



Trabajo Original

Epidemiología y dietética

Nutritional composition of common vegetarian food portions

Composición nutricional de las porciones de alimentos comunes en las dietas vegetarianas

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Abstract

Introduction: A vegan diet can meet nutritional requirements if it is well planned. In this sense, vegans should be advised to choose alternatives to animal products and to select the appropriate respective serving size of them. The nutritional value of traditional plant foods portions is well known, however, the vegetarian market offers other products whose chemical composition is less known, as they are not widely consumed by the population. It is necessary to know both, the nutrient content of portions of these foods, and bioavailability of these nutrients in plant food diets.

Objectives: This work aims to refine the available information about the nutritional contribution to the diet of a healthy adult of the main common vegan foods portions. In addition, some points about bioavailability of the most relevant nutrients are discussed, and alternatives proposed to improve nutrient utilization.

Methods: Composition data of common vegan foods *per* 100 g were searched from food composition database, and serving size nutrient composition was calculated. Nutritional data were compared to European dietary reference values for nutrient intakes for adult population, and bioavailability of the most important nutrients was discussed.

Key words:

Nutrient content.
Vegan foods. Nutrient
bioavailability.

Resumen

Introducción: una dieta vegetariana puede satisfacer las necesidades nutricionales si está bien planificada. En este sentido, los vegetarianos deben ser aconsejados para elegir alimentos alternativos a los productos de origen animal seleccionando el tamaño de porción adecuada de cada uno de ellos. El valor nutricional de las porciones de los alimentos vegetales tradicionales es bien conocido, sin embargo, el mercado vegetariano ofrece otros productos cuya composición química es menos conocida, ya que no son alimentos ampliamente consumidos por la población. Es necesario conocer tanto el contenido de nutrientes de las porciones de estos alimentos como la biodisponibilidad de estos nutrientes en la dieta vegetariana.

Objetivos: este trabajo tiene como objetivo mejorar la información disponible sobre el aporte nutricional a la dieta de un adulto sano de las porciones de alimentos utilizados por la población vegetariana. Además, se discuten algunos puntos sobre la biodisponibilidad de los nutrientes más relevantes, y se proponen alternativas para mejorar su utilización.

Métodos: los datos de composición de los alimentos veganos, por 100 g, se buscaron en bases de datos de composición de alimentos, y a partir de ellos se calculó la composición química de las porciones. Después, estos datos nutricionales se compararon con las ingestas dietéticas de referencia europeas para la población adulta, y se discutió la biodisponibilidad de los nutrientes más importantes.

Palabras clave:

Contenido nutricional.
Dietas vegetarianas.
Biodisponibilidad de
nutrientes.

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INTRODUCTION

A vegetarian diet is one that excludes foods of animal origin although many variations on the vegetarian dietary pattern exist. A percentage of self-identified vegetarians follow a vegan diet, which is characterized by the exclusion of dietary animal products, such as red meat, fish, poultry, dairy and eggs. The lacto-ovo vegetarian diet includes dairy products and eggs but no red meat, fish or poultry. Likewise, some vegetarians, such as pesco-vegetarians, may include fish, milk and eggs but no red meat or poultry (1).

Evidence on the health benefits of a vegan diet from short and long-term cohort studies shows positive obesity, hypertension, type-2 diabetes, cardiovascular, and overall mortality effects (1-3), however, vegetarian diets may result in inadequate nutritional intake of some nutrients due to reduced bioavailability in plant sources. Vitamin B-12, omega-3 fatty acids, protein and minerals, such as calcium, iron, zinc and other trace minerals are the most concerning (4-7). Although a vegetarian diet can meet current recommendations for all of these nutrients, the use of supplements and fortified foods provides a useful shield against deficiency (8).

All vegans need to identify a source of vitamin B-12 in their diet by means of fortified foods as vegetable beverages, breakfast cereals, meat analogs or yeast. Vitamin D is not a problem if vegans have adequate sun exposure, although it can also be obtained from fortified foods (5). Although dairy foods are the most common source of calcium, vegans find it in fortified foods such as fruit juices, vegetable beverages and breakfast cereals (8,9). A vegan diet can easily meet human dietary protein requirements with an adequate energy intake and through consumption of a variety of plant sources such as whole grains, legumes, grains, nuts and seeds; nevertheless, they can also use soy products and meat analogs as another source of protein (5,10). Requirements of omega-3 fatty acid, a nutrient found in fish, can be located in vegetal sources such as ground flaxseed or flaxseed oil, walnuts and canola oil (11,12). Finally, vegetarians need dietary strategies to enhance content and bioavailability of zinc, iron and other minerals foods in their menu planning (13), since the bioavailability of zinc, iron and other minerals from plants is lower than from animal products (4-6).

Knowledge of the nutrient content of the common serving size of these key vegan foods is important to evaluate their nutritional contribution to the diet. In this sense, it is necessary to know both the nutrient content of portions, and the bioavailability of these nutrients in plant food diets. The objective of this work was to collect information about the nutrient content of vegan food portions in order to know their nutritional contribution to the diet of a healthy adult. Also, some points about the bioavailability of these nutrients and factors that can limit the nutrient value of vegan foods are discussed.

MATERIAL AND METHODS

The review had four phases: a) creation of an appropriate food list of common vegan foods; b) definition of the daily portion size

of the selected foods; c) development of a vegan food composition database *per* portion; and d) characterization of the nutritional value of daily portions based on content, dietary adult requirements and bioavailability of nutrients.

From a food frequency questionnaire (FFQ) previously validated in the Spanish population (14), vegan foods were included to study the dietary pattern of a vegetarian sample of subjects. These common vegan foods were selected in order to form the basis for the vegan food list for this study. The food list generated the following categories: a) dairy analogs; b) seeds; c) nuts-seeds spreads; d) legumes; e) meat analog products; f) vegetable oils; g) sea vegetables; and h) miscellaneous. The serving food sizes were determined according to the above-referenced FFQ, and corresponded to the typical daily portions consumed by this population.

In order to develop the serving size database, a template was prepared in Microsoft Excel 2010, including food name, group, energy and nutrient components with units of expression. Composition data of these foods *per* 100 g were searched and borrowed mainly from the Spanish Food Composition Database (15). If some food or some nutrient were not found, data were completed with nutritional information from a foreign database, such as the United States Nutrient Database (16) or the Finnish Food Composition Database (17). From centesimal food composition (*per* 100 g), serving size nutrient composition was calculated and the nutritional values were assessed in comparison to European dietary reference values for nutrient intakes for adult population (18), since these are the labelling reference intake values of Spanish food. The reference nutrient intake for sodium (2.4 g) was calculated from the reference intake for salt (6 g). Bioavailability of the most important nutrients in vegan foods was analyzed by means of a literature review, in which understanding of the impact of single dietary factor over nutrients was recomplied.

RESULTS AND DISCUSSION

Nutritional composition in different vegan food portions is shown in table I, which includes food group or sub-group, list of common vegan foods, portions, energy and nutrient content. Comparison of the vegan food nutritional composition to European dietary reference nutrient intakes (RNI) for adult population is shown in table II.

DAIRY ANALOGS

Based on portion weight indicated and on nutritional mean values, calcium (165.9 mg) was the most abundant mineral, but there was a high variation between portion foods (SD = 102.9 mg), due, in some cases, to the different artificial enrichment of these products. Comparing to RNI (18), portions of dairy analogs represented approximately 20.7% of RNI, being the portions of vegetable beverages sub-group the most important contributors of calcium (22.8% *versus* 18.6% of RNI for soy products).

Table I. Nutrient content of selected vegan food portions

Dairy analogs	Portion (g)	E (kcal)	Pr (g)	HC (g)	Fib (g)	TL (g)	MFAs (g)	PFAs (g)	SFAs (g)	Ch (mg)	Ca (mg)	Zn (mg)	P (mg)	Fe (mg)	Mg (mg)	K (mg)	Na (mg)	B1 (mg)	B2 (mg)	B3 (mg)	B6 (mg)	B9 (µg)	B12 (µg)	C (mg)	A-RAE (µg)	D (µg)	E (mg)	
																												W-3
Soy products																												
Soy drink	200	106.0	6.4	11.5	2.6	3.7	0.6	1.6	0.4	0.0	200.0	0.8	94.0	1.6	56.0	382.0	6.0	0.2	0.8	1.8	0.1	2.0	0.0	0.0	0.0	4.0	0.0	1.5
Soy yogurt	125	76.3	4.3	5.8	0.0	4.1	1.1	0.1	2.6	0.0	151.3	0.7	118.8	0.1	15.0	193.8	57.5	0.0	0.2	0.1	0.0	8.8	0.0	0.6	0.6	37.1	0.3	0.0
Flavor soy shake	200	164.0	10.0	7.8	0.0	10.4	2.0	5.2	1.2	0.0	200.0	0.4	94.0	0.8	30.0	240.0	64.0	0.1	0.1	0.2	0.1	38.0	0.0	0.9	0.0	0.0	1.5	
Tofu	60	71.4	6.9	2.0	0.2	4.0	0.8	1.9	0.5	0.0	120.0	0.4	114.0	1.0	42.0	108.0	4.2	0.0	0.0	0.1	0.1	9.0	0.0	0.0	0.1	0.0	0.6	
Soy cheese	40	60.4	5.0	2.8	0.0	3.2	0.7	1.8	0.5	0.0	75.2	0.7	88.8	2.2	91.2	79.6	8.0	0.0	0.1	0.2	0.0	8.8	0.0	0.0	0.0	0.8	0.0	0.2
Mean		95.6	6.5	6.0	0.6	5.1	1.0	2.1	1.0	0.0	149.3	0.6	101.9	1.1	46.8	200.7	27.9	0.1	0.2	0.5	0.1	13.3	0.0	0.0	8.4	0.1	0.8	
SD		41.8	2.2	3.9	1.1	3.0	0.6	1.9	0.9	0.0	53.0	0.2	13.5	0.8	29.0	120.1	30.1	0.1	0.3	0.7	0.0	14.1	0.0	0.0	16.1	0.1	0.7	
Vegetable beverages																												
Oat drink	200	88.0	3.0	11.4	2.0	3.0	1.2	0.8	0.2	0.0	240.0	1.0	86.2	1.2	27.0	82.0	79.6	0.1	0.4	0.8	0.0	9.2	0.8	0.0	0.0	0.0	1.5	0.4
Rice drink	200	94.0	0.6	17.7	0.6	1.9	1.3	0.6	0.0	0.0	236.0	0.3	112.0	0.4	22.0	54.0	78.0	0.1	0.3	0.8	0.1	4.0	1.3	0.0	126.0	2.0	0.9	
Tigger nut drink	200	196.0	2.4	34.0	0.2	5.4	4.0	0.6	0.8	0.0	58.0	2.0	52.0	2.4	30.0	104.0	18.0	0.0	0.0	0.3	0.0	2.0	0.0	0.1	0.0	0.0	0.0	
Almond drink	200	100.0	1.3	18.0	0.8	2.5	0.0	0.0	0.0	0.0	376.0	1.3	38.0	1.1	24.0	150.0	142.0	0.0	0.4	0.2	0.0	0.0	2.5	8.8	126.0	2.0	5.6	
Vegetal cream	25	34.3	0.3	2.8	0.0	2.5	1.9	0.0	0.5	0.0	2.3	0.0	16.0	0.0	0.0	47.8	16.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.2
Mean		102.5	1.5	16.8	0.7	3.1	1.7	0.4	0.3	0.0	182.5	0.9	60.8	1.0	20.6	87.6	66.9	0.0	0.2	0.4	0.0	3.0	0.9	1.8	50.5	1.1	1.4	
SD		58.5	1.2	11.4	0.8	1.4	1.5	0.4	0.3	0.0	151.3	0.8	38.3	0.9	11.9	41.6	52.0	0.1	0.2	0.4	0.0	3.8	1.0	3.9	69.0	1.0	2.4	
Total group mean		99.0	4.0	11.4	0.6	4.1	1.5	1.3	0.7	0.0	165.9	0.8	81.4	1.1	33.7	144.1	47.4	0.1	0.2	0.4	0.0	8.2	0.5	1.0	29.4	0.6	1.1	
SD		48.1	3.1	9.9	0.9	2.4	1.0	1.5	0.8	0.0	102.9	0.6	34.7	0.8	25.1	103.6	45.0	0.1	0.3	0.5	0.1	11.2	0.8	2.7	52.2	0.9	1.7	
Seeds																												
Flax seeds	10	56.7	1.8	0.2	2.7	4.2	0.8	0.4	0.4	0.0	25.5	0.4	64.2	0.6	39.2	81.3	3.0	0.2	0.0	0.3	0.0	8.7	0.0	0.1	0.0	0.0	0.0	0.0
Sesame seeds	10	57.3	1.8	2.3	1.2	5.0	1.9	0.7	0.7	0.0	97.5	0.8	62.9	1.5	35.1	46.8	1.1	0.1	0.0	0.5	0.1	9.7	0.0	0.0	0.0	0.7	0.0	0.0
Chia seeds	10	48.6	1.7	0.8	3.4	3.1	0.2	0.3	0.3	0.0	63.1	0.5	86.0	0.8	33.5	40.7	1.6	0.1	0.0	0.9	0.0	-	0.0	0.2	1.6	0.0	0.1	0.0
Total group mean		54.2	1.8	1.1	2.5	4.1	1.0	2.5	0.5	0.0	62.0	0.6	71.0	0.9	35.9	56.3	1.9	0.1	0.0	0.5	0.0	9.2	0.0	0.1	0.8	0.0	0.0	
SD		4.9	1.1	1.1	1.2	1.0	0.8	0.4	0.2	0.0	36.0	0.2	13.0	0.5	2.9	21.9	1.0	0.1	0.0	0.3	0.0	0.7	0.0	0.1	0.8	0.0	0.0	
Nut-seeds spreads																												
Tahini	10	59.5	1.7	1.2	0.9	5.4	2.0	2.4	0.8	0.0	42.6	0.5	73.2	0.9	9.5	41.4	11.5	0.1	0.0	0.5	0.0	9.8	0.0	0.0	0.3	0.0	0.0	0.0
Peanut cream	10	60.2	2.6	1.1	0.7	5.1	2.6	1.3	1.0	0.0	4.0	0.3	36.6	0.2	18.0	75.0	31.3	0.0	0.0	-	0.1	6.7	0.0	0.0	0.0	0.0	0.0	0.5
Almond cream	10	38.0	0.5	6.0	0.1	1.3	0.8	0.2	0.1	0.0	4.9	0.1	16.8	0.1	6.3	18.6	0.3	0.0	0.0	0.1	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.5
Chocolate paste with hazelnuts	10	54.4	0.5	5.6	0.1	3.3	1.7	0.5	1.0	0.6	7.4	0.1	15.2	0.1	7.2	28.8	9.4	0.0	0.0	-	0.0	2.2	0.0	0.0	1.8	0.0	1.2	
																												PFAs (g)
Total group mean		53.0	1.3	3.5	0.4	3.8	1.8	1.1	0.7	0.2	14.7	0.2	35.5	0.3	10.3	41.0	13.1	0.0	0.0	0.3	0.0	4.9	0.0	0.0	0.5	0.0	0.6	
SD		10.3	1.0	2.7	0.4	1.9	0.8	1.0	0.4	0.3	18.6	0.2	27.0	0.4	5.3	24.5	13.1	0.1	0.0	0.3	0.0	4.1	0.0	0.0	0.8	0.0	0.5	
Legumes																												
Adzuki bean	80	263.2	15.9	40.2	10.2	0.4	0.0	0.1	0.2	0.0	52.8	4.0	304.8	4.0	101.6	1,003.2	4.0	0.4	0.2	2.1	0.3	497.6	0.0	0.0	0.8	0.0	-	-
Soybean	80	280.0	28.7	7.8	12.6	14.9	2.8	7.3	1.8	0.0	192.0	3.4	528.0	7.8	200.0	1,384.0	4.0	0.5	0.2	1.8	0.3	296.0	0.0	0.0	1.6	0.0	2.3	
																												PFAs (g)
Mungo bean	80	272.8	20.2	32.6	14.6	1.3	0.0	0.0	0.0	110.4	2.7	303.2	6.1	213.6	786.4	30.4	0.4	0.2	1.2	0.2	1.2	172.8	0.0	0.0	0.8	0.0	-	
																												PFAs (g)
Lupin	60	239.4	21.7	24.2	11.3	5.8	2.4	1.5	0.7	105.6	2.9	264.0	2.6	118.8	607.8	9.0	0.4	0.1	1.3	0.2	335.0	0.0	2.9	4.1	0.0	-		
																											PFAs (g)	W-3
Total group mean		263.9	21.6	26.2	12.2	5.6	1.3	2.2	0.7	0.0	115.2	3.3	350.0	5.1	158.5	945.4	11.9	0.4	0.2	1.6	0.3	325.4	0.0	0.7	1.8	0.0	2.3	
SD		17.7	5.3	13.9	1.9	6.6	1.5	3.4	0.8	0.0	57.5	0.6	120.2	2.3	56.5	334.1	12.6	0.1	0.0	0.4	0.0	134.0	0.0	1.4	1.6	0.0	-	

(Continuation in next page)

Table 1 (Cont.). Nutrient content of selected vegan food portions

Meat analogs products	Portion (g)	E (kcal)	Pr (g)	HC (g)	Fib (g)	TL (g)	MFAs (g)	PFAs (g)	SFAs (g)	Ch (mg)	Ca (mg)	Zn (mg)	P (mg)	Fe (mg)	Mg (mg)	K (mg)	Na (mg)	B1 (mg)	B2 (mg)	B3 (mg)	B6 (mg)	B9 (µg)	B-12 (µg)	C (mg)	A-RAE (µg)	D (µg)	E (mg)	
Textured soy	30	100.2	14.8	6.3	4.5	0.7	0.1	0.3	0.1	0.0	73.2	1.5	210.3	4.1	91.8	147.0	0.9	0.2	0.3	0.8	0.7	90.9	0.0	0.0	0.0	0.6	0.0	0.0
Tempeh	60	115.8	11.1	5.6	-	6.5	1.8	2.3	1.3	0.0	66.6	0.7	159.6	1.6	48.6	247.2	5.4	0.0	0.2	-	0.1	14.4	0.0	0.0	0.0	0.0	0.0	14.4
Seitan	90	111.6	21.6	1.8	-	1.8	-	-	-	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vegetable burger	90	154.2	17.5	5.1	3.6	5.5	1.5	2.6	1.1	0.9	61.5	1.1	146.7	2.8	16.8	167.7	432.6	1.7	0.2	3.9	0.4	111.6	3.3	1.4	0.3	0.0	0.2	
Total group mean		120.5	16.3	4.7	4.1	3.6	1.1	1.7	0.8	0.2	67.1	1.1	172.2	2.8	52.4	187.3	146.3	0.6	0.2	2.4	0.4	72.3	1.1	0.5	0.3	0.0	4.9	
SD		23.4	4.4	2.0	0.6	2.8	0.9	1.3	0.6	0.5	5.9	0.4	33.6	1.3	37.6	52.9	248.0	0.9	0.1	2.2	0.3	51.2	1.9	0.8	0.3	0.0	8.3	
Vegetable oils	Portion (g)	E (kcal)	Pr (g)	HC (g)	Fib (g)	TL (g)	MFAs (g)	PFAs (g)	SFAs (g)	Ch (mg)	Ca (mg)	Zn (mg)	P (mg)	Fe (mg)	Mg (mg)	K (mg)	Na (mg)	B1 (mg)	B2 (mg)	B3 (mg)	B6 (mg)	B9 (µg)	B12 (µg)	C (mg)	A-RAE (µg)	D (µg)	E (mg)	
Flaxseed oil	10	88.8	0.0	0.0	0.0	10.0	2.0	6.6	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8
								5.3	1.4																			
Canola oil	10	88.4	0.0	0.0	0.0	10.0	6.3	2.8	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8
								0.9	1.9																			
Soy oil	10	89.9	0.0	0.0	0.0	10.0	2.1	5.9	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7
								0.3	5.6																			
Safflower oil	10	88.4	0.0	0.0	0.0	10.0	1.4	7.5	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4
								0.0	7.5																			
Walnut oil	10	88.6	0.0	0.0	0.0	10.0	1.7	6.9	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1
								1.1	5.8																			
Sesame oil	10	88.8	0.0	0.0	0.0	10.0	4.0	4.2	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
								0.0	4.2																			
Grape seed oil	10	88.4	0.0	0.0	0.0	10.0	1.6	6.7	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9
								0.0	6.7																			
Total group mean		88.8	0.0	0.0	0.0	10.0	2.7	5.8	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9
SD		0.5	0.0	0.0	0.0	0.0	1.8	1.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Sea vegetables	Portion (g)	E (kcal)	Pr (g)	HC (g)	Fib (g)	TL (g)	MFAs (g)	PFAs (g)	SFAs (g)	Ch (mg)	Ca (mg)	Zn (mg)	P (mg)	Fe (mg)	Mg (mg)	K (mg)	Na (mg)	B1 (mg)	B2 (mg)	B3 (mg)	B6 (mg)	B9 (µg)	B12 (µg)	C (mg)	A-RAE (µg)	D (µg)	E (mg)	
Nori	50	17.5	2.9	2.6	0.2	0.1	0.0	0.1	0.0	0.0	35.0	0.5	29.0	0.9	1.0	178.0	24.0	0.0	0.2	0.7	0.1	73.0	0.0	19.5	130.0	0.0	0.5	
Espirulina	50	13.0	3.0	1.2	0.2	0.2	0.0	0.1	0.1	0.0	6.0	0.1	5.5	1.4	9.5	63.5	49.0	0.1	0.2	0.6	0.0	4.5	0.0	0.5	1.5	0.0	0.2	
Wakame	50	22.5	1.5	4.3	0.3	0.3	0.0	0.1	0.1	0.0	75.0	0.2	40.0	1.1	53.5	25.0	436.0	0.0	0.1	0.8	0.0	98.0	0.0	1.5	9.0	0.0	0.5	
Irishmoss	50	24.5	0.8	6.1	0.7	0.1	0.0	0.0	0.0	0.0	36.0	1.0	78.5	4.5	72.0	31.5	33.5	0.0	0.2	0.3	0.0	91.0	0.0	1.5	3.0	0.0	0.4	
Kombu	50	21.5	0.8	4.8	0.7	0.3	0.0	0.0	0.1	0.0	84.0	0.6	21.0	1.4	60.5	44.5	116.5	0.0	0.1	0.2	0.0	90.0	0.0	1.5	3.0	0.0	0.4	
Total group mean		19.8	1.8	3.8	0.4	0.2	0.0	0.1	0.1	0.0	47.2	0.5	34.8	1.9	39.3	68.5	131.8	0.0	0.2	0.5	0.0	71.3	0.0	4.9	29.3	0.0	0.4	
SD		4.6	1.1	1.9	0.2	0.1	0.0	0.0	0.0	0.0	32.0	0.4	27.5	1.5	31.9	63.0	173.9	0.0	0.1	0.3	0.0	38.5	0.0	8.2	56.4	0.0	0.1	
Miscellaneous	Portion (g)	E (kcal)	Pr (g)	HC (g)	Fib (g)	TL (g)	MFAs (g)	PFAs (g)	SFAs (g)	Ch (mg)	Ca (mg)	Zn (mg)	P (mg)	Fe (mg)	Mg (mg)	K (mg)	Na (mg)	B1 (mg)	B2 (mg)	B3 (mg)	B6 (mg)	B9 (µg)	B12 (µg)	C (mg)	A-RAE (µg)	D (µg)	E (mg)	
Beer yeast	5	13.5	2.6	1.7	1.1	0.3	-	-	-	-	4.0	0.5	65.0	0.2	11.0	105.0	0.5	0.6	0.2	2.5	0.1	0.1	0.0	-	-	-	-	
Wheat germ	10	33.7	2.5	3.3	1.6	1.1	0.1	0.5	0.2	0.0	5.5	1.7	97.1	0.8	25.0	87.1	0.9	0.2	1.0	1.0	0.2	35.0	0.0	0.0	0.0	0.0	2.1	
Miso	15	31.4	1.8	4.0	0.8	0.9	0.2	0.5	0.2	0.0	8.6	0.4	23.9	0.4	7.2	31.5	559.2	0.0	0.0	0.1	0.0	-	0.0	0.0	3.9	-	0.0	
Total group mean		26.2	2.3	3.0	1.2	0.8	0.2	0.5	0.2	0.0	6.0	0.9	62.0	0.4	14.4	74.5	186.9	0.3	0.1	1.2	0.1	17.5	0.0	0.0	2.0	0.0	1.1	
SD		11.0	0.5	1.2	0.4	0.4	0.0	0.0	0.0	0.0	2.3	0.7	36.7	0.3	9.4	38.3	322.5	0.3	0.1	1.2	0.1	24.7	0.0	0.0	2.8	-	1.5	

E: Energy; Pr: Protein; HC: Carbohydrates; Fib: Fiber; TL: Triglyceride; MFAs: monounsaturated fatty acids; PFAs: Polyunsaturated fatty acids; SFAs: Saturated fatty acids; Ch: Cholesterol.

Table II. Comparison of vitamins and minerals content of vegan food portions to European dietary reference nutrient intake (RNI) values for adult population (18)

Dairy analogs	Portion (g)	Ca (% RNI)	Zn (% RNI)	P (% RNI)	Fe (% RNI)	Mg (% RNI)	K (% RNI)	Na (% RNI)	B1 (% RNI)	B2 (% RNI)	B3 (% RNI)	B6 (% RNI)	B9 (% RNI)	B12 (% RNI)	C (% RNI)	A-PAE (% RNI)	D (% RNI)	E (% RNI)	
Soy products																			
Soy milk	200	25.0	7.8	13.4	11.4	14.9	19.1	0.3	21.8	60.0	11.0	8.6	1.0	0.0	0.0	0.5	0.0	0.0	12.3
Soy yogurt	125	18.9	7.4	17.0	0.4	4.0	9.7	2.4	3.4	12.7	0.6	2.9	4.4	0.0	0.8	4.6	5.0	0.0	0.0
Flavor soy shake	200	25.0	4.0	13.4	5.7	8.0	12.0	2.7	12.7	4.3	1.3	10.0	19.0	0.0	1.2	0.0	0.0	0.0	12.3
Tofu	60	15.0	4.2	16.3	7.3	11.2	5.4	0.2	3.3	1.3	0.4	4.3	4.5	0.0	0.0	0.0	0.0	0.0	5.0
Soy cheese	40	9.4	6.9	12.7	16.0	24.3	4.0	0.3	0.0	4.0	1.3	2.0	4.4	0.0	0.0	0.1	0.0	0.0	2.0
Mean	-	18.6	6.1	14.6	8.2	12.5	10.0	1.2	8.2	16.5	2.9	5.5	6.7	0.0	0.4	1.1	1.0	0.0	6.3
Vegetable beverages																			
Oat drink	200	30.0	10.0	12.3	8.6	7.2	4.1	3.3	9.1	28.6	5.0	0.0	4.6	32.0	0.0	0.0	30.0	0.0	3.3
Rice drink	200	29.5	3.0	16.0	2.9	5.9	2.7	3.3	9.1	21.4	5.0	7.1	2.0	52.0	0.0	15.8	40.0	0.0	7.5
Tiger nut drink	200	7.3	20.0	7.4	17.1	8.0	5.2	0.8	3.6	0.0	1.6	0.0	1.0	0.0	0.1	0.0	0.0	0.0	0.0
Almond drink	200	47.0	13.0	5.4	7.9	6.4	7.5	5.9	0.0	28.6	1.3	0.0	0.0	100.0	11.0	15.8	40.0	0.0	46.7
Vegetal cream	25	0.3	0.0	2.3	0.0	0.0	2.4	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7
Mean	-	22.8	9.2	8.7	7.3	5.5	4.4	2.8	4.4	15.7	2.6	1.4	1.5	36.8	2.2	6.3	22.0	0.0	11.8
Total group mean	-	18.3	7.6	11.6	7.7	9.0	7.2	2.0	6.3	16.1	2.7	3.5	4.1	18.4	1.3	3.7	11.5	0.0	9.1
Seeds																			
Flax seeds	10	3.2	4.3	9.2	4.1	10.5	4.1	0.1	14.9	1.1	1.9	3.4	4.4	0.0	0.1	0.0	0.0	0.0	0.3
Sesame seeds	10	12.2	7.8	9.0	10.4	9.4	2.3	0.0	7.2	1.8	2.8	5.6	4.9	0.0	0.0	0.1	0.0	0.0	0.2
Chia seeds	10	7.9	4.6	12.3	5.5	8.9	2.0	0.1	5.6	1.2	5.5	0.0	-	0.0	0.2	0.2	0.0	0.0	0.4
Total group mean	-	7.8	5.6	10.1	6.7	9.6	2.8	0.1	9.2	1.4	3.4	3.0	4.6	0.0	0.1	0.1	0.0	0.0	0.3
Nuts-seeds spreads																			
Tahini	10	5.3	4.6	10.5	6.4	2.5	2.1	0.5	11.1	3.4	3.4	1.1	4.9	0.0	0.0	0.0	0.0	0.0	0.2
Peanut cream	10	0.5	3.0	5.2	1.4	4.8	3.8	1.3	1.4	0.7	-	3.6	3.4	0.0	0.0	0.0	0.0	0.0	4.2
Almond cream	10	0.6	0.7	2.4	0.6	1.7	0.9	0.0	0.5	0.7	0.7	0.1	0.4	0.0	0.0	0.0	0.0	0.0	4.3
Chocolate paste with hazelnuts	10	0.9	1.0	2.2	0.8	1.9	1.4	0.4	1.0	0.9	-	0.4	1.1	0.3	0.0	0.2	0.0	0.0	10.3
Total group mean	-	1.8	2.3	5.1	2.3	2.7	2.0	0.5	3.5	1.4	2.1	1.3	2.4	0.1	0.0	0.1	0.0	0.0	4.7

(Continuation in next page)

Table II (Cont.). Comparison of vitamins and minerals content of vegan food portions to European dietary reference nutrient intake (RNI) values for adult population (18)

Legumes	Portion (g)	Ca (% RNI)	Zn (% RNI)	P (% RNI)	Fe (% RNI)	Mg (% RNI)	K (% RNI)	Na (% RNI)	B1 (% RNI)	B2 (% RNI)	B3 (% RNI)	B6 (% RNI)	B9 (% RNI)	B12 (% RNI)	C (% RNI)	A-PAE (% RNI)	D (% RNI)	E (% RNI)
Azuki bean	80	6.6	40.3	43.5	28.5	27.1	50.2	0.2	33.1	12.6	13.2	20.1	248.8	0.0	0.0	0.1	0.0	-
Soybean	80	24.0	34.4	75.4	55.4	53.3	69.2	0.2	44.4	15.4	11.0	21.7	148.0	0.0	0.0	0.2	0.0	19.3
Mungo bean	80	13.8	26.8	43.3	43.3	57.0	39.3	1.3	19.9	14.5	7.2	16.1	86.4	0.0	0.0	0.1	0.0	-
Lupin	80	13.2	28.5	37.7	18.7	31.7	30.4	0.4	34.9	9.4	8.2	15.4	167.5	0.0	3.6	0.5	0.0	-
Total group mean		14.4	32.5	50.0	36.5	42.3	47.3	0.5	33.1	13.0	9.9	18.3	162.7	0.0	0.9	0.2	0.0	19.3
<i>Meat analogs products</i>																		
Textured soy	30	9.2	15.0	30.0	29.3	24.5	7.4	0.04	18.0	21.4	5.0	50	45.5	0.0	0.0	0.0	0.0	0.0
Tempeth	60	8.3	6.8	22.8	11.6	13.0	12.4	0.2	4.3	15.3	-	9.2	7.2	1.9	0.0	0.0	0.0	120.0
Seitan	90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vegetable burger	90	7.7	11.0	21.0	19.7	4.5	8.4	18.0	154.1	16.8	24.5	27.9	55.8	130.9	1.7	0.0	0.0	1.7
Total group mean		8.4	11.0	24.6	20.0	14.0	9.4	6.1	54.5	7.14	15.0	14.3	36.2	44.3	0.6	0.0	0.0	40.6
<i>Vegetable oils</i>																		
Flaxseed oil	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7
Canola oil	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7
Soy oil	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
Safflower oil	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7
Walnut oil	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
Sesame oil	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
Grape seed oil	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4
Total group mean		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
<i>Sea vegetables</i>																		
Nori	50	4.4	5.3	4.1	6.4	0.3	8.9	1.0	4.5	15.9	4.6	5.7	36.5	0.0	24.4	16.3	0.0	4.2
Espirulina	50	0.8	1.0	0.8	10.0	2.5	3.2	2.0	10.1	12.2	3.7	1.2	2.3	0.0	0.6	0.2	0.0	2.0
Wakame	50	9.4	1.9	5.7	7.8	14.3	1.3	18.2	2.7	8.2	5.0	0.1	49.0	0.0	1.9	1.1	0.0	4.2
Irishmoss	50	4.5	9.8	11.2	31.8	19.2	1.6	1.4	0.7	16.6	1.9	2.5	45.5	0.0	1.9	0.4	0.0	3.6
Kombu	50	10.5	6.2	3.0	10.2	16.1	2.2	4.9	2.3	5.4	1.5	0.1	45.0	0.0	1.9	0.4	0.0	3.6
Total group mean		5.9	4.8	5.0	13.2	10.5	3.4	5.5	4.0	11.7	3.3	1.9	35.7	0.0	6.1	3.7	0.0	3.5
<i>Miscellaneous</i>																		
Beer yeast	5	0.5	5.0	9.3	1.1	2.9	5.3	0.0	54.5	14.3	15.6	10.0	0.0	0.0	-	-	-	-
Wheat germ	10	0.7	17.0	13.9	5.4	6.7	4.4	0.0	18.2	4.3	6.1	15.7	17.5	0.0	0.0	0.0	0.0	17.5
Miso	15	1.1	3.8	3.4	2.7	1.9	1.6	23.3	1.4	2.5	0.9	2.1	-	0.5	0.0	0.5	-	0.0
Total group mean		0.8	8.6	6.7	3.1	3.8	2.8	7.8	24.7	7.0	7.5	9.3	8.8	0.2	0.0	0.2	0.0	8.8

As almonds are a primary source of calcium, almond milk was the beverage with the most content of calcium. A serving size (200 g, 1 glass) provided 47.0% of RNI. Based on these data, dairy analog portions could be considered as sources of calcium, as they provided more to 15% RNI (19), in spite of the changing fortification market. Phosphorus (81.4 mg) was another important mineral in portions of dairy analogs, with 11.6% of RNI. Variation between products was observed. It emphasized portions of soy products with contents from 13.4 to 17.0% of RNI.

Based on our data, these dairy analogs could be considered to be a good alternative to milk and dairy products due to the similar mineral composition of serving, but it is important to consider calcium absorption in these enriched foods. Commercial calcium salts, such as calcium carbonate and citrate are the most common ways of calcium fortification in vegetable milks (and the most studied ones), showing good bioavailability of calcium, similar to that of dairy products (20,21).

In relation to vitamins, it was necessary to look at the different levels of drink fortification. Portions of many types of vegetable beverages were a good source of riboflavin (15.7% of the RNI), but this content was not relevant in other products. It emphasized the high vitamin B12 content of a portion of some enriched vegetable beverages, as they could provide all the dairy requirements in vitamin B12 (32-100% of the RNI). Data regarding soy products included in this study did not show vitamin B12 content, although there are other B12 fortified soy products. In this sense, enriched vegetable beverages are one of the reliable regular sources of vitamin B12, especially for vegans (5,8). In relation to other relevant nutrients to calcium metabolism in vegetarians, some vegetable beverages presented an important enrichment in vitamin D, with a mean portion content of 22% of RNI (SD = \pm 11.5). For its part, almond drink was a natural source of vitamin E, a portion of this beverage covering almost half of the requirements (46.7% of RNI).

Taking into account that EU reference protein intake for adults is 50 g *per* day (18), portions of vegetable beverages only contained 3% of the RNI in relation to this nutrient. These levels are higher in soy products, covering 13.5% of adult requirements. In this sense, a 200 g portion of soy milk could provide more protein than the same amount of other vegetable beverages. This fact should be taken into account in dietary guidelines.

SEEDS

It is well known that calcium requirements could be met by consuming other vegetal foods such as seeds, despite the fact that dairy analogs are considered as an important source of calcium in vegan diets. Although seeds present lower calcium bioavailability (22), they are naturally high in calcium, with 6 times more calcium *per* 100 g than that found in the enriched dairy analogs group. Nevertheless, when seeds' calcium content was considered using a common serving size (10 g, 1 tablespoon), it was observed that seeds contained a mean of 62.0 mg of calcium, covering 7.8% of adult requirements (18). In this sense, it would be necessary to consume 20 to 30 g (2 or 3 tablespoons) of seeds

in order to reach the calcium content of a dairy food serving. In addition, this amount of seeds (20-30 g) would also provide iron and zinc, two minerals of great importance in vegan diets, with a mean content up to 15% of RNI in both cases. Furthermore, a significant amount of phosphorus and vitamin B1 would be found (20.2% and 18.4% of RNI, respectively). These data concluded that a daily intake of 2 or 3 tablespoons of seeds could be an important component in vegan diets in terms of mineral content. However, some points should be considered to improve its availability. Processing of seeds can change their nutritional value. Calcium level increases when hulls of sesame seeds are conserved (23,24), however, the form of calcium in the hulls is less absorbable, due to the presence of phytate, a mineral storage compound (25). In this sense, it is desirable to choose whole seeds and to apply a treatment to reduce the phytate content in them. Roasted or milled seeds should be considered in dietary counseling (24). Also, some food preparation techniques such as soaking and sprouting seeds may also improve iron and zinc bioavailability (26).

The Spanish adult mean adequate intake of fiber is 28 g *per* day (27). Based on this value, a portion of seeds provided high fiber content (2.5 g), covering 8.8% of daily fiber requirements in a 10 g serving. These data are comparable to other common vegetables that provide about 2 to 6 g of fiber when a portion of 200 g is consumed (15).

Seeds contain many essential fatty acids, which add to their efficacy as part of a balanced diet. Based on an indicated portion weight (10 g), seeds contained 4.1 g of lipids, made up mainly of polyunsaturated fatty acids (PFAs) (2.5 g) in the form of omega-3, for flax seeds (2.3 g) and chia seeds (1.8 g), and omega-6 for sesame seeds (2.2 g). Both omega-3 and omega-6 fatty acids are essential and they must be consumed in the diet. Because omega-6 acid is widely available in vegetal foods, vegans usually have higher intakes of omega-6 acid compared with omega-3 acid (28). According to the Spanish RNI, a 10 g (1 tablespoon) portion of seeds, such as flax or chia seeds, provided up to 100% of the omega-3 requirements, representing an important contribution of seeds to the diet.

NUT-SEED SPREADS

Some portions of seeds were found to be good sources of essential fatty acids, iron, zinc, phosphorous and vitamin B1 and E. Nevertheless, when they are made into spread, nutritional values differ. Mean data showed that nut-seed spreads servings did not contribute significant amounts of any nutrients (< 15% of RNI). In particular, it is remarkable that a 10 g portion of tahini, a spreadable paste made from sesame seeds, contained similar amount of omega-6 fatty acids (17.5% of RNI), phosphorous (10.5% of RNI) and vitamin B1 (11.1% RNI) as the same amount of sesame seeds, but a lower calcium content (5.3% *versus* 12.2% of RNI). Although tahini, usually made from hulled seeds, contains lower amounts of calcium, it is more easily digested due to the milling process (29). In this sense, nutritional values of both servings are comparable.

LEGUMES

Like other types of legumes, consumed portions of common vegan legumes, such as soy, adzuki or mungo bean, could be considered as sources of protein (21.6 g, 43.2% of RNI) and dietary fiber (12.2 g, 43.4%). Protein content in legumes is similar and even higher than that of meat (18-25%). Although the protein digestibility-corrected amino acid score varies between legumes, they have a higher protein quality compared with other vegetal foods such as cereals (30). In this sense, a serving of legumes could be used by vegans as an alternative to servings of meat or fish after the reduction of antinutritional factors. Dehulling, soaking or cooking improve their nutritional value (13,29).

An important difference was found between lipid content; a soybean portion (80 g) contained higher amount of lipids (14.9 g) than that reported for other common legumes, made up mainly of PFAs (7.3 g; 0.84 g omega-3 acid and 6.4 g omega-6 acid *per* serving). It is important to note that a portion of soybean provides more than half of the Spanish adult recommendations for omega-3 (62.2% of RNI) (27), a restricted nutrient in vegan diets. In relation to other important nutrients, a portion of these legumes was considered as a source of calcium (14.4% of RNI), iron (36.5% of RNI) and zinc (32.5% of RNI). Although antinutritional substances reduce mineral bioavailability, they are sensitive to the cooking process (32).

MEAT ANALOG PRODUCTS

Meat analogs are defined as foods which are structurally similar to meat but differ in nutrient composition (32). Vegans choose them in order to accomplish the satisfaction of meat consumption as well as to provide nutrition and health. In these sense, it is necessary to analyze the nutritional value of the meat substitutes serving.

Protein was the major macronutrient in portions of meat analogs, ranging from 11.1 to 21.6 g *per* portion and providing 32.6% of protein requirements in an adult. In this way, a portion of these products could serve as a replacement of animal protein. Although some antinutritional factors present in soybeans and wheat grains could hamper the utilization of these proteins, processing methods to obtain common meat substitutes (fermentation, soaking or cooking of soybeans or grains) remove or inactivate them (11,33).

Meat analog portions could be considered as similar to meat in relation to other minor nutrients. They provided significant amounts of phosphorous and iron covering up to 15% of RNI. Although the chemical form of iron is an important factor affecting iron availability of vegetarian diets, there is no risk of iron deficiency because these diets are typically rich in vitamin C, the most significant enhancer of non-haem iron absorption (34). In relation to vitamins, a mean portion of these products provided an important source of vitamins of the B group, particularly B1 (54.4% of RNI), B12 (44.3% of RNI) and B9 (36.2% of RNI), and vitamin E (40.6% of RNI). The other components showed values lower than 15% in all cases.

VEGETABLE OILS

PFAs are the main constituents of vegetable oils *per* serving portion (6.3 g), mainly in the form of omega-3 fatty acids, for flaxseed oils (5.3 g), and omega-6 for canola (1.9 g), soy (5.6 g), safflower (7.5 g), walnut (5.8 g), sesame (4.2 g) and grape seed (6.7 g) oils. In terms of omega-3, a relevant nutrient in vegan diets, according to the Spanish RNI (39), a 10 g (1 tablespoon) portion of canola or walnut oils provides 66 and 82% of the omega-3 dairy requirements, respectively. The same amount of flaxseed oil provides nearly 400% of Spanish RNI. In dietary guidelines, it would be necessary to note the differences between the amounts of each vegetable oil that would be necessary to meet the RNI of omega-3 acid, for example, 2.5 g (half a teaspoon) of flaxseed oil, 15 g (1^{1/2} tablespoon) of canola oil or 12 g (1^{1/4} tablespoon) of walnut oil.

SEA VEGETABLES

Seaweeds present a high content in minerals due to their marine habitat, and the diversity of minerals they absorb is wide. They have been described as an ideal food-safe natural source of minerals such as calcium, iron, potassium or magnesium (35), although the nutritional value is lower when a 50 g portion of wet weight is considered. Mean data showed that a seaweeds serving portion did not contribute significant amounts of any minerals (< 15% of RNI), although a mean serving represented a source of vitamin B9 (35.7% of RNI). These data show that there should not be a particular nutritional reason to recommend the consumption of seaweeds beyond their culinary taste.

MISCELLANEOUS

These foods are used in vegan diets as dietary supplements. Data on nutritional composition *per* 100 g showed variable amounts of vitamins of the B group, such as B1, B2, B6 and B9, and minerals such as calcium, phosphorous, magnesium, and potassium. It is important to highlight the vitamin E and sodium content of 100 g of wheat germ and miso, respectively.

Although these dietary supplements are foods of high nutritional value *per* 100 g, data differ when common serving sizes are considered. A 5 g portion of beer yeast (1 teaspoon) only provided significant amount of vitamins B1 (54.5% of RNI) and B3 (15.6% of RNI). A wheat germ portion (10 g, 1 tablespoon) could be considered as a source of zinc (17% of RNI), vitamin B1 (18.2% of RNI), B6 (15.7% of RNI), B9 (17.5% of RNI) and E (17.5% of RNI). Other micronutrients were found at low concentrations.

For its part, a miso serving portion (15 g, 1 tablespoon) could be considered as a high-sodium food, since it contained 559.2 g of sodium (23.3% of RNI), it should be careful and restricting the ingestion.

CONCLUSIONS

Nutritional data per serving portion of common vegan foods have been identified. These data provided information about nutritional composition in comparison to the Dietary Reference Intakes (DRIs) for a healthy adult. Some aspects about bioavailability of the relevant nutrients are pointed, and alternatives are proposed. This information could be useful to improve dietary advice and food choices for a healthy vegetarian diet of an adult, and contribute to improve dietetic practice with vegetarian adult population.

The authors note that this information is focused on healthy adult population; pediatric stage is not included.

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