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Vegan diet: Reaching the reference values for nutrient intake of critical nutrients

Assortment and necessity of fortified foods

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Abstract

In a vegan diet, the supply of certain nutrients must be regarded as critical. These include vitamin B_{12}, iron, calcium and iodine. The objective of this research was to examine whether people on a vegan diet could reach the reference values for daily nutrient intake in Germany, Austria and Switzerland (known as the D-A-CH reference values of nutrient intake) through the consumption of natural or fortified foods and the extent to which fortified foods suitable for this group are available on the market. A random survey of food retailers in the region of the city of Bonn revealed that a variety of vegan foods fortified with vitamin B_{12} and calcium were available. In contrast, only a few vegan products fortified with iron were available at the time; the survey found no foods fortified with iodine.

Analysis revealed that the D-A-CH reference values of intake for calcium and iron could be reached solely through natural foods. Vegans are advised to take a vitamin B_{12} supplement, as the bioavailability of vitamin B_{12} from plant-based foods is not definitively established. Reference values for iodine intake could be met through targeted fortification of milk substitutes such as plant-based drinks and yoghurt alternatives as well as the use of iodized salt in the manufacture of vegan foods and baked goods.

Keywords: vegan diet, fortified foods, critical nutrients, iodine, vitamin B_{12}, iron, calcium

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Introduction

The number of vegans in Germany has increased in recent years. Approximately 900,000 people follow a vegan diet today in Germany, i.e. approximately 1.1% of the population [1, 2]. Vegans exclusively consume foods and ingredients derived from plants and reject all animal-based products, including honey [3]. This can lead to deficiencies in nutrients which are found primarily in animal foods.

A critical nutrient is, by definition, a nutrient whose intake does not reach the reference value of nutrient intake within a certain group of the population. Vitamin B_{12}, calcium, iron and iodine in particular are potentially critical for vegans [4, 5]. Essential amino acids, long-chain omega-3 fatty acids, vitamin B_2, vitamin D, zinc and selenium may also be regarded as critical nutrients for vegans; however, deficiency symptoms are rarely observed for these nutrients. The data currently available is insufficient to provide a conclusive evaluation of nutrient supply among vegans in Germany [5].

The growing number of vegetarians and vegans in the population has resulted in a rapid increase in the quantity of vegan foods available on the market, especially in the convenience food sector. These are often fortified with various vitamins and minerals.

Question

This study addressed the following questions:

- To what extent does the food market accommodate the particular needs of vegans, in relation to nutrient supply, by means of fortified and processed foods?
- Can fortified products contribute to the supply of (critical) nutrients or does a good combination of natural foods suffice to reach the reference values of nutrient intake?
- Is there reason to fear overconsumption of nutrients as a result of the fortification of foods?

Methodology

To begin with, the study recorded the fortified vegan foods available in food retailers during the period from March to April 2015. The availability of relevant products was checked in one branch of each retail chain found in the center of the city of Bonn and its surrounding area – a total of 14 stores. In addition to general food retailers, the survey also looked at discount stores, organic supermarkets, a food section in a department store, a drugstore and a health food store. Many of these stores sold own brands (mainly soy drinks and fruit juices) in addition to well-known brand products. The criteria for food selection were as follows:

1.) Availability for the consumers, i.e. only those varieties of a product or products of a firm which were offered for sale in at least one of the observed branches at the time of the survey.
2.) Suitability for a vegan diet, i.e. free from animal ingredients according to the list of ingredients.[1]
3.) Fortification with at least one of the above-mentioned critical nutrients (vitamin B_{12}, iron, calcium, iodine), i.e. explicit inclusion in the list of ingredients as an added nutrient, **or**
4.) natural foods which contain the critical nutrient in a relevant quantity, i.e. > 15% of the reference value per portion (according to EU Directive 1169/2011 [6]), and/or which are ideally frequently consumed as part of a vegan diet [7].

Energy drinks and specially marketed "vitamin waters" were not taken into account.

These food lists are not exhaustive, as the range of products available is continually expanding and the varieties also change from time to time. These tables offer only an initial attempt at a list of product groups which were fortified in 2015 and an illustration of the extent to which these could be useful as part of the nutrient intake for vegans.

Data for healthy male and female adults aged from 25 to 50 was used as the basis for the evaluation as to whether the D-A-CH reference values for the intake of the selected critical nutrients could be reached. The study listed the available fortified foods and natural foods and calculated the theoretical quantities of each food required to meet the D-A-CH reference values of nutri-

[1] The product label did not need to include one of the vegan logos or labels.

food group	variety	vitamin B_{12} (µg/100 g or 100 mL)	% of reference value[a]		quantity required to meet reference value (g or mL)
			pro 100 g or 100 mL	per portion	
fortified foods					
cereals	3	1.40–4.20	46.7–140.0	14–42 [30 g]	71.4–214.3
desserts	8	0.38	12.7	15.8 [125 g]	789.5
meat alternatives	1	0.38	12.7	15.8 [125 g]	789.5
fruit juices	22	0.38–1.25	12.7–41.7	25.3–83.3 [200 mL]	240.0–789.5
yoghurt alternatives (e.g. soy-based)	9	0.38	12.7	15.8 [125 g]	789.5
plant-based drinks (e.g. soy drinks)	14	0.38	12.7	25.3 [200 mL]	789.5
sweets[b]	8	1.5–7.0	50.0–233.0	8.9–14.2 [var.]	43.0–200.0
natural foods					
nori seaweed[c]		77.6	2586.7	77.6 [3 g]	3.9
shiitake mushrooms[c]		1.3–12.7	43.3–423.3	86.7–846.7 [200 g]	23.6–230.8

Tab. 1: **Vegan foods containing vitamin B_{12} with information on quantities in µg per 100 g or 100 mL, percentages of the reference values of nutrient intake and quantities theoretically required to meet the reference values of nutrient intake**
[a] 3.0 µg/day (DGE et al. 2015 [9])
[b] Instant drink powders, biscuits, multi-vitamin sweets and chewy sweets
[c] Watanabe et al. 2014 [10]

food group	variety	calcium (mg/100 g or 100 mL)	% of reference value[a]		quantity required to meet reference value (g or mL)
			per 100 g or 100 mL	per portion	
fortified foods					
cereals	4	478–619	47.8–61.9	14.3–18.6 [30 g]	161.6–209.2
desserts	8	120	12	15 [125 g]	833
fruit juices	2	120	12	24 [200 mL]	833
yoghurt alternatives	9	120	12	15 [125 mL]	833
plant-based drinks (conventional products)	15	120	12	24 [200 mL]	833
plant-based drinks (EU-Eco-Regulation)	18	120	12	24 [200 mL]	833
natural foods					
pseudocereals					
amaranth[b]		214	21.4	2.6 [12 g]	467.3
chia seeds[c]		631	63.1	6.3 [10 g]	158.5
vegetables					
broccoli, cooked[b]		87	8.7	13.1 [150 g]	1,149.4
kale, cooked[b]		117	11.7	17.6 [150 g]	854.7
rocket, raw[b]		160	16.0	24 [150 g]	625.0
spinach, raw[b]		117	11.7	17.6 [150 g]	854.7
pulses					
beans, white, ripe, cooked[b]		73.3	7.3	4.4 [60 g]	1,364.3
chickpeas, ripe, cooked[b]		81.7	8.2	4,9 [60 g]	1,224.0
soy beans, ripe, cooked[b]		130	13.0	7.8 [60 g]	769.2
mineral water[d]					
Contrex		46.8	4.7	9.4 [200 mL]	2,136.8
Gerolsteiner		34.7	3.5	6.9 [200 mL]	2,881.8
Rewe Beste Wahl		50.0	5.0	10.0 [200 mL]	2 000
Rosbacher		20.9	2.1	4.2 [200 mL]	4,784.7
San Pellegrino		17.8	1.8	3.6 [200 mL]	5,618
Steinsieker		62.0	6.2	12.4 [200 mL]	1,612.9
nuts					
hazelnuts, raw[b]		149	14.9	4.5 [30 g]	671.1
almonds, raw[b]		85	8.5	2.6 [30 g]	1,176.5
Brazil nuts[b]		161	16.1	4.8 [30 g]	621.1
fruit					
apricot, dried[b]		82	8.2	2.1 [25 g]	1,219.5
fig, dried[b]		193	19.3	4.8 [25 g]	518.1

Tab. 2: **Vegan foods containing calcium with information on quantities in mg per 100 g or 100 mL, percentages of the reference values of nutrient intake and quantities theoretically required to meet the reference values of nutrient intake**
[a] 1,000 mg/d (DGE et al. 2015 [9])
[b] BLS [11]
[c] Bechthold 2015 [12]
[d] Refers to a selection of brands.

ent intake in full, as an illustration of the ranges of required quantities within one food group. The percentage of the reference value per portion and per 100 g or 100 mL was also noted (portion sizes according to DGExpert software [8]).

Results

Vitamin B_{12}

The study revealed that many different types of products (n = 65, ◆ Table 1) are fortified with vitamin B_{12}. However, the quantities added vary considerably from product to product, particularly among sweet goods, which, based on the varying portion sizes (e.g. 5 g for candy, 40 g for cookies), exhibit the greatest variations in terms of fortification. The quantity added is also generally very small, so significant quantities of the food would have to be consumed to reach the reference value of nutrient intake.

Vitamin B_{12} is often only present in natural foods in traces, which exist on the surface by way of contaminants. In nature, this vitamin is exclusively produced by microorganisms and is therefore primarily contained in those plant-based foods which are subjected to bacterial fermentation, e.g. beer or sauerkraut [9]. However, the quantities contained in these foods are small and probably exist in a non-bioavailable form, so that they are not able to meet the recommended intake of 3.0 µg/day [4].

A potentially biologically active form of vitamin B_{12} may exist in e.g. nori seaweed (77.6 µg/100 g, i.e. an intake of 3.9 g of seaweed would be sufficient to meet the reference value) and shiitake mushrooms (in which however the quantities vary widely). The vitamin B_{12} content varied from approx. 1.3–12.7 µg/100 g [10]. According to *in vitro* studies, quantities of 24–231 g of mushrooms would need to be consumed to reach the reference value for vitamin B_{12}. However, this data has still not been confirmed by human studies and is therefore not reliable.

Calcium

Calcium is added to all fortified milk substitutes (such as drinks, yoghurt alternatives and desserts) at a quantity of 120 mg per 100 g or per 100 mL. This quantity imitates the quantity of calcium found in milk. Products which are produced in accordance with the EU Directive for Organic Food always contain calcium additives in the form of *Lithothamnium calcareum*, a marine seaweed. As can be deduced from ◆ Table 2, juices and cereals are also fortified with calcium.

In addition to the foods listed, some herbs used for flavoring in everyday cooking also contain high quantities of calcium (≥ 150 mg/100 g); however, these are less important owing to the very small portion sizes; the same applies to seeds (e.g. sesame). Many mineral waters contain large quantities of minerals; however, the content varies considerably between different bottlers and/or sources. ◆ Table 2 lists some of the mineral waters which were available for purchase in at least one of the observed branches.

Iron

There is a limited range of vegan products which are fortified with iron. Only a few meat alternatives are fortified with iron. Many of the products fortified with iron contain elements of animal origin and therefore could not be included in this study. The type of iron compound is not declared on most products, although this plays a decisive role in absorption and bioavailability; trivalent iron must first be reduced to divalent iron (Fe^{2+}) to improve bioavailability. Breakfast cereals in particular contain added iron, which can make a significant contribution to the daily requirement in a portion size of 30 g (◆ Table 3).

A large number of plant-based foods are available for vegans as a natural source of iron – grains, fruits, vegetables and pulses, as well as processed foods such as tofu and soy "meat" and various herbs which are not listed owing to the generally small portion sizes (see calcium). The poorer bioavailability of trivalent iron should also be taken into account here.

Iodine

None of the products studied were fortified with iodine. Many vegan meat substitutes contain sea salt, whose iodine content corresponds to non-iodized table salt [14].

Iodized table salt which is suitable for a vegan diet contains between 15 and 25 µg iodine per gram. This substance was not used in any of the studied products marketed and particularly promoted for vegans at the time of the survey.

To consume the recommended amount of iodine solely through iodized table salt would require an intake of between 8 and 13.3 g of iodized table salt per day depending on the quantity added. At an average fortification of 20 µg iodine/g, 10 g of iodized salt would be required. In Germany, natural foods such as fruit and vegetables contain no more than 20 µg iodine/100 g as a result of iodine-deficient soils; this value tends to be relatively overestimated, applies to only a few foods and exhibits significant natural variations.

High quantities of iodine are present naturally in certain seaweeds such as arame, kombu, wakame and hijiki [15]. However, the iodine content can vary considerably, e.g. values of 980 to 5,640 µg/g are found in arame (*Eisenia bicyclis*), i.e. a percentage of the recommended intake of 1,470 to 8,460% per

portion (3 g) [15]). In contrast, nori (here: dulse *Porphyra tenera*) contains on average 16 µg/g, i.e. 24% of the recommended intake of iodine (200 µg/day [9]) per portion (3 g) [16].

Discussion

The range of fortified foods available in the retail food industry which are suitable for vegans is now extremely varied. These foods can make a valuable contribution to the needs of vegans, particularly in regard to critical nutrients.

Vitamin B_{12}

Vitamin B_{12} exists naturally almost exclusively in animal foods. Although the few plant foods which contain the vitamin in relevant quantities (primarily seaweed) are enjoying increased popularity, it is unclear whether they actually deliver forms which are retrievable by our bodies [3]. *In vitro* studies show that marine seaweed (e.g. nori [here: dulse *Porphyra yezoensis*]) and freshwater microalgae chlorella can deliver bioavailable forms for people [10, 17–19]. Should human studies confirm that the forms present in nori seaweed or shiitake mushrooms are bioactive and can be used by human bodies, this food could be incorporated in future in order to avoid a deficiency in the vegan diet and to provide an alternative source of vitamin B_{12}. Further examination of the foods listed in ◆ Table 1 reveals that the reference value of intake for vitamin B_{12} can be reached with 70 g of selected breakfast cereals, yet that scarcely achievable quantities (up to 790 g or mL) of fruit juices or yoghurt alternatives would have to be consumed to that end. There is still some uncertainty regarding the form of the vitamin and its potentially poorer absorption rate in a vegan diet, both in the use of natural foods which deliver potentially bioavailable vitamin B_{12} and in fortified products. Therefore, according to a position paper on the vegan diet produced by the German Nutrition Society (DGE, *Deutsche Gesellschaft für Ernährung*), an appropriate intake of vitamin B_{12} in a vegan diet can only be achieved through supplementation [5]. As a deficiency has serious health consequences for the organism (hyperchromic macrocytic anemia or funicular myelosis) and even irreversible neurological damage among children [3, 20–30], it is important that vitamin B_{12} status is periodically checked, particularly among vegans [5]. The European Food Safety Authority (EFSA) has determined that there is no upper tolerable limit to the intake of vitamin B_{12}; there is therefore no health risk from increased absorption according to current knowledge [31].

Iron

Iron is present in many plant foods; however, it is usually present as non-heme iron (Fe^{3+}) and must be reduced to divalent heme iron for better absorption in the intestine. Vitamin C and organic acids promote bioavailability, whereas phytates inhibit it, as well as polyphenols, soy proteins, calcium salts, phosphates and in part also dietary fibers [3, 32]. Many of the natural foods listed in ◆ Table 3 contain absorption-inhibiting components.
Iron-fortified fruit juice can make a valuable contribution to iron supply thanks to the inclusion of acids which improve bioavailability. Cereals contain a high level of iron (5.3–13 mg) per 100 g depending on the variety (◆ Table 3). The fact that only very few meat substitute products such as seitan, textured soy protein etc. are fortified with iron is unproblematic in as much as iron supply can be fully guaranteed through natural plant foods or so-called superfoods[2], including in particular chia seeds. These are a good option given that they also guarantee a supply of other potentially critical nutrients (including calcium) [12]. In conclusion, a varied diet which includes pulses and wholegrain products would easily provide the recommended amount of intake for iron for vegans aged between 25 and 50. It may be useful for some people to increase iron intake through moderate consumption of fortified foods, particularly for women, who have a greater need for iron, as well as during pregnancy and breastfeeding. Excessive iron intake via natural foods and fortified foods should be avoided [9].

Iodine

Iodine is a nutrient whose recommended intake cannot be reached through common natural plant foods. Iodine supply should therefore be regarded as problematic for vegans, particularly given that no vegan convenience products are hitherto fortified with iodine. People following a vegan diet, as well as those who follow an omnivorous diet, should use iodized table salt and should look for products which contain iodine when purchasing baked goods [33]. However, these measures will not suffice for vegans who consume no animal iodine sources such as fish and dairy products; that is why alternatives are necessary.
Seaweed in particular could contribute to the supply of this nutrient; however, the iodine content is extremely variable. Consumers should be able to check the type of seaweed and the level of iodine content; the packaging should perhaps also warn of excessive consumption of certain seaweeds above a specific maximum quantity. Such information is already provided on many products which can be obtained in organic markets and health food stores. The

[2] Article on superfoods by Clausen and Röchter in Ernährungs Umschau 11/2016, page M646 and further

food group	varieties	iron (mg/100 g or 100 mL)	% of reference value[a]				quantity required to meet reference value (g or mL)	
			per 100 g or 100 mL		per portion			
			m	f	m	f	m	f
fortified food								
cereals	10	5.3–13	53.0–130	35.3–86.7	15.9–39.0 [30 g]	10.6–26.0 [30 g]	76.9–188.7	115.4–283.0
meat alternatives	3	2.1–3.4	21.0–34.0	14.0–22.7	21.0–34.0 [100 g]	14.0–22.7 [100 g]	294.1–476.2	441.2–714.3
fruit juices	2	2.1	21.0	14.0	42.0 [200 mL]	28.0 [200 mL]	476.2	714.3
natural foods								
cereals/ pseudocereals								
amaranth, grain[b]		7.59	75.9	50.6	9.1 [12 g]	6.1 [12 g]	131.6	197.6
chia seeds[c]		6.5	65.0	43.3	6.5 [10 g]	4.3 [10 g]	153.9	230.8
green spelt, cooked[b]		1.59	15.9	10.6	6.34 [40 g]	4.24 [40 g]	628.9 g	943.4
oats, wholegrain[b]		4.44	44.4	29.6	26.6 [60 g]	17.8 [60 g]	225.2	337.8
millet, corn, husked[b]		6.9	69.0	46.0	17.6 [40 g]	18.4 [40 g]	144.9	217.4
wholegrain flour type 1,700[b]		3.4	34.0	22.7	6.8 [20 g]	4.5 [20 g]	294.1	441.2
wheat germs, dried[c]		8.5	85.0	56.7	8.5 [10 g]	5.7 [10 g]	117.6	176.5
wheat bran[c]		16	160.0	106.7	16 [10 g]	10.7 [10 g]	62.5	93.8
vegetables								
spinach, raw[b]		3.42	34.2	22.8	51.3 [150 g]	34.2 [150 g]	292.4	438.6
pulses								
beans, ripe, white, cooked[b]		2.42	24.2	16.1	14.5 [60 g]	9.7 [60 g]	413.2	619.8
chickpeas, ripe, cooked[b]		2.75	27.5	18.3	16.5 [60 g]	11 [60 g]	363.6	545.5
lentils, ripe, raw, cooked[b]		2.59	25.9	17.3	15.5 [60 g]	10.4 [60 g]	386.1	579.2
mungo beans, ripe, baked[b]		6.85	68.5	45.7	41.1 [60 g]	27.4 [60 g]	146	219
broad beans, ripe, cooked[b]		2.15	21.5	14.3	12.9 [60 g]	8.6 [60 g]	465.1	697.7
soy beans, ripe, cooked[b]		2.59	25.9	17.3	15.5 [60 g]	10.4 [60 g]	386.1	579.2
miscellaneous								
"soy meat"[b]		11	110.0	73.3	5.5 [5 g]	3.7 [5 g]	90.9	136.4
tofu[b]		2.84	28.4	18.9	28.4 [100 g]	18.9 [100 g]	352.1	528.2
"superfoods"[d]								
chlorella powder[c]		210	2,100.0	1,400.0	105.0 [5 g]	70 [5 g]	4.8	7.1
barley grass powder[c]		37.3	373.0	248.7	18.7 [5 g]	12.4 [5 g]	26.8	40.2
goji berries, dried[c]		71.4	714.0	476.0	35.7 [5 g]	23.8 [5 g]	14.0	21.0
spirulina-powder[c]		20	200.0	133.3	10.0 [5 g]	6.7 [5 g]	50.0	75.0

Tab. 3: **Food containing iron with information on quantities in mg per 100 g or 100 mL, percentages of the reference values of nutrient intake and quantities theoretically required to meet the reference values of nutrient intake**
[a] 10 mg/day (m) or 15 mg/day (f) (DGE et al. 2015 [9])
[b] BLS [11]
[c] Reifenhäuser 2015 [13]
[d] Superfoods": foods characterized by a high density of nutrients [13]
m = men, f = female

consumption of too much iodine can have adverse effects. The EFSA determined the upper tolerable limit as 600 µg/day [31]. The Federal Institute for Risk Assessment (BfR, *Bundesinstitut für Risikobewertung*) also mentioned the potential risks of excessive seaweed consumption [15].

Fortified plant-based drinks could be fortified with an adequate quantity of iodine in imitation of cow's milk, as is already the case with calcium. Marine seaweed is used in biologically produced drinks as calcium additive. However, the packaging does not indicate the quantity of iodine with which the foods are fortified. The iodine content of the marine seaweed *Lithothamnium calcareum* used is not known with certainty, as here there are also significant variations. The consumption of supplements, superfoods and (potentially harmful) seaweed could be avoided through the standardization of iodine content in milk and dairy product substitutes. If none of the named products are consumed, iodine tablets should be taken to avoid a deficiency. Continual medical examination of individual supply could also be called for here, as previously mentioned for vitamin B_{12}.

Calcium

One natural food which can contribute measurably to calcium supply is mineral water. Some mineral waters contain ≥ 300 mg calcium/L and can therefore provide the full daily intake. Here there are also none of the effects which may negatively influence bioavailability. Other calcium-rich natural foods often contain absorption-inhibiting substances such as phytic acids, oxalic acids or various dietary fibers [3]. As regards fortified foods, the alignment of milk substitutes such as soy drinks, fruit juices or yoghurt alternatives to the corresponding dairy products is a good measure, as the calcium content of these products thereby corresponds to that of the substituted goods. "Soy yoghurt" also contains fewer phytates than untreated soy; these are removed when the soy beans are soaked [3].

However, cereals whose calcium content offers a full supply of calcium in one "portion" may lead to consumption above the recommended amount when they are consumed in larger quantities or in combination with other foods fortified with this nutrient. If people are consuming calcium-rich natural foods, they should eliminate fortified cereals from their diet so as not to exceed the maximum value of 2,500 mg/day determined by EFSA [34].

Thanks to a combination of calcium-rich natural foods, fortified vegan milk and dairy alternatives and calcium-rich mineral water, it is easy to guarantee supply of calcium in Germany nowadays for vegans aged 25 to 50. The D-A-CH reference values of nutrient intake can also be reached without fortified foods given an appropriate selection of natural foods.

Conclusion: are fortified foods useful for a vegan lifestyle?

Fortified foods are not essential to ensure that the reference values of intake of the above-mentioned critical nutrients are reached, insofar as the corresponding natural nutrient sources are consumed and a vitamin B_{12} supplement is taken. A guaranteed calcium supply is facilitated by the variety of fortified vegan products. Fortification of plant-based milk substitutes with iodine would facilitate iodine consumption for vegans.

There is no risk of overconsumption of the above-mentioned critical nutrients in the event of moderate consumption of fortified foods according to this study analysis and current knowledge. If vegans consume natural calcium sources, they should avoid consuming fortified products such as cereals, so as not to exceed the determined maximum value of 2,500 mg/day [34, 35]. The same also applies to iron, as the reference value can be easily exceeded through excessive consumption of fortified cereals in combination with other sources of iron [9].

Care should be taken in the consumption of nutrient-rich natural foods such as seaweed, which may have negative effects on the organism due to its unknown and frequently very high iodine content [15, 31].

A vegan diet is currently not recommended in certain circumstances, such as infancy, pregnancy or breastfeeding due to an increased risk of nutrient deficiency [5]. Fortified foods could make a valuable contribution for these groups, alongside supplements.

Limitations

The illustrated (fortified) foods were available during the above-mentioned time period in at least one of the studied stores. These encompassed a broad spectrum of discount stores and supermarkets in the city of Bonn. However, as mentioned in the introduction, establishing a complete record of all products found on the market is almost impossible. These figures provide only a snapshot, yet they do indicate that a growing number of products are available [36].

Many markets sell own brand products alongside well-known brands. This is particularly the case for juices and fortified soy drinks. In light of this fact, there may be duplications in the listed products, as all the own brand products were taken into consideration.

Although many of the product labels contained no vegan logo or label, the study assumed that the

majority of fruit juices were suitable for a vegan diet. Major brands provide corresponding information on their websites.

Other critical nutrients presented by the German Nutrition Society (DGE) in its latest position paper on the vegan diet [5] must also be regarded as critical among the general population (vitamin D), or can be regarded as less problematic (riboflavin, zinc, selenium, essential amino acids [4]), or were not added to any products at the time of the survey or no need is recognized (long-chain omega-3 fatty acids); these nutrients were therefore not explicitly discussed in this article.

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Conflict of Interest
The authors declare no conflict of interest.

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