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Geographical Context of European Consumers' Choices of Alternative Protein Food:

A Systematic Review

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Abstract

This review synthesizes empirical evidence for the associations between alternative protein food (APF) choices and geographical context factors, including differences and similarities between European countries, rural versus urban environments, and the "local" attribute of APF. The preregistered systematic review (PROSPERO repository, no. CRD42023388700) was conducted in 13 databases with a 29 original studies being included. Risk of bias was evaluated with Joanna Briggs Institute quality evaluation tools.

The findings indicate that across European countries, the levels of intention to eat, try, and buy APF are low-to-moderate. Consumers' choices of APF in Scandinavian countries differ from those in Southern and Central-Eastern European macro-regions. For example, Denmark emerges as an example of a Scandinavian country "in transformation," with an increasing awareness of importance of sustainability issues, and higher intake of insect-based APF. Poland emerges as an example of a Central-Eastern European country "in stagnation", with low levels of knowledge and low readiness to shift dietary patterns toward APF intake. Our findings do not support rural–urban differences but suggest that consumers in major cities in a macro-region (e.g., country capitals, exposed to international food trends) are more inclined to choose APF. Finally, perceiving an APF product as local may increase the likelihood of APF choice by European consumers. Our review provides insights into geographical differences, suggesting the use of different messages to promote APF intake across Europe.

Keywords: alternative proteins; consumer; local food; rural; urban; geographical context

1. Introduction

Replacing proteins from traditional sources (such as meat, dairy, and eggs) with alternative proteins is expected to enhance nutrition, leading to improved health outcomes (Naghshi et al., 2020). Alternative protein food (APF) encompasses protein concentrates obtained from various sources, including insects, krill, microbial biomass, mushrooms, fungi, or plants such as peas or rapeseed (cf. Grossmann & Weiss, 2021). While multiple definitions of alternative proteins exist, some stress that APFs should refer to proteins produced from sources with lower environmental impact than conventional protein sources (e.g., beef, pork, poultry, and animal dairy). This definition excludes cultured meat due to ongoing debates about the environmental benefits of its production (Grossmann & Weiss, 2021).

Discussions on food systems, food environments, food production, and food consumption typically revolve around geographically defined political and administrative units, such as countries, states, regions, and cities (Arcaya et al., 2015; Boto, 2013; Vandecandelaere et al., 2009). These units represent populations residing in the same geographic areas, exposed to similar risk factors and protective factors, including food policies, and distances to various built food environment structures, such as local grocery stores/supermarkets where people usually shop for food (Arcaya et al., 2015). The geographically defined European units (countries, regions, cities, etc.) exhibit diverse cultural, political, and economic characteristics, shaping consumer health behaviors and overall health (Bambra et al., 2019). These differences contribute to health inequalities between countries, regions, cities, and urban and rural environments (Arcaya et al., 2015). Considering and understanding these differences in food environments and food systems across Europe's countries, regions, cities, and rural areas is crucial to reducing disparities and, in turn, promoting better nutrition and better health for all (Monfort, 2008).

The importance of geographical factors is highlighted in frameworks discussing key contextual factors that may determine the effectiveness of health promotion policies or interventions, including those addressing healthy and sustainable nutrition choices (Pfadenhauer et al., 2017). Moreover, geographical factors determine the feasibility and acceptability of policies and interventions as evaluated by the food system actors (see Pfadenhauer et al., 2017). Existing evidence suggests that country, region, or city (or a lower administrative unit) are meaningful categories, crucial in both health promotion research (Bambra et al., 2019) and research focusing on development of sustainable food systems (Pucci et al., 2021).

Numerous original research studies examining consumers' choice indicators of APF have investigated differences across geographical or political/administrative units in Europe (e.g., Banovic et al., 2022; Banovic & Sveinsdóttir, 2021; Grasso et al., 2022; Gomez-Luciano et al., 2019; Henn et al., 2022; Naranjo-Guevara et al., 2021; Piha et al., 2018; Ribeiro et al., 2022; Tzompa-Sosa et al., 2023; Weinrich & Elshiewy, 2023). However, existing systematic reviews have largely overlooked differences between administrative units (e.g., countries, regions, and rural vs. urban environments). For example, Mancini et al. (2019) analyzed the determinants of consumers' choices within Europe as a single administrative unit. Siddiqui et al. (2022) presented plant-based and insect-based APF choices in specific countries but did not summarize research testing between-country differences. As major differences in production, intake, and acceptability of APF (e.g., insect based) are observed between Europe and continents such as Asia, Africa and South America (Kim et al., 2019) and as Europe is the leading market in production and sales of APF (Andreani et al., 2023; Pippinato et al., 2020), this review focuses on one continent (Europe) only. In sum, although research on this topic is mounting, an overarching synthesis of the geographical differences in APF choices across Europe is missing.

Beyond cross-country differences in health determinants and health outcomes, there are well-documented regional differences within certain European countries (e.g., Germany and the United Kingdom), as well as rural–urban differences (Bambra et al., 2019; Giannakis & Bruggeman, 2020). These disparities may relate to economic development in the region, socio-economic position, and age of consumers (Bambra et al., 2019; Giannakis & Bruggeman, 2020). Moreover, the food environment may differ greatly across these geographical units. For example, research conducted in the Netherlands indicated that between 2004 and 2018, there was an increase in the number of supermarkets and food convenience stores in urbanized neighborhoods, while a decrease was observed in less urbanized areas (Pinho et al., 2020). While some original studies addressing consumers' choices of APF have considered regional and urbanization-related differences (Brandner et al., 2022; Bryant & Sanctorum, 2021; Florença et al., 2021; Henn et al., 2022; Szendrő et al., 2020), a synthesis of such evidence has not been presented so far.

Besides country-level or urbanization-related differences, the frameworks of local food systems (Deller et al., 2017) highlight the importance of food locality as a determinant of food choices. Local food systems can be referred to as networks involving producers, intermediate food system actors, and consumers who, by prioritizing "local products," collectively contribute to the economic development of local communities and promote a better environment through shorter producer-to-consumer supply chains (Deller et al., 2017). The definition of "local food" is relative and may encompass a range of geographic areas, from a neighborhood to an entire country (Deller et al., 2017; Giovannucci et al., 2010). Conversely, other approaches propose more restrictive definitions of local food systems, defining them as systems in which foods are produced, processed, and retailed within approximately a 100 km radius (Kneafsey et al., 2013). Reviews of local food (other than alternative proteins) indicate that consumers are willing to pay more for local foods than non-local ones, and that local

producers benefit from greater recognition, which, in turn, affects economic well-being of the local community (Enthoven & van den Broeck, 2021). Research on APF choices has analyzed associations between the locality of the production and APF choices by the consumers, and products (Aaslyng & Højer, 2021; Brayden et al., 2018; Henn et al., 2022; Hoerterer et al., 2022; Porretta et al., 2019). However, there is currently no comprehensive synthesis of these findings.

Using the methods of a systematic review, this study aims to synthesize empirical evidence for the geographical context factors as the source of differences in consumers' dietary choices of APF products. We explore: (i) differences and similarities across European countries; (ii) differences and similarities within regions of European countries; (iii) differences between rural and urban areas in European countries, and (iv) the associations between the "local" positioning of APF products in European countries and consumers' choice indicators.

2. Methods

2.1 Materials and general procedures

This study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021). The present study reports findings from a search conducted in a larger systematic review (registered with the PROSPERO database; no. CRD42023388700) aimed at eliciting physical environment characteristics that are related to consumers' choices of APF.

2.2 Search strategy

A systematic search encompassing 11 databases of peer-reviewed journals (Academic Search Ultimate, PsycInfo, PsycArticles Business Source Ultimate, Agricola, GreenFILE,

Health Source: Nursing Academic Edition, SocINDEX, MEDLINE, MasterFILE Premier, Academic Research Source eJournals) was performed using the EBSCO platform. The selected databases either have a multidisciplinary focus or cover fields related to economics and business, agriculture, medical sciences, and social sciences. Searches in Web of Science and SCOPUS were also conducted. Documents and articles published between the inception of the databases and March 2023 were included.

The search was conducted using a combination of three groups of keywords referring to: (1) APF (e.g., "seaweed*" OR "alga*" OR "insect*" OR "lupin*" OR "mealworm protein" OR "krill protein" OR "microbial protein" OR "cultivated mushroom protein" OR "fermented fungal protein" OR "pea protein"); (2) physical environment, including geographical context variables allowing for conducting cross-country or cross-cultural comparisons, urban, rural environment, and investigation of locality, as well as physical environment variables (e.g., "cross-cultur*" OR "cross-countr*" OR "between-countr*" OR "between-cultur*" OR "across-countr*" OR "urban" OR "local sale" OR "rural" OR "suburban" OR "geograph*" OR "neighborhood*"); and (3) consumer or behavior-related (e.g., "intake" OR "food" OR "consume*" OR "eat" OR "sale" OR "purchase" OR "buy*" OR "sell*"). The keywords were selected based on existing reviews on APF (Biasini et al., 2021; Mancini et al., 2019; Nguyen et al., 2022), the food environment typology by Downs et al. (2020), geographical context variables investigated in geography of health inequalities such as country, region, and urban versus rural area (cf. Arcaya et al., 2015), and frameworks for research on interventions accounting for geographical context (Pfadenhauer et al., 2017). For this review, we employed a broad and inclusive search string (e.g., applying multiple terms that could represent the investigated factors, using only basic operators [AND, OR], and applying no specific limits) that could be used across the databases. The decision to use this

broad search string aimed to maximize the number of identified articles. The feasibility of this search strategy was pretested across the selected databases before initiating the search.

To secure the robustness of the search, the systematic search was complemented by: (1) manual searches of the references of retrieved full-text original studies that were assessed for inclusion; (2) complementary searches in Google Scholar; and (3) CORDIS and Open Research Europe (ORE) Databases. The search was performed using "alternative protein" keywords (the keywords were modified as CORDIS and Open Research Europe impose limits for the length of search strings, allowing for up to 50 characters).

2.3 Inclusion and exclusion criteria

The following inclusion criteria were applied: (1) peer-reviewed English-language original quantitative or qualitative studies; (2) studies addressing alternative protein-based food, including plant-based proteins, insect-based proteins, or any other sources, such as krill, bacteria, or fungi, etc.; (3) studies investigating differences in APF choices in at least two European countries, or investigating differences in/effects of urban, suburban, and rural areas, or investigating the effects of the locality of production of APF on a consumer choice indicator; and (4) studies measuring a consumer choice indicator, such as perceptions of availability, intention to buy, intention to eat, actual intake, or actual sales.

The exclusion criteria were: (1) documents that do not report any original data, including reviews or position papers; (2) dissertations, protocols, conference materials, and book chapters; (3) studies focusing solely on a reduction of meat intake without investigating how proteins could be supplemented in diet by APF products; (4) studies focusing on increasing fruit and/or vegetable intake without specific data on plant-based protein sources; (5) studies accounting for countries located in Asia, Africa, or South America, entailing locally collected wild-living insects and their local consumption or local retail; (6) studies comparing consumer choices in only one European country with a country in Asia or Africa,

or South America (no cross-European comparisons); (7) studies involving "novel food" without an indication that the food is made from/with alternative protein sources; (8) studies addressing consumers' choices of laboratory-based in-vitro grown meat (no other APF investigated); and (9) studies investigating APF products as supplements or as animal feed.

2.4 Data collection, extraction, and coding

Figure 1 presents the details of the data selection process. All identified abstracts were screened by two researchers (randomly assigned from a group of five researchers: HZ, EK, ZS, MS, and AB) to elicit potentially relevant studies. Any conflicts related to the potential inclusion of a document were resolved through discussions with a fourth researcher (AL). Next, three researchers (AL and two researchers randomly assigned from a group of five: HZ, EK, ZS, MS, AB) independently read the full-text versions of the articles and determined their alignment with the inclusion criteria. Additional searches for any other papers reporting original peer-reviewed studies, beyond those identified in the database search, involved the following strategies: screening references of the articles evaluated for inclusion (conducted by two reviewers independently (PC and TP), searches in Google Scholar (conducted independently by HZ and AL) and searches in CORDIS database and Open Research Europe database (conducted by AL). Overall, the search process and evaluation of all studies resulted in the inclusion of 30 articles reporting 29 independent studies (two articles were reporting the same study) (see Figure 1).

To address the study objectives, the following data were extracted (see Table 1): characteristics of the studied population; the country where data was collected; the location within the country (rural vs. suburban vs. rural; an indicator of locality); the design of the original study; the type of APF investigated; the indicators of consumer choice; the key results.

Data extraction and coding were conducted by two researchers (HZ and AL). Any disagreements during these stages were resolved through a consensus method, which involved searching for possible rating errors, followed by discussion and arbitration by a third researcher, AB (Higgins et al., 2022).

Data retrieved from each original study were coded into three categories: (1) type of APF products; (2) geographical context variables (countries, regions within countries, living in urban vs. rural environment, locality); and (3) type of consumer choice indicator. The APF products were coded into the following categories, based on their protein sources (Grossman & Weiss, 2021): (1) food developed with land or sea plant-based protein (including microalgae-based proteins); (2) food including or made of insect-based protein (encompassing any type of insects used in the food production); and (3) food including or made of other types of alternative protein sources, such as krill, bacteria, or fungi. Within plant-based alternative proteins, we distinguish a sub-category of food developed with a combination of plant-based proteins and meat. These products were categorized as plant-meat hybrid foods, including food developed by combining meat products (pork, beef, poultry) with plant protein sources, with a proportion of 50-50% or 25-75% of respective types of sources. The APF consumer choice indicators may include: (1) attitudes toward and perceptions of the physical and social environment, which either facilitate or hinder APF consumption or the APF product itself (i.e., its attractiveness, approval, acceptance, appropriateness); (2) intentions to act (e.g., intention to buy, intention to eat APF); and (3) actual behavioral performance (e.g., buying APF, intake of APF). These indicators align with theories of health behavior change (e.g., Ajzen & Schmidt, 2020; Luszczynska & Schwarzer, 2020). For further details referring to coding of geographical context variables and APF choice indicators, see Supplementary Material.

2.5 Risk of bias and quality assessment

Pairs of two researchers (PC and TP or AB and MS) independently rated the potential risk of bias related to the quality of each included study using the Joanna Briggs Institute Critical Appraisal Tool (Moola et al., 2020). This tool was selected because it is suitable for evaluating both qualitative studies and quantitative cross-sectional research (there were no longitudinal studies included, whereas only $k = 3$ experimental studies were included). Each study was evaluated along eight criteria, followed by an overall quality evaluation (good, fair, or poor). The scores are reported in Table 1 and Supplementary Material (Table S1). Studies were scored based on the responses to the critical appraisal questions (Yes = 2 – the criterion met completely, No = 0 – the criterion was not met, Unclear = 1 – some information provided, no complete clarity/information was inadequate to make a judgement). Any discrepancies in ratings were resolved through discussion or by involving the third researcher (AL). The overall risk of bias for individual studies was determined using the following cutoffs: low risk of bias – at least 70% of answers were "yes", moderate – 50 to 69% of answers were "yes", and high risk if the scores were below 50%.

2.6 Data analysis

The included material in this review exhibited heterogeneity in terms of the countries compared, consumer choice indicators, and types of APF (see Table 1). Additionally, there was a limited number of comparative studies between any pair of countries (e.g., Spain vs. Germany). Given this, a meta-analysis was not deemed appropriate. We employed a narrative synthesis method based on the Economic and Social Research Council guidance (Campbell et al., 2019; Popay et al., 2006). For further details, see Supplementary Material.

3. Results

3.1 Descriptive information

A total of $k = 29$ original studies were included. Table 1 presents the details of the populations analyzed, the country of data collection, the overall design, the type of alternative protein food (APF) products, and a summary of the main results.

Original studies were conducted in 19 European countries, with data from Germany (n=10 studies, 34.48%), Denmark (n=9, 31.03%), and the UK (n=7, 21.8%) being analyzed most frequently. One study included comparisons of 12 European countries, k=1 compared 8 European countries, k=3 compared 5 countries, k=3 included samples from 4 countries, k=3 accounted for 3 countries, and, k=6 compared 2 countries. Twelve studies addressed rural-urban differences or locality of the product (for details, see Supplementary Material). Seven studies were published between 2013 and 2018, the remaining 22 studies were published between 2019 and 2023. The enrolled populations were heterogeneous, with sample sizes ranging between N=106 and N=4,322 (M=1,173.88, SD=1,128.03) and age ranging from 15 to 89 years old (see Supplementary Material for further information about the population characteristics).

Most studies applied an observational cross-sectional design (k=26, 89.65 %), while two studies (6.89%) were experimental and a single study (3.22%) was qualitative.

No study was excluded based on the quality assessment. Overall, 26 of the studies had a low risk of bias, 1 had a moderate risk of bias, and 2had a high risk of bias (see Table 1 and Supplementary Table S1). The values of the inter-rater reliability coefficient (the weighted Cohen's κ) showed that there was a high agreement between the two raters with $\kappa = 0.91$ (95 CI: [0.74, 1.00]).

3.2 Cross-country similarities and differences

3.2.1 Cross-country differences in APF production

Edible insect producers in Europe were identified in 12 countries. The majority of the producers were located in northern European countries, with the United Kingdom (n = 14), Germany (n = 7), and Belgium (n = 7) showing the highest number of activities, followed by the Netherlands, France, Finland, and Denmark (Pippinato et al., 2020). Additionally, in the period 2019–2021, between 250 and 500 APF products (from any sources) were launched in France, the UK, Germany, and the Netherlands, 150 to 250 were launched in Poland, Spain, and Denmark, while 100–150 were launched in Italy (Andreani et al., 2023).

3.2.2 Cross-country similarities and differences in European consumers' choices

Sixteen studies (Andreani, et al., 2023; Banovic et al., 2022; Banovic & Sveinsdóttir, 2021; Barska, 2014; Gomez-Luciano et al., 2019; Grasso et al., 2022; Henn et al., 2022; Naranjo-Guevara et al., 2021; Piha et al., 2018; Pippinato et al., 2020; Ribeiro et al., 2022; Verneau et al., 2020; Verneau et al., 2016; Tzompa-Sosa et al., 2023; Weinrich & Elshiewy, 2019, 2023 [two papers presenting findings from one study]; Zabrocki, 2017) compared indicators of consumers' choices of APF in at least two European countries.

The findings suggest the *similar levels of knowledge, willingness to pay, willingness to try, willingness to buy, or acceptance of APF* and *low to moderate levels of the indicators of consumers' choices* (e.g., moderate intention or a moderate percentage of consumers declaring willingness to buy an APF product) across European countries. In particular, objective knowledge about insect-based products did not differ across Sweden, Finland, Germany, and the Czech Republic (Piha et al., 2018). Moreover, no significant difference in average willingness to pay for more microalgae-based meat substitutes was found across Germany, the Netherlands, and France (Weinrich & Elshiewy, 2019). Across the UK, Denmark, and Spain,

aat least 50% of consumers were willing to try hybrid meats (Grasso et al., 2022). Additionally, consumers across these three countries were less willing to buy hybrid meat than to try these products (e.g., 71% of Spanish consumers were willing to try, but only 63% were willing to buy; Grasso et al., 2022). Willingness to buy hybrid products (50% meat + 50% plant combination) was low to moderate in the UK, Denmark, and Spain (between 3.5 and 4.0 on a 7-point response scale; Banovic & Sveinsdóttir, 2021). Intention to buy was the lowest for hybrid products containing rapeseed protein (*M*=3.68) and soy protein (*M*=3.95; Banovic & Sveinsdóttir, 2021). Willingness to buy plant-based alternative proteins was reported by only 50–60% of consumers in the UK and Spain, and even lower for insect-based alternative proteins 18–22% of consumers in the UK and Spain (Gomez-Luciano et al., 2019). No difference in the acceptance of insects as human food was observed between Dutch and German students: In general, the acceptance was low-to-moderate, and 51% of the participating young people either did reject the idea of including insects into their diet, or had no opinion about it (Naranjo-Guevara et al., 2021).

Besides similarities across countries, 4 of the 16 studies (25%) suggested *differences between countries* (Banovic et al., 2022; Piha et al., 2018; Ribeiro et al., 2022; Weinrich & Elshiewy, 2019, 2023 [two papers reporting the same study]). First, the studies indicate *cross-country differences referring to insect-based APF*. For example, consumers in Sweden and Finland (data combined) seem to have generally more positive attitude toward insect-based food and a higher willingness to buy compared to consumers in Germany and the Czech Republic (data combined) (Piha et al., 2018). Also, Rebeiro et al. (2022) showed higher acceptance of including insect-based APF into the daily diet in Norway compared to Portugal.

Second, research suggested that *cross-country differences in the consumer beliefs about AFP*, which may be further moderated by other consumers' characteristics, e.g., gender. For example, among Dutch women, a higher frequency of dining out/going to restaurants with

friends and family was related to positive beliefs that microalgae-based APFs are healthy, sustainable, and nutritious (Weinrich & Elshiewy, 2023). However, among Dutch and German men, a higher frequency of dining out/going to restaurants with friends and family was related to unfavorable beliefs of microalgae-based APF (e.g., perceiving limited healthiness or nutritional values of algae-based foods; Weinrich & Elshiewy, 2023).

Furthermore, *preferences for specific types of plant-based proteins may differ across European countries*. Spanish participants indicated the strongest intention to buy hybrid products (combining 50% meat with 50% plant ingredients) with pea protein (mean scores of 4.33), while UK participants reported the strongest intention to buy hybrid products with bean protein (M=4.45; Banovic et al., 2022). The differences may be explained by familiarity with the respective types of pulses in the analyzed countries (Banovic et al., 2022).

3.3 Differences between macro-regions: Scandinavia vs. Central-Eastern vs. Southern Europe

3.3.1 Scandinavian countries: the case of Denmark

Seven studies compare consumer choice of APFs in Denmark with other European countries (Banovic et al., 2022; Banovic & Sveinsdóttir, 2021; Grasso et al., 2022; Henn et al., 2022; Pippinato et al., 2020; Verneau et al., 2020; Verneau et al., 2016).

Levels of knowledge and attitudes of Danish consumers indicate that they favor plant-based APF. For example, for Danish consumers hybrid and plant-based meat-free alternatives were rated higher than meat products on the attributes healthy, ethical, environmentally friendly, and nutritious (Grasso et al., 2022). Compared to German, Polish, Spanish, and UK-based consumers, Danish consumers declared more frequent use of pulse-based APF to replace beef (Henn et al., 2022). Danish consumers may be in the “advanced stages” of meat reduction and focusing on a reduction of beef rather than poultry or fish (Henn et al., 2022).

Besides, they are more informed about the environmental impact of beef production, which could lead to more conscious choices in reducing beef consumption compared to other types of meat (Henn et al., 2022). Danish consumers have equal awareness of the healthiness of pulses-based protein products as Spanish consumers (Banovic et al., 2022). However, the trends in pulses consumption show an increase in the intake of pulses per capita in Denmark (from 0.8 in 2018 to 1.5 kg in 2020; FAO, 2023). In comparison, pulses intake is stable and relatively high in Spain (from 6.3 to 5.9 kg respectively) (FAO, 2023).

Research addressing the intention to buy plant-and-meat hybrid products indicates lower intention in Denmark than in the UK or Spain (Banovic et al., 2022). In Denmark, only 46% of consumers were willing to buy hybrid meat (a product combining plants and meat), compared to 63% of consumers in Spain and 53% in the UK) (Grasso et al., 2022). Although previous research explained low intention to buy plant-and-meat hybrid products in Denmark by higher intake of meat in Denmark, compared to other countries (Banovic & Sveinsdóttir, 2021), this may not be the case any longer. The country-level data collected in years 2018-2020 (FAO, 2023) indicated a substantial reduction in meat intake in Denmark (from 79 to 64 kg) and only minor reductions in Spain (108 in 2018 to 102 kg in 2020), Iceland (92 to 90 kg), Finland (78 to 71 kg), and Germany and the UK (81 to 79 kg). No reduction in meat intake in Romania (66 kg). Thus, the low intention to buy hybrid meat among Danish citizens (Banovic et al., 2022) may reflect lower purchase per capita of any meat-based products (including hybrid meat) in Denmark.

Finally, one study suggested that women in Denmark reported moderate intention to buy plant-based APF and to replace meat with plant-based APF in Denmark, whereas respective intentions were moderate-to-high among women in Romania, Germany, Finland, and Iceland (Banovic & Sveinsdóttir, 2021). These differences, however were obtained in samples which appear to differ in education levels (e.g., with the Danish sample including

more people with primary education); education levels are well-established determinants of plant-based APF choices by the consumers (e.g., Graça et al., 2019). Thus, these specific results (not adjusted for cross-countries differences in education level) may be considered with caution.

Besides specific patterns for plant-based APF, Danish consumers differ from consumers in southern European countries, such as Italy, in terms of intention to eat insect-based APF. Specifically, in comparison to Italy, the intention to eat insect-based APF was stronger in Denmark (Verneau et al., 2020). Another study indicated that intention to eat insects was higher in Denmark than in Italy before and after a psychosocial intervention addressing benefits of eating insects (Verneau et al., 2016). Importantly, participants from both countries benefitted from the intervention: in Denmark intention increased from M=4.37 to M=4.43, in Italy intention increased from M=3.55 to M=3.84 (Verneau et al., 2016).

Concluding, Danish consumers are in a *transition stage*. Specifically, they already hold positive attitudes toward plant-based APF. Although their overall intentions to adopt plant-based APT are still moderate and their intake of plant-based APF is relatively low, Danish consumers may be on their way to increase the intake of plant-based APF, as indicated by the changes in the actual intake of meat and pulses (FAO, 2023). They also indicate stronger intentions to reduce beef intake and stronger intention to include insect-based APF than consumers in other investigated countries. Finally, in contrast to consistent findings for positive attitudes, the findings for intention to eat plant-based APF are inconsistent (similar to vs. lower than other countries), which may be indicative of the transition process, during which the consumers hesitate, are aware of many pros but still perceive some cons of adopting a new behavior, and consequently do not form strong and stable intentions yet. For a summary of findings, see Figure 2.

3.3.2 Central-Eastern European countries: the case of Poland

Three studies highlight specificity of Central-Eastern European countries, particularly Poland, when compared to Northern European countries (Barska, 2014; Henn et al., 2022; Zabrocki, 2017). Polish consumers report higher intentions to use pulses to replace animal-based protein products (pork, poultry, fish, cheese, and eggs), but also higher intentions to replace nuts and tofu with pulse-based APF, compared to consumers in Denmark, Germany, Spain, and the UK, all of which had relatively similarly lower intention to replace the respective products with pulse-based APF (Henn et al., 2022). In contrast to consumers in Poland, the preferences of Danish consumers were first and foremost to replace beef (Henn et al., 2022). The difference in replacing poultry/pork/eggs vs. beef may result from relatively low sustainability awareness among Polish consumers, compared to Danish consumers (Henn et al., 2022). Additionally, meat consumption in Poland is high, with 90 kg per capita in 2018–2020, and consumption of pulses is very low, with 1.3–1.0 kg per capita in 2018–2020. In Denmark, the consumption of meat is declining (79 to 64 kg) while the consumption of pulses is increasing (0.8 to 1.5 kg) between 2018 and 2020 (FAO, 2023).

Compared to German consumers, Polish consumers aged >55 years had lower levels of knowledge regarding innovative food products, were more hesitant in their decisions, and less frequently decided to purchase such products (Zabrocki, 2017). Among young people in Germany, “food innovators” (i.e., buying soon after various innovative foods are out) and “early followers” (those who buy after some consideration) constitute 73% of the population (Barska, 2014). This contrasts with young people in Poland, the Czech Republic, and Slovakia, where “food innovators” and “early followers” constitute only 24–36% of consumers (Barska, 2014). Furthermore, while reluctance to buy innovative APF was found among 0% of young consumers in Germany, it was present among 13% - –17% of consumers in Poland, the Czech Republic, and Slovakia (Barska, 2014).

Concluding, research indicates that Polish consumers are characterized by having limited knowledge regarding innovative food products and relative reluctance to adopt novel foods. They may report strong overall intentions to use plant-based products to replace animal-based proteins, but these intentions reflect limited sustainability awareness. For a summary of findings, see Figure 2.

3.3.3 Southern European countries: the case of Italy and Portugal

Three studies indicate differences in intentions to eat insect-based APF between Italy and other European countries (Verneau et al., 2020; Verneau et al., 2016; Tzompa-Sosa et al., 2023). In Italy, intentions to eat insects were weaker than in Denmark (Verneau et al., 2016; Verneau et al., 2020). The effects indicating between-country differences were of medium size (Verneau et al., 2016). Compared to Belgium or the US, Italy had the highest proportion of consumers indicating they would not eat whole insects (72% and 74%, respectively, versus 80% in Italy; Tzompa-Sosa et al., 2023). The refusal to include powdered insect-based food into the meal was also higher in Italy (61%) as compared to USA (54%), Belgium (48%), China (16%), and Mexico (18%; Tzompa-Sosa et al., 2023).

A study conducted in Portugal yielded a similar pattern of consumer choices for insect-based APF. Acceptance of insects as food was low-to-medium in both Portugal and Norway, but significantly lower in Portugal than in Norway (Ribeiro et al., 2022). The predictors of acceptance vs. rejection of insects as food were also partly different across countries with lower disgust, higher education, and higher familiarity among Norwegians and by lower disgust, younger age, and male gender related to acceptance on insect-based APF among Portuguese respondents (Ribeiro et al., 2022).

One study (Pippinato et al., 2020) which addressed the production of insect-based APF across 12 European countries, showed that Italy is among the countries with the lowest

number of insect-based APFs producers, possibly linking low intention to eat insects with low product availability.

Overall, these studies suggest a potential difference in attitudes, intentions, or acceptance of insect-based APF among consumers from Southern Europe, compared to consumers in Northern European countries. For a summary of findings, see Figure 2.

3.3.4 Differences Across Regions Within European Countries

Four studies indicated within-country regional differences (Brandner et al., 2022; Bryant & Sanctorum, 2021; Lucas et al., 2019; Menozzi et al., 2017). The differences may be mostly explained by factors such as availability, familiarity, ethnicity.

Paris and western France had a higher self-reported intake of more plant-based APF (seaweed) compared to the rest of France (Lucas et al., 2019). Western France is where more seaweed-based food is produced, hence likely to be more available, and Paris is considered fast in incorporating a variety of international food trends (Lucas et al., 2019). In Italy, intention to eat insect-based APF was weakest in the south and strongest in the central region. However, no differences between Italian regions in the actual levels of insect-based food intake were found (Menozzi et al., 2017). It may be the case that, as in France (Lucas et al., 2019), the exposure of consumers to insect-based food is more frequent in large Italian cities (e.g., Rome and Milan) in central and northern regions, than in southern Italy (Lucas et al., 2019).

Higher levels of self-reported purchases of plant-based meat alternatives were found in England, compared to Scotland (Brandner et al., 2022). Differences may be driven by ethnicity, e.g., people of Asian and African origin (who more frequently reside in England than in Scotland) may be more likely to report purchase of plant-based meat alternatives than people of European origin (Brandner et al., 2022).

Significant but small differences in acceptance of plant-based APF were found between regions of Belgium (higher in Flanders [49%] compared to Walloon [46%] or Brussels [44%]; Bryant & Sanctorum, 2021). These differences may be explained by the higher acceptance of a meat-free diet in the Netherlands, while a less positive attitude toward a meat-free diet is found in consumers from France (Weinrich & Elshiewy, 2019). Flanders is a Dutch-speaking region of Belgium, whereas Walloon is a French-speaking region, with cultural influences of respective countries persisting in these regions of Belgium (Weinrich & Elshiewy, 2019).

3.4 Rural Versus Urban Environment

Five studies indicated no difference in consumers' choices of plant-based and insect-based APF between rural and urban environments (Brandner et al., 2022; Bryant & Sanctorum, 2021; Florença et al., 2021; Henn et al., 2022; Szendrő et al., 2020). Living in urban/rural/small-town locations had no effect on the level of satisfaction with plant-based meat alternatives in Belgium (Bryant & Sanctorum, 2021). The willingness to replace animal products (meat, cheese, and eggs) with plant-based products (pulses) was similar among consumers from urban and rural residences in five European countries: Denmark, Germany, Poland, Spain, and the UK (Henn et al., 2022). In Portugal, living in urban, rural, or suburban environments had no effect on attitudes toward/acceptability of edible insects (Florença et al., 2021). Similarly, there were no associations between the type of residence (urban vs. rural) and acceptance or rejection of insect-based foods in Hungary (Szendrő et al., 2020). The lack of differences between urban and rural environments is in line with an absence of evidence for differences between areas of high vs. low economic deprivation. Regarding the self-reported purchase of plant-based meat alternatives, no differences in areas of high vs. low deprivation index were found in a UK-based study (Brandner et al., 2022).

On the other hand, two studies (Hoek et al., 2013; Nevalainen et al., 2023) indicated the effect of living in an urban area on (more favorable) consumer behavior and preferences for APF. Being a meat substitute consumer (self-reported) was related to a higher level of urbanization in the Netherlands (Hoek et al., 2013). This study, however, is one of the earliest studies on plant-based meat substitutes and the effects could have changed in the period of more than 15 years that passed between the Hoek et al. (2013) study and more contemporary research on urban vs. rural environment (Brandner et al., 2022; Bryant & Sanctorum, 2021; Florença et al., 2021; Henn et al., 2022; Szendrő et al., 2020). A study conducted in Finland showed that consumers who tend to agree with the statement "less red meat, more plant proteins" were more likely to live in a larger city compared to the whole sample, however Finns agreeing with "No/very little meat, more plant proteins" lived mostly in the capital area of Helsinki (Nevalainen et al., 2023). These findings show that the differences may be driven by the differences in overall dietary patterns between major cities in a region (e.g., country capitals, exposed to international food trends) and other locations in the country, as found in France (Lucas et al., 2019).

3.5 Local APF Products

Seven studies addressed the "locality" of the production or the origin of APF and their relationships with consumer choices (Aaslyng & Højer, 2021; Brayden et al., 2018; Henn et al., 2022; Hoerterer et al., 2022; Lucas et al., 2019; Porretta et al., 2019; Weinrich & Elshiewy, 2023). Six of the seven studies (85.7%) suggest that locality may be a relevant predictor of consumer choice of APF.

Consumers in Denmark were more likely to indicate higher intake of APF products based on peas or beans-based protein if these products were "locally" produced (Aaslyng & Højer, 2021). Local seaweed-based food production and intention to buy and willingness to

pay among German consumers were significantly correlated (Hoerterer et al., 2022). In the case of seaweed-based products, "local" was defined as a national or a European product (Hoerterer et al., 2022). Another study indicated that in the case of seaweed-based APF, in France (vs. imported foods) locality had no effect on self-reported intake (Lucas et al., 2019). However, this study did not specify if the seaweed-based product was imported from another European country or from elsewhere. Consumers in France, Germany and the Netherlands indicated a preference for purchasing food from local plant-based meat substitutes (79% of consumers reported such preference; Weinrich & Elshiewy, 2019). This may be compared to a preference for buying "organic" meat (found among 64% of consumers; Weinrich & Elshiewy, 2019). Among consumers aged >50 years old, willingness to buy insect-based food was higher if the food was produced in the same country where it was sold (Porretta et al., 2019). Similar to the majority of the European studies, a study conducted in the USA indicated higher willingness to pay for APF if a food item had a local production certificate (within the state) (Brayden et al., 2018).

Only one study showed no effect of APF' local origin and consumer acceptance. Among consumers from Denmark, Germany, Poland, Spain, and the UK (Henn et al., 2022), there was no effect of locality of the product on consumers' willingness to purchase plant-based (pulses) replacements of animal products (meat, cheese, and eggs). The study only specified that locality referred to the consumers' place of residence; the actual breadth of the "local" origin was not defined (e.g., a region in the country, the whole country, the European Union market).

4 Discussion

This review synthesizes evidence on the associations between geographical context variables and the intentions, purchase, or intake of APF. Specifically, we elucidate evidence-

based differences and similarities across European countries (in particular, located in Scandinavia, Southern Europe, and Central-Eastern Europe), as well as the effects of urban and rural environments, and locality of APF production.

The findings reveal some similarities across European countries. Notably, there is *a recurring pattern of relatively low levels of intention to eat, acceptance, intention to buy, try or adopt insect-based APF products. Additionally, there is a moderate intention to buy hybrid products (plant-based proteins combined with meat-based proteins) and plant-based APFs*. Importantly, all existing studies testing cross-country differences accounted for only a small number of European countries (e.g., three to five countries). Thus, there is a need for a pan-European research that could address holistically cross-country differences, that can also allow for more solid conclusions. Nonetheless, our work provides a first step to understand the role of geographical context in consumers' choices of APF.

Given the low or moderate level of intentions to buy or eat APF, it is imperative to develop and implement targeted intervention and promotion campaigns that aim to bolster consumer motivation. In line with theories of behavior change, such as the theory of planned behavior (Ajzen & Schmidt, 2020), social cognitive theory (Luszczynska & Schwarzer, 2020), or the COM-B model (Michie et al., 2011), in case of weak or moderate intention to adopt a new behavior, such as buying and/or eating APF, interventions should initially focus on increasing individual motivational factors. These could include perceived health and environmental benefits (Graca et al., 2019; Onwezen et al., 2021), beliefs about one's own capabilities to act (e.g., prepare meals with APF; Graca et al., 2019), or propose changes in the physical and social environment to nudge consumers toward a nutritional change.

The results of this study indicate that there may be macro-regional differences within Europe. The first difference refers to acceptance of insect-based APF, which may be lower in the South of Europe (e.g., Italy, Portugal) than in the Scandinavia. The relatively low

willingness of Italians to include whole insects in a meal may be attributed to the relatively short presence of this type of food in the Italian market as compared to markets like Belgium or Norway (Ribeiro et al., 2022; Tzompa-Sosa et al., 2023). Food culture and eating patterns in Scandinavia might have changed in recent decades, embracing innovative approaches, whereas Italian food culture is considered one of the strongest in Europe, nurtured and promoted within the Italian food system (Verneau et al., 2016), with over 200 food products awarded Protected Designation of Origin or Protected Geographic Indication certificates, and where meat plays an important role in this local cuisine (Mancini & Antonioli, 2022). Our findings align with a previous review on the Italian market of alternative proteins conducted by Mancini and Antonioli (2022), which suggests limited readiness among Italians to embrace insect-based APF. Similar reluctance to mainstream insect-based APF may hold for other Southern European countries, with comparably strong culinary cultures.

The findings suggest Scandinavian countries, (e.g., Denmark) may be characterized by positive attitudes, such as viewing plant-based APF as healthier and more sustainable than meat. On the other hand, the intention to adopt plant-based APF may be relatively low in Denmark (compared to countries in other European macro-regions). This should be considered in the context of a decrease in meat intake and an increase in pulse intake in recent years in Denmark, compared to other European countries (FAO, 2023). The results may suggest that Scandinavian countries, such as Denmark, are undergoing a transformation in their consumption habits of plant-based APF and meat. Using the terminology applied in the transtheoretical model of behavior change (DiClemente & Prochaska, 1998), Danish consumers' attitudes toward plant-based APF align with the stages of contemplation (considering behavioral changes) and initiation (moving toward initiation of behavioral change).

In contrast, findings for Central-Eastern European countries suggest differences in consumers' lower knowledge regarding innovative food products (e.g., Poland vs. Denmark) and higher reluctance to adopt novel foods (e.g., Poland vs. Germany). These patterns should be considered in the context of persistently high (vs. low) intake of meat (vs. pulses) per capita in the years between 2018 and 2020 in countries such as Poland (FAO, 2023). Referring to the terminology applied in the transtheoretical model (DiClemente & Prochaska, 1998), Eastern European consumers are positioned in the stage of precontemplation (or "in stagnation"). This suggests that they are not yet considering the pros and cons of moving toward more sustainable food choices and embracing APF, indicating a potential need for targeted interventions and awareness campaigns to promote such dietary changes.

Any conclusions drawn for the European macro-regions are tentative. They are based on studies involving specific countries in the regions, as research showing trends across all countries in the respective macro-regions is lacking. Further studies, involving all European countries and macro-regions, are needed to conclude if consumers from Scandinavia, Central-Eastern Europe, and Southern Europe differ in their APF choices.

Our findings indicate that, except for the oldest study (Hoek, 2013), recent research indicated limited rural-urban differences in APF choices within Europe. When differences are observed, they may be explained not solely by the size of the city, but rather by its multicultural and cosmopolitan character in comparison to other locations within the country. For example, cities like Paris (France), Helsinki (Finland), and Milan (Italy), which are more ethnically diverse, tend to exhibit higher levels of consumer acceptance of APF or intentions to consume APF compared to less diverse regions within respective countries (cf. Lucas et al., 2019). Such major cities in a region (e.g., country capitals) are also more likely to have restaurants offering alternative cuisine or introducing novel food trends, including alternative proteins (Pérez-Lloréns, 2020; Schwark et al., 2020).

Our review aligns with previous reviews addressing the effect of locality of production of various foods (Enthoven & van den Broeck, 2021). The findings indicate that consumers are more likely to choose APF products when they are perceived as "local". It is important to note that most of the studies in our review did not specify how "local" was defined and whether it accounted for sustainable and short food chains or simply meant a product originating in the same country. Nevertheless, labeling APF products as local and promoting locally produced APF could facilitate dietary shifts among European consumers.

The findings have some important implications for policies and strategies aiming to increase APF choices. Our review provides insights into geographical variations, suggesting the use of different strategies to promote APF intake across macro-regions of Europe. For example, enhancing beliefs about APF-related benefits may be more necessary and a priority for countries in Central-Eastern Europe than in Scandinavia. Across Europe, intention to eat, try, and buy APFs is moderate or low-to-moderate, which points toward the importance of further interventions prompting consumers' motivational factors and environmental opportunities (such as higher availability of APFs, cf. Bianchi et al., 2018; Stiles et al., 2022).

The present study has several limitations. First, the number of available studies testing cross-country differences was limited. Across the studies, the heterogeneity of APF types (and their sensory characteristics) was high. Differences in APF were studied in different countries which limits the comparability of findings. The conclusions referring to differences between European macro-regions should be treated with caution, as the systematic cross-regional comparisons are lacking. Another limitation is the absence of longitudinal studies, which could provide more robust insights into the process of change over time. The included research used a wide range of indicators for APF choices, from intention (to buy or to try/eat) to actual intake. Actual intake was investigated rarely. It has to be noted that intention is only moderately associated with respective food intake (Mullan et al., 2014). The quality of the

included studies was good, with only $k = 3$ studies of moderate or high risk of bias. This poses a limitation to drawing firm conclusions. As discussed, the between-country differences may, at least partially, be explained by "third variables", including sociodemographic characteristics of the consumers enrolled in respective studies, their motivations and capabilities, and policies operating in the respective country. Future research should consistently control for key sociodemographic and motivational variables that have an empirically established association with consumers' choices of APF. Furthermore, the applied methods of the systematic review had their limitations as well. The narrative synthesis and a lack of possibility to conduct a meta-analysis to evaluate the actual effect sizes limit any conclusions.

5 Conclusions

This review offers new insights into the patterns of consumers' choices of APF across European countries. In general, intention to eat, try, and buy APF are considered moderate or low-to-moderate. Key differences are observed in the acceptability of insect-based APF, with Scandinavian countries showing higher acceptance compared to Italy (where strong cuisine traditions of local food and meat intake may counteract the adoption of insect-based APF). Second, we present Denmark as an example of a country "in transformation" in terms of sustainability awareness, trends for meat intake reduction, and increasing intake of protein-rich plants. Third, we present Poland as an example of a country "in stagnation", with low readiness to shift dietary patterns toward higher APF intake. Our findings suggest that the more "cosmopolitan" environments in Europe (e.g., country capitals) are more likely to choose APF. Finally, positioning APF products as local may be a possible strategy to increase the likelihood of choosing APF products by European consumers.

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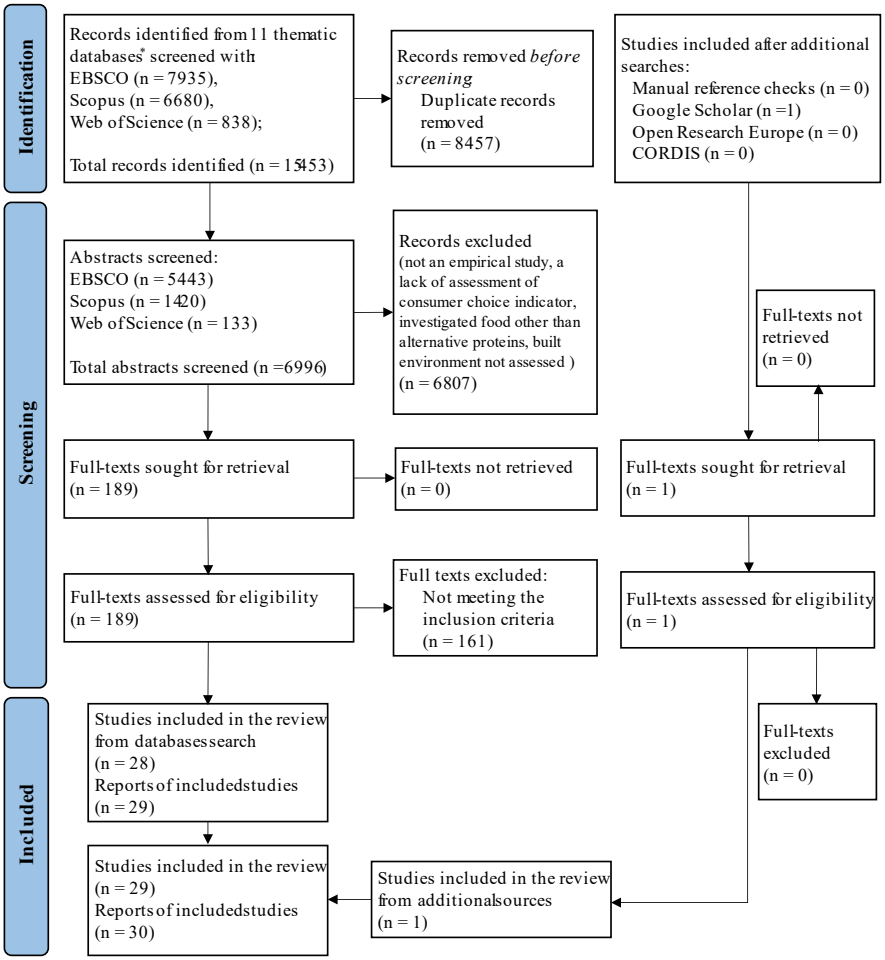
Figure 1

The Data Selection Process



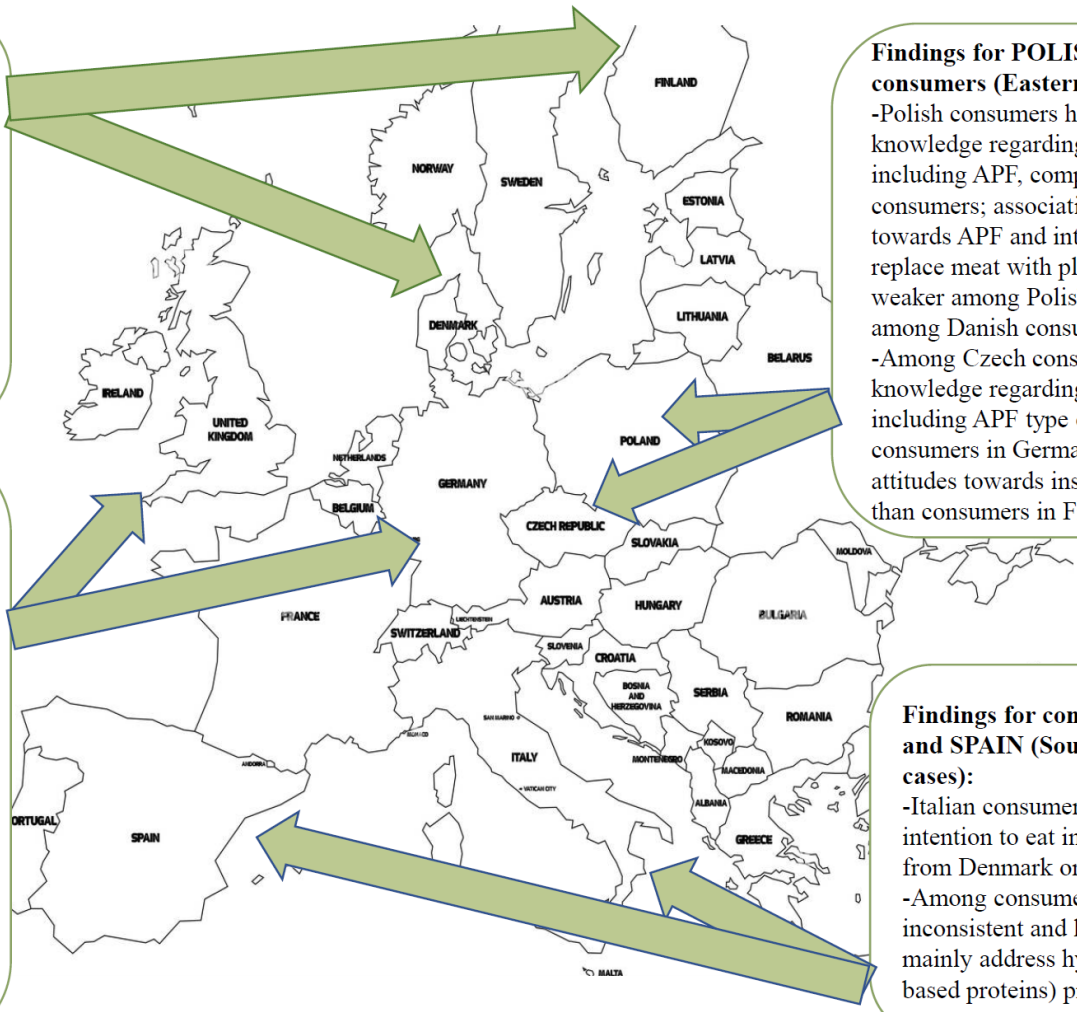
*Academic Search Ultimate, PsycInfo, PsycArticles, Business Source Ultimate, AgriculturaGreenFILE, Health Source: Nursing Academic Edition, SocINDEX, MEDLINE, MasterFILE Premier, Academic Research Source Journals

Figure 2

Alternative Protein Food (APF) Choices among Consumers Recruited in Northern, Eastern, Western, and Southern European Countries

Findings for DANISH and FINNISH consumers (Northern European cases):
-Danish consumers are in the stage of "contemplating a change," defined as positive beliefs and attitudes about plant-based APF and hybrid products, but relatively low intention to consume these types of products
-Finnish and Danish consumers have more positive attitudes and intentions to include plant-based APF in their diet (compared to consumers from Czech Republic and Germany

Findings for GERMAN and UK-based consumers (Western European cases):
-Among German consumers, indicators of choices of plant-based and microalgae-based APF were similar to those obtained among consumers from other Western European countries
-Insect-based APF choice indicators: German consumers have less favorable indicators than consumers from Northern European countries but more favorable than consumers from Eastern Europe
-Regarding hybrid products, inconsistent findings are observed when consumers from the UK are compared with consumers from Spain or Denmark; similarities to, e.g., German consumers in terms of intention and preference for plant-based products



Findings for POLISH and CZECH consumers (Eastern European cases) :
-Polish consumers have limited knowledge regarding innovative food, including APF, compared to German consumers; associations between attitudes towards APF and intention of intention to replace meat with plant-based APF are weaker among Polish consumers than among Danish consumers.
-Among Czech consumers, limited knowledge regarding innovative food, including APF type of food, compared to consumers in Germany; less positive attitudes towards insect-based proteins than consumers in Finland and Sweden

Findings for consumers from ITALY and SPAIN (Southern European cases):
-Italian consumers have lower intention to eat insects than consumers from Denmark or Belgium
-Among consumers from Spain, inconsistent and limited findings that mainly address hybrid (meat + plant-based proteins) products

Table 1

Descriptive Information About the Original Research Included in the Systematic Review.

Author, year	Population *(N,* age, gender	Type of the study (design), the JBI quality evaluation score	Type of consumer choice indicators	Type of alternative proteins	Country/region/ urbanization /locality	Main findings of the original studies
Comparisons Between European Countries						
Banovic & Sveinsdóttir (2021)	N = 1,397; women only; M_{age} = 43	Quantitative (questionnaire) JBI = low	Intention to buy, the attractiveness of APF	Plant-based	Denmark, Romania, Germany, Finland, Iceland (k = 5 countries)	Positive attitude, attractiveness of meat analogues: similar level across 5 countries. Intention to buy was the lowest in Denmark (higher meat intake) compared to Romania, Germany, Finland, and Iceland.
Banovic et al. (2022)	N = 2,766; 51% women; M_{age}= 42	Quantitative (online questionnaire) JBI = low	Intention to buy	Hybrid products, including plant-based proteins and meat	Denmark, Spain, the UK (k = 3 countries)	Hybrid products (50% meat + 50% plant combination): UK, Denmark, Spain. Intention to buy hybrid products was low-to-moderate across countries (around 3.5-4.5 on a 7-point scale). Intention to buy was the lowest when hybrid products contained rapeseed (M = 3.68) and soy (M = 3.95) protein. This was particularly true for Spanish participants who showed lowest levels of appropriateness for rapeseed protein (M= 3.17), mainly due to their lower levels of familiarity with this plant-based ingredient; Danish participants had lower preference for soy protein (M = 3.60). Intention to buy hybrid products was highest when containing pea (M = 4.20), followed by bean (M = 4.15), and oat (M = 4.09) protein. Pea protein was preferred by Spanish participants (M = 4.33), while bean protein was preferred among UK participants (M = 4.45) as an appropriate ingredient for APF. For Danish participants, pea and bean proteins were found as appropriate parts of APF (pea: M = 4.04; bean: M = 4.07).
Barska (2014)	N = 791; 60% women; consumers aged 18-29	Quantitative (survey) JBI = high	Self-reported buying, intention to buy	Various innovative foods (plant- and insect-based)	Poland, Czech Republic, Slovakia, Germany (k = 4 countries)	Innovators and early followers (buying soon after various innovative foods are out vs. after some consideration): a difference between Germany (73%) compared to Poland, the Czech Republic, and Slovakia (24-36%); reluctance to buy new product: 0% in Germany, 13-17% Poland, Czech, Slovakia.

Gómez-Luciano et al. (2019)	*N* = 983; UK sample = 48.3% men, 51.7% women; Spain sample = 50.5% men, 47% women; age range: 25 and 54	Quantitative (digital and paper questionnaire) JBI = low	Intention to buy	Various innovative foods (plant- and insect-based)	UK, Spain (*k* = 2 countries) (also included: Brazil, Dominican Republic) (*k* = 2 countries)	Percentage of willingness to buy plant-based alternative proteins high among countries (50-60% in UK and Spain), much lower willingness to buy insect-based alternative proteins 18-22% in UK and Spain, respectively.
Grasso et al., (2022)	*N* = 2,405; 25.63% were 18–32 years old, 24.74% were 33–46 years old, 31.68% were 47–61 years old and 17.95% were 62–75 years old.; UK – 51.0% women; Spain – 49.8% women; Denmark – 50% women	Quantitative (online survey) JBI = low	Intention to eat; Intention to buy	Hybrid products, including plant-based proteins and meat	UK, Spain, Denmark (*k* = 3 countries)	Hybrid meat: In the UK and Denmark there was no significant difference between the meat-to-plant ratios, 75:25 and 50:50, indicating that both ratios were deemed equally preferable. Spanish consumers ranked the 50:50 ratio as the most preferable, followed by 75:25. Across 3 countries, at least 50% of consumers were willing to try hybrid meats but less willing to buy them. Spanish consumers seemed to be the most favorable, with 71% willing to try and 63% willing to buy. In the UK, the willingness to buy was 53%, in Denmark- 46% was willing to buy hybrid meat.
Henn et al. (2022)	*N* = 4,322	Quantitative (web-based survey) JBI = low	Intention to eat	Plant-based	Denmark, Germany, Spain, UK, Poland (*k* = 5 countries)	Poland had higher intention to replace animal products (meat, cheese, and eggs) with pulses-based (pulses) products, compared to Denmark, Germany, Spain and UK. Poland had higher intention to replace animal products (meat, cheese, and eggs) with pulses-based (pulses) products, compared to Denmark, Germany, Spain and UK. Respondents from Poland did not only show higher odds of being part of the "replacer" segment, but significantly more respondents indicated replacing pork and poultry, fish, cheese, and eggs with pulses. Polish consumers did not replace beef to an extent comparably to pork and poultry. In contrast, many Danish consumers used pulses to first and foremost replace beef. Danish consumers may be in advanced stages of meat reduction, i.e., consume less beef than poultry. The Danish consumers may be more informed about the environmental impact of beef production, leading to more conscious choices on reducing beef compared to other meat types.

Naranjo-Guevara et al. (2021)	*N* = 222; 30% women; university students; M_{age} = 21	Quantitative (survey) JBI = low	Consumers attitudes and beliefs (acceptance)	Insect-based	Netherlands, Germany (*k* = 2 countries)	No differences between Dutch and German students in acceptance of insects as food.
Piha et al. (2018)	*N* = 887; Northern Europe - 60% women; M_{age} = 37 years old; Central Europe - 61% women; M_{age} = 39	Quantitative (questionnaire) JBI = low	Intention to buy	Insect-based	Sweden, Finland, Germany, Czech Republic (*k* = 4 countries)	Consumers in Sweden and Finland (data from two countries combined) had more positive beliefs about insect-based food and higher willingness to buy them than consumers in Germany and Czech Republic (data combined). Objective knowledge about insect-based products did not differ across the clusters whereas product related experiences were higher in Sweden-Finland cluster than in Germany-Czech Republic cluster.
Ribeiro et al. (2022)	*N* = 666; Norway - 67% women, Portugal - 59% women; M_{age} Norway = 41 years old; M_{age} Portugal = 40 years old; Age range: 18 and >55	Quantitative (online-based questionnaire) JBI = low	Consumers attitudes and beliefs (acceptance)	Insect-based	Norway, Portugal (*k* = 2 countries)	Acceptance of insects as food was low-to-medium but higher in Norway than in Portugal. The predictors of acceptance vs rejection of insects as food are determined by lower disgust, higher education, higher familiarity among Norwegians and by lower disgust, younger age, male gender among Portuguese. Norway had higher and earlier promotion of insect-based food than southern European countries.
Tzompa-Sosa et al. (2023)	*N* = 1046 Belgium - 271 women and 247 men; Italy - 278 women and 250 men Age range: 18 to >65 years old	Quantitative (online survey) JBI = low	Intention to eat	Insect-based	Belgium, Italy, (*k* = 2 countries); (also included: the USA, China, Mexico)	Italy (compared to Belgium) had the highest number of people who indicate they are not willing to include whole insects into their food (80% vs. 72% and 74% respectively). The lowest approval to include whole insects in Italy may be based on the shortest time this type of food is present in the market (compared to Belgium). For powdered insect-based food the refusal of including was respectively 61% (Italy), 48% (Belgium). Europeans are more likely to refuse the inclusion of whole insects than non-Europeans.
Weinrich & Elshiewy (2019)	*N* = 938; 51% women; M_{age} between 31 and 34	Quantitative (questionnaire) JBI = low	Intention to pay	Microalgae-based APF	Germany, the Netherlands, France (*k* = 3 countries)	There was no significant difference in the average willingness to pay for more micro-algae-based proteins in meat substitutes across Germany, the Netherlands, and France. Some determinants of willingness to pay may differ across the countries, e.g., the most positive attitude toward a meat-free diet was found in the Netherlands, while the opposite was true for France.

Weinrich & Elshiewy (2023)	N = 938; 51% women; M_{age} between 31 and 34	Quantitative (questionnaire) JBI = low	Consumers attitudes and beliefs (perceived healthiness)	Microalgae-based APF	Germany, the Netherlands, France (k = 3 countries)	Perceiving microalgae-based food as healthy, sustainable, and nutritious was unrelated to habits of shopping in specialty food stores among consumers from France, Germany, and the Netherlands (men and women subsamples).
Verneau et al. (2016)	N = 282; university students; Denmark - 65 women, M_{age} = 23; Italy - 74 women; M_{age} = 23	Quantitative (experiment) JBI = low	Intention to eat	Insect-based	Denmark, Italy (k = 2 countries)	The main effect of nation on intention was significant, $p < .001$, the mean score of intention was higher for the Danish (M = 4.37) compared to the Italians (M = 3.55). The effect of nation on intention was also significant $p < 0.01$, the mean score was higher for the Danish participants (M = 4.43) compared to the Italian participants (M = 3.84).
Verneau et al. (2020)	N = 280; 138 women; M_{age} = 23	Quantitative (computer-based questionnaire) JBI = low	Intention to eat	Insect-based	Denmark, Italy (k = 2 countries)	Intentions to eat insects are stronger in Denmark than in Italy.
Zabrocki (2017)	N = 428; population aged 55+	Quantitative (survey questionnaire) JBI = moderate	Intention to buy; consumers attitudes and beliefs (knowledge about APP)	Various innovative food (plant- and insect-based)	Germany, Poland (k = 2 countries)	Among individuals aged over 55 years old, German respondents declared greater knowledge of innovative products and were more inclined to make faster purchasing decisions for such products compared to respondents from Poland.
	Regional Differences					
Brandner et al. (2022)	N = 1,177; 65% women; the majority were Millenials	Quantitative (cross-sectional survey) JBI = low	Actual sales of products	Plant-based	England versus Scotland (k = 1 country)	Higher purchase in England than in Scotland (differences may be driven by ethnicity).
Bryant & Sanctorum (2021)	N = 1,001 in 2019 & N = 1,000 in 2020; 50% women; M_{age} = 48	Quantitative (cross-sectional survey) JBI = low	Consumers attitudes and beliefs (acceptability)	Plant-based	Flanders versus Walloon, versus Brussels (Belgium) (k = 1 country)	Significant but small differences in plant-based meat substitutes acceptance (higher in Flanders [49.1%] compared to Walloon [45.6] or Brussels [44.3]).

Lucas et al. (2019)	N = 495; Sample 1: 53% women; Sample 2: 54% women; Sample 3: 51% women; Age: > 15	Qualitative (in-person interviews) JBI = low	Self-reported intake	Seaweed-based APF	France (different regions) (k = 1 country)	Paris and western France had higher intake (Western France is where more seaweed-based food is produced hence likely to be more available).
Menozzi et al. (2017)	N = 109; 61% women; M_{age} = 23	Quantitative (questionnaire, tasting session) JBI = low	Intention to eat	Insect-based	Italy (different regions) (k = 1 country)	Intention to eat insect-based foods was weakest in Southern Italy and strongest in the Central and Northern regions. No associations between intention and actual behavior were found.
Rural Versus Urban Environment						
Brandner et al. (2022)	N = 1,177; 65% women; most of the participants were Millenials	Quantitative (cross-sectional survey) JBI = low	Actual sales of products	Plant-based	The UK (areas of low and high socioeconomic position index) (k = 1 country)	No overall differences in areas of high vs. low deprivation index (although there are differences in eating legumes, e.g., frozen or dried beans, with low deprivation buying more/indicating a good source of protein).
Bryant & Sanctorum (2021)	N = 1,001 in year 2019 & N = 1,000 in year 2020; 50% women; M_{age} = 48	Quantitative (cross-sectional survey) JBI = low	Consumers attitudes, beliefs (satisfaction)	Plant-based	Flanders versus Walloon versus Brussels (Belgium) (k = 1 country)	Urban vs. rural areas did not differentiate satisfaction with products.
Florença et al. (2021)	N = 213; 79% women; Age range between 18 and > 66	Quantitative (online questionnaire) JBI = low	Consumers attitudes and beliefs (acceptability)	Insect-based	Portugal (different regions, rural and urban) (k = 1 country)	Living in urban, rural or suburban environment has no effect on beliefs about edible insects or acceptability of insect-based food products.
Henn et al. (2022)	N = 4,322	Quantitative (web-based survey) JBI = low	Intention to eat	Plant-based	Denmark, Germany, Spain, the UK, Poland (rural and urban) (k = 5 countries)	Plant-based (pulses) replacements of animal products (meat, cheese, and eggs): no differences between urban and rural residence for analysis conducted from data of consumers from Denmark, Germany, Poland, Spain and the UK.

Hoek et al. (2013)	*N* = 3,613; vegetarians: *n*=32 (73% women); consumers of meat substitutes: *n*=17 (59% women); meat consumers: *n*=3,564 (54% women); age range: 18-75	Quantitative (survey) JBI = low	Self-reported intake by the consumers	Plant-based	The Netherlands (different regions, rural and urban) (*k* = 1 country)	Being a plant-based meat substitute consumer was related to a higher level of urbanization.
Nevalainen et al. (2023)	*N* = 1,000; 50.5% women; age range: 18-79	Quantitative (online questionnaire) JBI = low	Self-reported intake by the consumers	Various innovative foods (plant- and insect-based)	Finland (different regions, rural and urban) (*k* = 1 country)	The respondents in the "less red meat, more plant proteins" cluster were more likely to live in a larger city compared to the whole sample. Respondents of the "less red meat, more poultry" cluster: living in middle-sized or small cities or municipalities. "No/very little meat, more plant proteins" cluster: lived mostly in the capital area of Helsinki.
Szendrő et al. (2020)	*N* = 414; 65.5% women	Quantitative (questionnaire) JBI = low	Consumers attitudes and beliefs (acceptability)	Insect-based	Hungary (different regions, rural and urban) (*k* = 1 country)	No associations between the type of residence (urban vs. rural) and acceptance or rejection of insect-based foods.
Vartiainen et al. (2020)	*N* = 564; 66.8% women; age range: 16-89	Quantitative (questionnaire) JBI = low	Intention to eat	Insect-based	The Netherlands (different regions, rural and urban) (*k* = 1 country)	The strength of intention to consume insect-based foods in the future: people living in rural areas had less intention than people living in city areas. Nevertheless, most of those living in rural areas were among either potential or likely (76%) consumers of insect-based food. In urban areas either potential or likely consumers constituted 85% of the population.
	Locality of Products					
Aaslyng & Højer (2021)	*N* = 395; 78% women; age range: 18-29	Quantitative (online survey) JBI = low	Self-reported intake by the consumers	Plant-based	Denmark (*k* = 1 country)	Higher intake of plant-based proteins if they were "locally" produced.
Henn et al. (2022)	*N* = 4,322	Quantitative (web-based survey) JBI = low	Intention to eat, self-reported intake	Various innovative foods (plant- and insect-based)	Denmark, Germany, Spain, the UK, Poland *(k* = 5 countries)	Plant-based (pulses) replacements of animal products (meat, cheese, and eggs): no effect of locality (related to consumers residence) for the analyses conducted from data of consumers from Denmark, Germany, Poland, Spain, and the UK.

Hoerterer et al. (2022)	*N* = 362; 53% women; mostly ≤25 years old	Quantitative (questionnaire) JBI = low	Intention to pay	Seaweed-based APF	Germany (*k* = 1 country)	Attitudes towards seaweed-based APF: German consumers indicated the importance of its local production and considered locality as one of the key characteristics of the sustainability of aquaculture.
Lucas et al. (2019)	*N* = 495; Sample 1: 53% women; Sample 2: 54% women; Sample 3: 51% women; age > 15	Qualitative (in-person interviews) JBI = low	Self-reported intake by the consumers	Seaweed based APF	France (*k* = 1 country)	Seaweed-based food: production in France (versus imported) did not have an effect on self-reported intake. However, people living in areas of France where the production of seaweed-based APF is the highest in the country was associated with a higher intake of seaweed-based APF (Rennes compared with Montpellier, Lille, Lyon, Strasbourg, Bordeaux; the exception refers to Paris, where similar level of intake (as in Rennes) was observed (explained with a higher minority of Asian-origin, favoring seaweed-based food).
Weinrich & Elshiewy (2019)	*N* = 938; 51% women; M_{age} between 31 and 34	Quantitative (questionnaire) JBI = low	Intention to pay	Algae-based-based	Germany, the Netherlands, France (*k* = 3 countries)	79% of consumers have a positive preference to select local algae-based APF as meat substitutes. The locality of the production of algae-based APF was a significant predictor of the preference to substitute meat with APF.

Note. Study design = Type of the study; JBI = Joanna Briggs Institute overall study quality index; Study quality values are reported as three levels of risk of bias: low risk, moderate risk, or high risk; APF = alternative protein food; “plant-based APF” - products from plants such as pulses, rapeseed (seaweed-based APFand algae-based APF were excluded from this category).

Geographical Context of Consumers' Choices of Alternative Protein Food: A Systematic Review

Supplementary Material

Supplementary Material includes:

1. **The full list of keywords applied in the review**
2. **Details of coding of the study variables: geographical context and APF choice indicator**
3. **Additional information regarding data analysis**
4. **Preliminary results**

Supplementary Table S1 - *Quality Assessment of Studies Included in the Systematic Review*

1. The full list of keywords applied in the review

The search was conducted using a combination of three groups of keywords referring to:
(1) *APF*
("cultured meat*" OR "in vitro meat*" OR "synthetic meat*" OR "seaweed*" OR "alga*" OR "insect*" OR "lupin* protein*" OR "dry pea* protein*" OR "chickpea* protein*" OR "cow pea* protein*" OR "pigeon pea* protein*" OR "lentil* protein*" OR "pulse* protein*" OR "legume* protein*" OR "bean* protein*" OR "meat alternative*" OR "meat substitute*" OR "plant-based meat*" OR "meat analogue*" OR "plant-based protein*" OR "rapeseed kernel protein*" OR "mealworm protein*" OR "krill protein*" OR "microbial protein*" OR "cultivated mushroom protein*" OR "fermented fungal protein*" OR "pea protein*" OR "meat analogue*" OR "hybrid meat*" OR "non-meat protein source" OR "novel plant-based alternative*" OR "plant-based protein*" OR "substitute meat protein*" OR "insect-based food*" OR "insect-based protein*" OR "larvae protein*" OR "bacterial protein*" OR "lab grown meat*" OR "cultured meat-based protein*" OR "cultivated meat*" OR "fusarium venenatum" OR "quorn" OR "texture vegetable protein" OR "novel food" OR "innovative food*" OR "alternative type* of food*" OR "alternative protein*" OR "sustainable protein*" OR "soy protein*" OR "mycoprotein*" OR "whey protein*")
AND
(2) *Physical environment, including geographical context variables allowing for conducting cross-country or cross-cultural comparisons, urban, rural environment, and investigation of locality, as well as physical environment variables*
("home" OR "shop*" OR "retail*" OR "cater*" OR "restaurant*" OR "supermarket" OR "hotel*" OR "farmer market*" OR "grocer*" OR "vendor" OR "kiosk" OR "food environment" OR "school" OR "public institution*" OR "food vend*" OR "built environment" OR "physical environment" OR "food procurement" OR "accommodation" OR "neighborhood*" OR "neighbourhood*" OR "local communit*" OR "urban" OR "local sale" OR "food outlet*" OR "food store*" OR "workplace" OR "rural" OR "suburban" OR "transport" OR "geograph*" OR "architectur*" OR "menu design" OR "canteen" OR "in-store design" OR "point of sale" OR "fast-food store*" OR "fast-casual" OR "local market" OR "buildings" OR "market" OR "cross-cultur*" OR "cross-countr*" OR "between-countr*" OR "between-cultur*" OR "across-countr*" OR "across-countr")
AND
(3) *Consumer or behavior-related*
("intake" OR "food" OR "consume*" OR "eat" OR "sale" OR "purchase" OR "buy" OR "sell")

2. Details regarding coding of the study variables: geographical context and APF choice indicator

The *geographical context variables* referred to macro-level factors representing a broader physical, social, and political environment, as well as access to services (e.g., as proposed by the CICI framework, Pfadenhauer et al., 2017) and included country, regions within countries, urban vs. suburban vs. rural environment, locality of the production/sale of the alternative protein products.

The *consumer choice indicators* included three broad types of variables used in research on behavior determinants, as seen in theories such as the theory of planned behavior (Ajzen & Schmidt, 2020) or social cognitive theory (Luszczynska & Schwarzer, 2020). These include (1) attitudes towards/perceptions of the physical and social environment or the food product itself (i.e., its attractiveness, approval, acceptance, appropriateness), (2) intentions to act, and (3) the actual performance of a behavior. The indicators of relevant perceptions or attitudes included: acceptability of foods, perceived availability of foods, consumers' approval or liking of food, and preference for the point of sale (or the type of environment where the food is sold). According to behavior change theories, attitudes,

beliefs, and perceptions may refer to the consumers themselves (e.g., perceived capabilities, skills, or emotions). These types of perceptions, not referring to the physical environment directly, were not considered as consumer choice indicators but rather as individual characteristics of a consumer that determine other consumer choice indicators and, therefore, were excluded. The separation of perceptions of /beliefs about the environment from beliefs/perceptions of oneself is used in theoretical approaches focusing on environmental versus individual determinants of other human behaviors (c.f., the model of four domains of active living, Sallis et al., 2006).

The intentions to act encompassed variables such as intention to eat (e.g., the behavior change models such as the theory of planned behavior, Ajzen & Schmidt, 2020), intention/willingness to pay, and intention/willingness to buy (e.g., Lu & Hsee, 2019).

The actual behaviors included variables related to the actual consumption of the food in the study location, the actual purchase by a consumer, sales of a product in the study location/food environment type, and visiting the location selling alternative protein food products.

3. Additional information regarding data analysis

The included material in this review exhibited heterogeneity in terms of the countries compared, consumer choice indicators, and types of APF (see Table 1). Additionally, there was a limited number of comparative studies between any pair of countries (e.g., Spain vs. Germany). Given this, a meta-analysis was not deemed appropriate. Meta-analysis is typically considered when a group of studies demonstrates adequate homogeneity between participants, conditions, and outcomes to provide a meaningful summary. According to the Cochrane guidelines for systematic reviews (Higgins et al., 2022), if there is substantial diversity, a qualitative approach combining studies is appropriate. We employed a narrative synthesis method based on the Economic and Social Research Council guidance on narrative synthesis (Campbell et al., 2019; Popay et al., 2006). The narrative synthesis process consists of several key steps. First, it uses a theoretical model to provide the underpinnings for the analyzed patterns of associations (Campbell et al., 2019; Popay et al., 2006). In this review, we drew from health determinants and inequality frameworks, indicating that macro-level geographical factors explain differences in various health indicators in European populations (Arcaya et al., 2015) including indicators of dietary changes. This study also uses the CICI framework (Pfadenhauer et al., 2017), suggesting that the geographical context categories should be taken into account in any research that discovers ways to promote better health outcomes, including an uptake of a healthier diet. Second, the preliminary synthesis should be provided, including an initial description of the results of included studies (e.g., their textual description, forming data into a common rubric characterizing the studies, tabulation) (Campbell et al., 2019; Popay et al., 2006)). In the present review, we grouped studies along the three

categories (type of food product, the geographical context variable, and the consumer choice indicator) and provided an initial description of the results in the form of a table and textual synthesis. The third step of the narrative synthesis accounts for exploring the relationships in the data by examining emerging patterns that allow the identification of patterns of associations and provide explanations of differences in the direction of associations. This may be achieved through the analysis of emerging cluster groups, conceptual mapping, context description, and frequency distributions (Campbell et al., 2019; Popay et al., 2006). In this review, we grouped the studies based on geographical context variables and investigated the evidence for: (1) cross-country differences/similarities in consumer choices of alternative protein foods, (2) the evidence for rural vs. urban environment differences/similarities in consumer choices of alternative protein foods, (3) any country cases, with at least two studies showing that a country differs from other countries in terms of the levels of consumers' choices of alternative proteins, (4) the links between locality of production/sales and consumer choices of alternative protein foods. Fourth, the narrative synthesis should account for an assessment of the robustness of the obtained results, for example, using the quality assessment tools that address the respective risk of bias (Campbell et al., 2019; Popay et al., 2006). This review addressed the heterogeneity of studies in reference to the quality of included papers.

4. Preliminary results

Original studies were conducted in 18 European countries. The studies involved data collected in Germany (*n* = 8, 32%) (Banovic & Sveinsdóttir, 2021; Barska, 2014; Henn et al., 2022; Hoerterer et al., 2022; Naranjo-Guevara et al., 2021; Piha et al., 2018; Weinrich & Elshiewy, 2019, 2023; Zabrocki, 2017), Denmark (*n* = 7, 28%) (Aaslyng & Højer, 2021; Banovic et al., 2022; Banovic & Sveinsdóttir, 2021; Grasso et al., 2022; Henn et al., 2022; Verneau et al., 2020; Verneau et al., 2016), UK (*n* = 5, 20%) (Banovic et al., 2022; Brandner et al., 2022; Gomez-Luciano et al., 2019; Grasso et al., 2022; Henn et al., 2022), Italy (*n* = 4, 16%) (Menozzi et al., 2017; Verneau et al., 2020; Verneau et al., 2016; Tzompa-Sosa et al., 2023), Spain (*n* = 4, 16%) (Banovic et al., 2022; Gomez-Luciano et al., 2019; Grasso et al., 2022; Henn et al., 2022;), the Netherlands (*n* = 4, 16%) (Hoek et al., 2013; Naranjo-Guevara et al., 2021; Vartiainen et al., 2020; Weinrich & Elshiewy, 2019, 2023), Finland (*n* = 3, 12%) (Banovic & Sveinsdóttir, 2021; Nevalainen et al., 2023; Piha et al., 2018), Poland (*n* = 3, 12%) (Barska, 2014; Henn et al., 2022; Zabrocki, 2017), France (*n* = 2, 8%) (Lucas et al. 2019; Weinrich, 2019&2023), Belgium (*n* = 2, 8%) (Bryant & Sanctorum, 2021; Tzompa-Sosa et al., 2023), Czech Republic (*n* = 2, 8%) (Barska, 2014; Piha et al., 2018), Portugal (*n* = 2, 8%) (Florença et al., 2021; Ribeiro et al., 2022), One study each (4%) were conducted in: Romania (Banovic & Sveinsdóttir, 2021), Iceland (Banovic & Sveinsdóttir, 2021), Slovakia (Barska, 2014), Hungary (Szendrő et al., 2020), Sweden (Piha et al., 2018), Norway (Ribeiro et al., 2022).

Besides European countries, several studies included also data from 7 countries in other continents: USA (*n* = 1, 4%) Tzompa-Sosa et al., 2023), Brazil (*n* = 1, 4%) (Gomez-Luciano et al., 2019), Dominican Republic (1 study, 4%; Gomez-Luciano et al., 2019), China (1 study, 4%; Tzompa-Sosa et al., 2023), Mexico (1 study, 4%; Tzompa-Sosa et al., 2023).

Three studies (Banovic & Sveinsdóttir, 2021; Henn et al., 2022; Tzompa-Sosa et al., 2023) compared 5 countries, *k* = 3 included samples from 4 countries (Barska, 2014; Gomez-Luciano et al., 2019; Piha et al., 2018), *k* = 3 accounted for 3 countries (Banovic et al., 2022; Grasso et al., 2022; Weinrich & Elshiewy, 2019, 2023), *k* = 5 compared 2 countries (Naranjo-Guevara et al., 2021; Ribeiro et al., 2022; Verneau et al., 2020; Verneau et al., 2016; Zabrocki, 2017) and *k* = 11 (Aaslyng & Højer, 2021; Brandner et al., 2022; Bryant & Sanctorum, 2021; Florença et al., 2021; Hoek et al., 2013; Hoerterer et al., 2022; Lucas et al., 2019; Menozzi et al., 2017; Nevalainen et al., 2023; Szendrő et al., 2020; Vertiainen et al., 2020) addressed one country only (research rural-urban differences and locality of the product).

1) Types of alternative protein products – articles included

Across the original studies, *k* = 6 focused on the plant-based alternative protein products (Aaslyng & Højer, 2021; Banovic & Sveinsdóttir, 2021; Brandner et al., 2022; Bryant & Sanctorum, 2021; Henn et al., 2022; Hoek et al., 2013), *k* = 1 addressed microalgae & algae based APF (Weinrich & Elshiewy 2019,2023), *k* = 2 addressed seaweed based APF (Lucas et al., 2019; Hoerterer et al., 2022), *k* = 2 addressed hybrid APF combining meat and plant-based meat alternatives (Banovic et al., 2022; Grasso et al., 2022), *k* = 10 addressed insect-based alternative protein products (Florença et al., 2021; Menozzi et al., 2017; Naranjo-Guevara et al., 2021; Piha et al., 2018; Ribeiro et al., 2022; Szendrő et al., 2020; Tzompa-Sosa et al., 2023; Vartiainen et al., 2020; Verneau et al., 2020; Verneau et al., 2016;), *k* = 4 addressed both proteins form plant and insect-based sources (Barska, 2014; Gomez-Luciano et al., 2019; Nevalainen et al., 2023; Zabrocki, 2017), *k* = 2 focused on a broader category of novel food, including, among others, either plant-based or insect-based products (Barska, 2014; Zabrocki, 2017).

2) Consumer choice indicators:

The consumers' choice indicators included:

(a) consumers' willingness/intention to buy (*k* = 8 studies - Banovic et al., 2022; Banovic & Sveinsdóttir, 2021; Gomez-Luciano et al., 2019; Grasso et al., 2022; Hoerterer et al., 2022; Piha et al., 2018; Weinrich & Elshiewy, 2019; Zabrocki, 2017);

(b) consumers' willingness/intention to eat (k = 7 studies - Grasso et al., 2022; Henn et al., 2022; Menozzi et al., 2017; Vartiainen et al., 2020; Verneau et al., 2020; Verneau et al., 2016; Tzompa-Sosa et al., 2023);

(c) actual sales of products (k = 2 studies - Barska, 2014; Brandner et al., 2022);

(d) self-reported purchase by the consumers (k =4 studies - Aaslyng & Højer, 2021; Hoek et al., 2013; Lucas et al., 2019; Nevalainen et al., 2023);

(e) consumers' attitudes and beliefs (e.g., about healthiness, sustainability, etc.) (k = 7 studies - Bryant & Sanctorum, 2021; Florença et al., 2021; Naranjo-Guevara et al., 2021; Ribeiro et al., 2022; Szendrő et al., 2020; Weinrich & Elshiewy, 2023; Zabrocki, 2017).

3) Studied population

Among the studies, k = 22 (88%) included consumer samples from the general population, whereas k = 3 (12%) (Naranjo-Guevara et al., 2021; Verneau et al., 2016; Zabrocki, 2017) enrolled specific populations, such as students, homemakers (women), and participants only above 55 years old (Zabrocki, 2017).

Table S1

Quality and Risk of Bias Assessment of Studies Included in the Systematic Review (using the JBI tool)

).	Publication	1. Were the criteria for inclusion in the sample clearly defined?	2. Were the study participants and the setting described in detail?	3. Was the predictor measured in a valid and reliable way	4. Were objective, standard criteria used for measurement of the condition?	5. Were confounding factors identified?	6. Were strategies to deal with confounding factors stated?	7. Were the outcomes measured in a valid and reliable way?	8. Was appropriate statistical analysis used?	No. of 'YES'	No. of 'YES'*2 + No. of 'UN'*1	Overall quality score	Overall risk of bias
		Final score	Final score	Final score	Final score	Final score	Final score	Final score	Final score			of maximum ore (in case of 'NA' the ximum score as adjusted)	OW ≥ 70%; ODERATE = -69%; HIGH ≤ 49%
	aslyng & Højer, 2021)	Yes	Yes	Yes	Yes	No	No	Yes	Yes	6	12	75	LOW
	anovic & Sveinsdóttir, 2021)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	16	100	LOW
	anovic et al., 2022)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	16	100	LOW
	arska, 2014)	No	No	Yes	No	No	No	Yes	No	2	4	25	HIGH
	randner et al., 2022)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	16	100	LOW
	ryant & Sanctorum, 2021)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	16	100	LOW
	lorença et al., 2021)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	16	100	LOW
	ómez-Luciano et al., 2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	16	100	LOW
	rasso et al., 2022)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	16	100	LOW
	enn et al., 2022)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	16	100	LOW
	oek et al., 2013)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	16	100	LOW
	oerterer et al., 2022)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	16	100	LOW
	ucas et al., 2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	16	100	LOW
	Ienozzi et al., 2017)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	16	100	LOW
	aranjo-Guevara et al., 2021)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	16	100	LOW

evalainen et al., 2023)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	16	100	LOW
iha et al., 2018)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	16	100	LOW
ibeiro et al., 2022)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	16	100	LOW
zendrő et al., 2020)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	7	14	88	LOW
zompa-Sosa et al., 2023)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	7	14	88	LOW
/einrich, 2019)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	7	14	88	LOW
/einrich, 2023)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	16	100	LOW
artiainen et al., 2020)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	7	14	88	LOW
erneau et al., 2016)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	16	100	LOW
erneau et al., 2020)	No	No	Yes	Yes	Yes	Yes	Yes	Yes	6	12	75	LOW
abrocki, 2017)	Yes	Yes	Yes	Yes	No	No	Yes	No	5	10	63	[ODERATE

Note: NA - not applicable; Yes - 2 points; Unclear - 1 point; No - 0 points; In case of NA - the maximum score was adjusted respectively; maximum score (when all criteria were rated 'Yes') = 16 points; final score - a score agreed between the two reviewers.

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