

Article

Aspects Affecting Food Choice in Daily Life as Well as Drivers and Barriers to Engagement with Fungi-Based Food—A Qualitative Perspective

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Abstract: Fungi-based food is expected to contribute to more sustainable food systems. The present study has three focus areas: (i) aspects that affect food choices food in daily life, (ii) aspects that affect choices of fungi-based food in particular, and (iii) drivers that motivate, and barriers that prevent, engagement in cultivating fungi and cooking fungi-based food at home. One hundred and sixty participants, who were recruited using convenience sampling, filled out qualitative questionnaires. The results show that there are numerous aspects (e.g., environmental benefits, nutrition, sensory characteristics, production practices and ingredients) that are important when people choose food in daily life. In addition to curiosity, many of these aspects also affect the choice of fungi-based food. The study identified more drivers (e.g., self-providing, curiosity, awareness of ingredients) than barriers (time, knowledge, concerns about contamination) to cultivation and cooking of fungi-based food at home. The findings are relevant for the development of fungi-based food so that this type of food is engaged with, and so that it can contribute to more sustainable food systems.

Keywords: future food; sustainability; sustainable lifestyles; filamentous fungi; fungi-based food; resource recovery



Citation: Hellwig, C.; Bolton, K.; Häggblom-Kronlöf, G.; Roustae, K. Aspects Affecting Food Choice in Daily Life as Well as Drivers and Barriers to Engagement with Fungi-Based Food—A Qualitative Perspective. *Sustainability* **2023**, *15*, 317. <https://doi.org/10.3390/su15010317>

Academic Editor: Marian Rizov

Received: 25 November 2022

Revised: 22 December 2022

Accepted: 23 December 2022

Published: 25 December 2022



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1. Introduction

Although humans have harnessed fungi's powers in the production of food and drinks for centuries [1], there is still potential to increase the use fungi in food production, especially in the context of current and urgent environmental and social challenges. To provide food security to a growing world population requires sustainable food production that takes all facets of environmental, social and economic sustainability into account [2,3]. At the same time, substantial amounts of food is not eaten but instead is lost or wasted [4]. This results in large environmental impacts associated with, for example, greenhouse gas emissions and loss of resources used in the food supply chain [5]. Each year more than 4.4 gigatons of carbon dioxide equivalents are emitted from food loss and waste [6], which is equivalent to 8–10% of global anthropogenic greenhouse gas emissions [7]. The environmental impact of food waste is exacerbated when it occurs at households due to the up-stream packaging and transportation of the food [5].

Fungal cultivation can contribute to sustainable food production because it can be used to convert food waste (i.e., food that otherwise would not have gone to human consumption), leftovers and surplus products as well as biproducts of other production streams into edible and nutritious food [8,9]. Fungi-based food has recently been introduced to places where it was not commonly eaten [8,10]. In contrast to mushrooms, which are the fruiting body of fungi [11], fungi-based food is made from the mycelium of edible filamentous fungi [12]. These fungi are cultivated on substrates that are rich in carbohydrates and that

provide a source of nitrogen [13]. The cultivation of such fungi is a fermentation process since the fungi grow hyphae which penetrate substrates to access the nutrition by secreting enzymes [14]. As they grow, fungi convert substrates into fungal biomass. The difference in nutritional profiles of the substrate and the fungal biomass depend on the substrate, but is often marked by starch reduction and increased protein, fiber and fat content in the biomass [12,15,16].

Fungi-based food is highly nutritious and functional [15–18] and the bioaccessibility and absorption of nutrition in the human digestive system is improved when edible filamentous fungi convert the substrate they are grown on into fungal biomass [19–21]. Examples of fungi-based food that is available in many European Union (EU) countries are Quorn™ products. Fungi-based fermentation has been used for centuries in south-east Asia for the production of ‘tempeh’ (fungal-fermented soybeans [1]) and ‘koji’ mold (e.g., fungal-fermented rice or soybeans used in the production of rice wine, soy sauce, soybean paste and distilled spirits [22]).

Fungi-based fermentation is, in fact, even an activity that individuals can engage in [16]. Homemade soybean fermentation to make tempeh has long been common in places such as Indonesia [1]. Fungi-based fermentation in homes can also be done using other carbohydrate-rich substrates such as legumes [23], grains [24] or residuals [25] including leftover bread [16,26].

The present study investigates aspects that affect food choices in daily life and particularly those that affect choices of fungi-based food. It also explores drivers that motivate, and barriers that prevent, engagement in cultivating fungi and cooking fungi-based food at home. An improved understanding of what is important to individuals when they choose food for daily life is important. Such knowledge can then be used as a constructive foundation for initiatives that aim to encourage behavioral transitions towards more sustainable food products.

Far less is known about the aspects that affect choices of sustainable food such as fungi-based food. This is especially true in cultures where fungi-based food is not widespread. This knowledge would provide an insight into behavioral triggers that encourage and discourage engagement with more sustainable food. There are many benefits associated not only with choosing food that contributes to more sustainable systems but also with reducing food waste, especially at the household level. It is important to understand reasons for individuals to engage with fungi-based food when, for example, purchasing from supermarkets or restaurants or when cultivating fungi themselves for cooking at home. It is therefore important to understand what encourages or deters individuals from making sustainable nutritious food themselves from leftovers, such as bread, and how engaging in fungi cultivation at home can be encouraged. This study takes the first step towards exploring and describing engagement in fungi-based food and related activities, considering both purchasing of fungi-based food and cultivating and cooking fungi-based food at home.

The current study aims to study and explore lived realities to gain an understanding of experiences and perceptions that relate to (i) what is important to individuals when they choose food in daily life; (ii) reasons for choosing fungi-based food; and (iii) drivers and barriers of fungi cultivation and engagement in fungi-based food-related activities at homes.

2. Materials and Methods

2.1. Data Collection and Analysis

Given that the objectives of this study relied on capturing the perceptions and lived realities of participants, three questions were explored using a questionnaire with open ended questions. A qualitative research approach is used to study ‘the complexity of everyday life, the nuances of meaning-making in an ever-changing world and the multitude of influences that shape human lived experiences’ [27]. Moreover, qualitative questionnaires yield extensive and relevant data regarding, for example, social trends, behaviors, percep-

tions, values, attitudes and perspective [28,29] in contexts where conducting interviews with a large segment of diverse populations may be overwhelming. Data was collected through the questions presented in Table 1.

Table 1. Questions asked to achieve the aim of the present study.

Question as It Appeared in the Questionnaire	Rationale
What is important to you when you choose which food products to buy, cook or eat in your daily life?	This question focused on aspects that participants find important when they choose food in daily life. This question aimed at encouraging participants to share their preferences in order to provide data to explore the first objective
If you were to choose fungi-based food products, what would be your reason(s)?	This question focused on why participants would choose fungi-based food when they, e.g., shop for groceries or go out to eat. This question was included in the questionnaire to provide data for the second objective of this study
If you could cultivate fungi-based food at home, would you like to try it and eat it?	This question was included in the questionnaire to provide data to answer the third objective of this study by encouraging participants to share thoughts regarding cultivating fungi and fungi-based food-related activities at home.

Space that encouraged participants to share their perceptions and thoughts freely was provided underneath each question. Participants were asked to provide background data by giving their age, which gender they identify as, and whether they were vegan, vegetarian or had other dietary restrictions.

A qualitative deductive analysis [30] was performed. The summative content analysis was performed to review the experiences and perceptions that participants shared and to identify key messages [31]. Based on this, thematic groups emerged. The content of the responses was coded and tabulated, and the results are summarized and narratively reported in this contribution. A descriptive statistic of participants was provided based on age, gender and diet. To provide a basic overview, the frequencies with which thematic groups and aspects within thematic groups were mentioned were additionally counted.

2.2. Recruitment of Participants

A diverse range of participants were invited to take part in the study using convenience sampling without exclusion criteria. Participants were approached at several events. This included a running event, a guest lecture for undergraduate students in medical sciences (occupational therapy), two separate visits of high school students and retirees to the University of Borås, a regional meeting for sustainable development of a municipality, a meeting of the international Cost Action Cross Border Transfer and Development of Sustainable Resource Recovery Strategies Towards Zero Waste (FULLRECO4US), and the international European Cooperation in Science & Technology conference in Borås and Gothenburg, Sweden. As a result of the diversity of the events, individuals who were approached to participate in this study were of different ages and from over 30, mostly EU, countries. Data were collected between the autumn of 2021 and the spring of 2022.

To provide participants with a reference point and examples of fungi-based food products, participants had the chance to taste a variety of sweet and savory fungi-based products. The fungal biomass for these products was cultivated at the University of Borås and processed in cooperation with Millow AB (a Swedish food tech and fungi-based food producing company). Participants were encouraged to ask questions about fungi-based food, and verbal information was provided when participants had questions regarding, for example, the expected contribution of these foods to more sustainable food systems or

their nutritional benefits. Additional information about the study was provided through information sheets which participants were asked to read prior to signing their consent to participate. Ethical approval for this study was granted by the Swedish Ethical Review Authority (approval number 2021-02253).

3. Results

The number of questionnaires collected was $n=160$ which represents the total number of participants (100%). 59% of the participants identified themselves as female, 39% as male, 1.3% as non-binary, and the remaining 0.7% of participants did not provide information. The average age of the participants was 39 years. The youngest participants were 17 years old and the oldest was 79 years old. The majority of the participants (73%) did not have any restrictions with respect to their diets, 14.4% were vegetarians and, in addition to this, 3.1% choose not to eat pork. Of the remaining participants, some were vegan (2.5%), flexitarian (1.9%), pescatarians (2.5%), choose halal food (1.3%) or did not indicate any possible dietary restrictions (1.3%).

Analysis of the participants' answers to the three questions yielded four thematic groups: environment & food security; health-related demands; choices & interests; and information. Appendix A provides an overview of the aspects mentioned by the participants including a count of how often aspects were mentioned.

3.1. Food Choices in Daily Life and Reasons for Choosing Fungi-Based Food

The results revealed a diverse range of keywords that fall within the thematic groups. The results regarding aspects that are important when choosing food in daily life as well as reasons for choosing fungi-based food are presented in Table 2. It may be noted that general preferences for food in daily life do not always mirror reasons for choosing fungi-based food.

Table 2. Identified aspects for preferences regarding food in daily life and reasons for choosing fungi-based food.

Thematic Group	Identified Aspects for Food Preferences in Daily Life	Identified Aspects for Choosing Fungi-Based Food
Environment & food security	<p>Sustainability</p> <p>Climate benefits (e.g., climate impact; carbon dioxide emissions; carbon footprint)</p> <p>Environmental benefits (e.g., non-toxic/life-promoting; biodiversity)</p> <p>Actions (e.g., taking waste generated through choices into account; buy good food so as to eat everything and avoid waste)</p> <p>Packaging (e.g., recyclability; appropriateness of packaging; no unnecessary/only little packaging)</p>	<p>Sustainability (e.g., contribution to sustainable development/future)</p> <p>Climate benefits (e.g., climate impact; reduce carbon dioxide emissions)</p> <p>Environmental benefits (e.g., benefits depend on production)</p> <p>Production (e.g., possibility to cultivate on different organic matter ensures accessibility/availability)</p> <p>Implications of production (e.g., improve food security; sustainable food production in many/more countries; less affected by extreme weather; less land use; when waste impact is reduced through resource recovery strategies, i.e., circularity/reuse/recycling)</p> <p>Incentives (e.g., reducing/minimizing waste/food waste; added value products; if products require less packaging than other products)</p>
Health-related demands	<p>Healthy (e.g., good for body; wholesome)</p> <p>Safety (e.g., allergy concerns; quality of materials; official health and safety certificates)</p> <p>Natural/unprocessed (e.g., healthy ingredients; no/few additives)</p> <p>Clean (e.g., no toxic/dangerous/chemical/poisonous or synthetic ingredients; few ingredients/no unnecessary ingredients; no preservatives)</p> <p>Nutrition (e.g., protein, fat and carbohydrate content; calories)</p> <p>Labels and certifications of production conditions (e.g., organic/biological/ecological agriculture)</p>	<p>Healthy (e.g., good for health; better/healthier; wholesome; functional; more digestible/positive dietary effect)</p> <p>Natural (e.g., healthy ingredients; no/few additives)</p> <p>Clean (e.g., no toxic/dangerous/chemical/poisonous or synthetic ingredients; few ingredients/no unnecessary ingredients; no preservatives)</p> <p>Nutrition (e.g., protein content; vitamin B; probiotics; nutritionally good alternative)</p>

Table 2. Cont.

Thematic Group	Identified Aspects for Food Preferences in Daily Life	Identified Aspects for Choosing Fungi-Based Food
Choices & interests	Dietary choices (e.g., vegan; vegetarian)	Dietary choices (e.g., vegan; vegetarian)
	General preferences (e.g., versatile/varied diet; options/choices should be provided; less meat and more greens/vegetables; no semi-finished products; fresh products)	General preferences (e.g., to vary diet; to reduce consumption of other products; to expand range on market)
	Solidarity with animals (e.g., ethics relating to animal rights/welfare)	Personal interests (e.g., fun to make; curiosity; enables self-providing)
	Social implications (e.g., suitability for family)	Solidarity with animals (e.g., ethics relating to animal rights/welfare/suffering; to not support meat industry; reduce meat consumption; to replace meat; to avoid environmental issues associated with meat)
	Origin of products (e.g., locally produced/grown; national/Swedish or nearby production; regionality)	Social implications (e.g., advantages for societies in crisis; food security for everyone)
	Expenses (e.g., cheap; priceworthy, affordable)	Moral (e.g., global solidarity; future generations)
	Sensory characteristics (i.e., taste; flavor; texture; appearance)	Origin of products (e.g., if locally produced; if no transportation needed)
Information	Convenience (e.g., easy to make/cook; accessible; suitability for hobbies; filling)	Implications of origin (e.g., local value chains/jobs)
	Utility (e.g., expiry date/shelf life; good (not further specified))	Expenses (e.g., cheap; priceworthy, affordable)
		Sensory characteristics (i.e., taste; flavor; texture; structure; unicity; consistence; meat-like consistence)
		Convenience (e.g., potential of fungi to make edible food)
		Practicality (e.g., good in food preparation; if there are recipes/good dishes available)
	Communication (e.g., convey impact through information on label; companies to label products in a way that makes it easier for consumers to determine the environmental impact of products)	Communication (e.g., knowing why/how fungi-based food is part of circular economy; require knowledge about calories)
		Knowledge (e.g., require more research to find reason to choose fungi-based food; do not know about reasons; do not know what fungi-based food is)

3.2. Cultivating, Cooking and Eating Fungi-Based Food at Home

The responses showed that the majority of participants (70%) are inclined to try to cultivate, cook and eat fungi at home. This may be due to the fact that the study was done at several events that focused on sustainability. Some of the responses (20%) indicated that participants seemed neutral towards the idea, and 10% were either not inclined or it was not possible to tell from the responses whether or not the respondents were inclined to try cultivating and cooking fungi-based foods at home. Overall, more aspects that drive engagement were mentioned by participants than aspects that may pose barriers (Table 3).

Table 3. Drivers and barriers to fungi cultivation and cooking at home.

Thematic Group	Identified Aspects
Drivers	Environment & food security
	Climate change Environmental benefits Actions (e.g., using fungi to upcycle/improve) Implications (e.g., food waste reduction/avoidance; make use of leftovers) Incentives (e.g., resource recovery; circular economy)
	Health-related demands
	Wholesome/good Healthier Composition known and understood Nutritional incentives (e.g., increased nutritional value; protein source; calories)
Choices & interests	Personal interests (e.g., previous consideration; education/professional background)
	Curiosity (e.g., willingness to try/test; interest)
	Expectations (e.g., fun; exciting; sense of pride; sense of independence; social activity with friends)
	Origin (i.e., local production)
	Sensory characteristics (i.e., good taste)
	Convenience (e.g., good, useful; likable; enables one to produce own food)
	Utility (e.g., perception that cultivating fungi is like other enjoyable hobbies such as gardening/planting or fermenting/pickling)
	Practicality (e.g., nice for cooking; variation; good alternative)

Table 3. *Cont.*

	Thematic Group	Identified Aspects
Barriers	Environment & food security	Rather reduce food waste than cultivate
	Health-related demands	Safety (e.g., health; allergies) Fear of contamination
	Choices & interests	Expectations (e.g., cumbersome/difficult) Disinterest (e.g., preferred purchase of fungi-based food) Individual deterrents (e.g., laziness) Economic Convenience (e.g., too work intense; no time; if no space/special conditions required) Utility (e.g., perception that cultivating fungi is like other hobbies that are not enjoyable or at which individuals are not good such as gardening/planting or cooking)
	Information	Knowledge dependent (e.g., only if information is accessible)

4. Discussion

In the following sections, the results regarding drivers and barriers to home cultivation are discussed at the beginning followed by food preferences in daily life and reasons for choosing fungi-based food. The subheadings in the discussion have been chosen as they were the most relevant way to summarize the aspects in the tables.

4.1. Environment and Food Security

4.1.1. Sustainability and Benefits for the Environment

In terms of cultivation and cooking fungi-based foods at home, environmental benefits of cultivating fungi, and its contribution to mediating climate change may additionally drive engagement. This is in line with other research that suggests that more and more individuals are taking efforts to change their behaviors because they are conscious of the implications for the environment [32].

The findings indicate that the participants are aware that their food choices have an impact on the environment. Aspects that relate to the environment, and especially the climate, were often mentioned in the context of preferences regarding food in daily life. Perceived environmental benefits were also the most mentioned reasons for choosing fungi-based food, followed by climate benefits (Appendix A).

The results show that many of the participants are aware that their choice of food has an impact on, for example, greenhouse gases. Since a reduction in greenhouse gas is important for achieving sustainable development, people can contribute to sustainability by choosing food that is associated with lower greenhouse gas emissions [33]. In fact, recent studies have focused on patterns where food products that emit a large quantity of greenhouse gases are substituted with products that have lower emissions [34,35]. Edenbrandt and Lagerkvist [35] found that individuals who already find sustainability-related aspects important when they choose food products are also more willing to buy food products that are associated with lower greenhouse gas emissions. Moreover, the same study found that individuals are more willing to pay for plant-based meat alternatives when labels inform about the large greenhouse gas emissions from alternative products like meat.

Choosing fungi-based food products is perceived to be an effective strategy to achieve food security in environmentally benign ways. Previous publications also recognize that fungal fermentation has such potential [36]. It should be mentioned, however, that there are also alternative perspectives. For example, it may be difficult to conclude whether fungi-based food is sustainable because sustainability is determined by many, often conflicting, factors such as reducing greenhouse gas emissions at the same time that sufficient food production and choices must be ensured [37]. Even in terms of environmental criteria, there are many environmental categories that need to be assessed (e.g., global warming, ozone depletion potential, eutrophication, and land use). As an example, Brancoli, et al. [38] used life cycle assessment to study several categories when assessing the environmental impact of fungi-based products made from surplus bread.

4.1.2. Food Production

While aspects that relate to the way food is produced were not mentioned in the context of fungi cultivation at home, the results show that production processes are relevant not only in terms of food choices in daily life but also in the context of engagement with fungi-based food. Critical stances, e.g., that reasons for choosing fungi-based food depend on how it is produced, are justified since different ways of cultivating fungi differ in water-, energy-, and post-treatment requirements [8,12].

The perception of the participants is that the production of fungi-based food is beneficial in that fungi can be cultivated on organic matter which ensures both accessibility and availability of this type of food. The diverse range of substrates that participants assumed fungi can be cultivated on, in turn, is perceived to improve food security because it enables sustainable (i.e., less land and resources) global food production that is also less affected by extreme weather. It may be noted that this level of awareness among some of the participants may not be representative of a wider population because they were shared among participants who attended the events about resource recovery strategies as well as science and technology.

The participants' perceptions regarding the benefits of fungi-food production are in agreement with the results of Souza Filho, et al. [39] that the production of fungi-based food may be sustainable because it is expected to have a lower environmental impact compared to other protein-rich foods such as meat. Compared to meat, the environmental impact of fungi-based food is lower due to the high demand for land and water, loss of diversity and greenhouse gas emissions associated with the meat supply chain [40]. Cultivation of fungi typically takes two to seven days [15,16] and is therefore expected to be less energy intensive than, for example, growing plants over several months or raising animals over several years. It may be noted, however, that the energy consumption of fungi-food production is expected to vary depending on other aspects such as pre- and post-treatments.

4.1.3. Resources

In terms of cultivation and cooking of fungi-based food at home, the findings show that aspects that relate to waste and resource recovery pose both barriers and drivers of engagement. Using fungi to upcycle leftovers and thereby reduce or avoid food waste was a driver that encourages engagement in cultivation and cooking of fungi-based foods at home. In the context of preventing food waste at homes, it was perceived that there are more benefits in not generating food waste to begin with, so as to make fungi cultivation obsolete. This sentiment is in line with current policies. While cultivating fungi on leftovers at the household level can be a constructive waste management strategy [16], avoiding and preventing food waste in the first place is most prioritized in food waste management hierarchies [9].

The findings show that aspects that relate to waste and resource recovery are relevant for food choices in daily life and for choosing fungi-based food. That individuals are aware of issues related to waste from packing, and especially plastic packaging, and try to avoid this type of waste is in line with other research that found that plastic waste avoidance and recycling are strongly linked to an individual's environmental concerns [41].

In terms of production, the findings reveal that many participants perceive positive consequences in engaging with food that can be made in ways that utilize circular approaches. Knowing why and how fungi-based food is part of a circular economy can even become a reason for choosing fungi-based food. These findings point toward the need to address and communicate such specific information in accessible ways. Fungi cultivation requires substrates that are often agricultural products, but it is particularly beneficial when by-products and leftover or surplus food are used [8]. Food that is made from by-products may be perceived as less valuable or attractive because by-products may be associated with food that would otherwise go to waste [42]. The results of this study show that participants are aware of issues associated with resources and waste as well as its impact on the climate,

and thought that fungi cultivation is a promising strategy where leftovers and waste can be turned into nutritious food. This, in turn, was associated a low environmental impact. This finding is in line with other research that found that fungi cultivation is particularly beneficial when by-products and leftover food products are used as this contributes to efforts that encourage circular economies and effective resource recovery [8,15,16,43,44]. Moreover, it has been suggested that fungi-based food made from leftover bread can have the potential to become an accepted product when its environmental benefits are specifically communicated [44].

4.2. Health-Related Demands

4.2.1. Health

In terms of cultivation and cooking fungi-based foods at home, the findings show that aspects that relate to health can encourage and discourage engagement. Perceptions, such as that fungi-based food is good for the body because it is healthy and nutritious, are drivers of engagement. On the other hand, issues relating to contamination, safety, health and allergies can be barriers to engagement in fungi cultivation and in activities that relate to fungi-based food at home. Some of the edible fungi that can be used in homes are not expected to cause allergic reactions and there are only a few reported incidences of intolerances [45]. However, the relative novelty of cultivating fungi indicates that there is a need for more knowledge and information to consumers. This includes detailed instructions which may be best accompanied by pictures or videos which show the appearance of the biomass should when it is free from contamination and, importantly, how contamination can be identified. Such material is important so that individuals have information and visualizations that they can refer to.

Health-related aspects are also relevant regarding food in daily life and reasons for choosing fungi-based food. Participants associated several health benefits with the consumption of fungi-based food. Health benefits that have been studied with regard to fungi-based food include reduced total cholesterol levels [46–50] as well as induced muscular protein synthesis [46,51–53]. At the same time, the evidence of the effects of consuming this type of food on blood glucose and insulin levels is not conclusive [54]. A review about health evidence of fungi-based food only found seven studies [54] which indicate the need for more research, which can assist individuals in making informed decisions regarding their engagement with this type of food.

The findings suggest that it is important for individuals to engage with food that provides benefits to them. Participants' perceptions that fungi-based food is good for them is justified in that the biomass gained through fungal fermentation is considered wholesome, functional and highly nutritious [15–18]. Engaging with fungi-based food can have benefits because many plant-based food sources do not provide adequate levels of essential amino acids. Plant-based food may also contain antinutritional compounds (e.g., phytate) which negatively impact the bioavailability and absorption of nutrition during digestion [55]. Fungi-based food is associated with beneficial bioavailability [54] and improved absorption of nutrition [19–21].

4.2.2. Natural, Clean and Unprocessed Products

The results show that knowing the composition of fungi-based food when it is home-made is a relevant driver of engagement in the cultivation and cooking of such foods at home. This could be attributed to desires for healthier food intakes than that provided by the ingredients in, for example, convenience foods which can contain high levels of fat, sugar and salt for taste and preservation [56]. The finding that knowing what is in food encourages individuals to cultivate and cook fungi-based food at home is also in line with research advances that found that familiar ingredients, 'clean labels' and trust in food sources are aspects that individuals increasingly seek [57].

Ingredients are also important when choosing food in daily life and when choosing fungi-based food. In fact, ingredient-related aspects were mentioned much more often in

the context of food in daily life compared to choosing fungi-based food. This might be due to the fact that the participants are more aware of ingredients in food that is known to them rather than in novel foods.

Nonetheless, the results show that clean (this, according to participants, is food that does not contain any toxic, dangerous, chemical, poisonous or synthetic ingredients, or that contains only a few ingredients but no unnecessary ingredients and no preservatives) and natural (which, according to participants, is food that contains healthy ingredients and no or only a few additives) food is important. This finding is in line with other research that found that individuals seem to be more willing to change to more sustainable food if it is natural [58,59]. The participants' perception of 'chemicals' is in line with other research that found that attitudes towards chemicals in food lead people to choose natural foods over food that contains extensively processed or that contains chemical ingredients [58,60]. Europeans see a conflict between highly processed food products and sustainability, and dislike additives and isolated ingredients (such as proteins isolated from whole foods) [61]. For example, in Germany people are advised not to consume products with many ingredients or products that contain ingredients that people do not have in their kitchens [62]. Binders, such as methylcellulose, are named in this context due to the lack of long-term studies and adverse health effects [63]. Despite this, most fungi-based (and other vegetarian/vegan) meat-alternatives that are currently on the market are highly processed or they contain isolates, additives or 'chemicals' such as binders. Thus, to encourage engagement with fungi-based food, there may be need for innovation in technologies that result in 'clean' fungi-based products that do not require the addition of isolates or additives and that are made in the absence of pre- or postprocessing.

4.2.3. Nutrition

The current study identified nutrition-related aspects as drivers of cultivating and cooking fungi-based foods at home. In fact, cultivating fungi on substrates, is one way that enables individuals to increase nutritional value [16]. This finding also indicates that there is not only awareness of the importance of nutritional scores among the participants but that this awareness is also an aspect that encourages individuals to act upon. In line with this, individuals with greater nutrition knowledge were found to report significantly healthier food choices [64].

Additionally, nutrition-related aspects are not only important in the context of food in daily life but were often mentioned in the context of reasons for choosing fungi-based food. Many participants commented on the nutritiousness of fungi-based food, and indeed several studies found that the protein content in this type of food is higher than that of other plant-based sources, and it is also high in fibers, bioactive compounds, calcium, phosphorous, magnesium, zinc and choline [54,65–68]. Moreover, filamentous fungi produce vitamins such as vitamin B₂ (riboflavin), vitamin B₉ (folate), vitamin B₁₂ (cobalamin) [69]. In line with the awareness that fungi-based food is nutritious in terms of probiotics, fungi-based probiotics and prebiotics can have positive effects on the human digestive tract [70].

The term 'protein', is often used synonymously with 'nutritious', which may be due to protein-related marketing strategies [71]. It is noteworthy, however, that protein is only one of many nutritional compounds important for human health [72], and both consuming too much and too little protein are associated with adverse health effects [73–81]. In fact, nutrition programs that work in the context of malnutrition have shifted focus from controlling protein deficiencies to micronutrient deficiencies [82]. This is because micronutrient malnutrition is widespread and is expected to be the largest global nutritional problem [83].

4.3. Choices and Interests

4.3.1. Solidarity with Animals and Dietary Choices

Solidarity with animals was not mentioned in the context of drivers of cultivation and cooking fungi-based foods at home. Nonetheless, aspects that relate to animal welfare and

meat were even more often mentioned as a reason for choosing fungi-based food than in the context of preferences regarding food in daily life. These results are similar to those from other research that found that many people have shifted towards vegan, vegetarian or flexitarian diets [84]. Vegetarianism, for example, may be triggered by religious but also non-religious beliefs, and environmental and ecological consequences of meat production are among the drivers that lead some people to choose animal-free diets [85]. The results are also in line with other findings that suggest that individuals would choose fungi-based products over meat-based ones for environmental reasons [44]. These findings mirror studies that found that plant-based diets are increasingly perceived to be more sustainable than meat-based diets [44,86]. Securing adequate nutrition of animal origin is not only financially expensive but also has negative environmental consequences [75,87]. Nutritious alternatives, such as fungi, are expected to have a lower environmental impact compared to meat [39] because of the high demand for land and water, loss of diversity and greenhouse gas emissions in the meat supply chain [40].

4.3.2. Personal Interests

In terms of fungi cultivation at home, being able to produce one's own food is relevant for engaging with fungi-based food, and cultivating fungi at home that is subsequently used to cook food. Cooking one's own food is perceived to convey a sense of independence and a sense of pride. These narratives are in line with other research that found that food self-provision (i.e., food production at home) is important [88] and can be perceived as a constructive strategy to produce and consume environmentally benign food. This, in turn, reduces the negative consequences of conventional food systems on the environment, others and health [89].

The findings show that curiosity and being able to be self-sufficient also important reasons to choose fungi-based food. Curiosity is indeed an important driver of engagement in novel behaviors that allow individuals to explore something new and seek intrinsic rewards such as new experiences [90,91]. Research that examines the effect of curiosity on engagement with fungi-based food would be constructive. This is because research on another emerging food, namely insect-based food, found that curiosity not only predicts willingness to try new foods but also boosts the impact of other predictors of willingness to try unfamiliar food [92].

4.3.3. Origin

Being able to produce one's own food locally in one's own home is a driver for cultivating fungi for food at home. The importance of the origin of food that individuals are willing to engage with is in line with other studies that found that individuals are wary of how food is produced, and would appreciate more transparent supply chains [93]. In fact, several studies noticed that individuals rather engage with food that is associated with only short or no transport distance at all (e.g., [94]).

The current study also found that the location of food production is additionally among the most commonly mentioned aspects regarding food preferences in daily life, and is also a reason for choosing fungi-based food. The implied benefits of local production, however, may be subject to debate. Some studies found that many overestimate the impact of the country of origin of products [95,96]. While there are benefits associated with locally produced food (e.g., rural development, sense of community and benefits for some food producers), local production may not always be sustainable because it might not be able to provide enough food and may cause challenges for other producers who rely on trade [37]. In addition, better indicators of the carbon footprint of food than the distance food is transported are aspects such as the way land is used and the efficiency and scalability of production [37].

4.3.4. Expenses

In the context of cultivation and cooking of fungi-based food at home, the findings show that financial aspects (i.e., it being cheap) encourage engagement. Cultivating fungi at home may be especially beneficial when the substrates are made from surplus or leftover food products. This is because individuals already paid for such food, and using it as a substrate to make new food not only keeps the resource use circular but also prevents individuals from the financial loss associated with food waste [16].

Expenses are also important for choosing food in daily life and reasons for choosing fungi-based food. However, it is noteworthy that a meta-analysis by Tully and Winer [97] found that six out of ten respondents are willing to pay more for products that are socially and environmentally sustainable. There is a greater willingness to pay for products that are associated with social responsibility and benefits for other people (such as working conditions) than willingness to pay for products that are associated with environmental benefits [97]. Interestingly, the results of this study show that the environment was more often mentioned than social aspects in the context of cultivating and cooking at home, as well as for choosing fungi-based food and food choices in daily life.

4.3.5. Sensory Characteristics

The taste of fungi-based food is a driver of cultivation and cooking at home. This finding is interesting in light of previous research which found that the taste of fungi-based foods may pose the greatest barrier to public acceptance of such food [59].

Sensory characteristics, and especially taste, are important when choosing food in daily lives and in terms of reasons for choosing fungi-based food. The results regarding the importance of sensory characteristics are in line with other research that found that taste is important when choosing food [98]. In fact, a previous tasting found that many of the participants liked the taste- and texture characteristics of fungi-based burger patties [44]. Yet, the same study also found that sensory characteristics of the fungi-based burger patties need to be developed, especially if they were to cater to individuals who would otherwise prefer meat-based products. A tasting of minimally processed and spiced fungi-based burger patties found that most participants neither liked nor disliked the taste and texture of the burgers, which indicates that the taste of fungi-based food is relatively neutral and that sensory characteristics such as taste and texture can be adapted to the liking of consumers [12].

4.3.6. Convenience, Utility and Practicality

Convenience, utility and practicality-related aspects are among the most commonly mentioned drivers for fungi cultivation and cooking at home. Participants thought that cultivating fungi at home is nice because using fungi for cooking is good, useful, likeable, a good alternative for using leftover food, and provides dietary variation. These findings are in line with other research that found that convenience, along with taste, are core drivers when individuals make food-related choices [99].

Some of the participants perceive cultivation at home to be like growing vegetables in their garden rather than a fermentation activity. This perception can be a driver of cultivation when participants like the associated activity (i.e., growing vegetables). However, the reverse is also true, and it can be a barrier to cultivation at home if individuals do not feel confident with the associated activity. Examples of this include perceived lack of gardening skills or skills with growing vegetables. These findings may be due to the novelty of fungi-based fermentation (i.e., fungi cultivation). While fermentation of bread, for example, is easy and convenient, the perceptions that cultivating fungi is like growing mushrooms indicates that there is a lack of knowledge of this fermentation process. To encourage fungi cultivation, it would thus be necessary to make examples and instructions accessible to those who want to try this type of fermentation.

The results also show that time-related aspects play an important role in whether individuals will cultivate at home. In fact, time was the most commonly mentioned barrier

to cultivating at home. Time is a common barrier to many activities. However, fungi cultivation on certain substrates is less time-consuming than others since they do not require lengthy pre-treatment. Bread, for example, needs to only be dried and sterilized by heating it in the oven before it can be fermented [16], whereas soy beans need to be cooked and hulled before they can be fermented [1]. Once the pre-treatment is done and the substrate inoculated, however, the fermentation can take place in containers such as lunch boxes, and typically takes between three and five days, during which there is no labor required. In addition, fungi cultivation can be done at homes in any environment that is about 30 °C, including conventional kitchen ovens, sunny window sills and on top of heater elements [16].

Aspects that related to convenience, utility and practicality, including dietary variation, were also relevant for choosing food in daily life and for reasons for choosing fungi-based food. Similarly to these findings, convenience, utility and practicality in terms of food preparation has been found to motivate food choices [100].

4.4. Information

Aspects that relate to information can pose a barrier to cultivation and cooking of fungi-based food at home. As an example, a lack of knowledge of the fermentation process can discourage engagement. Providing instructions, information and know-how is thus vital in not only encouraging but also enabling individuals to cultivate at home.

The results further show that the participants have concerns when choosing food in daily life and when choosing fungi-based food. These concerns need to be answered in ways that communicate knowledge so that individuals can make informed decisions.

Providing information using labels is an important medium that is specifically requested. Labels informing that products are vegan can negatively affect sales and labels that use meat-sounding terminology have a weak biasing impact on how plant-based food is perceived [101]. In the context of meat alternatives that are vegan or vegetarian, there is a need for costly introduction, implementation, and management of new regulations regarding labels given their potential effect on choices [101,102]. While labels may be used to inform individuals in ways that influence them to buy products, labels can also be misused which can cause confusion about products and ultimately prevent consumption [101]. This is also relevant for the development of terminology used for fungi-based food. This is because terms that derive from Latin, such as ‘myco’ (e.g., mycoprotein) may not necessarily convey the fact that products are made from fungi, and thus may not fully inform individuals about what is in the product they are considering to buy and eat.

A labelling scheme could convey information that relate the food product to different aspects of sustainability, both in general terms and to specific sustainability criteria [37]. Research found that providing information that specifically targets sustainability is associated with higher ratings of perceived sustainability [103]. Stein and Santini [37] point to current discussions [104] and implementations [105] of such labels in terms of environmental impact. The lack of such information may be the reason why not all choices are always sustainable [106–108] despite the growing general awareness of the impact of food consumption and the preferences that go hand-in-hand with this awareness [97,109]. Importantly, the EU also seeks to develop a proposal for a labelling framework with the aim to empower people to make sustainable food choices as part of the European Commission’s Farm to Fork Strategy [110].

It is noteworthy that other ways to convey information were not mentioned by the participants. This raises the question if participants are only open to obtaining information via labels. This may be a relevant basis for future research given that there are currently many initiatives that aim to use media other than labels to provide individuals with information needed to make sustainable choices. One such example is the Danish think tank CONCITO which is making data about the climate impact of food publicly available in a database [111].

Information about calory-specific data and nutritional content were also requested. One reason for this comment may be that participants were not provided with tables of nutritional content of the fungi-based food that they were tasting as part of the study. In the EU, and many places across the world, however, individuals are provided with such information because manufacturers are required to present nutritional content on the packaging of products.

4.5. Considerations Regarding the Findings of the Study

As discussed above, choices and interests affect choices of food in daily life. It may be noted that the choices and interests discussed by participants may to some extent have been affected by the COVID-19 pandemic. Restrictions or lockdowns have been found to affect food choices and behavior [112] in that choices of products with longer shelf lives increased compared to fresh foods such as vegetables [113–115].

It is also noteworthy that participants mentioned on 15 occasions that it is important that food in daily life should be ‘good’, but this term was never defined or specified. The nature of questionnaires in terms of data collection, unfortunately, did not present the opportunity to follow up on how to interpret comments in instances such as this.

It may be noted that the qualitative data collected in this study represents participants’ self-reported narratives. While there are limitations associated with self-reported data, this study contributes with novel qualitative data which offers an insight into behavior that may be difficult to observe across a larger population. The findings build the foundation for future research that observes actual behavior that will contribute to a deeper understanding of engagement with food and that is expected to contribute to sustainability.

5. Conclusions

Engagement with food choices in daily life and with fungi-based food (whether by buying it at supermarkets or restaurants, or cultivating at home) is based on considerations that regard the environment and food security (e.g., climate and environmental benefits of production), health related demands (e.g., healthiness, nutritiousness, and natural products that are free of unnecessary, isolated or synthetic ingredients), choices and interests (e.g., dietary choices, solidarity with animals, sensory characteristics and convenience) as well as information (e.g., demands for improved communication that conveys why and how products contribute to sustainability and well-being).

Cultivating fungi for food at home is an activity that most of the participants are inclined to engage in. Among the drivers of engagement are aspects that relate to the environment and food security (e.g., climate change, environmental benefits, circular resource use), health-related demands (e.g., nutrition, knowledge regarding composition) and interests and choices (e.g., curiosity, expectations and convenience). In contrast, aspects that relate to information, such as dependence on know-how, concerns of contamination, time and expectations, are among the barriers that may prevent individuals from cultivating fungi at home.

The current study is a first step towards developing knowledge in the context of choosing fungi-based food as well as engagement in the cultivating and cooking of fungi at home. Future research may build on the findings, and assess in what ways specific aspects such as curiosity, and other behavioral triggers like perceived meaning and values affect engagement with fungi-based food. Specifically, in the context of fungal cultivation at home, deeper knowledge would be obtained by providing individuals with the opportunities to cultivate fungi at home and to observe and analyze their experiences.

Author Contributions: Conceptualization, C.H. and K.R.; Methodology, C.H. and K.R.; Validation, C.H., K.R. and G.H.-K.; Formal Analysis, C.H.; Investigation, C.H.; Resources, C.H. and K.R.; Data Curation, C.H.; Writing—Original Draft Preparation, C.H.; Writing—Review and Editing, C.H., K.B., G.H.-K. and K.R.; Visualization, C.H. and K.R.; Supervision, K.R., G.H.-K. and K.B.; Project Administration, K.R. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Swedish Agency for Economic and Regional Growth through a European Regional Development Fund with grant number 20201656, and the European Cooperation in Science and Technology through the Cross-Border Transfer and Development of Sustainable Resource Recovery Strategies Towards Zero Waste (FULLRECO4US) Action with grant number CA20133.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board (or Ethics Committee) of the Swedish Ethical Review Authority (approval number 2021-02253).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Not applicable.

Acknowledgments: The authors would like to express their gratitude to all those who participated in this study as well as the European Cooperation in Science & Technology conference and the Cost Action Cross Border Transfer and Development of Sustainable Resource Recovery Strategies Towards Zero Waste (FULLRECO4US) meeting organizers. Moreover, the authors would like to express their gratitude to Swarnima Agnihotri for her support in data collection and to Steven Wainaina for his support in discussing the results from a biotechnological perspective.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Aspects mentioned, subgroups and thematic groups.

	Thematic Group (n) ¹	Subgroup (n) ²	Aspects within Group (n) ³
Preferences regarding food in everyday life	Environment & food security (72)	Sustainability (7)	Sustainability (7)
		Climate benefits (20)	Climate (17) Carbon dioxide emissions (1) Carbon footprint (2)
		Environmental benefits (31)	Environment (28) Non-toxic/life-promoting (1) Biodiversity (2)
		Action (3)	Waste generated (2) Good so eat everything (1)
		Packaging (11)	No unnecessary/ only little packaging (2) Packaging (5) Recyclability (2) Appropriateness of packaging (2)
	Health-related demands (137)	Healthy (49)	Healthy (22) Wholesome (3) Good for body (2) Safe (4) Quality (not further specified) (12) Quality of materials (1) Allergy concerns (1) pH-value (1) Official health and safety certificate (1) No pathogens, drug resistant bacteria or other of antibiotic resistance (1) Well stored (1)
		Natural/unprocessed (11)	Natural/unprocessed (7) Healthy ingredients (5) No/few additives (6)
		Clean (15)	Clean food (3) No toxic/dangerous/chemical/poisonous or synthetic ingredients (9) Few ingredients/no unnecessary ingredients (2) No preservatives (1)
		Nutrition (34)	Nutritious (29) Fat, carbohydrates (fiber, sugar), proteins, calorific value, glucaric index (5)
		Labels and certifications of production conditions (28)	Communication that conveys impact (1) Information on label (1) Organic (17) Eco (3) Krav-label (3) Biological agriculture (1) Production condition (1) Way of cultivation (1)

Table A1. *Cont.*

Thematic Group (n) ¹	Subgroup (n) ²	Aspects within Group (n) ³
Choices & interests (247)	Dietary choices (14)	Vegan (4) Vegetarian (10)
	General preferences (22)	Seasonal (6) Versatile/varied (5) Less meat and more greens/vegetables (4) Halal (3) Fermentation (1) No semi-finished products (1) Not more than can be eaten (1) Fresh products (1)
	Solidarity with animals (10)	Animal rights/welfare (8) Ethics (1) No animal testing (1)
	Social implications (19)	Family and social impact (19)
	Origin of products (49)	Origin (8) Locally produced (21) Locally grown (3) Local (7) Swedish (4) Nearby production (3) From neighbor (1) Regionality (2)
	Expenses (42)	Cost (4) Price (28) Cheap (5) Priceworthy (2) Affordability (1) Economic (1) Not expensive (1)
	Sensory characteristics (49)	Taste (42) Flavor (1) Texture (4) Appearance (2)
	Convenience (22)	Convenient (2) Accessible (3) Suitable for hobby (1) Easy to make/cook (15) Filling (1)
	Utility (20)	Utility (1) Expiry date/ shelf life (3) Good (not further specified) (15) Good for cooking) (1)
Information (2)	Communication (2)	Convey impact through information on label (1) Companies to label products in a way that makes it easier for consumers to determine the environmental impact of products) (1)

Table A1. *Cont.*

Thematic Group (n) ¹	Subgroup (n) ²	Aspects within Group (n) ³
Reasons to buy fungi-based food	Environment & food security (155)	Sustainability (13)
		Sustainable development/future (2) Sustainable (11)
		Climate benefits (24)
		Climate impact (22) CO2 emissions (2)
		Environmental benefits (82)
		Beneficial for environment (76) Beneficial for the planet (3) Depends on production (1) Right choice for environment (2)
		Production (7)
		Possibility to cultivate son different organic matter (1) Accessibility /availability (4) Reduced cost of food production (1) Future food (1)
		Implications of production (19)
		Improve food security (1) Sustainable food production in many /more countries (3) Less affected by extreme weather (1) Less land consuming (1) Resources/resource recovery (4) Circularity/reuse/recycling (9) Waste impact reduction (1)
		Incentives (10)
		Reducing/minimizing waste/food waste (7) If less packaging (1) Added value (1) If resources ran out (1)
Health-related demands (60)	Healthy (28)	Good for health/healthy (22) Better/healthier (1) Functional effects (1) Wholesome (1) More digestible/positive dietary effect (3)
	Clean (3)	Natural products (2) Clean products (1)
	Nutrition (29)	Nutritious (17) Good alternative (3) Protein (7) Vitamin B (1) Probiotics (1)
	Choices & interests (126)	Dietary choices (8)
		Vegan (1) Vegetarian (3) Fungi-based (4)
		General preferences (4)
		To vary diet (1) Reduce consumption of other products (2) Would like an expanded range on market (1)

Table A1. *Cont.*

Thematic Group (n) ¹	Subgroup (n) ²	Aspects within Group (n) ³
	Personal interests (22)	Fun to make (1) Enables self-providing (2) Curiosity (12) Because fungi are amazing (1) Because of profession/education (3) For self (3)
	Solidarity with animals (23)	Reduction of meat consumption (4) Meat replacement (7) To not support meat industry (1) To avoid environmental issues associated with meat (1) Animal rights/welfare/suffering (10)
	Social implications (3)	Advantages for societies in crisis (1) Food security for everyone (2)
	Moral (10)	Global solidarity (2) Ethics (1) Future generations (6) To introduce fungi-food production everywhere (1)
	Origin of products (5)	Local production (4) If no transportation (1)
	Implications of origin (2)	Local value chains (1) Local jobs (1)
	Expenses (12)	Economically beneficial (5) Cheap (4) Cost/price (3)
	Sensory characteristics (27)	Taste (21) Structure (1) Texture (1) Unicity (1) Flavor (1) Consistence (1) Meat-like consistence (1)
	Convenience (2)	Potential of fungi to make edible food (2)
	Practicality (8)	For baking (1) Preserve food (1) Practicality (1) If recipes and good dishes are available (2) Fungi-based food is good (3)
	Information (7)	Knowing why/how fungi-based food is part of circular economy (1) Requiring knowledge about calories (1)
	Knowledge (5)	Do not know what fungi-based food is (1) Do not know the range of fungi-based food (1) Do not know/no idea (2) Require more research (1)

Table A1. *Cont.*

	Thematic Group (n) ¹	Subgroup (n) ²	Aspects within Group (n) ³
Drivers of home cultivation	Environment (12)	Climate change (1)	Climate change (1)
		Environmental benefits (4)	Environmentally beneficial (4)
		Actions (1)	Usage of fungi to upcycle/improve (1)
		Implications (4)	Leftover usage (1) Food waste reduction/avoidance (3)
		Incentives (2)	Resource recovery (1) Circular economy (1)
	Health-related demands (9)	Wholesome/good (1)	Wholesome/good (1)
		Healthier (1)	Healthier (1)
		Knowledge of composition (1)	Knowledge of composition (1)
		Nutritional incentives (6)	Increased nutritional value (1) Protein source (4) Calories (1)
	Choices & interests (64)	Personal interests (3)	Previous consideration (2) Education/professional background (1)
		Curiosity (24)	Willingness to try/test (9) Interest (8) Curiosity (7)
		Expectations (11)	Fun (6) Exciting (2) Sense of pride (1) Social activity with friends (1) Sense of independence (1)
		Origin (3)	Local production (3)
		Sensory characteristics (2)	Good taste (2)
		Convenience (10)	Good, useful (1) Likable (1) Produce own food (8)
		Utility (8)	Joy in gardening/planting (5) Joy in fermenting/pickling (3)
		Practicality (3)	Nice for cooking (1) Variation (1) Good alternative (1)

Table A1. *Cont.*

	Thematic Group (n) ¹	Subgroup (n) ²	Aspects within Group (n) ³
Barriers to home cultivation	Environment (1)	Rather reduce food waste than cultivate (1)	Rather reduce food waste than cultivate (1)
	Health-related aspects (10)	Safety (10)	Safety/health/allergies (5) Contamination (5)
	Choices & interests (39)	Expectations (3)	Cumbersome/difficult (3)
		Disinterest (6)	Disinterest (2) Preferred purchase (3) Not as replacement for all dietary habits (1)
		Individual deterrents (2)	Lazy (2)
		Economic (1)	If not expensive (1)
		Convenience (23)	Work intensity (2) Space/special conditions (7) Time (8) If easy/simple (6)
		Utility (4)	Dislike of cooking (1) Lack of gardening skills/skills with plants (3)
	Information (4)	Knowledge dependent (4)	Require instructions (4)

¹ Sum of mentions of aspects that form thematic group. ² Sum of mentions of aspects that form subgroup. ³ Number of mentions for each aspect.

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