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D5.2 - Report on current market developments and innovation potential of fermented food products – secondary market research

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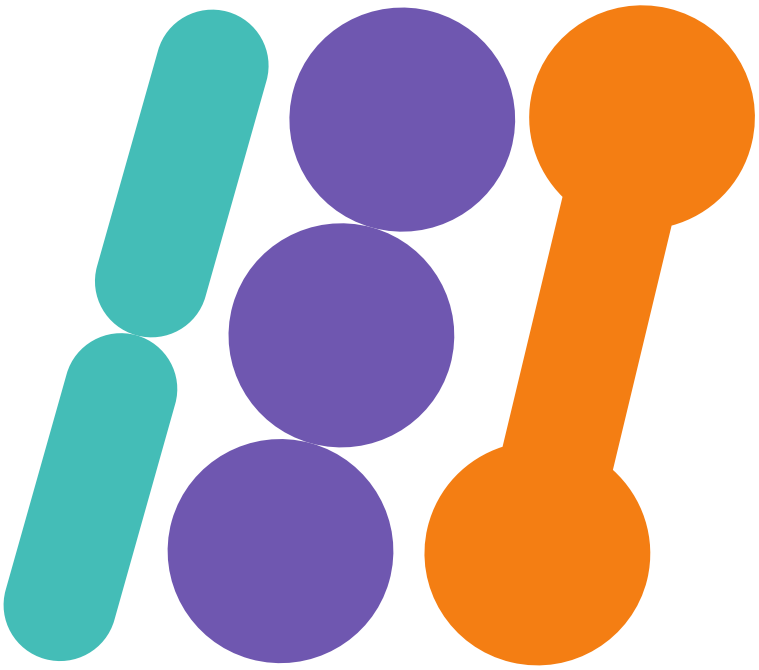

Report on current market developments and innovation potential of fermented food products – secondary market research

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Executive summary

The purpose of the work carried out is to deliver on the working package's task 5.2 (Market assessment and producer survey), including evaluation of marketing practices, nutritional composition, and microbiota used.

For the market assessment, the search strategy for and the final data set of the product launch data, and analysis of the data is completed. The data obtained through Mintel's Global New Product Database (GNPD) is used to assess the market dynamics of fermented foods, but also their nutritional value, employed product claims, and so forth – likewise in comparison to relevant product categories that are not fermented.

The data provided by Mintel allowed us to define several dependent variables for our independent variables 'product category' and 'fermentation status', which are mainly based on nutritional values and Front-of-Pack (FOP) claims. For meat substitutes, we introduced product categories ourselves to account for the different nature (and composition) of, for example, cold cuts and burgers. For beverages, we used the categories as provided by Mintel. We also introduced a variable describing the fermentation status, which is based on the products' ingredient lists: We identify fermented foods in the ingredient lists by checking these lists for more than 3,500 different fermented foods and assign a specific weight based on the total number of ingredients of a product and the position of the identified fermented food in that respective ingredient list.

This approach made it possible to determine the fermentation status of all considered products. For both, meat substitutes and beverages, the majority of products is not or slightly fermented. We applied one-way ANOVA to assess the significance of the variation in the means for our dependent variables. For significant results, we also performed pairwise comparisons per product category and fermentation status using the Bonferroni test.

This report summarizes the findings. However, those findings are rather of a descriptive nature as it was not possible to identify variables that explained the observed variation by product category and fermentation status. That also applies to the significance of these variations: If and how strongly means differ from one another very much depends on the variable, the product category, and the fermentation status, making it challenging to draw general conclusions. Still, carefully expressed, when using the A-Score, the vegan status, and the number of ingredients and additives as proxies for healthiness and naturalness, there is an indication that meat substitutes and beverages with higher fermentation statuses tend to be "healthier" or "more natural" than their not or slightly fermented counterparts.

Background

This deliverable describes the conducted work for task 5.2. In order to define the right population for GNPD and literature research, the term 'fermented' needs to be specified for that instance. In the grant agreement/project proposal of this project, the project partners describe fermentation by the following characteristics:

Foods or drinks that contain microbes which either

- contribute to preservation, or
- improve sensory properties

are considered as fermented foods or drinks. [Project Proposal, Part B, p. 3, 1.1.3. Ambition]

A more detailed definition might be:

Fermented foods and drinks are created through desired microbe(s)

- either as ingredient(s) or means of production,
- either added on purpose or as natural compound of the raw product,
- either for purpose of preservation, taste, texture, or other physical characteristics, and/or as production method,
- excluding the very strains/microbes themselves as a fermented product.

The above definition of fermentation reveals that fermentation might define one or more of the following product attributes:

- Means of preservation/conversation (e.g., smoking, deep frying, … or biological, chemical, …)
- As a food additive (e.g., bacteria, preservation agents, vitamins, …)
- A food production method (e.g., traditional, industrial, …)
- A specific taste (e.g., sour and savory, salty, …)
- A food category (e.g., meat, superfood, …)

Having those attributes in mind will help to identify products that belong to the category of fermented products – for both, GNPD and literature research. Furthermore, the current definition of The International Scientific Association for Probiotics and Prebiotics (Marco *et al.*, 2021) and the Periodic Table of Fermented Foods (Gänzle, 2022) are to be considered as well along, with possible limitations/exclusions based on this project's focus.

Work carried out

3.1. Data retrieval

To assess market dynamics, data from Mintel's Global New Product Database (GNPD) is used and analyzed. This database is comprised of global product launches in the Fast Moving Consumer Goods (FMCG) and includes, next to launch data, all information that is provided on the product's outside packaging (Solis, 2016).

The analysis of GNPD product launches will yield insights into current marketing practices (Front of Packaging (FOP) labels; health claims), nutritional composition and microbiota used, and economic potential (competitiveness; price ranges) of FF products newly introduced to the market. The results of the analysis shall also be used to conclude on the innovation potential of fermented foods and drinks as it is a promising approach to derive innovation dynamics in a market.

3.1.1. Assessment path

For identifying eligible products, it was required to define fermented foods and drinks in general. In addition, it is key to this analysis to fetch the relevant product launches in GNPD. Therefore, an appropriate search strategy was designed for the database, but also specific inclusion and exclusion criteria were derived, since Mintel tracks around 40,000 launches per month globally (Mintel Group Ltd., 2023).

In order to construct searches, a core search was developed in Mintel's GNPD to quickly perform individual searches on specific attributes using the core search as starting point for amending search limiters and filters. The core search was fine tuned in an interactive approach to account for the maximum number of relevant product launches in the database but also to limit the number of search results. Therefore, inclusion criteria were defined as follows:

- Market: Only products launched in France, Germany, Italy, Spain, and UK are considered to account for the most dominant markets in the EU and align with the project's focus[1]
- Launch date: Only products launched between 2000 and 2022 are considered (2000 because, acc. to Mintel, market coverage in those markets starts to be sufficient in 2000 to fetch most product launches and 2022 to disregard new launches afterwards for constant search results)[2]
- Launch type: New packaging is excluded since it is not associated with an innovation of the product itself (project's focus on innovation potential of FF)

Consequently, the final search query for the core search is:

Search for products

where **Market** matches one or more of France; Germany; Italy; Spain; UK

and **Super-Category** matches one or more of Food; Drink

and **Launch Type** matches one or more of (New Variety/Range Extension; New Product; Relaunch; New Formulation)

and **Date Published** is between Jan 2000 and Dec 2022

Figure 1 Mintel search query for core search

As a next step, the database's record features were assessed to derive inclusion criteria (i.e., identifiers) for fermented and non-fermented foods and drinks. This approach was chosen to retrieve search results for fermented and non-fermented products separately in order to be able to compare both categories. Even though the derived identifiers referred to in Milestone Report MS.3 ("Evaluation of current market developments and innovation potential of FF products") were confirmed by Mintel's account director and analysts to fetch all relevant products according to their fermentation status, assessment of the retrieved search results revealed that segmentation of the retrieved product launches was not accurate, this is, non-fermented products were part of the retrieved search results applying the criteria for fermented products and vice versa.

The applied inclusion criteria (i.e., Mintel's search limiters) were as follows:

[1] Republic of Ireland, even though a relevant market to the project, is not considered due to its market size (e.g., from 2000 to 2022 1,259 meat substitute products were launched in the UK (without re-packaging launches) whereas only 46 launches took place in Ireland of which 58% took also place in the UK.

[2] GNPD data quality (integrity and completeness) tends to improve throughout the decades – acc. to Mintel, market coverage for product launches in respective markets is supposed to be 90% and above.

- Product claim: Probiotic (considered relevant as FF-related product feature but not retrievable using term *ferment**; claim "digestive" is excluded since it is too vague)
- Ingredients: Food Micro-Organism; Probiotics (considered relevant as FF-related product feature but not retrievable using term *ferment**)
- Product category: Kombucha & other fermented drinks; Drinking yogurt & liquid cultured milk (all products in these sub-categories are of relevance)
- Ingredient preparation: Fermented[3] (to fetch products with fermented ingredients but without the term *ferment** in their name)
- Full-text search: *ferment** (to retrieve all products that do not comply with previous searches on claims and ingredients)

For respective non-fermented products, these limiters were negated, this is, for instance, product claim being *NOT* probiotic. Consequently, however, the inclusion criteria were dropped entirely[4]. Instead, all product launches that are in line with the above-mentioned search query are to be considered relevant. The segmentation of products into fermented and non-fermented foods and drinks will then not be carried out by applying different search limiters but instead by assessing the products' ingredients.

3.1.2. Final data set

Based on the above findings, it was decided to focus the analysis of product launch data on individual product categories that are a) of relevance to the project and b) reflect the rising interest in functional and sustainable food choices. The chosen product categories are:

- Selected beverages, and
- Meat substitutes

Beverages were chosen because one focus of the project lies on Kefir. Therefore, products of the following (sub-) categories of GNPD are to be analyzed:

- Nutritional & meal replacement drinks
- Kombucha & other fermented drinks
- Drinking yogurt & liquid cultured milk
- Plant-based drinks (dairy alternatives)
- Juice drinks (fruit/flavored still drinks, juice, nectars)

Other beverages (alcoholic beverages, carbonated soft drinks, hot beverages, RTDs, sports & energy drinks, water, beverage concentrates, and mixes) were excluded to focus the analysis on functional or health-related drinks only and allow for a comparison between fermented and non-fermented beverages where fermentation might still be perceived as product attribute by consumers (i.e., the working hypothesis is that the higher the processing degree, the less fermentation is relevant to the final product). Alcoholic beverages are excluded even though it might contradict the above working hypothesis but due to health impacts (apart from low alcoholic content below 2% like Kefir).

The resulting search strategy comprises relevant fermented (sub-) categories as well as the above-mentioned core search (see Table 1).

[3] Includes fermented; bottom fermented; cold fermented; fast fermented; from Aspergillus Oryzae fermented Maltodextrin; from ferment media; fully-fermented; Lactic Acid fermented; Lactobacillus fermented; long fermentation; partially fermented; partially Lactic Acid fermented; semi-fermented; pre fermented; Shiitake mushroom fermented; top fermented; traditionally fermented

[4] The intermediate results of Milestone Report MS.3 ("Evaluation of current market developments and innovation potential of FF products") are, therefore, outdated and not comparable to the final data set of this deliverable report.

Table 1 Search query for selected beverages (Note: Categories applied are of Mintel GNPD sub-categories)

Mintel search limiter	Match
(Category *OR*	Juice Drinks
Sub-Category *AND*	Kombucha & Other Fermented Drinks; Drinking Yogurt & Liquid Cultured Milk; Nutritional & Meal Replacement Drinks; Plant-based Drinks (Dairy Alternatives))
(Market *AND*	UK; Italy; France; Germany; Spain)
(Launch type *AND*	New Product; New Variety/Range Extension; New Formulation; Relaunch)
(Date published	between Jan 2000 and Dec 2022)

Meat substitutes (or alternatives or analogs) are non-meat-based products that are supposed to be meat-like, i.e., sharing same attributes like texture, taste or meal function (Rödl, 2018). They are of particular relevance to a) the project and b) from a research perspective in order to foster more sustainable diets. Therefore, this GNPD sub-category is analyzed entirely (distinguished between fermented and non-fermented). The resulting search query is displayed in Table 2.

Table 2 Search query for meat substitutes

Mintel search limiter	Match
(Sub-Category *AND*	Meat Substitutes)
(Market *AND*	UK; Italy; France; Germany; Spain)
(Launch type *AND*	New Product; New Variety/Range Extension; New Formulation; Relaunch)
(Date published	between Jan 2000 and Dec 2022)

Eventually, the sets of relevant products were finalized and downloaded from Mintel GNPD in MS Excel format, including product details as provided, such as label information, country of origin, nutritional details, ingredients, pricing, packaging details, and so forth.

3.2. Data processing

We performed several steps to process Mintel data and enrich it with additional details. Firstly, the downloaded MS Excel files were imported into the statistics software Stata (v18). Secondly, cleansing of product data was performed, e.g., special characters such as "<=" or ">" had to be removed from nutritional details to be able to perform mathematical operations. Additionally, Mintel data was labeled, and variables were defined.

Mintel data also includes information about the **FOP labels** of a product. We assessed all the labels born by the products and segregated those into nutritional or health claims[5]. **Nutritional claims** are based on the Annex of Regulation (EC) No 1924/2006, lastly amended by Regulation (EU) No 1047/2012 (European Parliament and Council of the European Union, 2006; European Commission, 2012) and include, for example, 'dairy free' and 'reduced cholesterol', whereas **health claims** are, for instance, 'diabetic' or 'wholegrain'.

We also removed **outliers** for all nutritional values, such as energy or fiber, and sales price per 100g/ml by applying the BACON algorithm. BACON stands for 'blocked adaptive computationally efficient outlier nominators' and its algorithm identifies multiple outliers in multivariate data (Weber, 2010). Furthermore, we completed **missing nutritional values** as follows:

- Energy (kJ): Derived from energy (kCal) by multiplying it with 4.2 (Santé publique France, 2015)
- Energy (kCal): Derived from energy (kJ) by dividing it by 4.2 (Santé publique France, 2015)
- Sodium (mg): Derived from salt (g) by dividing it by 2.5 and multiplying it with 1000 (Santé publique France, 2015)
- Salt (g): Derived from sodium (mg) by multiplying it with 2.5 and dividing it by 1000 (Santé publique France, 2015)
- Fibre (g): Derived from (Energy (kCal) - 9 * Fat (g) - 4 * Carbohydrates (g) - 4 * Protein (g)) / 2 (European Parliament and Council of the European Union, 2011)

In addition, some GNPD data contained fairly high energy levels (kJ and kCal) with values above 10,000. We assume this to be a conversion error (e.g., kJ vs. J) and corrected it by replacing those values with 1/1000 of their original value.

To assess the **nutritional quality** of the products, we utilize the A-score of the Ofcom-score. The Ofcom-score is comparable to the Nutri-Score as "nutrients to limit" (energy, sodium, saturated fat, and sugar) are put into relation with "nutrients to encourage" (fruit, fiber, nut, protein, or vegetable content) (Rayner *et al.*, 2009). Since information about nut content is not necessarily provided on a product's packaging, only "nutrients to limit" can be derived by assigning points to specific nutrient thresholds – the so-called A-score. The higher the A-score, the lower the nutritional quality of the food/beverage. Thus, the A-score can be applied as a proxy to assess the nutritional quality of products (Petersen, Hartmann and Hirsch, 2021). In case information about the relevant nutrients could not be obtained, we refrained from calculating the score.

For the assessment of the **healthiness** of products, we apply another proxy: the number of food additives in a product. Even though scientific prove of the unhealthiness of additives is still vague, consumers perceive products with additives less healthy and natural, and riskier. By applying this proxy, we follow the approach of Petersen et al. (2021). To calculate the number of additives, we checked the product's list of ingredients against the food additives listed by the Directorate-General for Health and Food Safety (European Commission and Directorate-General for Health and Food Safety, no date), and counted the matches.

[5] where applicable; see Table A 1. Nutritional claims are based on the Annex of Regulation (EC) No 1924/2006, lastly amended by Regulation (EU) No 1047/2012. Health claims relate to all other FOP claims alluding to health, independent of EU regulation.

For further analysis, we distinguish between **vegetarian and vegan**, that is, solely plant-based products. For that matter, we assigned all products their respective status based on their product descriptions and claims. Products with descriptions mentioning the terms "vegetarian" or "vegetal", or bearing the claim "vegetarian" are considered vegetarian. Products with descriptions mentioning "vegan" or "plant-based", or bearing the claim "Vegan/No Animal Ingredients" are assigned the vegan status. However, products that do not explicitly mention their status, either in their product descriptions or by bearing a respective claim, are not assigned to one of the statuses even though they still might be vegetarian or vegan.

For meat substitutes, Mintel does not provide **additional categorization** of the products. This is, all products, independently from their category, belong to Mintel's sub-category of meat substitutes. However, we expect product details, nutritional composition, and pricing to be different among, for instance, plant-based cold cuts and plant-based minced meat. Therefore, we introduced additional categorization of meat substitutes to account for the heterogeneity of the sample and to better analyze similar products for the sake of nutritional values and fermentation degree. The categories originate from previous research/literature (Hoek *et al.*, 2011; Petersen, Hartmann and Hirsch, 2021). To conclude on the category of a product, the product's name was analyzed for keywords of the respective category (e.g., category burger contains keywords such as patty, tartare, and quarter (for the full list see Table A 2)). In case no keyword was found in the product's name, the category was assigned manually by checking the product picture in Mintel's database or consulting the product's description (e.g., "spinach pie" is categorized as burger). In case multiple keywords were identified, the product was manually assessed as well and assigned to the most applicable category (e.g., "Plant-based Chicken-Like Minced Meat with Provence Herbs by Hiltl" was associated with pieces (due to "minced" and to cuttings (due to "chicken") and, eventually, assigned to pieces due to its fragmented (but not minced) nature). For product mixes, the main product (based on weights stated in Mintel's database) was decided to be the dominating category and assigned accordingly (e.g., "Vegan Grilling Selection" was assigned to burgers since the main component rather imitates a burger patty).

The **fermentation degree** is defined by the number of fermented ingredients of the product's listed ingredients and their respective position in this very list to account for the decreasing relative share of an ingredient (weight-based) in the product the lower its position in the list. For this purpose, only the products' fermented ingredients and their position in the ingredients list are considered (in relation to the total number of ingredients of the product). To match the fermented ingredients, we used Gänzle's Periodic Table of Fermented Foods (2022) and Campbell-Platt's dictionary of Fermented Foods of the World (1987). For that matter, we retrieved and digitized 3,585 fermented foods and beverages to be applied to the product's list of ingredients.

Example "Barley Goat Honey Burgers" (ID 10457266): The product is made of 13 ingredients of which 4 classify as fermented (cheese, goats' cheese, vinegar, malt). Their respective positions in the ingredients list are 3, 3, 10, and 12. Duplicates are only accounted for once like in the instance with cheese and goats' cheese. Each value is assigned a corresponding weight, i.e., 12.92%, 2.7%, and 1.23%. The fermentation degree is the sum of the fermented ingredients' weights, i.e., 16.86%.

The respective weights are specified as follows:

$$W_i = \sum_{j=i}^{n} \frac{1}{p_i * n} \qquad (1)$$

with

W_i *Weight of i-th ingredient*

p_i *Position of i ingredient in ingredient list*

n *Total number of ingredients*

As a result, the total weights $W = \sum_{i=1}^{n} W_i = 1$. For the entire weighting matrix, please see Table A 3.

Next to the numerical fermentation degree, we also assigned a **fermentation status** that categorizes the fermentation degree into the following buckets:

Table 3 Fermentation status as per fermentation degree

Fermentation status	Fermentation degree
Not fermented	0%
Slightly fermented	1 - 15%
Partly fermented	16 - 50%
Mainly fermented	51 - 100%

The assessment and processing of both, fermentation degree and status, were performed in Stata. Using the products' record ID, we merge all datasets and analyses into one Stata dataset for further analysis. Figure 2 summarizes all data used and the processing steps.

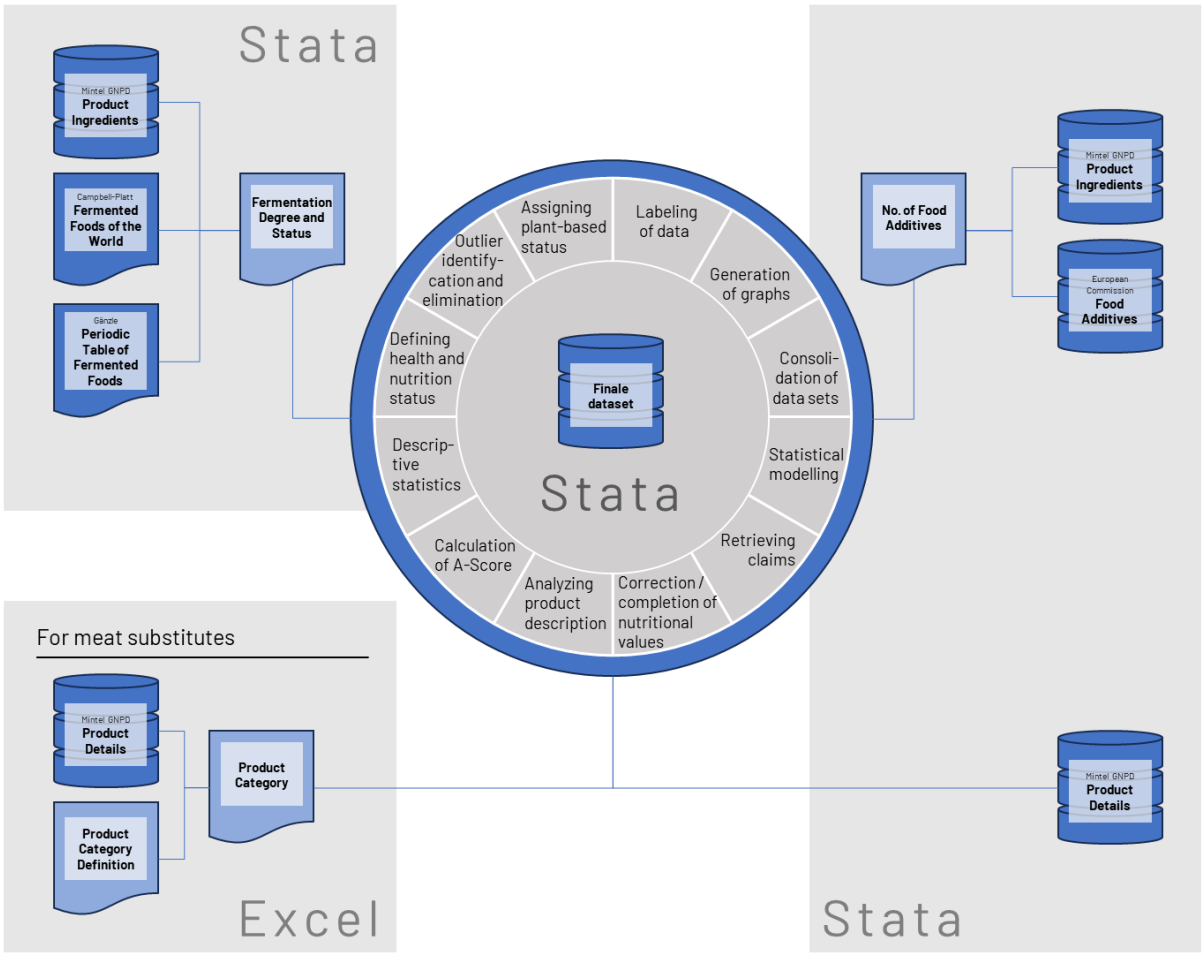

Figure 2 Used data and processing steps

Results

4.1. Meat substitutes

4.1.1. Overview

Overall, GNPD lists 4,385 product launches for meat substitutes (excl. re-packaging) from 2000 until 2020 in France, Germany, Italy, Spain and UK. Based on the fermentation status we defined, products can be summarized as follows:

Table 4 Summary table for meat substitutes as per market and fermentation status

Fermentation status / Market	Not fermented	Slightly fermented	Partly fermented	Mainly fermented	Total
France	353	408	177	3	941
Germany	559	544	141	9	1,253
Italy	177	286	86	0	549
Spain	200	280	101	7	588
UK	359	521	170	4	1,054
Total	1,648	2,039	675	23	4,385

Most of the meat substitutes are launched in Germany (29%), followed by the UK (24%). The largest share of meat substitutes is not or slightly fermented. For all the countries, most of the products are slightly fermented, apart from Germany, where the largest share of products is not fermented. Slightly fermented products often contain yeast, yeast extract, vinegar, olives, malt, or soy sauce. To provide an example, the three fully fermented meat substitutes in France are:

- Raw Ham (GNPD ID 844382)
- Provençale Barbecue Sausages (GNPD ID 368252)
- Panettine (GNPD ID 7454113)

Launch dynamics picked up in the second decade of the millennium, as illustrated in Figure 3, especially after 2015, with a decrease again after 2019. However, apart from an increase in the number of launched products, also Mintel's increasing market coverage in those markets might account for a higher share of products identified when being launched in a market. We are not able to counteract this effect but rather rely on Mintel's statement of covering more than 90% of the respective markets from 2000 onwards.

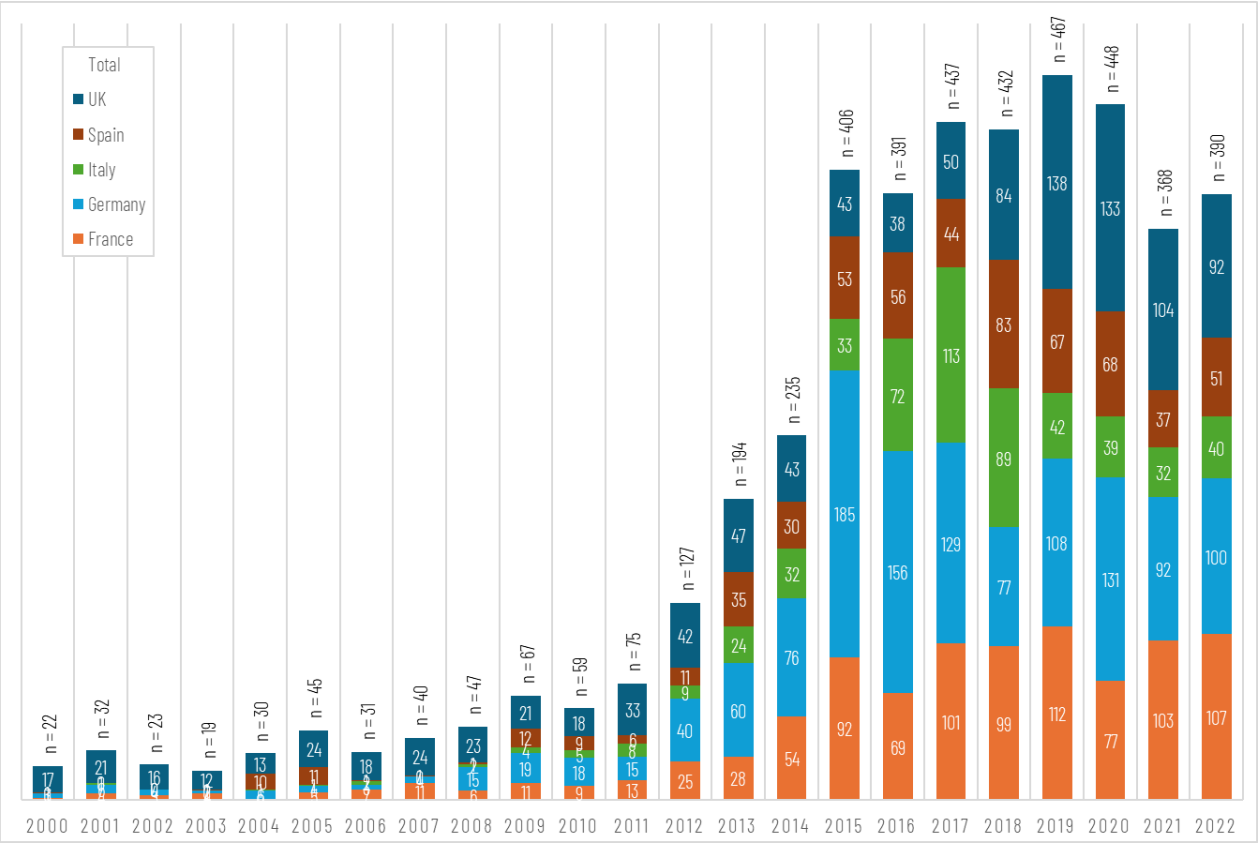

Figure 3 No. of meat substitute launches per year and market [Source: Own illustration based on Mintel GNPD]

When assessing the product categories that we assigned to the products, burgers and cutting/trimming are the most represented categories among the product launches (30% and 22% respectively), followed by coated meat substitutes (13%).

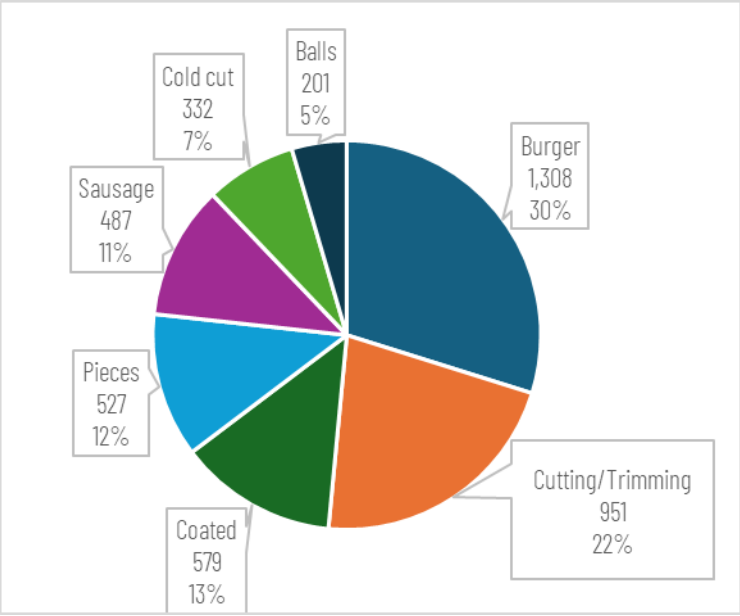

Figure 4 Distribution of product categories for meat substitutes

The fermentation status as per product category reveals that most of the partly and mainly fermented products belong to the categories of coated meat substitutes (n = 187), burger (n = 179), or cutting/trimming (n = 156). Balls and pieces are not, or only slightly or partly fermented, but not mainly fermented.

Table 5 Summary table for meat substitutes as per product category and fermentation status

Fermentation status / Product category	Not fermented	Slightly fermented	Partly fermented	Mainly fermented	Total
Burger	446	683	177	2	1,308
Cutting/Trimming	455	340	152	4	951
Coated	86	306	185	2	579
Pieces	265	198	64	0	527
Sausage	187	249	44	7	487
Cold cut	133	159	32	8	332
Balls	76	104	21	0	201
Total	1,648	2,039	675	23	4,385

On a time scale, launch activities as per product category start to diverge from 2010 onwards with burgers and cutting/trimming experiencing a boost in launches compared to the other categories, but also dropping again after 2019.

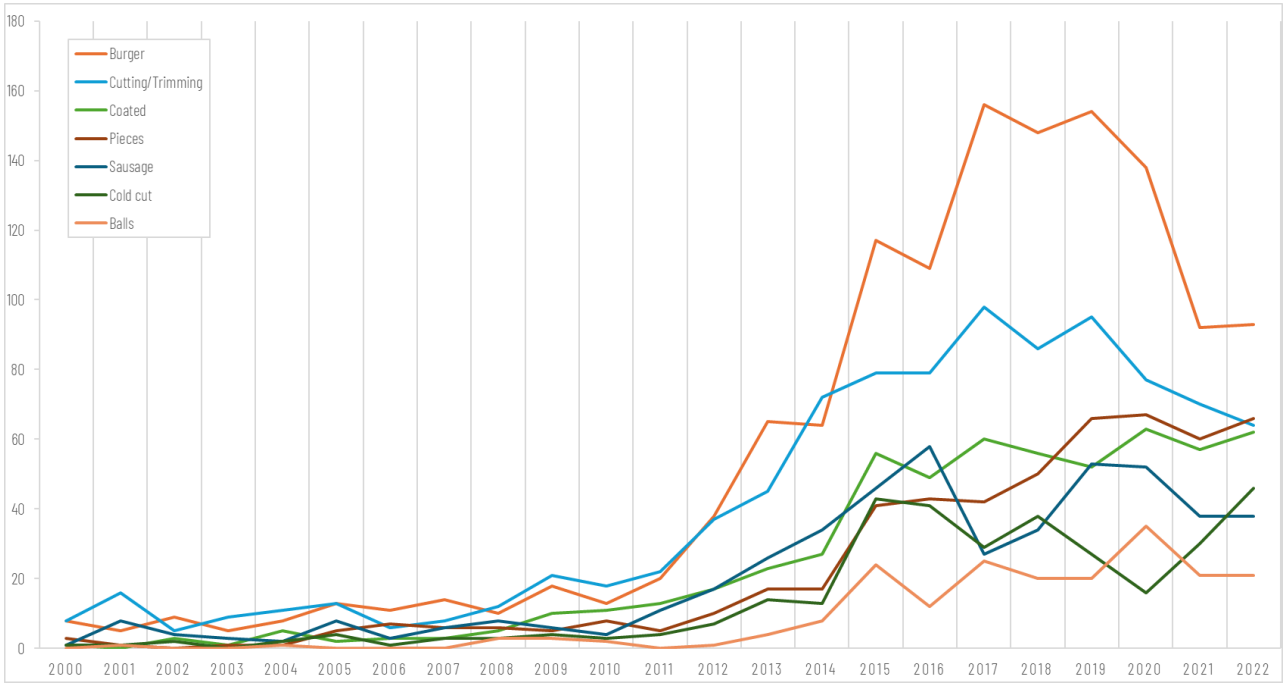

Figure 5 Meat substitute launches as per year and product category

4.1.2. Statistical assessment

To test for the significance of variances between the means of the different product categories as per fermentation status and corresponding dependent variables, we applied one-way analyses of variances (ANOVA). For significant differences in the means ($p < 0.05$), we performed a mean-by-mean post-hoc comparison with Bonferroni correction to test for significant variances in the means as per fermentation status. We apply Bonferroni to account for heterogenous and, for higher fermentation status, small sample sizes as well as data that is not normally distributed. Significant differences ($p < 0.05$) exist for the A-Score, health claims, number of ingredients and additives, vegan, private label, and time on market. No significant differences can be reported for nutritional claims, launch type, and price per 100g/ml. We report the results of the individual ANOVA as per dependent variable below, and respective significance values (p-value). The dependent variables we looked at are illustrated in Table 6.

Table 6 Dependent variables and respective ranges/values

Dependent variables	**Variable values**
A-Score	0-26
Nutritional Claims	No-Yes
Health Claims	No-Yes
No. of Additives	0-7
Vegan	No-Yes
Private label	No-Yes
Price per 100g/ml	0.26-16.98
Launch type	New Formulation, New Product, New Variety/Range Extension, Relaunch
No. of ingredients	1-69
Time on market	0.01-22.98 years (01.01.2000 – 31.12.2022)

We also tested for additional interaction effects, this is including additional variables as independent variables in the ANOVA assessment like the country of the launch, vegetarian or vegan status, health or nutritional claim status, and private label. However, we were not able to retrieve a better model fit or more significant p-values across all dependent variables. For example, for meat substitutes in Spain and the UK, the means of the vegetarian status differ significantly by fermentation status and product category, while it is not significant for the remaining countries. That is also true for the health claim status of products launched in Germany and the UK, but again, not for the other countries.

For ANOVA with significant variation in the means as per product category and fermentation status, we observe the best explanatory power, this is the most product categories with significant differences in the means of their fermentation statuses as determined by the Bonferroni test, for number of ingredients and additives with all product categories means' p-value being < .05. For health claims as well as price per 100g/ml only two product categories show significant differences in their means as of fermentation status (for health claims, cutting/trimming and cold cuts; for price per 100g/ml, coated products and cold cuts).

A-Score

Table 7 Mean A-Score as per fermentation status and product category for meat substitutes

Fermentation status / Product category	**Not fermented**	**Slightly fermented**	**Partly fermented**	**Mainly fermented**	**Total**	**p-value** (one-way ANOVA)
Burger	7.95	8.23	7.96	2.00	**8.10**	0.1095
Cutting/ Trimming	5.23 [a]	8.60 [b]	7.59 [c]	12.00 [abc]	**6.90**	<0.0001
Coated	8.10 [a]	8.78 [a]	8.25 [ab]	17.00 [b]	**8.53**	0.0036
Pieces	7.08 [a]	8.44 [b]	7.34 [ab]	n/a	**7.64**	0.0004
Sausage	11.59 [a]	10.30 [b]	9.49 [ab]	10.00 [ab]	**10.71**	0.0023
Cold cut	11.30	11.51	10.06	n/a	**11.27**	0.1196
Balls	8.51	8.55	8.95	n/a	**8.58**	0.8567

Note: Different letters in the same row (product category) indicate significant differences between fermentation statuses as evaluated by the Bonferroni post-hoc test ($p < 0.05$); missing letters for insignificant ANOVA results; n/a for missing products or missing A-Score input data (nutritional values)

The means of the A-Score, as a proxy for the nutritional quality of food products, differ significantly by fermentation status, $F(3, 3859) = 23.25$, $p < .0001$. As the A-Score captures the 'nutrients to limits', the higher the score, the lesser the nutritional quality of the product. In that regard, cold cuts and sausages observe the lowest nutritional quality with an A-Score of 11.27 and 10.71, respectively. Cuttings/trimmings and pieces, on the other hand, show the best nutritional quality with an A-Score of 6.9 and 7.64, respectively. Considering the fermentation status, the A-Score tends to slightly increase – apart from sausages – from not to slightly fermented, dropping – apart from balls – at partly fermented and, for products with A-Score information, rising again for mainly fermented products. For cutting/trimming and coated meat substitutes, the A-Score is highest for mainly fermented, while for burgers, this status observes the lowest A-Score.

Once the one-way ANOVA revealed significant differences in means for the fermentation status as per product category, we performed a Bonferroni post-hoc test for each product category individually. We used the Bonferroni test with a 95% significance level to determine the differences between fermentation status per product category as presented in Table 7. For **Burgers** (sample size = 1,169), the fermentation status had no significant effect on the A-Score, $F(3, 1165) = 2.02$, $p = .1095$. For **Cutting/Trimming** (sample size = 777), we observe a significant effect with $F(3, 773) = 46.77$, and $p < .0001$. However, there is no significant difference in the means for partly and mainly fermented products with $p = 1.0$, but for the means of not and slightly fermented only. Also for **Pieces** (sample size = 489), we can show a significant effect with $F(2, 486) = 8.07$, $p = .0004$. Means only differ significantly for not and slightly fermented products ($p < 0.05$) as well. For **Coated** ($n = 534$), results are significant too ($F(3, 530) = 4.58$, $p = .0036$), with significant differences between the means of all fermentation statuses vs. mainly fermented. For the remaining product categories, individual one-way ANOVA did not show significant effects of the fermentation status on the A-Score (**Sausage** ($n = 414$): $F(3, 410) = 4.9$, $p = .0023$; **Cold cut** ($n = 287$): $F(2, 284) = 2.14$, $p = .1196$; **Balls** ($n = 193$): $F(2, 190) = 0.15$, $p = .8567$).

Nutritional claims

Across all product categories, the mean for the presence or absence of nutritional claims does not differ significantly as a result of the one-way ANOVA ($F(3, 4381) = 2.14$, $p = .0928$). That also applies to the means of the individual ANOVA as per product category. Table 8 summarizes the means as per category and fermentation status, also showing that the means do not differ significantly from one another.

Table 8 Mean for nutritional claim as per fermentation status/product category for meat substitutes

Fermentation status / Product category	**Not fermented**	**Slightly fermented**	**Partly fermented**	**Mainly fermented**	**Total**	**p-value** (one-way ANOVA)
Burger	0.52	0.56	0.53	0.50	**0.54**	0.6363
Cutting/ Trimming	0.60	0.59	0.57	0.75	**0.59**	0.7926
Coated	0.60	0.50	0.50	0.00	**0.51**	0.1452
Pieces	0.71	0.75	0.69	n/a	**0.72**	0.5011
Sausage	0.57	0.56	0.45	0.71	**0.56**	0.4468
Cold cut	0.62	0.56	0.59	0.50	**0.59**	0.6859
Balls	0.62	0.63	0.48	n/a	**0.61**	0.3967

Note: 0 = claim absent, 1 = claim present; different letters in the same row (product category) indicate significant differences between fermentation statuses as evaluated by Bonferroni test ($p < 0.05$); missing letters for insignificant ANOVA results; n/a for missing products

Nutritional claim (as dummy variable) is equal to 1 if any of the claims listed in Table A 1 (such as 'no added sugar' or 'high/added protein') are shown on the FOP information. Pieces and balls are most likely to bear nutritional claims with a mean of 0.72 and 0.61, respectively. Coated meat substitutes and burgers, on the other hand, bear an average of 0.51 and, respectively, 0.54 nutritional claims. For all product categories, a product is more likely to bear a nutritional claim than not a claim. Since the means do not differ significantly as per category, we refrain from describing them in detail. However, apart from cutting/trimming and sausage, the means tend to decrease with increasing fermentation status. The results of the ANOVA as per product category are reported below.

- Burger ($n = 1{,}308$): $F(3, 1304) = 0.57$, $p = .6363$
- Cutting/Trimming ($n = 951$): $F(3, 947) = 0.35$, $p = .7926$
- Coated ($n = 579$): $F(3, 575) = 1.8$, $p = .1452$
- Pieces ($n = 527$): $F(2, 524) = 0.69$, $p = .5011$
- Sausage ($n = 487$): $F(3, 483) = 0.89$, $p = .4468$
- Cold cut ($n = 332$): $F(3, 328) = 0.5$, $p = .6859$
- Balls ($n = 201$): $F(2, 198) = 0.93$, $p = .3967$

Health claims

Across all product categories, the mean for the presence or absence of health claims does differ significantly as a result of the one-way ANOVA with $F(3, 4381) = 7.62$, $p < .0001$. This also applies to the significance levels of the individual ANOVA of cutting/trimming and cold cut, but not the other product categories. Table **9** summarizes the means as per category and fermentation status.

Table 9 Mean for health claim as per fermentation status/product category for meat substitutes

Fermentation status / Product category	**Not fermented**	**Slightly fermented**	**Partly fermented**	**Mainly fermented**	**Total**	**p-value** (one-way ANOVA)
Burger	0.50	0.48	0.45	0.50	**0.48**	0.6797
Cutting/ Trimming	0.51[a]	0.41[b]	0.40[ab]	0.75[ab]	**0.46**	0.0071
Coated	0.48	0.37	0.41	1.00	**0.40**	0.1076
Pieces	0.51	0.47	0.50	n/a	**0.49**	0.7391
Sausage	0.45	0.37	0.45	0.57	**0.41**	0.1971
Cold cut	0.46[a]	0.36[ab]	0.16[b]	0.25[ab]	**0.38**	0.0112
Balls	0.45	0.39	0.24	n/a	**0.40**	0.2234

Note: 0 = claim absent, 1 = claim present; different letters in the same row (product category) indicate significant differences between fermentation statuses as evaluated by Bonferroni test ($p < 0.05$); missing letters for insignificant ANOVA results; n/a for missing products

In general, the share of products not bearing a health claim is smaller compared to those bearing one. Health claims aggregated to this dummy variable are listed in Table A 1 as well, like, for instance, 'no additives' or 'probiotic'. Pieces and burgers are most likely to bear health claims with a mean of 0.49 and 0.48, respectively. Cold cut, coated meat substitutes and balls, on the other hand, bear an average of 0.38 and, respectively, 0.4 health claims. For all product categories, a product is less likely to bear a health claim than bearing a claim. As per product category and fermentation status, the means tend to follow a V-shape across the fermentation statuses. However, only for **cutting/trimming** and **cold cut** means differ significantly from one another with either not and slightly (cutting/trimming) or not and partly (cold cut) being significantly different. The results of the ANOVA as per product category are reported below.

- Burger (n = 1,308): $F(3, 1304) = 0.5$, $p = .6797$
- Cutting/Trimming (n = 951): $F(3, 947) = 4.05$, $p = .0071$
- Coated (n = 579): $F(3, 575) = 2.04$, $p = .1076$
- Pieces (n = 527): $F(2, 524) = 0.3$, $p = .7391$
- Sausage (n = 487): $F(3, 483) = 1.56$, $p = .1971$
- Cold cut (n = 332): $F(3, 328) = 3.76$, $p = .0112$
- Balls (n = 201): $F(2, 198) = 1.51$, $p = .2234$

Number of additives

Since the number of products considered for the fermentation status partly and mainly is fairly limited, conclusions on the nutritional quality of products with higher shares of fermented ingredients are limited as well. Therefore, we also apply another proxy for the assessment of healthiness, this is the number of additives.

Table 10 Average no. of additives as per fermentation status and product category for meat substitutes

Fermentation status / Product category	**Not fermented**	**Slightly fermented**	**Partly fermented**	**Mainly fermented**	**Total**	**p-value** (one-way ANOVA)
Burger	0.45[a]	0.73[b]	0.51[a]	0.00[a b]	**0.60**	<0.0001
Cutting/ Trimming	0.37[a]	0.72[b]	0.24[a]	0.00[a b]	**0.47**	<0.0001
Coated	0.53[a]	0.97[b]	0.66[a]	0.00[a b]	**0.80**	0.0008
Pieces	0.17[a]	0.74[b]	0.27[a]	n/a	**0.40**	<0.0001
Sausage	0.73[a]	0.97[a]	1.02[a]	0.00[a]	**0.87**	0.0271
Cold cut	0.71[a]	0.80[a]	0.16[b]	0.00[a b]	**0.68**	0.0018
Balls	0.61[a b]	0.94[a b c]	0.38[a c]	n/a	**0.76**	0.0092

Note: Different letters in the same row (product category) indicate significant differences between fermentation statuses as evaluated by Bonferroni test ($p < 0.05$); missing letters for insignificant ANOVA results; n/a for missing products or missing input data (ingredients)

The lowest number of additives are reported for the product categories pieces and cuttings/trimmings (0.4 and 0.47). As per fermentation status, the lowest number of additives is observed for mainly fermented products (0.0 for all categories with data). The number of additives increases from not to slightly fermented for all product categories, dropping again from slightly fermented onwards to either 0 additives at the level of mainly (burgers, cuttings/trimmings, coated, sausage, and cold cut), or to a smaller number at the level of partly fermented for products without data (pieces, and balls).

The highest number of additives are accounted for in the product categories sausages and coated. Consequently, partly fermented sausages and slightly fermented coated products observe the highest number of additives (1.02 and 0.97, respectively). Since there are no products available for the product categories pieces and balls with the fermentation status mainly, information on the number of additives is not available as well.

The means of the number of additives differ significantly by fermentation status, $F(3, 4381) = 50.82$, $p < .0001$. For **Burger** (sample size = 1,308), the fermentation status had a significant effect on the number of additives, $F(3, 1304) = 9.05$, $p < .0001$. Means only differ significantly for slightly fermented burgers compared to not and partly fermented ones. The same applies to **Cutting/Trimming** (sample size = 951), with $F(3, 947) = 14.25$, and $p < .0001$. Also for **Pieces** (sample size = 527), we can show a significant effect with $F(2, 524) = 29.34$, $p < .0001$. Means only differ significantly for not and slightly fermented products ($p < 0.05$) as well. For **Coated** (n = 579), results are significant too ($F(3, 575) = 5.63$, $p = .0008$), with significant differences between the means of slightly and partly fermented vs. not fermented. For **Sausage** (n = 487), no mean as per fermentation states differs significantly from one another with ANOVA results across all fermentation statuses of $F(3, 483) = 3.08$, and $p = .0271$. For **Cold cut** (n = 332), with $F(3, 328) = 5.13$, and $p = .0018$, means only differ significantly for partly fermented vs. not and slightly fermented, whereas for **Balls** (n = 201), only the means of slightly and partly fermented statuses differ significantly from one another with $F(2, 198) = 4.81$, $p = .0092$.

Vegan

A vegan diet, thus consuming vegan products only, is not necessarily related to a healthier lifestyle, particularly when this diet causes an undersupply of specific nutrients such as vitamins B12 and D, calcium, and essential fatty acids. However, studies have also shown lower levels of cholesterol, obesity, and the risk for heart diseases (Key, Appleby and Rosell, 2005; Craig, 2009; Le and Sabaté, 2014). Therefore, products of vegan nature might as well be considered to contribute to healthier diets.

Table 11 Average vegan status as per fermentation status and product category for meat substitutes

Fermentation status / Product category	**Not fermented**	**Slightly fermented**	**Partly fermented**	**Mainly fermented**	**Total**	**p-value** (one-way ANOVA)
Burger	0.48 [a]	0.50 [a]	0.38 [a]	1.00 [a]	**0.48**	0.0494
Cutting/ Trimming	0.54	0.56	0.57	0.50	**0.55**	0.5933
Coated	0.60 [a]	0.50 [a]	0.35 [b]	0.50 [ab]	**0.46**	0.0004
Pieces	0.67	0.66	0.67	n/a	**0.67**	0.9343
Sausage	0.38 [a]	0.57 [b]	0.50 [ab]	0.29 [ab]	**0.49**	0.0005
Cold cut	0.41 [a]	0.61 [bc]	0.75 [c]	0.38 [abc]	**0.54**	0.0003
Balls	0.51	0.52	0.71	n/a	**0.54**	0.2301

Note: Vegan = 1, Non-vegan = 0; different letters in the same row (product category) indicate significant differences between fermentation statuses as evaluated by Bonferroni test ($p < 0.05$); missing letters for insignificant ANOVA results; n/a for missing products

The highest shares of vegan products are attributed to the product categories of pieces (0.67) and cuttings/trimmings (0.55). The lowest share is observed for products belonging to coated products (0.46) and burgers (0.48). As for the above variables, the means as per product category and fermentation status show two dynamics: first, means are either increasing (cuttings/trimmings, sausages, cold cuts) or decreasing (burgers, coated, pieces, balls) across fermentation status followed by the opposite trend at higher fermentation statuses, meaning either decreasing or increasing towards the mainly fermented status. Again, the small number of products in the latter fermentation statuses reduces the significance of that effect, limiting interpretation efforts (see chapter 4.1.3).

The means of vegan differ significantly by fermentation status with $F(3, 4381) = 2.71$, and $p = .0435$. As per product category, the difference in means is significant for burgers, coated products, sausages, and cold cuts. For the first, **burgers**, we observe an N-shaped trend in means, meaning increasing, decreasing, and increasing again with all 2 products belonging to the mainly fermentation status being vegan. Applying letters again for describing the trends in means, **coated** products' means rather follow a V-shape, whereas **sausages** and **cold cuts** follow a Λ-shape with their respective lows and highs at either slightly fermented (sausages) or partly fermented (coated and cold cuts). The results of the ANOVA as per product category are reported below.

- Burger ($n = 1{,}308$): $F(3, 1304) = 2.62$, $p = .0494$
- Cutting/Trimming ($n = 951$): $F(3, 947) = 0.63$, $p = .5933$
- Coated ($n = 579$): $F(3, 575) = 6.09$, $p = .0004$
- Pieces ($n = 527$): $F(2, 524) = 0.07$, $p = .9343$

- Sausage (n = 487): F(3, 483) = 6.03, p = .0005
- Cold cut (n = 332): F(3, 328) = 6.36, p = .0003
- Balls (n = 201): F(2, 198) = 1.48, p = .2301

Private label

Private labels mean a product is launched under a retailer's brand, this is an own-brand product, whereas branded products are usually launched by the producers (Mintel Group Ltd., 2024c). For meat substitutes, the means are significantly different with F(3, 4379) = 17.1, and p < .0001.

Table 12 Private label status as per fermentation status and product category for meat substitutes

Fermentation status / Product category	**Not fermented**	**Slightly fermented**	**Partly fermented**	**Mainly fermented**	**Total**	**p-value** (one-way ANOVA)
Burger	0.20 [a c]	0.32 [b]	0.27 [b c]	0.00 [b c]	**0.27**	< 0.0001
Cutting/ Trimming	0.18	0.21	0.18	0.00	**0.19**	0.3868
Coated	0.19 [a]	0.36 [b]	0.37 [b]	0.00 [a b]	**0.34**	0.0120
Pieces	0.15 [a]	0.21 [a b]	0.31 [b]	n/a	**0.19**	0.0101
Sausage	0.22 [a]	0.22 [a]	0.43 [b]	0.00 [a b]	**0.24**	0.0078
Cold cut	0.21	0.17	0.06	0.00	**0.17**	0.1247
Balls	0.24	0.35	0.19	n/a	**0.29**	0.1626

Note: 0 = Branded, 1 = Private label; different letters in the same row (product category) indicate significant differences between fermentation statuses as evaluated by Bonferroni test (p < 0.05); missing letters for insignificant ANOVA results; n/a for missing products

Across all product categories and fermentation statuses, products tend to be launched branded rather than under a private label. That also applies across the fermentation statuses: The higher the fermentation status, the more likely products are launched branded. In fact, none of the mainly fermented meat substitutes is launched under a private brand. For balls, coated products, pieces, and sausages, one-way ANOVA proved significant variances in the means with p < .05. However, once again, means as of fermentation status do not differ significantly from one another necessarily. Cold cuts have the smallest share of products being launched branded (0.17), whereas coated products have the highest share with 0.34.

The results of the ANOVA as per product category are reported below.

- Burger (n = 1,308): F(3, 1304) = 7.58, p < .0001
- Cutting/Trimming (n = 951): F(3, 947) = 1.01, p = . 3868
- Coated (n = 578): F(3, 574) = 3.68, p = .0120
- Pieces (n = 527): F(2, 524) = 4.64, p = .0101
- Sausage (n = 486): F(3, 482) = 4.01, p = .0078
- Cold cut (n = 332): F(3, 328) = 1.93, p = .1247
- Balls (n = 201): F(2, 198) = 1.83, p = .1626

Price per 100g/ml

Another variable with no significant variances in the means is the price per 100g/ml in Euro with F(3, 4166) = 0.15, and p = .9284. We calculated the price per 100g/ml by dividing the total sales price as reported by Mintel by the total pack size of a product. For all products not retailing in Euro (UK), we use the rates converted and provided by Mintel, which reflect the rates at the time of entry into the database (Mintel Group Ltd., 2024b).

Table 13 Average price per 100g/ml in Euro as per fermentation status and product category for meat substitutes

Fermentation status / Product category	**Not fermented**	**Slightly fermented**	**Partly fermented**	**Mainly fermented**	**Total**	**p-value** (one-way ANOVA)
Burger	1.53	1.49	1.49	2.22	**1.50**	0.3964
Cutting/ Trimming	1.50	1.65	1.65	1.34	**1.58**	0.1711
Coated	1.59 [a b]	1.39 [a]	1.43 [a]	3.13 [b c]	**1.43**	0.0053
Pieces	1.67	1.65	1.58	n/a	**1.65**	0.7281
Sausage	1.39	1.53	1.50	1.32	**1.47**	0.2575
Cold cut	2.04 [a]	2.26 [a b]	2.67 [b]	n/a	**2.22**	0.0022
Balls	1.44	1.41	1.55	n/a	**1.44**	0.5441

Note: Prices as per launch date (not indexed or inflation-adjusted); different letters in the same row (product category) indicate significant differences between fermentation statuses as evaluated by Bonferroni test ($p < 0.05$); missing letters for insignificant ANOVA results; n/a for missing products or no price information available (cold cut)

The highest prices per 100g/ml in Euro are charged for products belonging to cold cuts (2.22 Euro) and pieces (1.65 Euro), while the lowest prices are observed for coated products (1.43 Euro) and balls (1.44 Euro). Mainly fermented coated meat substitutes, on the other hand, have the highest sales price (3.13 Euro), compared to mainly fermented sausages (1.32 Euro). Also prices per 100g/ml do not follow a linear trend across fermentation statuses but rather depend on product category and fermentation status. However, apart from cold cuts and pieces, prices tend to decrease from mainly to fully fermented for the remaining product categories. With regards to significance in the variances of means, only coated products and cold cuts observe $p < 0.05$.

The results of the ANOVA as per product category are reported below.

- Burger (n = 1,254): F(3, 1250) = 0.99, p = .3964
- Cutting/Trimming (n = 883): F(3, 879) = 1.67, p = .1711
- Coated (n = 563): F(3, 559) = 4.28, p = .0053
- Pieces (n = 515): F(2, 512) = 0.32, p = .7281
- Sausage (n = 458): F(3, 454) = 1.35, p = .2575
- Cold cut (n = 301): F(2, 298) = 6.26, p = .0022
- Balls (n = 196): F(2, 193) = 0.61, p = .5441

Launch type

Since the launch type is a categorical variable with more than 2 values (New Formulation, New Product, New Variety/Range Extension, Relaunch), we do not report the means as per product category and

fermentation status but rather provide an overview as per product category, fermentation status, and launch type.

Table 14 Launch type for meat substitutes as per product category and fermentation status

Fermentation status / Product category	Launch type	Not fermented	Slightly fermented	Partly fermented	Mainly fermented	Total
Burger	New Formulation	11 (2%)	19 (3%)	3 (2%)	-	**33 (3%)**
	New Product	183 (41%)	254 (37%)	61 (34%)	1 (50%)	**499 (38%)**
	New Variety	203 (46%)	336 (49%)	93 (53%)	1 (50%)	**633 (48%)**
	Relaunch	49 (11%)	74 (11%)	20 (11%)	-	**143 (11%)**
Cutting/ Trimming	New Formulation	9 (2%)	9 (3%)	4 (3%)	-	**22 (2%)**
	New Product	220 (48%)	113 (33%)	55 (36%)	-	**388 (41%)**
	New Variety	186 (41%)	196 (58%)	86 (57%)	4 (100%)	**472 (50%)**
	Relaunch	40 (9%)	22 (6%)	7 (5%)	-	**69 (7%)**
Coated	New Formulation	1 (1%)	7 (2%)	7 (4%)	-	**15 (3%)**
	New Product	42 (49%)	102 (33%)	60 (32%)	-	**204 (35%)**
	New Variety	36 (42%)	165 (54%)	96 (52%)	2 (100%)	**299 (52%)**
	Relaunch	7 (8%)	32 (10%)	22 (12%)	-	**61 (11%)**
Pieces	New Formulation	6 (2%)	7 (4%)	1 (2%)	n/a	**14 (3%)**
	New Product	106 (40%)	72 (36%)	27 (42%)	n/a	**205 (39%)**
	New Variety	116 (44%)	101 (51%)	27 (42%)	n/a	**244 (46%)**
	Relaunch	37 (14%)	18 (9%)	9 (14%)	n/a	**64 (12%)**
Sausage	New Formulation	8 (4%)	10 (4%)	3 (7%)	-	**21 (4%)**
	New Product	67 (36%)	74 (30%)	16 (36%)	6 (86%)	**163 (33%)**
	New Variety	101 (54%)	137 (55%)	22 (50%)	1 (14%)	**261 (54%)**
	Relaunch	11 (6%)	28 (11%)	3 (7%)	-	**42 (9%)**
Cold cut	New Formulation	4 (3%)	1 (1%)	1 (3%)	-	**6 (2%)**
	New Product	63 (47%)	77 (48%)	15 (47%)	4 (50%)	**159 (48%)**
	New Variety	54 (41%)	73 (46%)	16 (50%)	4 (50%)	**147 (44%)**
	Relaunch	12 (9%)	8 (5%)	-	-	**20 (6%)**
Balls	New Formulation	-	1 (1%)	-	n/a	**1 (0%)**
	New Product	35 (46%)	38 (37%)	6 (29%)	n/a	**79 (39%)**
	New Variety	37 (49%)	53 (51%)	14 (67%)	n/a	**104 (52%)**
	Relaunch	4 (5%)	12 (12%)	1 (5%)	n/a	**17 (8%)**

Note: New Variety includes Range Extension as well, %-figures in relation to product category and fermentation status

Apart from cold cut, new varieties/range extensions are the most common launch types for meat substitutes. For cold cut, new products are the dominating launch type, while new varieties/range extensions remain the most important launch type across all fermentation statuses and product categories. Relaunches and new formulations are, in general, less common while the first is still more likely than the latter. However, Mintel does not track if products undergo a reformulation but rather rely on the information provided on the product's packaging such as "new formula" or "tastier". We excluded "New Packaging" as launch type from our original dataset as this launch type usually does not cover innovations of the food product itself but the packaging only and launches are accounted for as relaunches if several launch types apply. The difference between new product and new variety is determined by the brand the product is launched under, this is, if product range, region, and subcategory are new under a brand, the launch is considered as new product (Mintel Group Ltd., 2024a).

Number of ingredients

Another variable of the set of dependent variables with significant differences in means is the total number of ingredients of a product with $F(3, 4381) = 378.43$, and $p < .0001$.

Table 15 Average no. of ingredients as per fermentation status and product category for meat substitutes

Fermentation status / Product category	**Not fermented**	**Slightly fermented**	**Partly fermented**	**Mainly fermented**	**Total**	**p-value** (one-way ANOVA)
Burger	10.86 [a]	15.88 [b]	13.38 [c]	2.50 [a]	**13.81**	< 0.0001
Cutting/ Trimming	5.76 [a]	13.55 [b]	8.81 [c]	1.25 [a]	**9.01**	< 0.0001
Coated	8.09 [a]	16.47 [b]	12.56 [c]	3.00 [a b]	**13.93**	< 0.0001
Pieces	5.74 [a]	13.79 [b]	10.34 [c]	n/a	**9.32**	< 0.0001
Sausage	12.58 [a]	15.13 [b]	15.48 [b]	1.14 [c]	**13.98**	< 0.0001
Cold cut	11.71 [a]	13.47 [b]	11.88 [a b]	1.00 [c]	**12.31**	< 0.0001
Balls	13.36 [a]	16.69 [b]	13.38 [a]	n/a	**15.08**	0.0001

Note: Different letters in the same row (product category) indicate significant differences between fermentation statuses as evaluated by Bonferroni test ($p < 0.05$); missing letters for insignificant ANOVA results; n/a for missing products

The highest number of ingredients can be found in balls (15.08) and sausages (13.98). As per fermentation status, slightly fermented meat substitutes have the highest number of ingredients across all product categories except for sausages (highest amount for partly fermented). For all product categories with products in the bucket of mainly fermented, the higher the fermentation status, the smaller the number of ingredients, meaning mainly fermented meat substitutes have the least ingredients, being mostly composed of a small number of ingredients only, such as tempeh or

fermented tofu. In terms of product category, the smallest number of ingredients is observed for cuttings/trimmings (9.01) and pieces (9.32).

Even though meat substitutes belong to the group of ultra-processed foods according to the NOVA food classification system in general (Augusto Monteiro *et al.*, 2017), the number of ingredients can be an indicator of the processing degree (Braesco *et al.*, 2022). A dietary shift from unprocessed or minimally processed foods (NOVA group 1) to ultra-processed foods (group 4) is associated with an increasing risk of obesity and other non-communicable diseases (Monteiro *et al.*, 2019). It is therefore justified to state that an increasing fermentation status might contribute to foods being less processed and, eventually, also account for diets with less associated diet-related health risks.

The individual ANOVA as per product category reveals significant variances in means for all categories. The results are reported below.

- Burger (n = 1,308): $F(3, 1304) = 83.0$, $p < .0001$
- Cutting/Trimming (n = 951): $F(3, 947) = 127.83$, $p < .0001$
- Coated (n = 579): $F(3, 575) = 59.28$, $p < .0001$
- Pieces (n = 527): $F(2, 524) = 108.4$, $p < .0001$
- Sausage (n = 487): $F(3, 483) = 20.11$, $p < .0001$
- Cold cut (n = 332): $F(3, 328) = 22.71$, $p < .0001$
- Balls (n = 201): $F(2, 198) = 10.16$, $p = .0001$

Time on market

For time on market, we calculated the years the product is already on the market using the base Dec. 31st, 2022, meaning products, that are, for instance, launched on Jan. 1st, 2020 are on the market for ~3 years. We limited our dataset for products launched on or after Jan. 1st, 2000 to account for Mintel's increasing market coverage in the respective markets which is, according to Mintel, sufficient from 2000 onwards to fetch most of the product launches. Also this variable is, based on our ANOVA, significant with $F(3, 4381) = 11.9$, and $p < .0001$.

Table 16 Time on market for meat substitutes as per product category and fermentation status

Fermentation status / Product category	**Not fermented**	**Slightly fermented**	**Partly fermented**	**Mainly fermented**	**Total**	**p-value** (one-way ANOVA)
Burger	6.39 [a]	5.72 [a]	6.16 [a]	2.25 [a]	**6.00**	0. 044
Cutting/ Trimming	7.30 [a]	6.35 [b]	6.55 [a b]	10.75 [a b]	**6.86**	0.0167
Coated	6.25	5.44	5.44	8.84	**5.57**	0.2447
Pieces	5.30	4.92	5.19	n/a	**5.14**	0.6361
Sausage	6.79	6.29	5.82	10.12	**6.49**	0.1067
Cold cut	6.02 [a]	5.58 [a b]	3.84 [b]	8.53 [a c]	**5.66**	0.013
Balls	5.34	4.39	4.40	n/a	**4.75**	0.1622

Note: Time on market in years (base: Dec. 31, 2022); different letters in the same row (product category) indicate significant differences between fermentation statuses as evaluated by Bonferroni test ($p < 0.05$); missing letters for insignificant ANOVA results; n/a for missing products

Cuttings/trimmings are on the market for the longest period of time with an average time on market of 6.86 years. The p-value of the one-way ANOVA is significant with p = .0167 while the means as per fermentation status are only significantly different for not and slightly fermented. The "youngest" meat substitute category on the market is **balls** with 4.75 years in average. However, the p-value of the one-way ANOVA for balls is not significant. In general, most product categories are on the market for 5-7 years in average, being somewhat in line with the launch dynamics as reported in **Figure 5** above. **Burgers** tend to be shorter on the market the higher the fermentation status. However, even though the one-way ANOVA proved significance ($p = .044$) the means as per fermentation status do not differ significantly from one another. For cuttings/trimmings, **coated** products, **sausages**, and **cold cuts** time on market for mainly fermented products is higher than for not fermented counterparts. Yet only the latter observes $p < .05$ ($p = .013$), while not fermented is significantly different from partly, and partly from mainly fermented. The results of the ANOVA as per product category are reported below.

- Burger ($n = 1308$): $F(3, 1304) = 2.71$, $p = .044$
- Cutting/Trimming ($n = 951$): $F(3, 947) = 3.43$, $p = .0167$
- Coated ($n = 579$): $F(3, 575) = 1.39$, $p = .2447$
- Pieces ($n = 527$): $F(2, 524) = 0.45$, $p = .6361$
- Sausage ($n = 487$): $F(3, 483) = 2.04$, $p = .1067$
- Cold cut ($n = 332$): $F(3, 328) = 3.65$, $p = .013$
- Balls ($n = 201$): $F(2, 198) = 1.84$, $p = .1622$

4.1.3. Discussion and limitations

The results of the statistical assessment of meat substitutes do not necessarily allow to draw a distinct picture of the healthiness and naturalness of fermented products in that food segment. Also, the presence and absence of health or nutritional claims do not differ significantly across different fermentation statuses. Still, when using the A-Score, the vegan status, and the number of ingredients and additives as proxies for healthiness and naturalness, there is an indication that meat substitutes with higher fermentation degrees tend to be "healthier" or "more natural" than their not or slightly fermented counterparts.

However, this conclusion must be drawn carefully. Firstly, the number of products with higher fermentation statuses is limited. Of all considered 4385 meat substitutes, only 23 comply as mainly, and 675 products as partly fermented. One reason might be that the food segment of meat substitutes is generally considered ultra-processed, often containing many ingredients. The higher the number of ingredients, the smaller the share of potentially included fermented ingredients. Alternatively, the thresholds of the fermentation status derived from the fermentation degree might be set differently. However, we applied multiple thresholds and a number of fermentation status buckets but were not able to retrieve significantly different results. Especially the variances of means are often not significantly different for the latter fermentation statuses, limiting the implications of any conclusion.

Secondly, the assessment is performed on data from Mintel's database, which only includes FOP information of the respective products. When considering the product attributes fermentation might have an impact on (means of preservation/conversation, as a food additive, a food production method, a specific taste, or a food category), that information is generally not part of the FOP information and is, therefore, hard to assess. In addition, the level of detail of the products' ingredient lists is not necessarily exhaustive, this is, products containing other end products are not broken down into their individual ingredients. For instance, "Vegetarian Grill Plate" (GNPD ID 1372062) contains "Artificial Sausage", not allowing to further detail the assessment of the fermentation degree.

4.2. Beverages

4.2.1. Overview

Overall, GNPD lists 25,169 product launches for beverages (excl. re-packaging) from 2000 until 2020 in France, Germany, Italy, Spain and UK. Based on the fermentation status we defined, products can be summarized as follows:

Table 17 Summary table for beverages as per market and fermentation status

Fermentation status / Market	Not fermented	Slightly fermented	Partly fermented	Mainly fermented	Fully fermented
France	4,371	384	229	89	**5,073**
Germany	4,869	776	670	274	**6,589**
Italy	2,923	243	186	119	**3,471**
Spain	3,564	399	253	47	**4,263**
UK	4,395	683	560	135	**5,773**
Total	20,122	2,485	1,898	664	**25,169**

The largest share of beverages is not or only partly or slightly fermented. Most of the beverages are launched in Germany (26%), followed by the UK (23%). For those two countries, the share of partly and mainly fermented beverages is higher compared to the other countries (14%, and 12% vs. 7-8%). For all the countries, most of the products are not fermented. The most fermented ingredients (top 15) are illustrated in Table 18.

Table 18 Top 15 fermented ingredients in beverages

Fermented ingredient	No. of beverages (abs.)	(in %)
Yogurt	1,673	6.6%
Cocoa	1,363	5.4%
Chocolate	1,060	4.2%
Vanilla	998	4.0%
Tea	693	2.8%
Chai	302	1.2%
Kefir	244	1.0%
Coffee	212	0.8%
Cassava	200	0.8%
Kombucha	184	0.7%
Buttermilk	160	0.6%
Malt	97	0.4%

Vinegar	86	0.3%
Lassi	78	0.3%
Yeast	64	0.3%

Launch dynamics picked up in the second decade of this millennium, as illustrated in **Figure 6**, especially after 2012, with a decrease again after 2018. As for meat substitutes, we are not able to counteract the effect of Mintel's rising market coverage against the increasing number of product launches but rather rely on Mintel's statement of covering more than 90% of the respective markets from 2000 onwards.

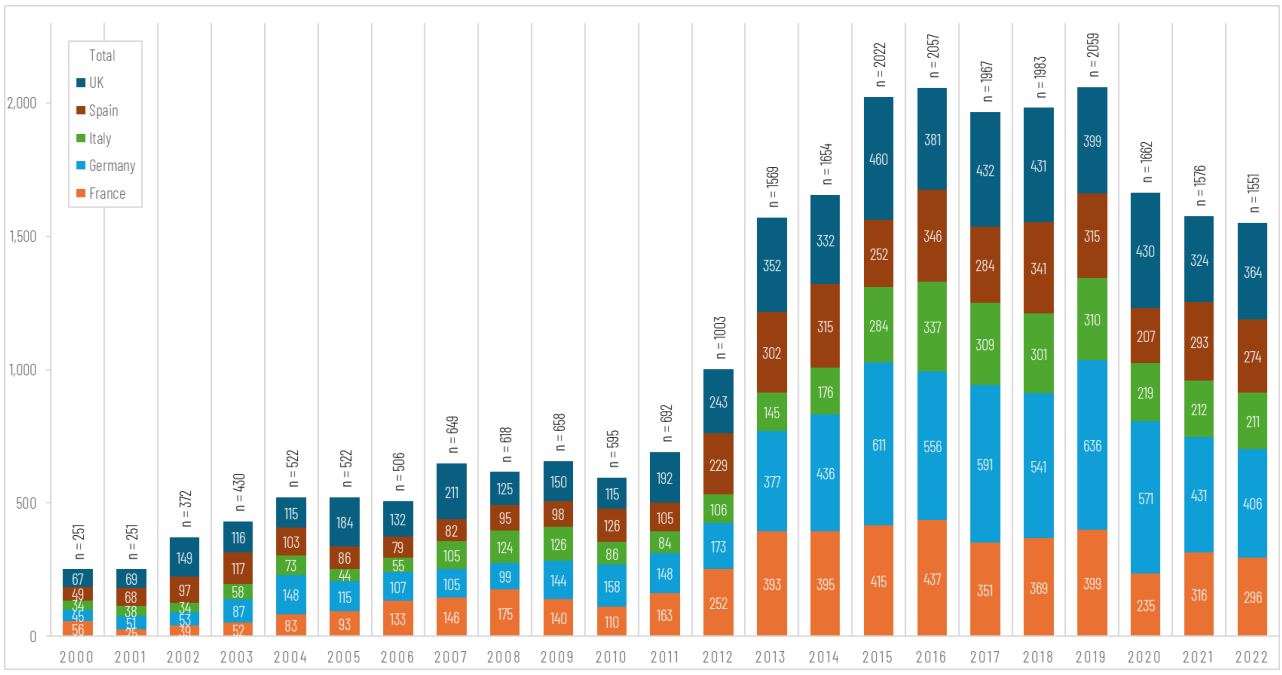

Figure 6 No. of beverage launches per year and market [Source: Own illustration based on Mintel GNPD]

When assessing the product categories provided by Mintel, juices and nectars are the most represented categories among the product launches (32% and 17.3% respectively), followed by Nutritional & Meal Replacement Drinks (17.1%).

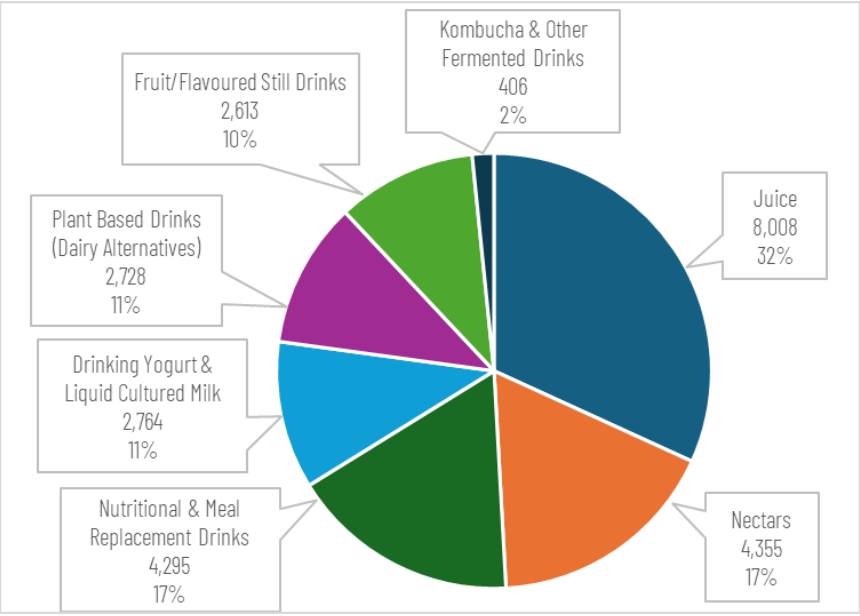

Figure 7 Distribution of product categories for beverages

The fermentation status as per product category reveals that most of the mainly fermented products belong to the categories of Drinking Yogurt & Liquid Cultured Milk (n= 438) and Kombucha & Other Fermented Drinks (n = 98). Mainly fermented juices often contain apple cider, cider vinegar, or sauerkraut juice. As for meat substitutes, the number of products per product category decreases with increasing fermentation status. Interestingly, we also identified not fermented products in the category of Kombucha & Other Fermented Drinks, which do not – on the base of the products' ingredients lists – contain any fermented ingredient or specific cultures only (which are not part of the fermented foods according to Gänzle and Campbell-Platt).

Table 19 Summary table for beverages as per product category and fermentation status

Fermentation status / Product category	Not fermented	Slightly fermented	Partly fermented	Mainly fermented	Total
Juice	7,691	209	60	48	**8,008**
Nectars	4,139	137	62	17	**4,355**
Nutritional & Meal Replacement Drinks	2,385	1,284	595	31	**4,295**
Drinking Yogurt & Liquid Cultured Milk	1,291	202	833	438	**2,764**
Plant-based Drinks (Dairy Alternatives)	2,111	448	144	25	**2,728**
Fruit/Flavored Still Drinks	2,455	117	34	7	**2,613**
Kombucha & Other Fermented Drinks	50	88	170	98	**406**
Total	**20,122**	**2,485**	**1,898**	**664**	**25,169**

On a time scale, launch activities as per product category start to diverge from 2010 onwards with Juices and Nectars experiencing a boost in launches compared to the other categories, but also dropping again after 2016. Nutritional & Meal Replacement Drinks also experience a boost in launch activities slightly later, starting 2013 and dropping again after 2019, still having caught up with Juices. Since 2018, Plant-based Drinks (Dairy Alternatives) are launched more often than nectars becoming the third most launched category in 2022 (after Nutritional & Meal Replacement Drinks and Juices).

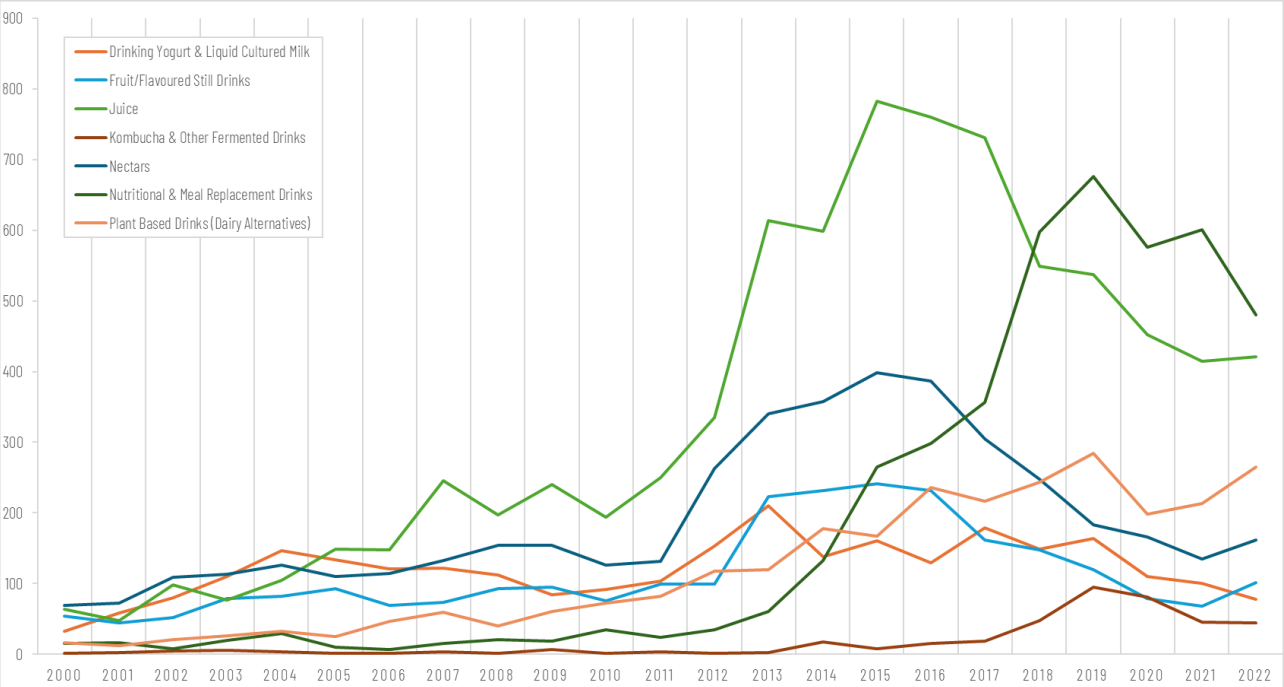

Figure 8 Beverage launches as per year and product category

4.2.2. Statistical assessment

As for meat substitutes, we tested for the significance of variances between the means of the fermentation status with corresponding dependent variables (by using a one-way ANOVA). Significant differences ($p < 0.05$) exist for all dependent variables. In Table 20 we list all relevant dependent variables and their respective ranges.

Table 20 Dependent variables and respective ranges/values for beverages

Dependent variables	Variable values
A-Score	0-38
Nutritional Claims	No-Yes
Health Claims	No-Yes
No. of Additives	0-11
Vegan	No-Yes
Private label	No-Yes
Price per 100g/ml	0.01-298
Launch type	New Formulation, New Product, New Variety/Range Extension, Relaunch

No. of ingredients	1-61
Time on market	0-22.99 (01.01.2000 – 31.12.2022)

As for meat substitutes, we also tested for additional interaction effects, this is including additional variables as independent variables in the ANOVA assessment like the country of the launch, vegetarian or vegan status, health or nutritional claim status, and private label without significant improvement of the models.

Table 21 Mean A-Score as per fermentation status and product category for beverages

Fermentation status / Product category	**Not fermented**	**Slightly fermented**	**Partly fermented**	**Mainly fermented**	**Total**	**p-value** (one-way ANOVA)
Drinking Yogurt & Liquid Cultured Milk	2.06 [a]	2.58 [b]	2.41 [b]	2.42 [b]	**2.26**	< 0.0001
Fruit/Flavored Still Drinks	1.25 [a]	0.75 [b]	1.06 [a b]	n/a	**1.22**	0.0002
Juice	1.78 [a b]	1.86 [a]	1.43 [b]	2.88 [c]	**1.79**	< 0.0001
Kombucha & Other Fermented Drinks	1.25	0.67	0.69	0.25	**0.65**	0.1496
Nectars	1.72	1.56	1.50	2.50	**1.71**	0.2388
Nutritional & Meal Replacement Drinks	7.57 [a]	8.28 [b]	9.48 [c]	5.64 [a b c]	**8.10**	< 0.0001
Plant-based Drinks (Dairy Alternatives)	0.84 [a]	1.20 [b]	1.77 [c]	2.67 [a b c]	**0.95**	< 0.0001

Note: Different letters in the same row (product category) indicate significant differences between fermentation statuses as evaluated by Bonferroni test ($p < 0.05$); missing letters for insignificant ANOVA results; n/a for missing A-Score input data (nutritional values)

The means of the A-Score, as a proxy for the nutritional quality of food products, differ significantly by fermentation status, $F(3, 17951) = 494.33$, $p < .0001$. As the A-Score captures the 'nutrients to limits', the higher the score, the lesser the nutritional quality of the product. In that regard, Nutritional & Meal Replacement Drinks and Drinking Yogurt & Liquid Cultured Milk observe the lowest nutritional quality with an A-Score of 8.1 and 2.26, respectively. Kombucha & Other Fermented Drinks and Plant-based Drinks (Dairy Alternatives), on the other hand, show the best nutritional quality with an A-Score of 0.65 and 0.95, respectively. Considering the fermentation status, the A-Score tends to follow an ambiguous trend with lowest means in all possible fermentation statuses depending on product category. Mainly fermented products observe the best, this is the lowest A-Score for Kombucha & Other Fermented (0.25) Drinks and Nutritional & Meal Replacement Drinks (5.64). For Drinking Yogurt & Liquid Cultured Milk and Plant-based Drinks (Dairy Alternatives) the best A-Score is observed for not fermented

products (2.06, and 0.84, respectively). Slightly fermented products have the best A-Score for products belonging to the category of Fruit/Flavored Still Drinks (0.75). And juices and nectars have their lowest A-Score in the bucket of partly fermented products (1.43, and 1.5, respectively).

Once the one-way ANOVA revealed significant differences in means for the fermentation status as per product category, we performed a Bonferroni test for each product category individually. We used the Bonferroni test with a 95% significance level to determine the differences between fermentation status per product category as presented in Table 21. For **Drinking Yogurt & Liquid Cultured Milk** (sample size = 1,756), the fermentation status had a significant effect on the A-Score, $F(3, 1752) = 10.31$, $p < .0001$, but only the mean for not fermented is significantly different from the means of higher fermentation statuses. For **Fruit/Flavored Still Drinks** (sample size = 1,570), we observe a significant effect as well with $F(2, 1567) = 8.62$, and $p = .0002$. However, there is no significant difference in the means between not and partly, and slightly and partly fermented products with $p > .05$, but for the means of not and slightly fermented only. Also for **Juice** (sample size 5,783), we can show a significant effect with $F(3, 5779) = 15.4$, $p < .0001$. Rather exceptionally: The mean of mainly fermented juices differs significantly from all other fermentation statuses, which is, for most of the assessments, usually the case for not vs. slightly and partly fermented. For **Kombucha & Other Fermented Drinks** (n = 283), results are not significant with $F(3, 279) = 1.79$, $p = .1496$. Also for **Nectars** (n = 2,772), the individual one-way ANOVA did not show significant effects of the fermentation status on the A-Score ($F(3, 2768) = 1.41$, $p = .2388$), but again for **Nutritional & Meal Replacement Drinks** (n = 3,410) and **Plant-based Drinks (Dairy Alternatives)** (n = 2,381). The test statistics for the first are $F(3, 3409) = 16.69$, $p < .0001$, and for the latter, Plant-based Drinks, $F(3, 2377) = 13.02$, $p < .0001$, while for both categories, all means as per fermentation status differ from one another except for mainly fermented products.

Nutritional claims

Across all product categories, the mean for the presence or absence of nutritional claims differ significantly as a result of the one-way ANOVA ($F(3, 25165) = 312.79$, $p < .0001$). That also applies to the majority of the means of the individual ANOVA as per product category. Fruit/Flavored Still Drinks and Juice do not differ significantly. Table 22 summarizes the means as per category and fermentation status, including the respective levels of significance.

Table 22 Mean for nutritional claim as per fermentation status/product category for beverages

Fermentation status / Product category	**Not fermented**	**Slightly fermented**	**Partly fermented**	**Mainly fermented**	**Total**	**p-value** (one-way ANOVA)
Drinking Yogurt & Liquid Cultured Milk	0.58 [a]	0.52 [ab]	0.62 [a]	0.49 [b]	**0.58**	< 0.0001
Fruit/Flavored Still Drinks	0.42 [a]	0.56 [b]	0.44 [ab]	0.29 [ab]	**0.42**	0.0255
Juice	0.39	0.43	0.40	0.23	**0.39**	0.0795
Kombucha & Other Fermented Drinks	0.44	0.57	0.59	0.58	**0.57**	0.2766
Nectars	0.40 [a]	0.49 [a]	0.50 [a]	0.18 [a]	**0.41**	0.0174

Nutritional & Meal Replacement Drinks	0.81 [a]	0.90 [b]	0.95 [b]	0.90 [a b]	**0.86**	< 0.0001
Plant-based Drinks (Dairy Alternatives)	0.90 [a]	0.92 [a]	0.83 [b]	0.92 [a b]	**0.90**	0.0157

Note: 0 = claim absent, 1 = claim present; different letters in the same row (product category) indicate significant differences between fermentation statuses as evaluated by Bonferroni test ($p < 0.05$); missing letters for insignificant ANOVA results

Nutritional claim (as dummy variable) is equal to 1 if any of the claims listed in Table A 1 (such as 'no added sugar' or 'high/added protein') are shown on the FOP information. Plant-based Drinks and Nutritional & Meal Replacement Drinks are most likely to bear nutritional claims with a mean of 0.9 and 0.86, respectively. These product categories and Kombucha & Other Fermented Drinks and Drinking Yogurt & Liquid Cultured Milk are more likely to bear a nutritional claim than not a claim. On the other hand, Juice and Nectars bear an average of 0.39 and 0.41 nutritional claims, respectively. For the means of the fermentation statuses as per product category, we observe the well-known pattern of the means from the meat substitutes assessment, even though the sample size of beverages is 5.7 bigger: Means tend to increase or decrease with higher fermentation statuses with an opposite trend either with every increasing status or around slightly or partly fermented. Another repeating pattern is the significance of the mean variances as per product category and fermentation status: While for most of the product categories, the lower fermentation statuses tend to be significantly different, the higher fermentation statuses are less likely to do so. However, the status of the smallest share of products bearing a nutritional claim is mainly fermented for four product categories (Drinking Yogurt & Liquid Cultured Milk, Fruit/Flavored Still Drinks, Juice, and Nectars). The results of the ANOVA as per product category are reported below.

- Drinking Yogurt & Liquid Cultured Milk ($n = 2{,}764$): $F(3, 2760) = 7.62$, $p < .0001$
- Fruit/Flavoured Still Drinks ($n = 2{,}613$): $F(3, 2609) = 3.11$, $p = .0255$
- Juice ($n = 8{,}008$): $F(3, 8004) = 2.26$, $p = .0795$
- Kombucha & Other Fermented Drinks ($n = 406$): $F(3, 402) = 1.29$, $p = .2766$
- Nectars ($n = 4{,}355$): $F(3, 4351) = 3.39$, $p = .0174$
- Nutritional & Meal Replacement Drinks ($n = 4{,}295$): $F(3, 4291) = 34.07$, $p < .0001$
- Plant-based Drinks (Dairy Alternatives) ($n = 2{,}728$): $F(3, 2724) = 3.46$, $p = .0157$

Health claims

Across all product categories, the mean for the presence or absence of health claims does differ significantly as a result of the one-way ANOVA with $F(3, 25165) = 297.84$, $p < .0001$. That also applies to the significance levels of the individual ANOVA of all product categories apart from Plant-based Drinks (Dairy Alternatives). Table 9 summarizes the means as per category and fermentation status.

Table 23 Mean for health claim as per fermentation status/product category for beverages

Fermentation status / Product category	**Not fermented**	**Slightly fermented**	**Partly fermented**	**Mainly fermented**	**Total**	**p-value** (one-way ANOVA)
Drinking Yogurt & Liquid Cultured Milk	0.62 [a]	0.59 [a]	0.59 [a]	0.47 [b]	**0.59**	< 0.0001
Fruit/Flavored Still Drinks	0.44 [a]	0.57 [b]	0.47 [ab]	0.43 [ab]	**0.44**	0.0352
Juice	0.36 [a]	0.47 [b]	0.55 [b]	0.33 [ab]	**0.36**	0.0001
Kombucha & Other Fermented Drinks	0.50 [a]	0.72 [a]	0.68 [a]	0.59 [a]	**0.65**	0.0322
Nectars	0.33 [a]	0.47 [b]	0.44 [ab]	0.18 [ab]	**0.34**	0.0007
Nutritional & Meal Replacement Drinks	0.77 [a]	0.86 [b]	0.81 [ab]	0.90 [ab]	**0.80**	< 0.0001
Plant-based Drinks (Dairy Alternatives)	0.68	0.70	0.62	0.56	**0.68**	0.1709

Note: 0 = claim absent, 1 = claim present; different letters in the same row (product category) indicate significant differences between fermentation statuses as evaluated by Bonferroni test ($p < 0.05$); missing letters for insignificant ANOVA results

Health claims aggregated to this dummy variable are listed in Table A 1 as well, like, for instance, 'no additives' or 'probiotic'. Nutritional & Meal Replacement Drinks and Plant-based Drinks (Dairy Alternatives) are most likely to bear health claims with a mean of 0.9 and 0.68, respectively. Nectars, Juice, and Fruit/Flavored Still Drinks, on the other hand, bear an average of 0.34, 0.36, and, respectively, 0.44 health claims. For 5 out of 7 product categories, products that are mainly fermented have the least number of health claims on their packaging (Drinking Yogurt & Liquid Cultured Milk, Fruit/Flavored Still Drinks, Juice, Nectars, and Plant-based Drinks). For Kombucha & Other Fermented Drinks, and Nutritional & Meal Replacement Drinks, however, it is the opposite – not fermented. On a product category level, the means' variances differ significantly from one another, apart from Plant-based Drinks. The results of the ANOVA as per product category are reported below.

- Drinking Yogurt & Liquid Cultured Milk ($n = 2{,}764$): $F(3, 2760) = 11.01$, $p < .0001$
- Fruit/Flavoured Still Drinks ($n = 2{,}613$): $F(3, 2609) = 2.87$, $p = .0352$
- Juice ($n = 8{,}008$): $F(3, 8004) = 6.89$, $p = .0001$
- Kombucha & Other Fermented Drinks ($n = 406$): $F(3, 402) = 2.96$, $p = .0322$
- Nectars ($n = 4{,}355$): $F(3, 4351) = 5.65$, $p = .0007$
- Nutritional & Meal Replacement Drinks ($n = 4{,}295$): $F(3, 4291) = 14.25$, $p < .0001$
- Plant-based Drinks (Dairy Alternatives) ($n = 2{,}728$): $F(3, 2724) = 3.46$, $p = .0157$

Number of additives

As for meat substitutes, we also apply another proxy for the assessment of healthiness, this is the number of additives.

Table 24 Average no. of additives as per fermentation status and product category for meat substitutes

Fermentation status / Product category	**Not fermented**	**Slightly fermented**	**Partly fermented**	**Mainly fermented**	**Total**	**p-value** (one-way ANOVA)
Drinking Yogurt & Liquid Cultured Milk	1.02 [a]	1.04 [a]	0.61 [b]	0.10 [c]	**0.75**	< 0.0001
Fruit/Flavored Still Drinks	1.06 [a]	1.13 [a]	0.85 [a]	0.00 [a]	**1.06**	0.0451
Juice	0.04	0.03	0.02	0.00	**0.04**	0.3845
Kombucha & Other Fermented Drinks	0.16 [a b]	0.28 [a]	0.20 [a b]	0.06 [b]	**0.18**	0.0071
Nectars	0.58 [a]	0.60 [a]	0.48 [a b]	0.00 [b]	**0.58**	0.0249
Nutritional & Meal Replacement Drinks	1.68 [a]	2.24 [b]	1.24 [c]	0.10 [d]	**1.77**	< 0.0001
Plant-based Drinks (Dairy Alternatives)	0.66 [a]	0.89 [b]	0.67 [a b]	0.00 [c]	**0.70**	< 0.0001

Note: Different letters in the same row (product category) indicate significant differences between fermentation statuses as evaluated by Bonferroni test ($p < 0.05$); missing letters for insignificant ANOVA results

The lowest number of additives are reported for the product categories Juice and Kombucha & Other Fermented Drinks (0.04 and 0.18). As per fermentation status, the lowest number of additives are observed for fully (0.0) and mainly fermented products (0.43), following the same pattern as meat substitutes. Apart from Drinking Yogurt & Liquid Cultured Milk and Nutritional & Meal Replacement Drinks, the number of additives decreases from not to slightly fermented, increasing slightly again from partly fermented onwards to 0 additives at the level of mainly (burgers, cuttings/trimmings, pieces) and fully fermented (coated, sausages).

The highest number of additives are accounted for in the product categories Nutritional & Meal Replacement Drinks and Fruit/Flavored Still Drinks, and for the fermentation status slightly fermented. Consequently, slightly fermented Nutritional & Meal Replacement Drinks and slightly fermented Fruit/Flavored Still Drinks observe the highest number of additives (2.24 and 1.13, respectively).

The means of the number of additives differ significantly by fermentation status, F(3, 25169) = 544.32, p < .0001. For **Drinking Yogurt & Liquid Cultured Milk** (sample size = 2,764), the fermentation status had a significant effect on the number of additives, F(3, 2760) = 135.47, p < .0001. All means differ significantly from one another apart from not vs. slightly fermented. For **Fruit/Flavored Still Drinks** (sample size = 2,613), on the other hand, none of the means differ significantly as per fermentation status, with F(3, 2609) = 2.68, and p = .0451. For **Kombucha & Other Fermented Drinks** (n = 406), the results of the ANOVA are significant too (F(3, 402 = 4.09, p = .0071), with significant differences between the means of slightly fermented vs. mainly fermented. For **Nectars** (n = 4,355), mainly fermented is significantly different from not and slightly fermented, but not partly fermented, with ANOVA results across all fermentation statuses of F(3, 4351) = 3.12, and p = .0249. For **Nutritional & Meal Replacement Drinks** (n = 4,295) with F(3, 4291) = 62.97, and p < .0001, all means differ significantly from one another – being rather exceptional across all assessments. For **Plant-based Drinks** (n = 2,724), only the means of not and slightly vs. partly fermented statuses do not differ significantly from one another with F(2, 2724) = 11.71, p < .0001. For **Juice** (sample size 8,008) – as the only product category - we cannot show a significant effect with F(3, 8004) = 1.02, p = .3845.

Vegan

As for meat substitutes, we also assess the status of products being vegan as a vegan diet might contribute to a healthier diet.

Table 25 Average vegan status as per fermentation status and product category for beverages

Fermentation status / Product category	**Not fermented**	**Slightly fermented**	**Partly fermented**	**Mainly fermented**	**Total**	**p-value** (one-way ANOVA)
Drinking Yogurt & Liquid Cultured Milk	0.00	0.00	0.00	0.00	**0.00**	-
Fruit/Flavored Still Drinks	0.07 [a]	0.16 [b]	0.15 [ab]	0.00 [ab]	**0.07**	0.0002
Juice	0.14 [a]	0.38 [b]	0.20 [a]	0.08 [ab]	**0.15**	< 0.0001
Kombucha & Other Fermented Drinks	0.48	0.51	0.46	0.46	**0.47**	0.8648
Nectars	0.07 [a]	0.20 [bc]	0.23 [c]	0.12 [abc]	**0.08**	< 0.0001
Nutritional & Meal Replacement Drinks	0.19 [a]	0.17 [a]	0.19 [a]	0.35 [a]	**0.19**	0.0374
Plant-based Drinks (Dairy Alternatives)	0.55 [a]	0.56 [a]	0.46 [a]	0.28 [a]	**0.54**	0.0063

Note: Vegan = 1, Non-vegan = 0; different letters in the same row (product category) indicate significant differences between fermentation statuses as evaluated by Bonferroni test ($p < 0.05$); missing letters for insignificant ANOVA results

The highest shares of products with a vegan claim are attributed to the product categories of Plant-based Drinks (0.54) and Kombucha & Other Fermented Drinks (0.47). It might be surprising that Plant-based Drinks are not vegan entirely. However, the vegan status is based on the FOP claim of a product being either "vegan" or "Plant-based". In addition, we also found yogurt or milk proteins in products' ingredient lists of this category. The lowest share of products bearing a vegan claim is observed for products belonging to Drinking Yogurt & Liquid Cultured Milk (0.0) and Fruit/Flavored Still Drinks (0.07). The means as per product category and fermentation status are, firstly, increasing, being highest at the slightly or partly fermented status and, secondly, dropping again. Only Nutritional & Meal Replacement Drinks show a contradictory trend (apart from Drinking Yogurt & Liquid Cultured Milk with constant means of 0.0).

The means of vegan differ significantly by fermentation status with $F(3, 25165) = 57.12$, and $p < .0001$. As per product category, the difference in means is only not significant for Kombucha & Other Fermented Drinks. None of the fermentation-specific means is significant from one another for Nutritional & Meal Replacement Drinks and Plant-based Drinks, whereas for the remaining product categories (Fruit/Flavored Still Drinks, Juice, and Nectars), mostly the lower fermentation statuses are significantly different. The results of the ANOVA as per product category are reported below.

- Drinking Yogurt & Liquid Cultured Milk (n = 2,764): $F(3, 2760) = 0$
- Fruit/Flavoured Still Drinks (n = 2,613): $F(3, 2609) = 6.44$, $p = .0002$
- Juice (n = 8,008): $F(3, 8004) = 30.73$, $p < .0001$
- Kombucha & Other Fermented Drinks (n = 406): $F(3, 402) = 0.25$, $p = .8648$
- Nectars (n = 4,355): $F(3, 4351) = 16.57$, $p < .0001$
- Nutritional & Meal Replacement Drinks (n = 4,295): $F(3, 4291) = 2.82$, $p = .0374$
- Plant-based Drinks (Dairy Alternatives) (n = 2,728): $F(3, 2724) = 4.13$, $p = .0063$

Private label

Private labels mean a product is launched under a retailer's brand, this is an own-brand product, whereas branded products are usually launched by the producers (Mintel Group Ltd., 2024c). For beverages, the means are significantly different with $F(3, 25118) = 109.14$, and $p < .0001$.

Table 26 Private label status as per fermentation status and product category for beverages

Fermentation status / Product category	**Not fermented**	**Slightly fermented**	**Partly fermented**	**Mainly fermented**	**Total**	**p-value** (one-way ANOVA)
Drinking Yogurt & Liquid Cultured Milk	0.33 [a]	0.28 [ab]	0.25 [b]	0.18 [bc]	**0.28**	< 0.0001
Fruit/Flavored Still Drinks	0.26 [a]	0.14 [b]	0.09 [ab]	0.00 [ab]	**0.25**	0.0011
Juice	0.35	0.28	0.30	0.31	**0.35**	0.1457

Kombucha & Other Fermented Drinks	0.02	0.03	0.02	0.03	**0.03**	0.9436
Nectars	0.34 [a]	0.18 [b]	0.23 [ab]	0.06 [ab]	**0.33**	< 0.0001
Nutritional & Meal Replacement Drinks	0.11	0.13	0.10	0.13	**0.11**	0.0962
Plant-based Drinks (Dairy Alternatives)	0.26 [a]	0.20 [b]	0.27 [ab]	0.12 [ab]	**0.25**	0.0085

Note: 0 = Branded, 1 = Private label; different letters in the same row (product category) indicate significant differences between fermentation statuses as evaluated by Bonferroni test ($p < 0.05$); missing letters for insignificant ANOVA results

Across all product categories and fermentation statuses, products tend to be launched branded rather than under a private label. That also applies across the fermentation statuses: The higher the fermentation status, the more likely products are launched branded, apart from Kombucha & Other Fermented Drinks, and Nutritional & Meal Replacement Drinks, but with small differences only. In fact, none of the mainly fermented Fruit/Flavored Still Drinks is launched under a private brand. For Drinking Yogurt & Liquid Cultured Milk, Fruit/Flavored Still Drinks, Nectars, and Plant-based Drinks, one-way ANOVA proved significant variances in the means with $p < .05$. However, once again, means as of fermentation status do not differ significantly from one another necessarily. Kombucha & Other Fermented Drinks have the smallest share of products being launched branded (0.03), whereas Juice has the highest share with 0.35.

The results of the ANOVA as per product category are reported below.

- Drinking Yogurt & Liquid Cultured Milk ($n = 2,758$): $F(3, 2754) = 13.77$, $p < .0001$
- Fruit/Flavoured Still Drinks ($n = 2,598$): $F(3, 2594) = 5.4$, $p = .0011$
- Juice ($n = 8,001$): $F(3, 7997) = 1.8$, $p = .1457$
- Kombucha & Other Fermented Drinks ($n = 406$): $F(3, 402) = 0.13$, $p = .9436$
- Nectars ($n = 4,344$): $F(3, 4340) = 8.05$, $p < .0001$
- Nutritional & Meal Replacement Drinks ($n = 4,289$): $F(3, 4285) = 2.11$, $p = .0962$
- Plant-based Drinks (Dairy Alternatives) ($n = 2,726$): $F(3, 2722) = 3.9$, $p = .0085$

Price per 100g/ml

Another variable with significant variances in the means is the price per 100g/ml in Euro with $F(3, 22402) = 155.37$, and $p < .0001$. We calculated the price per 100g/ml by dividing the total sales price as reported by Mintel by the total pack size of a product. For all products not retailing in Euro (UK), we use the rates converted and provided by Mintel, which reflect the rates at the time of entry into the database (Mintel Group Ltd., 2024b).

Table 27 Average price per 100g/ml in Euro as per fermentation status and product category for beverages

Fermentation status / Product category	**Not fermented**	**Slightly fermented**	**Partly fermented**	**Mainly fermented**	**Total**	**p-value** (one-way ANOVA)
Drinking Yogurt & Liquid Cultured Milk	0.43 [a]	0.50 [b]	0.41 [a]	0.38 [a]	**0.42**	0.0002
Fruit/Flavored Still Drinks	0.30 [a]	0.60 [b]	0.54 [b]	0.62 [a b]	**0.31**	< 0.0001
Juice	0.58	0.77	0.84	0.77	**0.59**	0.8368
Kombucha & Other Fermented Drinks	1.22	0.83	0.94	0.85	**0.92**	0.0570
Nectars	0.35 [a]	0.67 [b]	0.64 [b]	0.59 [a b]	**0.37**	< 0.0001
Nutritional & Meal Replacement Drinks	4.92 [a]	4.06 [b]	4.95 [a]	4.30 [a b]	**4.66**	< 0.0001
Plant Based Drinks (Dairy Alternatives)	0.30 [a]	0.38 [b]	0.35 [a b]	0.40 [a b]	**0.31**	0.0022

Note: Prices as per launch date (not indexed or inflation-adjusted); different letters in the same row (product category) indicate significant differences between fermentation statuses as evaluated by Bonferroni test ($p < 0.05$); missing letters for insignificant ANOVA results

The highest prices per 100g/ml in Euro are charged for products belonging to Nutritional & Meal Replacement Drinks (4.66 Euro) and Kombucha & Other Fermented Drinks (0.92 Euro), while the lowest prices are observed for Plant-based Drinks, and Fruit/Flavored Still Drinks (0.31 Euro), and Nectars (0.37 Euro). Partly fermented Nutritional & Meal Replacement Drinks have, consequently, the highest sales price with 4.95 Euro, compared to not fermented Plant-based Drinks, and Fruit/Flavored Still Drinks (0.30 Euro). Also prices per 100g/ml do not follow a linear trend across fermentation statuses but rather depend on product category and fermentation status. However, for Drinking Yogurt & Liquid Cultured Milk, Kombucha & Other Fermented Drinks, and Nutritional & Meal Replacement Drinks, prices tend to decrease from partly to mainly fermented, while for the remaining product categories prices increase towards the mainly fermented status. With regards to significance in the variances of means, only Juice and Kombucha & Other Fermented Drinks observe $p > 0.05$.

The results of the ANOVA as per product category are reported below.

- Drinking Yogurt & Liquid Cultured Milk ($n = 2,280$): $F(3, 2376) = 6.48$, $p = .0002$
- Fruit/Flavoured Still Drinks ($n = 2,162$): $F(3, 2158) = 17.39$, $p < .0001$
- Juice ($n = 7,188$): $F(3, 7184) = 0.28$, $p = .8368$
- Kombucha & Other Fermented Drinks ($n = 358$): $F(3, 354) = 2.53$, $p = .0570$

- Nectars (n = 3,740): F(3, 3736) = 12.96, p < .0001
- Nutritional & Meal Replacement Drinks (n = 4,090): F(3, 4086) = 8.95, p < .0001
- Plant-based Drinks (Dairy Alternatives) (n = 2,488): F(3, 2484) = 4.86, p = .0022

Launch type

Since the launch type is a categorical variable with more than 2 values (New Formulation, New Product, New Variety/Range Extension, Relaunch), we do not report the means as per product category and fermentation status but rather provide an overview as per product category, fermentation status, and launch type.

Table 28 Launch type for beverages as per product category and fermentation status

Fermentation status / Product category	Launch type	Not fermented	Slightly fermented	Partly fermented	Mainly fermented	Total
Drinking Yogurt & Liquid Cultured Milk	New Formulation	44 (3%)	-	22 (3%)	3 (1%)	**69 (2%)**
	New Product	546 (42%)	88 (44%)	315 (38%)	211 (48%)	**1160 (42%)**
	New Variety	580 (45%)	99 (49%)	406 (49%)	200 (46%)	**1285 (46%)**
	Relaunch	121 (9%)	15 (7%)	90 (11%)	24 (5%)	**250 (9%)**
Fruit/Flavored Still Drinks	New Formulation	59 (2%)	-	1 (3%)	-	**60 (2%)**
	New Product	1178 (48%)	82 (70%)	26 (76%)	4 (57%)	**1290 (49%)**
	New Variety	1011 (41%)	27 (23%)	5 (15%)	3 (43%)	**1046 (40%)**
	Relaunch	207 (8%)	8 (7%)	2 (6%)	-	**217 (8%)**
Juice	New Formulation	86 (1%)	6 (3%)	-	-	**92 (1%)**
	New Product	3068 (40%)	55 (26%)	28 (47%)	26 (54%)	**3177 (40%)**
	New Variety	3912 (51%)	127 (61%)	31 (52%)	17 (35%)	**4087 (51%)**
	Relaunch	625 (8%)	21 (10%)	1 (2%)	5 (10%)	**652 (8%)**
Kombucha & Other Fermented Drinks	New Formulation	1 (2%)	-	-	-	**1 (0%)**
	New Product	31 (62%)	52 (59%)	104 (61%)	61 (62%)	**248 (61%)**
	New Variety	17 (34%)	33 (38%)	57 (34%)	33 (34%)	**140 (34%)**
	Relaunch	1 (2%)	3 (3%)	9 (5%)	4 (4%)	**17 (4%)**
Nectars	New Formulation	78 (2%)	1 (1%)	-	-	**79 (2%)**
	New Product	1841 (44%)	80 (58%)	34 (55%)	8 (47%)	**1963 (45%)**
	New Variety	1897 (46%)	52 (38%)	26 (42%)	9 (53%)	**1984 (46%)**
	Relaunch	323 (8%)	4 (3%)	2 (3%)	-	**329 (8%)**
Nutritional & Meal Replacement Drinks	New Formulation	79 (3%)	56 (4%)	20 (3%)	1 (3%)	**156 (4%)**
	New Product	1320 (55%)	726 (57%)	310 (52%)	22 (71%)	**2378 (55%)**
	New Variety	869 (36%)	408 (32%)	229 (38%)	8 (26%)	**1514 (35%)**
	Relaunch	117 (5%)	94 (7%)	36 (6%)	-	**247 (6%)**

Plant-based Drinks (Dairy Alternatives)	New Formulation	52 (2%)	19 (4%)	1 (1%)	1 (4%)	**73 (3%)**
	New Product	878 (42%)	189 (42%)	59 (41%)	13 (52%)	**1139 (42%)**
	New Variety	970 (46%)	191 (43%)	69 (48%)	9 (36%)	**1239 (45%)**
	Relaunch	211 (10%)	49 (11%)	15 (10%)	2 (8%)	**277 (10%)**

Note: New Variety includes Range Extension as well, %-figures in relation to product category and fermentation status

New varieties/range extensions are the most common launch types for Drinking Yogurt & Liquid Cultured Milk, Juice, Nectars, and Plant-based Drinks. Fruit/Flavored Still Drinks, Kombucha & Other Fermented Drinks, and Nutritional & Meal Replacement Drinks are rather launched as a new product. While for most of the product categories, the distribution of launch types as per fermentation status is equal to the categories' overall distributions, mainly fermented Juice is more often launched as a new product (compared to this category's main launch type new variety/range extension). That also applies to slightly and mainly fermented Nectars and mainly fermented Plant-based Drinks, which are, against the overall categories' biggest share in new varieties, new products as well. Relaunches and new formulations are, in general, less common while the first is still more likely than the latter. However, Mintel does not track if products undergo a reformulation but rather relies on the information provided on the product's packaging, such as "new formula" or "tastier". We excluded "New Packaging" as launch type from our original dataset as this launch type usually does not cover innovations of the food product itself, but the packaging only and launches are accounted for as relaunches if several launch types apply. The difference between new product and new variety is determined by the brand the product is launched under, this is, if product range, region, and subcategory are new under a brand, the launch is considered as new product (Mintel Group Ltd., 2024a).

Number of ingredients

Another variable of the set of dependent variables with significant differences in means is the total number of ingredients of a product with $F(3, 25165) = 1398.6$, and $p < .0001$.

Table 29 Average no. of ingredients as per fermentation status and product category for beverages

Fermentation status / Product category	**Not fermented**	**Slightly fermented**	**Partly fermented**	**Mainly fermented**	**Total**	**p-value** (one-way ANOVA)
Drinking Yogurt & Liquid Cultured Milk	7.77 [a]	9.72 [b]	8.54 [c]	2.64 [d]	**7.33**	< 0.0001
Fruit/Flavored Still Drinks	7.58 [a]	10.74 [b]	7.59 [a]	1.43 [c]	**7.70**	< 0.0001
Juice	3.36 [a]	8.32 [b]	5.28 [c]	1.50 [d]	**3.49**	< 0.0001
Kombucha & Other Fermented Drinks	4.26 [a]	7.52 [b]	6.15 [c]	2.94 [d]	**5.44**	< 0.0001

Nectars	6.21[a]	9.58[b]	7.05[a]	1.53[c]	**6.31**	< 0.0001
Nutritional & Meal Replacement Drinks	11.96[a]	17.75[b]	9.12[c]	2.45[d]	**13.23**	< 0.0001
Plant-based Drinks (Dairy Alternatives)	6.03[a]	8.14[b]	7.34[c]	1.28[d]	**6.40**	< 0.0001

Note: Different letters in the same row (product category) indicate significant differences between fermentation statuses as evaluated by Bonferroni test ($p < 0.05$); missing letters for insignificant ANOVA results

The highest number of ingredients can be found in Nutritional & Meal Replacement Drinks (13.23) and Fruit/Flavored Still Drinks (7.7). Juice and Nectars have the smallest amount of ingredients (3.49, and 6.31, respectively). As for meat substitutes, slightly fermented beverages have the highest number of ingredients across all product categories. For all product categories, the higher the fermentation status, the smaller the number of ingredients, meaning mainly fermented beverages have the least ingredients, being mostly composed of a small number of ingredients only, such as buttermilk or kombucha.

The individual ANOVA as per product category reveals significant variances in means for all categories, and across most of the fermentation statuses. The results are reported below.

- Drinking Yogurt & Liquid Cultured Milk ($n = 2,764$): $F(3, 2760) = 317.60$, $p < .0001$
- Fruit/Flavoured Still Drinks ($n = 2,613$): $F(3, 2609) = 28.72$, $p < .0001$
- Juice ($n = 8,008$): $F(3, 8004) = 211.22$, $p < .0001$
- Kombucha & Other Fermented Drinks ($n = 406$): $F(3, 402) = 74.39$, $p < .0001$
- Nectars ($n = 4,355$): $F(3, 4351) = 52.94$, $p < .0001$
- Nutritional & Meal Replacement Drinks ($n = 4,295$): $F(3, 4291) = 160.48$, $p < .0001$
- Plant-based Drinks (Dairy Alternatives) ($n = 2,728$): $F(3, 2724) = 82.9$, $p < .0001$

Time on market

For time on market, we calculated the years the product is already on the market using the base Dec. 31st, 2022, meaning products, that are, for instance, launched on Jan. 1st, 2020 are on the market for ~3 years. We limited our dataset for products launched on or after Jan. 1st, 2000, to account for Mintel's increasing market coverage in the respective markets, which is, according to Mintel, sufficient from 2000 onwards to fetch most of the product launches. Also this variable is, based on our ANOVA, significant with $F(3, 25165) = 177.36$, and $p < .0001$.

Table 30 Time on market for beverages as per product category and fermentation status

Fermentation status / Product category	**Not fermented**	**Slightly fermented**	**Partly fermented**	**Mainly fermented**	**Total**	**p-value** (one-way ANOVA)
Drinking Yogurt & Liquid Cultured Milk	10.57[a]	9.85[a]	10.06[a]	12.03[b]	**10.59**	< 0.0001

Fruit/Flavored Still Drinks	9.85 [a]	9.17 [a]	8.95 [a]	16.90 [b]	**9.82**	0.0039
Juice	8.03 [a]	5.55 [b]	7.14 [a b]	8.69 [a]	**7.96**	< 0.0001
Kombucha & Other Fermented Drinks	5.91 [a]	4.00 [a b]	4.62 [a b]	3.91 [b]	**4.47**	0.0306
Nectars	9.59 [a]	9.52 [a]	8.42 [a]	16.99 [b]	**9.60**	< 0.0001
Nutritional & Meal Replacement Drinks	4.58 [a]	4.47 [a]	3.88 [b]	6.49 [c]	**4.46**	< 0.0001
Plant-based Drinks (Dairy Alternatives)	6.59 [a]	7.24 [a]	7.02 [a]	10.02 [b]	**6.75**	0.0005

Note: Time on market in years (base: Dec. 31, 2022); different letters in the same row (product category) indicate significant differences between fermentation statuses as evaluated by Bonferroni test ($p < 0.05$); missing letters for insignificant ANOVA results

Drinking Yogurt & Liquid Cultured Milk are on the market for the longest period of time with an average time on market of 10.59 years. The p-value of the one-way ANOVA is significant with $p < .0001$, while the means as per fermentation status are only significantly different for mainly fermented. The "youngest" beverage category on the market is **Nutritional & Meal Replacement Drinks** with 4.46 years in average. **Kombucha & Other Fermented Drinks** tend to be shorter on the market the higher the fermentation status. However, even though the one-way ANOVA proved significant ($p = .0306$), the means as per fermentation status only differ significantly from one another for not vs. mainly fermented. For Drinking Yogurt & Liquid Cultured Milk, **Fruit/Flavored Still Drinks**, and **Nectars** time on market for mainly fermented products is higher than for not fermented counterparts. For the two latter, the difference in means is worth noting (9.85 vs. 16.9, and 9.59 vs. 16.99). Consequently, mainly fermented nectars are on the market the longest, with an average launch date 16.99 years ago. The results of the ANOVA as per product category are reported below.

- Drinking Yogurt & Liquid Cultured Milk ($n = 2{,}764$): $F(3, 2760) = 11.63$, $p < .0001$
- Fruit/Flavoured Still Drinks ($n = 2{,}613$): $F(3, 2609) = 4.46$, $p = .0039$
- Juice ($n = 8{,}008$): $F(3, 8004) = 17.45$, $p < .0001$
- Kombucha & Other Fermented Drinks ($n = 406$): $F(3, 402) = 3.0$, $p = .0306$
- Nectars ($n = 4{,}355$): $F(3, 4351) = 10.95$, $p < .0001$
- Nutritional & Meal Replacement Drinks ($n = 4{,}295$): $F(3, 4291) = 9.04$, $p < .0001$
- Plant-based Drinks (Dairy Alternatives) ($n = 2{,}728$): $F(3, 2724) = 5.88$, $p = 0.0005$

4.2.3. Discussion and limitations

As for meat substitutes, the statistical assessment of beverages in favor of their fermentation statuses reveals ambiguous results. Even though the sample size of beverages is 5.7 larger than for meat substitutes, the independent variables often do not explain the variances of the dependent variables. This is, as per product category, means might differ significantly, but often, means as of fermentation status do not. Consequently, the fermentation status does not necessarily have an explanatory power over the dependent variables. This might again be reasoned by the nature of fermentation, which does not have an impact on the FOP information provided by Mintel GNPD and which we analyzed for this report. We also see that the significance of the means' differences very much depends on the sample size. Smaller samples, like Kombucha & Other Fermented Drinks in general, or the bucket of mainly fermented products, often lead to insignificant results. However, for the proxies we used to assess the healthiness of products, this is the A-Score, the number of additives, the presence of health claims, and the vegan status, there is – even though often not significant – a tendency of partly and mainly fermented products to be considered healthier than their not and slightly fermented counterparts. And yet, we would refrain from making this a general conclusion as it depends on the specific product category and variable.

We observed the most significant variances across all product categories and for all fermentation statuses for the number of ingredients, meaning the higher the fermentation status (or degree), the smaller the total number of ingredients in a product. Consequently, mainly fermented products can be considered "purer" with fewer different ingredients. However, this effect is, of course, mainly explained by the way we derive the fermentation status, this is, attributing the fermentation status based on the total number of ingredients and the respective position of a fermented ingredient in the product's ingredient list.

For further analysis, additional dependent variables might be looked upon. For instance, we aggregate nutritional values to the A-Score or individual FOP claims to either nutritional or health claims. The individual nutritional values or claims might be assessed as well. One variable that is also provided by Mintel is, for example, storage type. Here, fermentation, based on the above definition, might indeed have an impact on the types chilled, frozen, or shelf-stable. In fact, storage type is significant across all product categories with $F(3, 27917) = 451.34$, and $p < .0001$. Also, all means as per fermentation status differ significantly from one another, with $p < .0001$. The descriptive statistics, as presented in Table 31, reveal that, apart from Juice, the share of products that are chilled increases with increasing fermentation status, or, the other way, the higher the fermentation status, the higher the share of products that need chilling.

Table 31 Storage type for beverages as per product category and fermentation status

Fermentation status / Product category	Launch type	Not fermented	Slightly fermented	Partly fermented	Mainly fermented	Total
Drinking Yogurt & Liquid Cultured Milk	Chilled	1268 (98%)	190 (94%)	813 (98%)	428 (98%)	2699 (98%)
	Frozen	0 (0%)	0 (0%)	0 (0%)	1 (0%)	1 (0%)
	Shelf-stable	11 (1%)	11 (5%)	20 (2%)	1 (0%)	43 (2%)
Fruit/Flavored Still Drinks	Chilled	368 (15%)	15 (13%)	6 (18%)	2 (29%)	391 (15%)
	Frozen	4 (0%)	0 (0%)	0 (0%)	0 (0%)	4 (0%)
	Shelf-stable	2041 (83%)	101 (86%)	28 (82%)	3 (43%)	2173 (83%)
Juice	Chilled	3080 (40%)	130 (62%)	39 (65%)	11 (23%)	3260 (41%)
	Frozen	17 (0%)	0 (0%)	0 (0%)	0 (0%)	17 (0%)
	Shelf-stable	4522 (59%)	79 (38%)	21 (35%)	37 (77%)	4659 (58%)
Kombucha & Other Fermented Drinks	Chilled	8 (16%)	31 (35%)	80 (47%)	50 (51%)	169 (42%)
	Frozen	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Shelf-stable	41 (82%)	57 (65%)	89 (52%)	48 (49%)	235 (58%)
Nectars	Chilled	653 (16%)	34 (25%)	28 (45%)	4 (24%)	719 (17%)
	Frozen	4 (0%)	0 (0%)	0 (0%)	0 (0%)	4 (0%)
	Shelf-stable	3438 (83%)	103 (75%)	33 (53%)	9 (53%)	3583 (82%)
Nutritional & Meal Replacement Drinks	Chilled	41 (2%)	17 (1%)	7 (1%)	2 (6%)	67 (2%)
	Frozen	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Shelf-stable	2299 (96%)	1264 (98%)	588 (99%)	29 (94%)	4180 (97%)
Plant-based Drinks (Dairy Alternatives)	Chilled	293 (14%)	64 (14%)	19 (13%)	10 (40%)	386 (14%)
	Frozen	4 (0%)	0 (0%)	0 (0%)	0 (0%)	4 (0%)
	Shelf-stable	1804 (85%)	384 (86%)	125 (87%)	14 (56%)	2327 (85%)

Note: %-figures in relation to product category and fermentation status

However, we did not include this assessment in our statistical assessments as we wanted to focus on general describing variables and variables with insights into the healthiness of foods.

Deviations or delay

5.1. Description and reason for deviations or delay

Not applicable.

5.2. Impact on other tasks

Not applicable.

5.3. Corrective actions taken to catch up with initial schedule

Not applicable.

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Lists of Figures and Tables

Appendix

Table A 1 Mintel FOP label (product claim)

Neutral	Nutritional claim	Health claim
All Natural Product	Added Calcium	Anti-Ageing
Carbon Neutral	Dairy Free	Antioxidant
Children 5-12	Diet/Light	Diabetic
Cobranded	High/Added Fibre	Free from Added/Artificial Additives
Convenient Packaging	High/Added Protein	Free from Added/Artificial Colourings
Ease of Use	Low/No/Reduced Allergen	Free from Added/Artificial Flavourings
Economy	Low/No/Reduced Calorie	Free from Added/Artificial Preservatives
Ethical - Animal	Low/No/Reduced Carb	Functional - Beauty Benefits
Ethical - Biodegradable	Low/No/Reduced Cholesterol	Functional - Bone Health
Ethical - Charity	Low/No/Reduced Fat	Functional - Brain & Nervous System
Ethical - Environmentally Friendly Package	Low/No/Reduced Lactose	Functional - Cardiovascular
Ethical - Environmentally Friendly Product	Low/No/Reduced Saturated Fat	Functional - Digestive
Ethical - Human	Low/No/Reduced Sodium	Functional - Energy
Ethical - Recycling	Low/No/Reduced Transfat	Functional - Eye Health
Ethical - Sustainable Habitat/Resources	Low/Reduced Sugar	Functional - Immune System
Ethical - Toxins Free	No Added Sugar	Functional - Other
Event Merchandising	Sugar Free	Functional - Skin
Female	Vitamin/Mineral Fortified	Functional - Slimming
Halal		Functional - Stress & Sleep
High Satiety		Functional - Weight & Muscle Gain
Innovative Ingredient		Gluten Free
Kosher		GMO Free

Limited Edition		Hormone Free
Maternal		Nails & Hair
Microwaveable		No Additives/Preservatives
Novel		Prebiotic
On-the-Go		Probiotic
Organic		Wholegrain
Palm Oil Free		
Plant-based		
Portionability		
Premium		
Refill/Refillable		
Seasonal		
Social Media		
Time/Speed		
Vegan/No Animal Ingredients		
Vegetarian		

Note: Nutritional claims are based on the Annex of Regulation (EC) No 1924/2006, lastly amended by Regulation (EU) No 1047/2012. Health claims relate to all other FOP claims alluding to health, independent of EU regulation. Neutral claims are all FOP claims not nutritional and not related to health.

Table A 2 Meat substitutes' categories and respective keywords

Pieces	**Sausage**	**Burger**	**Coated**	**Balls**	**Cutting/ Trimming**	**Cold cut**
Piece	Sausage	Burger	Coat	Ball	Roulade	Cold cut
Chunk	Sausgs	Patties	Breaded	Cevapcici	Steak	Ham
Cube	Viennese	Pattie	Nugget	Kofta	Fillet	Salami
Guillette	Chorizo	Tartare	Nug-get	Köttbullar	Filet	Bacon
Bit	Sucuk	Patty	Finger	Köfte	Kyiv	Rasher
Strip	Hot Dog	Frikadelle	Z*nger	Kefta	Kiev	Mortadella
Kebab	Frankfurter	Rissole	Buenggies		Tender	Serrano
Gyros	Frankfurts	Nest	Stick		Loaf	Prosciutto
Filling	Wurst	BurVeg	Cutlet		Loav	Aspic
Dumpling	Würstel	Quarter	Cordon bleu		Roast	Pepperoni
Bolognese	Veyona	Cake	Schnitzel		Meatloaf	Slice
Mince	Chipolata	Vegadelle	Escalope		Medaillion	Lyoner

Tex Mex	Salsiccia	Falafel	Goujon		Medallion	Sandwich
Textured	Merguez		Crisp		Medalion	Bresaola
Texturised	Weenie		Crunch		Goulash	Carpaccio
Structured	Kabano		Hash Brown		Tempe	Mopur
Granulate	Dog		Bake		Terrine	Luncheon
Granule	Wiener		Crispbake		BBQ	Altervcon
Shawarma	Shroomdog		Panettine		Jackfruit	
Lardon	Griller		Croquette		Tofu	
Pulled	Banger		Escallop		Fish	
Chili sin carne	Whirl				Tuna	
Shred	Grills				Tuno	
Square	Haggis				Vuna	
Chick'n Pops	Brat				Shrimp	
Tikka Masala	Sizzler				Caviar	
Pudding					Salmon	
Curry					Breast	
Fry-Up					Drumstick	
Bourguignon					Liver	
Dipper					Plain	
Chops					Chuna	
Lasagne					Tandoori	
Fricassee					Plant-based Chicken	
Semolina					Wing	
Flakes					Chicken bucket	
Ground					Tatty	
Fajita					Hempfu	
Pâté					Seafood Alternative	
Satay*					Galette	
Sate*					Roll	
Saté*					Kassler	
Skewer*					Medaillons	
Vegbab*					Duck	
Stacks*					Quefu	
					Nature	

* Note: Category “Satey” was included in category “Burger” since only 9 products complied with the respective keywords

Table A 3 Fermentation degree matrix

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