Fueling the Vegetarian (Vegan) Athlete

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FUHRMAN, J. and D.M. FERRERI. Fueling the vegetarian (vegan) athlete. *Curr. Sports Med. Rep.*, Vol. 9, No. 4, pp. 233–241, 2010. *Vegetarian diets are associated with several health benefits, but whether a vegetarian or vegan diet is beneficial for athletic performance has not yet been defined. Based on the evidence in the literature that diets high in unrefined plant foods are associated with beneficial effects on overall health, lifespan, immune function, and cardiovascular health, such diets likely would promote improved athletic performance as well. In this article, we review the state of the literature on vegetarian diets and athletic performance, discuss prevention of potential micronutrient deficiencies that may occur in the vegan athlete, and provide strategies on meeting the enhanced caloric and protein needs of an athlete with a plant-based diet.*

INTRODUCTION

According to the American Dietetic Association (ADA) (7), vegetarian diets are nutritionally adequate for all stages of life and for athletes. However, many discussions of nutritional adequacy of vegetarian diets focus on avoidance of nutrient deficiencies rather than inclusion of health-promoting whole foods whose benefits are supported by the literature.

Vegetarian diets are associated with a number of health benefits: lower risk of death from heart disease, lower low-density lipoprotein (LDL) cholesterol levels, lower blood pressure, lower rates of type 2 diabetes, lower body mass index, and lower rates of cancers (7). The avoidance of meat and other animal products alone does not explain these health benefits. The primary dietary factor that likely confers these benefits is the increased consumption of whole plant foods (fruits, vegetables, whole grains, seeds, nuts, beans) and associated beneficial nutrients — fiber, antioxidants, vitamins, minerals, and phytochemicals. Processed foods and animal products account for 90% of calories consumed in the typical American diet, and these foods lack antioxidants and supportive phytochemicals abundant in unrefined plant foods (50). For example, a recent analysis reported the overall mean antioxidant content of plant foods to be 11.57 mmol·100 g^{-1}. Compare this to the mean antioxidant content of animal foods — a minute 0.18 mmol·100 g^{-1} (4).

In Table 1, we define vegetarian, vegan, flexitarian, and nutritarian diets. We use the word nutritarian to describe an individual who follows an eating style that is high in micronutrients. It can be vegan or include a limited amount of animal products, but it is distinguished from other eating styles as follows: a nutritarian diet includes a large amount of high-micronutrient, unrefined plant food — based on vegetables, fruits, nuts, seeds, and beans. In addition to minimizing or avoiding animal products, a nutritarian diet avoids or minimizes nutrient-depleted foods like refined grain products, refined sugars, sweeteners, and added oils. We propose that vegan athletes who also follow a nutritarian diet (with additional attention to micronutrient quality) will have a performance advantage.

Present day vegan athletes — such as Tony Gonzalez of the Kansas City Chiefs, Ironman triathlete Brendan Brazier, track and field Olympian Carl Lewis, and bodybuilder Kenneth Williams — provide evidence that high-level athletic performance can be achieved without consuming animal products. However, the avoidance of animal foods does not in itself define a health-promoting diet that will support athletic performance. The optimal diet for the vegan athlete has not yet been defined.

Nutritional excellence and avoidance of deficiencies can aid in the maintenance of low body fat, while maximizing muscle endurance and disease-resistance. We have accumulated a great deal of evidence working with athletes, suggesting that a vegan athlete can compete effectively at a high level in endurance sports by focusing the diet on micronutrient-rich whole plant foods and avoiding potential deficiencies.

VEGETARIAN DIETS AND ATHLETIC PERFORMANCE

High-performance athletes demonstrate mildly suppressed immune function and often experience increased incidence of

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TABLE 1. Definitions of vegetarian, vegan, flexitarian, and nutritarian.

Vegetarian	Eats no animal flesh, but may consume eggs or dairy
Vegan	Does not consume any foods of animal origin
Flexitarian	Regularly follows a vegan diet, but occasionally consumes dairy, meat, fowl, or fish
Nutritarian	Follows an eating style high in micronutrients, based on unrefined plant foods; may or may not be vegan

upper respiratory tract infections. These symptoms are thought to be a consequence of the long-term stresses of intense daily training. Even in the short term, a single intense workout temporarily diminishes immune function. Immune parameters diminished by intense training include natural killer cell number and activity and neutrophil function. Neutrophil function is the immune parameter most affected by intense exercise, and this potentially could result in increased susceptibility to microbial infections, disrupting training and thereby compromising performance (14).

Our experience in working with top amateur and professional athletes is that they desire to avoid disruptions in training and competing by avoiding illness especially from viral infections. The main advantage for the serious athlete to adopt a nutritarian-style vegan or near vegan diet may be the improved immunocompetence — not missing training and events because of illness.

Excess fat intake and poor food choices may exacerbate exercise-induced immunosuppression. Adequate micronutrient intake (notably folate, carotenoids, B6, B12, C, E, zinc, copper, iron, and selenium) by athletes has been suggested to attenuate suppression of immune function (14). Carotenoids, pigment molecules abundant in green and other colored vegetables, are known to enhance immune function (5). Omega-6 polyunsaturated fatty acids (PUFA) are provided in excess in the typical American diet, contributing to chronic inflammation. Seeds containing omega-3 (flax, hemp, chia, sesame, pumpkin, sunflower) are a healthier alternative to animal-based fats and oils. They offer a substantial amount of protein and are a healthy fat source with the right balance of fatty acids, lignans, sterols, and other beneficial components contributing to immunocompetence.

A diet high in antioxidants and phytochemicals may also attenuate exercise-induced oxidative stress in athletes. A single bout of exercise induces oxidative stress in both skeletal muscle and blood, which may last several days (38); this same exercise stimulus upregulates endogenous antioxidant defenses. However, the reactive oxygen species (ROS) produced from exercise may be proportionally larger, overwhelming the increased endogenous defenses (27).

The consistent intake of high-antioxidant plant foods attenuates undesirable consequences of oxidative stress by keeping ROS at favorable levels. Antioxidant supplementation has not consistently curtailed exercise-induced oxidative stress or inflammatory markers (36). In fact, these supplements may slow recovery — creatine kinase, a marker of muscle damage, remained elevated longer in those given antioxidant capsules than in those given placebo (48). In another study, a concentrated antioxidant supplement actually increased lipid peroxidation and decreased levels of the antioxidant enzyme glutathione peroxidase (23). We propose that supplements of specific isolated antioxidants would be vastly outperformed by the complex combinations of antioxidants and other phytonutrients in high-micronutrient, whole foods; the same is observed in epidemiological studies

TABLE 2. Protein-rich plant foods.

Vegetables	
Vegetable (Portion Size)	**Protein Content (g)**
Broccoli rabe (3 cups, cooked)	15
Spinach (3 cups, cooked)	15
Asparagus (3 cups, cooked)	12
Bok choy (3 cups, cooked)	9
Swiss chard (3 cups, cooked)	9
Broccoli (3 cups, cooked)	6
Mushrooms (3 cups, cooked)	6
Cauliflower (3 cups, cooked)	6
Kale (3 cups, cooked)	6
Spirulina (100 g)	6
Watercress (3 cups, raw)	3
Beans, Nuts, Seeds, Grains	
Food (Portion Size)	**Protein Content (g)**
Tofu, extra firm (1/2 block)	22.5
Tempeh (1/2 block)	19
Lentils (1 cup, cooked)	18
Edamame (1 cup, blanched)	17
Split peas (1 cup, cooked)	16
Oats (1/2 cup dry)	13
Beans, various (1 cup, cooked)	13
Whole wheat pasta (2 servings – 4 oz. dry)	12
Hemp seeds (1/4 cup)	10
Pignolia[a] (1/4 cup)	9.5
Pumpkin seeds (1/4 cup)	8.5
Quinoa (1 cup cooked)	8
Almonds (1/4 cup)	7
Wild rice (1 cup cooked)	7
Sunflower seeds (1/4 cup, hulled)	7
Sprouted grain bread (Manna brand, 1-inch slice)	8
Unhulled sesame seeds (1/4 cup)	6
Pine nuts	4
Cashews (1/4 cup)	5
Whole wheat bread (1 slice)	4

[a]Mediterranean pine nuts (pignolia; from the Italian Stone Pine — grown in Italy, Spain, and Portugal) can be mail-ordered and are naturally high in protein.

of chronic disease. There is strong evidence for the protective effect of vegetables against coronary heart disease, which is known to involve oxidative damage (29). Supplementation with antioxidant vitamins, however, has not shown any clear benefit (42).

Green vegetables, such as kale, collards, broccoli, and bok choy, have measurable micronutrient contents per kcal, dwarfing other foods, and also are high in protein. All colorful vegetables are high-antioxidant foods (43). Fruits with very high antioxidant content include black currants, berries, pomegranate, sour cherries, oranges, and kiwi. Pistachio nuts and seeds, such as unhulled sesame seeds (especially black sesame seeds), are rich in vitamin E and other antioxidants.

Scientific data in the literature investigating vegetarian diets for athletes is sparse. A search of the PubMed medical literature database for "vegetarian AND athlete" returns only 13 articles. Reviews on the topic appeared in *The American Journal of Clinical Nutrition* in 1988 (34) and 1999 (33). Reviews on special nutritional considerations for vegetarian athletes appeared in *Nutrition* in 2004 (1) and in *Sports Medicine* in 2006 (51).

There is much anecdotal evidence of athletic success on vegetarian and vegan diets, which was discussed in the previously mentioned reviews in the *American Journal of Clinical Nutrition* by Nieman (33,34). As early as the 1890s, vegetarian cyclists and long-distance walkers in the United States and Great Britain performed as well as or better than their omnivorous peers. In 1912, a vegetarian was one of the first men to complete a marathon in less than 2 h 30 min. Studies performed in the early 1900s showed that strength and endurance were superior in vegetarian compared with omnivorous athletes. A 1970 study comparing thigh muscle width and pulmonary function in athletes saw no difference between those on vegetarian and omnivorous diets. Similar results on pulmonary function, endurance, limb circumferences, and strength measures were seen in a 1986 study of vegetarian female Israeli athletes and matched nonvegetarian peers. Notably, this study also saw no difference in total serum protein between vegetarian and nonvegetarian subjects. Vegetarian athletes also performed equally to their omnivorous peers in athletic events of long duration — vegetarians and nonvegetarians consuming the same quantity of carbohydrate did not show any difference in their rate or time of completing a 20-d, 1000 km run in West Germany in 1989 (33). Despite these results, which clearly do not indicate a performance deficiency in vegetarians, concern regarding plant-based diets for athletes persists.

POTENTIAL SHORTCOMINGS OF A VEGAN DIET: SPECIAL CONSIDERATIONS FOR ATHLETES

There are several concerns about micronutrient adequacy of a vegan diet — some of these concerns are justified, and others are not, assuming that the diet is based on nutrient-rich, whole plant foods rather than refined carbohydrates and oils. The ADA has identified key nutrients for vegetarians — omega-3s, iron, zinc, iodine, calcium, vitamin D, and vitamin B12 (7).

Calcium and Iron Can Be Obtained Readily on a Vegan Diet

Calcium

U.S. recommended daily intake (RDI): 1000 mg

World Health Organization recommended daily intake: 400–500 mg

Low-oxalate vegetables such as bok choy and kale have higher levels of calcium bioavailability than milk (approximately 50% vs 30%) (53). Nuts and seeds also are rich in several minerals including calcium. Seeds are invaluable in the diet of an athlete, vegan or nonvegan. Seeds are protein- and mineral-rich, contributing to fulfilling the increased caloric and protein needs of athletes while simultaneously delivering many useful micronutrients. Exercise decreases urinary calcium excretion (32). Because of the great availability of calcium in vegetables, nuts, and seeds, calcium deficiency is an invalid concern for vegan athletes. A favorite dish of our athletes is blending seeds and nuts such as cashews, almonds, and unhulled sesame seeds with hemp milk for a delicious cream sauce, used over steamed kale and bok choy for a high-calcium dish with complete protein and a favorable fatty acid profile. Calcium-rich plant foods include watercress, bok choy, arugula, kale, tofu, unhulled sesame seeds, chia seeds, kidney beans, and almonds. One cup of cooked bok choy provides 160 mg calcium.

Iron

U.S. RDI: men – 8 mg; women – 18 mg

The concern for iron deficiency is based on reduced bioavailability of iron from plant foods. However, vegetarian diets often contain more iron than omnivorous diets. Plant foods contain nonheme iron, which generally is not as absorbable (10%) as heme iron contained in animal foods (18%). Absorption of each type of iron is inversely related to body iron stores, but nonheme iron is more responsive to iron stores. Thus, when iron stores are low, nonheme iron has greater absorption efficiency than heme iron. This efficiency, however, also depends on absorption enhancers and inhibitors present in foods. Plant foods contain inhibitors such as phytate (in legumes and grains), but also contain absorption-enhancing substances such as vitamin C and carotenes. Although some studies have cited decreased iron stores in vegetarians, none have demonstrated increased rates of iron deficiency anemia or decreased hemoglobin concentrations (19).

Athletes may be at risk for iron deficiency due to exercise-induced iron losses. A recent study of female professional athletes reported a high prevalence of iron depletion and anemia (35).

Vegan athletes should include iron-rich plant foods in their diets, but iron supplementation is not essential except in cases of iron insufficiency marked by a very low ferritin or anemia, or in women with heavy menstrual bleeding (39,28). High body iron stores may be a risk factor for cardiovascular disease (41) and cancer (49) and also reduced cardiovascular fitness (26). Men typically do not need iron supplementation on a vegan diet. Leafy greens are an often overlooked but rich source of iron. Typically, greens are eaten in small serving sizes that do not supply adequate iron, but athletes who consume large portions of greens in vegetable-based meals, smoothies, and shakes will receive the benefit of extra protein and iron from those greens. One pound of kale alone provides almost 8 mg of iron. Clearly, iron content is not low on a nutritarian-style vegan diet, but a vegan diet using grain products and protein powders as major calorie sources without attention to including iron-rich plant foods could contribute to suboptimal athletic performance. Iron-rich plant foods include spinach, asparagus, swiss chard, broccoli rabe, bok choy, tofu, lentils, pumpkin seeds, sesame seeds, and soybeans.

Suggested Supplements for Vegan Athletes

Zinc

U.S. RDI: men – 11 mg; women – 8 mg

Zinc is essential for immune function and supports enzymatic reactions related to DNA stabilization and gene expression. Zinc, similar to iron, is provided in abundance by a vegetarian diet, but is not absorbed readily from plant foods. Approximately 25% of the zinc in the standard U.S. diet comes from beef. Beans, whole grains, nuts, and seeds have high zinc content. However, these foods contain phytate, which inhibits absorption of both iron and zinc. Bioavailability of zinc also is enhanced by dietary protein and inhibited by supplemental folic acid (the synthetic form of food folate), iron supplements (not food iron), and other essential minerals (calcium, copper, magnesium). Based on these factors, the most recent estimate of zinc requirements for vegans is approximately 50% higher than the U.S. RDI, that is, 12 $mg{\cdot}d^{-1}$ for female vegans and 16.5 $mg{\cdot}d^{-1}$ for male vegans. Unrefined plant foods provide a significant amount of zinc. Refined grains contain far less phytate, but also far less zinc (12).

For these reasons, absorption efficiency may be quite low and attention to foods high in zinc cannot be expected by most vegans. A 2009 study of vegetarians found a high prevalence of zinc deficiency (9). Zinc supplementation or a multivitamin/multimineral containing zinc is a wise choice for vegan athletes. For those athletes who refuse supplementation or those who wish to increase their food-based zinc intake, pumpkin seeds and hemp seeds each contain 5 mg in a half cup serving.

Iodine

U.S. RDI: 150 μg

The choice of whether to consume added salt is an important contributor to iodine intake, as iodized salt is the chief source of iodine in the western diet. Most plant foods are low in iodine because of soil depletion. Seaweeds are a potential iodine source for vegans, but commonly are consumed only occasionally. Added salt beyond what is present in natural foods carries risks of hypertension, kidney disease, and stroke (44).

A 2003 study of vegans in Germany estimated that only about 40% of the daily requirement for iodine commonly was met on a vegan diet. Iodized salt consumption in these populations was not taken into account (52). Another study based on iodine excretion concluded that 80% of vegans, 25% of vegetarians, and 9% of conventional eaters are iodine-deficient (21). Thus it is important for vegan athletes to supplement with iodine in a multivitamin/multimineral or regularly consume a small amount of kelp or other seaweeds.

Vitamin B12

U.S. RDI: 6 μg

Vitamin B12 is essential for proper nervous system function, homocysteine metabolism, and DNA synthesis, especially in erythrocytes. After long-term insufficient intake of B12, stores become depleted, resulting in neurological and hematological symptoms. Long-term deficiency is characterized by morphological changes in blood cells and hematopoietic cells, since the deficit in DNA synthesis mostly affects cells with a high turnover rate. Irreversible neurological damage also can result. Deficiency in B12 causes circulating homocysteine to rise. Elevated homocysteine levels are associated with cardiovascular risk (17).

Vitamin B12 is synthesized only by microorganisms and therefore is more abundant in animal foods than in plant foods. Supplementation of a minimum of 6 $\mu g{\cdot}d^{-1}$ vitamin B12 is essential for vegans. It has now become common knowledge that vegans need to supplement with B12.

Docosahexaenoic Acid

There is overwhelming evidence that the omega-3 fatty acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) contribute to brain and heart health. Alpha-linolenic acid (ALA), an omega-3 fat that can be elongated to produce EPA and DHA, is present in flaxseeds, chia seeds, hempseeds, walnuts, and leafy greens. Adequate levels of omega-3s for most individuals can be maintained by regularly consuming these plant sources of ALA. However, there is evidence that many individuals do not self-produce ideal levels of DHA and EPA even when proper attention is placed on obtaining sufficient ALA. Genetic differences account for varying degrees of activation of the enzyme delta-6 desaturase, which elongates the ALA to EPA and DHA. Our experience in seeing suboptimal blood levels in a substantial percentage of vegans is supported by research studies that document prevalence of long-chain omega-3 deficiencies in vegans. A reasonable option is to take an algae-based DHA supplement, which is vegan. Since ALA is readily converted to EPA and DHA can undergo retroconversion to EPA (6), an algae-based DHA supplement plus ALA sources (such as some flax or hemp in the diet) supplies adequate omega-3s.

Omega-3 supplementation may be especially beneficial to athletes. A recent study suggested that omega-3 supplementation attenuates exercise-induced inflammation and oxidative stress (2). Wrestlers given omega-3 supplements (1000 $mg{\cdot}d^{-1}$) for 12 wk experienced enhanced pulmonary function during training (47).

Vitamin D

U.S. RDI: 400 IU

Widespread vitamin D deficiency has been reported in the general population. This vitamin may be especially important for athletes because of its function in skeletal muscle. In the early 20th century, athletic trainers believed that ultraviolet-B (UVB) radiation benefited athletic performance. In light of current data, these observations could have been vitamin D-dependent. Vitamin D receptors are present in almost all cells of the body, including myocytes. Vitamin D modulates gene expression of calcium metabolism-related and unrelated proteins. Calcium handling is an integral part of muscle contraction and relaxation, and vitamin D's actions are thought primarily to affect calcium channels. This could have implications for both performance and injury prevention (16).

The current U.S. RDI for vitamin D of 400 IU is thought by scientists to be suboptimal, in light of the recent finding that deficiency is exceedingly common, affecting 30%–50% of the population. In addition, vitamin D insufficiency is thought to contribute to several cancers, diabetes, cardiovascular disease, depression, and autoimmune diseases (18,24). The Institute of Medicine currently is in the process of revising the recommendations for daily intake of vitamin D. The minimum sufficient blood level of vitamin D, measured by 25(OH)D, is thought to be 30 ng·mL^{-1} (18), and vitamin D supplements of 2000 IU typically are needed to ensure adequacy. Adequacy of supplementation can be confirmed with a blood test.

Taurine

Taurine is a supplement that may offer a performance benefit to athletes, and frequently in our experience is low or deficient in vegan athletes. Taurine is an amino acid that is concentrated in skeletal muscle tissue. Urinary excretion of taurine correlates with markers of muscle damage (8). Taurine presupplementation has been shown to increase athletic performance in human and animal studies. Animal studies also have reported benefits to insulin sensitivity and muscle glycogen storage (13). A nonvegetarian diet supplies approximately 100 to 400 mg·d^{-1} of taurine. Supplementation with 500 mg taurine twice daily is appropriate for serious vegan athletes.

CALORIE AND PROTEIN REQUIREMENTS

A diet for vegan athletes must take into account additional energy requirements above those of moderate activity levels. The low calorie density of many plant foods make energy requirements a consideration.

During exercise, there is increased protein oxidation and breakdown, followed by enhanced muscle protein synthesis and further protein breakdown during recovery (3). The rise in circulating amino acids after a protein-containing meal stimulates intramuscular protein synthesis and also slightly suppresses muscle protein breakdown (45). Ingesting carbohydrate alone fails to induce this increase in muscle protein synthesis. Similarly, benefits to immunity, muscle soreness, and overall health by protein-containing meals compared with carbohydrate-only meals have been suggested in the literature (3). For these reasons, timing of content of protein in meals may be an important factor in recovery and muscle mass maintenance and gain. Specifically, branched chain amino acid (BCAA) supplements (isoleucine, leucine, and valine in approximate 1:2:1 ratio) have been studied for their effects on performance, muscle protein synthesis, and recovery. Oxidation of leucine is upregulated significantly during endurance exercise, reflecting the need for increased protein intake by athletes. A review concluded that BCAA supplements do not significantly affect performance, but do attenuate exercise-induced muscle damage and promote muscle protein synthesis (31). Plant proteins such as sesame seeds, sunflower seeds, tofu, and pumpkin seeds are rich sources of BCAA.

Protein Requirements for Athletes

Athletes indeed do require a greater quantity of protein than sedentary individuals; however, the amount of protein required has been a point of confusion and disagreement among both athletes and the scientific community. Because protein may comprise 5% of the energy burned during exercise, positive nitrogen balance is needed as raw material for anabolic processes — to replace these losses and/or build additional muscle mass. Insufficient protein ingestion leads to negative nitrogen balance and insufficient recovery. An early nitrogen balance study of sedentary subjects and strength athletes revealed that for zero nitrogen balance, sedentary subjects required 0.69 g·kg^{-1}·d^{-1} and strength athletes required 1.41 g·kg^{-1}·d^{-1}. This demonstrates that 1.41 g·kg^{-1}·d^{-1} represents a minimum for muscle maintenance in strength athletes (46). Some recommendations are made as a percentage of kilocalorie, some as grams of protein per kilogram body mass. A 2004 review concluded that athletes, even those in strength sports, should follow the same recommendations as the general public — approximately 12%–15% of calories from protein, adjusting only total calories based on physical activity (37). Increasing caloric intake to meet physical activity requirements would inevitably increase the 0.8 g·kg^{-1}·d^{-1} figure that has been established for most of the population, regardless of whether the percentage of calories from protein changes. Therefore, it is not difficult to reach protein requirements with proper dietary planning, even for an athlete on an entirely vegan diet (Table 2).

A 2009 review places the ideal protein requirement for athletes between 1.4 and 2.0 g·kg^{-1}·d^{-1} (22). The International Society of Sports Nutrition recommends 1.0–1.6 g·kg^{-1}·d^{-1} for endurance athletes (depending on intensity and duration of exercise) and 1.6–2.0 g·kg^{-1}·d^{-1} for strength athletes, compared with the 0.8 g·kg^{-1}·d^{-1} RDI for sedentary individuals. They further recommend that this protein come primarily from whole foods (3). In 2009, the Swiss Forum for Sport Nutrition designed a food pyramid for Swiss athletes taking athletes' extra energy requirements into account. By their estimates based on their review of the literature, protein intake for athletes should be 1.6–1.9 g·kg^{-1}·d^{-1} depending on training duration and intensity. Meal plans based on these variables were tested and were able to meet energy demands of athletes in 97% of instances (30). We suggest that percentage of kilocalorie likely is the more favorable way to express athletes' protein needs, since athletes' caloric needs are related more closely to training volume than to body mass. Based on the Swiss Society for Nutrition's estimates of calorie expenditure (30) and a mid-range of proposed estimates of protein requirements from the literature, we calculated approximate kilocalorie and protein requirements for a 150-lb endurance athlete (3600 kcal, 120 g protein) and 200-lb strength athlete (4800 kcal, 160 g protein), each training 4 h·d^{-1}. Sample menus for athletes on a vegan diet are included in an appendix at the end of this article.

Potential Dangers of Excess Protein

There is no demonstrated benefit for an athlete to consume more than 2 $g{\cdot}kg^{-1}{\cdot}d^{-1}$ protein, and in fact, excess protein may affect negatively calcium stores, kidney function, bone health, and cardiovascular health (11,15). Athletes regularly consume supplements in the form of isolated protein — for vegan athletes, these commonly are isolated soy, rice, pea, or hemp proteins. We encourage whole food sources of protein — such as tofu, nuts, seeds, and hemp seed meal — blended into shakes and smoothies. First, isolated protein powders are micronutrient-poor compared with whole foods. Second, their use may pose health risks — excess animal protein may promote cancers via upregulation of insulin-like growth factor 1 (IGF-1) (20). Importantly, not just animal proteins, but isolated protein from plant sources also has been found to elevate IGF-1 levels (10). What exactly defines excess protein for athletes has not yet been defined clearly, as studies on protein safety in athletes are scarce (25). However, increased consumption of either animal products or possibly protein isolates in the attempt to maximize growth for sports such as power lifting or body building likely is not lifespan-favorable. There is a difference between maximizing body size and muscle growth and maximizing health.

Clearly, a properly designed vegan (or near-vegan) diet can meet the nutritional demands of a speed and agility athlete, such as tennis, skiing, basketball, track, and soccer, but may not be ideal to maximize growth over 300 lb as a football linebacker. Data suggest that these very large athletes have much shorter lifespans and that eating to maximize size is not lifespan-favorable (40). Besides promoting excellent health, a carefully designed and intelligently supplemented vegan diet can meet caloric needs and supply adequate protein without excess.

This poses the question of whether athletes requiring overly large body mass would be capable of meeting their kilocalorie and protein requirements on whole plant foods alone. My experience has been that they would not be able to eat enough protein to maximize growth potential. Although they would have excellent stamina, improved power, and strength per body weight, they would not become massive enough to be highly competitive as a football linebacker, for example. Excessive eating, not lifespan-favorable, with a high consumption of animal products and/or plant protein concentrates likely would be required to achieve that degree of unnaturally high body mass. Nevertheless, plant protein concentrates such as maca, pea, rice, and hemp protein powders are options when the athlete desires to remain vegan or considerably reduce dependency on animal products yet still support a high body mass.

CONCLUSION

Vegetarian, vegan, flexitarian, and nutritarian diets are healthful options for serious athletes. To maximize performance, recovery, endurance and resistance to illness, enhanced intake of beans, greens, seeds, nuts, whole grains, and other colorful plant products are recommended. These same suggestions also are important for the nonvegan athlete. Excellent nutrition to maximize long-term performance and athletic life is much more than macronutrient adequacy and adequate protein intake; it is micronutrient density and adequacy as well. Supplemental protein is an option but not needed for most athletes who carefully construct their diet, paying attention to the higher-protein plant foods. Rather, added B12, vitamin D, zinc, DHA, and possibly taurine are more likely to be helpful.

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APPENDIX
Sample Daily Menus for Vegan Athletes

Sample Daily Menu 1: Approximately 3600 kcal, 120 g Protein

Breakfast

Smoothie made with raw collards, banana, ground flaxseed, blueberries, pumpkin seeds, hemp seeds

Lunch

Mixed greens and romaine salad topped with avocado, carrots, and tomato almond dressing (tomato sauce, almond butter, garlic, onion, vinegar)

Baked tofu topped with tomato sauce

Strawberries

Snack

Sprouted grain bread topped with cashew butter

Apple

Dinner

Raw broccoli and green peppers with hummus

Sautéed kale, shiitake mushrooms, peas, and onions in cashew cream sauce (cashews, hemp milk, onion flakes) topped with sesame seeds, served over wild rice

Baked butternut squash topped with apricot sauce.

Dessert

Date-nut rolls (medjool dates, hemp seeds, coconut)

	kcal	Protein (g)
Breakfast		
3 cups collards	33	3
2 tablespoons flax	75	2.5
1 cup blueberries	84	1
1 banana	105	1
1/4 cup pumpkin and hemp seeds	210	6
Breakfast Total	507	13.5
Lunch		
3 cups mixed greens	24	2
2 cups romaine	16	2
1 avocado	220	2.5
1 cup chopped carrots	52	1

	kcal	Protein (g)
2 tablespoons tomato almond dressing	255	10
1 cup quinoa (cooked)	220	8
1/2 block tofu	200	22.5
1/2 cup tomato sauce	30	1.5
2 cups strawberries	100	2
Lunch Total	1117	51.5
Snack		
1 slice sprouted grain bread	175	8
2 tablespoons cashew butter	200	6
1 apple	95	0.5
Snack Total	470	14.5
Dinner		
2 cups raw broccoli	60	5
2 raw green peppers	48	2
1/2 cup hummus	220	6
3 cups cooked kale	105	6
2 cups cooked shiitake mushrooms	160	4
1/2 onion	22	0.5
1/2 cup peas	60	4
1/4 cup cashews	155	5
1/4 cup hemp milk	35	2
1 tablespoon sesame seeds	50	2
1 cup wild rice (cooked)	165	7
3 cups butternut squash	80	2
1/2 cup dried apricots	155	2
1/2 cup unsweetened soy milk	40	3.5
Dinner Total	1355	51
Dessert		
5 medjool dates	325	2.5
1/4 cup hempseeds	180	10
2 tablespoons shredded coconut	90	1
Dessert Total	595	13.5
Daily Total	4044	144

Sample Daily Menu 2: Approximately 4800 kcal, 160 g Protein

Breakfast

Oatmeal with chopped apple, sliced banana, ground flax-seeds, and sunflower seeds

Sprouted grain bread with almond butter

Lunch

Mixed greens salad with topped with chickpeas, avocado, tomato, red pepper, tempeh, and creamy blueberry salad dressing (cashews, sunflower seeds, fresh blueberries, vinegar).

Two servings vegetable bean soup (vegetable stock, mush-rooms, parsnips, leeks, onions, split peas, pinto beans, collards, broccoli-rabe, cashew butter, basil, dill, thyme, nutritional yeast, Italian seasoning mix).

Cantaloupe

Snack

Smoothie made with spinach, kale, banana, pineapple, cherries

Pistachio nuts

Dinner

Steamed broccoli topped with lentils (French lentils, onion, carrot juice, mushrooms, nutritional yeast)

Whole wheat pasta topped with cabbage, zucchini, tomato, and pignolias

Baked sweet potato

Dessert

Orange

Sprouted grain bread topped with cashew butter and fruit compote or all fruit jam

	kcal	Protein (g)
Breakfast		
2 cups (cooked) oatmeal	332	12
2 tablespoons flax	75	2.5
1/4 cup sunflower seeds	205	7
1 slice sprouted grain bread	175	8
2 tablespoons almond butter	200	5
2 apples	190	1
1 banana	105	1
Breakfast Total	1282	36.5
Lunch		
Mixed greens salad, 5 cups	40	3
1 tomato	20	1
1 avocado	220	2.5
1/2 cup chickpeas	130	3.5
1 cup diced red pepper	45	1.5
1/4 block tempeh	120	9.5
2 tablespoons blueberry cashew dressing	175	3
2 servings vegetable bean soup:		
2 cups vegetable stock	24	0
1/2 cup mushrooms	20	1.5
1/4 cup parsnips	25	0.5
1/2 cup onions & leeks	30	1
1/4 cup split peas	60	4
1/4 cup pinto beans	60	4
1/2 cup collards	25	2
1/2 cup broccoli rabe	25	3
2 tablespoons cashew butter	200	6
1 tablespoon nutritional yeast	22	4
2 cups cantaloupe	110	2.5

	kcal	Protein (g)
Lunch Total	1351	52.5
Snack		
1/4 cup pistachio nuts	170	6
2 cups spinach	14	2
2 cups kale	65	4
1 banana	105	1
1 cup diced pineapple	80	1
10 oz. bag cherries	180	2
Snack Total	614	16
Dinner		
3 cups steamed broccoli	160	6
1/2 cup lentils (cooked)	115	9
1/2 cup carrot juice	45	1
1/2 cup (cooked) mushrooms	20	1.5
1 tablespoons nutritional yeast	22	4
1/2 cup onions	30	1
4 oz. whole wheat pasta	380	12
1 cup (cooked) cabbage	35	2
1 zucchini	30	2
1 tomato	20	1
1/4 cup pignolia	170	9.5
Baked sweet potato	100	2
Dinner Total	1127	51
Dessert		
1 orange	60	1
1 slice sprouted grain bread	175	8
2 tablespoons cashew butter	200	6
3 tablespoons all fruit jam	120	0
Dessert Total	555	15
Daily Total	4929	171