Veggie burgers in the EU market: a nutritional challenge?

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Abstract:

Nutritional information of burgers launched in the EU market during 2020 was retrieved from their labels. Products were initially classified into 4 types: *i.e.,* veggie, red meat-, fish- and poultry-based. Gluten, wheat, and soy were the most declared allergens regardless of the burgers type. Veggie burgers showed levels of energy, fat, and saturate fatty acids (SFA) similar to fish- and poultry-based burgers, but lower than red meat burgers. Compared to conventional burgers, veggie had higher amounts of carbohydrates and sugars and a lower content of proteins, but no difference in salt. Due to the high compositional intra-variability in the veggie burgers, vegetarian and vegan burgers were further analyzed separately. Vegan burgers had higher levels of energy, fat, SFA and protein than vegetarian burgers, but lower carbohydrates and sugars. Once again large differences in the nutritional parameters were observed in both vegan and vegetarian burger categories due to the wide range of ingredients and formulations employed in these types of product. A clear and comprehensive informative labelling is especially needed for vegan and vegetarian burgers to allow the consumer to make a rational decision based on the nutritional facts of these products.

Keywords: burger, vegan, vegetarian, meat, nutritional labeling, allergens

1. Introduction

Meat burgers are one of the most popular meat products owing to their composition (rich in proteins, fats, minerals, and vitamins), availability, convenience, and affordability. Nevertheless, diet rich in meat products can be related to health concerns including colon cancer, obesity, and cardiovascular diseases due to the high content of cholesterol, saturated fatty acids and salt [1–3]. In the frame of European Food and Nutrition Action Plan by World Health Organization (WHO), recommendations have been proposed and specific frameworks have been implemented to reduce population intake of salt, fat and sugar [4]. Beside health concerns, impact of meat production on the environment and animal welfare rights are boosting toward changing eating habit toward more sustainable and healthy food consumption patterns [5, 6]. The shift from a meat-centric to a semi-vegetarian diet (*i.e.* flexitarian) is giving room to hybrid products made with blends of meat and plant-based ingredients to reduce meat consumption [7].

Hybrid burgers are reformulated products with the aim to reduce the amount of meat in the original recipe and to improve the nutritional composition. For this reason, reformulation focused on finding alternative natural and clean label ingredients to replace partially protein or/ and fat without hindering the characteristics of the traditional product. Soy proteins was one the most used alternative proteins for its functionality and affordability, yet currently its allergenicity contribute into the raise of other less allergenic sources [8]. Cereals proteins deriving from wheat, rice, barley, and oats are included in their different forms (*e.g.*, flour, isolates or concentrates) [9, 10]. Legume (*e.g.*, pea, lentil and chickpea) are used to partially substitute meat to obtain low-calorie burgers with high protein and fiber contents [11]. Pseudo-cereals (*e.g.*, quinoa and buckwheat) have attracted much attention because of excellent nutritional ingredients and being less allergenic compounds (gluten-free) and high nutritional value [8]. Mycoproteins and algal proteins are also increasingly included in burger formulations owing to their high nutritional value [12, 13]. Fat and saturated fat reduction was achieved by replacing animal fat by vegetable and/or marine oils [12, 14, 15]. In response to demands for healthier/functional meat burgers products, bioactive components (*e.g.,* probiotics, fibers, antioxidants, and omega-3) were also added [15–19].

Global plant-based burgers market started as a niche industry for vegan and vegetarian community and now it is growing into a mainstream food [20]. The global plant-based burgers market reached around US$ 2.7 billion in 2020 and is forecast to increase at compound annual growth rate (CAGR) of 22% between 2020 and 2030. Europe is expected to emerge as the leader of this market worldwide as it covers nearly half of the global market currently [21]. In the EU, veggie burger market is governed by the Netherlands (18% of new launches in the 2020), followed by Germany (14.7%), Spain (8.2%), Switzerland and Poland (7.6%), and Portugal (7.1%) [22]. Veggie burgers can be classified in two products vegan (made from non-animal ingredients) and vegetarian (contain non-meat ingredients such as eggs, mild, and whey proteins). These products are made using non-animal proteins deriving from

soy, pea, lentil, wheat or fungi, vegetal oils, starches, colorings/ flavoring agents and spices to enable a meat-like experience [23].

There is currently a reasonable debate with the food industry on the nutritional health and wellness of alternative meat products versus those traditional [23, 24]. The font-of-pack labeling is the tool that can help consumers to make informed choice while purchasing a food product [25]. Nutritional labeling is important to enable a further understanding of the healthiness of burger products rather than only relying on the mention meat, vegan or plant based or the list of ingredients. Regulation (EU) 1169/2011 on food information to consumers requires mandatory nutrition declaration for energy, total and saturated fats, carbohydrates, sugars, proteins and salt in prepacked foods [25]. In the case of food alternatives such as veggie burgers, labeling remains a source of contention since there is no legally binding definition of the terms “vegan” and “vegetarian” in EU regulation. Regulation (EU) No. 1169/2011), article 36 (3)(b) mentions information “related to suitability of a food for vegetarians or vegans” within the list of voluntary food information. This article leaves largely unclear the labeling of such foods, as it does not provide a definition for “vegan” or vegetarian”. Due to the rising interest and demand for vegan and vegetarian foods and the correspondingly increasing relevance of this market segment, a clear definition of these products is indeed required to avoid confusing the consumers. An initiative started by vegetarians and vegans across the EU to identify suitable food [26]. The European food and drink industry and the European Vegetarian Union submitted a joint position to propose a wording which meets the requirements of consumers interested in vegan and vegetarian products [26]. In 2018, European Commission has registered a European Citizens' Initiative entitled “Mandatory food labelling Non-Vegetarian / Vegetarian / Vegan” [27]. No official decision has been taken on either to make an amendment or not yet. The labelling of plant-based alternatives using meat and dairy terms also created a debate in the EU and opinions diverged into two ways: *i*) the protection of dairy and meat terms by banning products without meat or dairy from using associated terms (to avoid consumer confusion and misleading) and *ii*) the allowance of plant-based alternative to keep meat related nomenclature (and not use terms like “fingers” or “discs”). In 2020, the European parliament has rejected the proposal to ban the use of words like “burger” and “sausages”, while prohibiting dairy-like terms [28] .

Consumers, vegan or not, are facing the dilemma of choosing the product that can respond to their dietary style and nutritional expectations. The nutritional labeling might be a way for consumers to compare a veggie product to that animal-based, and decide the healthiest option. The present work is not limited to a number of lab-developed products but it is a market survey of vegan products and their traditional counterparts. This investigation comes to answer the question if vegan products are a healthier or not than the traditional products considering burger as a case study. Therefore, the present work gives a closer analysis to the nutritional labeling of veggie burgers in comparison to the conventional meat- and fish-based products launched during the 2020 in the EU market. For this reason,

mandatory nutritional information mentioned on the label of veggies, red meat-, fish-, and poultry-based burgers were collected and compared. Likewise, allergenicity information were retrieved and discussed. A closer focus was afterward attributed to veggie burgers by identifying two classes "vegan" and "vegetarian" and investigating their nutritional properties.

2. Material and methods

2.1. Data Collection

Identification of burgers launched in the global market during the year2020 was carried out by consulting the Mintel Global New Product Database (Mintel GNPD-Mintel Group Ltd., London, UK). The Mintel GNPD tracks packaged food and beverage launches in 86 markets worldwide. Each item has detailed product information, such as price, ingredients, claims made and nutritional information, as well as photographs of all sides of the packaging.

Out of the super-category of "foods", the search was focused on the category "Processed Fish, Meat & Egg Products" that was searched for the keyword "Burger". The Mintel GNPD search was conducted on February14th, 2021, using the search parameters specified in Table 1. The results of all searches were exported to Microsoft Excel (Microsoft Office, Washington, WA, USA).

Table 1. Search strategy used on Mintel Global New Product Database.

Criteria	**1st search**	**2nd search**	**3rd search**
Product name	Burger	Burger	Burger
Sub-Category	Processed Fish, Meat & Egg Products	Processed Fish, Meat & Egg Products	Processed Fish, Meat & Egg Products
Category	• Meat Substitutes • Fish Products • Meat Products • Poultry Products	• Meat Substitutes • Fish Products • Meat Products Poultry Products	Meat Substitutes
Region	• Europe • Latin America • Asia Pacific • North America • Middle East & Africa	Europe	Europe
Date	Last complete year	Last complete year	Last complete year

Nutrition	-	-	Carbohydrates (listed on pack); Sugars (listed on pack); Protein (listed on pack); Fat (listed on pack); Salt (listed on pack); Energy (kcal) (listed on pack); Saturated Fat (listed on pack)

2.2. Data Extraction

Following the 3rd search, burgers were classified into 4 sub-categories, veggie burgers, red meat burgers, fish burgers and poultry burgers. In a second phase, veggie burgers were further subdivided into non-vegan and vegan products. For all burger products launched in the EU market and having complete mandatory nutritional labelling, energy (kcal/100 g), total fat (g/100 g), saturated fatty acids—SFA (g/100 g), carbohydrates (g/100 g), sugars (g/100 g), protein (g/100 g), and salt (g/100 g) were retrieved. Furthermore, list of ingredients, allergies and suitability for vegan and vegetarian information were retrieved.

2.3. Statistical Data Analysis

The statistical analysis was carried out using the Statistical Package for Social Sciences software (IBM SPSS Statistics, Version 25.0, IBM corp., Chicago, IL, USA). Energy and nutrient contents per 100 g of products were analyzed using Kruskal–Wallis non-parametric one-way ANOVA for independent samples with multiple pairwise comparisons and Mann–Whitney non-parametric test for two independent samples.

3. Results and discussion

3.1. Overview on the global market of burgers with emphasis on EU

For a better understanding of EU market position, a search was conducted in Mintel database to retrieve all new burger products launched during the year 2020. Results showed that a total of 262 new veggie burgers, 182 red meat burgers, 28 fish burgers and 41 poultry burgers were launched in the global market (Table 2). These results show clearly the raising trend of consuming plant-based products that boosts food companies to enlarge their portfolios [23]. Vegan and vegetarian products are not new to the market; but more companies now are competing to develop product that mimic the taste and structure of traditional burgers in response to the raising demand. Changes in food habit during Coronavirus disease 2019 (COVID-19) outbreak boosted the raise in veggie burgers and a drop in meat burgers

launches [in 2019, global market: 173 veggies, 192 red meat, 21 fish and 39 poultry] [22]. Similarly, US sales of plant-based meat alternatives increased by almost 200% in April 2020 compared to the same period in 2018 [29]. This can be attributed to several reasons including shortages in meat availability, heighted concern about food safety and health, raise of meat prices [$255/cwt at March 2020 reaching $459/cwt at May 2020], and competitive marketing of meat alternatives as producers seize the current disruption as an ideal opportunity to attract new customers [30, 31].

Table 2 summarizes the launches in 2020, where the number of launches varied depending on burger category and the region. In the EU, veggie burgers had the largest share followed by red meat, fish, and poultry burgers. Noteworthy, Europe had the highest number of launches in all categories worldwide [veggies burgers ~70% (184 products out of 262) of total launches in 2020 versus red meat burgers ~48% (87 products out of 182) versus fish burgers ~75% (21 products out of 28) versus poultry burgers 32% (13 products out of 41)]. A survey in Spain showed this can be due to consumers lowering substantially red meat intake and eating more plant-based food [32]. In Asia, veggie burgers had the highest launches rate followed by red meat and fish, but no new launches in poultry burgers. It was reported that the demand for plant-based protein foods is surging in Asia due to links between wild animal meat and COVID-19 urging consumers to rethink diets [33]. In Latin America, red meat burgers had the highest launches, followed by veggie, poultry, and fish burgers. Indeed, red meat burger is the preferred meat processed product in the Latin market representing 40 % of the market of processed meat considering Brazil and Argentine as one of the most import producers [34]. In the Middle East and Africa, red meat burgers had more new products than veggie burgers, poultry, and fish burgers. This is because the adoption of veganism in this region is a recent trend [35]. In North America, the number of launches was limited, where only 6 new veggies products were launched in the market, and 7 red meat burger, 3 fish burgers and 2 poultry burgers.

From a nutritional labelling perspective, not all launched products have all mandatory information set by the EU regulation 1169/2011 [25] that align with those cited in the Codex Alimentarius [36]. Even so, only 90% of total launched burgers in EU (273 product out of 305) had the mandatory nutritional labelling information. For the other regions having different laws to apply, 19% of Asian products (20 product out of 62) have nutritional labelling, while almost all products from the Middle East and Africa, Latin and North America did not have it.

Table 2: Nutritional labelling of burgers lunched in the global market in 2020.

Region	**Veggie burgers**		**Red meat burgers**		**Fish burgers**		**Poultry burgers**	
	All	with nutritional labelling*	All	with nutritional labelling	All	with nutritional labelling	All	with nutritional labelling

Europe	184	170	87	72	21	19	13	12
Asia Pacific	31	12	20	0	0	0	11	0
Latin America	21	0	44	0	2	0	9	0
Middle East & Africa	20	0	24	0	2	0	6	1
North America	6	0	7	0	3	0	2	0
Total	262	182	182	72	28	19	41	13

*: nutritional labeling: energy (kcal/100 g), total fat (g/100 g), saturated fatty acids—SFA (g/100 g), carbohydrates (g/100 g), sugars (g/100 g), protein (g/100 g), and salt (g/100 g)

3.2. Veggie burgers versus meat burgers launched in the EU

3.2.1. Nutritional labelling

Focusing on the nutritional labeling of EU burgers launched during 2020 (Figure 1, Table S1), statistical analysis showed significant difference for all nutrients except salt among veggie, meat, fish and poultry burgers. Red meat burgers showed the highest median values of energy, fat, and SFA. An interesting finding is the similarities between veggie, fish, and poultry burgers in term of energy. The high range of variability of fat and SFA in veggie burgers is quite surprising as values might vary between 39 g/100 g and 13 g/100 g, respectively. Analysis of the ingredient's lists (Table 3) pointed up that most recipes include vegetal oils having low amount of SFA (*e.g.,* sunflower oil, corn oil, turnip oil, and rapeseed oil), while other formulation contain vegetal oils or fats rich in SFA (*e.g.,* coconut oil and palm oil). In veggie products, butter, milk powder and cheese were also identified as a source of SFAs. Noteworthy, 13% (N=9) of veggies out of 170 products, were claimed "Low/No/Reduced Saturated Fat"; while 1% (N=5) of veggies, 3% (N=2) of red meat and 5% (N=1) fish burger) were claimed "Low/No/Reduced Fat".

As in part expected the level of carbohydrates in veggie burgers was the highest, as plant-based products contain different starch-rich ingredients like flours, starches, and breadcrumbs. On the contrary, red meat burgers are produced primary from 70% of meat (pork, veal or beef) and 25-30% of fat as main ingredients [13].Meat burgers containing plant-based ingredients (N=46) are made by replacing only a part of red meat with vegetables and legumes [carottes (N=16), pea (N=15), soy (N=5) and chickpea (N=2)] in different forms mainly proteins, starches or/ and fibers. These products are categorized within meat burgers and consumers have to read the ingredients' list to be distinguish them from the traditional meat burgers. In the present study, hybrid products (a part of meat was substituted with a more sustainable source) were not considered separately from meat burgers because the addition level of the plant-based ingredients was not mentioned in all products and when mentioned it did not exceed 15%. Consequently, this makes difficult understanding if the substitution is for functionality reasons (it is a

meat burger with plant-based ingredients) or for meat reduction (it is an hybrid product). Poultry and fish burgers had intermediate carbohydrates median values due the inclusion of breadcrumbs or flours/ starches deriving from corn, rice, or wheat) that are used as binders. Veggie burgers showed also the highest sugar content, with a high range of variability due to the diversity of ingredients used in the different formulations (*e.g.*, potato and tapioca starches, dextrose, maltodextrin) which are supposed to be added as fat replacers in these products. In some formulation, raw cane sugar, caramel sugar syrup and honey were also declared. No differences were found for this parameter between red meat, fish and poultry burgers.

Protein content was significantly higher in red meat and poultry burgers than in the veggie products. Interestingly, the range of values for this parameter in veggie burgers is extremely variable, reaching a maximum of 40 g/100 g in one product. This also explains the fact that 76 veggie burgers were claimed high/ added of proteins, while other veggie burgers are poor sources of proteins, probably due to the high relevance of starchy ingredients in their formulations.

Salt content did not show any significant differences between the four burger types. This observation does not agree with the results of a survey carried out in a UK supermarket in June 2019, which find out that salt in plant-based mince was much higher (almost 6 times) than in meat mince, while meat sausages contained 66% more salt than the plant-based sausages [37]. This positive change could be due to the progressive consciousness of the food industry about the need to reduce the use of salt in the new formulations. Anyway, none of the products were claimed low/no/ reduced salt, highlighting the need for further efforts to reduce salt in this type of products. WHO recommends to limit salt intake to no more than 5 g per day [4]. The current daily salt consumption in most European countries is estimated to range between 8 to 12 grams per day, with few Member States (*e.g.,* Spain, France, and Italy) above and other few (*e.g.,* Germany) below this intake level [38]. Salt intake above of 7.2 g/d is strongly related to elevated blood pressure and can lead to cardiovascular and renal disease [39]. Again, a high variability in the salt content was observed in both red meat and veggie products. Noteworthy, in some red meat burgers, no added salt was used, as the recipes were made from 100% minced meat, while, in one red meat burger, the salt reached ~4g/100 g.

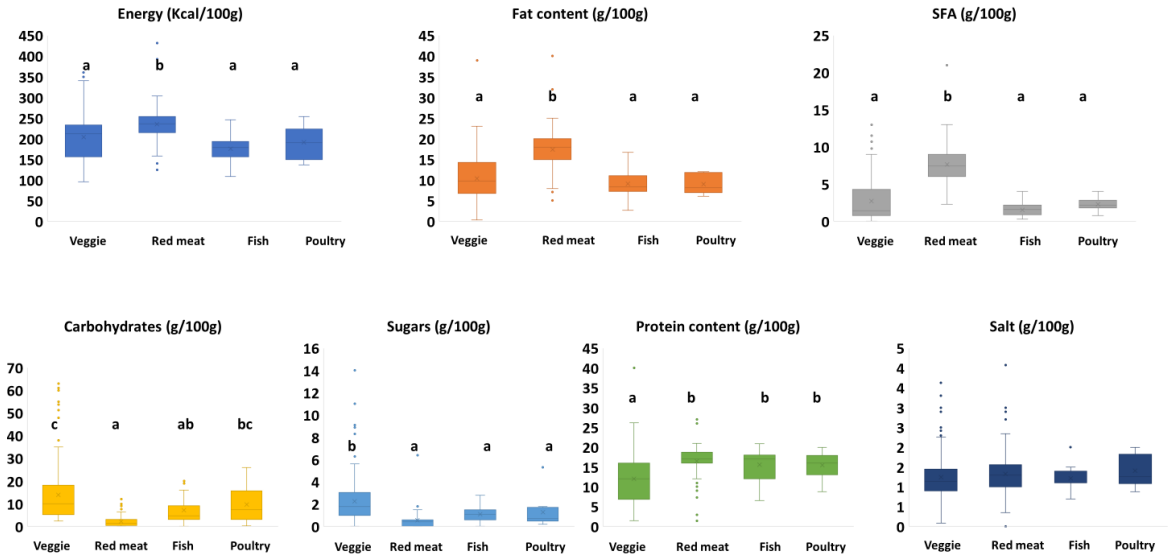

Figure 1: Nutritional profile of veggie (n = 170), red meat burgers (n = 72), fish (n = 19), and poultry (n = 12) burgers launched in the EU market during 2020. Statistical significance based on Kolmogorov–Smirnov test ($p < 0.05$). The box-plot legend: the box is limited by the lower (Q1 = 25th) and upper (Q3 = 75th) quartile; the median is the horizontal line dividing the box; Whiskers above and below the box indicate the 10th and 90th percentiles; outliers: are the points outside the quartile 10–90th percentiles.

Table 3: Main ingredients declared on the package of products launched in EU market in 2020.

	Veggie	**Red meat**	**Fish**	**Poultry**
Carbohydrates/ sugars	Wheat flour, spelt flour, semolina, burgur, rice flour potato, starches (potato, tapioca, corn), breadcrumb, dextrose, honey, cane sugar, maltodextrin	Glucose, sugar, potato starch, bread crumb	Breadcrumb, potato starch, potato flakes, dextrose, glucose, maltodextrin	Glucose syrup, dextrose, maltodextrin, honey, potato starch, wheat flour, breadcrumb, rice flour, corn flour
Fat /SFA	sunflower oil, corn oil, turnip oil, rapeseed oil, coconut oil and palm oil, butter, milk powder and cheese	Beef, porc, veal, cheese, egg, rapeseed oil,	Milk, cheese, rapeseed oil, sunflower oil , cod	Chicken, chicken skin, rapeseeds oil, milk, egg
Proteins	Soy protein, pea protein, quinoa protein, lentil, chickpeas, soybeans,	Beef, porc, veel egg, soy protein, pea protein, mix of vegetables and legumes	Fish (salmon, tuna, cod, and haddock), egg white, pea protein,	Chicken, duck, hydrolysed vegetable protein (hydrolysed corn protein, hydrolysed rapeseed protein), soy protein, pea protein,

3.2.2. Allergens

The list of allergens, declared on the package under the Regulation (EU) No. 1169/2011, is summarized in terms of percentages per each type of burgers in Table 4. Only 2.34% of veggie burgers was claimed gluten-free, while none of the other categories received this denomination. No product (regardless of the category) was claimed dairy-free or allergen- free or lactose-free.

Gluten was the most declared allergens in the case of veggie burgers due to the presence of gluten-containing flours or semolina (*e.g.,* wheat, spelt and barley), derived ingredients (*e.g.,* wheat fiber, wheat proteins and vital gluten) or processed forms (e.g., breadcrumb). These ingredients were also found in in fish and poultry burgers, which explains the high percentage of products declared with gluten in both types (42.1 and 66.7 %, respectively). Red meat burgers showed low number of products containing wheat and gluten compared to the other categories.

Dextrose and maltodextrin are commonly used as binders and fat replacers or to improve juiciness and tenderness in both veggie and meat, fish and poultry burgers [40], and this explains why wheat was declared as an allergen in many products. As expected, soybean was declared in 49% of veggie burgers, since it is one of the most used plant protein sources in alternative formulations. Red meat, poultry and fish burgers also may contain soybeans but at less extent.

Veggie burgers contained milk and eggs in 8.8% and 15.9% products. Eggs (egg white powder) are the most common and effective binder in vegetarian burgers, while egg replacers including wheat germ, breadcrumbs, oats, and ground flaxseeds are used in vegan burgers. Milk and cheese (*e.g.,* mozzarella, Emmental cheese), milk powder, or whey powder are also added to provide flavoring and functionalities. Likewise, red meat, fish and poultry burgers contained milk and egg products such as skimmed milk, whey protein concentrate, whey powder, cheese, cream powder, and white egg powder.

Mustard was also declared mostly in fish and poultry burgers since mustard can provide meat tendering and flavoring [41]. Celery and sesame are used as flavoring ingredient [24], and were declared only in a small percentage of veggie products.

Sulphur dioxide/sulphites were employed mostly in poultry burger but was not declared in any of the veggie products. Sulphur dioxide/sulphites are commonly used in burgers as food preservatives to prevent browning or discoloration owing to their antimicrobial, color stabilizing, antibrowning, and antioxidant properties [42]. In Europe, the Regulations (EC) no. 1129/2011 and (EC) no. 1333/2008 authorize the addition of sulfites (up to 450 mg/kg) in meat burger (made with a minimum amount of cereal or/ and vegetable of 4 %).

Table 4: List of allergens declared on the package of burgers launched in 2020.

Allergen	Veggie burgers	Red meat burgers	Fish burgers	Poultry burgers
Gluten	68.8% (N=117)	6.9%(N=5)	42.1%(N=8)	66.7%(N=8)
Wheat	58.8% (N=100)	6.9%(N=5)	36.8%(N=7)	41.7%(N=5)
Soybeans	48.8% (N=83)	4.2%(N=3)	21.0%(N=4)	33.3%(N=4)
Milk	8.8% (N=15)	6.9%(N=5)	5.3%(N=1)	41.7%(N=5)
Eggs	15.9% (N=27)	2.8%(N=2)	10.5%(N=2)	16.7%(N=2)
Fish	0.0% (N=0)	27.1%(N=19)	100.0%(N=19)	8.3%(N=1)
Mustard	3.5% (N=6)	2.8%(N=2)	10.5%(N=2)	33.3%(N=4)
Celery	7.6% (N=13)	0.0%(N=0)	0.0%(N=0)	0.0%(N=0)
Sulphur dioxide/Sulphites	0.0% (N=0)	2.8%(N=2)	10.5%(N=2)	50.0%(N=6)
Sesame seeds	1.8% (N=3)	0.0%(N=0)	0.0%(N=0)	0.0%(N=0)
Nuts	1.2% (N=2)	0.0%(N=0)	0.0%(N=0)	0.0%(N=0)

3.3. Nutritional labelling of veggie burgers in the EU: vegan versus vegetarian

As "veggie" includes products with the indication "vegan" or vegetarian" on the package, the nutritional information of these two categories was further analyzed by considering them separately, and several significant differences were highlighted (Figure 2). Statistically, energy, carbohydrates, sugars, fat, SFA and proteins varied significantly. Vegan burgers had higher energy, fat, SFA and protein contents than vegetarian burgers, but contained less carbohydrates and sugars. Salt did not vary significantly between both groups. Anyway, a great heterogeneity was observed in the nutritional profile of both groups of products launched in the EU market during 2020, which could confuse the consumer when making the purchase decision.

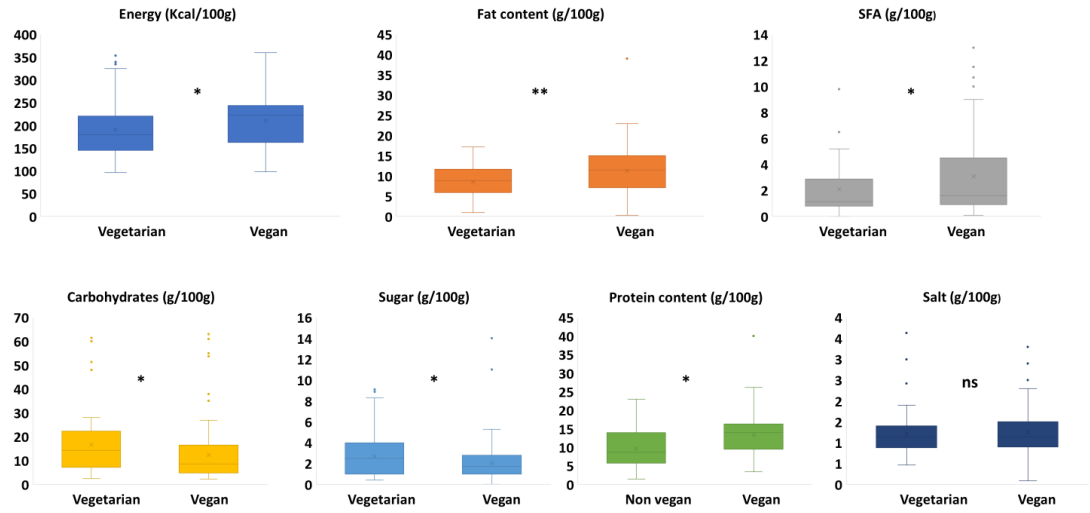

Figure 2: Nutritional profile of vegetarian burgers (n = 59) versus vegan burgers (n = 111) launched in the EU market during 2020. Statistical significance based on Kolmogorov–Smirnov test (*: $p < 0.05$, **: $p < 0.01$, ns: non-significant ($p > 0.05$)); the box-plot legend: the box is limited by the lower (Q1 = 25th) and upper (Q3 = 75th) quartile; the median is the horizontal line dividing the box; Whiskers above

and below the box indicate the 10th and 90th percentiles; outliers: are the points outside the quartile 10–90th percentiles.

4. Conclusion

The evaluation of the nutritional composition available on the labels of burger products launched in 2020 in EU showed that veggie, red meat, fish, and poultry products differed considerably in their nutrient composition, being veggie burgers more similar to poultry and fish burgers, even if they generally contain more sugars and less proteins than the other meat or fish products. Therefore, food developers need to focus on overcoming this shortness (high sugar and low protein) to boost the market of veggie burgers as healthy foods and to offer consumers (especially vegan) a nutritionally balanced product. Such action is required to avoid any health complication for people consuming important amount of vegan products. For instance, consuming high sugar product might lead to weight problem or obesity, while low protein diet can affect the immunity system. To overcome the nutritional limitation, the technological and sensory aspects are equally relevant and consequently suitable ingredient/ processing must be identified for the production of nutritious and tasty products. Overall, the veggie market is clearly growing as evidenced by the high number of new products launched in the EU market during 2020. This offer consumer to choose the product fitting their health habits and expectation. Indeed, veggie burgers showed a great heterogeneity in their nutritional profile, inclusive between the vegan and vegetarian categories. This could confuse the consumer and emphasizes the importance of a clear and complete label information for a suitable purchase decision.

Gluten is the most declared allergen in veggie burgers as well as in fish- and poultry-based products, but eleven different categories of allergens appeared to some extent in the products launched in the EU market in 2020. Only a small percentage of new products was labelled as gluten-free (only 2.35% of veggie burgers), while none was claimed allergen-free. Focusing on veggie burgers, vegan burgers have higher energy, fat, SFA and protein than vegetarian burgers, but lower carbohydrates and sugars. Thanks to the wide range of vegetables and legumes that can be used in formulating veggie products, versatility of ingredients can help having products exempt of allergen (s) or not depending on the formulation. In this case, clear labeling is mandatory so consumers can make the right decision.

Supplementary materials

Table S1: Nutritional profile of veggie burgers (n = 170) versus red meat burgers (n = 72), fish burgers (n = 19), and poultry burgers (n = 12).

Author Contributions

Conceptualization, F.B. and M.C.; methodology, F.B. and M.C.; validation, F.B. and M.C.; formal analysis, F.B.; investigation, F.B. and M.C.; resources, M.C.; data curation, F.B.; writing—original draft

preparation, F.B.; writing—review and editing, F.B. and M.C.; project administration, M.C.; funding acquisition, M.C. All authors have read and agreed to the published version of the manuscript.

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Ethics declarations

Conflicts of Interest

The authors declare no conflict of interest.

Ethical approval

This article does not contain any studies with human or animal subjects.

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