

# Protein-enriched foods: A promise older adults will accept? A systematic review of consumer acceptance in later life

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## ABSTRACT

Protein consumption is essential for healthy ageing, yet many older adults fail to meet recommended levels. Protein-enriched foods have been proposed as an intermediate solution between habitual diets and oral supplements; however, their acceptance among older adults remains inconsistent. This systematic review synthesizes factors influencing the acceptance of protein-enriched foods among adults aged 65 years and older.

Following PRISMA guidelines, 14 peer-reviewed studies were analyzed using a multilevel framework encompassing product-related, individual, and sociocultural determinants. Influencing factors were classified as barriers, facilitators, neutral, or debated variables and synthesized according to their frequency and explanatory emphasis across analytical levels.

Across 43 identified determinants, acceptance was primarily constrained at the microlevel: when taste, texture, or ease of consumption were compromised, protein-enriched foods were generally rejected. On the meso-level, psychological and social factors, including familiarity, perceived health relevance, and professional endorsement helped to foster acceptance, once sensory and physiological requirements were met. Lastly, on the macro-level sociocultural factors shaped legitimacy and trust but exerted limited influence in the absence of satisfactory functional acceptability.

Overall, acceptance of protein-enriched foods in later life emerges as a hierarchically structured, multilevel process in which product characteristics and consumer physiology delimit choice, while psychological and sociocultural factors condition openness, relevance, and sustained adoption. Designing protein-enriched foods that feel familiar, enjoyable, and worth eating may therefore be as critical as their nutritional potential for supporting everyday eating in older age.

## 1. Introduction

Ensuring adequate protein intake in older adulthood remains challenging, not because protein-enriched solutions are absent, but because their acceptance by older consumers tends to be inconsistent. Ageing is associated with increased protein requirements due to muscle loss and declining immune efficiency, while simultaneously introducing sensory, physiological, and functional changes that constrain food intake and enjoyment (Alraes et al., 2025; Morgan et al., 2025). This imbalance contributes to widespread protein inadequacy, with consequences for sarcopenia, mobility, and health-related quality of life (Höglund et al., 2018; Wendin et al., 2017).

Protein-enriched foods have therefore been proposed as an

intermediate strategy between habitual diets and oral nutritional supplements, aiming to increase protein intake without increasing meal volume or disrupting established eating practices. From a technological stance, enrichment of familiar foods with protein sources such as whey, soy, or legume-derived ingredients has proven feasible (Badia-Olmos et al., 2025; Song et al., 2018). However, from a consumer perspective, nutritional improvement does not guarantee consumer acceptance. Empirical studies consistently report variable responses to protein-enriched foods, even when nutritional targets are met (Beelen et al., 2017; Geny et al., 2024).

A key source of this variability lies in the sensory consequences of protein enrichment. Added proteins may modify intrinsic product characteristics that are pivotal to liking, including taste, texture, and

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appearance. Properties such as bitterness, dryness, graininess, and increased thickness have been reported in protein-enriched products, attributes that are particularly salient for older consumers. For instance, protein-enriched sauces have been described as bitter or overly dense (Tsikritzi et al., 2015), and high-protein baked goods often show reduced moistness and lower hedonic ratings among older adults (Norton et al., 2020). These findings highlight the tension between nutritional optimization and sensory acceptability.

Beyond intrinsic sensory features, consumer-related determinants further shape acceptance. Psychological factors such as food neophobia, familiarity, and perceived relevance impact willingness to try and repeatedly consume protein-enriched foods. Higher food neophobia is associated with perceptions of fortified products as artificial or unnecessary, whereas familiarity with the food carrier facilitates acceptance by reducing perceived risk (Carrillo & Tárrega, 2025; van der Zanden et al., 2014). In parallel, physiological constraints common in later life, like reduced appetite and oral health difficulties limit consumption, regardless of positive attitudes (Geny et al., 2024; Hastoğlu et al., 2023).

Acceptance is also influenced by contextual and sociocultural conditions, including product availability, trust in technological practices, and the perceived legitimacy of specific food carriers. Intermediaries such as healthcare professionals may further shape exposure and recommendations (Beelen et al., 2017; van der Zanden et al., 2014). However, these contextual factors are rarely examined alongside sensory and consumer-related determinants within a unified analytical framework.

Despite a growing empirical literature, evidence on older adults' acceptance of protein-enriched foods remains uneven. Most studies focus on individual products or food categories, and few are explicitly grounded in food acceptance theory. Existing reviews have largely prioritized nutritional or clinical outcomes, devoting limited attention to the sensory, psychological, physiological, and contextual determinants central to consumers preference. Consequently, it remains unclear which factors consistently constrain acceptance and where explanatory emphasis lies across analytical levels.

To address the forementioned gap, this review intends to provide a pioneer structured, theory-informed synthesis, that clarifies how sensory integrity, consumer characteristics, and context interact to shape acceptance of protein-enriched foods in later life.

Specifically, this review aims to:

- (1) identify determinants influencing older adults' acceptance of protein-enriched foods;
- (2) organize these determinants across an ecological level of analysis; and
- (3) clarify where acceptance is most strongly constrained or enabled within the literature.

## 2. Methods

This systematic review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses PRISMA guidelines (Page et al., 2021). The protocol for this review was registered on OSF Registries (7qjc3). A systematic review protocol was not published for this study.

### 2.1. Conceptual framework

The present review synthesizes empirical evidence on acceptance of protein-enriched foods among older adults with an integrative framework. First, it implements the ecological perspective of Bronfenbrenner (1994) to categorize the complex interaction of individual (micro-level), social, relational (meso-level), and contextual variables (macro-level), that might be hindering the studied phenomena (De Sousa et al., 2022; Savarese, Castellini, Paleologo, & Graffigna, 2022), in this case, older adults' protein-enriched products acceptance.

Secondly, the food acceptance framework proposed by Köster and Mojet (2018a, 2018b) was included, as it has been widely applied in sensory and consumer research due to its holistic conceptualization of acceptance as the outcome of interacting product-related, consumer-related, and contextual influences. In synthesis, it establishes that consumption can occur due to intrinsic or extrinsic product characteristics, individual aspects such as their physiological status, psychological drivers, social factors or contextual situations that impact its ability and tendency to accept a determinate product (Castellini & Graffigna, 2022b). This integration of both models has been depicted in Fig. 1.

### 2.2. Data sources and search strategy

The PICO (population, exposure, comparator, outcome and study design) approach was applied to identify a broad range of search terms related to protein-enriched foods, older adults, and consumer behavior, as summarized in Table 1.

Searching was conducted using Scopus, PubMed, PsycINFO, Web of Science, ScienceDirect, and Consumer Health for articles published from database inception through November 2025, reflecting the relatively recent emergence of protein-enriched products targeting older populations.

The search strategy combined terms related to protein enrichment, ageing, and consumer behavior. The following search string was developed and adapted across databases: TITLE-ABS-KEY ("protein enrich\* food" OR "high protein food" OR "protein rich food" OR "protein enriched diet" OR "protein enrichment" OR "hyperproteic\* food" OR "hyperproteic diet" OR "high protein food" AND "elder" OR "late adult\*" OR "aged" OR "senior\*" OR "old age" OR "older\*" OR "older adult" OR "over65" OR "ageing" AND "buy" OR "purchase\*" OR "consum\*" OR "prefer\*" OR "accept" OR "avoid" OR "perceive" OR "attitude" OR "market\*").

All database results were limited to studies conducted with human populations, published in peer-reviewed journals, and written in English.

### 2.3. Study selection

Studies were included if they examined consumer behavior toward protein-enriched foods among adults aged  $\geq 65$  years in community settings. Studies including broader populations were eligible if results for older adults could be independently extracted.

Studies were excluded if they were conducted in hospitals or nursing homes, or if they focused on populations with specific diseases or condition-specific dietary interventions. Studies reporting only nutritional composition without consumer-related outcomes were also excluded.

### 2.4. Screening and extraction

All records were managed using Zotero reference management software. After removal of duplicates, titles and abstracts were screened, followed by full-text assessment for eligibility.

Data extraction was conducted independently by two reviewers using a standardized template. Extracted data included study characteristics (authors, year, country, design), participant characteristics (sample size, age), product and protein enrichment characteristics, and outcome measures related to acceptance.

Determinants influencing acceptance were coded inductively and classified by analytical level (micro, meso, macro), sublevel, and valence: facilitator (+), barrier (−), neutral (0), or mixed ( $\pm$ ). Discrepancies were resolved through discussion and consultation with a third reviewer.

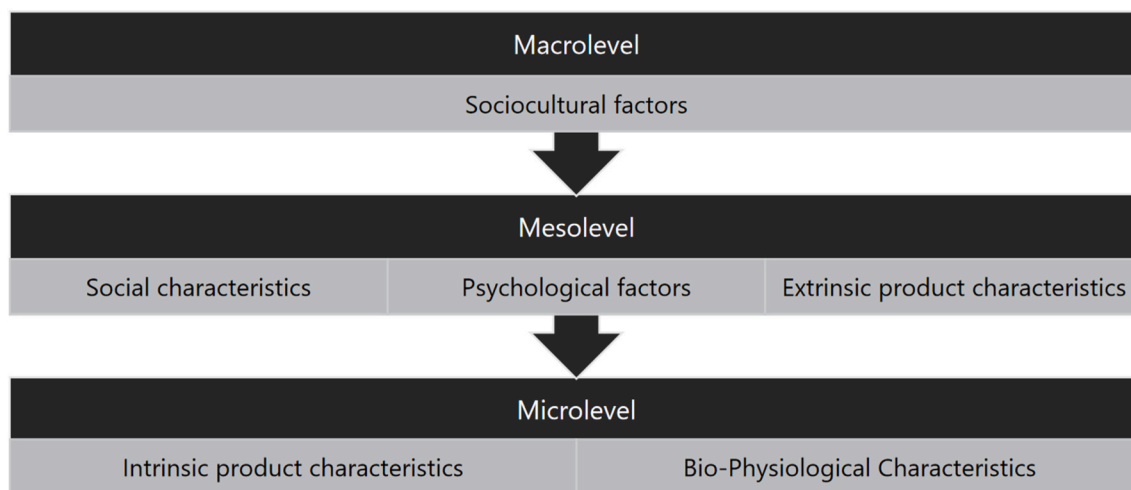


Fig. 1. Ecological comprehension of the food acceptance framework.

**Table 1**  
PICO criteria for inclusion of studies.

PICO criterion	Inclusion criteria
Population	Adults aged $\geq 65$ years; studies including broader populations were eligible if data for older adults were reported separately.
Exposure	Protein-enriched foods, including protein-fortified products, milk-based supplements, and protein-rich diets.
Comparisons	Not required.
Outcomes	Consumer-related outcomes including acceptance, preference, purchase intention, willingness to adopt protein-enriched diets, sensory evaluation, and perceived facilitators or barriers.
Study Design	Primary quantitative and qualitative studies (e.g. surveys, sensory evaluation panels, controlled consumer trials)

Note. PICO = Population, Intervention, Comparator, Outcome. Inclusion criteria were defined a priori.

### 2.5. Quality assessment

The methodological quality of the 14 included studies was independently assessed by two reviewers using the Joanna Briggs Institute (JBI, 2020) critical appraisal tools appropriate to each study design.

The checklist for analytical cross-sectional studies was applied to 11 studies (Appendix A1, A2), the checklist for randomized controlled trials to one study (Appendix B), and the checklist for qualitative research to two studies (Appendix C), with the mixed-methods study appraised based on its qualitative component.

Each criterion was rated as Yes (Y), No (N), Unclear (U), or Not Applicable (N/A). Disagreements were resolved through discussion or consultation with a third reviewer. No studies were excluded based on quality assessment; instead, appraisal results were used to contextualize the findings.

### 2.6. Data synthesis

Due to heterogeneity in study designs and methodological approaches, a meta-analysis was not feasible. A narrative synthesis was therefore conducted. To support the synthesis and account for unequal numbers of determinants across analytical levels, two indicators were calculated: frequency of appearance and adjusted appearance density.

**Frequency of appearance (F)** was defined as the percentage of included studies reporting a given determinant ( $n/N \times 100$ ), where  $n$  is the number of studies reporting the determinant and  $N$  is the total number of included studies. Higher values indicate greater consistency across literature.

**Adjusted appearance density (D)** was calculated as the total number of appearances of determinants within a sublevel divided by the number of determinants in that sublevel and the total number of included studies. For example, if 5 determinants appeared 28 times across  $N = 14$  studies,  $D = 0.40 (28/[5 \times 14])$ . This adjustment ensures that sublevels with more determinants do not appear overrepresented and enables a standardized estimate of determinants' representation in the literature.

## 3. Results

A total of 479 records were identified. After removal of duplicates ( $n = 47$ ), 432 titles and abstracts were screened independently by three reviewers following an initial calibration phase. Fifty-two full-text articles were assessed independently by two reviewers for eligibility. Disagreements were resolved by consensus or consultation with a third reviewer. A total of 14 studies met the inclusion criteria and were included in the final review. The study search strategy and selection process (Page et al., 2021) is outlined in Fig. 2.

A bibliometric overview of the included studies is presented in Figs. 3–5. Fig. 3 depicts the publication years ranged from 2014 to 2025, with a visible increase in output during 2021 and 2022.

Fig. 4 shows that most studies were conducted in Northern European countries, particularly the Netherlands, followed by the United Kingdom, Denmark, France, Norway, and Spain.

Fig. 5 illustrates that in terms of research areas, most papers were classified within agricultural and biological sciences (41%), followed by nursing (33%), and medical and psychological sciences (7%).

The detailed characteristics of the included studies are summarized in Appendix D, including author, year of publication, study design, and sample size. Studies were also coded according to the type of protein-enriched food investigated and its classification based on the LARN guidelines.

### 3.1. Overview of determinants

A total of 43 determinants of protein-enriched food acceptance in older adults were identified across the 14 included studies. Table 2 provides a comprehensive mapping of all determinants, valences and corresponding references.

A total of 43 determinants of acceptance were identified across the 14 included studies and organized into a multilevel framework comprising macro-, meso-, and micro-levels, as presented in Fig. 6.

As the determinants were unevenly distributed across levels, the following results will include the combined use of frequencies and

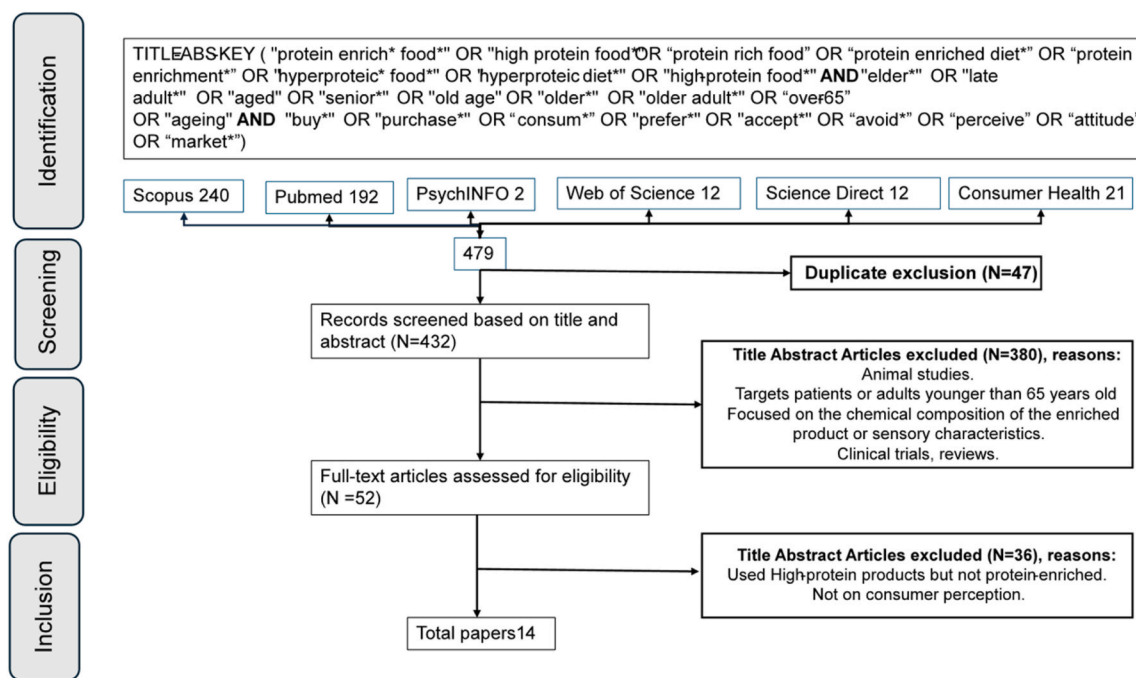


Fig. 2. PRISMA flow diagram applied on this systematic review n = 14.

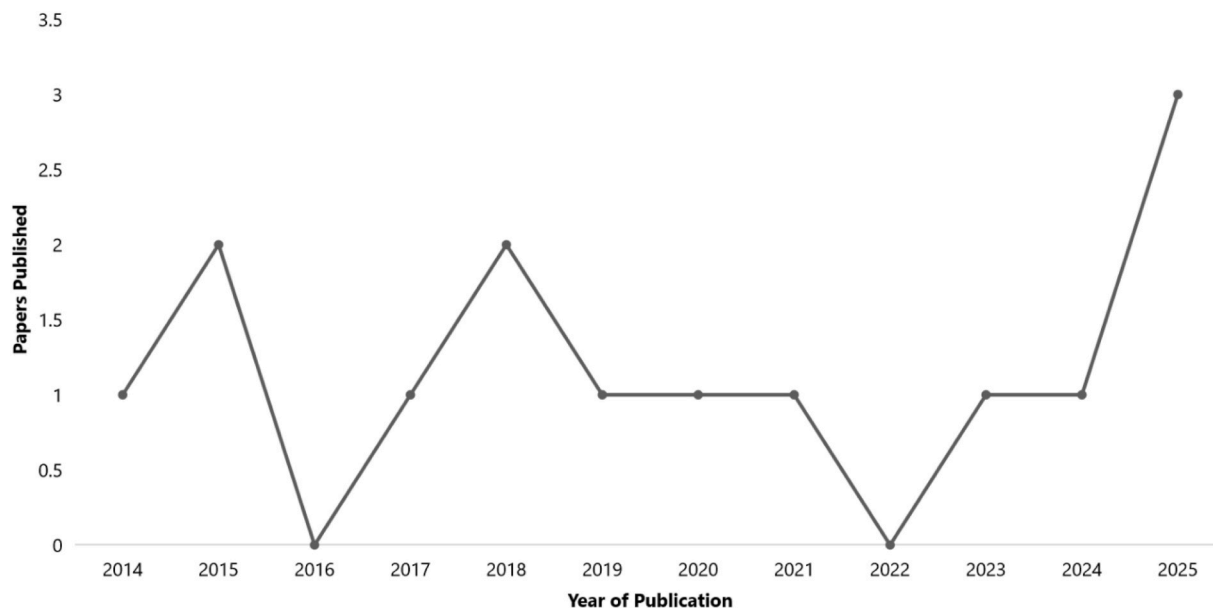


Fig. 3. Time distribution of included studies, n = 14.

adjusted densities.

3.2. Distribution of determinants across analytical levels

Table 3 exhibits the adjusted appearance density of determinants by analytical level. The hierarchical organization portrays the leading role of Micro-level variables, followed by meso-level and macro-level ones, indicating that acceptance of protein-enriched foods among older adults is most strongly framed in the literature by sensory and biophysiological constraints.

As shown in Table 3, findings indicate that acceptance of protein-enriched foods among older adults has been examined primarily through sensory and biophysiological constraints, whereas social and

broader sociocultural factors have received comparatively less attention.

3.3. Macro-level determinants: sociocultural context

Macro-level determinants were limited to sociocultural factors and showed moderate representation overall (D = 0.36; Table 3). As shown in Table 4, availability was the most frequently reported determinant at this level (50%), although its role was mixed, acting as either a facilitator or a barrier depending on access conditions. The representation of the carrier food as suitable for enrichment was also prominent and was consistently described as a facilitator.

By contrast, changing nutritional guidelines, stigma associated with

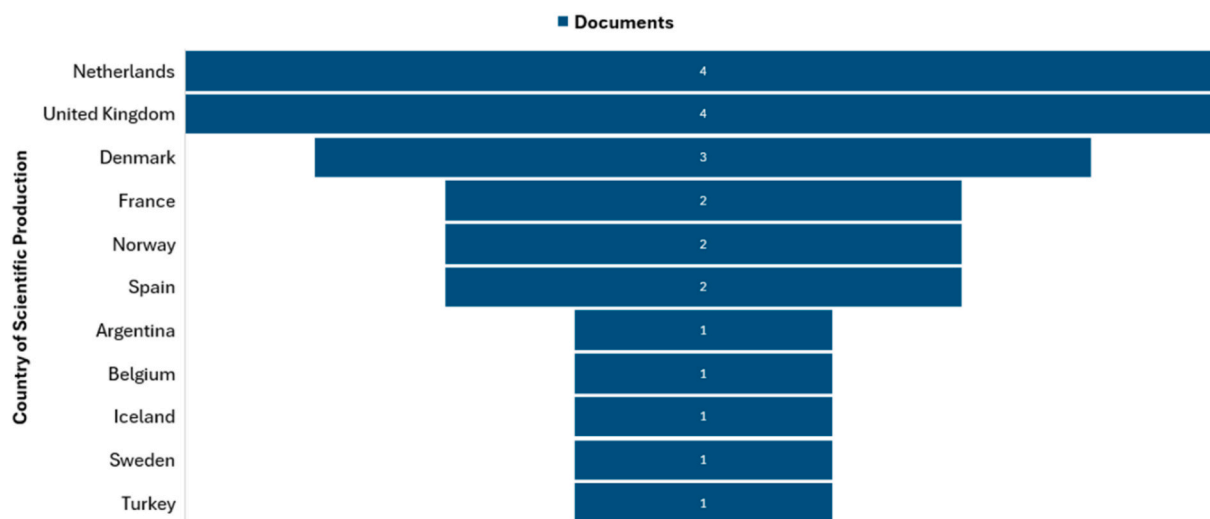


Fig. 4. Geographical distribution of included studies, n = 14.

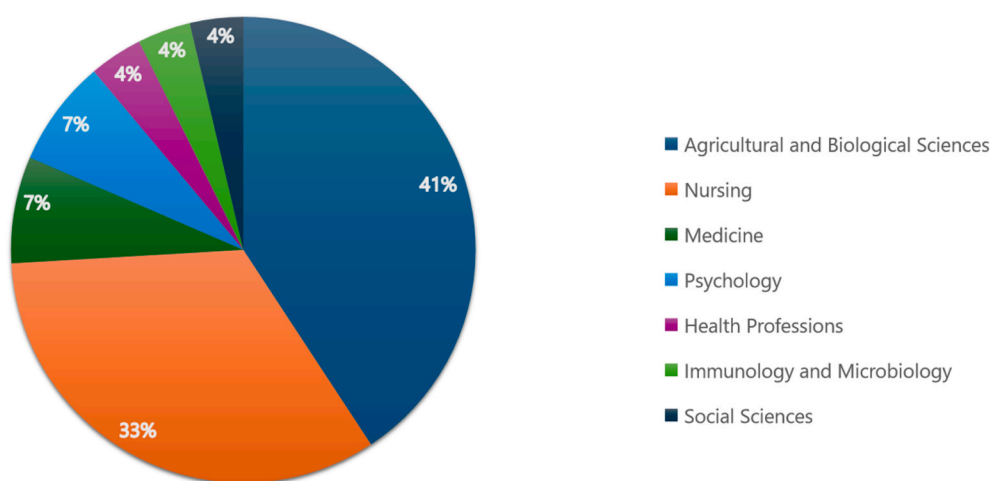


Fig. 5. Research areas of included studies, n = 14.

supplements, and distrust toward enriched foods were each reported in five studies (36%) and were consistently described as barriers. Food education initiatives were mentioned less often and generally acted as facilitators, whereas education level appeared infrequently and was coded as neutral.

Overall, macro-level acceptance appeared to be shaped primarily by trust, cultural legitimacy, and product availability rather than by educational variables.

### 3.4. Meso-level determinants

Meso-level determinants comprised social characteristics, psychological factors, and extrinsic product characteristics (Table 3). Among these, psychological factors showed the highest adjusted appearance density (D = 0.35), followed by extrinsic product characteristics (D = 0.31), whereas social characteristics were least represented (D = 0.29).

#### 3.4.1. Social characteristics

Social characteristics showed the lowest adjusted density among meso-level determinants (D = 0.29; Table 3). All identified determinants within this sublevel were described as facilitators. Involvement in co-design was the most frequently reported (36%), followed by advice from doctors or dietitians (29%) and eating in company (21%).

Although less frequently represented than other meso-level sublevels, these findings suggest that acceptance may be supported by relational and interpersonal processes.

In the studies included, social influence was mainly framed in terms of professional guidance, shared eating situations, and user involvement in product development. By contrast, broader forms of social influence, such as advice from family or friends, everyday food-related beliefs within the social environment, and the potential role of loneliness or social isolation, were not examined explicitly and were therefore not included on the final determinants.

#### 3.4.2. Psychological determinants

Psychological factors showed the highest adjusted density among meso-level determinants (D = 0.35; Table 3). The most frequently reported facilitators were familiarity with the product (71%) and the importance attributed to health (57%), followed by concern about protein intake and willingness to taste (both 43%). Food neophobia, low protein knowledge, and lack of perceived relevance were reported in 36% of studies.

Psychological determinants were primarily reported in relation to general health motivations, familiarity, and perceived relevance. No study explicitly examined the relative importance of protein compared to other nutritional concerns, nor broader diet-related beliefs, and these

**Table 2**  
Determinants of protein-enriched food acceptance in older adults and corresponding references.

Determinants	Reference (Author, year)
<b>Sociocultural factors</b>	
(-) Changing nutritional guidelines	Broeckhoven et al. (2021), Geny et al. (2025), van der Zanden et al. (2014), Norton et al. (2020), Tsikritzi et al. (2015)
(+) Presence of food education initiatives	Broeckhoven et al. (2021), Geny et al. (2025), Beelen et al. (2017), Song et al. (2018)
(-) Stigma of supplements	van der Zanden et al. (2015), van der Zanden et al. (2014), Badia-Olmos et al. (2025), Beelen et al. (2017), Song et al. (2018)
(-) Distrust towards enriched food	Carrillo and Tárrega (2025), van der Zanden et al. (2015), van der Zanden et al. (2014), Badia-Olmos et al. (2025), Song et al. (2018)
(±) Availability	van der Zanden et al. (2015), van der Zanden et al. (2014), Norton et al. (2020), Hastaoğlu et al. (2023), Höglund et al. (2018)
(+) Representation of the carrier food as enrichable	Geny et al. (2024, 2025), van der Zanden et al. (2015), van der Zanden et al. (2014), Song et al. (2018), Tsikritzi et al. (2015)
(0) Education level	Broeckhoven et al. (2021), van der Zanden et al. (2014), Song et al. (2018)
<b>Social characteristics</b>	
(+) Involvement in co-design	Geny et al. (2024), Carrillo and Tárrega (2025), Geny et al. (2025), Norton et al. (2020), Song et al. (2018)
(+) Eating in company	Geny et al. (2024, 2025), van der Zanden et al. (2014)
(+) Advice from doctors and dietitians	Geny et al. (2024), van der Zanden et al. (2015), van der Zanden et al. (2014), Beelen et al. (2017)
<b>Psychological factors</b>	
(+) Familiarity with the enriched product	Geny et al. (2024), Carrillo and Tárrega (2025), Broeckhoven et al. (2021), van der Zanden et al. (2015), van der Zanden et al. (2014), Norton et al. (2020), Song et al. (2018), Beelen et al. (2017), Tsikritzi et al. (2015)
(-) Food neophobia	Geny et al. (2024), Carrillo and Tárrega (2025), van der Zanden et al. (2015), Badia-Olmos et al. (2025), Song et al. (2018)
(+) Concern about proteins	Carrillo and Tárrega (2025), Broeckhoven et al. (2021), Geny et al. (2025), van der Zanden et al. (2015), van der Zanden et al. (2014), Badia-Olmos et al. (2025), Beelen et al. (2017), Song et al. (2018)
(+) Willingness to taste	Broeckhoven et al. (2021), Geny et al. (2025), van der Zanden et al. (2015), van der Zanden et al. (2014), Song et al. (2018), Song et al. (2018)
(-) Lack of perceived relevance	Carrillo and Tárrega (2025), Geny et al. (2025), van der Zanden et al. (2015), van der Zanden et al. (2014), Beelen et al. (2017)
(+) Importance attributed to health	Broeckhoven et al. (2021), Geny et al. (2025), van der Zanden et al. (2015), van der Zanden et al. (2014), Song et al. (2018), Badia-Olmos et al. (2025), Song et al. (2018)
(+) Importance attributed to sustainability	Broeckhoven et al. (2021), Geny et al. (2025)
(-) Low protein knowledge	Carrillo and Tárrega (2025), Geny et al. (2025), van der Zanden et al. (2014), Badia-Olmos et al. (2025), Beelen et al. (2017), Song et al. (2018)
(+) High expected liking	Carrillo and Tárrega (2025), Geny et al. (2025)
(+) Trust in the product	Carrillo and Tárrega (2025), Geny et al. (2025), Song et al. (2018)
<b>Extrinsic product characteristics</b>	
(-) Novelty/strangeness of the product	Geny et al. (2024), Carrillo and Tárrega (2025), Broeckhoven et al. (2021), Geny et al. (2025), van der Zanden et al. (2015), van der Zanden et al. (2014), Badia-Olmos et al. (2025), Song et al. (2018)
(+) "Do-It-Yourself" formulation	Geny et al. (2025), Hastaoğlu et al. (2023), Badia-Olmos et al. (2025)
(+) Ease of preparation	Geny et al. (2024), Carrillo and Tárrega (2025), Geny et al. (2025), Hastaoğlu et al. (2023), Song et al. (2018), Badia-Olmos et al. (2025), Beelen et al. (2017)

**Table 2 (continued)**

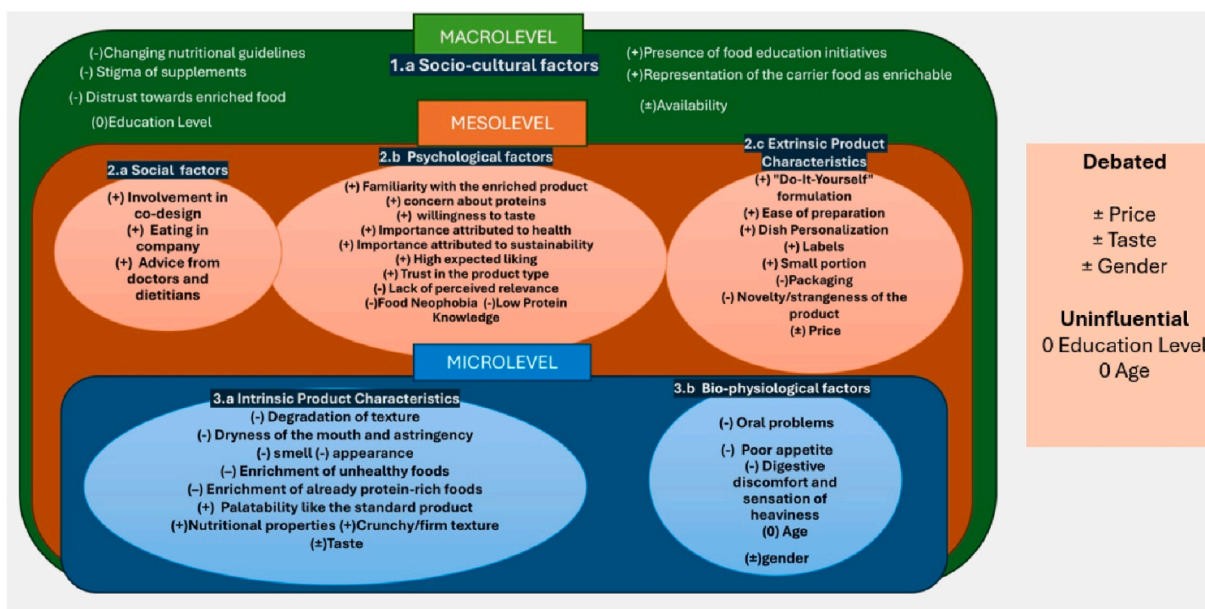
Determinants	Reference (Author, year)
	et al. (2017), Song et al. (2018), Höglund et al. (2018)
(+) Dish personalization	Geny et al. (2025)
(-) Price	Geny et al. (2025), van der Zanden et al. (2014)
(+) Labels	Geny et al. (2025), Beelen et al. (2017)
(-) Packaging	Geny et al. (2025), Beelen et al. (2017), Höglund et al. (2018)
(+) Small portion	Geny et al. (2024, 2025), van der Zanden et al. (2014), Norton et al. (2020), Hastaoğlu et al. (2023), Song et al. (2018), Beelen et al. (2017), Höglund et al. (2018)
<b>Intrinsic product characteristics</b>	
(-) Degradation of texture	Geny et al. (2024, 2025), Norton et al. (2020), Song et al. (2018), Badia-Olmos et al. (2025), Beelen et al. (2017), Tsikritzi et al. (2015), Höglund et al. (2018)
(-) Dryness of the mouth and astringency	Geny et al. (2024), Carrillo and Tárrega (2025), Geny et al. (2025), Norton et al. (2020), Song et al. (2018), Badia-Olmos et al. (2025), Tsikritzi et al. (2015)
(±) Taste	Geny et al. (2024), Carrillo and Tárrega (2025), Geny et al. (2025), Norton et al. (2020), Song et al. (2018), Badia-Olmos et al. (2025), Beelen et al. (2017), Song et al. (2018), Tsikritzi et al. (2015), Höglund et al. (2018)
(+) Palatability similar to standard product	Geny et al. (2024), Carrillo and Tárrega (2025), Broeckhoven et al. (2021), Geny et al. (2025), van der Zanden et al. (2015), Norton et al. (2020), Song et al. (2018), Badia-Olmos et al. (2025), Beelen et al. (2017), Song et al. (2018), Tsikritzi et al. (2015)
(-) Smell	Carrillo and Tárrega (2025), Geny et al. (2025), Norton et al. (2020), Song et al. (2018)
(+) Nutritional properties	Broeckhoven et al. (2021), Badia-Olmos et al. (2025)
(-) Appearance	Geny et al. (2024, 2025), Norton et al. (2020), Song et al. (2018), Tsikritzi et al. (2015), Höglund et al. (2018)
(+) Crunchy/firm texture	Geny et al. (2025), Song et al. (2018)
(-) Enrichment of unhealthy foods	van der Zanden et al. (2014), Song et al. (2018)
(-) Enrichment of already protein-rich foods	van der Zanden et al. (2014)
<b>Bio-physiological characteristics</b>	
(-) Oral problems	Geny et al. (2024), Carrillo and Tárrega (2025), Norton et al. (2020), Hastaoğlu et al. (2023), Song et al. (2018), Badia-Olmos et al. (2025), Beelen et al. (2017), Tsikritzi et al. (2015), Höglund et al. (2018)
(-) Poor appetite	Geny et al. (2024), Broeckhoven et al. (2021), Geny et al. (2025), van der Zanden et al. (2015), van der Zanden et al. (2014), Norton et al. (2020), Hastaoğlu et al. (2023), Song et al. (2018), Badia-Olmos et al. (2025), Beelen et al. (2017), Song et al. (2018), Tsikritzi et al. (2015), Höglund et al. (2018)
(-) Digestive discomfort and sensation of heaviness	Carrillo and Tárrega (2025), Hastaoğlu et al. (2023), Beelen et al. (2017)
(0) Age	Broeckhoven et al. (2021), Norton et al. (2020)
(±) Gender	Broeckhoven et al. (2021), Geny et al. (2025), Norton et al. (2020), Song et al. (2018), Song et al. (2018), Höglund et al. (2018)

**Note.** Determinants are classified by analytical level and sublevel. Valence indicates whether each determinant was reported as a facilitator (+), barrier (-), neutral (0), or debated (±) in the included studies. References correspond to the studies in which each determinant was identified.

were therefore not included among the identified determinants.

**3.4.3. Extrinsic product characteristics**

Extrinsic product characteristics showed moderate representation (D = 0.31; Table 1). The most frequently reported facilitators were ease of preparation (64%) and small portion size (50%). Novelty or perceived



**Fig. 6.** Multilevel Synthesis of Protein-enriched Product Acceptance among older Adults  
 Note: (–) Barrier (+) Facilitator (0) Neutral (±Debated). Number of studies included = 14.

**Table 3**  
 Adjusted distributions of determinants influencing protein-enriched foods acceptance in older adults.

Analytical level	Sublevel	Adjusted appearance density
Macro level	Sociocultural factors	0.36
Meso level	Social characteristics	0.29
	Psychological factors	0.35
Micro level	Extrinsic product characteristics	0.31
	Intrinsic product characteristics	0.37
	Biophysiological characteristics	0.40

**Note.** Adjusted appearance density reflects the relative representation of determinants within each analytical level or sublevel, accounting for differences in the number of determinants across categories. Higher values indicate greater representation in literature rather than greater causal importance.

**Table 4**  
 Macro-level sociocultural determinants influencing acceptance of protein-enriched foods in older adults (N = 14).

Determinant	Valence	n	%
Availability	±	7	50
Representation of carrier food as enrichable	+	6	43
Changing nutritional guidelines	–	5	36
Stigma of supplements	–	5	36
Distrust toward enriched foods	–	5	36
Presence of food education initiatives	+	4	29
Education level	0	3	21

**Note:** Frequencies indicate the proportion of included studies (N = 14) in which each determinant was reported as influencing acceptance. Valence indicates whether determinants were described as facilitators (+), barriers (–), neutral (0), or debated (±).

strangeness of the product was the most frequently reported barrier (57%).

Other extrinsic factors, including packaging (21%), price and labels (14% each), were reported less frequently (Table 5). Packaging-related barriers referred mainly to usability and legibility, while labels were occasionally reported as facilitating reassurance and overall acceptance. “Do-it-yourself” formulations (21%) and dish personalization (7%) appeared sporadically, suggesting underexplored opportunities to

**Table 5**  
 Meso-level determinants influencing acceptance of protein-enriched foods in older adults.

Sublevel	Determinant	Valence	n	%
Social	Involvement in co-design	+	5	36
	Advice from doctors/dietitians	+	4	29
Psychological	Eating in company	+	3	21
	Familiarity with product	+	7	50
	Importance attributed to health	+	8	57
	Concern about protein intake	+	6	43
	Willingness to taste	+	6	43
	Food neophobia	–	5	36
	Low protein knowledge	–	5	36
	Lack of perceived relevance	–	5	36
	Trust in the product	+	2	14
	High expected liking	+	1	7
Extrinsic product characteristics	Importance attributed to sustainability	+	1	7
	Ease of preparation	+	9	64
	Small portion size	+	7	50
	Novelty/strangeness of product	–	8	57
	“Do-it-yourself” formulation	+	3	21
	Packaging	–	3	21
	Price	–	2	14
Labels	+	2	14	
Dish personalization	+	1	7	

**Note:** Frequencies indicate the proportion of included studies (n = 14) in which each determinant was reported as influencing acceptance. Valence indicates whether determinants were described as facilitators (+) or barriers (–).

enhance acceptance through flexibility.

Overall, extrinsic characteristics functioned as supportive or constraining conditions that modulated acceptance but did not override sensory or physiological constraints.

3.5. Micro-level determinants

3.5.1. Intrinsic product characteristics

Intrinsic product characteristics were highly represented (D = 0.37;

**Table 3).** Taste was the most frequently reported determinant (79%), with both facilitating and constraining roles depending on product performance. Palatability comparable to standard products was reported as a facilitator in 71% of studies.

As indicated in **Table 6**, key sensory barriers included degradation of texture (57%), changes in appearance (50%), and dryness or astringency (36%). Nutritional properties were reported less frequently (14%) indicating that nutritional value does not offset sensory dissatisfaction.

### 3.5.2. Biophysiological characteristics

Biophysiological characteristics showed the highest adjusted density ( $D = 0.40$ ; **Table 3**). Poor appetite (64%) and oral problems (57%) were the most frequently reported barriers, followed by digestive discomfort or heaviness. Gender emerged as a debated factor ( $\pm$ , 43%), whereas chronological age itself was rarely addressed explicitly (0, 14%).

## 4. Discussion

This systematic review identified and synthesized determinants influencing the acceptance of protein-enriched foods among older adults within a multilevel framework. Findings indicate that acceptance is primarily constrained by micro-level factors, particularly sensory and biophysiological characteristics, while meso- and macro-level determinants act as enabling or contextual conditions. Across the literature, acceptance was consistently framed as contingent on whether products can be sensorially acceptable and physically consumable, with psychological, social, and sociocultural factors shaping how these products are interpreted, integrated, and legitimized.

### 4.1. Micro-level determinants: sensory and physiological constraints as foundational conditions

The present review demonstrates that acceptance of protein-enriched foods among older adults is primarily constrained at the micro level, by intrinsic product characteristics and biophysiological attributes of consumers. These determinants showed the highest adjusted appearance densities, indicating that literature consistently frames acceptance as contingent on whether products can be sensorially enjoyed and physically consumed.

**Table 6**

Micro-level determinants influencing acceptance of protein-enriched foods in older adults.

Sublevel	Determinant	Valence	n	%
<b>Intrinsic product characteristics</b>	Taste	$\pm$	11	79
	Palatability similar to standard product	+	10	71
	Degradation of texture	-	8	57
	Appearance	-	7	50
	Dryness/astringency	-	5	36
	Smell	-	4	29
	Nutritional properties	+	2	14
	Crunchy/firm texture	+	2	14
	Enrichment of unhealthy foods	-	2	14
	Enrichment of already protein-rich foods	-	1	7
<b>Biophysiological characteristics</b>	Poor appetite	-	9	64
	Oral problems	-	8	57
	Digestive discomfort/heaviness	-	3	21
	Gender	$\pm$	6	43
	Age	0	2	14

**Note.** Frequency indicates the proportion of included studies ( $n = 14$ ) in which each determinant was reported as influencing acceptance. Valence indicates whether determinants were described as facilitators (+), barriers (-), neutral (0), or debated ( $\pm$ ).

Intrinsic product characteristics were mainly determined by taste, texture, and appearance. Taste was the most frequently cited variable, yet its debated classification highlights a key insight: protein enrichment is not inherently rejected if sensory integrity is preserved (Geny et al., 2024; Hastoğlu et al., 2023). When enrichment alters texture or appearance, rejection is likely. This finding aligns with sensory-driven development research showing that older consumers apply strict sensory standards while evaluating enriched foods as replacements for their familiar products (Song et al., 2018; Tsikritzi et al., 2015).

Biophysiological factors further impose non-negotiable boundaries on acceptance. Poor appetite and oral problems were the most frequently reported barriers, reflecting age-related functional changes that directly limit intake (Höglund et al., 2018; Norton et al., 2020; Wendin et al., 2017). Importantly, chronological age itself was rarely discussed, reinforcing gerontological perspectives that emphasize functional capacity over age (Russell, 2024). Together, these findings indicate that sensory and physiological compatibility constitute necessary conditions for acceptance.

### 4.2. Meso-level determinants: psychological and social processes as conditional enablers

At the meso level, psychological determinants emerged as key factors shaping whether protein-enriched foods are perceived as relevant, acceptable, and worth trying. Familiarity with the enriched product was the most prominent facilitator, supporting schema-based and heuristic models of food choice whereby familiar formats reduce perceived risk and cognitive effort (van der Zanden et al., 2014; Wansink & Sobal, 2007).

Perceived health relevance also supported acceptance, particularly among individuals motivated to maintain functional independence. This aligns with the Theory of Planned Behavior, which emphasizes the role of personally relevant goals in shaping intention and behavior (Ajzen, 1991). However, these facilitators appeared to operate conditionally, as their influence depended on prior alignment with sensory and functional expectations.

Food neophobia, low protein knowledge, and lack of perceived relevance were consistently identified as barriers, suggesting that resistance to protein-enriched foods often reflects experiential uncertainty rather than ideological opposition (Carrillo & Tárrega, 2025). The recurring presence of low protein knowledge and limited perceived relevance indicates that protein is not systematically integrated into everyday decision-making criteria.

While older adults are generally attentive to the nutritional composition of their diet, this attention is not uniformly distributed across nutrients. Dietary choices in later life are often guided by long-established heuristics centered on reducing sugar, fat, or overall caloric intake, reflecting decades of public health messaging (Hadar et al., 2021; Kim & Kang, 2025; van Oppenraaij et al., 2025; Zhan, 2025). Within this framework, protein may remain comparatively less salient, despite its established role in maintaining muscle mass, functional capacity, and overall health in ageing populations (Carrillo & Tárrega, 2025; Daly et al., 2025).

As a result, protein-enriched foods may not be readily interpreted as relevant unless their benefits are clearly linked to tangible outcomes such as strength, mobility, or recovery (Andreassen et al., 2023; Daniele et al., 2024). For example, a product positioned as “high-protein” may carry less meaning than one framed in terms of supporting independence or preventing frailty, particularly when competing against more familiar cues such as “low fat” or “reduced sugar” that tend to be more salient and highly documented.

Although the included studies did not directly compare the salience of protein with other nutritional concerns, the consistent presence of low protein knowledge and lack of perceived relevance as barriers (Beelen et al., 2017; Van der Zanden et al., 2014) suggests that acceptance is partly shaped by how nutritional value is framed and prioritized, rather

than by the intrinsic properties of the products alone.

On the social sublevel, determinants were infrequently addressed but consistently categorized as facilitators when examined. In the included studies, social influence was primarily operationalized through professional advice, co-design involvement, and shared eating contexts. These factors can be interpreted through Social Cognitive Theory as forms of social modelling and normative influence, whereby individuals rely on external cues, such as expert recommendations or the behaviour of others, to evaluate the appropriateness and desirability of a food (Bandura, 1986). In this sense, professional advice and shared eating situations may function as sources of validation, reducing uncertainty and increasing confidence in engaging with unfamiliar or modified products (Beelen et al., 2017; Van der Zanden et al., 2014).

Importantly, broader relational influences; as informal advice from family members or peers, as well as shared beliefs about what constitutes appropriate or necessary food in later life, were not explicitly examined in the included studies and therefore cannot be considered as findings of this review. This represents a notable gap, given that everyday food choices are often shaped within close social networks and influenced by normative beliefs and interpersonal dynamics (Castellini & Graffigna, 2022a).

Similarly, loneliness and social isolation were not directly addressed in the reviewed literature. Their absence is particularly relevant, as eating in later life is rarely an individual act and is typically embedded within routines, relationships, and care structures that can influence food intake and dietary quality (Beelen et al., 2017; Eglseer et al., 2025). Social isolation has been associated with reduced meal enjoyment, lower motivation to prepare food, and simplified eating patterns, all of which may plausibly affect the acceptance of novel or modified food products (Hanna et al., 2023; Jones & Ismail, 2022).

Taken together, the limited representation of these dimensions suggests that current research tends to operationalize acceptance at the individual level, often under controlled or product-focused conditions. As a result, the role of informal social influence, interpersonal beliefs, and social connectedness in shaping acceptance remains insufficiently characterized, despite their likely relevance in real-life consumption contexts (Caso & Vecchio, 2022; Geny et al., 2025).

#### 4.3. Macro-level determinants: sociocultural framing of legitimacy and appropriateness

Macro-level sociocultural determinants provided an important contextual framework for acceptance. Availability and representation of the carrier food as enrichable were the most frequently cited macro-level variables, highlighting that acceptance depends on whether protein enrichment aligns with culturally embedded food meanings and norms (Lillekroken et al., 2024). It should be noted that most of the included studies were developed in Northern European countries, which means that the acceptability parameters reported on each document will be linked to their associated realities. It is therefore important that new literature is developed in broader contexts, to capture the acceptance characteristics that shape the heterogeneous representation of protein-enriched food for older adults around the world.

From a sociocultural perspective, foods function as symbolic artefacts rather than neutral nutrient carriers (Castellini & Graffigna, 2022a, 2022b; Fischler, 1988). The recurrent appearance of stigma toward supplements and distrust toward enriched foods suggests that protein enrichment may be perceived as overly medicalized or artificial when it conflicts with normative expectations of “proper food.” (Geny et al., 2025; van der Zanden et al., 2015) Changing nutritional guidelines further contributed to uncertainty, undermining trust and complicating decision-making, consistent with research on institutional trust in food systems.

Crucially, macro-level facilitators did not override micro-level barriers. Improved availability or positive framing cannot compensate for poor sensory quality or physiological incompatibility. Instead, macro-

level factors appear to set the conditions of legitimacy and access, determining whether protein-enriched foods are considered acceptable options worthy of evaluation.

#### 4.4. An integrated micro-meso-macro model of acceptance

Taken together, the findings support a hierarchical yet interactive model of acceptance. Sensory and physiological compatibility at the micro level constitute foundational requirements; psychological readiness and social validation at the meso-level enable engagement; and sociocultural framing at the macro level shapes legitimacy and access.

At the micro level, acceptance is mainly constrained by sensory and physiological factors. Products are judged against familiar standards, and changes, especially in texture and appearance, are often rejected. Protein enrichment is therefore experienced as a modification of known foods rather than an added value. This translates into the need to preserve acceptable taste and ensure textures remain easy to consume (e.g., smooth or soft rather than dry or grainy), particularly in the presence of oral limitations and reduced appetite.

At the meso level, acceptance depends on how easily products fit into everyday habits. Familiarity, perceived relevance, and ease of preparation support uptake, while novelty can create resistance. Accordingly, products are more likely to be adopted when they resemble commonly eaten foods, require minimal preparation, and are offered in portion sizes consistent with reduced appetite and routine consumption.

At the macro level, acceptance is shaped by legitimacy and access within the food environment. The choice of carrier food, together with availability and trust, influences whether products are seen as appropriate. In this context, positioning within familiar food categories, alongside adequate availability and visibility in retail environments, supports their consideration as part of everyday food choices.

This structure aligns with multilevel models of food acceptance and reinforces that interventions targeting a single level are unlikely to succeed in isolation (Köster & Mojet, 2018a, 2018b). For protein-enriched foods, adoption depends on alignment across product design, daily use, and the food environment. Improvements at the meso and macro levels may facilitate uptake, but do not compensate for shortcomings at the micro level.

## 5. Limitations

This review is subject to limitations. First, most included studies were conducted in Western and Northern European contexts, which may limit the transferability of the findings, particularly about sociocultural determinants of acceptance. Future research should therefore consider more geographically and culturally diverse populations.

Second, heterogeneity in study designs, products, and outcome measures precluded quantitative meta-analysis, and limited the possibility of more granular analyses, such as comparisons across specific food categories. This decision was primarily due to the heterogeneity of food matrices investigated across the included studies, with several works assessing protein-enriched products spanning multiple food categories. Moreover, acceptance outcomes were generally reported in relation to the enriched products rather than being explicitly attributed to the underlying food category. As a result, disentangling category-specific acceptance barriers and facilitators would have required assumptions not sufficiently supported by the available data. For this reason, and to ensure analytical coherence and methodological robustness, the analysis performed in this review focused on the barriers and facilitators influencing consumer acceptance of protein-enriched food products.

Third, frequency-based synthesis reflects the analytical emphasis of the literature rather than effect size or causal strength; greater methodological harmonization would enable more robust comparative analyses.

Finally, social and situational determinants may be

underrepresented due to methodological preferences for individual sensory testing; incorporating studies conducted in real-life consumption contexts, including shared eating environments, would contribute to a more comprehensive understanding of acceptance processes.

## 6. Conclusions

This systematic review shows that acceptance of protein-enriched foods among older adults is primarily constrained by micro-level sensory and physiological factors, enabled by meso-level psychological readiness, and framed by macro-level sociocultural conditions. Nutritional efficacy alone is insufficient to ensure acceptance if products fail to preserve sensory integrity or accommodate age-related functional limitations.

For food developers and policymakers, these findings underscore the need to prioritize sensory preservation, texture adaptation, portion suitability, and routine compatibility, with health communication and availability acting as supportive, rather than primary, levers. For food preference research, this review highlights the importance of conceptualizing acceptance in later life as an embodied, meaning-driven process, requiring integrated approaches that bridge product design, consumer psychology, and sociocultural context.

## CRedit authorship contribution statement

**Michelle Calvete-Labouz:** Writing – review & editing, Writing – original draft, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Xiaoyu Hu:** Writing – original draft, Software, Methodology, Investigation, Formal analysis. **Guendalina Graffigna:** Writing – review & editing, Validation, Supervision, Project administration, Data curation, Conceptualization.

## Ethical statement

This study is a systematic review of previously published research. It did not involve the collection of new data from human participants or animals. All procedures were conducted in accordance with institutional and international standards for research integrity. Ethical approval was therefore not required.

## Declaration of generative AI and AI-assisted technologies in the manuscript preparation process

During the preparation of this work, authors used NotebookLM and Rayyan to organize papers and extract general data. Writefull. Ai was also used to improve text coherence. After using these tools, the authors reviewed and edited the content as needed and took full responsibility for the content of the published article.

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## Declaration of competing interest

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

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.appet.2026.108585>.

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