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Report on Consumer Perception of Fermented Foods

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Table of content

Abbreviations

AT: Austria
DE: Germany
EE: Estonia
ES: Spain
FR: France
IE: Ireland
IT: Italy

List of Tables

List of Figures

Executive Summary

Fermentation has the potential to enhance the sensory qualities, nutritional value, and environmental sustainability of contemporary diets. However, the realization of this potential is contingent upon consumer acceptance and their willingness to integrate fermented foods into their dietary practices. We surveyed 4971 European consumers across seven countries to obtain insights into their knowledge, attitudes and preferences with regard to fermented foods, focusing in particular on their perceived health- and sustainability aspects.

The presented report consolidates preliminary findings from the survey. It is the first of two consumer surveys planned within WP5 (Task 5.3) and has been built on the outcomes of consumer-visioning focus groups held at the DOMINO Living Labs, aiming to validate and expand upon these findings with quantitative insights. We highlight both a solid understanding of the benefits of fermented foods among European consumers, as well as lingering misconceptions, and identify trusted communication channels for effectively addressing knowledge gaps. Results from this survey with regard to sensory appeal, quality- and functional preferences will feed into the design of the fermented food prototypes in WP4. A selection of these prototypes will be subjected to sensory experiments toward the end of the project to assess consumer acceptance, hedonic liking, and willingness to pay. Furthermore, insights gained from this first consumer survey, such as misconceptions, doubts, and trust factors, will be leveraged to design a targeted second survey that addresses relevant consumer perceptions.

1. Introduction

1.1. Setting the scene

1.1.1. Consumer interest in fermented foods

For millennia, people worldwide have practiced the ancient art of fermenting local plant and animal materials to create nutritious and shelf-stable foods and beverages. Yet advances in food production, such as more efficient supply chains, cold storage and preservatives, have diminished the popularity of fermented foods, at least in the context of home fermentation. The recent surge in popularity of fermented foods can be mainly attributed to the growing public awareness and interest in their potential nutritional and health benefits, such as providing vitamins, prebiotics and probiotics and improving digestibility (Galimberti et al., 2021). However, many consumers are still unclear about the specific role of fermented foods in providing such benefits (Vinderola et al., 2023). Despite such uncertainties the fermented food market has recorded steady growth over the last two decades, as was shown in a market assessment that we carried out in the first phase of the project. Using data from Mintel's Global New Product Database (see DEL5.2), we identified a clear upward trend in the launch of fermented or at least partially fermented foods, highlighting a growing consumer demand for these products. The fermented food market is also witnessing a greater variety of fermented food products. Many fermented foods that were previously unknown or origin-specific, such as kimchi, skyr, miso, tempeh and kombucha, are now widely available commercially (Šikić-Pogačar et al, 2022). However, the exact reasons for the greater number of products on the fermented food market remain unknown and little is understood about consumers' perception of these foods in general and their attitudes towards specific fermented foods.

1.1.2. Barriers and opportunities

The presented survey is intended to build on outcomes of the Living Lab consumer visioning sessions that have taken place from M1-18 in Estonia, France, Germany, Italy, Ireland, and Spain. The data analysis of the consumer visioning and the design requirement sessions with Living Lab leaders (both conducted by VU) helped us to identify various prevalent themes that consumers face with regard to fermented foods. We categorized these into opportunities and barriers (Table 1). Since these themes represent data from qualitative studies, we aimed at undermining these findings with quantitative data via the presented survey.

Barriers	Opportunities
Knowledge	
Limited knowledge on fermented foods and fermentation processes	Strong interest in and desire to learn more about fermented foods and fermentation processes
Various misconceptions (e.g., "process of fermented foods results in unnecessary waste", "Foods needs to rot before fermentation")	

Perceived benefits & risks	
Uncertainty and lack of evidence about the health impacts of fermented foods	Perceived health benefits & disease prevention
Fear about freshness, spoilage and health risks	Perceived environmental protection
	Preference for locally produced foods
	Traditional and cultural value (reinforcing cultural practices, maintaining cultural heritage)
Products	
Confusion about whether fermented foods are "processed foods" or "natural foods" (i.e. what qualifies as "natural process" and what as "processed")	Demand for fermented foods with high nutritional value
Difficulty in identifying fermented foods and understanding their benefits	Demand for convenience and ease of use (e.g., spreadable fermented foods, products for direct consumption)
Difficulties in determining which product category fermented foods belong to	
Sensory aspects	
Unfamiliarity with sensory properties of fermented foods	Interest in international cuisine and new flavors (e.g., kimchi)
Some consumers perceive the look, texture and odor of fermented foods as unappealing (highly subjective to the type of fermented food, personal preferences and cultural background)	
Pricing	
Value for money: concern that fermented foods should not be more expensive than alternatives	
Marketing	
	Fermented foods should be aimed at niche audiences who appreciate their benefits
	Fermented foods should be marketed to young people and parents as they shape consumption habits of generations to come

Table 1: Barriers and opportunities related to fermented foods from the consumer's perspective

N.B.: the prevalent themes are a summary of all country sessions and do not account for individual country differences

1.2. Research objectives

The prevalent themes identified in the consumer-visioning sessions of the living labs (as described in the previous chapter), along with insights from a preliminary literature review – referenced throughout the following chapters – served as a foundation for defining our research objectives. Furthermore, living lab leaders were consulted during the survey development process to ensure that outcomes can be effectively leveraged for the design of the fermented food case studies to meet consumer needs.

Presented in the following are general aspects deemed relevant for the case studies, based on comments from partners to the D5.2 report on market developments & innovation potential, online meetings and insights gathered from the design requirement sessions:

- What are consumer's needs and wants with regard to fermented foods?
- What do they appreciate about fermented foods?
- What obstacles do they face with regard to fermented foods?
- Do they have preference for specific fermented foods?
- What are country differences in knowledge and attitudes toward fermented foods?

Taking into account these and the previous mentioned aspects, we defined the following research objectives (RO) for the survey:

RO1: To assess consumers' **objective and subjective knowledge** on fermentation, fermented foods and microorganisms.

RO2: To understand **consumer perceptions** of fermented foods in relation to attributes such as health benefits and risks, environmental benefits, natural vs. processed qualities, convenience, and sensory appeal.

RO3: To investigate current **consumption patterns and willingness to try**, while distinguishing between traditional and novel fermented foods.

The research focus of the present survey also aligns with the consumer survey that was previously conducted by HealthFerm (sister project). We made sure to avoid aspects that were already thoroughly investigated by the mentioned survey and to focus on topics that were not or only briefly touched upon, such as knowledge and perceived health and sustainability aspects of fermented foods, while making sure that the focus still aligns with DOMINO-specific topics of interest. In accordance with the researchers at Umeå University who conducted the HealthFerm survey, we have adopted some of their scales for our questionnaire to allow for comparability of the results of both surveys.

1.3. Scope

The content in this report is preliminary and reflects initial findings based on descriptive statistics. Discussions of these results should be framed within this context, i.e., any interpretation or discussion should take into account the limitations of the current data. The presented findings are not final and should be seen as an early stage of analysis. Further analyses and predictive behavior models will be conducted separately to provide more robust conclusions for scientific publication.

2. The Survey

2.1. Questionnaire development

An online questionnaire was designed for the study, consisting of five parts. The first part contained questions on sociodemographic data. The second part included questions assessing dietary preferences and factors that may influence these. The third part consisted of questions about respondents' subjective and objective knowledge of microorganisms, of fermentation and fermented foods, and of the gut microbiome. In this part, we also inquired about information sources. The fourth part dealt with questions specifically related to the perceptions, attitudes, consumption and willingness to try fermented foods. The last part addressed respondents' health status and interest in gut health innovations.

Whenever possible, we used validated scales (e.g., Food Choice Questionnaire, Variety Seeking Scale) to assess the aboved mentioned areas of interest. Other questions were modeled based on those previously published by similar studies on the respective topics, including the HealthFerm study (Pérez-Cueto et al., 2024). All questions were formulated as closed questions with multiple response options.

The questionnaire was developed in English and presented to living lab leaders to obtain feedback. After making necessary changes, we submitted the questionnaire to the Ethic Committee of the Technical University Munich. On November 28, 2024, we received ethical approval from the committee to conduct our study (2024-134-NM-BA). Subsequently, we subcontracted a market research agency (Innofact, www.innofact-marktforschung.de) for the programming and distribution of the survey in the respective countries. When selecting a suitable company, we ensured it operated online consumer panels in the target countries, in some cases in cooperation with partner companies, ensured high data quality through rigorous quality checks, and could implement the requested quotas (see following chapter). We also instructed the agency with translating the questionnaire into the respective languages (German, Spanish, French, Italian, Estonian) and asked partners for a final check of the translated questionnaires.

2.2. Data collection

The target group of the presented survey were people aged 18 and over who reside in the following (project partner) countries: Austria (AT), Germany (DE), Estonia (EE), Spain (ES), France (FR), Ireland (IE), and Italy (IT). Respondents that were excluded from the study were people aged below 18 years and nutrition and health professionals. The recruitment of participants and data collection were entirely carried out by Innofact. A country-specific representative distribution of respondents was pursued with regard to the following parameters:

- Gender
- Age
- Region of residence
- Household size
- Monthly net household income

Statistical data on those parameters was obtained from Eurostat and provided to Innofact before launching the survey. We aimed for a at least 800 valid responses in DE, ES, FR, IT and 400 valid responses in AT, EE, IE.

Before carrying out the field work, a soft launch was done with a sample size of 731 participants, which did not lead to any adjustments. The actual field work took place between 17 and 23 December 2024.

2.3. The sample

In total, 4917 responses were collected in AT, DE, EE, ES, FR, IE, and IT (Table 2). The mean age of the respondents was 49 years (Min = 18, Max = 85). Country-specfic sample sizes sometimes exceeded the targeted numbers to meet quota requirements. The respondents were approximately equally distributed, with about 50% being female, 50% male, and 0,1% each choosing "Other" or "Prefer not to say" as their gender. All socio-demographic characteristics are detailed in Table 3.

2.3.1. Distribution of respondents by country

Country	France	Spain	Italy	Germany	Ireland	Estonia	Austria
Number	903	873	989	866	449	456	435
Proportion (%)	18,2	17,6	19,9	17,4	9,0	9,2	8,7

Table 2: Distribution of respondents by country

NB: For the regional distribution of respondents by country, see Appendix, A2.

2.3.2. Socio-demographic characteristics

Variable	%
Age Groups	
18-30	14,3
31-40	18,5
41-50	20,2
51-60	20,8
61+	26,2
Gender	
Female	49,5
Male	50,3
Other	0,1
Prefer not to say	0,1

Level of Education	
Elementary school	3,3
High school or secondary school	25,0
Trade or vocational school degree	33,1
University degree	23,0
Postgraduate degree (Masters / PhD)	15,6
Professional Status	
Student	3,7
Employed	52,8
Homemaker	5,5
Retired/Pensioner	21,2
Searching for a job/unemployed	7,8
Self-employed	8,9
Industry	
Banking	4,8
Construction	5,9
Farming	1,7
Food industry or grocery sector	5,0
Forestry	0,3
Hospitality	4,5
Human resources	4,0
Media	2,0
Mining	0,5
Teaching/Education	7,9
Transportation	5,1
Other	58,3
Living area	
In a city	39,1
In a town	35,7
In the countryside/rural area	25,2

Household size	
1	28,8
2	32,1
3	17,8
4	15,1
5 or more	6,2
Number of children (in households ≥ 2)	
0	41,8
1	16,1
2	10,0
3	2,5
4	0,5
5 or more	0,3

Table 3: Sociodemographic characteristics of respondents across all countries

We also inquired about respondents' **income levels**, providing four response options with different income ranges tailored to each country. We calculated those income ranges based on social statistics (income distribution by quantiles) of the respective country which we obtained from Eurostat (Eurostat, 2024). We aimed at recruiting 25% of the total sample for each income level, ensuring an equal distribution of income levels within our total sample. A detailed overview of income distribution can be found in the Appendix (A1) .

2.3.3. Food shopping behavior

Responsibility	%
Only me	53,0
Mainly me, sometimes someone else	23,5
Me and someone else equally	19,6
Mostly someone else, sometimes me	3,1
Always someone else	0,8

Table 4: Responsibility for food shopping in households

3. Diets: What drives EU Consumers' Food Choices?

With regard to the potential of fermented foods to support the dietary transition toward plant-based products, an assessment of current dietary lifestyles and factors that may influence these was conducted.

3.1. Dietary lifestyle

The **OMNIVORE DIET STILL REPRESENTS THE MOST COMMON DIET**, with nearly 70% of the 4971 surveyed consumers indicating that they frequently eat meat such as beef, pork, chicken, turkey, and fish or shell-fish. A total of 23% of respondents identified as flexitarians, meaning they are trying to reduce their meat consumption and often choose plant-based foods instead (Figure 1). Within this segment, Austria and Germany come out on top with 38% and 35% respectively describing themselves as flexitarians. Spain and Estonia have the lowest share of flexitarians (14%) and of vegetarians (< 2%). Countries that mark the highest share of people following a meat-free diet (vegetarians or vegans) are Austria (5,9%), Ireland (5,4%), Germany and Italy (4,5%). Less than 1% of all respondents follow a completely plant-based diet (vegan), with Spain and Austria having a higher-than-average proportion of vegans, exceeding the 1% mark (Figure 2).

At first glance, age doesn't seem to be a strong predictor for a low-meat or meat-free dietary lifestyle, although it can be noted that the 41-50 age group has a comparatively lower share of flexitarians than the other age groups (Figure 3). Gender on the other hand appears to play a bigger role. While the majority of both genders identify as omnivores, among female respondents, 27% consider themselves flexitarians and 6% vegetarians or vegans, compared to 19% and 2,5% of male respondents, respectively.

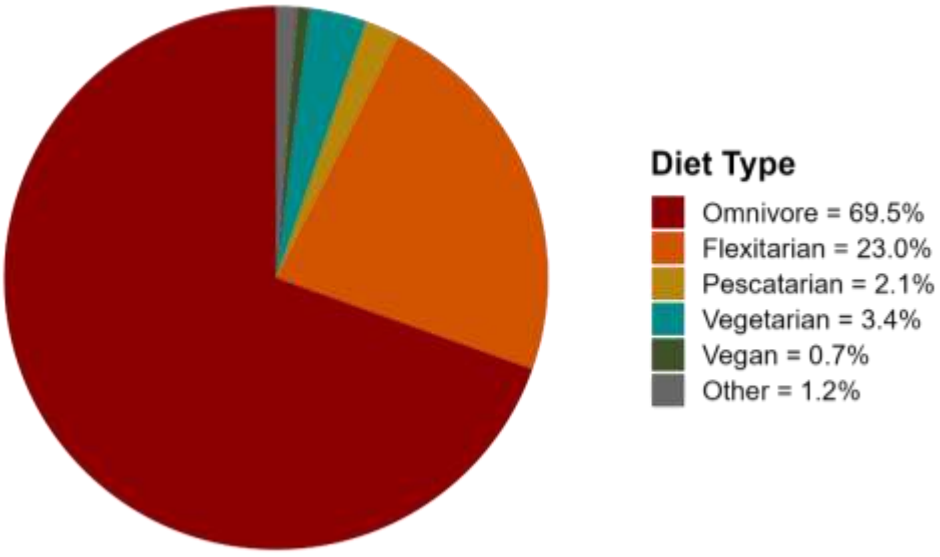

Figure 1: Dietary lifestyle distribution among total sample

3.1.1. By country

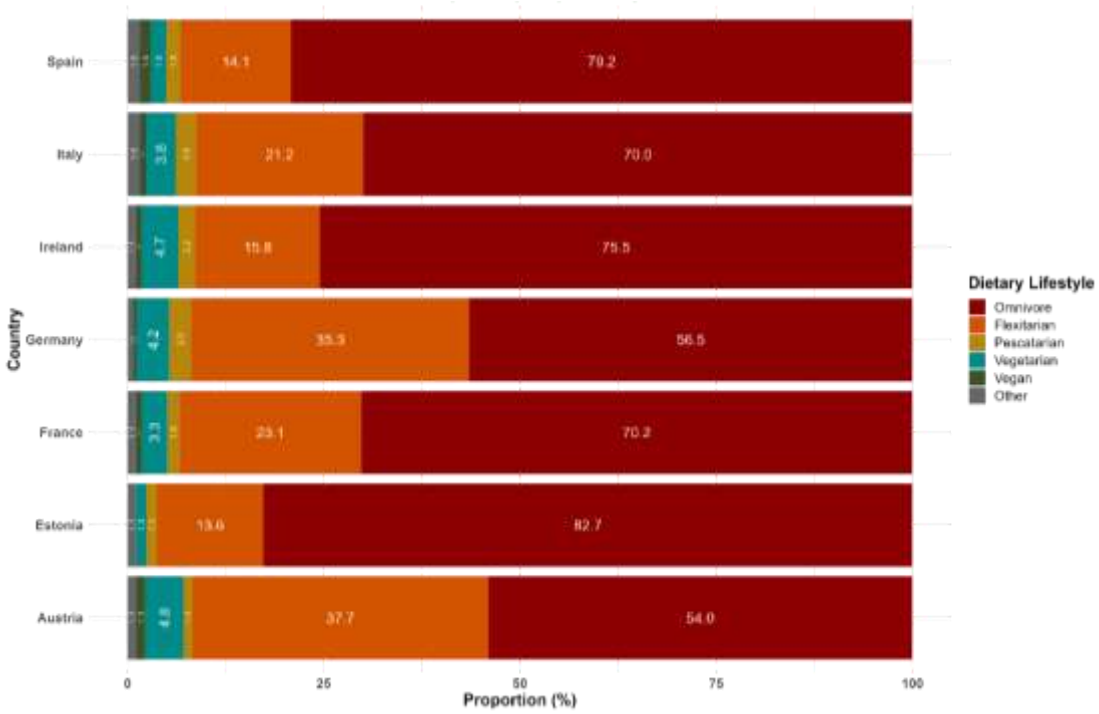

Figure 2: Dietary lifestyle distribution by country

3.1.2. By age

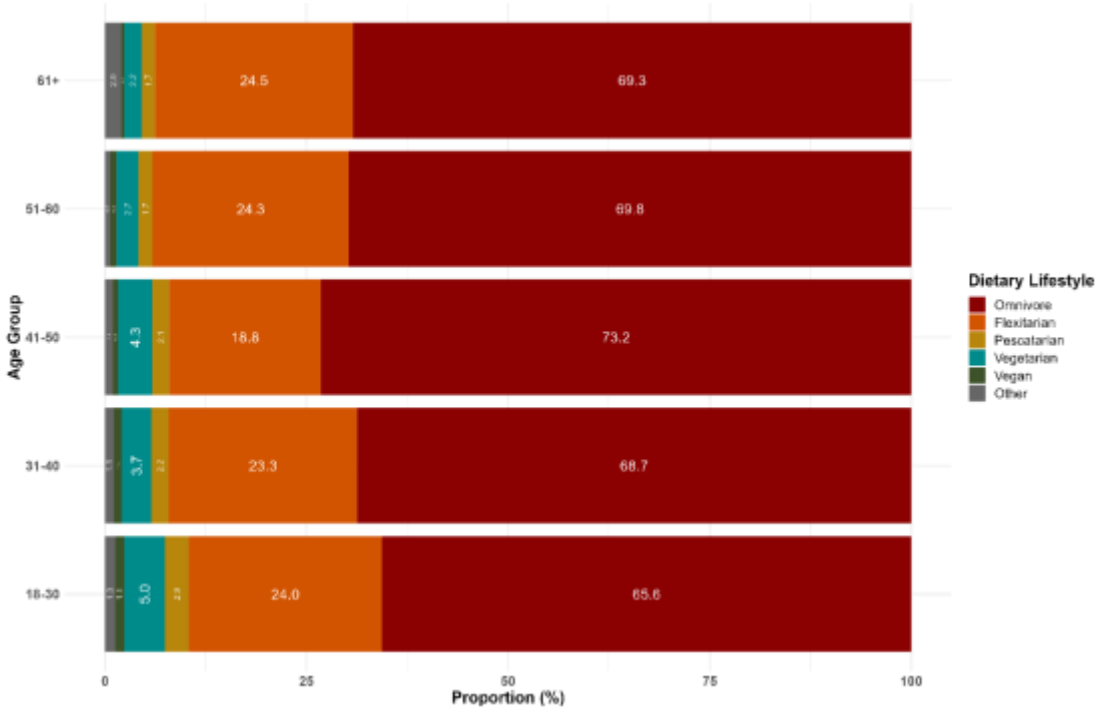

Figure 3: Dietary lifestyle distribution by age

3.2. Food choice motives

Understanding food choices is complex given the variety of factors that play a role. We combined the well-established Food Choice Questionnaire (Steptoe et al., 1995) with the Sustainable Food Choice Questionnaire (Verain et al., 2021) to measure the importance of different food choice motives that may deliver important insights into facilitators and barriers of fermented food consumption. The questionnaire consisted of 36 items, which can be summarized in nine motive dimensions. For each item, respondents rated the importance on a scale from 1 (*not at all important*) to 5 (*extremely important*). Based on these ratings , the mean value was calculated for each of the nine dimensions (Figure 4).

The **PRIMARY FACTOR INFLUENCING FOOD CHOICES AMONG RESPONDENTS CONTINUES TO BE THE ENJOYMENT OF SENSORY EXPERIENCES**. This is followed by a food product's naturalness, price and healthiness. Environmental dimensions such as a low environmental impact and local and seasonal production, although important, seem to be less dominant. As least important, respondents rated familiarity with a food, potentially offering a window of opportunity for fermented foods that consumers may not know yet and may be introduced to.

Some differences across countries can be observed (Table 5). For instance, the natural content of a food product was rated particularly high in Italy, as was its environmental impact, compared to the other countries. In contrast, respondents from Estonia and Ireland assigned less importance to environmental impact and local or seasonal production relative to their EU counterparts.

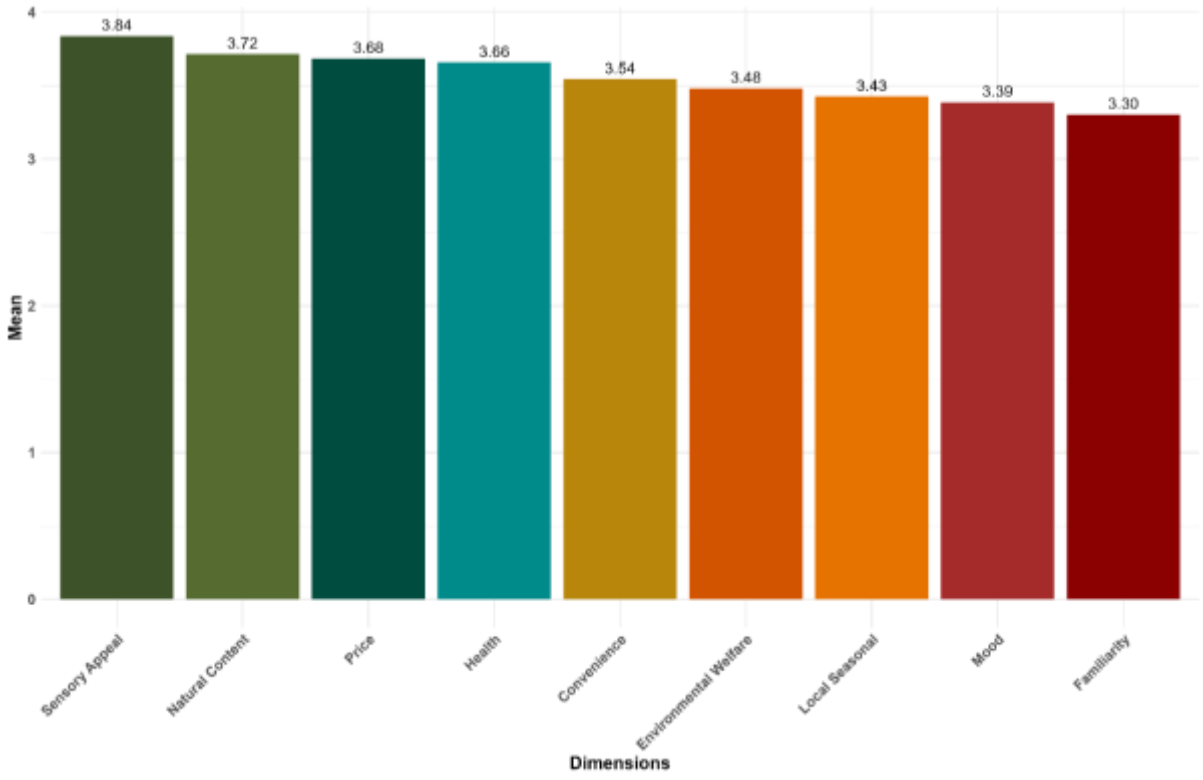

Figure 4: Mean ratings of food choice motives per dimension

By country

	DE	IE	IT	EE	FR	AT	ES
Health	3.54	3.69	3.73	3.61	3.67	3.62	3.71
Mood	3.25	3.27	3.54	3.41	3.43	3.27	3.42
Convenience	3.53	3.55	3.54	3.53	3.56	3.57	3.54
Sensory Appeal	3.80	3.82	3.82	3.82	3.91	3.80	3.86
Natural Content	3.64	3.44	3.92	3.45	3.79	3.77	3.75
Price	3.72	3.56	3.65	3.90	3.67	3.70	3.65
Familiarity	3.37	3.12	3.31	3.14	3.35	3.29	3.37
Environmental Welfare	3.40	3.26	3.74	3.02	3.59	3.48	3.51
Local and Seasonal	3.35	3.05	3.61	2.93	3.61	3.52	3.51

Table 5: Mean ratings of food choice motives per dimension across countries

3.3. Values

Personal values, "*... beliefs upon which a man acts by preference*" (Allport, 1963), have been widely recognized in consumer research as an important influence on consumer behavior, also in the context of food choice behavior. To shed light on the relationship between personal values and healthy and sustainable food choices, particularly in relation to the consumption of fermented foods, a scale by De Groot and Steg was used that measures egoistic, altruistic and biospheric value orientations (De Groot & Steg, 2008). Each of those value orientations consisted of four to five value items that participants had to rate each for their importance on a five-point scale from *Not important at all* to *Extremely important*. Figure 5 presents the distribution of mean ratings for the value items.

Values related to the well-being of the environment, such as *respecting nature, protecting the environment, and preventing pollution*, as well as values related to the welfare of other people, including *a world at peace* and *social justice*, received the highest ratings, with a significant proportion of respondents rating them as very to extremely important. In contrast, values that are focused on personal benefits such as *social power*, *influential* and *authority* are rated lower, with a higher proportion of respondents assigning them less importance. The results indicate a stronger emphasis on altruistic and biospheric over egoistic values.

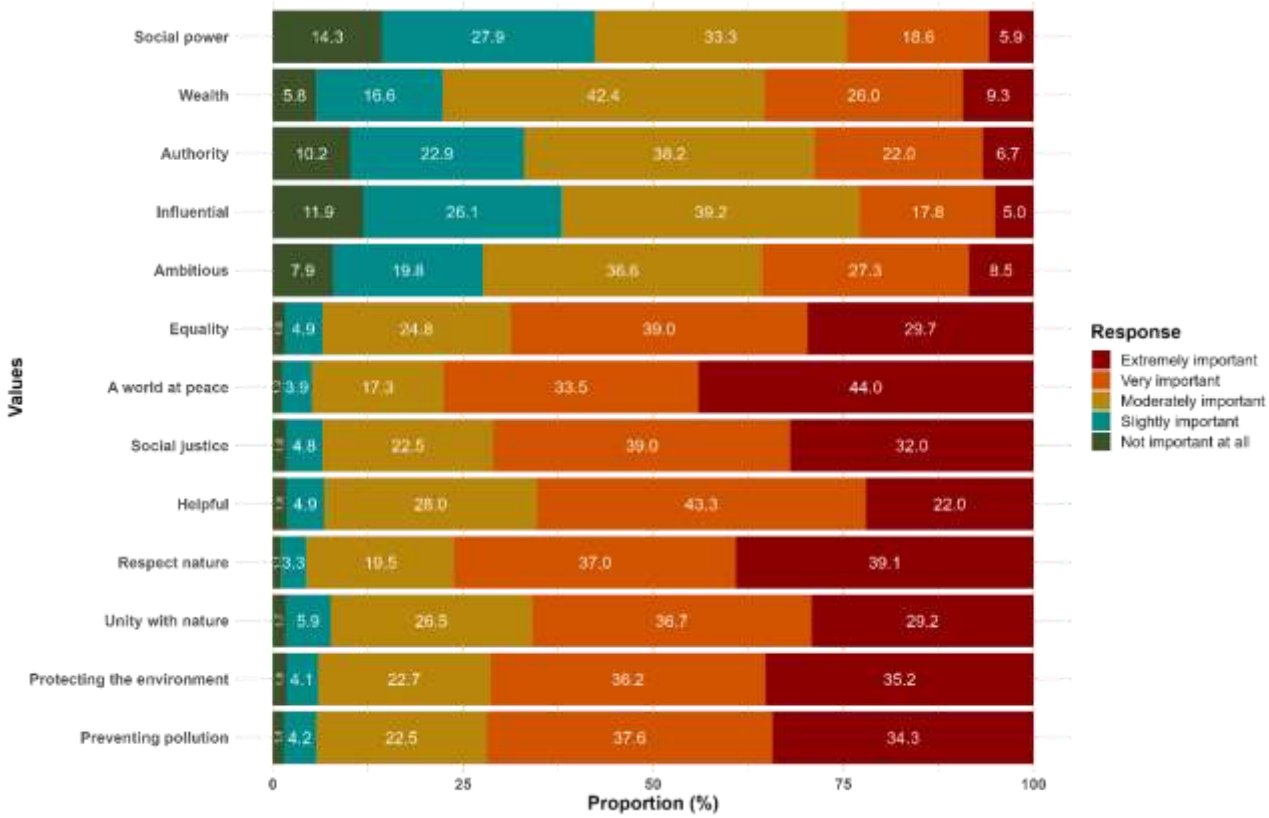

Figure 5: Distribution of mean ratings (level of importance) for value items

3.4. *Variety seeking*

Another important characteristic that influences consumers' food choice behavior is variety seeking tendency, an intrinsic desire for variety in food choices. The Variety Seeking Tendency Scale (VARSEEK; Van Trijp & Steenkamp, 1992) is a commonly used instrument to assess consumers' willingness to try novel and unfamiliar foods, a trait also referred to as *food neophilia*. The VARSEEK was used in this survey to understand how openness to new food experiences may influence consumers' receptiveness of exploring traditional and novel fermented food products, whose sensory characteristics may sometimes be unfamiliar to consumers.

A SIGNIFICANT PROPORTION OF RESPONDENTS SHOWED OPENNESS TO TRYING NEW AND UNFAMILIAR FOODS, with more than 50% agreeing that they enjoy exploring unfamiliar foods and recipes and are curious about food products they have not encountered before, suggesting an overall inclination toward food neophilia. However, agreement with statements relating to the pleasure of eating exotic foods and trying unusual dishes without knowing whether they would be to their liking was comparatively low (Figure 6).

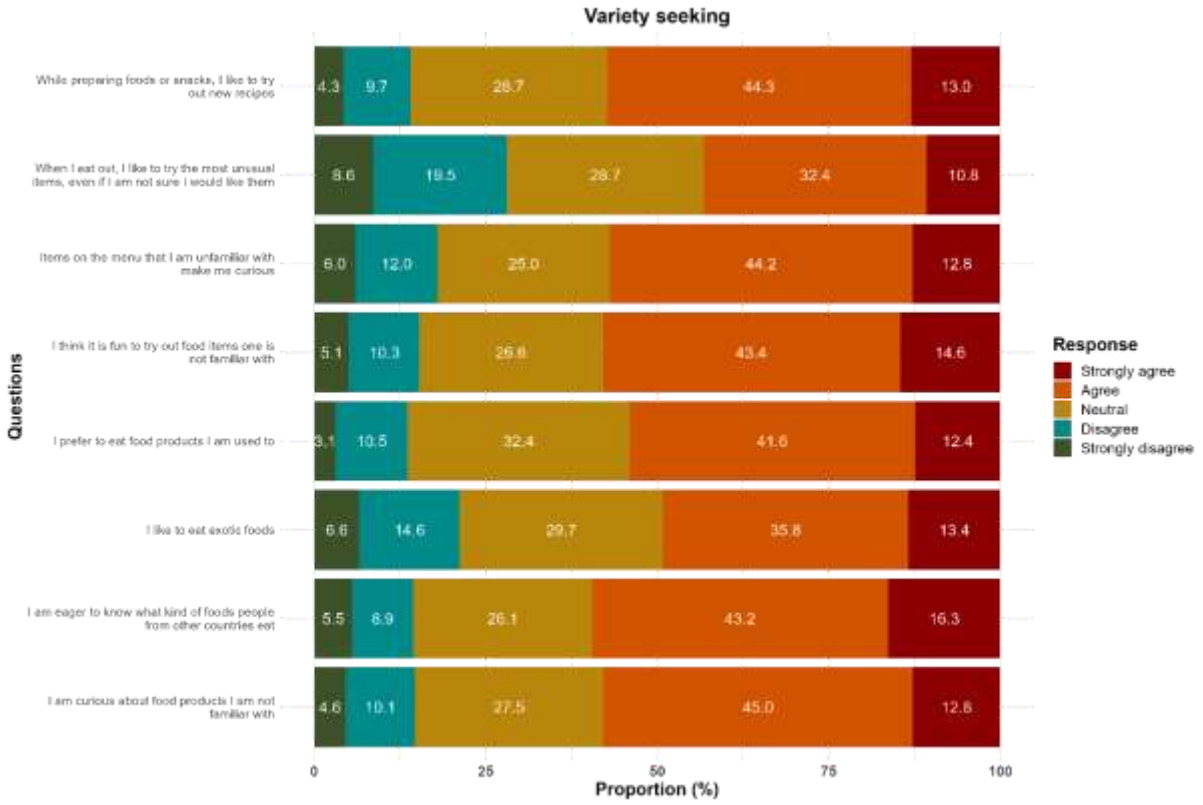

Figure 6: Distribution of levels of agreement with statements assessing Variety Seeking Tendency

4. Knowledge: What do EU Consumers know about Fermentation?

Knowledge is one of the major determinants that drives human behavioral intention. Lack of knowledge about fermentation and fermented foods may be an important factor limiting the consumption of these foods and thus reducing opportunities for their valuable contribution to healthy and sustainable diets. We aimed at assessing EU consumers' "*microbial literacy*", a term coined by Timmis et al., refering to people's knowledge of microorganisms and their theatre of activities, how they affect our lives, and how they may be harnessed to benefit humankind (Timmis et al., 2019). For this survey, the focus was specifically directed toward knowledge of fermentation and fermented foods, but some questions on nutrition knowledge and knowledge about the gut microbiome were also included. Lastly, when assessing the influence of knowledge on consumption behavior, it is important to make a distinction between subjective knowledge (what a person perceives to know) and objective knowledge (what a person actually knows), as they may influence the consumption behavior in different ways (Brucks, 1985).

4.1. Subjective knowledge

4.1.1. Knowledge of microorganisms

To assess subjective knowledge of microorganisms and more general, subjective nutrition knowledge, participants were first asked to rate their knowledge of microorganisms on a five-point Likert scale from *No knowledge at all* to *Complete knowledge*. The majority (31,3%) of respondents indicated possessing *slight knowledge*, immediately followed by 29,6% stating that they possess *some knowledge*. Nearly a fifth (18,5%) of respondents admitted having *no knowledge at all*. (Figure 7). Similar self-rated scores can be observed with regard to the more specific knowledge of the use of microorganisms in food processing and knowledge of the gut microbiome (Figure 8). Overall, these results indicate that most respondents consider their knowledge of microorganisms to be very limited, regardless of the respective subject area or context of microbiology.

4.1.2. Nutrition knowledge

We also investigated participants' subjective knowledge of nutrition and its role in health, as this could provide valuable insights into how participants' self-rated nutritional knowledge might be reflected in their general interest in nutrition and in their health awareness, potentially influencing their attitudes towards and consumption of fermented foods. As seen in Figure 8 respondents rate their nutrition knowledge slightly higher than their knowledge about microorganisms. Although, they do not perceive themselves as experts in nutrition, they have a favorable view of their own nutrition knowledge relative to others. This is highlighted by the fact that while only 22% agree or completely agree with the statement that they are seen as experts in nutrition by others, 41% agree or completely agree to the statement that they have above-average knowledge of nutrition's role in health.

(QUESTION) HOW WOULD YOU JUDGE YOUR PERSONAL KNOWLEDGE OF MICROORGANISMS?

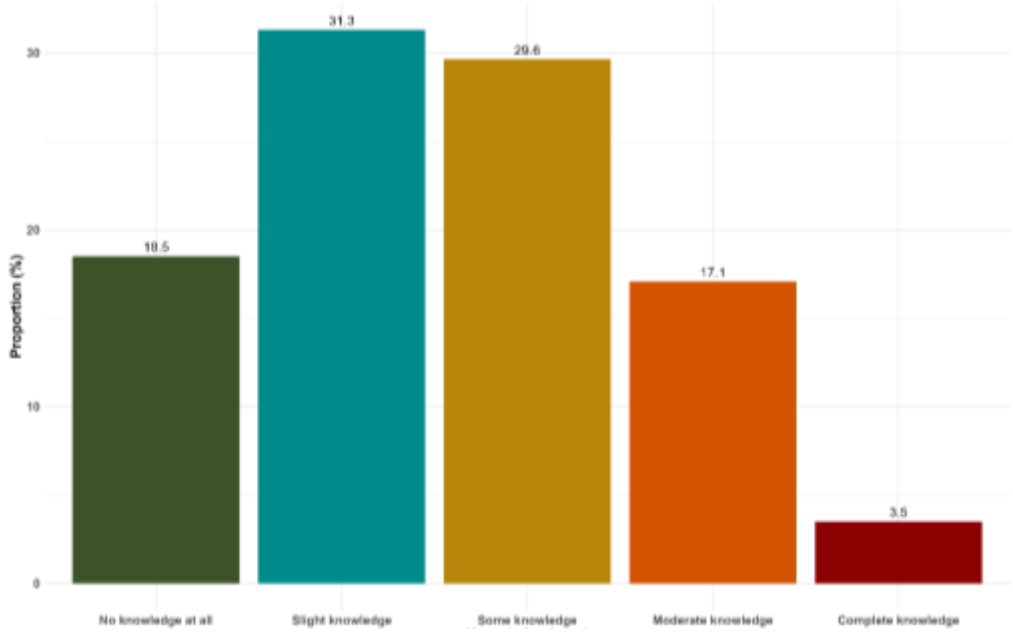

Figure 7: Self-rated knowledge of microorganisms

(QUESTION) PLEASE INDICATE HOW STRONGLY YOU AGREE WITH THE FOLLOWING STATEMENTS.

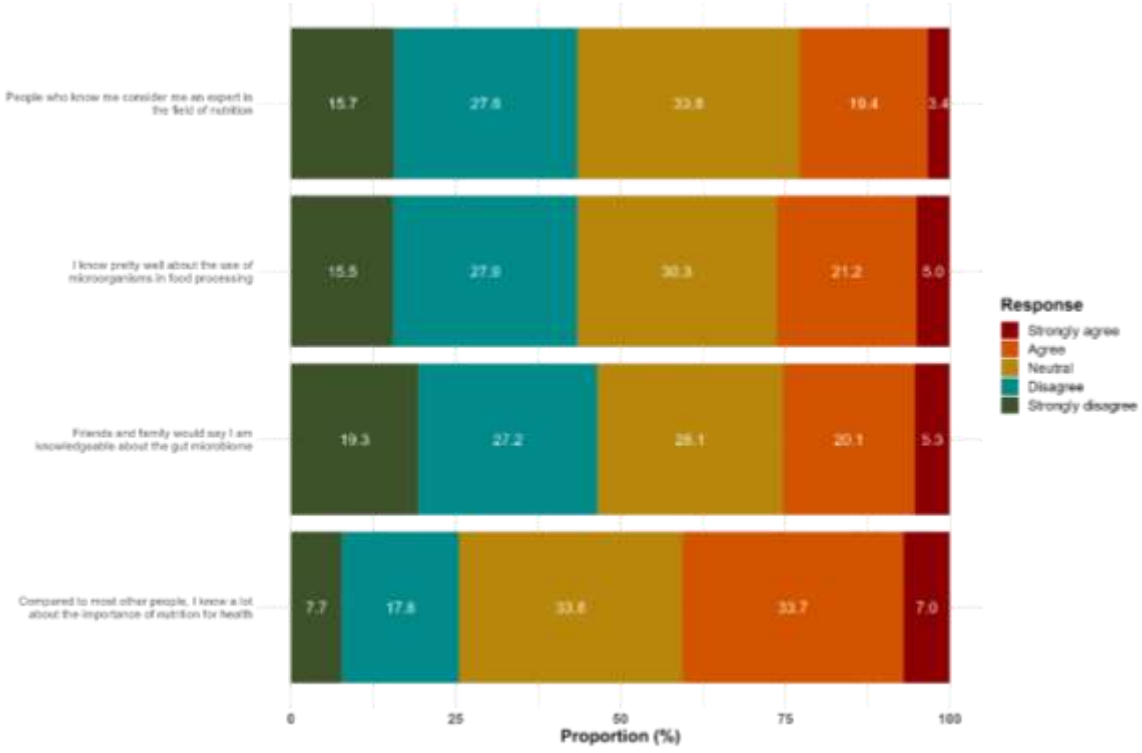

Figure 8: Distribution of levels of agreement with statements on self-rated knowledge of nutrition and microorganisms

4.2. Objective knowledge

4.2.1. Food fermentation

Definition of food fermentation

Participants were asked to identify the correct definition of food fermentation among three different statements. The question was single-answer with only one correct option. Overall, 3196 (64.3%) of the participants were able to identify the correct statement defining food fermentation, while 1775 (35.7%) chose a wrong statement (Figure 9).

(QUESTION) WHICH OF THE FOLLOWING BEST DEFINES FOOD FERMENTATION?

- ☐ **A PROCESS OF HEATING FOODS TO HIGH TEMPERATURES TO KILL BACTERIA AND OTHER MICROORGANISMS.**
- ☐ **THE ADDITION OF SPICES AND SALTS TO FOOD TO IMPROVE DIGESTION, ENHANCE FLAVOR AND EXTEND SHELF LIFE.**
- ☐ **A PROCESS OF USING MICROBIAL CULTURES TO PRESERVE FOODS AND IMPROVE THE NUTRITIONAL VALUE AND NUTRIENT UTILISATION.** *(correct answer)*

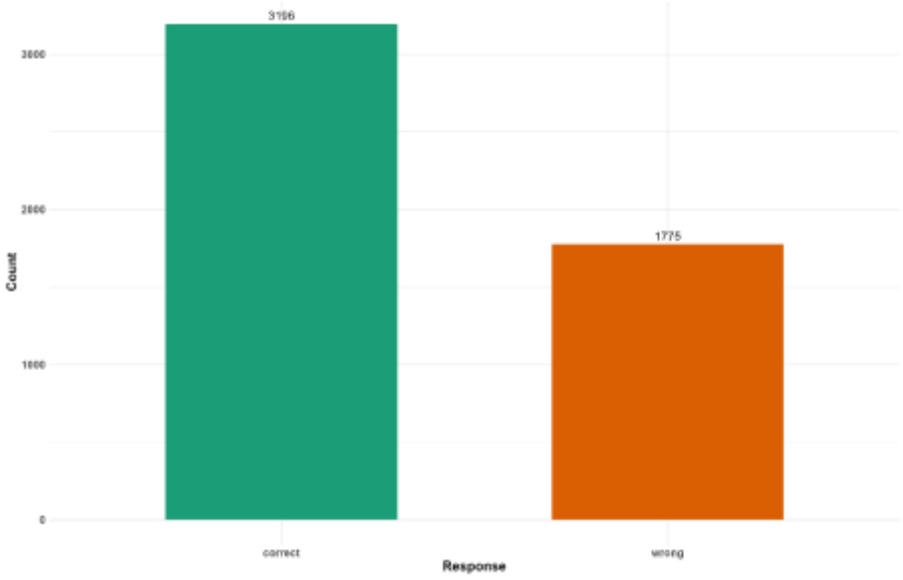

Figure 9: Proportions of participants who identified (correct) and didn't identify (wrong) the correct definition of food fermentation

Microorganisms involved in food fermentation

We also investigated participants' knowledge of the microorganisms involved in food fermentation. The question was multiple-select with three correct answers (lactic acid bacteria, yeasts and molds), three wrong answers (algae, parasites, viruses) and a neutral response option (*I don't know*). Figure 10 and Figure 11 give a detailed overview of correct and wrong answers per microorganism. The results show that the majority of participants were able to identify up to two types of microorgansims (lactic acid bacteria and yeasts). Figure 12 shows the percentage of participants who identified one, two, three or none of the correct microorganisms. **A CONSIDERABLE NUMBER OF PARTICIPANTS (23.7%) SHOWED EXCELLENT KNOWLEDGE OF THE MICROORGANISMS INVOLVED IN FOOD FERMENTATION** and were able to identify all three types of microorganisms. **THE ROLE OF MOLDS IN FERMENTATION SEEMS TO BE LESS PROMINENT**.

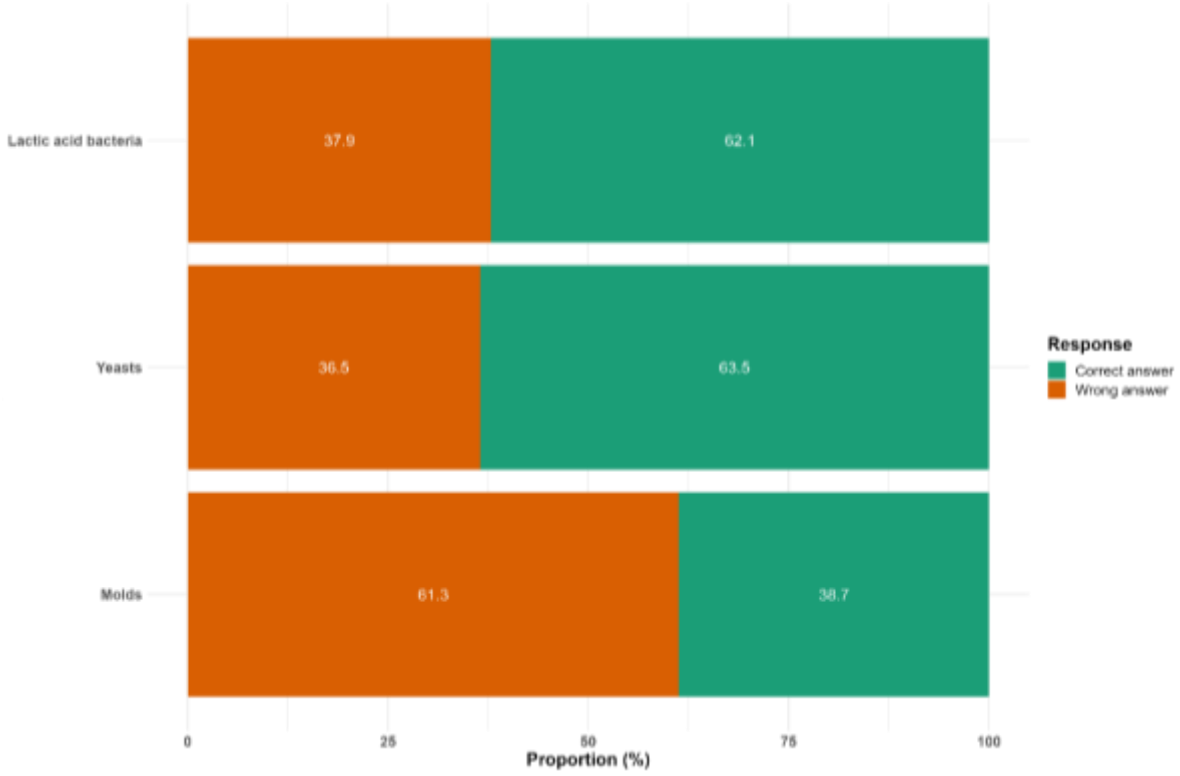

Figure 10: Proportions of participants who identified (correct) and didn't identify (wrong) the microorganisms that can be involved in food fermentation

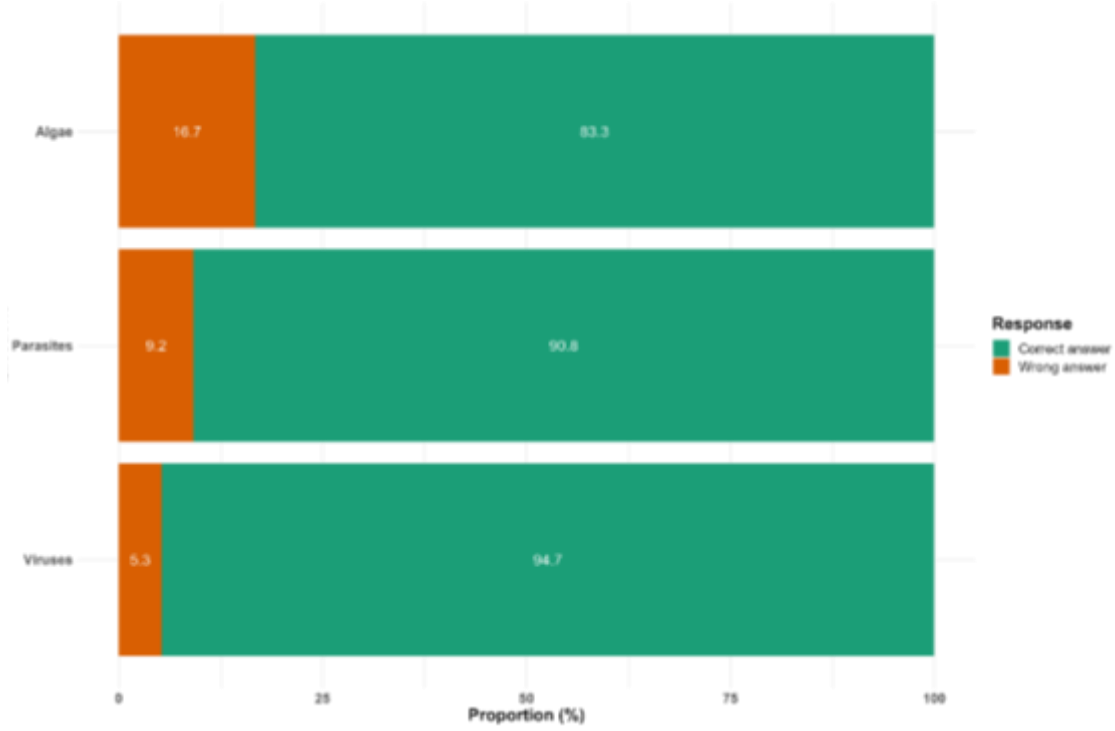

Figure 11: Proportions of participants who identified (correct) and didn't identify (wrong) the microorganisms that cannot be involved in food fermentation

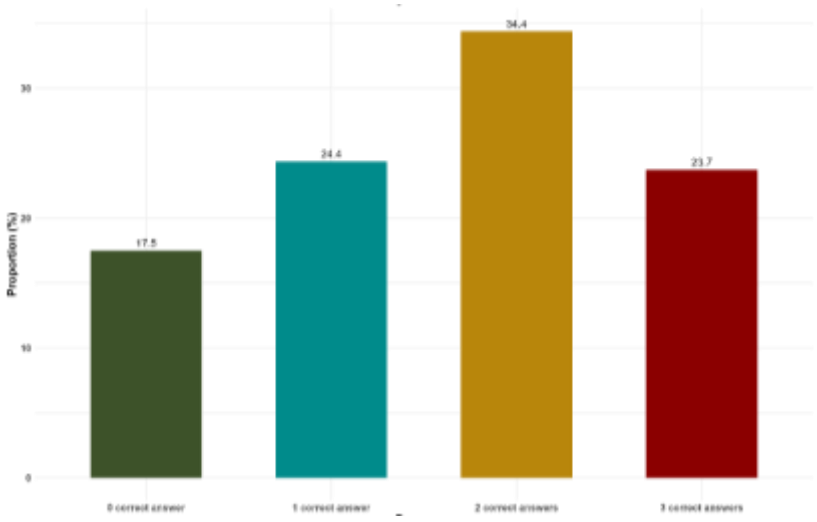

Figure 12: Proportions of correctly identified microorganisms

4.2.2. Fermented foods

Identification of typical fermented foods

Participants were asked to identify from a list of foods those that are typically produced by fermentation. The question was multiple-select with five correct answers (cheese, vinegar, table olives, beer and yoghurt) and three wrong answers (orange juice, olive oil and honey). Figure 13 shows the percentage of participants who identified one, two, three, four, five or none of the foods that are typically fermented. Figure 14 and Figure 15 give a detailed overview of correct and wrong answers per food type. It is noteworthy that the **ROLE OF FERMENTATION IN VINEGAR (38.5%) AND ESPECIALLY TABLE OLIVES (9.5%) IS LESS WELL KNOWN**, while most participants were aware of the role of fermentation in cheese, beer and yoghurt production. Most participants were able to identify up to three fermented foods, while only a minority (2.4%) could identify all five of them. The same amount of participants were not able to identify any of the fermented foods.

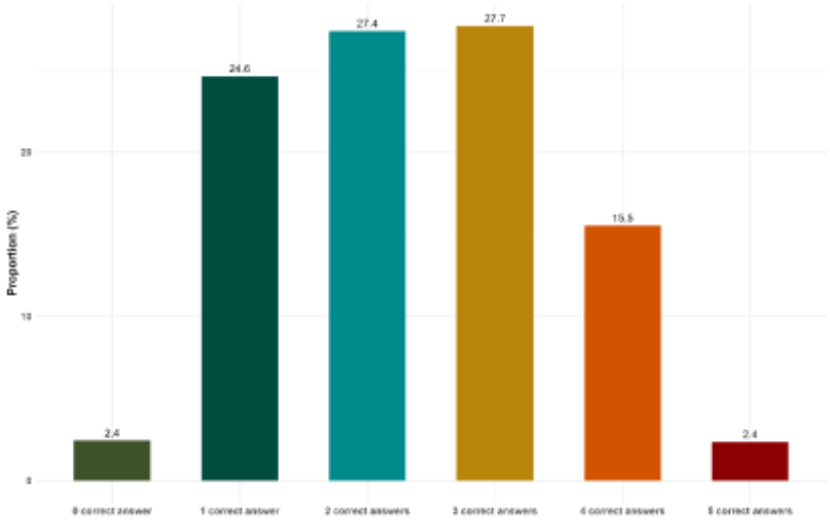

Figure 13: Proportions of correctly identified fermented foods

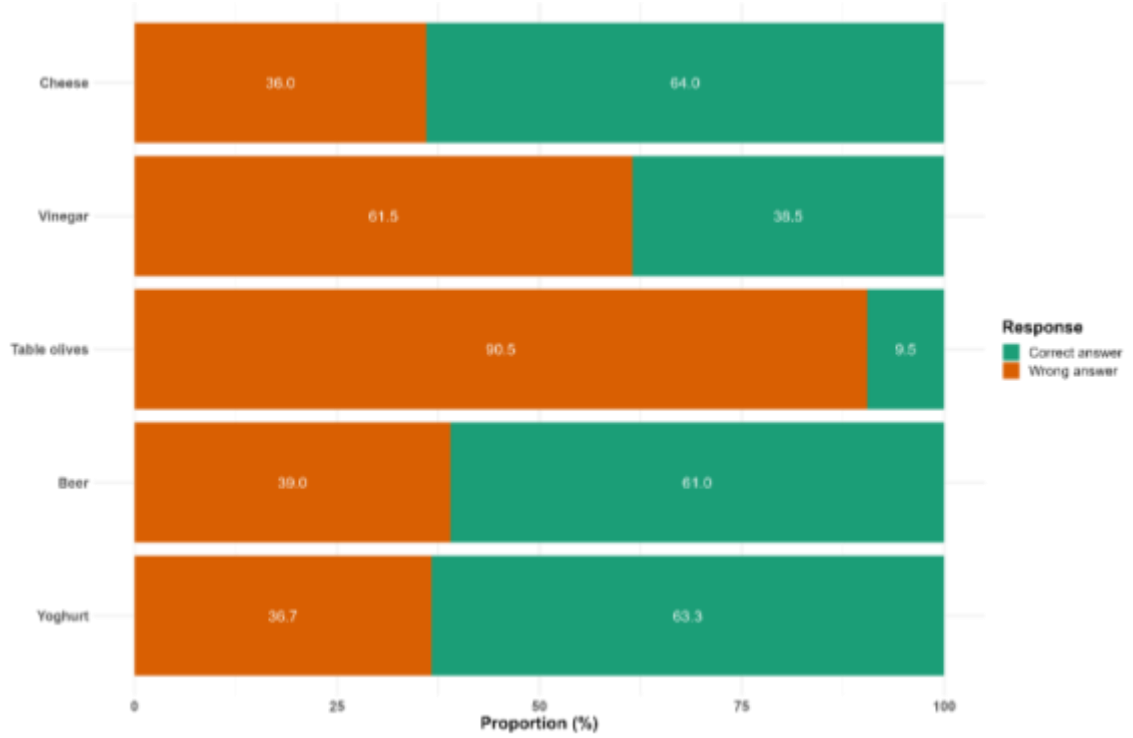

Figure 14: Proportions of correct and wrong answers per food type (correct: respondents identified the food as fermented; wrong: respondents didn't identify the food as fermented)

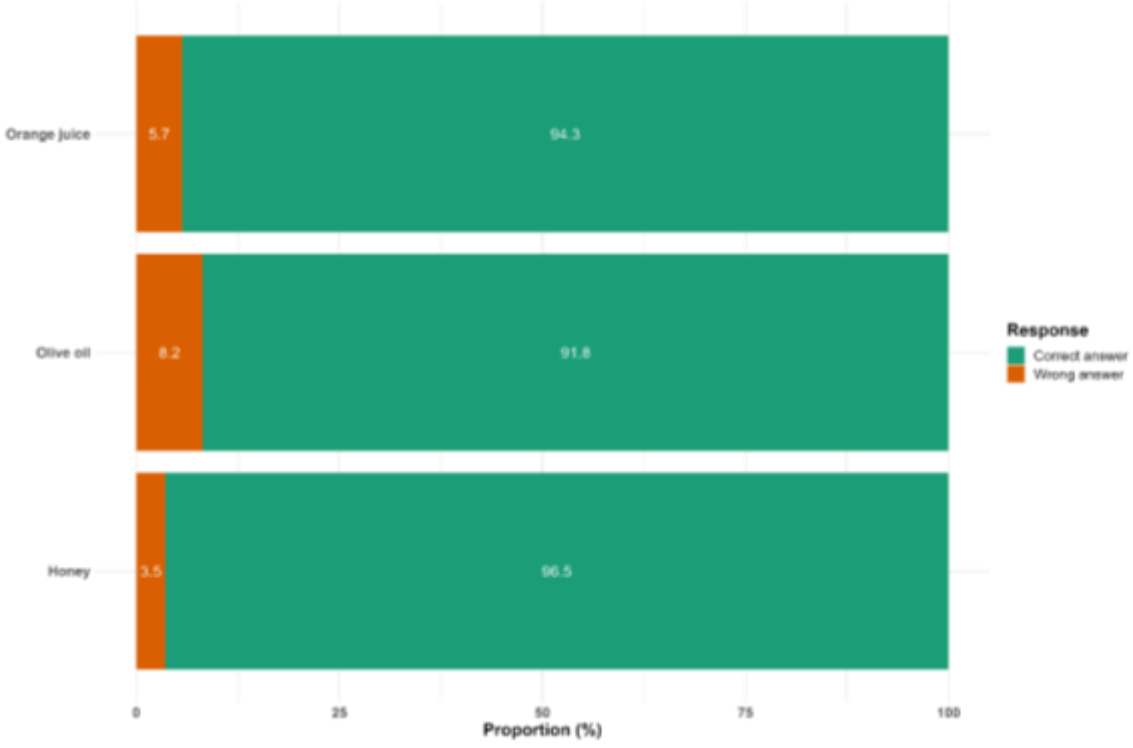

Figure 15: Proportions of correct and wrong answers per food type (correct: respondents identified the food as not fermented; wrong: respondents didn't identify the food as not fermented)

Knowledge of fermented foods

Participants were furthermore presented with a set of true and false statements about fermented foods and the gut microbiome (see 4.2.3.) and asked to determine whether each statement was true or false. The question was single-answer. They were also asked to indicate their degree of certainty for each response. Figure 16 and Figure 17 show the proportions of correct and wrong answers for each statement, with Figure 16 displaying only the true statements and Figure 17 only the false statements. Figure 18 and Figure 19 illustrate the distribution of degrees of certainty for each response.

More than three-quarters of participants demonstrated to be knowledgeable about the benefits of food fermentation, with **79.5% RECOGNIZING ITS POSITIVE IMPACT ON SHELF LIFE AND 77.9% ACKNOWLEDGING ITS ROLE IN IMPROVING DIGESTIBILITY**. A similar share of participants (78%) correctly identified the false statement that *foods need to rot before they can be fermented*, a misconception captured during one of the DOMINO consumer sessions. Of considerable importance is the observation that **A SIGNIFICANT PROPORTION OF PARTICIPANTS BELIEVED THAT ALL FERMENTED FOODS CONTAIN LIVE MICROORGANISMS**, with fewer than 25% correctly identifying this statement as false. Furthermore, respondents appeared confident in their answers to this statement, as 46.7% indicated they were certain or very certain of their choice. This highlights a widespread misconception that all fermented foods contain live microorganisms and thus have a probiotic effect, which does not correspond to the truth.

4.2.3. Gut microbiome

Knowledge of the gut microbiome

Similar knowledge levels can be observed with regard to the gut microbiome. A definition of the gut microbiome was provided that nearly 87% of respondents could identify as correct. Also the **INFLUENCE OF DIET ON GUT MICROBIOME COMPOSITION AND GUT MICROBIOME'S ROLE IN HUMAN HEALTH, INCLUDING BRAIN HEALTH** – a topic of growing attention – were **WELL RECOGNIZED**, with nearly 80% of participants answering these questions correctly. Respondents also appeared slightly more confident in their knowledge about the gut microbiome compared to their confidence in fermented food knowledge (Figure 16 - 19).

(QUESTION) BELOW WE PRESENT STATEMENTS CONCERNING FERMENTED FOODS AND THE GUT MICROBIOME. PLEASE INDICATE WHETHER THEY ARE TRUE OR FALSE AND ASSESS YOUR CERTAINTY OF THE ANSWER.

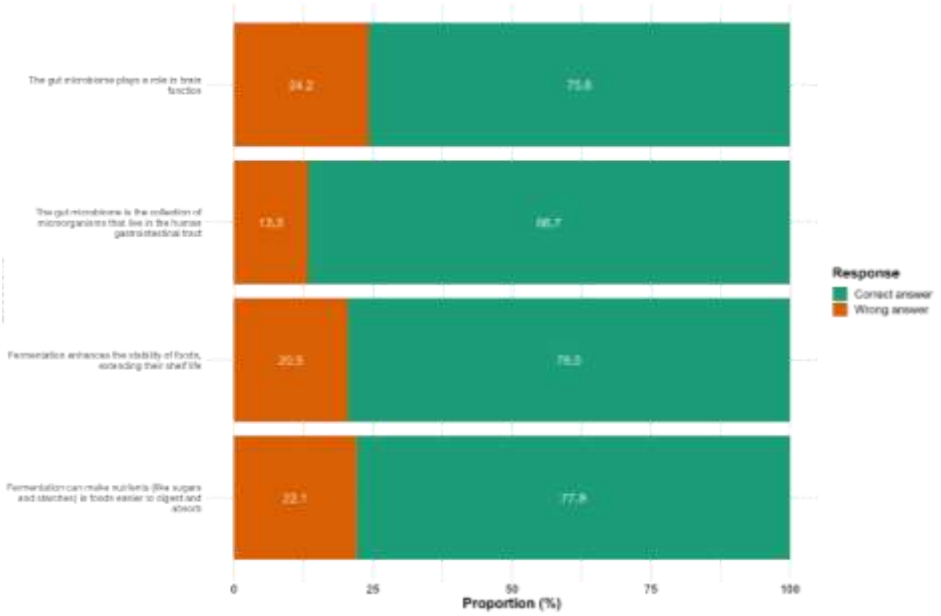

Figure 16: Proportions of correct and wrong answers to true statements about fermented foods and the gut microbiome (correct: respondents thought the statement to be true; wrong: respondents thought the statement to be false)

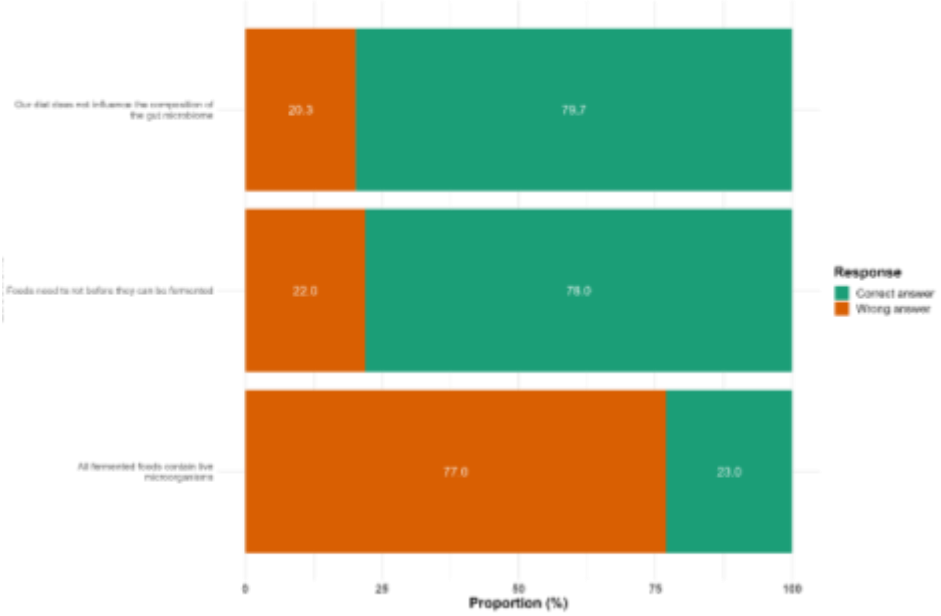

Figure 17: Proportions of correct and wrong answers to false statements about fermented foods and the gut microbiome (correct: respondents thought the statement to be false; wrong: respondents thought the statement to be true)

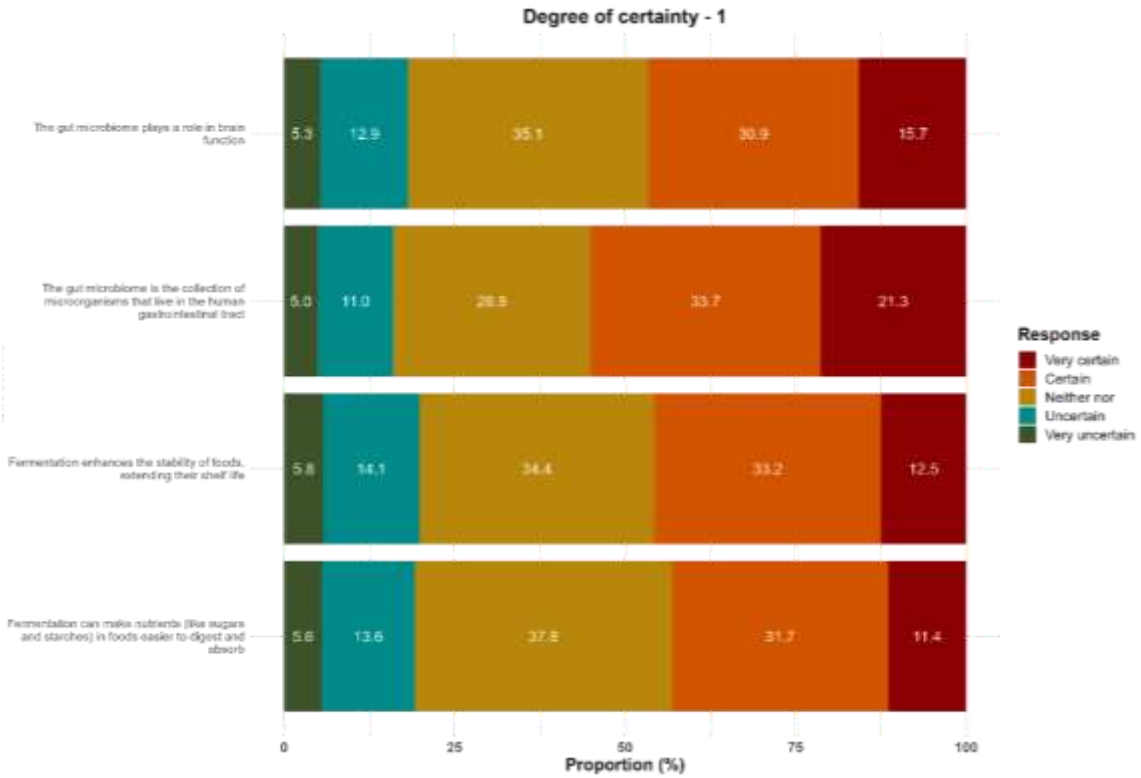

Figure 18: Distribution of degree of certainty assigned to correct statements

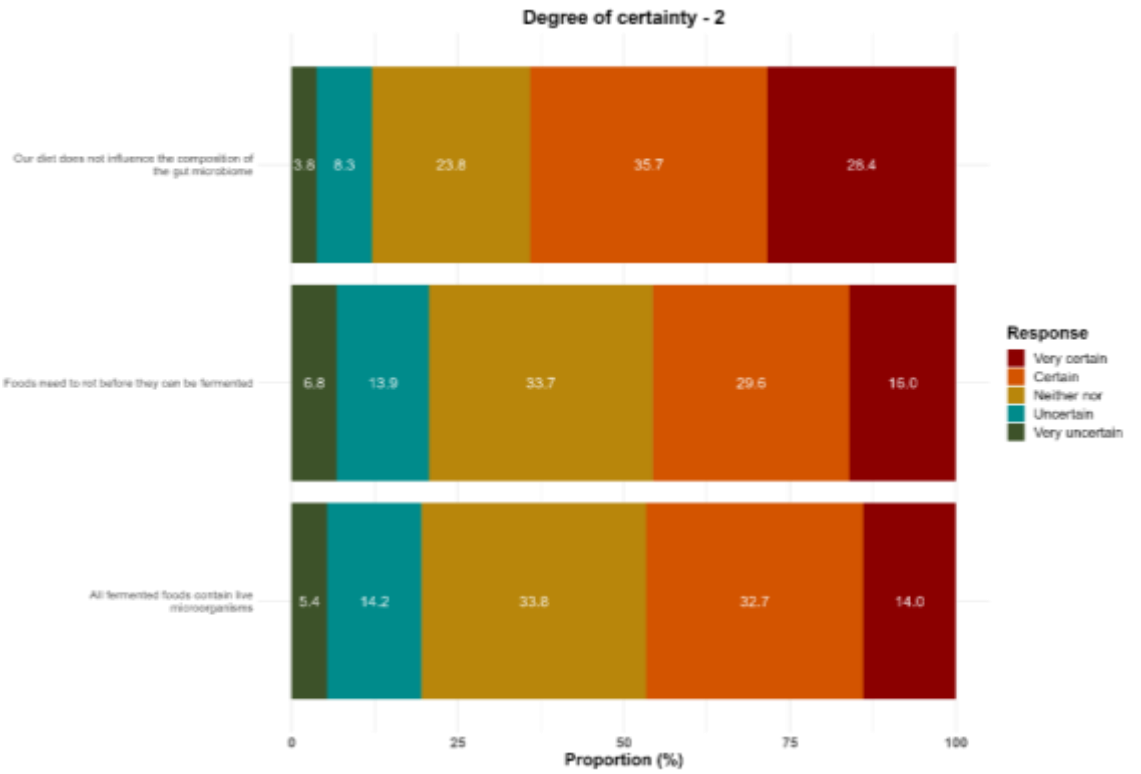

Figure 19: Distribution of degree of certainty assigned to false statements

4.3. Information sources

Fermented foods

Participants were also asked where they learned about fermented foods (Figure 20). The question was multiple-select. **PARTICIPANTS MOST FREQUENTLY INDICATED LEARNING ABOUT FERMENTED FOODS AT HOME, ON THE INTERNET/SOCIAL MEDIA, OR AT SCHOOL.** A smaller proportion of participants learned about fermented foods through newspapers/magazines or through friends. A high percentage of participants indicated that they have never learned about fermented foods. The least common information sources are advertisements, health practicioners and the workplace.

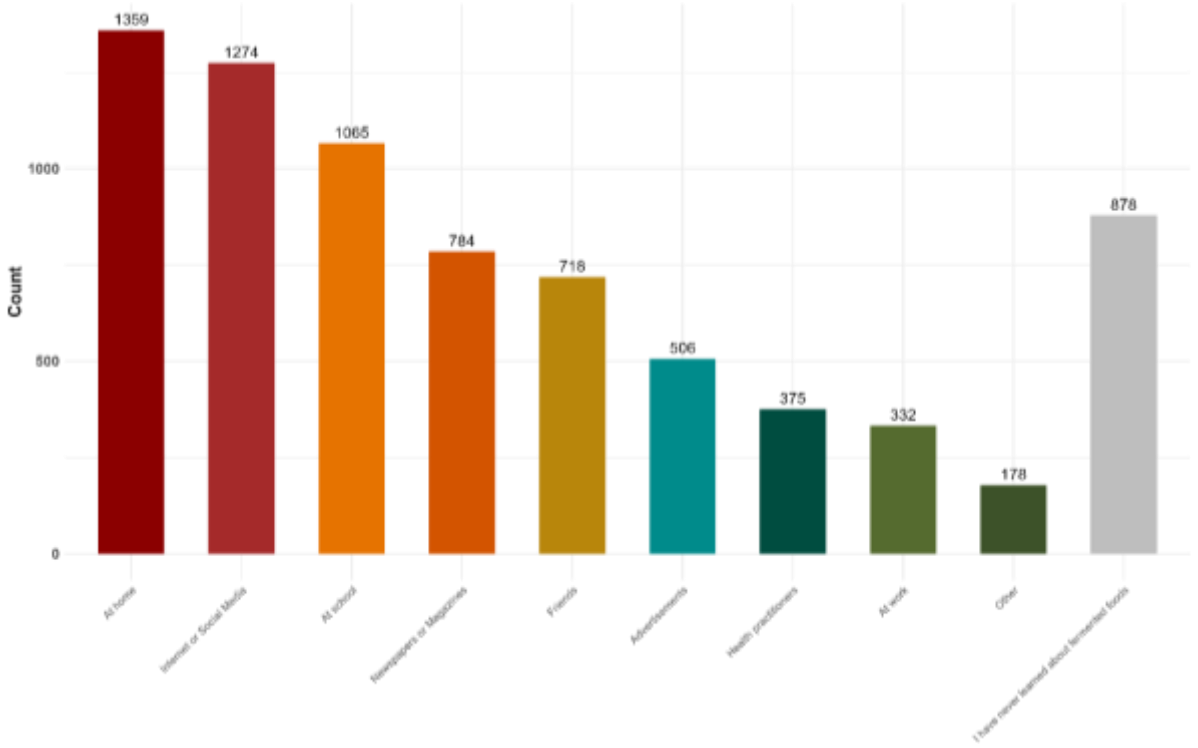

Figure 20: Sources where participants learned about fermented foods

Gut microbiome

When asked where they learn about or (would) seek information about the gut microbiome (Figure 21), participants show a clear preference for health and wellness websites as their primary source of information. Unlike with fermented foods, health practitioners are also considered a valuable source for gut microbiome information. Additionally, scientific journals and research articles, books, and television are popular sources, with television surpassing social media. The least frequented sources are online forums and communities, schools or trainings, and consumer associations.

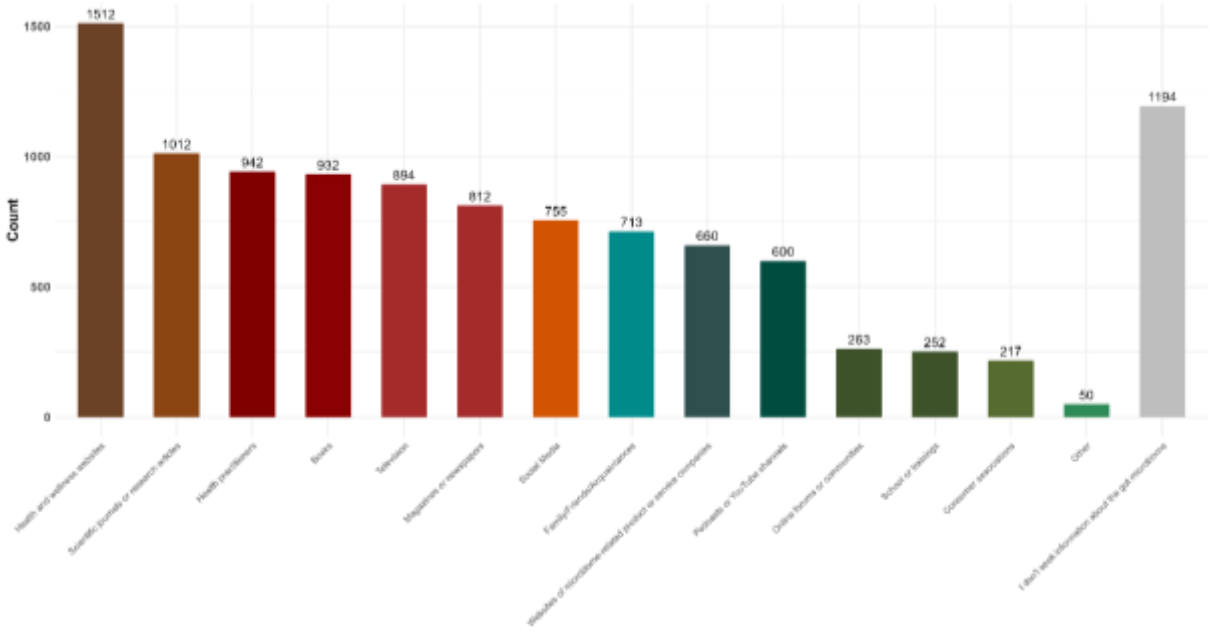

Figure 21: Preferred sources for gut microbiome information

5. Consumption Pattern and Willingness to Try

To understand how prevalent fermented foods are in current European diets and to identify potential gaps in familiarity and adoption, we assessed participants' consumption frequency of different fermented foods. In the conceptualization and analysis of the survey, we made a distinction between traditional and novel fermented foods to understand which fermented foods are well established and which novel options are emerging. However, respondents were not aware of this distinction when answering the consumption frequency, and the order in which the individual fermented foods were shown to respondents was randomized. The participants had to indicate their consumption frequency for each fermented food on a 7-point scale ranging from '*I do not recognize the product*' to '*I consume it on a daily basis*'. Whenever the options '*I do not recognize the product*' or '*I recognize the product, but I have never tasted it*' were chosen, respondents were shown a brief description of the fermented food (no visuals) and asked to rate their willingness to try the fermented foods with a simple '*yes*' or '*no*' (single-choice answer). Figure 24 and Figure 25 show the willingness to try in absolute numbers for traditional and novel fermented foods, respectively.

Consumption frequency of traditional and novel fermented foods

Figure 22 presents the consumption frequency of various fermented foods traditionally consumed in European diets. **YOGURT STANDS OUT AS THE MOST FREQUENTLY CONSUMED FERMENTED FOOD**, with a significant proportion of respondents consuming it on a weekly or even daily basis. In contrast, foods like fermented sausages, table olives, sourdough bread, and Sauerkraut show a more diverse distribution across different consumption frequencies. **THE CONSUMPTION OF MILK KEFIR APPEARS TO BE MODERATE COMPARED TO OTHER TRADITIONAL FERMENTED FOODS**, with the majority of respondents indicating that they do not consume or are unfamiliar with the product. Overall, traditional fermented foods exhibit relatively high familiarity and integration into respondents' diets.

Figure 23 illustrates the consumption frequency of novel fermented foods, including some that are traditionally consumed in Asian cultures and have only relatively recently reached the European market, as well as plant-based fermented foods, whose market presence as vegan-friendly alternatives is growing. Compared to traditional fermented foods, these products generally show lower consumption frequencies, with a notable share of respondents, ranging from 70-80%, reporting no consumption. **PLANT-BASED FERMENTED CHEESES AND YOGHURTS EMERGE AS THE MOST FREQUENTLY CONSUMED AMONG THE NOVEL FERMENTED FOODS**, whereas water kefir and Tempeh are consumed less frequently.

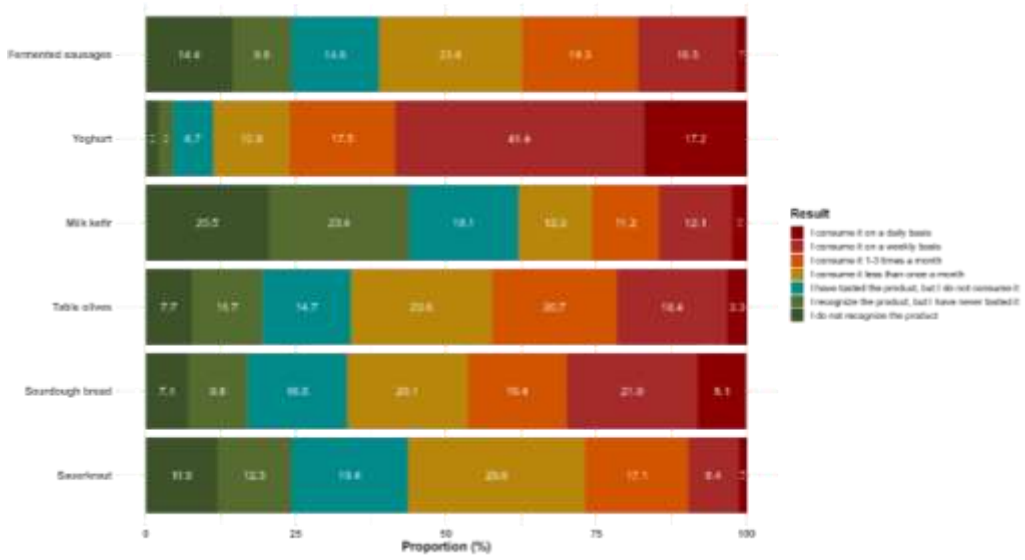

Figure 22: Distribution of consumption frequency of traditional fermented foods

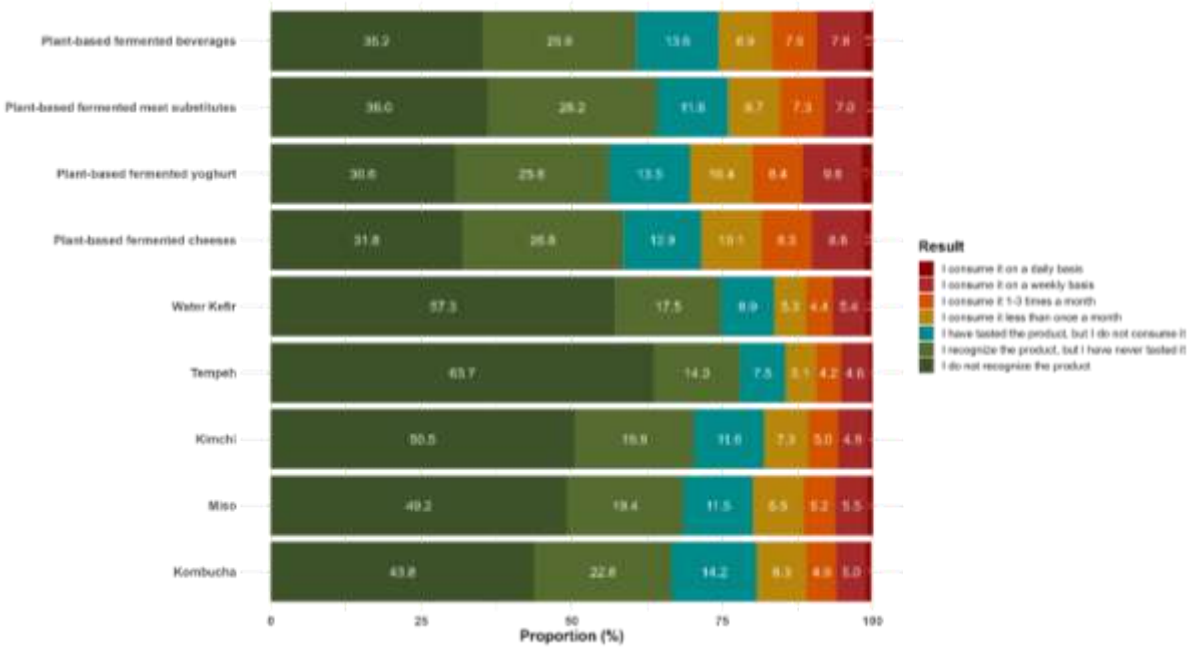

Figure 23: Distribution of consumption frequency of novel fermented foods

Willingness to try traditional and novel fermented foods

As we saw earlier, respondents show a general higher familiarity with traditional fermented foods, explaining the lower counts of respondents indicating their willingness to try them (Figure 24). Sourdough bread has relatively high acceptance rates, with 60% of respondents expressing willingness to try. Overall, there is a **MODERATE WILLINGNESS TO TRY TRADITIONAL FERMENTED FOODS**, with most foods showing near-equal or slightly favorable proportions of unwillingness over willingness. With regard to novel fermented foods, the same picture presents itself. Tempeh and Miso have the highest proportions of respondents willing to try, with 52-53% expressing interest, respectively. The **LOWEST ACCEPTANCE RATES (40%) CAN BE OBSERVED FOR PLANT-BASED FERMENTED MEAT SUBSTITUTES** (Figure 25). Although these findings suggest a somewhat cautious attitude toward trying unfamiliar fermented foods, it remains to be seen whether these patterns vary across different age groups and other influencing factors. Additionally, participants were only provided with a brief description of each fermented food. Including images in the questionnaire may have influenced their willingness to try, as sensory stimulation plays a crucial role in shaping food preferences.

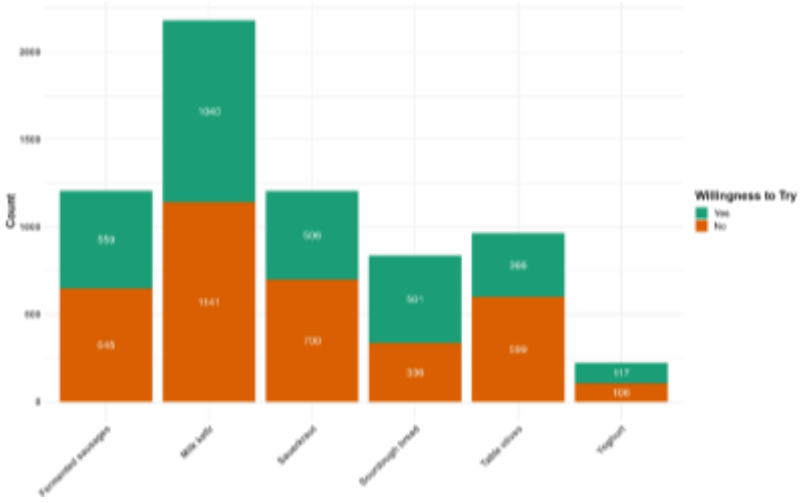

Figure 24: Willingness to try traditional fermented foods

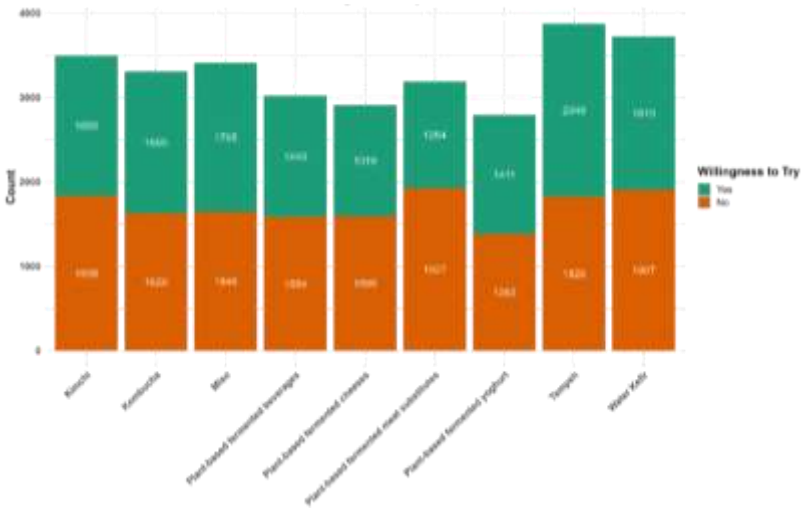

Figure 25: Willingness to try novel fermented foods

6. Perceptions and Attitudes

Studying consumer perceptions and preferences is key to identifying factors that drive consumer behavior, including eating behavior. Food choices are complex and influenced by interacting factors of different nature (e.g., extrinsic product characteristics, psychological and situational factors, etc.). One main objective of the present study was to assess consumers' current perceptions of fermented foods, in particular in relation to attributes such as health benefits and risks, environmental benefits, natural vs. processed qualities, convenience, and sensory appeal. Further analysis will explore how these perceptions relate to other factors examined in the survey, including sociodemographic characteristics, openness to food innovation, and level of knowledge, which will be addressed in future scientific publications. Furthermore, the insights gained from this initial consumer survey on perceptions of fermented foods and the factors influencing them will inform the design of a more targeted second survey, focusing potentially on more specific consumer perceptions and particular fermented food types.

Consumer perceptions of fermented foods were assessed across four dimensions: sensory appeal, perceived sustainability, health beliefs, and acceptance. When asked to indicate their level of agreement with the statements on a five-point Likert scale, respondents were unaware of the underlying dimensions and the statements were presented to them in a randomized order. However, in Figure 26, the statements are shown with their corresponding dimension solely for clarification purposes.

Overall, responses indicate **PREDOMINANTLY POSITIVE CONSUMER PERCEPTIONS OF FERMENTED FOODS** with a significant proportion of participants expressing favorable views across all four dimensions. The most widely accepted statements were those concerning health benefits with a calculated mean score of 3.74 (Figure 27). For instance, **66% OF RESPONDENTS PERCEIVE THE CONSUMPTION OF FERMENTED FOODS AS BENEFICIAL FOR GUT HEALTH.** But also the benefits for overall health and the safety of consumption received strong endorsement. General acceptance of fermented foods was also relatively high, with 62% agreeing or strongly agreeing. Particular attention should be paid to **NATURALNESS, ESPECIALLY THE ABSENCE OF FOOD ADDITIVES, AND CONVENIENCE**, as they appear to **HAVE A SIGNIFICANT IMPACT ON ACCEPTANCE RATES**. The role of fermented foods in supporting sustainable practices, and in particular in contributing to food waste reduction and the use of seasonal and local produce, appears to be well understood. However**, RESERVATIONS CAN BE OBSERVED IN RELATION TO THEIR CULTURAL SIGNIFICANCE, AS WELL AS TO THE BROADER CLAIM OF THEIR ENVIRONMENTAL BENEFITS**, reflecting potential uncertainties about the environmental impact of fermentation processes and variations in production methods. Also with regard to the sensory appeal of fermented foods, the majority of respondents expressed **NEUTRAL OPINIONS ABOUT THEIR TASTE AND OVERALL APPEAL**. This may, at least in part, be due to the lack of specificity in the survey regarding the types of fermented foods, as sensory preferences are likely influenced by familiarity with particular products.

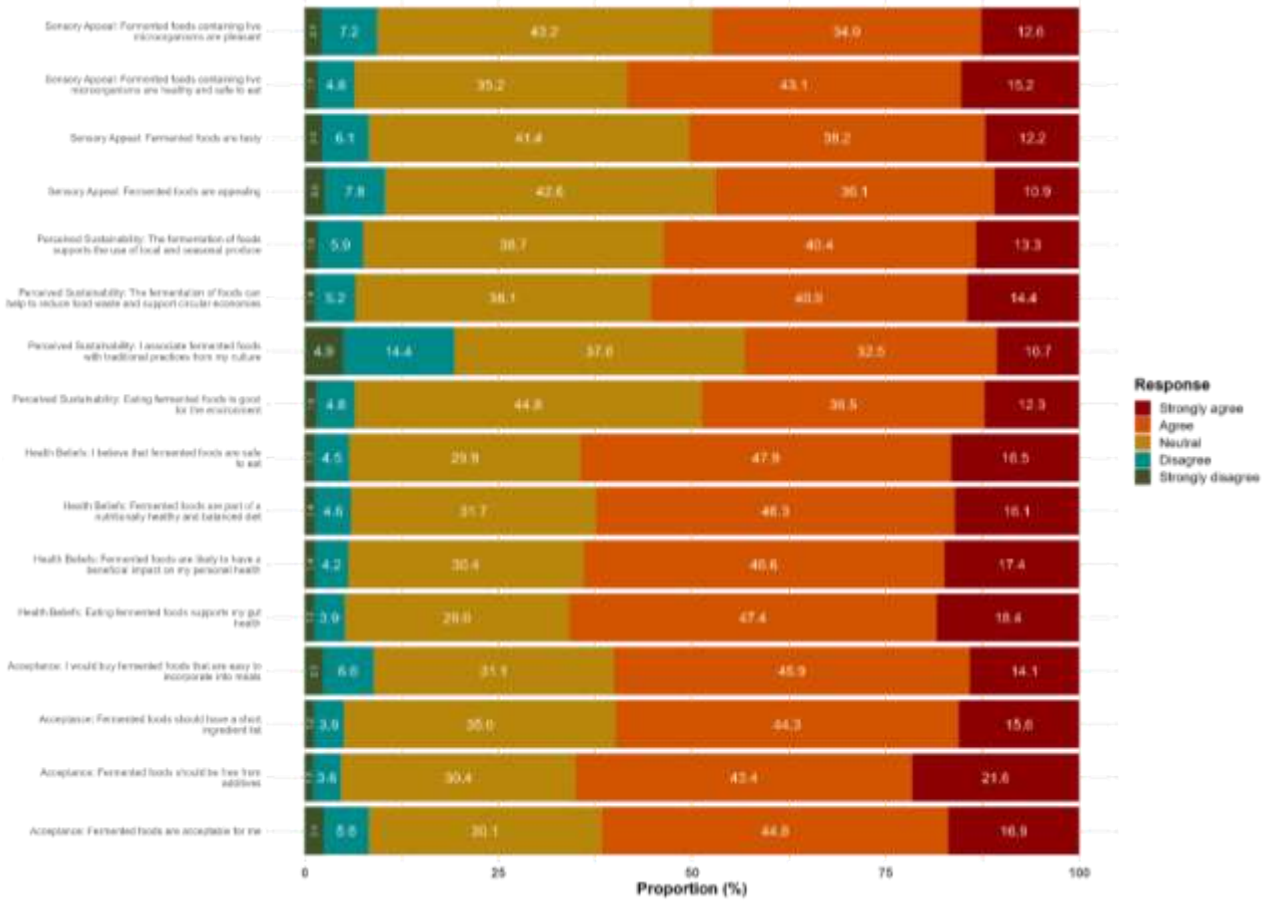

Figure 26: Distribution of levels of agreement with statements on the perceived sensory appeal, sustainability, health benefits and acceptance of fermented foods

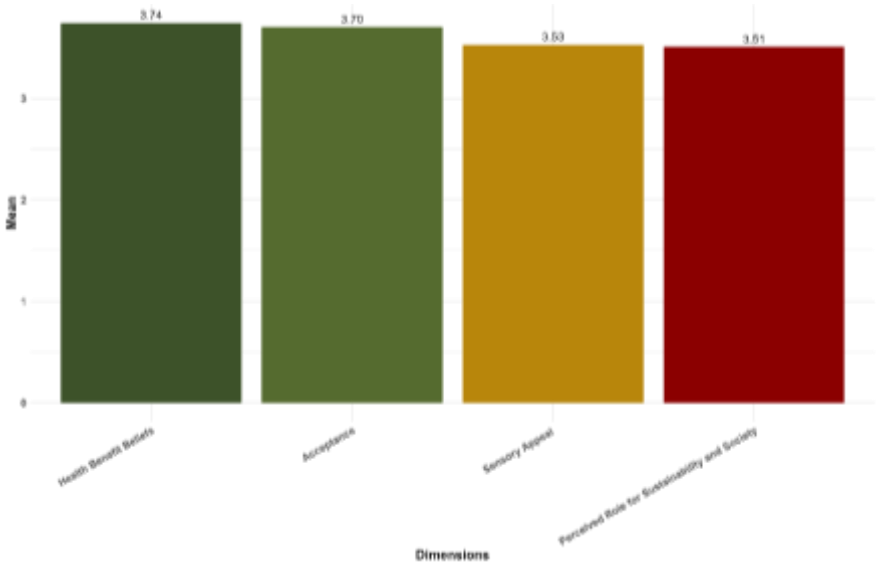

Figure 27: Mean ratings of fermented food perception per dimension

7. Gut Health Innovations

As we saw in the previous chapters, many consumers associate the consumption of fermented foods with beneficial effects on digestion and the gut microbiome, including probiotic effects. Indeed, fermented foods have the potential to deliver large amounts of live microbes and function as vectors for the proliferation of gut microbes (Gänzle et al., 2024). Recent analytical approaches, such as high-throughput genomic analyses and functional metabolite screening, have made the selection of microbial strains with specific traits (e.g., immune-modulating) possible. The design of tailor-made functional and healthy fermented foods is therefore more realistic than ever. On the other hand, it remains to be determined what appetite consumers have for such products and which consumer segments are likely to adopt functional fermented foods into their diets.

For this study, our aim was to explore whether an increased interest in gut health and microbiome innovations is associated with higher consumption of fermented foods and/or more favorable attitudes toward them. To this end, we first asked participants to provide a self-assessment of their current health status, which the majority rated as *good* (45%) to *very good* (26%) (Table 6). Next, we inquired about previous experience with analysis of their gut microbiome (Figure 28). Participants were provided with an explanation of how the process is usually performed and the benefits that it may provide (e.g., insights into digestive health). 75% of respondents demonstrated no previous experience. A notable proportion of **17% HAD ALREADY UNDERGONE A GUT MICROBIOME ANALYSIS**. Those who answered in the negative or were unsure about their previous experience, were asked how interested they would be in having their gut microbiome analyzed (Figure 29). Most participants show at least some interest in gut microbiome analysis, with *moderate interest* being the most common response (33%), followed by *very interested* (21%).

Although the use of personalized dietary recommendations based on microbiome analysis is currently still critical and lacking scientific validation (Simon et al., 2023), an increasing number of companies are offering these services to consumers. Therefore, we explored interest in such services and preferred service providers. Similar to the general interest in gut microbiome analysis, most respondents (32%) expressed *moderate interest* in dietary recommendations based on gut microbial composition. However, a notable 28% of respondents indicated they were *very interested*, highlighting a slightly stronger inclination toward this (nutritional) aspect of the service (Figure 30). Lastly, with regard to preferred service providers, there is a clear preference for general health care providers. At-home testing kits offered by biotech companies and specialized microbiome service centers also received significant interest (Figure 31).

7.1. Self-reported health

Health status	Poor	Fair	Good	Very good	Excellent
%	4,0	17,5	45,3	25,9	7,3

Table 6: Respondents' self-reported health status

7.2. Previous experience

(QUESTION) HAVE YOU EVER HAD YOUR GUT MICROBIOME ANALYZED?

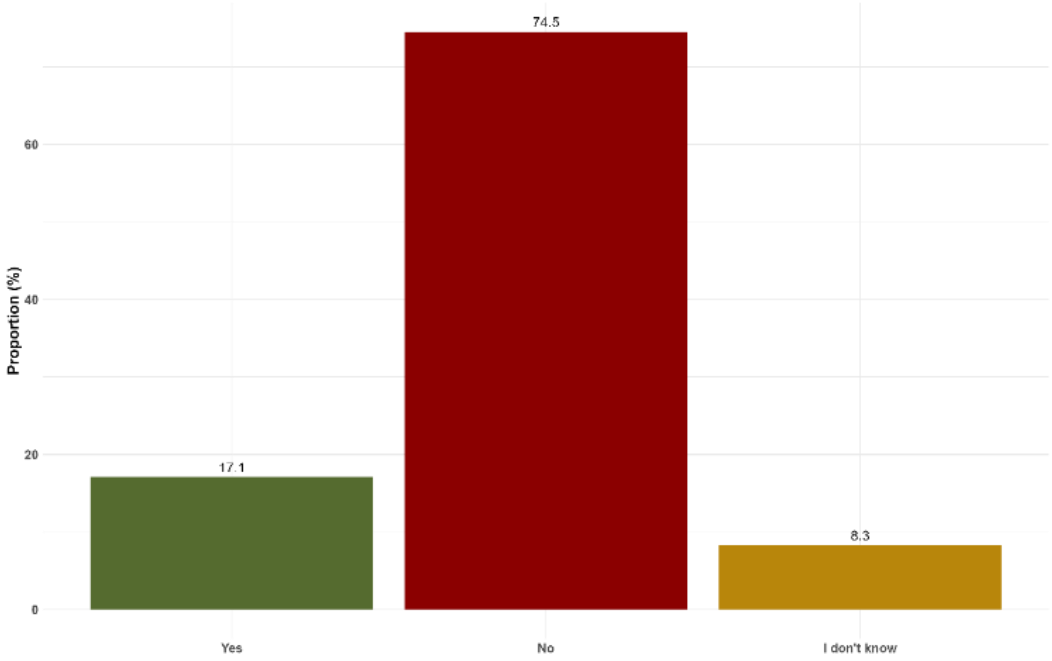

Figure 28: Proportion of respondents with previous experience in gut microbiome analysis

7.3. Interest

(QUESTION) HOW INTERESTED ARE YOU IN HAVING YOUR GUT MICROBIOME ANALYZED?

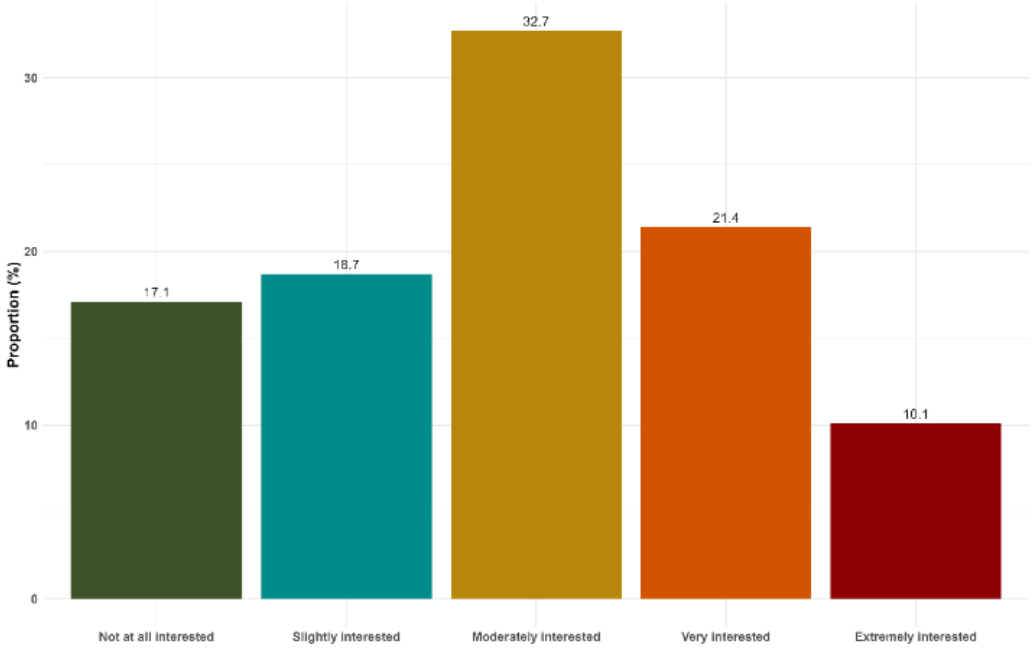

Figure 29: Distribution of degree of interest in gut microbiome analysis

(QUESTION) HOW INTERESTED ARE YOU IN RECEIVING PERSONALIZED DIETARY RECOMMENDATIONS TAILORED SPECIFICALLY TO THE MICROBIAL COMPOSITION IN YOUR GUT?

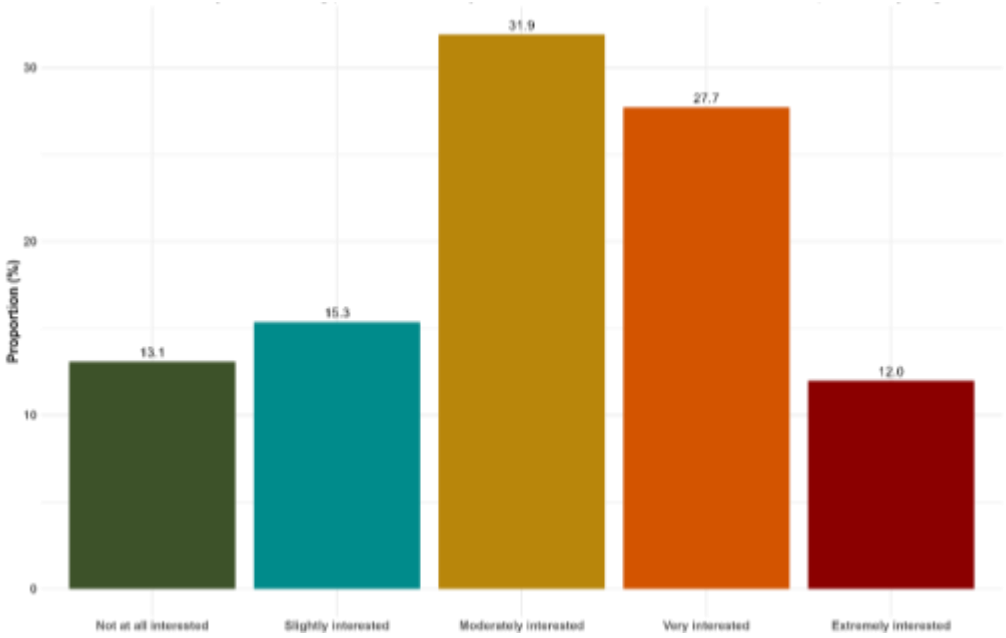

Figure 30: Distribution of degree of interest in personalized dietary advise based on the gut microbiome

7.4. Preferred services

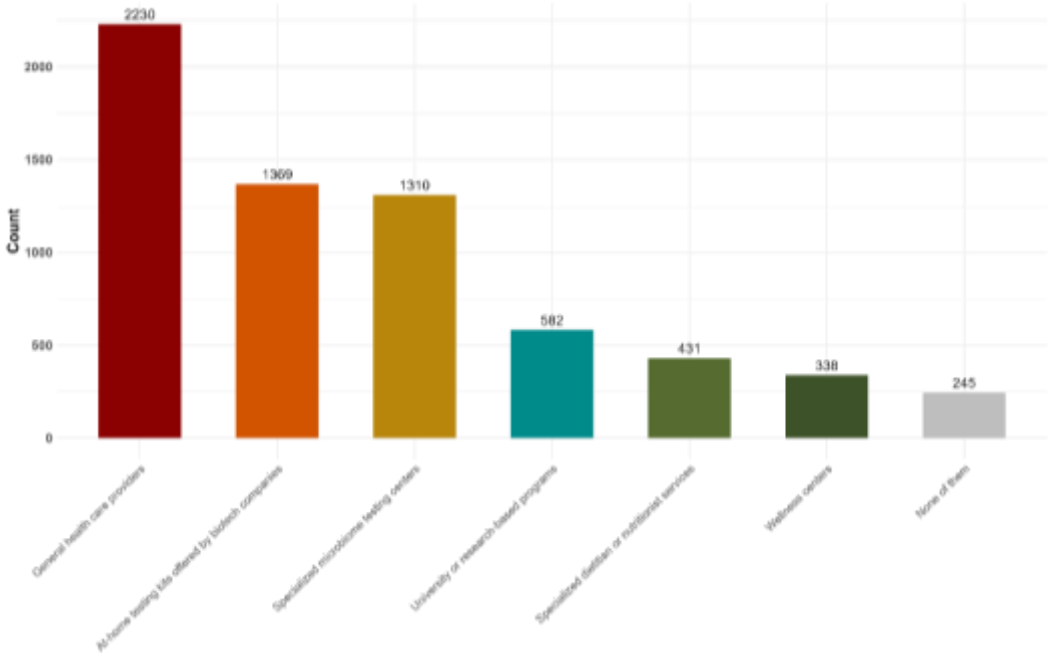

Figure 31: Preferred services for gut microbiome analysis

8. Conclusion

The present report sheds light on European consumers' knowledge, perceptions, and attitudes toward fermented foods. Overall, consumers demonstrate a solid understanding of fermentation processes, including the role of microorganisms, as well as the key benefits of fermented foods, such as extended shelf life and improved digestibility. Moreover, there is broad awareness of the connection between nutrition, gut health, and overall well-being. We also identify certain misconceptions and knowledge gaps that persist among consumers. By examining the information sources they rely on and prefer when learning about fermented foods and the gut microbiome, we gain valuable insights into how best to address these gaps. Leveraging these trusted channels for targeted education and clear product communication can help dispel misunderstandings, build consumer confidence, and encourage wider adoption of fermented foods.

In terms of consumption habits, traditional fermented foods - such as yogurt and sourdough bread - are already well integrated into daily diets. By contrast, while curiosity about novel or exotic fermented foods like kimchi, tempeh, and plant-based dairy and meat alternatives is growing, their presence in mainstream European diets remains limited. For now, these products occupy a niche market, with adoption lagging behind more familiar options.

When it comes to consumer attitudes toward fermented foods, we observe a balance between interest and slight hesitation. Fermented foods are generally perceived as beneficial for health, particularly for digestion. Consumers also value them for their role in reducing food waste and promoting sustainable, locally sourced food systems. However, despite acknowledging these health and sustainability benefits, overall opinions on taste and appeal remain neutral, with moderate willingness to try. As seen in food choice motives, sensory appeal is the primary driver of food selection, closely followed by natural content. Similarly, consumer acceptance of fermented foods is also influenced by their perceived naturalness — such as a short ingredient list with no additives — as well as convenience. Therefore, the overall liking of a fermented food is ultimately likely to be shaped by the specific sensory characteristics of the product and the individual's taste preferences. A key opportunity to explore these preferences in greater detail will come with the sensory experiments planned toward the end of the project, where fermented food prototypes will be tested and evaluated by a group of consumers.

Undoubtedly, there is substantial consumer interest in fermented foods, and this report presents initial findings that will be further analyzed moving forward. We highlight important opportunities and barriers toward their adoption, which, when addressed properly, can encourage the greater integration of fermented foods in European diets.

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Appendix

Distribution of income levels among participants

	Household Income	Count	Proportion (%)
Austria	1899€ or less	128	29.43
	1900€ - 3899€	127	29.20
	3900€ - 5099€	115	26.44
	5100€ or more	65	14.94
Estonia	799€ or less	129	28.29
	800€ - 1899€	128	28.07
	1900€ - 2699€	128	28.07
	2700€ or more	71	15.57
France	1499€ or less	227	25.14
	1500€ - 2999€	234	25.91
	3000€ - 4099€	235	26.02
	4100€ or more	207	22.92
Germany	1599€ or less	243	28.06
	1600€ - 3299€	245	28.29
	3300€ - 4499€	233	26.91
	4500€ or more	145	16.74
Ireland	1899€ or less	112	24.94
	1900€ - 3799€	132	29.40
	3800€ - 5199€	126	28.06
	5200€ or more	79	17.59
Italy	1099€ or less	249	25.18
	1100€ - 2499€	278	28.11
	2500€ - 3499€	266	26.90
	3500€ or more	196	19.82
Spain	999€ or less	149	17.07
	1000€ - 2299€	255	29.21
	2300€ - 3299€	250	28.64
	3300€ or more	219	25.09

A1: Income distribution across countries

Distribution of participant origin by region

	Region	Count	Proportion (%)
Austria	Ostösterreich	205	47.13
	Südösterreich	101	23.22
	Westösterreich	129	29.66
Estonia	Kesk-Eesti	46	10.09
	Kirde-Eesti	13	2.85
	Lääne-Eesti	63	13.82
	Lõuna-Eesti	113	24.78
	Põhja-Eesti	221	48.46
France	Auvergne-Rhône-Alpes	111	12.29
	Bourgogne – Franche-Comté	36	3.99
	Bretagne	43	4.76
	Centre - Val de Loire	35	3.88
	Corse	2	0.22
	Grand Est	76	8.42
	Hauts-de-France	81	8.97
	Normandie	45	4.98
	Nouvelle-Aquitaine	91	10.08
	Occitanie	80	8.86
	Pays de la Loire	49	5.43
	Provence-Alpes-Côtes d'Azur	75	8.31
	Régions Ultrapériphériques Françaises	3	0.33
	Île-de-France	176	19.49
Germany	Baden-Württemberg	101	11.66
	Bayern	137	15.82
	Berlin	45	5.20
	Brandenburg	33	3.81
	Bremen	7	0.81
	Hamburg	28	3.23
	Hessen	63	7.27
	Mecklenburg-Vorpommern	14	1.62
	Niedersachsen	73	8.43
	Nordrhein-Westfalen	191	22.06

	Rheinland-Pfalz	41	4.73
	Saarland	13	1.50
	Sachsen	46	5.31
	Sachsen-Anhalt	23	2.66
	Schleswig- Holstein	31	3.58
	Thüringen	20	2.31
Ireland	Eastern and Midland	209	46.55
	Northern and Western	94	20.94
	Southern	146	32.52
Italy	Centro	195	19.72
	Isole	89	8.99
	Nord-Est	200	20.22
	Nord-Ovest	283	28.61
	Sud	222	22.45
Spain	Canarias	43	4.93
	Centro	106	12.14
	Comunidad de Madrid	159	18.21
	Este	155	17.75
	Noreste	109	12.49
	Noroeste	98	11.23
	Sur	203	23.25

A2: Regional distribution of respondents by country

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