the bioavailability of iron, we recommend that iron-containing foods be eaten with foods that are rich in vitamin C, organic acids and beta carotene. It is also important to maintain acidophil colonic flora and to use methods to reduce the phytic acid content of foods. It is advisable to avoid foods that are rich in calcium, caseinophosphopeptides and polyphenols when eating iron-rich foods.

To optimize zinc absorption, we recommend that foods rich in vitamin C and organic acids be eaten with protein- and zinc-containing meals. To reduce inhibitory effects on zinc absorption, casein and calcium should be avoided at these meals and the phytic acid content of foods should be reduced.

In a strict vegetarian diet, calcium sources should be prioritized. Calcium-fortified plant milks can be used to replace cow milk. Other calcium-containing foods will be listed in the text of this report.

Vitamin B12 can be supplemented with plant capsules or drops at the dose of at least 10 mcg/day to maintain good B12 levels. Because of the particulars of the B12 metabolism, nutritionists may prescribe up to 1,000 mcg/day of supplementation, depending on laboratory findings (according to Anvisa and to the Federal Nutrition Board).

Omega-3 intake may be increased by eating oil seeds and nuts, such as flaxseed and walnuts. This recommendation applies also to the omnivore population that does not eat fish regularly.

The vegetarian diet does not lead to eating disorders, such as anorexia nervosa or orthorexia.

Levels of agrichemical contamination are lower in vegetables than in animal based foods, because agrichemicals are fat-soluble xenobiotics and build up in greater amounts in the fatty tissue of animals than in vegetables, which, by nature, have a lower fat content.

2. DEFINITIONS

According to the Brazilian Vegetarian Society, “a vegetarian is a person who excludes from his or her diet every type of meat, poultry, fish, seafood and their byproducts and who may decide whether or not to eat dairy products and eggs. Vegetarianism includes veganism, which is defined as the practice of not using any type of animal-derived products as food, personal care products, clothing, etc.”[2]

Individuals who follow a vegetarian diet may be classified according to their consumption of eggs and dairy as:

- Ovo-lacto vegetarian: vegetarians who include eggs, milk and dairy in their diet.

- Lacto vegetarian: vegetarians who don’t include eggs in their diet, but include milk and dairy.

- Ovo vegetarian: vegetarians who don’t eat dairy but eat eggs.

- Strict vegetarian: vegetarians who include no animal product in their diet, also known as pure vegetarians.

Note: the correct term is strict vegetarian, and not restricted vegetarian. The strict vegetarian diet, by the way, tends to be more diversified than the omnivore diet[3].

- Vegan: individuals who are strict vegetarians and who don’t use any other type of animal product, such as leather, silk, wool or products that were tested on animals.

The vegetarian diet should not be confused with the macrobiotic diet, which may be vegetarian but not necessarily so. Macrobiotic individuals eat a specific diet that is based mostly on whole grains and is part of a very specific philosophical framework. Unlike the vegetarian diet, the macrobiotic diet establishes specific proportions for the

different food groups and may occasionally include meat (usually white meats) and fish). It does not recommend consumption of milk, dairy or eggs.

In the scientific literature, we also find the term **semi-vegetarian** to describe individuals who eat white meat up to 3 times a week. They are not vegetarians, but the term is used in the search for scientific data regarding associations between the studied groups, as these individuals eat less meat than omnivores, but are not vegetarian.

2.1 Reasons why people become vegetarian

Individuals become vegetarian for a number of reasons:

1) Ethics

   The awareness that animals are sentient beings (can suffer or feel pleasure and happiness) leads people to decide not to support the slaughter of animals and, oftentimes, any other type of use or exploitation of animals for any purpose, be it to produce food, clothing, cosmetics, etc.

2) Health

   Many studies associate a greater intake of plant foods and a restriction of animal foods in the diet with positive health outcomes. For this reason, many people report greater wellbeing after adopting a vegetarian diet.

3) Environment

   According to the FAO (Food and Agriculture Organization)[4], of all human activities, livestock farming is the one that causes most soil erosion and groundwater contamination. From 1999 to 2001, the world produced 229 million tons of meat. It is estimated that the world meat production will be 465 million tons by 2050.

   Livestock farming also produces high levels of greenhouse gas emissions, particularly due to the digestive process of ruminants (gases and belching). Within the scope of human activities, livestock farming accounts for 9% of all CO_2 emissions, 65% of nitrous oxide emissions (296 times more aggressive than

CO_2), 37% of methane (23% more noxious than CO_2) and 64% of the ammonia (a great contributor to acid rain). All in all, these emissions account for 18% of the GHG emissions associated with human activities.

Today, livestock farming uses 30% of the world's farm land, and another 30% of it is used to grow the grains that will be used to feed the animals. Moreover, livestock farming is the main reason why deforestation happens.

4) Family

   Some people become vegetarian after their parents, spouses or other relatives adopt that diet.

5) Spiritual and religious

   Followers of a several religions, including The Seventh-Day Adventist Church, Spiritism, Hinduism, Jainism, Zoroastrianism, and Buddhism sometimes adopt a vegetarian diet as part of their faith.

6) Yoga

   Yoga practitioners often adopt a vegetarian diet because of energetic, ethical or health-related reasons. In the Yogi's Code of Ethics, the principle of non-violence, Ahimsa, also applies to animals.

7) Philosophy

   For different philosophical reasons, some individuals choose not to eat meat and, often, other animal products (eggs, milk and cheese).

8) Palate

   It is not rare to find people who don't eat meat because their palate won't accept its taste.

2.2 Vegetarianism in Brazil.

According to IBOPE (a market survey organization), of individuals aged 18 or more in Brazil, 10% of men and 9% of women are vegetarians[5].

2.3 Reasons and statistics for the adoption of a vegetarian diet in Brazil

There are no official data on the prevalence of reasons why people become vegetarian. However, an assessment of 664 vegetarian individuals seen in a private practice in the city of São Paulo from 2008 to 2010 found the following breakdown (Table 1)[6]:

Table 1: Type of diet adopted by vegetarians

Diet	Percentage
Ovo-lacto vegetarian	67%
Strict vegetarian	22%
Lacto vegetarian	10%
Ovo vegetarian	1%

Among the reasons for adopting a vegetarian diet, the prevalence was (Table 2):

Table 2: Reasons for the adoption of a vegetarian diet by the different vegetarian groups

	Ovo-lacto veg	Lacto veg	Ovo veg	Strict
Ethical	42.0%	38.8%	0.0%	60.1%
Health	14.6%	17.9%	33.3%	14.0%
Environment	3.1%	1.5%	0.0%	1.4%
Don't like meat	8.8%	6.0%	33.3%	3.5%
Family	5.6%	4.5%	22.2%	2.8%
Spirituality / Religion	5.4%	13.4%	11.1%	4.2%
Yoga	3.6%	4.5%	0.0%	1.4%
All of the above	3.6%	3.0%	0.0%	2.8%
Philosophy	4.0%	6.0%	0.0%	1.4%
Miscellaneous	9.2%	4.5%	0.0%	8.4%

In this assessment it is evident that the chief reason why most of the people surveyed adopted a vegetarian diet is not related to health, but rather to aspects associated

with individual judgments of value – something that professional nutritionists must respect.

The international literature would indicate that health is one of the main reasons why people become vegetarian. However, most of these studies were carried out with Adventist groups, which encourage the adoption of this diet for health reasons. This was not seen in the Brazilian sample, which did not include individuals from one specific group only.

In that same assessment, individuals were asked whether they intended to keep their current diet or to change it. Their answers are in Table3.

Table 3: Intended diet of vegetarians

	Intended diet					
Current diet:	Ovo-lacto	Lacto veg	Ovo veg	Strict	Semiveg	Omnivore
Ovo-lacto	75.1%	3.4%	1.1%	20.4%	0%	0%
Lacto veg	4.5%	65.7%	0%	29.9%	0%	0%
Ovo veg	0%	0%	88.9%	11.1%	0%	0%
Strict	1.4%	0%	0%	97.9%	0.7%	0%

With such findings, we conclude that most people are happy with their diet of choice and, in case they want to change it, most would like to become strict vegetarians.

There is no evolutionary scale in vegetarianism. Thus, someone who adopts an ovo-lacto vegetarian diet is not always intending to become a strict vegetarian, and vice-versa.

3. HEALTH BENEFITS

3.1 Population Studies

Studies do not show increased prevalence of any non-communicable, chronic or degenerative diseases in vegetarian populations. We do see, however, positive

outcomes, such as decreases in serum cholesterol levels and reduced risk and prevalence of cardiovascular diseases, blood pressure, different cancers and type 2 diabetes.

3.2 Antioxidants

Among other organic changes found in vegetarians, the antioxidant defense changes are particularly marked and fundamental for the understanding of many findings of population studies.

Vegetarians have higher serum levels of several antioxidants, higher activity of SOD (superoxide dismutase), more protection against lipoprotein oxidation and greater genomic stability. Vegetarians who do not supplement with vitamin B12 tend to have higher levels of homocystein, which increases free radical formation. However, even in such conditions, some researchers have found lower levels of atherogenicity, lipid peroxidation and oxidation. This underscores how important the antioxidant system is as an integrated system that depends on integrated aggression and protection variables [7-17]

3.3 Obesity

Population studies show that vegetarians have lower BMI when compared to omnivores [18-23].

This does not mean that the vegetarian diets per se lead to weight adjustment and loss, but rather it could indicate that vegetarians might be more concerned with their health, choosing their food more judiciously and improving their lifestyle.

It is often thought that strict vegetarians are thinner than ovo-lacto vegetarians. Most studies substantiate that; however, in some cases, the BMI of strict vegetarians is higher than the BMI of ovo-lacto vegetarians because it all depends on individual dietetic choices[19]. Fats and sugars can be part of a strict vegetarian diet.

A vegetarian diet can result in weight loss, maintenance or gain. It all depends on the specific diet, lifestyle and individual metabolism.

3.4 Cardiovascular diseases

It is a fact that vegetarians' cholesterol levels are lower, and they have reductions in lipid peroxidation, which promotes enhanced antioxidant status [8, 24-31], but these are not the only reasons why cardiovascular disease prevalence is lower in vegetarians.

Cholesterol levels of strict vegetarians are lower than those of ovo-lacto vegetarians[32, 33].

Two cohort studies [34, 35] and one meta-analysis [36] showed that vegetarians (ovo-lacto vegetarians and strict vegetarians) are at a lower risk of cardiovascular disease, even after adjustments for body mass index (BMI), smoking and social class[34]. The hypothesis that the lower BMI would account for the difference is not confirmed by studies and, apparently, the antioxidant effect of the diet could be an additional factor to be considered, having an effect also on the nitrous oxide metabolism. In fact, vegetarians show better response to vasodilatation than do omnivores, which suggests greater endothelial integrity. Moreover, the lipid profile, and particularly inflammation, would be important factors in such protection [7, 10, 14-16, 35, 37-39].

Analysis of 5 prospective studies that included 76,000 individuals found reduction in ischemic cardiac disease mortality in vegetarians: 31% reduction in vegetarian men and 20% in vegetarian women[36].

A review of 9 studies showed that ovo-lacto vegetarians and strict vegetarians have serum cholesterol levels that are respectively 14% and 35% lower than those of omnivores[24]. This difference persists even after figures are adjusted for BMI[25].

A large cohort study found that ischemic cardiovascular disease incidence is reduced by 24% in ovo-lacto vegetarians and 57% in vegans, when compared to omnivores[34].

Following a vegetarian diet for a long period of time contributes to lesser thickening of the carotid intima layer as one ages[37]. A study involving 90 menopausal women and an average of 10.8 years of follow-up found that the 49 vegetarian women in the group had lower brachial artery resistance but no changes in its distensibility when compared to omnivores [40].

Even though they have higher levels of homocystein, vegetarians are at a lower cardiovascular risk. This does not mean that they should not adjust homocystein levels by supplementation with vitamin B12, which should always be optimized for maintenance.

3.5 Systemic arterial hypertension (SAH)

Most studies show that the prevalence of SAH is lower in vegetarian populations [28, 34, 35, 41-43]. Some other studies show slight pressure differences in black individuals [44, 45], and one study was conducted with athletes[46].

Two other studies carried out with black individuals also found lower arterial blood pressure levels in the vegetarian subgroup [44, 47].

The lowest arterial blood pressure figures were recorded for the strict vegetarians[34, 42, 48].

One study showed that the prevalence of SAH was 42% in non-vegetarians and 13% in vegetarians[35].

Another study looked at the blood pressure of 98 vegetarians and compared it with that of omnivores and found values significantly lower in vegetarians. SAH (defined in the study as more than 160 x 95 mmHg) was seen in 2% of vegetarians and 26% of non-vegetarians. This difference persisted even when findings were adjusted for BMI, smoking and family history. Average arterial blood pressure was 126 x 77 mmHg for vegetarians and 147 x 88 mmHg for omnivores. Sodium intake was higher than recommended in both groups, as assessed by urinary excretion, and vegetarians had a higher potassium urinary excretion, given their higher intake[49]. This difference in urinary electrolytes was also found in another study but does not justify the lower blood pressure of vegetarians [50].

Compared to vegetarians, omnivores have a relatively higher risk for HAS of 2.23 (men) and 2.24 (women) in a cohort of 34,198 Adventist individuals[35].

Some studies show that vegetarians' systolic and diastolic pressure is from 5 to 10 mmHg lower. A 4 mmHg blood pressure reduction already markedly decreases cardiovascular mortality [51]. The adoption of a vegetarian diet reduced blood pressure both of normotensive and hypertensive individuals [52, 53].

These findings may be partly explained by vegetarians' higher insulin sensitivity and better antioxidant status that favor reduction of atherogenicity and preservation of the nitric oxide synthesized by the endothelium[43, 54].

3.6 Type 2 Diabetes

The vegetarian diet shows striking effects on diabetes incidence and treatment.

Eating meats and especially processed meats has negative results in terms of diabetes, even after adjustments for BMI, caloric intake and physical activity. Studies with Seventh-Day Adventists, who have low rates of alcohol consumption, smoking and physical activity, show that the incidence of type 2 diabetes is twice that of vegetarians [35].

A cohort study showed that for every serving of food that is eaten, the risk of diabetes increased by 26% when that food was red meat, and by 38% to 73% when it was processed meats[55].

Vegetarians have lower fasting blood glucose and blood insulin levels and greater insulin sensitivity. Their diet and BMI may be partially accountable for the results[56-60].

A study with 15,200 Adventist men and 26,187 Adventist women saw a direct association between a vegetarian diet and a reduced prevalence of type 2 diabetes[61].

A randomized controlled trial [62] assessed 99 individuals with type 2 diabetes for 22 weeks. Fifty of them followed the omnivore diet recommended by the American Diabetes Association (58% carbohydrates, 16% proteins and 25% lipids) and 49 followed a low-fat strict vegetarian diet (75% carbohydrates, 15% proteins and less

than 15% lipids). By week 22 both groups had positive outcomes, but they were more marked in the vegetarian group (statistically significant), as shown in Table 4:

Table 4: Effects of the omnivore and of the vegetarian diets on several parameters

Variable:	Reduction in the Omnivore Group:	Reduction in the Vegetarian Group:
LDL	10.7%	21.2%
Use of medications	26.0%	43.0%
Weight loss	3.1 kg	6.5 kg
Microalbuminuria	10.9 mg	15.9 mg

For the 74 weeks of the study, it was observed that the parameters were maintained and that the strict vegetarian group had better blood glucose levels and lipid profiles [63]. Furthermore, the acceptance of the diet was similar in both groups [62]. The omnivore group reduced its intake of carbohydrates and iron and the strict vegetarians decreased their intake of calcium and vitamin B12 but increased its intake of carbohydrates, fiber, beta-carotene, folate, vitamin K, vitamin C, folic acid, magnesium, and potassium[64].

A strict vegetarian diet with a high content of complex carbohydrates seems to support the metabolic control of individuals with type 2 diabetes [65, 66].

One meta-analysis showed that meat intake was associated with higher risk for type 2 diabetes [67].

3.7 Metabolic syndrome

The findings of studies that looked at the different factors leading to metabolic syndrome independently suggest that it would be less prevalent in vegetarians. Indeed, a study with 773 Adventist individuals (average age of 60 years) showed that in vegetarians, the prevalence of metabolic syndrome is lower, even after adjustments for lifestyle and demographics [68].

3.8 Cancer

Some studies [35, 69-71], but not all [72, 73], showed a lower prevalence of different types of cancer in vegetarian populations, perhaps because of their lower BMI, better antioxidant and inflammatory status and lower insulin levels.

A higher meat intake is associated with a higher incidence of several types of cancer. Most studies show a lower colon cancer incidence in vegetarians; however, one study [74] found an overall lower cancer incidence in vegetarians but a higher incidence of colon cancer.

Some meta-analyses looked at the impact of higher meat intake on the risk for large intestine (colon and rectal) cancer. It was found that an increase of 100g in the daily intake of any kind of meat is associated with a 12% to 17% increase in the risk for colon and rectal cancer. An increase of 25g in the daily intake of processed meats is associated with a 49% increase in the risk for colon and rectal cancer[75].

Another meta-analysis showed that a 120g increase in the daily red meat intake is associated with a 24% increase in the risk for colon and rectal cancer. A 30g increase in the daily intake of processed meat is associated with a 36% increase in the risk for colon and rectal cancer[76].

A more recent meta-analysis confirms the increase in risk for colon and rectal cancer with a higher intake of red meat and processed meats[77].

Another meta-analysis concluded that it is the heme iron itself that is associated with a higher risk for colon cancer[78].
Some studies associated red meat intake with endometrial cancer[79] and lung cancer with the consumption of fried meats, barbecued and cured meats[80]

The intake of vegetables, fruits and whole grains, however, is associated with the prevention of different types of cancer.

3.9 Diverticular disease

A recent population study followed 47,033 English and Scottish men for 11.6 years and found a 31% lower risk for diverticular disease in vegetarians, when compared to omnivores[81].

4. CONTROVERSIAL TOPICS

4.1 Anorexia Nervosa

Anorexia nervosa is a complex eating disorder involving psychological, physiological and social components. Anorexia nervosa is a disease.

Because meat is high in calories and in fat, it is natural that people with anorexia will eliminate it from their diets at some point over the progression of the disease, just as they eliminate other high-calorie foods, including pasta, yellow cheeses and candies.

Anorexics can take advantage of the fact that people in general still have misconceptions about the vegetarian diet and use vegetarianism as an excuse to hide their signs of anorexia nervosa from people around them.

In 1987, a study assessed 116 patients with anorexia nervosa and 54.3% of them would say they were vegetarian. Only 6.3% of them had adopted a vegetarian diet before the onset of the disease [82]. Also, 45.7% of those anorexic women were not vegetarian and 93.7% of them had not been vegetarian before the onset of the disease, which might lead to the wrong conclusion that eating meat leads to anorexia.

A greater concern that vegetarians may have with maintaining a healthy diet may be erroneously interpreted as an eating disorder by some researchers. This misconception is found in the indexed literature [83, 84].

When seeing patients with body image disorders, healthcare professionals should be particularly careful if these patients say that their low weight is caused by the adoption

of a vegetarian diet. The vegetarian diet does not cause excessive weight loss, unless there are nutritional mistakes or when anorexia nervosa is its primary cause[85].

Vegetarianism does not cause anorexia, but some anorexics may take advantage of people's ignorance and use vegetarianism to try to hide their disease.

4.2 Orthorexia

Orthorexia is a change in eating habits that is not recognized as a disease.

Ortho means correct and *Orexis*, appetite. Orthorexia can be defined as a change in people's eating habits in which individuals show an "obsession" with eating only healthy foods, as if it were a "healthy diet cult". Such "obsession" could be motivated by a desire to improve one's health, treat diseases or lose weight.

In this context, some people might eliminate meat from their diet, which means that this disorder could lead to the adoption of a low-meat or vegetarian diet. Vegetarianism does not lead to orthorexia. To substantiate this statement, and similar to what we saw with anorexia, the health benefits of the diet are not what leads most of these people to become vegetarian.

Eating disorders are diseases that cause eating behaviors that are detrimental to one's health, and not the other way around.

4.3 Agrichemicals

Of all xenobiotics, agrichemicals are the main ones that cause people to be concerned about plant foods.

Organ chlorine pesticides were the first pesticides to be produced. Organophosphate, carbamate, pyrethroid and triazine pesticides were developed later.

Several organochlorine pesticides (DDT, Aldrin, Heptachlor, Chlordane, Dieldrin, BHC, Hexachlorobenzene, Camphechlor) were banned in Brazil on September 3, 1995[86].

Some of these chemicals are highly fat-soluble, which means that they have great capacity to be incorporated into fatty tissues and rapidly reach every level of the food chain in the environment after being sprayed on crops.

Moreover, organochlorines are slow to break down. A study in Hong Kong measured organochlorines in cow milk from 1993 to 1995 and found DDE and BHC levels that were above the maximum amounts established by the Coder Committee on Pesticide Residues, despite the fact that China had banned those compounds in 1983, that is, ten years before the study was carried out[86].

The situation is not different in Brazil. Studies show contamination in several water basins. DDT contamination was found in eggs of all of the layer chickens in an area of Rio de Janeiro more than 10 years after DDT was last used there [86].

Chlorinated pesticides enter the body through the skin, airways and gastrointestinal tract. DDT and Dicofol contaminate the human body primarily through the intake of high-fat foods. Animals who are fed with feed are more exposed to contamination because they eat industrial crops that use pesticides on a large scale [86].

Studies have shown that the level of contamination of mothers' milk is lower in vegetarians than in omnivore women [87]. Because agrichemicals are fat-soluble, secondary and tertiary consumers in the food chain are more exposed to them: when one animal feeds on another, it eats all of the chemicals that accumulated in its prey's adipose tissue over its life. Strict vegetarians are primary consumers exclusively.

Human beings' greatest source of contamination with organochlorines is meat and other animal products [88, 89]. A study looked at the Maximum Theoretical Daily Intake, based on the Maximum Residue Level calculated as a percentage of the Acceptable Daily Intake. Meats and eggs were the main reason why the intake of organochlorine pesticides was 348% higher than the Acceptable Daily Intake in the overall population, against 146% to 183% in vegetarians, for Aldrin. Despite these findings, the authors still supported the misconception that theoretically a vegetarian

diet increases the chance of contamination with other pesticides because of a higher intake of fruits and vegetables[90].

The healthy diet guidelines of Brazil's Ministry of Health [91] recommends the intake of up to 100g of meat a day. If people become vegetarians and replace that meat with beans, they will not be exposed to a higher amount of agrichemicals. Animals are primary or secondary consumers and accumulate pesticide residues in their fatty tissues over their whole lives. When they eat animal fats, human beings eat concentrated amounts of these xenobiotics.

5. NUTRITIONAL SUITABILITY OF VEGETARIAN DIETS

Over 250 studies have directly or indirectly assessed the nutritional intake of vegetarians, sometimes comparing it to that of omnivores.

Of all the nutrients, vitamin B12 is the only one that cannot be found in a strict vegetarian diet. All of the other nutrients can be obtained in abundance and with good bioavailability in every vegetarian diet, including the strict vegetarian diet.

Ovo-lacto, lacto and ovo vegetarian diets supply all of the nutrients that are required by the human body in every stage of life.

5.1 MACRONUTRIENTS

The replacement of animal for plant food items usually changes the proportions of macronutrients in one's diet. However, they remain within the ranges suggested by the DRI (Dietary Reference Intakes), according to population studies that quantified macronutrient intake.

Professional nutritionists and dietitians, who know the macronutrient content of food items, should help patients to choose foods and to change their diets so as to meet the patients' needs in specific clinical situations.

The DRIs[92] for macronutrients are shown in Table 5:

Table 5: DRI for macronutrients

Macronutrient	Recommended percentage of caloric intake
Carbohydrate	45 to 65%
Fat	25 to 35%
Protein	10 to 35%

It is recommended that protein be 10% to 15% of the Total Caloric Volume (TCV) and, in some cases, 20%.The maximum DRI of 35% of protein in Table 5 was just the

number required to total 100% after calculating carbohydrate and lipid requirements for different groups and ages.

5.1.1 Carbohydrates

Adopting a vegetarian diet does not lead to excessive carbohydrate intake.

Some studies indicate that vegetarians eat more carbohydrates than omnivores do; however, vegetarian carbohydrate intake is less than the recommended maximum of 65% of the TCV[18, 19, 93-96].

The way you design a vegetarian diet allows you to increase or decrease its total carbohydrate content. Population studies have shown that the commonly adopted vegetarian diets (with no specific therapeutic considerations) usually have 51% to 62.7% of the TCV as carbohydrates. The same comparative studies showed that carbohydrates amounted to 43.5% to 58% of the TCV of omnivores [18, 19, 93-96].

A study with dyslipidemic patients showed that ovo-lacto vegetarian individuals who followed their dietary prescriptions were able to decrease their carbohydrate intake to 26% of their TCV. This diet was called the Eco-Atkins diet [97].

We can thus observe that the carbohydrate content, as well as the other macronutrients content of the diet, can be adjusted according to diet choices and clinical objectives of the nutritional prescription.

5.1.2 Fats

The adoption of a vegetarian diet usually changes the amount and type of fat intake.

The fat intake of vegetarians in population studies ranges from 23% to 34% of their TCV. In the same studies, the fat intake of omnivores was found to be between 30.7% and 36% of their TCV[18, 19, 93-96].

In the Eco-Atkins diet, that percentage can even be as high as 43% of the TCV for ovo-lacto vegetarians[97].

Studies found that as to the type of lipid intake, the major differences between omnivores and vegetarians is that vegetarians eat less saturated fats and more polyunsaturated fats[96].

It should be stressed that, as there are countless diet choices, it is possible to prescribe the amount and type of lipids in different ways. It is up to professional nutritionists and dieticians to design such prescriptions.

5.1.3 Omega-3

Omega-3 (w-3) intake is not usually a problem in a vegetarian diet; however, when omega-6 (w-6) intake is excessive, the conversion of w-3 into its active forms (EPA – eicosapentaenoic acid and DHA –docosahexaenoic acid) may be jeopardized.

The change found in the literature related to low w-3 levels in vegetarian diets is a shorter coagulation time, which can be corrected with diet adjustments[96, 98-103].

Because w-3 needs to be converted into EPA and DHA (which can be found in some fish and some few other animal-derived foods), its DRI for vegetarian diets is twice the DRI for omnivores, as seen in Table 6:

Table 6: Omega-3DRI [92]

Sex (age)	Omnivore	Vegetarian
Male (aged 14 or more)	1.6 g	3.2 g
Female (aged 14 or more)	1.1 g	2.2 g

Still, because the standard Brazilian diet does not include good omega-3 sources, similar care must be taken by both omnivores and vegetarians.

A study[104] with overweight men and women of around 60 years of age compared 12,210 individuals that ate fish but not other meat (pescetarians), 1,934 individuals that ate all types of meat but not fish, 250 ovo-lacto vegetarians and 28 strict

vegetarians showed that those who ate fish had the highest omega-3 intake, followed by that of ovo-lactovegetarians, those who ate meat but not fish, and those who were strict vegetarians. For males, the average daily omega-3 was 1.57g for pescetarians, 1.27g for ovo-lacto vegetarians, 1.15g for those who also ate other meats, and 1.04g for strict vegetarians. For females, it was 1.27g for pescetarians, 0.98g for ovo-lacto vegetarians, 0.91 g for strict vegetarians and 0.89 g for those who ate other meats. For men, plasma levels were:

Variable (mmol/L)	Pescetarians	Meat-eaters (except fish)	Ovo-lacto vegetarians	Strict vegetarians
Omega-3 (total)	364.5 +- 164.8	333.0 +- 147.7	335.5 +- 211.1	327.4 +- 123.6
Omega-6	1164 +- 329.5	1207.9 +- 333.3	1238.2 +- 421.6	1337.7 +- 414.1
EPA	57.5 +- 43.2	47.4 +- 30.3	55.9 +- 45.3	65.1 +- 45.5
DHA	239.7 +- 106.2	215.6 +- 96.4	222.2 +- 138.4	195.0 +- 58.8

For women, the levels were:

Variable (mmol/L)	Pescetarians	Meat-eaters (except fish)	Ovo-lacto vegetarians	Strict vegetarians
Omega-3 (total)	407.7 +- 169.3	373.1 +- 166.2	353.5 +- 191.5	426.8 +- 284.0
Omega-6	1236.9 +- 328.4	373.1 +- 166.2	353.5 +- 191.5	426.8 +- 284.0
EPA	64.7 +- 43.4	57.1 +- 38.4	55.1 +- 52.5	50.0 +- 29.4
DHA	271.2 +- 113.1	241.3 +- 109.6	223.5 +- 137.8	286.4 +- 211.7

This study showed that omega-3 intake was not proportional to omega-3 serum levels. One hypothesis to explain that is that the conversion of omega-3 into EPA and DHA is greater in those who do not eat fishes, in an attempt of the body to keep its homeostasis. The discussion in that paper took into account not only the ratio of 3 parts of w-6 to 1 part of w-3 as a means to keep the enzymeΔ-6-desaturase geared toward converting w-3 into EPA and DHA, but also the total amounts of w-6 and w-3 in the diet as a relevant factor for the extension of the w-3 carbon chain. The study also concluded that plant sources of w-3 can be adequately converted into EPA and DHA.[104]

The best sources of omega-3 can be found in Table 7.

Table 7: Omega-6andomega-3 content in some plant foods

Food (100 g)	w-6 Content(g)	w-3 Content(g)	w-6 : w-3 ratio
Flaxseed oil *	12.7	53.3	1 to 4
Canola oil*	18.8	6.3	3 to 1
Olive oil *	9.7	0.7	13.7 to 1
Soybean oil *	51.0	6.8	7.5 to 1
Flaxseed**	5.4	19.8	1 to 3.6
Walnuts, raw**	35.3	8.8	4 to 1

*Source: US Department of Agriculture – SR23[105]

**Source: Brazilian Food Composition Table - T Taco 3rd edition[106]

5.1.4 Proteins and Amino acids

Several studies have shown that the protein intake of ovo-lacto vegetarians and strict vegetarians ranges from 12% to 13.8% of their TCV, and that the protein intake of omnivores ranges from 14.8% to 16.3% of their TCV[18, 19, 93-96, 107].

Thus, despite the fact that they eat less protein than omnivores, vegetarians eat more than enough protein and are not at risk of protein deficiency. A healthy diet includes 10 to 15% of the TCV as proteins, and therefore the vegetarian diet tends to be more suitable than the omnivore diet, according to population studies, to achieving protein intake in the DRI range.

In the Eco-Atkins diet, lacto vegetarians ate as much as 31% of their TCV as proteins, which shows us that the vegetarian diet can be customized to a great extent[97].

Because the theme “proteins” is surrounded by many questions regarding the correct adjustments of vegetarian diets, we summarize in Table 8 some issues that require review and update.

Table 8: Definitions and comments on basic concepts around the protein assessment of foods.

Topic	Definition	Comments
Limiting Amino Acid	Lowest-scoring amino acid when compared to egg albumin amino acids.	A limiting amino acid is not lacking in a given food. It is called "limiting" in a comparison with the amino acid content of egg albumin, which is the food that promotes greatest growth in animals. It is important to point out that the assessment of amino acids and growth in nonhuman animals does not apply to humans.
Nitrogen Balance	It is the difference between nitrogen intake and nitrogen loss (in skin, feces and urine).	This is the only method that has generated enough information for the assessment of protein requirement in humans [108].
Protein Use Coefficient	It is the relation between an animal's weight gain and its protein intake.	This measure is useless in human clinical practice because its effects are seen only in the mid and long term. Moreover, excess protein is turned into carbohydrate and fat and this leads to interpretation errors in diet design.
Digestibility	It is the difference between nitrogen intake and nitrogen excreted in the feces. It is an indirect measure of the amount of food protein that can be absorbed, that is, its availability to supply	It is considered that the digestibility of plant proteins is lower than that of animal proteins for most foods. However, recent studies measured the nitrogen content in the terminal ileum, and not in the feces, because colonic bacterial activity on plant fibers can increase nitrogen synthesis and be

	nitrogen.	misunderstood as lower digestibility of plant proteins.
PDCAA (Protein Digestibility Corrected Amino Acid Score)	It is the limiting amino acid content in 1 gram of the tested protein divided by the same amino acid content in the reference protein (egg albumin) multiplied by the actual digestibility of the food.	This method is better than the biological value but still has the limitation of comparing one food to another and not with the human amino acid requirement.
Chemical Score	It is a comparison of the amino acid content of a given protein or diet with a specific reference protein (egg albumin).	This is a comparison between foods and not with human needs.
Biological Value	It is the difference between absorbed nitrogen and nitrogen excreted in urine. It is an indirect measure of amino acid retained by tissues for growth and maintenance.	The biological value is not a proper measure to evaluate the protein quality of a mixed diet because it assesses foods eaten separately. What matters is the combined biological value of the meals (based on the sum total of their amino acids) and not that of foods individually.

Studies that assess protein requirements do not support the view that different protein intake recommendations should be given to vegetarians and non-vegetarians[108].

According to a meta-analysis, the way the human body incorporates plant protein is similar to the way it incorporates animal protein[109].

Because of the misconceptions around animal protein, the SVB urges professional nutritionists to become familiar with the 8 myths about plant protein (Table 9):

Table 9: Plant protein myths[110].

Myths and truths about plant proteins
1) **Plant proteins are incomplete (they lack amino acids).**
The truth: some plant foods may have low levels of one or more amino acids. Selecting and eating foods from different food groups ensures optimal amino acid supply.
2) **Plant proteins are not "as good as" animal proteins.**
The truth: the quality will depend on the sources of plant protein or on their combination. Plant proteins may be as good as or even better than animal proteins.
3) **Proteins from different plant food groups must be eaten together in the same meal so as to achieve high nutritional value.**
The truth: one does not need to eat all of the amino acids in a single meal, what is important is that they get eaten throughout the day.
4) **Methods that use animals determine nutritional protein requirements that are applicable to humans.**
The truth: these methods usually underestimate the nutritional quality of proteins, as protein requirements and speed of use are markedly different between nonhuman animals and humans.
5) **Plant proteins are not well digested.**
The truth: digestibility varies depending on the plant protein source and method of preparation. Plant protein digestibility may be as high as animal protein digestibility, depending on the food plant.
6) **Plant proteins on their own, without meat, eggs or dairy, cannot meet human amino acid requirements.**
The truth: the essential amino acid intake requirement can be easily met when one eats only plant proteins or when one combines them with some animal

proteins (eggs, milk and cheese).
7) The amino acids of plant proteins are not balanced and therefore their nutritional value is limited.
The truth: there is no evidence to support the view that such balance is important. What matters is that you eat the recommended amount of every amino acid over the day. In theory, an imbalance in amino acid intake could happen, but this is not usually a problem seen in practice.
8) You find amino acids in meat that can't be found in any plant food.
The truth: all of the essential amino acids are found abundantly in the plant kingdom.

A method to assess the safety of a vegetarian diet in terms of the protein content of plant foods is to compare the caloric value of the proteins against the total caloric value of the food. For instance, 100 grams of raw oats contains 17 grams of protein, that is, of 395 kcal (100g of oats), 68 kcal come from protein (17g x 4 kcal). So, in oats, protein accounts for 17% of the total caloric value of the food. Thus, if people ate nothing but oats until achieving their energy requirements, those people would have eaten 17% of the TCV as protein, which is comfortably above their protein requirements (10% of the TCV).

Table 10 shows the same calculation for different food groups [111]:

Table 10: Percent value of protein in different food groups

Food / Food group	Percentage of Protein in the TCV (%)
Red meat	57.68
Poultry	48.58
Processed meat	27.76
Eggs	32.35
Milks	24.67
Cheeses	26.53
Whole grains	13.32

Whole grains byproducts (flakes, flours)	14.30
Refined grains	10.34
Legumes	26.34
Soybean-derived foods	35.22
Oil seeds	10.92
Nuts	16.18
Vegetables	22.00
Leafy vegetables	32.79
Starchy roots (potatoes)	5.91
Fruits	6.86
Oils	0.00
Sugar	0.00

Looking at the table above, it is easy to understand why, once daily energy requirements are met, very hardly will protein requirements not be met. In their natural state, only starchy vegetables and fruits have a protein content that is less than 10% of their caloric value. There are two foods that are made by humans, oils and sugar, that have no protein.

As to amino acids, methionine is not a limiting amino acid for protein synthesis[110].The only amino acid requiring attention, in some cases, is lysine, as this is the amino acid found in lower levels in grains, which are usually staple foods for most of the world's population. However, even in grain-based diets, lysine is not usually a limiting factor for protein synthesis[112].

Human amino acid requirements[113] are shown in Table11:

Table 11: Amino acid requirements for adult humans

Essential amino acid	EAR (mg/kg/d)	RDA (mg/kg/d)
Histidine	11	14

Isoleucine	15	19
Leucine	34	42
Lysine	31	38
Methionine + Cysteine	15	19
Phenylalanine + Tyrosine	27	33
Threonine	16	20
Tryptophan	4	5
Valine	19	24

For the following calculations, we adopted the caloric value of the servings as defined by Brazil's Ministry of Health: a serving of grains is 150 kcal and one of beans is 55 kcal[91].

A 2,100 kcal diet designed for a 70kg man including only whole grains (the food with lowest lysine content), in a total of 14 servings, will supply 72.21 grams of protein, which is 1.03g/kg/d. In such a diet, the required lysine intake would be 2,660mg (RDA) and the man would eat 2,646mg.

Note that, even if we ate only the food group with the lowest lysine content, the difference between lysine intake and its RDA would be only 14mg. To be on the safe side, when someone's strict vegetarian diet does not include proper variation of food groups, 2 servings of beans (4 tablespoons of cooked beans) should be included in the meal plan, as beans have higher lysine content.

Thus, if that same man ate the same 2,100kcal a day but included 2 servings of beans (4 tablespoons a day, or 110kcal) and 13.26 servings of grains (1,990kcal), the daily lysine requirement would be 2,660mg a day, and he would be eating 2,506mg of lysine from grains and 498 g from beans, for a total of 3,004mg of lysine.

Thus, SVB guidelines for strict vegetarian diets is that they should include 2 servings of beans (110kcal, or 4 tablespoons of cooked beans) as a safety measure that would ensure that the lysine RDA is met and exceeded.

Table 12 shows the average lysine content in different food groups:

Table 12: Average lysine content in different food groups

Food group	Average Lysine Content (mg) per 100g *	Standard deviation	Average Lysine Content per serving (mg)	Calories per serving (kcal)
Whole grains	452	221	189	150
Refined grains	212	107	89	150
Beans	1552	182	249	55
Nuts	653	351	79	73
Leafy vegetables	121	58	68	15
Vegetables	584	31	32	15
Starchy root vegetables	563	11	70	150
Fruits	43	28	48	70
Cheeses	1794	762	722	120
Cow's milk	268	0	495	120
Egg (whole)	912	0	1212	190
Meat	1373	339	786	190

***Source:** US Department of Agriculture – SR23 [105] **Whole grains:** oats, brown rice, rye, quinoa, wheat, barley. **Refined grains:** rice, rice flour, starch de corn, flour wheat, pasta. **Beans:** adzuki, black, navy, red, lentils, pinto, split green pea, chickpea. **Nuts:** almonds, pecans, peanuts, hazelnuts, cashew nuts, Brazil nuts, dried coconut, roast sesame seeds, flaxseed, pumpkin seed, sunflower seed, watermelon seed, walnuts, pistachio, pine nuts, macadamia. **Raw leafy vegetables:** wakame seaweed, celery, spinach, watercress, lettuce, broccoli, broccoli greens, chicory, cabbage, cauliflower, mustard greens, collards. **Vegetables** :artichoke, eggplant, onion, white mushroom, shiitake, pumpkin, zucchini, beets, carrot, chayote, green and red bell pepper, okra, radish, tomato, cucumber. **Starchy roots:** manioc, sweet potato, taro root. **Fruits:** pineapple, avocado, prune, banana, persimmon, starfruit, fig, guava, jackfruit, kiwi, orange, apple – peeled or not, papaya, mango, watermelon, melon, strawberry, pear, peach, tangerine, green and red grapes. **Cheeses:** cheddar, cottage, cream cheese – regular and defat, mozzarella, parmesan, provolone,

ricotta, jack, brie, camembert, blue, Swiss. **Meats:** beef steak, raw shrimp, cooked tilapia, raw chicken breast (serving considered as beef steak and raw chicken breast).

Soybeans are not essential in a vegetarian diet. They indeed have high protein content; however, eating them is a matter of choice for those who enjoy them.

5.2 MICRONUTRIENTS

5.2.1 Iron

Heme iron has a porphirinic ring that promotes constant absorption of this mineral in the human gastrointestinal tract, ranging from 15% to 35%[114]. The absorption of non-heme iron ranges from 2% to 20%. The only inhibitory factor for the absorption of heme iron is calcium. Vitamin C, organic acids and other factors that promote the absorption of non-heme iron are not able to increase the absorption of heme iron[115]. Because current meat intake guidelines for a healthy diet are low, the recommended daily intake of iron cannot be achieved by eating meat by those who are not vegetarians.

Table 13 below shows the iron content in 100 grams of food (maximum daily intake for omnivores recommended by the Ministry of Health[91]), absorbed iron (considering that the bioavailability of iron in meats is 18%), and the human absorption requirement (1 to 2 mg/day) to support organic levels of iron in situations of metabolic balance.

Table 13: Iron content in meats and absorbed content

Food	Iron content (mg) in 100 g of the food*	Absorbed amount (mg)	Absorbed Percentage (%) vis-a-vis daily requirement	Gap (%) to achieve daily intake requirement
fresh tuna, raw	1.30	0.23	11.7 to23.4	76.6 to 88.3
Smooth weakfish, raw	0.20	0.04	1.8 to3.6	96.4 to 98.2
whole sardine, raw	1.30	0.23	11.7 to 23.4	76.6 to 88.3
Beef striploin, no fat, raw	1.70	0.31	15.3 to30.6	69.4 to 84.7
Beef topside, no fat, raw	1.90	0.34	17.1 to34.2	65.8 to 82.9
bovine liver, raw	5.60	1.01	50.4 to100.8	0.0to 49.6
tenderloin, no fat, raw	1.90	0.34	17.1 to34.2	65.8 to 82.9
beef hamburger, raw	1.90	0.34	17.1 to34.2	65.8 to 82.9

chicken breast, no skin, raw	0.40	0.07	3.6 to7.2	92.8 to 96.4
Chicken thigh, no skin, raw	0.90	0.16	8.1 to16.2	83.8 to 91.9
pork ribs, raw	0.90	0.16	8.1 to16.2	83.8 to 91.9
Raw pork sirloin, raw	0.50	0.09	4.5 to9.0	91.0to 95.5

*Source: Brazilian Food Composition Table–Taco 3rdedition[106]

Thus, nutritionists must always adjust diets taking into account the factors that optimize or inhibit non-heme iron absorption. This will enable those who eat or who do not eat meat to meet the daily iron intake that is required for a healthy diet.

Omnivores and vegetarians must be equally careful with their dietetic iron.

The iron DRI for vegetarians is different from the iron DRI for non-vegetarians, because some population studies suggest the average iron bioavailability in the vegetarian diet is from 5 to 12% and from 14 to 18% in the omnivore diet[114].

Thus, for people to absorb 1 to 2mg of iron, and considering the maximum absorption people could have depending on their diet, they would have to eat 5.5 to 11.1mg of iron if they are omnivores or 8.3 to 16.6mg if they are vegetarians. The DRIs incorporate an excessive margin of safety. If vegetarian women need to absorb 2mg of iron, they need to eat 16.6mg of iron.

The DRI suggests that healthcare professionals should prescribe to vegetarians twice as much iron as for omnivores (Table 14).

Table 14: Iron intake recommendations for vegetarians and omnivores

Sex (age)	Omnivore	Vegetarian
Male (more than 19 years of age)	8 mg	16mg
Female (19 to 50 years of age)	18 mg	36 mg

Vegetarian women will have difficulty achieving their iron DRIs. However, this is not a problem, as a review of 15 studies showed that the prevalence of iron deficiency

anemia is the same in omnivore and vegetarian women [116]. Another study found the prevalence of iron deficiency to be 60% in women who ate red meat and 40% in ovo-lacto vegetarian women[117].That result could be explained by individual differences in blood loss in the menstrual flow.

In the item "RECOMMENDED INTAKE OF FOOD GROUPS", see how meat should be replaced by beans so as to promote the same final iron absorption, even without the use of vitamin C.

The main factors that stimulate or inhibit non-heme iron absorption can be found in Table 15[114]:

Table 15: Factors that stimulate or inhibit the absorption of non-heme iron

Factors that **stimulate** the absorption of non-heme iron	Factors that **inhibit** the absorption of non-heme iron
Meat factor (sulfur-containing amino acids– also found in beans)	Calcium (inhibits absorption of heme and non-heme iron)
Vitamin C (75 mg increases 3-4 times iron absorption)	Casein phosphopeptides (proteins in eggs, milk and cheeses)
Organic acids (citric, malic, tartaric)	Phytic acid
Vitamin A and beta-carotene (questionable effect)	Polyphenols (tannins, catechins)found in several teas, coffee and wine
Fructooligosaccharides (acidophilic gut flora)	Reduced gastric acidity
Low iron stock (increases absorption 10 to 15 times)	Increased inflammatory status (increased hepcidin expression)

A very high intake of purified fiber has not been shown to interfere significantly with the absorption of minerals from the diet. The inhibitory effect on iron absorption caused by high-fiber foods is not due to the fiber itself, but rather to phytic acid. Foods' phytic acid content may be minimize by some cooking methods[118, 119].

Vitamin C is one of the most powerful iron-absorption stimulants, and it counteracts the inhibitory effect of polyphenols, phytate, calcium and casein phosphatopeptides. Even in the absence of these compounds, it is important to maintain vitamin C intake[114, 120].

Using cast-iron pots increases the iron content of food, but to an uncertain amount. Their use should be seen as a preventive measure that is not, however, a treatment for iron deficiency [121].

Most studies have found that the iron intake of individuals who adopt a vegetarian diet is similar to or higher than that of omnivores [18, 107, 122-127]. This is explained by the high iron content of foods that are the foundation of a vegetarian diet, as seen in Table 16.

Table 16: Iron content in 100g of plant foods

Food	Iron content (mg/100 g of food)*
Coriander (dry leaves)	81.4
Pinto beans, raw	18.6
Soybean flour	13.1
Kidney beans, raw	8.0
Soybean (soluble powder extract)	7.0
Lentils, raw	7.0
Black beans, raw	6.5
Chickpeas, raw	5.4
Cashew nuts, toasted, salted	5.2
Black-eyed peas, raw	5.1
Flaxseed, seed	4.7
Whole rye flour	4.7
Oat flakes, raw	4.4
Almond, toasted and salted	3.1

Corn breakfast cereal	3.1
Watercress, raw	3.1
Chicory, raw	3.1
Whole-grain breads	3.0
Brazil nuts, raw	2.3
Yellow corn flour	2.3
Arrow leaf elephant ear, raw	1.9
Soybean (Tofu)	1.4
Mustard greens, raw	1.1

*Source: Brazilian Food Composition Table - Taco 3rd edition[106]

Studies with vegetarian groups have shown a vitamin C intake that is much higher than that of omnivores[18, 123-125]. Blood serum levels of vitamin C were also found to be higher in vegetarians than in omnivores[10, 11].

Plant foods that have the highest vitamin C content (per 100g) are shown in Table 17:

Table 17: Vitamin C content in plant foods

Fruits	**Vitamin C (mg in 100 g)**
Acerola, raw	941.4
Tangerine, Rio, raw	112
Papaya, raw	82.2
Papaya, Formosa, raw	78.5
Kiwi, raw	70.8
Strawberry, raw	63.6
Starfruit, raw	60.9
Orange, “baía”, raw	56.9
Orange, “pera”, raw	53.7
Tangerine, Poncã, raw	48.8
Orange, Valencia, raw	47.8

Orange, “lima”, raw	43.5
Lime, Tahiti, raw	38.2
Fruit pulp	
Acerola, pulp, frozen	623.2
Cashew, pulp, frozen	119.7
Fruit juice	
Orange, baía, juice	94.5
Orange, pera, juice	73.3
Tangerine, Ponkan, juice	41.8
Orange, lima, juice	41.3
Vegetables	
Sweet pepper, yellow, raw	201.4
Sweet pepper, red, raw	158.2
Sweet pepper, green, raw	100.2
Leafy vegetables	
Collards, sautéed	76.9
Broccoli, cooked	42
Mustard greens, raw	38.6

*Source: Brazilian Food Composition Table - Taco 3rdedition[106]

We have been emphasizing how important food choices and combinations are, but these are not the measures of greatest impact on a proper metabolic iron status. Factors related to blood loss are more important than diet in the assessment of iron deficiencies, and nutritionists should pay attention to these non-diet factors. Any bleeding is a risk factor for iron deficiency, including menstrual bleeding, blood donation, or diseases and conditions that cause blood loss (myomas with bleeding, surgeries, hemorrhoids...), some parasitic diseases, in addition to metabolic use of iron in pregnancy[117, 119, 128-132]. In addition to that, reduced gastric acidity caused by long-term use of antacids or hypochlorhydria should also be considered. In most of these cases, iron supplementation will be required to correct the deficiency. Laboratory tests are important in these cases.

Iron deficiency (both in omnivores and vegetarians) must not be treated with diet alone.

In practical terms, clinical evaluation combined with laboratory tests are the method of choice for the assessment of clients' nutritional status of iron. Do not evaluate the iron status of vegetarians or of omnivores based only on intake calculations.

Treatment with iron supplementation must be prescribed after an iron deficiency is determined and after the following conditions have been ruled out: hemoglobinpathies, inflammatory flares and other metabolic conditions that can change the distribution of body iron and confuse the diagnosis. In these cases, medical assessment is important. Iron supplementation can be harmful to individuals who are not correctly evaluated, as it can increase oxidative stress and also cause gastric and intestinal mucosal damage[133, 134].

5.2.2 Zinc

Because meat is a good source of zinc, when it is eliminated from the diet, people should be more careful as to its intake. Similar to iron, as current recommendations of meat intake for a healthy diet are low, zinc's required intake cannot be achieved by eating meats only, and even non-vegetarians have to include zinc-containing plant foods in their diet.

Several factors can stimulate or inhibit the absorption of zinc[116, 135], as shown in Table 18:

Table 18: Dietetic factors that stimulate or inhibit zinc absorption

Factors that **stimulate** zinc absorption	Factors that **inhibit** zinc absorption
Protein in the diet	Phytic acid
Vitamin C	Casein

Organic acids

Calcium does not exert a direct inhibitory effect on zinc absorption, but it may enhance the inhibitory effect of phytic acid. Conversely, vitamin C and protein may reduce the inhibitory effect of phytic acid[116].

Zinc's bioavailability is considered high (50% to 55%), moderate (30% to 35%) or low (15%) depending on the presence of high phytic acid foods and animal proteins. The vegetarian diet is usually moderate in terms of zinc absorption but, as a safety measure, the DRI is based on a low bioavailability diet and underestimates the zinc absorption in vegetarian diets [116]. Thus, the DRI is 50% greater than the DRI for omnivores (Table 19):

Table 19: Recommended zinc intake for omnivores and vegetarians

Sex (age)	Omnivore	Vegetarian
Male (more than 14 years of age)	11 mg	16.5 mg
Female (more than 19 years of age)	8 mg	12 mg

Populational studies have not found the documented clinical prevalence of zinc deficiency to be higher in vegetarians than in omnivores.

To reduce their phytic acid content, beans and whole grains should be soaked in water (at room temperature) for 8 to 12 hours before they are cooked. The process of natural fermentation of bread, using biological yeast and not chemicals, also reduces its phytic acid content[136-138].

Some vegetarian sources of zinc can be found in Table 20:

Table 20: Zinc content of plant foods

Food	Zinc content in mg /100 g of food*
Corn breakfast cereal	7.6

Soybean (soluble powder extract)	5.8
Coriander (dry leaves)	4.7
Cashew nuts, toasted, salted	4.7
Soybean flour	4.5
Flaxseed	4.4
Brazil nuts, raw	4.2
Black-eyed peas, raw	3.9
Lentils, raw	3.5
Chickpeas, raw	3.2
Kidney beans, raw	2.9
Black beans, raw	2.9
Whole rye flour	2.7
Oat flakes, raw	2.6
Almonds, toasted and salted	2.6
Whole-grain breads	0.8 to 1.7
Walnuts, raw	2.1
Brown rice, raw	1.4
Whole chicken egg, raw	1.1

*Source: Brazilian Food Composition Table- Taco 3rdedition[106]

5.2.3 Calcium

The nutritional prescription for calcium is the same both for lactovegetarians and for omnivores. However, in the strict vegetarian diet, the choice of calcium sources becomes more important, as milk and other dairy products are the standard sources for most people. This prescription is not challenging to nutritionists, because it is similar to that for lactose-intolerant individuals.

Even though osteoporosis is usually associated with lack of calcium, its genesis is genetically-associated in more than 80% of cases[139-141]. And in the remaining 20%, the nutritional status of calcium and vitamin D are not the only factors determining

bone mass [142-145]. This is the clear reason why studies that associate calcium intake alone with the risk for osteoporosis have shown conflicting findings.

Studies with vegetarian and vegan populations have shown different findings in terms of bone mass, in that some found lower bone mass in strict vegetarians[146] and other found not differences when compared to omnivores[147-151]. A meta-analysis that looked at 9 studies, with a sum total of 2749 individuals (1880 women and 869 men), suggested that the bone density of strict vegetarians is usually 4% lower than that of omnivores, but that the clinical association of this finding is not significant[152].

The calcium intake recommendation is 1,000 mg/day for men of 19 to 70 years of age and women of 19 to 50 years of age.

In Brazil, most soy milks are fortified with calcium and offer roughly 240 mg of calcium per 200ml. Similarly, in the United States and in Europe, many plant milks (almond, rice, sesame seeds...) available in the market are also fortified with calcium. Many of these are found in Brazil, but they are not usually affordable for most people. In Brazil, we also find calcium-fortified oat milk. It is possible to attain the recommended calcium intake with a strict vegetarian diet, but that is much easier if one includes enriched foods in the diet[153].

Oxalic acid is the chief anti-nutritional factor hindering calcium absorption. Foods that are high in oxalic acid (spinach, Chinese cabbage, beet greens and cacao) should not be eaten with foods high in calcium. Cooking methods alone are not enough to mitigate the effects of oxalic acid[154, 155].

Moderation in salt consumption is also important to maintain good levels of calcium in the body. For every 2,300mg of sodium, 40 to 60mg of calcium are eliminated in the urine[153].

Acidophilic gut flora increases calcium absorption in the ascending colon [156-158]. Lowering the phytic acid content of foods can also help in increasing calcium absorption[136-138].

The following table shows foods with higher calcium content and lower oxalic acid content (Table 21):

Table 21: Calcium content in plant foods.

Food	Calcium content (mg /100 g)*
Coriander (dry leaves)	784
Navy beans, raw	240
Almonds, toasted and salted	237
Basil	211
Flaxseed	211
Soybean flour	206
Parsley, raw	179
Collards, sautéed	177
Arugula	160
Brazil nuts	146
Collards	145
Arrow leaf elephant ear	141
Watercress, raw	133
Sesame seeds	131
Sow thistle	126
Kidney beans, raw	123
Chickpeas, raw	114
Black beans, raw	111
Walnuts, raw	105
Broccoli, raw	86
Tofu	81
Spring onions, raw	80
Mustard greens	68
Chicory, sautéed	63

*Source: Brazilian Food Composition Table–Taco3rdedition[106]

Enriched plant milks have roughly 240mg of calcium per 200ml, the same amount as in fortified cow's milk.

Homemade plant milks made of almonds, sesame seeds, sunflower seeds, Brazil nuts, etc. may be nutritious but have low calcium contents, as these seeds have less than 240 mg (some have 150 mg) of calcium per 600 kcal.

Calcium bioavailability varies in different foods, and it can be high, even in plant foods, especially if the food is low in oxalic acid[159-161] (Table 22):

Table 22: Bioavailability of calcium in food [162]

Food	Bioavailability (%)
Broccoli	61.3
Chinese cabbage	53.8
Collards	49.3
Mustard greens	40.2
Milk	32.1
Yogurt	32.1
Cheese, cheddar	31.2
Tofu with calcium	31
Beans, adzuki	24.4
Sweet potato	22.2
Beans, navy	21.8

5.2.4 Vitamin B12 (Cobalamin)

Ovo-lacto and lacto vegetarian diets can provide the levels of vitamin B12 that are required by the human body. Strict vegetarians who do not eat foods that are enriched with B12 must use supplements. This is the only nutrient that a strict vegetarian diet may lack.

Vitamin B12 is synthesized by bacteria. Because plants do not need B12 to grow and develop, they do not incorporate this vitamin. Plants do not contain active, bioavailable B12.

Seaweeds must not be used as a source of B12. A study of 326 seaweeds showed that 171 had B12, which was obtained from symbiotic bacteria; however, most or all of this B12 is metabolically inactive in mammals[163, 164]. Nori and chlorella were the seaweeds found to be highest in B12, but theirs is (totally or mostly) an analog, or corrinoid, form of the vitamin, as clinical studies found that their B12 perform did not perform the role of the true vitamin. The intake of those types of seaweed led to an increase in serum B12 levels and also to an increase in the Mean Corpuscular Volume (MCV). One study stated in its abstract that chlorella is a good source of active vitamin B12, but that was not shown in the text of the paper[165].

Similarly, the following are not good sources of B12: fermented foods (miso, tempeh, shoyu), brewer's yeast or spirullina. The only reliable sources of B12 are meats, eggs, dairy milk, cheeses, enriched foods and supplements.

The vitamin B12 found in supplements is obtained from laboratory bacteria cultures.

Excessive vitamin B12 intake, be it from supplements or enriched foods, is not found to cause toxicity[166].

The recommended vitamin B12 intake for individuals who are 14 years of age or older (except during pregnancy or lactation) is 2.4mcg/day, and 1mcg/day is its absorption requirement[167].

Vitamin B12 content in foods is shown in Table 23:

Table 23: Vitamin B12 content in foods

Food	B12 content (mcg /100 g)*
Swiss cheese	3.34
Mozzarella cheese	0.73 to 2.31
Brie cheese	1.65
American cheese	1.5
Whole chicken egg, raw	1.29
Cheddar cheese	0.83
Ricotta	0.29 to 0.34

Cow's milk, low fat	0.46
Yogurt, low fat	0.46
Cow's milk, whole	0.36

*Source: US Department of Agriculture – SR23 [105]

Vitamin B12 is thermo stable. After it is ingested, gastric acid is required to remove it from the source food. The stomach produces the intrinsic factor that will bind with B12 in the duodenum, enabling it to be absorbed in the terminal ileum[164, 168].

The bacterial flora in the colon produces B12; however, in a site that is posterior to the absorption site. Studies with probiotics and prebiotics designed to increase gut flora and, consequently, B12 production, failed in proving that it is absorbed, as no changes were seen in the laboratory measures of the vitamin[169].

Vitamin B12 can be stored in the liver for 3 to 5 years, but it is not possible to predict how long one's stores will last after dietetic sources are no longer present in one's diet, because the metabolic use of B12 will depend on a number of factors, including neuronal activity, enteral-hepatic cycle, liver metabolism, glucose metabolism, and medication use. Even with the recommended B12 intake, most people do not have significant B12 reserves.

Therefore, irrespective of how long a person has been vegetarian, every vegetarian, even if they eat animal products, should be tested for B12 levels. Because B12 deficiency is also prevalent in omnivores, every individual who eats meat should also have their B12 blood levels measured.

The gallbladder can release up to 10mcg of B12 a day into the small intestine, from which B12 can return to the blood through the enteral-hepatic cycle. Individuals with low recycling capacity lose more vitamin B12 in their feces than they are able to eat, because even if they have a diet high in meats and dairy, it is difficult to have an intake of more than 10mcg a day[168].

Vitamin B12 deficiency affects the nervous system and the hematopoietic system. The nervous system is usually the first to be affected, and complaints usually associated with this deficiency are loss of memory, concentration and attention, in addition to tingling in the lower limbs and reduced proprioception. In advanced cases, even mental torpor and coma can occur. The elderly are more prone to B12 deficiency because of changes in gastric mucosa and reduced acid secretion. Hyperhomocysteinemia is correlated with dementia in the elderly. Homocystein also increases the risk for cardiovascular diseases, pre-eclampsia and fetal malformation. An impaired hematopoietic system may cause hemoglobin reduction (with increases in median corpuscular volume, in case the deficiency is isolated or combined with folic acid deficiency), leucopenia, and low platelet counts, these three factors can be found in combination or isolated[168, 170-173].

It is estimated that in Latin America, 50 to 60% of vegetarians have low B12 serum levels[164], as well as more than 40% of the omnivores[174]. Several studies in different places in the world have shown that the prevalence of this deficiency is high [175]. In Brazil, more than 50% of omnivores are B12-deficient. The small difference between vegetarians and omnivores is associated with some specific aspects of the cobalamin metabolism.

An accurate assessment of vitamin B12 status requires, in theory, an addition to its measurement, the measurement also of methylmallonic acid, which, if high, confirms the B12 deficiency. Methylmallonic acid tests are not always available or affordable. In vitamin B12 deficiency, as well as in folic acid or piridozine deficiencies, homocystein levels go up.

A study that looked at the correlation between vitamin B12 serum levels and methylmallonic acid found that if people's B12 tests lower than 490 pg/mL (normal range would be from 200 to 980 pg/mL), there is a high prevalence of individuals with elevated methylmallonic acid and, therefore, with vitamin B12 deficiency.

Therefore, the safe lower threshold for vitamin B12 is 490pg/mL[164].

If this value is adopted as reference, patients who are being followed up for B12 deficiency do not need to have their methylmallonic acid levels measured.

Studies have also shown that when vitamin B12 serum levels are less than 350 pg/mL, specific deficiency symptoms can be identified[176, 177].

Thus, to prevent vitamin B12 deficiency, it is safe to maintain its serum level above 490pg/mL.

If one wants to adopt less safe parameters, B12 serum levels must be kept at least at 350pg/mL.

Most scientific studies, however, for lack of knowledge on the part of authors, adopt the range of normality provided by laboratories and end up defining deficiency as B12 levels of less than 200pg/mL.

Thus, B12 deficiency is underestimated in scientific studies.

Several studies show that the B12 intake of vegetarians is lower and their B12 serum levels are lower as well. The B12 serum level of omnivores is higher than that of vegetarians, however, it is still too low to support good health[8, 178-181].

Studies about vitamin B12 deficiency in Brazil

A study carried out in the city of São Paulo with 22 omnivorous and 29 vegetarian non-pregnant women of child-bearing age found the same deficiency prevalence in both groups. The average B12 level was 348 +- 120.1pg/mL in the omnivore group and 350,2 +- 183.3pg/mL in the vegetarian group. In both groups, vitamin B12 levels were less than adequate (490pg/mL) in more than 50% of the women[182].

A Brazilian study that defined B12 deficiency as levels below 207pg/mL found deficiency in 11% of the 1,072 women tested and high levels of homocystein in 15% of the 1,085 women tested. The median vitamin B12 serum levels were 319pg/mL[183] and, therefore, actually more than 50% of those women had B12 deficiency if we consider 350pg/mL as a minimum level to maintain safe serum levels of vitamin B12.

A study carried out in the state of Acre (in a town located 100 km from the capital city, Rio Bronco) with 127 children aged 6 to 24 months detected vitamin B12 deficiency in 12% of them. B12 deficiency was defined as blood levels below 207pg/mL[184]. Similar to the previous study, the deficiency prevalence was underestimated.

A study by researchers at the Federal University of São Paulo evaluated 17 pregnant women (average gestation of 30.6 weeks, ranging from 21 to 38 weeks) who had fetuses with neural tube malformation. Their B12 levels ranged from 122 to 521pg/mL, with an average of 301,5 +- 109pg/mL. Because this study defined deficiency as vitamin B12 levels of less than 150pg/mL, it was considered to be present in only 11.8% of the subjects. However, 16 out of the 17 subjects (94%) had B12 serum levels below 490pg/mL, and 9 of the 17 subjects (53%) had B12 serum levels below 350pg/mL[185].

In a study about the prevalence of B12 deficiency in Latin America, the reference of normality was that defined by laboratories and, therefore it did not reflect the actual prevalence of the deficiency[174]. Thus, in Latin America the prevalence of vitamin B12 deficiency is much higher than 40%, and in Brazil, higher than 50%.

The easiest way to assess the vitamin B12 status is by having its serum levels measured.

Treatment requires high vitamin doses and, in some cases, injectable supplementation (by medical prescription).

Vitamin B12 deficiency in omnivores or in vegetarians should never be treated with the diet because this approach is ineffective.

Under Brazilian laws, nutritionists may prescribe up to 1,000 mcg of vitamin B12 supplementation a day[186]. This is usually a long treatment that, in some cases, requires more than 5 months of correct supplementation. Some individuals need up to 2,000mcga day of oral supplementation to correct their B12 deficiency, or even to maintain adequate levels. In such cases, a medical prescription is required.

For the maintenance of good serum levels, the literature recommends the use of 5mcg a day. However, in clinical practice, the dose required to maintain serum levels of at least 490pg/mL can vary from 5mcg to 2,000 cg a day.

Thus, as complementation to the diet, SVB recommends that nutritionists prescribe to strict vegetarians a B12 supplementation of at least 10mcg a day, ranging up to 1,000mcg a day (maximum amount that Brazilian laws allow a nutritionist to prescribe), based on the lab work of patients.

The same dose may be prescribed to ovo-lacto vegetarians and lacto vegetarians, as well as to omnivores who require supplementation.

There are no guidelines for the maintenance dose, because it will depend on the clinical response of the individual.

In case supplements will be compounded, plant capsules should be prescribed, because otherwise compounding pharmacies will most likely use animal products.

Pregnant vegetarian women and vegetarian children should always take vitamin B12 supplements. Children may be prescribed B12 in drops.

5.2.5 Vitamin D

According to some studies, vegetarian populations have lower levels of vitamin D. However, this is only found in places where omnivore individuals eat foods fortified with vitamin D and vegetarians do not[18, 187].

In Brazil, few products are fortified with vitamin D, and, therefore, the approach for vegetarians and non-vegetarians should be similar. The sun is still the main method to obtain vitamin D in Brazil.

It is important that government authorities, when defining fortification regulations, consider fortification of foods for different population groups, including the vegetarians groups.

6. RECOMMENDED INTAKE OF FOOD GROUPS

The number of calories supplied by each food group is but a guide serving as a starting point for nutritionists to design dietetic prescriptions. Generic recommendations do not replace individual assessments and prescriptions preceded by nutritional assessment and diagnosis.

Several food guides and pyramids have already been published for vegetarians, but many of them are not suitable to Brazil. Thus, SVB decided to prepare recommendations based on the official serving sizes adopted by the Ministry of Health[91], adapting them to vegetarian diets. In **Annex 1, Food Groups and Household Measures** are listed.

Table 24 was prepared to support clinical reasoning about different food groups. Its data are from the Taco Table, 3rd edition[106], supplemented with data from the US Department of Agriculture [105]. When an average nutrient content was listed as "trace" or "non applicable" on Taco, we assumed that the content was zero.

The smaller the standard deviations, the more accurate the figures for the food groups. When standard deviations are high, individualized calculation of content is recommended. The **food list** used in the calculation of each group is found in **Annex 2**.

Table 24: Average nutrient content in different food groups

Food group	Parameters	Kcal/ serving	Protein (g)	Lipids (g)	Carbohydrate (g)	Dietary fiber (g)	Calcium (mg)	Iron (mg)	Zinc (mg)
Whole grains	Average	150	4.1	1.1	31.5	1.1	10.6	1.6	0.9
	Standard deviation		1.2	0.9	2.6	1.2	10.7	1.7	0.6
Whole-grain products	Average	150	3.7	1.6	31.5	2.5	37.2	1.4	1.0
	Standard deviation		1.6	1.4	3.9	1.7	40.5	0.6	1.1
Refined grains	Average	150	3.6	1.5	29.9	1.1	8.2	0.5	0.5
	Standard deviation		0.6	2.0	4.0	0.4	7.9	0.3	0.4
Potatoes	Average	150	2.5	0.2	35.6	4.2	16.8	0.5	0.3
	Standard deviation		1.3	0.1	0.6	3.6	8.3	0.2	0.1
Egg	Average	190	17.3	11.8	2.1	0.0	55.8	2.1	1.5
	Standard deviation		0.0	0.0	0.0	0.0	0.0	0.0	0.0
Milk	Average	120	6.0	3.7	15.9	0.3	223.6	0.1	0.7
	Standard deviation		3.2	2.7	7.3	0.5	128.8	0.3	0.4
Beans	Average	55	3.6	0.7	9.1	3.4	10.9	1.2	0.5
	Standard deviation		0.5	0.9	2.3	1.3	13.0	0.7	0.1
Nuts	Average	73	2.3	6.1	3.3	1.6	14.5	0.5	0.5
	Standard deviation		0.7	0.8	1.5	1.5	12.2	0.2	0.2
Oils	Average	73	0.0	8.3	0.0	0.0	0.0	0.0	0.0
	Standard deviation		0.0	0.0	0.0	0.0	0.0	0.0	0.0
Butter. Margarine	Average	73	0.0	8.3	0.0	0.0	0.6	0.0	0.0
	Standard deviation		0.0	0.0	0.0	0.0	0.2	0.0	0.0

Vegetables	Average	15	0.8	0.1	3.3	1.5	17.3	0.2	0.2
	Standard deviation		0.4	0.1	0.3	0.5	34.0	0.3	0.4
Leafy vegetables	Average	15	1.3	0.3	2.6	1.7	52.4	0.7	0.3
	Standard deviation		0.5	0.3	0.6	0.6	36.9	0.7	0.2
Fruits	Average	70	1.2	0.4	17.5	3.1	24.5	0.3	0.2
	Standard deviation		0.5	0.9	2.2	2.2	23.0	0.2	0.2
Fruit pulp	Average	70	1.2	0.3	17.6	1.9	12.5	0.4	0.2
	Standard deviation		0.4	0.3	0.7	0.6	8.5	0.2	0.1
Fruit juice	Average	70	0.9	0.1	17.7	0.4	20.3	0.2	0.1
	Standard deviation		0.7	0.1	2.2	0.5	15.1	0.3	0.1
Fish	Average	190	35.9	4.1	0.0	0.0	216.2	1.0	1.3
	Standard deviation		5.9	2.8	0.0	0.0	448.3	0.8	1.1
Beef	Average	190	23.2	10.1	0.1	0.0	4.9	2.0	4.1
	Standard deviation		6.6	3.2	0.3	0.0	2.5	1.3	1.7
Chicken	Average	190	21.4	11.0	0.0	0.0	8.9	2.3	2.0
	Standard deviation		8.5	4.0	0.0	0.0	2.6	4.7	1.7
Pork	Average	190	16.7	13.1	0.0	0.0	6.9	0.5	1.2
	Standard deviation		8.2	3.9	0.0	0.0	4.6	0.3	0.6

Beans are the best meat substitutes as is evident in the table above. A serving of beans contains 55kcal, whereas a serving of meat contains 190kcal. Therefore, if we increase the serving of beans until we attain 190kcal, we would have the following comparison:

Table 25: Isocaloric comparison of nutrients in meat and beans

Food	Parameter	Kcal/serving	Protein (g)	Lipids (g)	Carbohydrate (g)	Dietary fiber (g)	Calcium (mg)	Iron (mg)	Zi (m
Beans	Average	190	12.3	2.3	31.4	11.6	37.8	4.2	1
Beef	Average	190	23.2	10.1	0.1	0.0	4.9	2.0	4
Chicken	Average	190	21.4	11.0	0.0	0.0	8.9	2.3	2
Fish	Average	190	35.9	4.1	0.0	0.0	216.2	1.0	1
Pork	Average	190	16.7	13.1	0.0	0.0	6.9	0.5	1

Meat should be substituted for with beans. Their lower protein content is not a matter of concern because, as we will see below, the protein in meat is not required to achieve the protein requirement in a standard diet. In fact, meat leads to excessive protein intake.

Note that at the same caloric content, beans contain twice as much iron as beef. That automatically adjusts for the lower bioavailability of plant iron, because, if plant iron bioavailability is half of meat iron bioavailability, when you use twice its content (present in beans) its absorption will be the same.

Therefore, red meat (190 kcal) can be substituted for by 3.5 servings of beans, or 7 tablespoons of cooked beans.

Other possible equivalent substitution of meats by beans can be found in Table26.

Table 26: Equivalence of substitution of meat by beans

Meat	Amount (190 kcal)	Beans	Amount(190 kcal)
Grilled steak	64g or 1 unit	**Lentil cooked**	168g or 7 tablespoons
Meat, cooked	80g or 4 small pieces	**Chickpeas, cooked**	126g or 5¼ tablespoons
Ground meat,	63g or 3½	**Soybeans, cooked**	150.5g or 5¼

sautéed	tablespoons		tablespoons
Meat skewers	92g or 2 units	**Beans, cooked**	175g or 7 tablespoons
Grilled chicken steak	100g or 1 unit	**Dry peas, cooked**	253.7g or 8¾ tablespoons
Sausage	60g or 1½ unit	**Navy beans, cooked**	168g or 5¼ tablespoons

Note that removing meat from the diet allows an intake of a larger volume of foods to achieve the same caloric intake, which contributes to greater satiety.

6.1 Nutritional Prescription for Vegetarian Individuals

A 70kg eutrophic individual who eats 2,000kcal is eating 28.5kcal/kg/d and needs 56g of protein (0,8 g/kg/d), 2,660mg of lysine, 1,000mg of calcium, 8mg of iron and 11mg of zinc.

The Ministry of Health recommends the following number of servings per food group in a diet with nearly 2,000kcal:

Food group	Number of servings
Grains and tubers, roots and byproducts	6
Beans	1
Fruits	3
Vegetables and leafy vegetables	3
Milk and dairy	3
Meat and eggs	1
Oils, fats and nuts	1
Sugars and sweets	1

Using the average nutrient content of the food groups, this recommendation would provide 1,943kcal, 76.2g of protein, 3,966mg of lysine, 25g of fiber, 945.6mg of calcium, 15.4mg of iron, and 13.5mg of zinc.

Food substitution in an ovo-lacto vegetarian diet would be as follows:

Food group	Number of servings
Whole grains	6
Beans	4.5
Fruits	3
Vegetables and leafy vegetables	3
Milk and dairy	3
Meat and eggs	0
Oils, fats and nuts	1
Sugars and sweets	1

Such a diet would provide 1,946kcal, 65.5g of protein, 4,051mg of lysine, 36.8g of fiber, 979mg of calcium, 17.6mg of iron, and 11.3mg of zinc.

In a strict vegetarian diet, the replacement of cow's milk by calcium-enriched plant milk will provide the same calcium content as in the table above.

This basic diet can be changed in a number of ways, provided at least 2 servings of beans are included in strict vegetarian diets.

Even a diet with a larger relative amount of grains would meet the recommended protein intake:

Food group	Number of servings
Whole grains	7
Beans	2
Fruits	3
Vegetables and leafy vegetables	3
Milk and dairy	3

Meat and eggs	0
Oils, fats and nuts	1
Sugars and sweets	1

According to this table, such a diet would provide 1,958kcal, 60.7g of protein, 3,618mg of lysine, 29.4g of fiber, 962.2mg of calcium, 16.6mg of iron, and 10.8mg of zinc.

A very different way of making up a strict vegetarian diet would be:

Food group	Number of servings
Whole grains	6
Beans	2
Fruits	7
Leafy vegetables	6
Fortified plant milks	2
Meat and eggs	0
Nuts	2
Sugars and sweets	0

In this case, we would have 1,976kcal, 64.6g of protein, 3,512mg of lysine, 48.8g of fiber, 1,047mg of calcium, 19.2mg of iron, and 11.9mg of zinc.

Strained green juices can be used if one wants to increase the intake of leafy vegetables and fruits, but not that of fiber.

The important thing is that nutritionists understand that food groups can be distributed in different ways. There are many menu possibilities, be they omnivore or vegetarian. Care must be exercised so as to achieve the required intake for different nutrients, even if the share of each food group is different from that usually found in omnivore guidelines.

To optimize the intake of specific nutrients, the richest foods in each group should be selected.

7. ANNEX 1 - Food Groups and Household Measures.

Servings of foods (in grams) and corresponding household serving measures according to the Food Guide of the Ministry of Health[91], based on the work of Dr. Sonia Tucunduva Philippi (Department of Nutrition, Public Health School of the University of Sao Paulo) - "Tabela de Composição de Alimentos: suporte para a decisão nutricional" (PHILIPPI, 2001)and "Tabela para Avaliação de Consumo Alimentar em Medidas Caseiras" (PINHEIRO ET 2005). This table was used by the General Coordination of the National Diet and Nutrition Policies (*Coordenação Geral da Política Nacional de Alimentação e Nutrição* - CGPAN) to incorporate foods or food products that were not available in PHILIPPI (2001) or to establish servings of foods and meals that were not in the tables of PHILIPPI, ST et al .

Rice, Breads, Pasta, Potatoes and Cassava

1 serving = 150 kcal

Food	Weight (g)	Usual serving measures
white rice, cooked	125.0	4 tablespoons
brown rice, cooked	198.0	6 tablespoons
potato, cooked	202.5	1½ unit
sweet potato, cooked	150.0	1½ serving spoons
yam cooked/ mashed	126.0	3½ tablespoons
breakfast cereal	43.0	1 tea cup
oat flour	37.5	2½ tablespoons
cassava flour	40.0	2½ tablespoons
corn flour	42.0	3½ tablespoons
cassava flour *farofa*	37.0	½ serving spoon
taro root, cooked/ mashed	126.0	3½ tablespoons
pasta, cooked	105.0	3½ tablespoons
cassava, cooked	128.0	4 tablespoons
corn on the cob	100.0	1 large cob
bread, rye	60.0	2 slices
Bread, traditional loaf	43.0	2 slices
bread, corn	70.0	1 medium-sized unit
French roll	50.0	1 unit
salted popcorn	31.5	3 tea cups
mashed potato	130.0	2 serving spoons
mashed taro root	135.0	3 serving spoons

toasted French roll	33.0	6 slices

Leafy Vegetables and Vegetables

1 serving = 15kcal

Foods	Weight (g)	Usual serving measures
Squash, cooked (butternut, kabocha, pumpkin)	70.0	2 tablespoons
zucchini, cooked	81.0	3 tablespoons
Chinese cabbage, cooked	85.0	21/2 tablespoons
Chinese cabbage, raw, chopped	90.0	9 tablespoons
watercress	132.0	22 branches
lettuce	120.0	15 leaves
eggplant, cooked	60.0	2 tablespoons
beets, cooked	43.0	3 slices
beets, raw, grated	42.0	2 tablespoons
broccoli, cooked	60.0	41/2 tablespoons
carrot, cooked (slices)	35.0	7 slices
carrot, raw, chopped	38.0	1 serving spoon
chayote, cooked	57.0	21/2 tablespoons
cauliflower, cooked	69.0	3 branches
collards-butter, cooked	42.0	1 serving spoon
escarole	84.0	15 leaves
spinach, cooked	67.0	21/2 tablespoons
mustard greens	60.0	6 leaves
Heart of palm, conserve	100.0	2 units
Cucumber, chopped	116.0	4 tablespoons
sweet pepper, raw, sliced (red/green)	56.0	8 slices
sweet pepper, raw, chopped (red/green)	60.0	21/2 tablespoons
okra, cooked	52.0	2 tablespoons
Cabbage, green, raw, chopped	72.0	6 tablespoons
cabbage, cooked	75.0	5 tablespoons
Cabbage, purple, raw, chopped	60.0	5 tablespoons
arugula	90.0	15 branches
celery, raw	95.0	5 tablespoons

Tomato, *caqui*	75.0	21/2 slices
Cherry tomato	70.0	7 units
Common tomato	80.0	4 slices
green beans, cooked	44.0	2 tablespoons

Fruits

1 serving = 70kcal

Foods	Weight (g)	Usual serving measures
avocado (mashed)	45.0	1 1/2 tablespoon
pineapple	130.0	1 slice
acerola	224.0	32 units
Prune, black	30.0	3 units
Prune, red	140.0	4 units
banana	86.0	1 unit
Fresh cashew fruit	147.0	21/2 units
persimmon	113.0	1 unit
star fruit	220.0	2 units
Cherry	96.0	24 units
Apricot, dried	30.0	4 units
Sugar-apples (*fruta-do-conde*)	75.0	1/2 unit
guava	95.0	1/2 unit
jabuticaba	140.0	20 units
Jack fruit	132.0	4 berries
kiwi	154.0	2 units
orange-*Bahia/seleta*	144.0	8 pieces
orange-*pera/lima*	137.0	1 unit
lime	252.0	4 units
apple	130.0	1 unit
papaya-*Formosa*	160.0	1 slice
papaya	141.5	1/2 unit
mango	110.0	1 unit
mango	110.0	5 slices
passion fruit (pure juice)	94.0	1/2 tea cup
watermelon	296.0	2 slices
melon	230.0	2 slices
strawberry	240.0	10 units

nectarine	184.0	2 units
pear	133.0	1 unit
peach	226.0	2 units
orange juice	187.0	3/4 of a 250ml glass
tangerine	148.0	1 unit
Grapes, common	99.2	22 grapes
grapes-*Italia*	99.2	8 grapes
grapes-*ruby*	103.0	8 grapes

Beans

1 serving = 55kcal

Food	Weight (g)	Usual serving measures
Dry peas, cooked	72.5	2½ tablespoons
Navy beans, cooked	48.0	1½ tablespoons
Beans, cooked (50% broth)	86.0	1 ladle
Beans, cooked	50.0	2 tablespoons
black beans, cooked	80.0	1 ladle
Chickpeas, cooked	36.0	1½ tablespoons
Lentils, cooked	48.0	2 tablespoons
Soybeans, cooked	43.0 1	½ serving spoon

Milks, cheeses, yogurts

1 serving = 120kcal

Food	Weight (g)	Usual serving measures
Lebneh	77.5	2½ tablespoons
No-fat fruit yogurt	300.0	1½ 250ml glasses
Plain no-fat yogurt	330.0	1½ 250ml glasses
Plain whole yogurt	165.0	1 250ml glass
Whole powdered milk	26.0	2 tablespoons
No-fat powdered milk	34.5	3 tablespoons
Type B milk 3.5% fat	182.0	1 tea cup
Cheese, *minas frescal*	40.0	1 large piece
Cheese, *minas*	50.0	1½ pieces
Cheese, mozzarella	45.0	3 slices

Cheese, parmesan, grated	30.0	3 tablespoons
Cheese, *prato*	30.0	1½ slice
Cheese, provolone	35.0	1 slice
requeijão	45.0	1½ tablespoons
ricotta	100.0	2 slices

Oils and Fats

1 serving = 73kcal

Foods	Weight (g)	Usual serving measures
Olive oil	7.6	1 tablespoon
Vegetable spread	10.0	1/2 tablespoon
butter	9.8	1/2 tablespoon
Vegetable margarine	9.8	1/2 tablespoon
soybean and olive oil	10.0	1 tablespoon
canola oil	8.0	1 tablespoon
Sunflower seed oil	8.0	1 tablespoon
Corn oil	8.0	1 tablespoon
soybean oil	8.0	1 tablespoon

Sugar and Sweets

1 serving = 110kcal

Foods	Weight (g)	Usual serving measures
Confectioners' sugar	28.0	1 tablespoon
Fine brown sugar	25.0	1 tablespoon
Brown sugar	27.0	1½ tablespoons
White sugar	28.0	1 tablespoons
Fruit jam	34.0	1 tablespoon
Molasses	32.0	2 tablespoons
Honey	37.5	2½ tablespoons

8. ANNEX 2– Foods used to calculate averages and standard deviations of food groups

NUTS

Peanuts, raw; Almonds, toasted and salted; Cashew nuts, toasted and salted; Brazil nuts, raw; Sesame seeds; Flaxseed raw; Walnuts, raw.

BEANS

Beans, kidney, raw; black-eyed peas, raw; Beans, *jalo*, raw; Beans, black, raw; Beans, pinto, raw; Beans, *rosinha*, raw; Beans, *roxo*, raw; Chickpeas, raw; *Guandu*, raw; Lentils, raw; Soybeans, flour; Soybeans, soluble extract, powder.

EGGS

Egg, chicken, whole, raw.

MILK

Yogurt, regular; Yogurt, regular, no-fat; Yogurt, strawberry flavor; Yogurt, peach flavor; Milk, fermented; Milk, goat; Milk, cow, chocolate.

OILS

Oil, palm; Oil, olive, extra virgin; Oil, babassu palm; Oil, canola; Oil, sunflower; Oil, corn; Oil, *pequi*; Oil, soybean .

BUTTER, MARGARINE

Butter, salted; Butter, unsalted; Margarine, with hydrogenated oil, salted (65% lipids); Margarine, with hydrogenated oil, unsalted (80% lipids); Margarine, with interesterified fat, salted (65% lipids); Margarine, with interesterified fat, unsalted (65% lipids);

FRUITS

Avocado, raw; Pineapple, raw; Abiu, raw; Acerola, raw; Prune, raw; Atemoya, raw; Banana, *fig*, raw; Banana, *maçã*, raw; Banana, *nanica*, raw; Banana, *ouro*, raw; Banana, *pacova*, raw; Banana, *prata*, raw; Cacao, raw; *Cajá-Manga*, raw; Cashew fruit, raw; Persimmon, *chocolate*, raw; Starfruit, raw; *Ciriguela*,

raw; Cupuassu, raw; Fig, raw; Breadfruit, raw; Guava, white; Guava, red; Soursop, raw; *Jabuticaba*, raw; Jackfruit, raw; *Jambo*, raw; Kiwi fruit, raw; Orange, *baía*, raw; Orange, *da terra*, raw; Orange, *lima*, raw; Orange, *pera*, raw; Orange, *Valencia*, raw; Lime, Tahiti, raw; Apple, Argentine, raw; Apple, Fuji, raw; Papaya, *Formosa*, raw; Papaya, raw; Mango, *Haden*, raw; Mango, Tommy Atkims, raw; Passion fruit, raw; Watermelon, raw; Melon, raw; Tangerine, *Murcote*, raw; Tangerine, *Rio*, raw; Strawberry, raw; Japanese plum, raw; Pear, Park, raw; Pear, Williams, raw; Peach, Aurora, raw; *Pinha*, raw; Brazilian cherry, raw; Pomegranate, raw; Tangerine, *Poncã*, raw; *Umbu*, raw; Grapes, *Green*, raw; Grapes, *Ruby*, raw.

FRUIT PULP

Acerola, pulp, frozen; Cashew, pulp, frozen; Cupuassu, pulp, frozen; Soursop, pulp, frozen; Mango, pulp, frozen; Passion fruit, pulp, frozen; Umbu, pulp, frozen.

FRUIT JUICE

Ponca Tangerine, juice; Orange, *baía*, juice; Orange, *da terra*, juice; Orange, *lima*, juice; Orange, *pera*, juice; Orange, Valencia, juice; Lime, *galego*, juice; Grapes, bottled concentrated juice; Coconut water; Sugarcane, juice.

POTATOES

Arracacha root, raw; Sweet potato, raw; Potato, raw; Yam, raw; Taro root, raw; Manioc, raw;

VEGETABLES

Squash, kabocha, cooked; Squash, kabocha, raw; Squash, Brazilian, raw; Pumpkin, standard, raw; Zucchini, Italian, cooked; Zucchini, Italian, raw; Zucchini, *paulista*, raw; Zucchini, pescoço, raw; Eggplant, cooked; Eggplant, raw; Beets, cooked; Beets, raw; Pigweed, raw; Carrot, cooked; Carrot, raw; Chayote, cooked; Chayote, raw; scarlet eggplant, raw; Bur cucumber, raw; Turnip, raw; Heart of palm, conserve; Cucumber, raw; Sweet pepper, yellow, raw; Sweet pepper, green, raw; Sweet pepper, red, raw; Pupunha, heart of palm; Radish, raw; Tomato, with seed, raw; Tomato, puree; Tomato, salad; Green beans, raw; Pea, in the pod; Onion, raw.

LEAFY VEGETABLES

Chinese cabbage, raw; Watercress, raw; Celery, raw; Iceberg lettuce, raw; Lettuce, oak leaf, raw; Lettuce, regular, raw; Broad-leaf basil, raw; Chicory, raw; Chicory, sautéed; Broccoli, cooked; Broccoli,

raw; Endive, raw; Escarole, raw; Collards, raw; Collards, sautéed; Cauliflower, raw; Cauliflower, cooked; Spinach, raw; Spinach, sautéed; Beans, sprouts, raw; Mustard greens, raw; Cabbage, green, raw; Sow thistle, raw; Arrow leaf elephant ear, raw; Basil, raw; Parsley, raw; Green onions, raw.

WHOLE GRAINS

Brown rice, raw; *Canjica*, white, raw; Quinoa; Wheat berries.

WHOLE-GRAIN PRODUCTS

Oats, flakes, raw; Corn, grains, flakes, unsalted; Breakfast cereal, corn; Breakfast cereal, corn, sugar; corn cream, powder; Curau, corn, powder; Whole rye flour; corn flour, yellow; Cornmeal, raw; Bread, oats, loaf; Bread, soybean; Bread, corn, loaf; Bread, wheat, loaf, whole.

REFINED GRAINS

Rice, type 1, raw; Rice, type 2, raw; Pasta, instant; Pasta, wheat, raw; Pasta, wheat, raw, with eggs; Bread, wheat, French roll; Bread, wheat, *sovado*.

FISH

Whiting, fillet, frozen, raw; Tuna, fresh, raw; Shark, slice, raw; Shrimp, raw; Corimba, raw; Corvine, fresh water, raw; Corvine, sea, raw; Lambari, frozen, raw; Merluza, fillet, raw; Pescada, branca, raw; Pescada, fillet, raw; Pescadinha, raw; Pintado, raw; Porquinho, raw; Sardine, whole, raw; Tucunaré, fillet, frozen, raw.

BEEF

Beef, chuck, minced, raw; Beef, chuck, no fat, raw; Beef, organ, raw; Beef, neck steak, with fat, raw; Beef, neck steak, no fat, raw; Beef, jerked, raw; Beef, rib eye roll, raw; Beef, striploin, with fat, raw; Beef, striploin, no fat, raw; Beef, rib, raw; Beef, outside flat, no fat, raw; Beef, topside, no fat, raw; Beef, hump, raw; Beef, liver, raw; Beef, tenderloin, no fat, raw; Beef, flank, no fat, raw; Beef, flank steak, raw; Beef, eye round, raw; Beef, tongue, raw; Beef, rump skirt, raw; Beef, eye of rump, no fat, raw; Beef, muscle, no fat, raw; Beef, shoulder clod, with fat, raw; Beef, shoulder clod, no fat, raw; Beef, knuckle, no fat, raw; Beef, brisket point end, no fat, raw; Beef, rump steak, with fat, raw; Beef, rump steak, no fat, raw; Beef, jerky, raw.

CHICKEN

Chicken, wing, with skin, raw; Chicken, heart, raw; Chicken, drumstick, with skin, raw; Chicken, drumstick, without skin, raw; Chicken, liver, raw; Chicken, whole, with skin, raw; Chicken, whole, without skin, raw; Chicken, breast, with skin, raw; Chicken, breast, without skin, raw; Chicken, thigh, with skin, raw; Chicken, thigh, without skin, raw; Sausage, chicken, raw.

PORK

Sausage, pork, raw; Pork chops, raw; Pork ribs, raw; Pork, tenderloin, raw; Pork, leg, raw; Bacon, raw.

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