Check for updates

Received: 23 July 2023 | Revised: 22 May 2024 | Accepted: 3 June 2024

DOI: 10.1111/nbu.12692

Nutrition Bulletin

ORIGINAL RESEARCH

Glycaemic index and glycaemic load of selected packaged vegan foods

Aylin Bayindir Gümüş[1] | **Alev Keser**[2] | **Murat Gökgöz**[3] | **Aşkın Güngüneş**[4]

[1]First and Emergency Aid Program, Vocational School of Health Services, Kırıkkale University, Kırıkkale, Turkey

[2]Department of Nutrition and Dietetics, Ankara University Faculty of Health Sciences, Ankara, Turkey

[3]Department of Nutrition and Dietetics, Kırıkkale University Faculty of Health Sciences, Kırıkkale, Turkey

[4]Department of Endocrinology and Metabolism, Faculty of Medicine, Kırıkkale University, Kırıkkale, Turkey

Correspondence
Aylin Bayindir Gümüş, First and Emergency Aid Program, Vocational School of Health Services, Kırıkkale University, Ankara Road 7th km, Yahşihan, Kırıkkale 71 450, Turkey.
Email: abayindir@kku.edu.tr

Abstract

While there are data regarding the glycaemic index (GI) and glycaemic load (GL) of many foods in the literature, the values for packaged vegan analogue foods have not been previously published, although processed vegan foods usually contain more carbohydrates than their animal-based counterparts. This study was carried out to determine the GI and GL values of a selection of packaged vegan foods popular in Türkiye. To determine the GI and GL of test foods, 12 healthy volunteer females participated in the study. Participants randomly consumed test and reference foods (glucose and white bread) on each trial day, and capillary blood glucose was measured at baseline, 15, 30, 45, 60, 90 and 120 mins in duplicate. The GIs of vegan schnitzel, vegan chickpea burger, vegan mince pita, vegan chocolate, vegan snack bar and vegan cheese were 26.1 ± 19.61 (low), 27.1 ± 17.21 (low), 65.1 ± 28.60 (moderate), 42.7 ± 22.32 (low), 63.6 ± 45.86 (moderate), 36.4 ± 16.85 (low), respectively, according to the glucose reference, and were 28.2 ± 16.17 (low), 34.7 ± 18.26 (low), 81.2 ± 31.96 (high), 48.8 ± 12.87 (low), 82.0 ± 54.05 (high), 46.7 ± 28.66 (low), respectively, according to the white bread reference. GLs were 3.5 ± 2.66 (low), 8.6 ± 5.46 (low), 26.6 ± 11.67 (high), 6.1 ± 3.19 (low), 14.2 ± 10.28 (moderate), 5.7 ± 2.63 (low), respectively, according to the glucose reference, and were 3.8 ± 2.19 (low), 11.0 ± 5.80 (moderate), 33.1 ± 13.04 (high), 7.0 ± 1.84 (low), 18.4 ± 12.12 (moderate), 7.3 ± 4.47 (low), respectively, according to the white bread reference. The data from this study provide preliminary data for the GIs and GLs of packaged and processed vegan foods and show that the GIs and GLs of meat and cheese vegan analogues, while still low or moderate, tend to be higher than their animal-based counterparts which have lower or no glycaemic responses. Further research on the GIs and GLs of more vegan foods is needed.

KEYWORDS
glycaemic index, glycaemic load, ultra-processed foods, vegan diet, veganism

INTRODUCTION

Vegan diets are based on the consumption of plant foods such as fruit, vegetables, cereals, legumes, fungi and oilseeds and the elimination of all animal-based foods including meat, poultry, fish and seafood, eggs and dairy products (Ostfeld, 2017) and are consumed for a variety of motivations, including ethical, health, religious, economic, environmental, cultural and social factors (Ion, 2007).

Individuals who eat predominantly plant-based diets have a lower risk of developing chronic diseases such as type 2 diabetes (T2DM), cardiovascular diseases (CVD) and metabolic syndrome compared to omnivores (Cui et al., 2019; Kahleova et al., 2018, 2019; Wright et al., 2017). Vegan diets are also associated with increased postprandial incretin secretion, improvement of ß-cell function, high insulin sensitivity and maintenance of bodyweight (Cui et al., 2019; Kahleova et al., 2018, 2019; Wright et al., 2017).

 © 2024 British Nutrition Foundation.

These benefits of vegan diets may be related to the fact that they are typically rich in antioxidants (vitamin C and vitamin E), phytochemicals, fibre and some micronutrients such as magnesium and folate. On the other hand, they tend to be lower in foods containing saturated and *trans* fatty acids (Davey et al., 2003; Dewell et al., 2008).

However, given the exclusion of many nutrient-rich foods, vegan diets need to be well planned to be healthy (NHS, 2022). In the definition of a healthy vegan diet, there is a recommendation in some countries to limit the consumption of processed foods (Agnoli et al., 2017; Baroni, 2015). There are many processed or ultra-processed, packaged vegan foods on the market that target vegans and the range of these products is gradually expanding. According to The Packaged Vegan Food Market, the market value of packaged vegan foods was $12.7 billion in 2019, while the annual growth rate was expected to increase by 9.5% from 2022 to 2027 (Market Data Forecast, 2022). In another study, the global vegan food market was expected to grow to $61.35 billion in 2028, with an estimated 12.95% growth rate between 2021 and 2028 (Fortune Business Insight, 2022). More recently, however, growth has slowed, and the global vegan food market size was valued at $16.45 billion in 2022 and is projected to reach only $36.02 billion by 2031, growing at a compound annual growth rate (CAGR) of 9.1% during the forecast period (2023–2031) (Straits Research, 2022). Disliking the taste of animal products is not one of the reasons commonly given for preferring a vegan diet with the issue of 'cruelty' to animals and environmental concerns being more commonly cited. This situation expands the potential marketplace for vegan packaged foods, which are sometimes called ultra-processed animal food analogues (Mycorena, 2021). In addition, while most animal foods do not have high glycaemic values, plant-based alternatives may have greater glycaemic effects due to their higher content of carbohydrate.

The glycaemic index (GI) is defined as the percentage value resulting from the comparison of the incremental area under the blood glucose (iAUC) of the test food containing 50 g of digestible carbohydrates within 2 h, compared to the glycaemic response of the reference (standard) food containing the same amount of carbohydrates, consumed by the same individual on different days (Food and Agriculture Organization/World Health Organization, 1998). However, since the amount of food consumed is not taken into account in determining GI, the glycaemic load (GL) is defined as the GI value multiplied by the amount of digestible carbohydrate (CHO) in the amount consumed (usually one serving) of food divided by 100 (Salmeron et al., 1997). GL is considered to reflect better the glycaemic responses to foods since it also takes into account the amount of carbohydrate consumed (Chaiyakul et al., 2023). However, their positive effects on health show that low GI and low GL foods should be included in a healthy diet (Livesey et al., 2019; Vega-López et al., 2018). As a result of many studies, there are comprehensive lists containing the GI and glycaemic load values of the foods (Atkinson et al., 2008; Çiftçi et al., 2008). However, while it is known that the positive effects of plant-based nutrition, especially on blood glucose regulation, are associated with low GIs and GLs, the glycaemic values of packaged, processed vegan foods in the market are not known. This study was conducted to determine the GI and GL values of the six most commonly consumed packaged vegan foods in Türkiye which target vegans in the market.

MATERIALS AND METHODS

Study design

This study consisted of five stages including the market investigation, determining test foods, analyses of the chemical contents of foods, deciding on the study population and determining the GI and GL values of the selected foods. Figure 1 shows the flowchart of the study.

The market investigation

In the first stage, a total of 313 vegan packaged foods from two hypermarkets with high sales capacities and four vegan and two vegan-friendly online markets in Türkiye were examined for inclusion in the study. The inclusion criteria for these vegan foods are below.

- Being packaged.
- Having a logo or a sign stating that it is vegan or 100% plant-based on the label.
- Not being an essential plant-based food such as fruits, vegetables, grains, legumes and spices.
- Being in stock and able to be sent all over Türkiye for online markets.
- Being ready for consumption directly or after a short-term, simple process (such as heating or mixing with hot water).
- Being targeted at adults.
- Including 10 g or more of digestible CHO per 100 g or 100 mL according to the label.

14673010, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/nbu.12692 by Ankara University Library, Wiley Online Library on [02/07/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

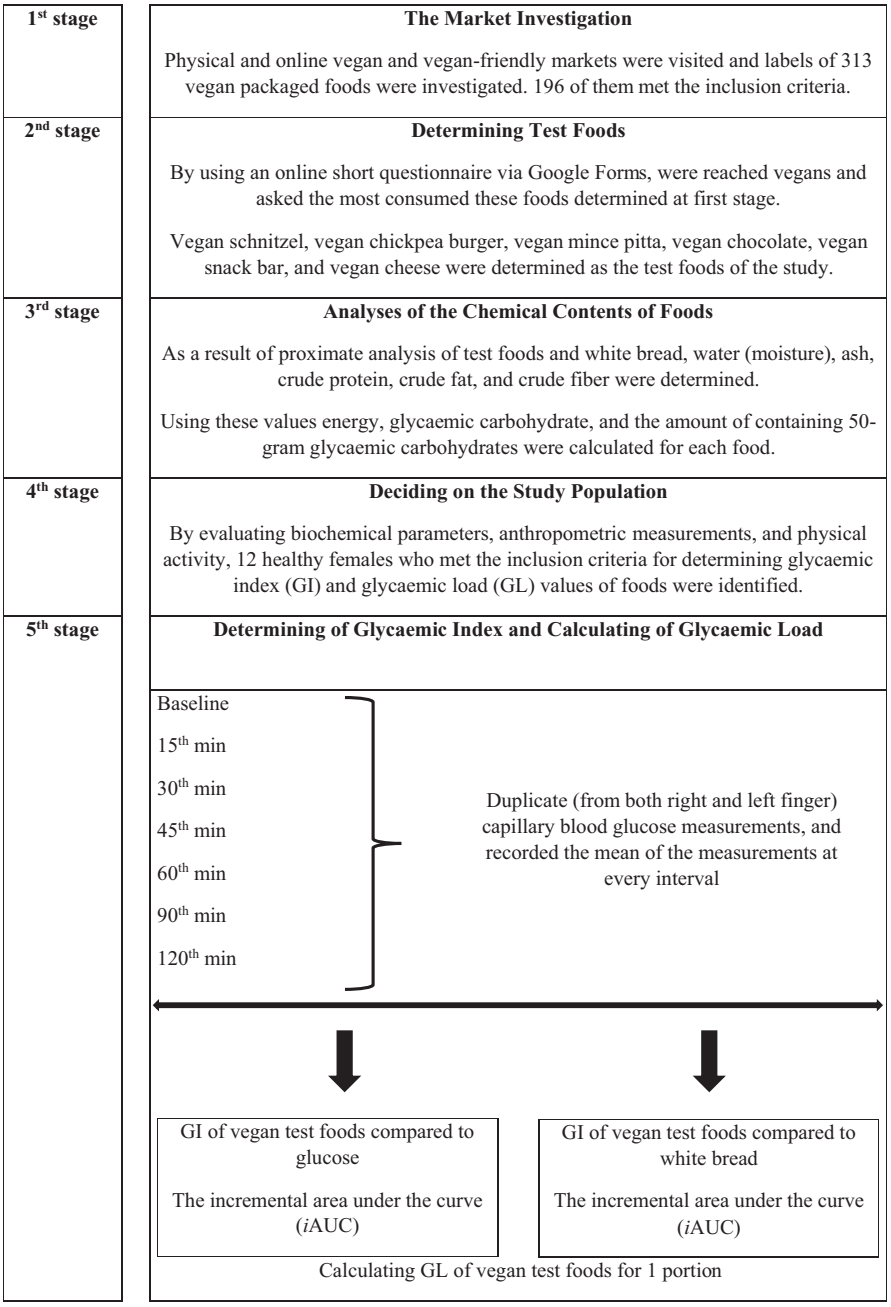


FIGURE 1 This study consists of five steps including market investigation, determining test foods, analyses of the chemical contents of foods, deciding on the study population, determining of glycemic index and calculating of glycaemic load, respectively.

It was determined that 196 packaged vegan foods met these criteria. The foods were grouped as vegan meat products, vegan dairy, vegan cereal products and vegan snacks.

Determining test foods

In the second stage, a short online questionnaire was sent to a selected group of those following a vegan diet via social media platforms investigating the most frequently consumed packaged vegan foods to determine the foods to be tested. The criteria for participating in the online survey were being a volunteer, stating that they were vegan and aged between 19 and 65 years. A total of 39 vegans (84.6 women, 15.4% men), most of whom had bachelor's degrees, participated in the online survey with a mean age of 27.1 years. Participants were asked with an open-ended question which vegan foods they consume most frequently (vegan meat products [vegan doner, meat, kebab, burger patty, chickpea burger, meatballs, minced meat, schnitzel, sausage]), vegan dairy [vegan cheese, tofu, yogurt], vegan cereal products ([vegan stuffed meatballs, ravioli types, wrap, mince pita, lahmacun] and vegan snacks [vegan cookies, wafers, biscuits, crackers, chocolate, cake, snack bar, ice cream]). The foods with the highest scores were accepted as the test foods of the study. Vegan schnitzel, vegan chickpea burger, vegan mince pita, vegan chocolate, vegan snack bar and vegan cheese were determined as the top six packaged vegan foods most frequently consumed by vegans in Türkiye.

14673010, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/nbu.12692 by Ankara University Library, Wiley Online Library on [02/07/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

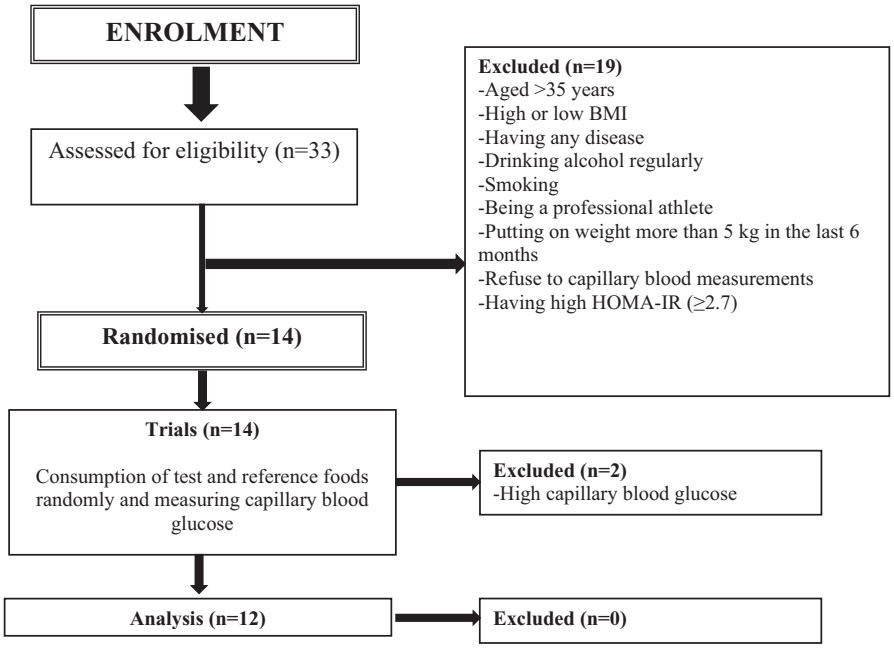


FIGURE 2 A total of 14 people were eligible for the study. Data from 12 people were analysed.

Analyses of the chemical contents of foods

In the third stage, moisture, ash, total fat, total protein and dietary fibre amounts of white bread and vegan test foods were analysed. By using results obtained from chemical analyses and formulas below, the digestible CHO amounts of foods in 100 g were calculated (Schakel et al., 1997).

$$\%\text{CHO} = 100 - (\text{moisture}\% + \text{ash}\% + \text{total fat}\% + \text{total protein}\% + \text{dietary fibre}\%).$$

After these calculations, amounts of foods containing 50 g digestible CHO were determined by using the formula below.

$$\text{The weight of food} = \left[(50 \times 100) / (\text{digestible CHO in } 100\,\text{g})\right].$$

Study size

In the fourth stage, the sample size and participants of the study were determined. It was reported that 10 or more adults should participate to determine the GI of foods (Brouns et al., 2005). Considering the sample size in the studies aiming to determine the GI of foods ($n = 10$, 12, 13, 14, 15) (Bakır Angay, 2019; Chen et al., 2010; Çiftçi, 2015; Lin et al., 2010; Ranawana et al., 2009; Toptaş Bıyıklı, 2018), it was decided that the sample size of this study was 12 healthy adults. Participants were recruited in Kırıkkale University Faculty of Medicine Endocrinology and Metabolic Diseases Polyclinic. Individuals who applied to the outpatient clinic with minor complaints but met the study criteria were included in the study.

The criteria for inclusion in the study were the following conditions: volunteering to participate in the study; being ≥19 years old and ≤35 years old; being in the range of normal body mass index (18.5–24.9 kg/m^2); not having a weight change of >5 kg in the last 6 months; not having any health problems (such as diabetes, cardiovascular disease, kidney, liver, thyroid, intestinal diseases, food allergy or intolerance) diagnosed by the physician; not having insulin resistance (HOMA-IR <2.7); Having normal fasting glucose (≤100 mg/dL); being normotensive (≤140) systolic and (≤90 mm Hg) diastolic blood pressure; not having undergone any surgery; not using prescription drugs regularly; not smoking; not drinking alcohol regularly (<7 glasses/week); not having a very active lifestyle (physical activity level <2.00); not being a professional or amateur athlete and not being pregnant or breastfeeding.

Anthropometric measurements (height and bodyweight) were taken by using a SECA stadiometer (Seca Corporation) and a digital scale while standing, with both feet together and the head in the Frankfurt line, and BIA measurements were conducted by research nutritionists. Endocrine and metabolic evaluations were conducted by the research physician. Statements of volunteers were considered for other criteria. No men volunteered to participate in the study and so all participants were women and had similar sociodemographic features. Figure 2 shows the flow diagram of the study.

Determining the glycaemic index and calculating the glycaemic load

The fifth stage is the main stage of this study. The participants were asked not to make any changes in their diet and to have sufficient carbohydrates (55–75 g) for dinner on the day before trials, to consume a meal with

14673010, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/nbu.12692 by Ankara University Library, Wiley Online Library on [02/07/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

a similar pattern to usual at dinner, to avoid excessive physical activity and not to consume beverages containing alcohol and caffeine. On the trial days, they were asked to come to the research room at the faculty between 09:00 and 10:00 a.m., having fasted for 8 h, not to consume food and drink during the trials (120 mins) and to maintain typical activity levels.

Three trials were made for reference foods (white bread and glucose) and one for the test foods. Test and reference foods were consumed with 250 mL of water within about 10 mins. 50 g glucose (one of the reference foods) was dissolved in 250 mL of water, and no additional water was given only for glucose trials. Capillary blood glucose was measured with the same glucometer before the participants consumed the food (beginning- 0 min) and at 15, 30, 45, 60, 90 and 120 min (7 times for every trial) after beginning to consume the food. Duplicated blood glucose was measured from two different fingers of two hands, and the average values were recorded. Roche Accu-Chek Performa Nano blood glucometer, strips and Softclix lancets (Roche Diabetes Care) were used for capillary blood glucose measurement. A curve was created with the blood glucose values, and the incremental area under the curve (*i*AUC) (glycaemic response area) was calculated (Food and Agriculture Organization/World Health Organization, 1998). The GI of the food was found by dividing the iAUC after the test food with the iAUC of the reference food and multiplying it by 100. After GIs of the foods were found for each participant, the arithmetic mean of these values was calculated. GLs were also calculated by considering one serving portion for each food with the formula as [the digestible CHO in the one portion (g) × GI of the food/100] (Salmeron et al., 1997). GI and GL were classified as high (≥70), moderate (56–69) and low (≤55), GL high (≥20), moderate (11–19) and low (≤10), respectively (Vega-López et al., 2018).

Ethical approval

The study has been conducted according to the guidelines laid down in the Declaration of Helsinki. The study protocol was approved by Kırıkkale University Clinic Studies Ethical Committee (dated 16 December 2021 numbered 20/01) and Kırıkkale University Faculty of Medicine Internal Diseases Department (dated 20 December 2021 numbered E.64273). All the participants were informed about the study, and their verbal and written consent was obtained. They did not receive any financial incentives for participating.

Statistical analyses

The results were analysed with IBM SPSS Statistics version 23.0. The regularity of the distribution of data was evaluated using the Shapiro–Wilk test, and it was determined that the data showed normal distribution. Mean, standard deviation (SD) and upper and lower values were calculated for the descriptive variables. The distribution of quantitative data was given in the table of percentages. The comparison among trials was performed using the repeated measures ANOVA test. Bonferroni correction was used to find the differences. The level of significance was set in all analyses as $p < 0.05$.

RESULTS

Description of the study population

The 12 volunteers participating in the study were women, high school graduates, unemployed and single. The mean age was 22.2 ± 1.90 years, and mean physical activity level (PAL) was 1.5 ± 0.11. Participants' baseline anthropometric and metabolic measurements are shown in Table 1.

Content of test and reference foods

Weights containing 50 g of digestible carbohydrates of white bread, vegan schnitzel, vegan chickpea burger, vegan mince pita, vegan chocolate, vegan snack bar

TABLE 1 Participants' baseline anthropometric and metabolic measurements.

	Mean	Standard deviation	Min	Max
Age (years)	22.2	1.90	20.0	27.0
Physical activity level/PAL	1.5	0.11	1.3	1.6
Body mass index/BMI (kg/m^2)	21.5	1.97	19.0	24.9
Waist circumference/WC (cm)	70.92	4.46	63.0	78.0
Waist-hip ratio/WHR	0.74	0.04	0.70	0.83
Body fat percentage (%)	25.6	5.93	16.5	28.0
Body fat (kg)	15.1	5.42	8.20	26.0
Total body water (kg)	30.7	1.96	27.6	33.8
Lean body mass/LBM (kg)	42.3	2.89	37.7	46.2
Visceral fat level	1.6	0.90	1.0	3.0
Systolic blood pressure (mmHg)	103.6	11.33	87.0	121.0
Diastolic blood pressure (mmHg)	76.7	11.07	60.0	85.0
Capillary blood glucose (mg/dL)	87.2	7.26	72.0	97.0

14673010, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/nbu.12692 by Ankara University Library, Wiley Online Library on [02/07/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 2 Moisture, ash, total protein, total fat, dietary fibre, digestible carbohydrate percentage of white bread and test vegan foods.

Samples	Chemical analyses							Food weights[a] (g)
	Energy (kcal/100g)	Moisture (%)	Ash (%)	T. protein (%)	T. fat (%)	Dietary fibre (%)	Digestible CHO (%)	
White bread	267.44	28.66	1.52	8.40	0.60	3.71	57.11	87.6
Vegan schnitzel	249.87	40.71	2.30	17.20	12.59	10.26	16.94	295.2
Vegan chickpea burger	220.18	45.00	2.40	8.80	9.70	9.68	24.42	204.8
Vegan mince pitta	185.41	52.68	1.74	5.50	3.65	3.79	32.64	153.2
Vegan chocolate	555.01	0.01	1.92	6.50	33.37	1.03	57.17	87.5
Vegan snack bar	313.08	13.49	2.03	4.50	7.88	16.06	56.04	89.2
Vegan cheese	353.25	42.39	3.91	N[b]	27.69	N[b]	26.01	192.2

[a]Weights containing 50g of digestible carbohydrates.
[b]Negligible.

and vegan cheese were 87.6, 295.2, 204.8, 153.2, 87.5, 89.2 and 192.2 g, respectively (Table 2).

Glycaemic indexes of vegan foods

When glucose was the reference food, GIs of white bread, vegan schnitzel, vegan chickpea burger, vegan mince pita, vegan chocolate, vegan snack bar and vegan cheese were 84.0 ± 31.62, 26.1 ± 19.61, 27.1 ± 17.21, 65.1 ± 28.60, 42.7 ± 22.32, 63.6 ± 45.86 and 36.4 ± 16.85, respectively. The GI of white bread was statistically different from the GIs of vegan schnitzel, vegan chickpea burger, vegan chocolate and vegan cheese ($p < 0.001$). It was found that the GI of vegan mince pita was higher than GIs of vegan schnitzel and vegan chickpea burger ($p < 0.001$, Table 3).

When white bread was the reference food, GIs of glucose, vegan schnitzel, vegan chickpea burger, vegan mince pita, vegan chocolate, vegan snack bar and vegan cheese were 136.3 ± 53.69, 28.2 ± 16.17, 34.7 ± 18.26, 81.2 ± 31.96, 48.8 ± 12.87, 82.0 ± 54.05 and 46.7 ± 28.66, respectively. The GI of glucose was statistically different from the GIs of vegan schnitzel, vegan chickpea burger, vegan chocolate and vegan cheese ($p < 0.001$). The GI of vegan mince pita was higher than GIs of vegan schnitzel and vegan chickpea burger ($p < 0.001$, Table 3). It was determined that the GIs of vegan schnitzel, vegan chickpea burger, vegan chocolate and vegan cheese were in the 'low GI category' according to both reference foods. GIs Of vegan mince pita and vegan snack bar were in the 'moderate GI category' according to glucose, and in the 'high GI category' according to white bread.

Glycaemic loads of vegan foods

When glucose was the reference food, GLs of vegan schnitzel, vegan chickpea burger, vegan mince pita, vegan chocolate, vegan snack bar and vegan cheese were 3.5 ± 2.66, 8.6 ± 5.46, 26.6 ± 11.67, 6.1 ± 3.19, 14.2 ± 10.28 and 5.7 ± 2.63, respectively. The GL of vegan mince pita was higher than other vegan test foods ($p < 0.001$). The GL of the vegan snack bar was statistically different from the GL of vegan schnitzel ($p < 0.001$). When white bread was the reference food, GLs of vegan schnitzel, vegan chickpea burger, vegan mince pita, vegan chocolate, vegan snack bar and vegan cheese were 3.8 ± 2.19, 11.0 ± 5.80, 33.1 ± 13.04, 7.0 ± 1.84, 18.4 ± 12.12 and 7.3 ± 4.47, respectively. It was found that the GL of vegan mince pita was higher than the GLs of other vegan test foods except for vegan snack bar ($p < 0.001$). The GL of vegan schnitzel was lower than the GLs of vegan chickpea burger, vegan chocolate and vegan snack bar ($p < 0.001$, Table 4).

14673010, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/nbu.12692 by Ankara University Library, Wiley Online Library on [02/07/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 3 Glycaemic index (GI) values of reference and vegan test foods.

	GI compared to glucose		
Foods	**$\bar{X} \pm$ SD**	**Lower–upper**	***p****
White bread	84.0 ± 31.62^{a}	44.06–145.90	<0.001
Vegan schnitzel	26.1 ± 19.61^{bc}	0.18–54.47	
Vegan chickpea burger	27.1 ± 17.21^{bc}	2.53–64.23	
Vegan mince pita	65.1 ± 28.60^{ad}	20.62–126.04	
Vegan chocolate	42.7 ± 22.32^{bcd}	14.81–79.56	
Vegan snack bar	63.6 ± 45.86^{acd}	5.13–182.16	
Vegan cheese	36.4 ± 16.85^{bcd}	6.44–71.40	
	GI compared to white bread		
Foods	**$\bar{X} \pm$ SD**	**Lower–Upper**	***p***
Glucose	136.3 ± 52.69^{a}	68.54–226.94	<0.001
Vegan schnitzel	28.2 ± 16.17^{bc}	0.41–55.64	
Vegan chickpea burger	34.7 ± 18.26^{bc}	2.50–63.89	
Vegan mince pita	81.2 ± 31.96^{ad}	43.19–129.67	
Vegan chocolate	48.8 ± 12.87^{bcd}	30.55–68.31	
Vegan snack bar	82.0 ± 54.05^{acd}	5.07–169.69	
Vegan cheese	46.7 ± 28.66^{bcd}	13.90–125.23	

Note: [a-d] Statistically significant difference between foods.
*Repeated Measures ANOVA test.

TABLE 4 Glycaemic load (GL) values of vegan test foods.

		GL compared to glucose		
Foods	**1 portion (gram)**	**$\bar{X} \pm$ SD**	**Lower–upper**	***p****
Vegan schnitzel	80	3.5 ± 2.66^{a}	0.02–7.38	<0.001
Vegan chickpea burger	130	8.6 ± 5.46^{ab}	0.80–20.39	
Vegan mince pita	125	26.6 ± 11.67^{c}	8.41–51.42	
Vegan chocolate	25	6.1 ± 3.19^{ad}	2.12–11.37	
Vegan snack bar	40	14.2 ± 10.28^{bd}	1.15–40.83	
Vegan cheese	60	5.7 ± 2.63^{abd}	1.00–11.14	
		GL compared to white bread		
Foods	**1 portion (gram)**	**$\bar{X} \pm$ SD**	**Lower–upper**	***p***
Vegan schnitzel	80	3.8 ± 2.19^{a}	0.06–7.54	<0.001
Vegan chickpea burger	130	11.0 ± 5.80^{b}	0.79–20.28	
Vegan mince pita	125	33.1 ± 13.04^{c}	17.62–52.91	
Vegan chocolate	25	7.0 ± 1.84^{d}	4.37–9.76	
Vegan snack bar	40	18.4 ± 12.12^{bcd}	1.14–18.37	
Vegan cheese	60	7.3 ± 4.47^{abd}	2.17–19.54	

Note: [a-d] Statistically significant difference between foods.
*Repeated Measures ANOVA test.

The GLs of vegan schnitzel, vegan chickpea burger, vegan snack bar and vegan cheese were in the 'low GL category', the GL of the vegan snack bar was in the 'moderate GL category' and the GL of the vegan mince pita was in the 'high GL category' according to both reference foods, although the GL of the vegan chickpea burger was in the 'moderate GL category' according to white bread.

14673010, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/nbu.12692 by Ankara University Library, Wiley Online Library on [02/07/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

DISCUSSION

In this experimental study, the GIs and GLs of vegan packaged foods that were being consumed frequently by vegan adults in Türkiye were determined. The vegan packaged foods that had higher GI and GL were vegan mince pita and vegan snack bar, while the lowest values were reported for vegan schnitzel and vegan chickpea burger. In the literature, when searching for 'vegan', 'vegan food', 'packaged vegan foods', 'plant-based packaged foods', 'glycaemic index' and 'glycaemic load' keywords in PubMed, Science Direct and Google Scholar, no publications were found that include GI and GL values of vegan foods. To our knowledge, this is the first study to examine the glycaemic responses of vegan packaged foods.

There is much evidence that vegan diets are associated with positive health outcomes (Cui et al., 2019; Kahleova et al. 2020a; Kahleova et al. 2020b; Kahleova et al., 2019; Wright et al., 2017). It is known that the positive effects on the health of vegan diets, especially on blood glucose regulation, are related to diets being balanced and well-planned. However, among the recommendations for well-planned vegan diets in some countries is that processed and ultra-processed foods should be limited (Agnoli et al., 2017). On the other hand, packaged vegan foods have been expanding their place in the markets in recent years. As these foods become more popular, it is thought that some of the positive health outcomes of vegan diets may disappear.

The main ingredients of commercially available, packaged, vegan foods are usually soy and other legumes, grains and mushrooms (Clément et al., 2018). Some also contain animal food analogues (meat analogues, milk analogues and cheese analogues). Plant-based ingredients such as almonds, soy, oats, wheat, rice and coconut are also used. Vegan meat, burgers, salami, sausages, cheese, plant-based alternatives to milk, desserts, snacks, texturized vegetable protein and seitan (made from wheat gluten) are available in the market, especially in Western countries (International Market Analysis Research & Consulting Group, 2020, 2022). Five of the six vegan test foods in this study (vegan schnitzel, vegan mince pita, vegan chocolate, vegan snack bar and vegan cheese) were foods consumed in place of animal foods. When the labels of these packaged vegan foods were examined, it was seen that they mainly included wheat, peas, potatoes, legumes, oilseeds, sugar, coconut and other plant foods. Thus, foods that resemble animal foods, especially in terms of taste and appearance, are produced by processing the plant foods preferred in vegan nutrition.

To increase the diversity of vegan foods for those wanting to eat a more plant-based diet, there has been an increase in processed plant-based foods on the market (ProVeg International, 2020). Studies examining the purchasing habits of vegans support this situation (Akkan & Bozyığıt, 2020; Bäckström et al., 2018; Market Data Forecast, 2022; ProVeg International, 2020). The results of market research conducted with 6221 participants from nine European countries showed that plant-based milk alternatives, meat alternatives, yogurt, butter/margarine, chocolate, bakery products, tofu/tempeh, ice cream, cheese alternatives and sauces were among the plant-based foods most frequently preferred by individuals on a plant-based diet (ProVeg International, 2020). According to the results of another global study, packaged vegan foods that had more diversity in the market were milk alternatives, meat alternatives, desserts, bakery products and packaged ready meals (Market Data Forecast, 2022). Therefore, a significant part of the packaged vegan food market consists of foods, especially meat analogues, which are processed plant-based foods (Bäckström et al., 2018). In the study conducted in Türkiye by Akkan and Bozyiğit with 38 vegan adults, it was determined that vegan cheese, vegan milk, tofu and soybean mince were the most purchased foods by vegans (Akkan & Bozyığıt, 2020). In this study, the most preferred packaged vegan foods by vegans were vegan schnitzel, vegan chickpea burger, vegan mince pita, vegan chocolate, vegan snack bar and vegan cheese.

Foods in the market targeting vegans or other plant-based eaters are often processed, animal-based food alternatives. The market research conducted in the first stage of the study supports this situation. There are logos or signs on the labels of these packaged foods indicating that they are completely plant-based or suitable for vegans. However, there is no information about the GI or GL of them. On the other hand, it was reported that plant-based foods generally have lower protein and higher carbohydrates when compared to animal-based foods (International Market Analysis Research & Consulting Group, 2020, 2022; Pointke & Pawelzik, 2022). Therefore, it is thought that they might cause a greater glycaemic response and have higher GIs and GLs. While GIs and GLs of legumes, cereals, fruits and vegetables that may be more commonly consumed by those following vegan diets are available, there is little scientific knowledge on GIs and GLs of processed vegan foods. GIs of soy milk and rice milk were reported as 34 and 86, respectively, compared to 39 ± 3 for cows' milk (Atkinson et al., 2008). However, the GI of soy milk is in the 'low GI category' and the GI of rice milk is in the 'high GI category'. There is no data on the GL of these foods.

When the ingredients of test foods in this study were examined, the main content of vegan schnitzel and vegan cheese was found to be peas, potatoes, vegetable oil and starch varieties (corn starch, potato starch and wheat starch). Compared to glucose, the GI of green peas ranges between 48 and 54, and GL varies between 3 and 5 (Çiftçi et al., 2008; Foster-Powell

14673010, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/nbu.12692 by Ankara University Library, Wiley Online Library on [02/07/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

et al., 2002; The University of Sydney, 2022). The GI of canned peas is 67 and GL is 13 (The University of Sydney, 2022). The GI of frozen peas is 51 compared to glucose and 73 compared to white bread (Foster-Powell et al., 2002), while the GI of corn starch is >92 (The University of Sydney, 2022), GIs of boiled potato and wheat starch are between 78 and 88 and 71–80, respectively (Çiftçi et al., 2008; Foster-Powell et al., 2002). In this study, the GIs of vegan schnitzel and vegan cheese were classified as 'low' compared to both reference foods and their GLs, in particular, were similar to the GLs of their basic ingredients.

The vegan chickpea burger in this study consisted of chickpeas, vegetables and spices. The GI of chickpeas varies between 28 and 51 and the GL varies between 2 and 11 (Atkinson et al., 2008; Çiftçi et al., 2008; Foster-Powell et al., 2002; The University of Sydney, 2022). It was reported that falafel, a food similar to chickpea meatballs, had low GI (33) and low GL (3) (Al-Mssallem, 2018). Similarly, in this study, the GI of vegan chickpea burger was 27.1 compared to glucose, and 28.2 compared to white bread, and it was in the 'low GI category'.

However, non-vegan meat and cheese (schnitzel, cheese and burger meat) do not produce a glycaemic response because they do not have more than 10 g digestible CHO in 100 g and are not, therefore, included in tables of GI and GL values. Therefore, it can be said that the vegan counterparts of these non-vegan foods have higher GI and GL values (Atkinson et al., 2008; Çiftçi et al., 2008) than their animal-based counterparts.

The dough of the vegan mince pitta in the study included wheat flour, water, salt and vegetable oil. The vegetable alternative that replaces minced meat consists of mushrooms, onions, tomatoes, as well as other vegetables and spices. In the literature, the GIs and GLs of most of these ingredients are known. The GI of white pitta is between 57 and 82 and the GL is between 9 and 15 (Foster-Powell et al., 2002; The University of Sydney, 2022). Except for those with high amounts of carbohydrates, the GIs, and GIs of vegetables are generally in the 'low or moderate categories' (Çiftçi et al., 2008). In this study, it was determined that the GI of vegan mince pita was higher than other packaged vegan foods, presumably due to the inclusion of the pitta bread. The GI of vegan mince pitta was in the 'moderate category' (65.1) compared to glucose and in the 'high category' (81.2) compared to white bread. Similarly, its GL was found to be in the 'high category' compared to both reference foods.

Chocolate is a food with high energy density, high in fat and CHO, and low in fibre (U.S. Department of Agriculture, 2022). Due to its high CHO content (approximately 50%–60% of energy), it creates a glycaemic response (Choi et al., 2020). While the GI of dark chocolate ranges from 40 to 52.1 (Atkinson et al., 2008; Chlup et al., 2008), the GL of chocolate is 13 (Çiftçi et al., 2008). It was determined that the GI of milk chocolate varied between 34 and 70 and the GL varied between 7 and 13, depending on the type of milk chocolate (Foster-Powell et al., 2002). Chocolate contains cocoa mass, cocoa butter, sugar, vegetable oil, lecithin, milk powder and milk fat. The GI of vegan chocolate in this study was similar to non-vegan chocolate at 42.7 compared to glucose and 48.8 compared to white bread and in the 'low GI category'. It is thought that the reason why the GI of milk chocolate is lower than vegan chocolate is due to the higher carbohydrate ratio (approximately 41% of energy) of vegan chocolate.

The vegan snack bar in this study consisted of dates, oilseeds, cocoa mass and other products. According to the international GI and GL table, the GI of dates was 103 ± 21 compared to glucose and 147 ± 30 compared to bread, and the GL was 42 (Foster-Powell et al., 2002). In another review, the GI of dates was found to be 42 ± 4 (Atkinson et al., 2008). In the study of Ali et al. (2009), the GIs of different date varieties ranged from 47.6 to 57.7 et al. 2009). The GIs and GLs of 17 date varieties were between 42.8–74.6 and 8.5–24, respectively (AlGeffari et al., 2016). The GI of the date-based vegan snack bar in this study was found to be in the 'moderate GI category' (63.6) compared to glucose and in the 'high GI category' (82.0) compared to white bread. The GL was in the 'moderate GL category' compared to both glucose (14.2) and white bread (18.4).

There are some strengths to the study. This study provides the first information on the GI and GL values of packaged vegan foods. The limitations to the study are that first, only females participated in this study. However, there are generally no reported differences between men and women in their glycaemic responses (Gökmen, 2015; Wolever et al., 2009). Second, only six packaged vegan foods were included in this study. However, since the GI studies were cross-over, each participant had to come to the study place many times. Further research should examine the GI and GL of other packaged vegan foods.

CONCLUSION

Vegan packaged foods target both vegans and individuals who wish to adopt more plant-based eating and their variety and availability in the market are increasing. While some of these foods are unprocessed such as grains, legumes, vegetables and fruits, they also include vegan analogues of dairy products and meat, which are produced from soy, vegetable proteins, oil seeds, mushrooms (such as vegan milk, vegan cheese, vegan yogurt, vegan sausage, vegan doner, vegan burger, vegan pita and vegan schnitzel), and referred to as 'ultra-processed' in the literature. This study has shown that the vegan counterparts of dairy and meat products produce glycaemic responses,

14673010, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/nbu.12692 by Ankara University Library, Wiley Online Library on [02/07/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

which while still low or moderate, are often higher than their non-vegan counterparts which produce a low or no glycaemic response. Therefore, the results on GI and GL, and the glycaemic responses of packaged vegan foods in this study will be useful, preliminary data for future studies. Although the GI and GL of these foods are generally not high, they have a higher glycaemic response compared to animal options. As the market for these foods is expanding gradually, there is a need for further studies that include more packaged vegan test foods.

ACKNOWLEDGEMENTS

The authors thank all participants for spending valuable time on this study. This article is extracted from Aylin Bayindir Gümüş's doctorate dissertation entitled 'Determination of glycemic index and glycemic load of frequently preferenced, packaged vegan foods', supervised by Prof. Dr. Alev Keser (Ph.D. Dissertation, Ankara University, Ankara, Türkiye, 2022).

CONFLICT OF INTEREST STATEMENT

None.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

ORCID

Aylin Bayindir Gümüş https://orcid.org/0000-0002-1311-2429
Alev Keser https://orcid.org/0000-0003-2620-6747
Murat Gökgöz https://orcid.org/0000-0003-4451-6116
Aşkın Güngüneş https://orcid.org/0000-0002-8998-9729

REFERENCES

Agnoli, C., Baroni, L., Bertini, I., Ciappellano, S., Fabbri, A., Papa, M. et al. (2017) Position paper on vegetarian diets from the working group of the Italian Society of Human Nutrition. *Nutrition, Metabolism, and Cardiovascular Diseases*, 27, 1037–1052.

Akkan, E. & Bozyığıt, S. (2020) Bir Niş Pazar Olarak Türkiye'deki Vegan Ürünler: Tüketici Bakış Açısından Keşfedici Bir Araştırma 1. *Journal of Consumer and Consumption Research*, 12, 101–149.

AlGeffari, M.A., Almogbel, E.S., Alhomaidan, H.T., El-Mergawi, R. & Barrimah, I.A. (2016) Glycemic indices, glycemic load and glycemic response for seventeen varieties of dates grown in Saudi Arabia. *Annals of Saudi Medicine*, 36, 397–403.

Al-Mssallem, M. (2018) Consumption of traditional Saudi foods and their estimated glycaemic index and glycaemic load. *Pakistan Journal of Nutrition*, 17, 518–523.

Atkinson, F.S., Foster-Powell, K. & Brand-Miller, J.C. (2008) International tables of glycemic index and glycemic load values. *Diabetes Care*, 31, 2281–2283.

Ali, A., Al-Kindi, Y.S. & Al-Said, F. (2009) Chemical composition and glycemic index of three varieties of Omani dates. *International Journal of Food Sciences and Nutrition*, 60, 51–62.

Bäckström, N., Egeman, H. & Mattsson, H. (2018) Why do companies produce vegan and vegetarian products imitated with real meat products? Exploring a virgin topic on the swedish market. In: *Marketing Management*. Jönköping Üniversitesi: Jönköping.

Bakır Angay, S. (2019) *Piyasada Satılan Bazı Glutensiz Ekmeklerin Glisemik İndeks Değerlerinin Belirlenmesi*. Ankara: *Beslenme Bilimleri Programı* Hacettepe Üniversitesi.

Baroni, L. (2015) Vegetarianism in food-based dietary guidelines. *International Journal of Nutrition*, 1, 48–73.

Brouns, F., Bjorck, I., Frayn, K., Gibbs, A., Lang, V., Slama, G. et al. (2005) Glycaemic index methodology. *Nutrition Research Reviews*, 18, 145–171.

Chaiyakul, S., Ketkham, N., Chaichana, C., Khumkhana, N., Deekum, W., Wongshaya, P. et al. (2023) Effects of a novel rice-based diabetes-specific formula on postprandial glucose and gastrointestinal hormones: a double-blinded multi-arm randomized crossover trial. *Frontiers in Endocrinology*, 14, 1141497.

Chen, Y.-J., Sun, F.-H., Wong, S.H. & Huang, Y.-J. (2010) Glycemic index and glycemic load of selected Chinese traditional foods. *World Journal of Gastroenterology*, 16, 1512–1517.

Chlup, R., Sečkař, P., Zapletalová, J., Langová, K., Kudlová, P., Chlupová, K. et al. (2008) Automated computation of glycemic index for foodstuffs using continuous glucose monitoring. *Journal of Diabetes Science and Technology*, 2, 67–75.

Choi, Y., Kim, D.-Y., Rhee, S.Y. & Lim, H. (2020) Postprandial glucose, insulin, and glucagon-like peptide-1 responses in healthy adults after consumption of chocolate-products. *Preventive Nutrition and Food Science*, 25, 338–345.

Çiftçi, H., Akbulut, G., Yıldız, E. & Mercanlıgil, S.M. (2008) Kan şekerini etkileyen besinler. Available from: http://www.netdata.com/UserFilesCenter3/613819aa-abf5-4ca0-b155-6ba4ecdbb262/ProjectsCenter1/e903343c-0648-4473-9e7a-b0a55f9db737/FileCenter/101.pdf [Accessed 15th June 2024].

Çiftçi, S. (2015) *Farklı pişirme yöntemlerinin patateslerin glisemik indeks değeri üzerine etkisi*. Ankara: *Diyetetik Programı* Hacettepe Üniversitesi.

Clément, T., Joya, R., Bresson, C. & Clément, C. (2018) *Market developments and policy evaluation aspects of the plant protein sector in the EU*. Brussels: Agrosynergie EEIG for the European Commission.

Cui, X., Wang, B., Wu, Y., Xie, L., Xun, P., Tang, Q. et al. (2019) Vegetarians have a lower fasting insulin level and higher insulin sensitivity than matched omnivores: a cross-sectional study. *Nutrition, Metabolism, and Cardiovascular Diseases*, 29, 467–473.

Davey, G.K., Spencer, E.A., Appleby, P.N., Allen, N.E., Knox, K.H. & Key, T.J. (2003) EPIC–Oxford: lifestyle characteristics and nutrient intakes in a cohort of 33 883 meat-eaters and 31 546 non meat-eaters in the UK. *Public Health Nutrition*, 6, 259–268.

Dewell, A., Weidner, G., Sumner, M.D., Chi, C.S. & Ornish, D. (2008) A very-low-fat vegan diet increases intake of protective dietary factors and decreases intake of pathogenic dietary factors. *Journal of the American Dietetic Association*, 108, 347–356.

Food and Agriculture Organization/World Health Organization. (1998) *Carbohydrates in human nutrition: report of a joint FAO/WHO expert consultation, Rome*, 14–18 April 1997.

Fortune Business Insight. (2022) *Vegan food market size, share & COVID-19 impact analysis, product type (vegan meat, vegan milk, and others), distribution channel (supermarkets/hypermarkets, convenience stores, online retails, and others), and regional forecast*, 2021–2028. Available at: https://www.fortunebusinessinsights.com/vegan-food-market-106421 [Accessed 04 June 2022].

Foster-Powell, K., Holt, S.H. & Brand-Miller, J.C. (2002) International table of glycemic index and glycemic load values. *The American Journal of Clinical Nutrition*, 76, 5–56.

14673010, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/nbu.12692 by Ankara University Library, Wiley Online Library on [02/07/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Gökmen, Ö. (2015) Glisemik indeks ve yük: Gerçekler ve çelişkiler. *Beslenme Ve Diyetetik Güncel Konular-II*, 1, 109–136.

International Market Analysis Research & Consulting Group. (2020) *Vegan food market: global industry trends, share, size, growth, opportunity and forecast 2020–2025*. Available at: https://www.yumpu.com/en/document/read/63416830/vegan-food-market-pdf-upcoming-trends-demand-regional-analysis-and-forecast-to-2020-2025 [Accessed 12 July 2022].

International Market Analysis Research & Consulting Group. (2022) *Vegan food market: global industry trends, share, size, growth, opportunity and forecast 2022–2027*. Available at: https://www.imarcgroup.com/vegan-food-market [Accessed 12 July 2022].

Ion, R.A. (2007) Reasons why people turn to vegetarian diet. *Economics of Agriculture*, 54, 353–358.

Kahleova, H., Levin, S. & Barnard, N.D. (2018) Vegetarian dietary patterns and cardiovascular disease. *Progress in Cardiovascular Diseases*, 61, 54–61.

Kahleova, H., Petersen, K.F., Shulman, G.I., Alwarith, J., Rembert, E., Tura, A. et al. (2020a) Effect of a low-fat vegan diet on body weight, insulin sensitivity, postprandial metabolism, and intramyocellular and hepatocellular lipid levels in overweight adults: a randomized clinical trial. *JAMA Network Open*, 3, e2025454.

Kahleova, H., Rembert, E., Alwarith, J., Yonas, W.N., Tura, A., Holubkov, R. et al. (2020b) Effects of a low-fat vegan diet on gut microbiota in overweight individuals and relationships with body weight, body composition, and insulin sensitivity. A randomized clinical trial. *Nutrients*, 12, 2917.

Kahleova, H., Tura, A., Klementova, M., Thieme, L., Haluzik, M., Pavlovicova, R. et al. (2019) A plant-based meal stimulates incretin and insulin secretion more than an energy-and macronutrient-matched standard meal in type 2 diabetes: a randomized crossover study. *Nutrients*, 11, 486.

Lin, M.-H.A., Wu, M.-C., Lu, S. & Lin, J. (2010) Glycemic index, glycemic load and insulinemic index of Chinese starchy foods. *World Journal of Gastroenterology*, 16, 4973–4979.

Livesey, G., Taylor, R., Livesey, H.F., Buyken, A.E., Jenkins, D.J., Augustin, L.S. et al. (2019) Dietary glycemic index and load and the risk of type 2 diabetes: a systematic review and updated meta-analyses of prospective cohort studies. *Nutrients*, 11, 1280.

Market Data Forecast. (2022) *Packaged vegan food market analysis by product (dairy alternatives, packaged meals and meat alternatives, bakery and confectionery product), distribution channel (supermarkets and hypermarkets, natural and organic stores, others) and by region – global industry analysis, size, share, growth, trends, and forecast 2022 to 2027*. Available at: https://www.marketdataforecast.com/market-reports/packaged-vegan-food-market [Accessed 04 June 2022].

Mycorena. (2021) *Why does the vegan industry make food look and taste like meat?*. Available at: https://mycorena.com/mycotalks/why-does-the-vegan-industry-make-food-look-and-taste-like-meat [Accessed 04 June 2022].

NHS. (2022) *The vegan diet*. Available at: https://www.nhs.uk/live-well/eat-well/how-to-eat-a-balanced-diet/the-vegan-diet/#:~:text=A%20vegan%20diet%20contains%20only,including%20dairy%20products%20and%20eggs [Accessed 04 June 2022].

Ostfeld, R.J. (2017) Definition of a plant-based diet and overview of this special issue. *Journal of Geriatric Cardiology*, 14, 315.

Pointke, M. & Pawelzik, E. (2022) Plant-based alternative products: are they healthy alternatives? Micro-and macronutrients and nutritional scoring. *Nutrients*, 14, 601.

ProVeg International. (2020) *European consumer survey on plant-based foods-describing the product landscape and uncovering priorities for product development and improvement*. Berlin: ProVeg International.

Ranawana, D., Henry, C., Lightowler, H. & Wang, D. (2009) Glycaemic index of some commercially available rice and rice products in Great Britain. *International Journal of Food Sciences and Nutrition*, 60, 99–110.

Salmeron, J., Manson, J.E., Stampfer, M.J., Colditz, G.A., Wing, A.L. & Willett, W.C. (1997) Dietary fiber, glycemic load, and risk of non—insulin-dependent diabetes mellitus in women. *JAMA*, 277, 472–477.

Schakel, S.F., Buzzard, I.M. & Gebhardt, S.E. (1997) Procedures for estimating nutrient values for food composition databases. *Journal of Food Composition and Analysis*, 10, 102–114.

Straits Research. (2022) *Vegan food market size, share & trends analysis report by product type (meat & seafood, creamer, ice cream & frozen novelties, yogurt, cheese, butter, meals, protein bars, others), by end-user (takeout, dine-in), by distribution channel (supermarkets & hypermarkets, convenience stores, e-commerce) and by region(North America, Europe, APAC, Middle East and Africa, LATAM) forecasts, 2023–2031*. Available at: https://straitsresearch.com/report/vegan-food-market [Accessed 13 April 2024]

The University of Sydney. (2022) *Glycemic index research and GI news*. Available at: https://glycemicindex.com/gi-search/ [Accessed 13 July 2022].

Toptaş Bıyıklı, E. (2018) Dirençli nişasta ile eriştenin posa içeriğinin artırılması ve glisemik indeks değerinin belirlenmesi. In: *Beslenme ve Diyetetik Anabilim Dalı*. Gazi Üniversitesi: Ankara.

U.S. Department of Agriculture. (2022) *FoodData central*. Available at: https://fdc.nal.usda.gov/ [Accessed 13 July 2022].

Vega-López, S., Venn, B.J. & Slavin, J.L. (2018) Relevance of the glycemic index and glycemic load for body weight, diabetes, and cardiovascular disease. *Nutrients*, 10, 1361.

Wolever, T.M.S., Jenkins, A.L., Vuksan, V. & Campbell, J. (2009) The glycaemic index values of foods containing fructose are affected by metabolic differences between subjects. *European Journal of Clinical Nutrition*, 63, 1106–1114.

Wright, N., Wilson, L., Smith, M., Duncan, B. & McHugh, P. (2017) The BROAD study: a randomised controlled trial using a whole food plant-based diet in the community for obesity, ischaemic heart disease or diabetes. *Nutrition & Diabetes*, 7, e256.

How to cite this article: Bayindir Gümüş, A., Keser, A., Gökgöz, M. & Güngüneş, A. (2024) Glycaemic index and glycaemic load of selected packaged vegan foods. *Nutrition Bulletin*, 00, 1–11. Available from: https://doi.org/10.1111/nbu.12692

14673010, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/nbu.12692 by Ankara University Library, Wiley Online Library on [02/07/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License