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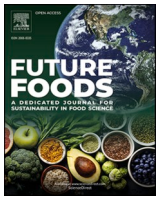

A cross-cultural comparison to find the most promising protein sources for milk and cheese alternatives among four European countries

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ABSTRACT

The transition to more sustainable diets can be facilitated by substituting milk and cheese with plant-based alternatives. To increase the consumption of milk and cheese alternatives, it is important to understand which protein sources are most accepted by consumers. An online survey was conducted in Finland, Germany, Italy, and Serbia (N = 2036) to assess consumer expectations regarding the taste, healthiness, and environmental friendliness of various protein sources for milk and cheese alternatives. The study also explored the influence of consumption contexts and consumer characteristics on the willingness to substitute milk and cheese. Nuts, including almond, hazelnut, and cashew, were identified as the most promising protein sources across all countries. The study further showed that participants were more willing to substitute milk than cheese and that they were particularly open to substituting milk in coffee. Additionally, individuals with lower food neophobia levels and those who considered health and ecological welfare as important attributes were more likely to substitute. It is recommended that producers and marketers of milk and cheese alternatives focus on preferred protein sources and promote these alternatives for consumption contexts in which substitution is more likely to occur. Through these strategies, familiarity with milk and cheese alternatives is increased and greater acceptance is fostered.

Introduction

A transition from animal-based to plant-based proteins is necessary to reduce the environmental impact of our food system (Aiking, 2014; Clune et al., 2017). One strategy to achieve this is to substitute milk and cheese with plant-based alternatives. Recent research has focused on novel protein extraction and manufacturing techniques to improve the sensory and nutritional attributes of milk and cheese alternatives (Bocker and Silva, 2022; Sethi et al., 2016). This has led to a substantial increase in the diversity of protein sources used in such products, including different types of nuts, seeds, grains, and legumes. Despite the rapid growth and increasing interest in milk and cheese alternatives, their market share within the broader dairy category remains relatively low. To illustrate, in 2022, the market share of milk alternatives accounted for merely 11 % of the total milk category in Europe (Good Food Institute, 2023). The market share of cheese alternatives was even lower, representing only 0.5 % of the total cheese category in Europe in 2022 (Good Food Institute, 2023). The lack of consumer acceptance of dairy alternatives represents a significant obstacle to their widespread adoption (Giacalone et al., 2022). To overcome this challenge, it is essential to gain a deeper understanding of consumers' expectations and attitudes toward milk and cheese alternatives, and to take these insights into account during the product development and marketing process.

While previous studies have examined the acceptance of different protein sources for meat alternatives (Chia et al., 2024; Etter et al., 2024b), the acceptance of protein sources for dairy alternatives remain relatively unexplored. The present study addresses this research gap by assessing consumers' expectations of a wide range of alternative protein sources for use in milk and cheese alternatives with the objective of identifying the most promising ones. In addition, the study explores consumers' willingness to substitute milk and cheese in different consumption contexts and investigates the influence of consumer characteristics.

Since cultural and geographical factors have a strong influence on food choice and preferences (Rozin, 1988), this study compares four European countries with different culinary traditions: Finland, Germany, Italy and Serbia. These countries were chosen to represent the north, east, south and west of Europe, while showing notable differences

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in dairy consumption patterns. According to the Statista platform, Finland's and Germany's per capita dairy consumption (66-67 kg milk/-year, 21 kg cheese/year) are higher than that of Italy (51 kg milk/year, 16 kg cheese/year) and Serbia (28 kg milk/year, 7 kg cheese/year). Despite the generally lower consumption rates, the current market situation for milk and cheese alternatives also varies between the four countries. Germany emerged as the most important market for milk alternatives within the EU in 2024, with a per capita consumption rate of 4.9 kg/year. In contrast, the per capita consumption of milk alternatives in Italy and Finland was 2.8 and 2.9 kg/year, respectively, whereas in Serbia it was only 0.4 kg/year. Consumption rates of cheese alternatives are very low across all countries (0.0-0.1 kg/capita/year) (Statista, 2025). Currently, the most common protein sources used in the production of dairy alternatives in Europe include oat, soy, and almond (Siegrist et al., 2024). However, an understanding of consumer preferences for a range of potential protein sources could contribute to the growth of the milk and cheese alternatives market in each respective country.

The role of product-related factors in the acceptance of dairy alternatives

One of the main barriers for the acceptance of dairy alternatives is their sensory quality, which is often perceived as inferior to that of conventional dairy products (Jaeger et al., 2023). The use of plant proteins in dairy alternatives often results in undesirable off-flavors and a grainy or gritty mouthfeel (Mittermeier-Klessinger et al., 2021; Sethi et al., 2016). For example, soy milk, one of the earliest and most common milk alternative, is associated with beany and painty off-flavors (Jaeger and Giacalone, 2021; Moss et al., 2022). However, the flavor profile of milk alternatives strongly depends on the protein source used (Cardello et al., 2022), and with the current increasing variety of protein sources, a wider range of flavor options has become available, including nutty, cereal, and sweeter notes (Vaikma et al., 2021). Expectations created by the ingredients of a product have been shown to influence how the product is perceived after consumption (Piqueras-Fiszman and Spence, 2015). This effect can work in both directions; positive expectations can increase the acceptance and actual liking of a product, while negative expectations can lead to decreased liking (Piqueras-Fiszman and Spence, 2015; Wansink, 2003). By understanding consumer expectations of different protein sources, marketing strategies, such as effective labeling, can be tailored to increase the acceptance of milk and cheese alternatives.

The perceived health and environmental benefits of milk alternatives in comparison to conventional cow milk are important drivers for individuals who regularly consume such alternatives (Haas et al., 2019; McCarthy et al., 2017). However, not all milk alternatives are perceived to be equally healthy and environmentally friendly, and the protein ingredient plays an important role in this regard (Ammann et al., 2023; Giacone et al., 2024). For example, Ammann et al. (2023) found that milk alternatives made from almonds, oats, or rice are perceived as healthier and more environmentally friendly than those made from soy. A limitation of this and other consumer studies is the comparison of only a small number of protein sources and primary focus on milk alternatives or other plant-based beverages. The present study adds to the literature by comparing consumer perceptions of a much wider range of protein sources for both milk and cheese alternatives.

The role of consumer-related factors in the acceptance of dairy alternatives

In addition to product-related factors, the acceptance of dairy alternatives is also influenced by multiple consumer-related factors (Giacalone et al., 2022). One such factor is food neophobia, a personality trait that can be defined as the tendency to avoid new or unfamiliar foods (Pliner and Hobden, 1992). Previous studies have found that high food neophobia levels are associated with lower acceptance of alternative proteins (Jaeger and Giacalone, 2021; Michel et al., 2021). Food neophobia is not only related to the willingness to try unfamiliar foods but also influences the expected liking of food (Siegrist et al., 2013); individuals with high levels of food neophobia tend to rate the tastiness of unfamiliar food as less pleasant compared to individuals with lower levels of food neophobia. This effect has also been observed by Pramudya et al. (2019), who found a negative correlation between food neophobia and the liking of rice-based milk alternatives. Moreover, Jaeger and Giacalone (2021) showed that food neophobia acts as a barrier to the consumption of various beverages, including plant-based drinks. Given the recent introduction and novelty of milk and, in particular, cheese alternatives, it is expected that food neophobia levels will influence the acceptance and willingness to consume these alternatives.

In addition to food neophobia, food choice motives, that is, the perceived importance of different factors in food choice (Steptoe, 1995), could act as either barriers or drivers for the consumption of milk and cheese alternatives. Previous studies which have examined the role of food choice motives in the context of meat alternatives and sustainable diets have found that higher interest in the health and natural content of foods, as well as higher concern for environmental issues, are associated with sustainable food consumption (Hoek et al., 2011; Marty et al., 2022; Verain et al., 2015). In the context of dairy alternatives, it has also been found that users of milk alternatives place a higher value on animal welfare and environmental protection compared to non-users (Haas et al., 2019; Halme et al., 2023). Other common motivations for the consumption of milk alternatives are health-related, such as better digestibility as well as allergen- and lactose-free attributes (Haas et al., 2019; McCarthy et al., 2017). The importance of different food choice motives varies between individuals and, at a higher level, between countries (Markovina et al., 2015). Therefore, understanding the influence of food choice motives on the willingness to consume milk and cheese alternatives in different countries can contribute to the development of more effective strategies to promote these products.

Aims of the present study

The present study aims to evaluate the acceptance of a wide range of protein sources for use in milk and cheese alternatives by measuring consumers' expectations regarding taste, healthiness, and environmental friendliness. To investigate whether consumer preferences for protein sources differ between cultural regions, the study compares four European countries: Finland, Germany, Italy, and Serbia. In addition, the study explores consumers' willingness to substitute milk and cheese with plant-based alternatives in different consumption contexts. Finally, the influence of socio-demographics, food neophobia, and food choice motives on the willingness to substitute milk and cheese are compared across the four countries.

Methods

Study participants

The data for this study was collected through an online survey in Finland, Germany, Italy, and Serbia. The participants were recruited via a commercial panel provider (Bilendi & Respondi AG, Cologne, Germany) and were compensated according to the reimbursement policy of the panel provider. To participate in the study, respondents were required to be at least 20 years of age. Quotas were set for age and sex in order to ensure an equal distribution between age groups. Incomplete responses ($n = 185$) and data from respondents who completed the survey in less than half of the median duration ($n = 125$) were excluded from the final dataset. The present study focused only on individuals who consume dairy products, as they represent the target group for the dietary transition. Therefore, those who indicated that they are vegan were also excluded from the analysis ($n = 24$).

The resulting study sample consisted of 2036 participants, of whom 530 were from Finland, 496 from Germany, 511 from Italy, and 499

from Serbia. The mean age of the total sample was 46 years (SD = 15), and 51 % of the participants were female. The participants exhibited diverse educational backgrounds, with the highest level of education reported as no degree for 1 % of the sample, compulsory education for 19 %, further education for 58 %, and higher education for 22 %. The majority of the participants identified themselves as omnivores (77 %) or flexitarians (22 %), while only a few participants indicated that they are pescetarians (3 %) or vegetarians (2 %). The characteristics of the study participants per country sample are presented in Table 1. Standardized quotas for age and gender allow for cross-country comparisons due to balanced demographics. However, it should be noted that the study samples may not align perfectly with the national census data of the respective countries. Furthermore, the education levels are slightly biased toward higher education, possibly due to the online recruitment process. Germany has a relatively higher proportion of flexitarians compared to the other countries, a finding that has also been observed in other studies (Bayudan et al., 2025).

Survey procedure

The survey was initially drafted in English and then translated into Finnish, German, Italian, and Serbian. To ensure that the original context was accurately conveyed, a back-translation was performed. The forward-and-backward translations were conducted by independent native speakers of the four abovementioned languages. The translated versions were distributed online using the Qualtrics software (Qualtrics, Provo, UT, USA). The survey began with the collection of demographic data from the participants, including their age, sex, educational background, self-identified dietary style, and food allergies. The response options for dietary style were defined in the following manner: omnivore (I regularly eat meat), flexitarian (I only eat meat rarely), pescetarian (I do not eat meat, but fish and seafood), vegetarian (I eat neither meat nor fish and seafood), and vegan (I eat no animal-based products at all). The remainder of the survey was structured into three sections. The first section involved a protein source rating task for milk and cheese alternatives, the second section assessed consumers' willingness to substitute milk and cheese in different consumption contexts, and the final section included several questions related to food consumption behavior.

Table 1
Characteristics of the study participants for each country sample.

Country	*n*	Age Mean (SD)	Sex	Dietary style	Food allergies/ intolerances
Finland	530	46 (15)	51 % female 49 % male	87 % omnivore 9 % flexitarian 3 % pescetarian 1 % vegetarian	15 % milk/lactose 1 % soy 4 % tree nuts/ peanuts 81 % none of the above
Germany	496	45 (15)	51 % female 49 % male	55 % omnivore 38 % flexitarian 3 % pescetarian 4 % vegetarian	4 % milk/lactose < 1 % soy 3 % tree nuts/ peanuts 92 % none of the above
Italy	511	45 (15)	50 % female 50 % male	79 % omnivore 17 % flexitarian 2 % pescetarian 1 % vegetarian	9 % milk/lactose < 1 % soy 3 % tree nuts/ peanuts 88 % none of the above
Serbia	499	46 (14)	53 % female 47 % male	71 % omnivore 27 % flexitarian 2 % pescetarian 1 % vegetarian	5 % milk/lactose < 1 % soy 2 % tree nuts/ peanuts 92 % none of the above

Protein source rating task for milk and cheese alternatives

The objective of the rating task was to evaluate consumer acceptance of different protein sources that can be used to make milk and cheese alternatives. A preliminary screening of potential protein sources for inclusion in the assessment was conducted based on a market analysis and a literature search. The results of this screening were discussed and refined with multiple experts in the field of food science, leading to a final selection of a wide range of nuts, seeds, grains, and legumes. For the evaluation of milk alternatives, a total of 12 protein sources were selected, including almond, hazelnut, cashew, coconut, flaxseed, hemp, quinoa, rice, potato, soy, oat, and peas. For the evaluation of cheese alternatives, the following five protein sources were selected: almond, cashew, soy, oat, and chickpea. These protein sources were selected in order to include a wide variety of plant species and varying degrees of familiarity. A few of the selected protein sources are commonly found in commercially available milk and cheese alternatives throughout Europe (e.g., almond, soy, and oat), so participants may be more familiar with them. However, others may not be as widely recognized because they have not yet been introduced to the market in all European countries (e.g., flaxseed, hemp, and quinoa). To serve as benchmarks for comparison, cow milk and conventional cheese were also included in the assessment.

In the beginning of the rating task, participants were provided with the following definition of milk and cheese alternatives: "Plant-based milk and cheese alternatives are products made from a wide variety of plant sources, including nuts, seeds, grains, and legumes, that can be consumed as a replacement for cow milk and conventional cheese. The different products available vary in nutritional content, flavor, color, and texture." The participants then rated the 12 protein sources for milk alternatives in terms of expected taste by answering the following question: "How tasty do you expect plant-based milk alternatives made from the following protein sources to be?" The responses were rated on a semantic differential continuous slider (from 0 = not tasty at all to 100 = very tasty). Thereafter, the protein sources were rated based on expected healthiness (from 0 = not healthy at all to 100 = very healthy) and expected environmental friendliness (from 0 = not environmentally friendly at all to 100 = very environmentally friendly). Subsequently, the participants rated the five protein sources for cheese alternatives, as well as cow milk and conventional cheese, based on the same three dimensions.

Willingness to substitute milk and cheese

The next part of the survey involved an assessment of the willingness to substitute milk and cheese in different consumption contexts. Participants were asked the following question: "How open are you to replacing the dairy in the following foods with a plant-based alternative?" The items that followed presented two milk replacements and two cheese replacements: "milk in coffee," "milk in hot cocoa," "cheese on a pizza," and "cheese in a sandwich." The participants rated their responses on a semantic differential continuous slider (from 0 = not open at all to 100 = very open).

Food consumption behavior

The final part of the survey was designed to obtain data regarding food consumption behavior. First, the participants were asked how often they consume cow milk, conventional cheese, plant-based milk alternatives, and plant-based cheese alternatives. The consumption frequency was measured on a 5-point scale (1 = daily, 2 = 4–6 times per week, 3 = 1–3 times per week, 4 = 1–3 times per month, and 5 = rarely or never).

Next, food neophobia (i.e., the tendency to avoid new or unfamiliar

foods) was assessed by using the 10-item Food Neophobia Scale developed by Pliner and Hobden (1992). Examples of items on the scale are "I don't trust new foods" and "I am afraid to eat things I have never had before." The level of agreement with each item was indicated on a 7-point Likert scale (1 = do not agree at all, 7 = fully agree).

Finally, food choice motives were assessed by using the Food Choice Questionnaire developed by Steptoe (1995), complemented with the Ecological Welfare Scale developed by Lindeman and Väänänen (2000). The Food Choice Questionnaire is a multidimensional measure comprising 36 items designed to assess nine distinct motives that influence food choices. The Ecological Welfare Scale consists of an additional five items. To ensure scale validity, all items from the Ecological Welfare Scale and the Food Choice Questionnaire were included in the survey, except for Steptoe's (1995) ethical concern items. However, further analysis only focused on the motives of health, ecological welfare, and natural content, as they were of particular interest to the present study. The selected subscales included items such as "it is important to me that the food I eat on a typical day …keeps me healthy," "…has been prepared in an environmentally friendly way," and "… contains no additives." The items were measured on a 5-point Likert scale (1 = do not agree at all, 5 = fully agree).

Reliability analyses revealed high internal consistencies for the food neophobia scale and food choice motive subscales across all countries, with Cronbach's alpha coefficients ranging from .73 to .90 (Table 2).

Data analysis

Separate repeated measures ANOVAs were conducted to examine the effects of protein source and country on the expected taste, healthiness, and environmental friendliness ratings of milk and cheese alternatives. Cousineau–Morey adjusted confidence intervals (Baguley, 2012) were calculated to enable within-country comparisons of the protein source ratings. Additional ANOVAs were conducted to investigate the effects of consumption context and country on the willingness to substitute milk and cheese. Again, the confidence intervals of the ratings were adjusted using the Cousineau–Morey correction to enable within-country comparisons of different consumption contexts.

A correlation analysis was performed to analyze the relationships between the willingness to substitute milk and cheese and consumer characteristics (age, gender, food neophobia, and food choice motives) (Table 3). Multiple linear regression models were used to identify the most important drivers of the willingness to substitute milk and cheese in each country. The dependent variable of willingness to substitute milk was the mean score of the two milk replacement items (i.e., milk in coffee and milk in hot cocoa). Similarly, the dependent variable of willingness to substitute cheese was the mean score of the two cheese replacement items (i.e., cheese on a pizza and cheese in a sandwich). The use of the mean scores was justified by the high internal consistency of the milk replacement (α = .87–.90) and cheese replacement (α = .83–.95) items across all countries (Table 2). The independent variables included in both regression models were age, sex, food neophobia level, and the food choice motives of health, ecological welfare, and natural content.

Data analysis was performed using IBM SPSS Statistics, Version 29.0 (IBM Corp. Armonk, NY, USA).

Results

The most promising protein sources for milk alternatives

The ANOVA on the expected taste ratings of milk alternatives demonstrated significant main effects of both protein source ($F(12, 24384) = 573.60$, $p < .001$, $\eta_p^2 = .22$) and country ($F(3, 2032) = 38.47$, $p < .001$, $\eta_p^2 = .05$). The interaction between country and protein source was also significant ($F(36, 24384) = 31.69$, $p < .001$, $\eta_p^2 = .05$). In general, the taste expectations of milk alternatives were lower than those of cow milk, regardless of the protein source used. However, compared to the other three countries, this contrast was less pronounced in Italy, where the expectations of the highest-rated alternative proteins sources (i.e., almond and hazelnut) did not significantly differ from those of cow milk. Across all four countries, participants expected nuts, including almond, hazelnut, and cashew, to be the tastiest protein sources for milk alternatives. Additionally, high taste expectations were observed for oats in Finland, and for coconut in Germany, Italy, and Serbia. Overall, seeds, including hemp and flaxseed, were expected to be the least tasty protein sources for milk alternatives, along with quinoa and soy (Fig. 1).

The expected healthiness ratings were found to be significantly influenced by the protein source ($F(12, 24384) = 153.89$, $p < .001$, $\eta_p^2 = .07$) and country ($F(3, 2032) = 16.61$, $p < .001$, $\eta_p^2 = .02$). The analysis revealed a significant interaction between country and protein source ($F(36, 24384) = 35.32$, $p < .001$, $\eta_p^2 = .05$). In comparison to the expected taste ratings, the expected healthiness ratings of the alternative protein sources demonstrated less variability and smaller contrasts to the ratings for cow milk. In Germany, cow milk was perceived as the healthiest option, whereas in the other countries, specific alternative proteins were perceived as equally healthy or healthier than cow milk: oats in Finland, almond, hazelnut, rice, potato, oats, and peas in Italy, and almond and coconut in Serbia. Hemp was considered to be the least healthy protein source for milk alternatives across all countries (Fig. 1).

With regard to the expected environmental friendliness ratings, the results once again revealed significant main effects of both protein source ($F(12, 24384) = 81.21$, $p < .001$, $\eta_p^2 = .04$) and country ($F(3, 2032) = 47.78$, $p < .001$, $\eta_p^2 = .07$) as well as a significant interaction between country and protein source $F(36, 24384) = 47.73$, $p < .001$, $\eta_p^2 = .07$). In Italy, all alternative protein sources were perceived as more environmentally friendly than cow milk. Similarly, in Germany, there was an overall perception that alternative protein sources were equally or more environmentally friendly. In contrast, in Serbia, all protein sources except almond, hazelnut, and coconut, were perceived as less environmentally friendly than cow milk. In Finland, there was a greater variability in the protein source ratings observed, with some protein

Table 2
Means and reliability scores for food neophobia, consumer food choice motives, and willingness to substitute milk and cheese.

	Finland (n = 530)		Germany (n = 496)		Italy (n = 511)		Serbia (n = 499)	
	Mean (SD)	α	Mean (SD)	α	Mean (SD)	α	Mean (SD)	α
Food neophobia	3.3 (1.2)	.88	3.3 (1.1)	.81	3.7 (1.0)	.81	3.4 (1.0)	.73
FCM ecological welfare	3.4 (0.9)	.90	3.8 (0.9)	.89	4.0 (0.8)	.90	3.6 (1.0)	.87
FCM health	3.7 (0.8)	.89	3.8 (0.8)	.84	4.0 (0.7)	.85	4.0 (0.7)	.83
FCM natural content	3.6 (1.0)	.88	3.9 (0.9)	.86	4.1 (0.8)	.82	4.2 (0.9)	.80
Willingness to substitute milk[a]	51.8 (36.1)	.88	51.0 (37.3)	.89	54.7 (34.4)	.90	57.9 (34.9)	.87
Willingness to substitute cheese[b]	28.9 (29.5)	.88	40.6 (35.7)	.95	46.0 (32.5)	.83	44.3 (34.1)	.90

Note: α = Cronbach's alpha.

[a] Willingness to substitute milk represents the mean score for replacing milk in coffee and milk in hot cocoa.

[b] Willingness to substitute cheese represents the mean score for replacing cheese on a pizza and cheese in a sandwich. Food neophobia was measured on a scale from 1 to 7 and food choice motives (FCM) on a scale from 1 to 5. Willingness to substitute milk and cheese was measured on a scale from 0 to 100.

Table 3
Correlations between the study variables.

	Finland (n = 530)	1	2	3	4	5	6	7	8
1	Age	1							
2	Sex[a]	.01	1						
3	Food neophobia	.06	-.05	1					
4	FCM ecological welfare	**.13****	**.23****	**-.12****	1				
5	FCM health	**.14****	**.16****	**-.11***	**.58****	1			
6	FCM natural content	**.26****	**.15****	-.05	**.60****	**.67****	1		
7	Willingness to substitute milk[b]	**-.14****	**.19****	**-.36****	**.24****	**.14****	**.09***	1	
8	Willingness to substitute cheese[c]	-.06	**.10***	**-.25****	**.28****	**.19****	**.15****	**.57****	1
	Germany (n = 496)								
1	Age	1							
2	Sex[a]	.01	1						
3	Food neophobia	**.13****	-.02	1					
4	FCM ecological welfare	**.23****	.03	**-.16****	1				
5	FCM health	**.11***	.01	**-.13****	**.62****	1			
6	FCM natural content	**.28****	-.01	-.03	**.64****	**.68****	1		
7	Willingness to substitute milk[b]	**-.24****	**.10***	**-.28****	**.25****	**.22****	.08	1	
8	Willingness to substitute cheese[c]	**-.21****	.06	**-.23****	**.29****	**.25****	.08	**.69****	1
	Italy (n = 511)								
1	Age	1							
2	Sex[a]	-.02	1						
3	Food neophobia	**.16****	**-.09***	1					
4	FCM ecological welfare	**.19****	**.14****	-.06	1				
5	FCM health	**.17****	.05	-.04	**.67****	1			
6	FCM natural content	**.27****	.04	.02	**.71****	**.74****	1		
7	Willingness to substitute milk[b]	**-.10***	**.17****	**-.24****	**.21****	**.22****	**.12****	1	
8	Willingness to substitute cheese[c]	**-.12****	**.16****	**-.17****	**.19****	**.16****	.07	**.66****	1
	Serbia (n = 499)								
1	Age	1							
2	Sex[a]	.00	1						
3	Food neophobia	.01	.06	1					
4	FCM ecological welfare	**.15****	**.25****	.04	1				
5	FCM health	.06	**.13****	-.01	**.60****	1			
6	FCM natural content	**.21****	**.14****	.02	**.53****	**.65****	1		
7	Willingness to substitute milk[b]	.05	**.18****	**-.15****	**.18****	**.20****	**.11***	1	
8	Willingness to substitute cheese[c]	.04	**.18****	-.06	**.27****	**.20****	**.14****	**.60****	1

Note: Correlations are significant at *$p < .05$, **$p < .01$. FCM = Food choice motives.
[a] Sex: 1 = female, 0 = male.
[b] Willingness to substitute milk represents the mean score for replacing milk in coffee and milk in hot cocoa.
[c] Willingness to substitute cheese represents the mean score for replacing cheese on a pizza and cheese in a sandwich.

sources considered to be more environmentally friendly than cow milk and others less. In this country, oats, peas, and potatoes received the highest ratings in terms of environmental friendliness, and soy the lowest (Fig. 1).

The most promising protein sources for cheese alternatives

The ANOVA on the expected taste ratings of cheese alternatives demonstrated significant effects of protein source ($F(5, 10160) = 1210.40$, $p < .001$, $\eta_p^2 = .37$) and country ($F(3, 2032) = 43.34$, $p < .001$, $\eta_p^2 = .06$). The interaction between country and protein source was also significant ($F(15, 10160) = 36.42$, $p < .001$, $\eta_p^2 = .05$). In all countries, conventional cheese was given significantly higher ratings in terms of expected taste compared to all alternative protein sources. As with milk alternatives, the participants expected nuts, such as almond and cashew, to also be the tastiest protein sources for cheese alternatives. In addition, oats were particularly favored in Finland (Fig. 2).

Similarly, the expected healthiness ratings were found to be significantly influenced by the protein source ($F(5, 10160) = 144.99$ $p < .001$, $\eta_p^2 = .07$) and country ($F(3, 2032) = 31.01$, $p < .001$, $\eta_p^2 = .04$). The interaction between country and protein source was again significant ($F(15, 10160) = 19.99$, $p < .001$, $\eta_p^2 = .03$). As for the expected environmental friendliness ratings, the findings once again revealed a significant effect of protein source ($F(5, 10160) = 82.92$, $p < .001$, $\eta_p^2 = .04$) and country ($F(3, 2032) = 58.42$, $p < .001$, $\eta_p^2 = .08$) as well as a significant interaction between country and protein source ($F(15, 10160) = 30.60$, $p < .001$, $\eta_p^2 = .04$). In Germany, Finland, and Serbia, conventional cheese was perceived as significantly healthier than all plant-based alternatives. However, this contrast was less pronounced compared to the expectations regarding taste. In Italy, only cheese alternatives based on soy and cashew protein were perceived as less healthy than conventional cheese, while the other alternative protein sources (almond, chickpea, and oats) were perceived as equally healthy (Fig. 2).

With regard to the environmental friendliness expectations of the protein sources for cheese alternatives, similar trends were observed to those in the context of milk alternatives. In Italy, all protein sources were perceived as equally or more environmentally friendly than conventional cheese, whereas in Serbia, they were all perceived as less environmentally friendly. In Finland and Germany, only oat-based cheese alternatives were identified as significantly more environmentally friendly than conventional cheese. Soy was considered the least environmentally friendly protein source for cheese alternatives in these two countries (Fig. 2).

Consumption frequency of dairy and dairy alternatives

The current consumption rates of dairy and plant-based dairy

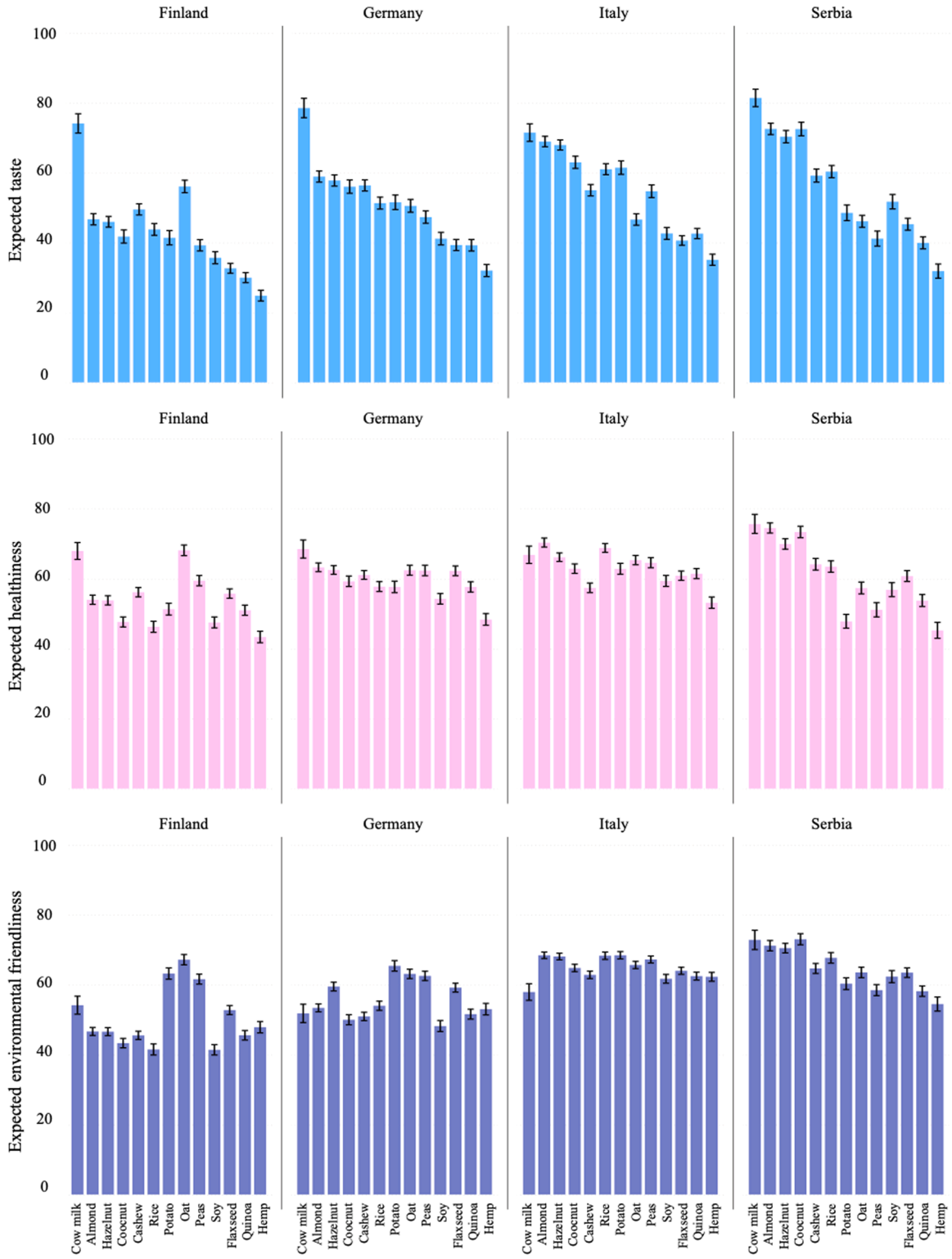

Fig. 1. Means and 95 % confidence intervals of the taste, healthiness, and environmental friendliness expectations of cow milk and the different protein sources for milk alternatives in Finland (n = 530), Germany (n = 496), Italy (n = 511), and Serbia (n = 499).
Note: Nonoverlapping confidence intervals indicate significant differences within each country sample ($p < .05$).

alternatives based on the self-reported data of the study participants are presented in Table 4. The highest rates of milk and cheese consumption were observed in Finland, where 56 % of the participants consume milk at least four times per week and 66 % consume cheese at least four times per week. In the remaining countries, 44 % of the participants consume milk at least four times per week, while 33 % to 51 % of the participants consume cheese at least four times per week. In contrast to dairy products, the consumption of plant-based dairy alternatives is relatively low in all countries. Half of the participants (48 %–51 %) indicated that they rarely or never consume plant-based milk alternatives. Plant-based cheese alternatives are consumed even less frequently, with the percentage of participants rarely or never consuming them ranging from 47

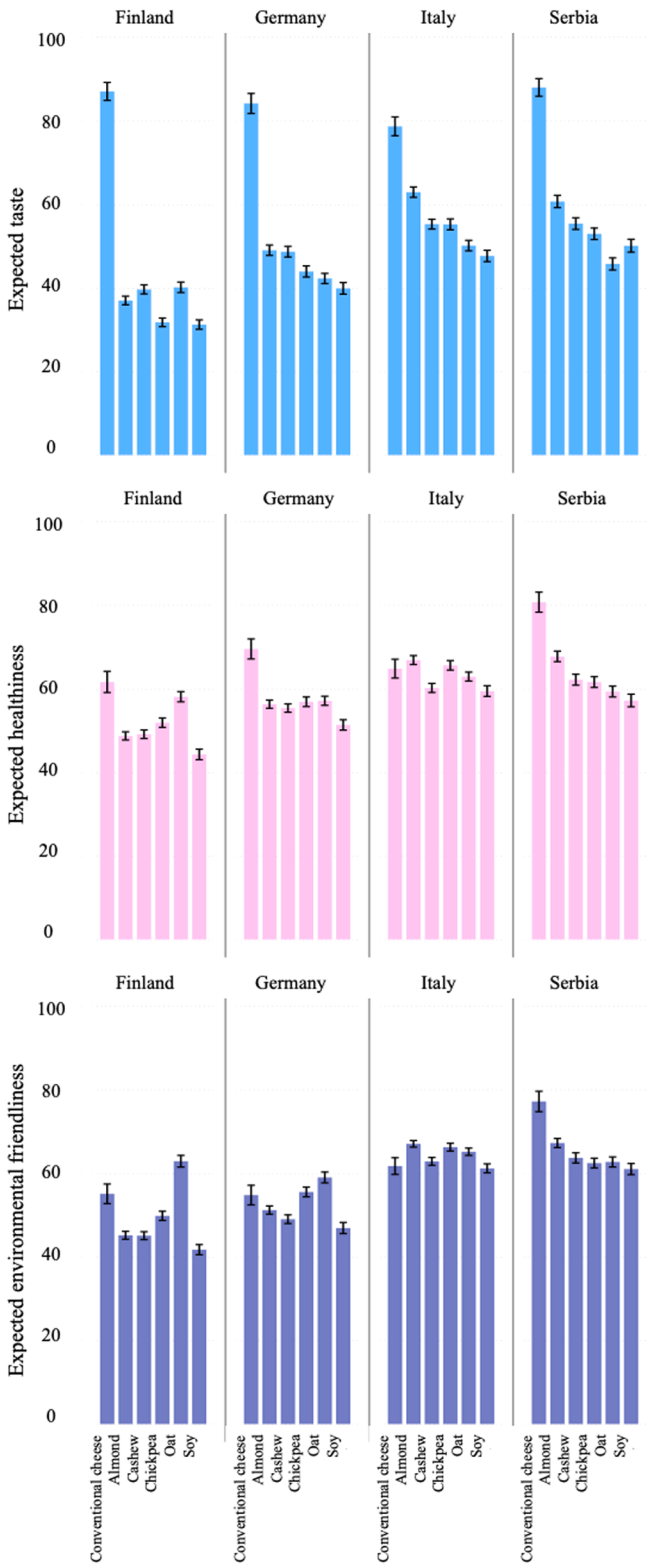

Fig. 2. Means and 95 % confidence intervals of the taste, healthiness, and environmental friendliness expectations of conventional cheese and the different protein sources for cheese alternatives in Finland (n = 530), Germany (n = 496), Italy (n = 511), and Serbia (n = 499).
Note: Nonoverlapping confidence intervals indicate significant differences within each country sample (p < .05).

% (in Serbia) to 82 % (in Finland).

The influence of consumption context on the willingness to substitute dairy

The consumption context was found to have a significant effect on participants' willingness to substitute ($F(3, 6096) = 294.22$, $p < .001$, $\eta_p^2 = .13$). Furthermore, a significant effect was observed at the country level ($F(3, 2032) = 13.31$, $p < .001$, $\eta_p^2 = .02$). The interaction between country and consumption context was also significant ($F(9, 6096) = 18.43$, $p < .001$, $\eta_p^2 = .03$). Overall, participants across all countries demonstrated a greater willingness to substitute milk than to substitute cheese. In Finland, Germany, and Serbia, participants were most open to substituting milk in coffee, while in Italy, they were equally open to substituting milk in hot cocoa. With regard to the consumption context for cheese substitution, no significant differences were observed in Finland, Germany, and Serbia. However, in Italy, replacing cheese on a pizza was significantly less acceptable than replacing cheese in a sandwich. In general, participants in Germany and Italy were more open to substitute cheese compared to participants in Finland and Serbia (Fig. 3).

Consumer-related factors that drive the willingness to substitute dairy

Separate multiple linear regression analyses were conducted to identify the most important drivers for the willingness to substitute milk and cheese. In the first model, the dependent variable (i.e., willingness to substitute milk) represented the mean score of the willingness to replace milk in coffee and milk in hot cocoa (α = .87–.90). In the second model, the dependent variable (i.e., willingness to substitute cheese) represented the mean score of the willingness to replace cheese on a pizza and cheese in a sandwich (α = .83–.95). Although there was a strong correlation between the willingness to substitute milk and the willingness to substitute cheese (r = .57–.69)(Table 3), separate analyses were conducted for these variables, as milk and cheese are consumed in different contexts and situations. Both regression models were significant in all countries, explaining between 10 % and 21 % of the variance (Table 5).

The models revealed that, in general, females, younger individuals, and those with lower food neophobia levels demonstrated a greater willingness to substitute milk compared to males, older individuals, and those with higher food neophobia levels (Table 5). However, with regard to the willingness to substitute cheese, age was only significant in Germany and Italy, while sex was only significant in Italy and Serbia. Additionally, the food choice motives of health, ecological welfare, and natural content were identified as significant predictors, although notable differences were observed among the four countries and between milk and cheese. In Germany, all three motives emerged as significant predictors in both models. This indicates that individuals who attribute greater importance to the health and ecological welfare aspects of food, and less to the natural content, were more open to plant-based milk and cheese alternatives. In Finland, the primary factor influencing the willingness to substitute milk and cheese was the ecological welfare motive. Finally, in Italy and Serbia, the willingness to substitute milk was only significantly associated with the health motive, while the willingness to substitute cheese was influenced by the ecological welfare motive in Serbia, and by all three motives in Italy.

Discussion

The overall aim of the present study was to evaluate the potential of different protein sources for milk and cheese alternatives based on consumer expectations in four different countries. The results showed that there remains a gap in taste expectations between cow milk and plant-based milk alternatives, and even more so between conventional cheese and plant-based cheese alternatives. This presents a major barrier to the adoption of milk and cheese alternatives, as taste is one of the

Table 4
Consumption frequency of cow milk, plant-based milk alternatives, conventional cheese, and plant-based cheese alternatives. Number of participants (percentage).

	Finland (n = 530)				Germany (n = 496)				Italy (n = 511)				Serbia (n = 499)			
	Milk	PBMA	Cheese	PBCA	Milk	PBMA	Cheese	PBCA	Milk	PBMA	Cheese	PBCA	Milk	PBMA	Cheese	PBCA
Daily	226 (43 %)	50 (9 %)	243 (46 %)	2 (< 1 %)	144 (29 %)	44 (9 %)	88 (18 %)	10 (2 %)	165 (32 %)	47 (9 %)	59 (12 %)	12 (2 %)	130 (26 %)	13 (3 %)	96 (19 %)	9 (2 %)
4–6 times per week	66 (13 %)	28 (5 %)	104 (20 %)	11 (2 %)	75 (15 %)	39 (8 %)	162 (33 %)	29 (6 %)	60 (12 %)	42 (8 %)	108 (21 %)	24 (5 %)	88 (18 %)	29 (6 %)	116 (23 %)	25 (5 %)
1–3 times per week	81 (15 %)	84 (16 %)	104 (20 %)	27 (5 %)	118 (24 %)	83 (17 %)	148 (30 %)	55 (11 %)	99 (19 %)	73 (14 %)	217 (43 %)	74 (15 %)	137 (28 %)	79 (16 %)	170 (34 %)	64 (13 %)
1–3 times per month	58 (11 %)	102 (19 %)	52 (10 %)	58 (11 %)	71 (14 %)	75 (15 %)	63 (13 %)	82 (17 %)	69 (14 %)	103 (20 %)	84 (16 %)	102 (20 %)	63 (13 %)	129 (26 %)	71 (14 %)	166 (33 %)
Rarely or never	99 (19 %)	266 (50 %)	27 (5 %)	432 (82 %)	88 (18 %)	255 (51 %)	35 (7 %)	320 (65 %)	118 (23 %)	246 (48 %)	43 (8 %)	299 (59 %)	81 (16 %)	249 (50 %)	46 (9 %)	235 (47 %)

Note: Milk = Cow milk; PBMA = Plant-based milk alternatives; Cheese = Conventional cheese; PBCA = Plant-based cheese alternatives.

most important factors influencing consumer food choices (Clark, 1998). However, significant differences in taste expectations were observed between different protein sources. In general, nuts, including almonds, hazelnuts, and cashews, were expected to be the tastiest protein sources for milk and cheese alternatives across all countries. Almond is the third most common plant-based milk on the European market, after oat and soy (Siegrist et al., 2024). Therefore, it is possible that consumers are already more familiar with the use of almond as milk alternative compared to most of the other protein sources that were evaluated. This may be particularly true for consumers in Italy, where almond milk has a long-standing tradition in specific regions of the country. The regular use of almond milk may positively influence the acceptance of other plant-based milk alternatives among Italian consumers. Hazelnut- and cashew-based milk are more recent additions to the plant-based milk market and represent a smaller segment. However, consumers' high taste expectations for nut-based milk alternatives show that this sector has great potential for growth.

The present study also observed country-specific preferences for protein sources, such as the strong preference for oats in Finland. This may also be related to a high level of familiarity with the ingredient. Finland is one of the world's largest oat producers, and the country's traditional diet includes various oat-based products, such as porridge and oat bread (Salmenkallio-Marttila et al., 2011). Furthermore, oat milk dominates the plant-based milk market in Finland, holding a 75 % market share (Halme et al., 2023). Since familiarity plays an important role in the acceptance of novel foods (Tuorila and Hartmann, 2020), using well-known protein sources that are already accepted by consumers could be an effective approach to increase the acceptance of milk and cheese alternatives. Highlighting the protein ingredient on the front of the package might further promote these products, as positive associations with the protein ingredient could enhance the overall perception of the product (Aschemann-Witzel and Peschel, 2019; Piqueras-Fiszman and Spence, 2015).

Among a small segment of the population, there is a growing interest in plant-based dairy alternatives for health, ethical, and environmental reasons (Haas et al., 2019). However, in line with the findings of other consumer studies conducted in Switzerland (Giacone et al., 2024) and Austria (Haas et al., 2019), the results of the present study indicate that in Europe, milk and cheese alternatives are not always perceived as healthier or more environmentally friendly than conventional cow milk and cheese. This finding was particularly evident in Finland, Germany, and Serbia, while relatively positive ratings were given in Italy. These variations could be attributed to differences in traditional diets across geographical regions. Previous studies have shown that northern and western European countries have a higher reliance on dairy as a primary source of protein (Daas et al., 2025; de Boer et al., 2006), which may pose a significant challenge to the adoption of alternative protein sources. In contrast, Mediterranean countries have historically relied more on plant-based sources, such as vegetables and cereals (Daas et al., 2025; de Boer et al., 2006), which may facilitate the transition.

In general, negative attitudes toward milk and cheese alternatives may be related to their common association with highly processed foods, which negatively affects consumers' perceived naturalness of the product (Hartmann et al., 2022). Consumers often rely on the "natural-is-better" heuristic, which is a mental shortcut that leads to the perception of natural foods as being tastier, healthier, and more environmentally friendly, while the opposite effect is observed for "unnatural" processed foods (Román et al., 2017).

Another potential explanation for the negative perceptions of milk and cheese alternatives relates to cognitive dissonance, which refers to the discomfort individuals experience when their behavior is in conflict with their beliefs (Festinger, 1957). One way to reduce this cognitive dissonance is to align one's beliefs with one's behavior. For instance, individuals who consume milk and cheese may be aware of the environmental impact of dairy products. However, as they care about the environment, they may rationalize their dairy consumption by arguing

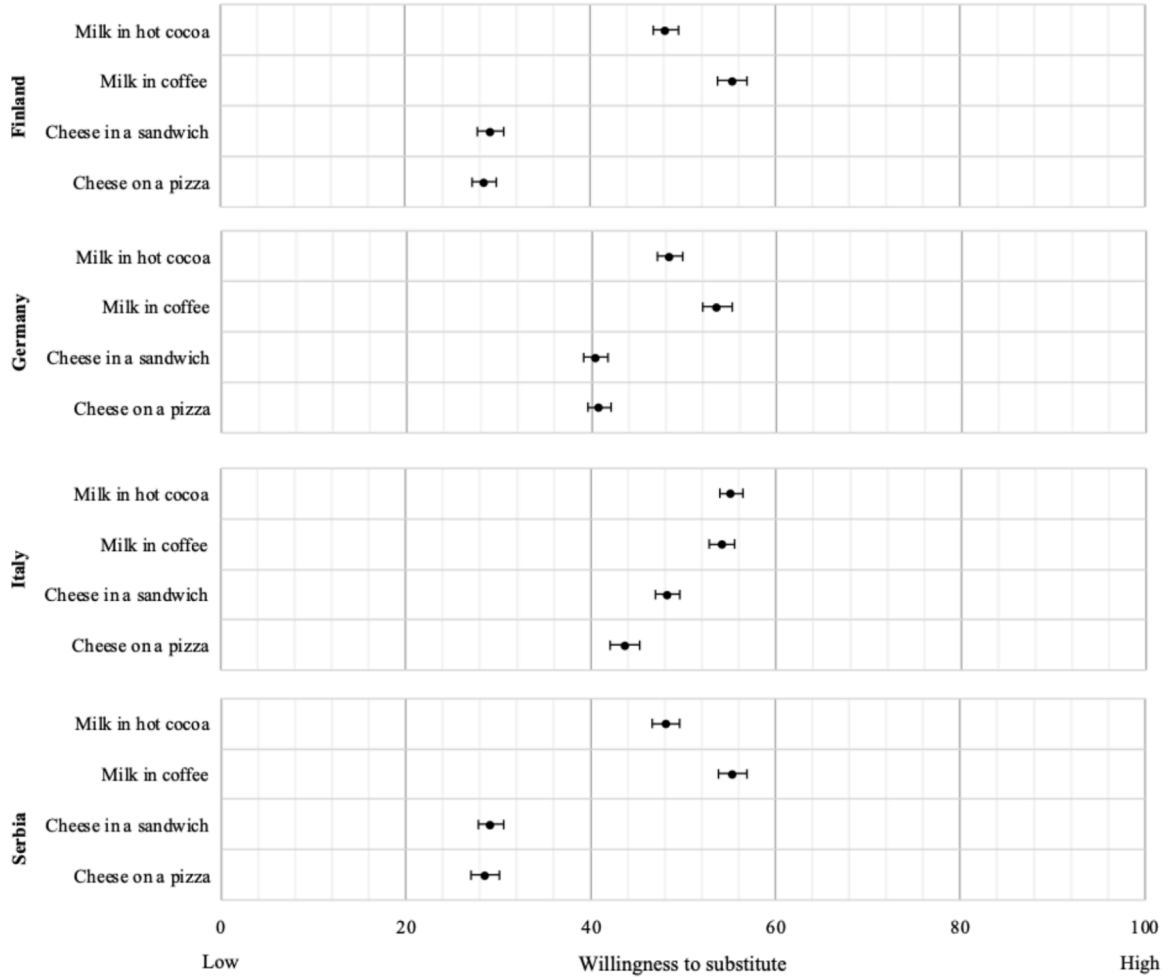

Fig. 3. Means and 95 % confidence intervals of the willingness to substitute milk and cheese in different consumption contexts in Finland (n = 530), Germany (n = 496), Italy (n = 511), and Serbia (n = 499).
Note: Nonoverlapping confidence intervals indicate significant differences within each country sample ($p < .05$).

that plant-based alternatives are even worse for the environment (Ammann et al., 2023).

Perceptions of the healthiness and environmental friendliness of milk and cheese alternatives varied greatly depending on the protein source used. Consistent with previous studies, consumers rated the healthiness and environmental friendliness of soy relatively low (Ammann et al., 2023; Giacone et al., 2024). These negative attitudes toward soy may be associated with consumer concerns about the estrogen content and GMOs (Tu et al., 2012). Moreover, soy production is often associated with deforestation, which can lead to a biased negative perception of the environmental impact of soy products (Siegrist and Hartmann, 2019). The acceptance of soy-based dairy alternatives may be higher in non-European countries, including those in Asia, where soy and soy-based products (e.g., tofu) are more integrated in traditional diets (Wassmann et al., 2024).

In addition to soy, seeds, including hemp and flaxseed, were among the least accepted protein sources for milk alternatives. Despite being identified as nutritional and environmental "superfoods" (Fernández-Ríos et al., 2022), the present study demonstrated their limited potential from a consumer perspective. There are several possible explanations for this. First, the limited use of hemp and flaxseed in currently available milk alternatives may have made it difficult for consumers to visualize the final product. Moreover, seeds may be associated with a source of fiber or fat (e.g., flaxseed oil) rather than protein, making them less appealing as milk alternatives. Finally, although hemp has a long history of food use, consumers may be less familiar with the ingredient after hemp cultivation declined significantly in Europe and nearly disappeared in the 20th century (Amaducci et al., 2015). Despite renewed interest after hemp was re-authorized in the European Union in the early 1990s, hemp remains a niche crop in Europe (Amaducci et al., 2015).

In addition to the intrinsic characteristics of the product (e.g., the protein ingredient), the present study showed that it is also important to consider external factors, such as the consumption context, when promoting milk and cheese alternatives. A study conducted by Etter et al. (2024a) found that consumers clearly differentiate cheese alternatives from conventional cheese, while milk alternatives are perceived as being more similar to cow milk. The authors' idea that products perceived as belonging to the same category are more likely to be substituted (Etter et al., 2024a) is supported by the findings of the present study. Across all countries, participants were more willing to substitute milk than cheese, and were particularly open to substituting milk in coffee. Moreover, the self-reported consumption rates indicated that the participants were already more familiar with milk alternatives than with cheese alternatives. Milk alternatives have been available for a longer period of time, whereas cheese alternatives are newer on the market. In addition, many cafés now offer milk alternatives (e.g., non-dairy lattes and cappuccinos based on oat- or almond-milk), that may have contributed to increased familiarity and, consequently, acceptance of milk alternatives. Therefore, it is recommended to promote the consumption of dairy alternatives in familiar contexts so that consumers can adopt them more easily.

While milk alternatives have advanced in terms of texture, flavor,

and nutritional content, cheese alternatives are still in the early stages of development, and food scientists are facing significant challenges in achieving desirable sensory and nutritional properties (Craig et al., 2022; Giacalone et al., 2022; Short et al., 2021). One technical challenge, for example, is replicating the smooth texture and meltability of cheese using plant-based ingredients (Short et al., 2021). Moreover, the important role of cheese in European culinary traditions is likely a contributing factor to consumers' reluctance to replace it. For instance, cheese is an integral part of Italian cuisine, often melted on pizza, grated over pasta dishes, or served as part of antipasti. In Finland, Germany, and Serbia, cheese is commonly consumed with bread or as part of a cold platter, often accompanied by meats or vegetables. While milk can be consumed on its own, which is a common practice in Finland, it is often used as a functional ingredient in food preparation or in other beverages, such as coffee. In contrast, cheese is often consumed independently and is more closely tied to cultural identity. Different cultures have developed many varieties of cheese, reflecting local techniques and preferences. This discrepancy in functionality and usage may explain why consumers are more open to replacing milk than cheese.

The regression models predicting the willingness to replace milk and cheese revealed that individual factors also play a role. Consistent with our hypothesis and previous research (Jaeger and Giacalone, 2021), the results showed that individuals with high food neophobia levels were less open to plant-based milk and cheese alternatives. One potential strategy for overcoming this barrier is to introduce familiar flavor profiles, as this has been shown to increase consumer liking and willingness to try unfamiliar foods (Stallberg-White and Pliner, 1999). This finding further supports the importance of focusing product development and marketing efforts for milk and cheese alternatives on already accepted protein sources and familiar consumption contexts.

A notable finding was the higher level of willingness to substitute cheese among German and Italian participants compared to Finnish and Serbian participants. In Finland and Serbia, the willingness to substitute cheese was mainly driven by environmental motives, while in Italy and Germany, health and the natural content were additional influencing factors. Dietary behavior is influenced by many factors, and in addition to key factors such as taste and price (Markovina et al., 2015), dietary messages and guidelines can also play a role in shaping consumption decisions. National dietary guidelines can help to promote healthy and sustainable diets, as they establish a basis for public food and nutrition policies and nutrition education programs. However, these guidelines differ across countries. For example, the Finnish dietary guidelines recommend two to three slices of cheese per day, while the Italian guidelines recommend only three portions of cheese per week (FAO, 2025).

Highlighting the health and environmental benefits of milk and cheese alternatives may be an effective strategy to facilitate their acceptance in certain consumer segments. However, as shown by the results of this study, many consumers remain skeptical about these benefits. Therefore, providing information on these benefits alone may not be enough to increase their wider acceptance; additional measures and interventions are needed for this. For example, nudging consumers towards plant-based choices and providing public cooking classes to improve people's skills in preparing healthy and tasty plant-based dishes could help to increase familiarity with and promote the use of dairy alternatives (M. Siegrist et al., 2024). The present study showed that younger consumers are more open to substitute milk and cheese. Therefore, educating this subgroup on how to maintain a healthy, balanced diet that includes plant-based alternatives may be particularly beneficial. Additionally, while not directly measured in this study, previous research has demonstrated that affordability significantly impacts the acceptance of milk and cheese alternatives (Adamczyk et al., 2022). Since plant-based alternatives are currently more expensive than conventional milk and cheese (Siegrist et al., 2024), achieving price parity could facilitate the transition. Nevertheless, for the

Table 5
Linear regression analyses exploring drivers of the willingness to substitute milk and cheese with plant-based alternatives.

	Finland (n = 530)			Germany (n = 496)			Italy (n = 511)			Serbia (n = 499)		
	B	95 % CI	β	B	95 % CI	β	B	95 % CI	β	B	95 % CI	β
Willingness to substitute milk[a]	$F(6, 523) = 22.38, p < .001, R^2 = .20$			$F(6, 489) = 21.88, p < .001, R^2 = .21$			$F(6, 504) = 13.65, p < .001, R^2 = .14$			$F(6, 492) = 8.64, p < .001, R^2 = .10$		
Constant	68.89	[51.38, 86.41]		49.11	[28.68, 69.55]		41.36	[20.87, 61.84]		36.25	[14.99, 57.50]	
Age	-0.32	[-0.50, -0.13]	**-.14*** **	-0.64	[-0.86, -0.43]	**-.26*** **	-0.23	[-0.42, -0.03]	**-.10***	0.11	[-0.11, 0.32]	.04
Sex[c]	9.26	[3.57, 14.95]	**.13** **	5.99	[0.10, 11.89]	**.08***	8.89	[3.22, 14.56]	**.13** **	11.03	[4.94, 17.12]	**.16*** **
Food neophobia	-9.56	[-11.89, -7.22]	**-.32*** **	-6.79	[-9.69, -3.89]	**-.19*** **	-6.74	[-9.53, -3.94]	**-.20*** **	-5.65	[-8.65, -2.65]	**-.16*** **
FCM ecological welfare	8.13	[4.16, 12.11]	**.21*** **	11.15	[6.46, 15.83]	**.26*** **	5.00	[-0.14, 10.14]	.12	2.62	[-1.36, 6.60]	.07
FCM health	0.85	[-4.17, 5.87]	.02	7.39	[1.66, 13.13]	**.15***	10.60	[4.31, 16.90]	**.21** **	8.63	[2.82, 14.43]	**.18** **
FCM natural content	-1.83	[-5.91, 2.25]	-.05	-5.03	[-9.91, -0.15]	**-.12***	-4.23	[-10.19, 1.73]	-.10	-3.16	[-7.75, 1.44]	-.08
Willingness to substitute cheese[b]	$F(6, 523) = 13.30, p < .001, R^2 = .13$			$F(6, 489) = 21.16, p < .001, R^2 = .21$			$F(6, 504) = 9.50, p < .001, R^2 = .10$			$F(6, 492) = 8.76, p < .001, R^2 = .10$		
Constant	21.20	[6.24, 36.16]		24.76	[5.14, 44.39]		35.02	[15.26, 54.79]		13.99	[-6.79, 34.76]	
Age	-0.14	[-0.30, 0.02]	-.07	-0.58	[-0.78, -0.37]	**-.24*** **	-0.25	[-0.44, -0.06]	**-.12** **	0.02	[-0.19, 0.23]	.01
Sex[c]	1.93	[-2.93, 6.79]	.03	2.98	[-2.69, 8.64]	.04	7.63	[2.16, 13.10]	**.12** **	8.64	[2.69, 14.59]	**.13** **
Food neophobia	-5.15	[-7.15, -3.15]	**-.21*** **	-4.37	[-7.16, -1.59]	**-.13** **	-3.81	[-6.51, -1.12]	**-.12** **	-2.71	[-5.64, 0.23]	-.08
FCM ecological welfare	7.77	[4.37, 11.16]	**.25*** **	13.06	[8.56, 17.55]	**.32*** **	7.36	[2.41, 12.32]	**.19** **	7.63	[3.74, 11.51]	**.22*** **
FCM health	1.67	[-2.62, 5.96]	.04	8.97	[3.46, 14.49]	**.19** **	7.25	[1.18, 13.33]	**.15***	3.40	[-2.27, 9.08]	.07
FCM natural content	-0.68	[-4.16, 2.81]	-.02	-7.25	[-11.93, -2.56]	**-.19** **	-6.05	[-11.80, -0.30]	**-.15***	-1.56	[-6.05, 2.94]	-.04

Note: Values in bold are significant at $*p < .05$, $**p < .01$, $***p < .001$. FCM = Food choice motive.
[a] Willingness to substitute milk represents the mean score for replacing milk in coffee and milk in hot cocoa.
[b] Willingness to substitute cheese represents the mean score for replacing cheese on a pizza and cheese in a sandwich.
[c] Sex: 1 = female, 0 = male.

long-term success of milk and cheese alternatives, it remains necessary to improve their sensory properties.

Limitations

While this study provides valuable insights into the acceptance of milk and cheese alternatives, some limitations need to be addressed. The evaluation of the different protein sources for milk and cheese alternatives was based on consumer expectations, with no actual products being tested. While consumer expectations are crucial for the initial trial of new products, they do not necessarily predict actual behavior. For the long-term adoption of milk and cheese alternatives into people's diet, it is thus essential that the products also meet consumer expectations. Moreover, for certain protein sources, it may have been difficult for participants to imagine the taste of the final product, especially if they lacked experience with the protein source or with dairy alternatives in general. Additionally, once the proteins have been processed into the final product, they likely taste different from their original source, which may result in a mismatch between consumer expectations and actual taste perceptions. Therefore, it would be interesting to conduct a follow-up sensory study with the products that are already available to optimize product development.

Furthermore, the primary focus of the study was on people who consume milk and cheese, as they are the target group for transitioning to plant-based alternatives. For this reason, those who adhere to a vegan lifestyle were excluded from the study. However, previous research has shown that users of milk alternatives have more positive perceptions regarding the taste and healthiness of milk alternatives compared to non-users (Ammann et al., 2023). Including vegans in future studies could provide additional insights into increasing the acceptance of milk and cheese alternatives.

Finally, the study showed that the consumption context, food neophobia, and food choice motives influence consumers' willingness to substitute milk and cheese. However, additional factors, such as the social and physical environment, cooking skills, and financial resources, also play an important role in food choice (Hartmann et al., 2013; Larson and Story, 2009). Therefore, future studies are needed to examine how these factors influence the acceptance of milk and cheese alternatives.

Conclusion

Low consumer expectations remain a significant barrier to the acceptance of milk and cheese alternatives. However, the results of this study indicate that their acceptance greatly depends on the protein source used. In general, nuts, including hazelnut, almond, and cashew, were identified as the most promising protein sources for milk and cheese alternatives in Germany, Finland, Italy, and Serbia. Furthermore, country-specific preferences were observed, such as for oats in Finland. In order to increase the acceptance of milk and cheese alternatives, preferred protein sources should be used. In addition, the study also showed that consumers are more likely to substitute milk than cheese and that the consumption context has a significant influence on the willingness to substitute. It is therefore important that marketing strategies not only focus on the product properties, such as the protein ingredient, but also consider the consumption context when promoting milk and cheese alternatives.

CRediT authorship contribution statement

Kirsten Pronk: Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Conceptualization. **Bruno Etter:** Writing – review & editing, Methodology, Conceptualization. **Fabienne Michel:** Writing – review & editing, Supervision, Project administration, Methodology, Conceptualization. **Michael Siegrist:** Writing – review & editing, Supervision, Project administration, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Ethical statement

Before participating, subjects were presented with information about the aim of the study, the general procedure for completing the questionnaire, details about anonymity and data protection, information about the subjects' right to withdraw at any point during the study, and the researcher's contact information. Participation in the study required the subject's informed consent. Participants were compensated according to the reimbursement policy of the panel provider. The study was approved by the ETH Zurich Ethics Commission on September 20, 2023 (proposal No EK 2023-N-234).

Data availability

All data is made available at https://doi.org/10.5281/zenodo.16529788

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