



Exploring consumer beliefs about novel fortified foods: A focus group study with UK-based older and younger adult consumers

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ABSTRACT

Consuming ‘nutritionally-enhanced’ food products (including those that are fortified or enriched to deliver nutritional and functional properties) may help to improve overall diet quality and combat risks associated with malnutrition. However, fortification can negatively impact consumer acceptance, particularly where expected sensory properties of ‘delivery’ foods are affected by target ingredients. Here, we explored factors influencing consumer acceptability for six novel food products that had been fortified, including both savoury and sweet meal components (e.g., high protein dumplings, probiotic yoghurt drink). In person focus groups (25 consumers aged between 22 and 76 years old) were conducted with two stages; firstly, participants completed a blind taste test of products without awareness of fortification. Secondly, participants discussed products with awareness of additional ingredients and food properties. Reflexive thematic analysis showed that liking of sensory properties differed between foods, but informing participants about the fortification of products highlighted potential trade-offs between taste, health, price, and familiarity. Though taste and texture were generally prioritised by participants, positive perceptions of health benefits increased consumer willingness to buy, whilst both cost and uncertainty about product use were potential barriers. Trust of information was a key concern for labelling and product claims. These results highlight product features that may be optimised to support the success of fortified foods. Greater transparency when building product brands and improving consumer knowledge of fortification may also be important for longer-term consumer acceptance.

1. Introduction

‘Malnutrition’ – relating to deficiencies in energy, macronutrients and/or micronutrients – can negatively impact health, particularly for older adults (Saunders & Smith, 2010). Malnutrition is a progressive condition that can worsen overtime, requiring dietary intervention to increase energy and nutritional intakes. Within this context, ‘oral nutritional supplements’ (typically prescribed in liquid or powdered forms) are most often used to address individual risks associated with specific nutritional deficiencies, particularly in healthcare settings (Haines, Gorenshtein, Lumpkin, Grisel, & Gallagher, 2023). By contrast, ‘fortification’ may be used as a ‘food-based’ approach to target population diet quality, increasing nutritional density of readily consumed food products as a preventative measure.

Fortification can take the form of added whole foods to items – such

as dairy products (Cave, Abbey, & Capra, 2020; Mills, Wilcox, Ibrahim, & Roberts, 2018; Sossen et al., 2021), fresh vegetables (López-Nicolás et al., 2014) and seaweed (Cofrades, Benedí, Garcimartin, Sánchez-Muniz, & Jimenez-Colmenero, 2017) – as well as concentrated nutritional powders or liquid extracts like milk/whey protein (Norton, Lignou, & Methven, 2021) and pulverised vegetables (Boukid, Zannini, Carini, & Vittadini, 2019; Ranawana et al., 2016). Studies across Europe have shown that fortification can support micronutrient levels, significantly increasing the intake of folate, iron, B vitamins, and vitamin D (Bird, Barron, Pigat, & Bruins, 2022; de Jong, Nawijn, & Verkaik-Kloosterman, 2022; Hennessy, Walton, & Flynn, 2013). In hospital and care settings with older adults, meals and snacks that are enriched with high-energy and/or high-protein ingredients (such as butter, cream, or milk powder) have been shown to significantly increase respective nutritional intakes relative to standard products or

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supplementation, in addition to encouraging greater food consumption in some studies (Mills et al., 2018; Sossen et al., 2021).

Legislation to encourage the use of fortification varies considerably between countries (Hennessy et al., 2013). In the UK, fortification is mandatory for some flours, which require additions of calcium carbonate and other micronutrients (including iron, vitamin B1, and vitamin B3) (The bread and flour regulations 1998, 1998). Margarine is also fortified with vitamin A and vitamin D (The Spreadable Fats (Marketing Standards) and the Milk and Milk Products (Protection of Designations) (England) Regulations 2008, 2008). However, fortification (during food processing) otherwise remains largely voluntary for manufacturers. Processed foods, which are widely consumed (Madruga, Steele, Reynolds, Levy, & Rauber, 2022), currently account for up to 15% of recommended daily intakes for different micronutrients when fortified (Bird et al., 2022). As recognised by the British Dietetic Association (BDA) (British Dietetic Association (BDA), 2021), fortification may be particularly important for products that are intended to replace other food sources in the consumer diet, such as plant-based meat and dairy alternatives, though fortification levels remain relatively low amongst these categories (Clegg, TarradoRibes, Reynolds, Kliem, & Stergiadis, 2021; Craig & Brothers, 2021; Curtain & Grafenauer, 2019; Melville et al., 2023; Nicol et al., 2023). Instead, children aged 1–14 years old are the largest consumer demographic for fortified foods (Bird et al., 2022). This has been shown to have some success in intervention studies particularly for micronutrient deficiencies, potentially reducing the risk of all-cause mortality, anaemia and other illness in child populations, though there are some inconsistencies between studies (Eichler et al., 2019; Tam et al., 2020). There also remains a need to target a more diverse range of products for adult consumers. Such variety may be particularly important for dietary intake of micronutrients in healthcare settings (Keller, Pereira De Paula, Wei, Duncan, & Duizer, 2019).

In order to increase the uptake of fortification from an industry perspective, there remains a need to de-risk investments within this product space. Consumer acceptance of fortified foods, particularly when utilising nutritional extracts that may influence the sensory properties of delivery foods, can be a significant barrier to product development. For example, use of whey protein and micronutrient-based powders in snacks, soups, and main meal components – particularly at higher levels of fortification – have been associated with reports of increased ‘dryness’ and ‘off-flavours’ (Field, Duncan, Keller, Stark, & Duizer, 2017; Norton, Lignou, Bull, Gosney, & Methven, 2020; Tsikritzi et al., 2015). In one UK study focussed on acceptance of Vitamin D fortification specifically (N = 13), willingness to switch to fortified food products was low among consumers in focus groups, with expectations for taste being among the most important influences on product choice (Clark, Hill, & Hubbard, 2019). In a second survey-based study (N = 109), almost half of participants were unsure about the benefits of increasing availability of fortified foods, instead preferring ‘natural’ sources of Vitamin D (Clark et al., 2019).

Therefore, considering that 1) fortification is predominantly focussed on a limited range of product categories/nutritional needs in the current market, and 2) consumer acceptance is a key challenge for delivering ‘novel’ fortified foods, the aim of this study was to explore the consumer acceptability of fortifying a diverse range of food products with additional nutritional properties. In a series of focus groups with community-dwelling older and younger adults, we explored consumer perceptions of product features and acceptance of fortified foods, consumer beliefs about product design and labelling for fortified foods, as well as general consumer knowledge of dietary guidelines and identification of food sources to meet these needs.

2. Methods

2.1. Overview of study design

Focus groups were conducted to encourage an in-depth discussion of

beliefs about fortified food products among consumers. Contrasting with our initial study preregistration involving only older adults (defined as those aged 55 yrs or older (Ferrari, Ferriday, Smit, McCaig, & Rogers, 2019; van den Heuvel, Newbury, & Appleton, 2019; Visser et al., 2020)), both older and younger adult age groups were included to ensure sufficient focus group sizes during early stages of data collection. (see the OSF: <https://osf.io/2vdrs>). This broadened the sample population in line with a lifespan approach to include those aged 18–39 (‘young adults’) and 40–54 (‘middle-aged adults’), but did not change the rationale of the study as this related to understanding the consumer acceptance and benefits of fortified food products to support healthy aging.

2.2. Participants

Five focus groups were conducted with a total of 25 participants. Participants were recruited to the study via older adult research volunteer mailing lists (e.g., [Blinded]), social media channels, local community boards, and the staff and student population at [Blinded]. Participants were also invited to share contacts of others who may be interested in taking part. Participants were included in the study if they could travel to the focus group location in [Blinded] and were able and willing to consume sample test foods. Participants were excluded from the study if they self-reported having any known food allergies/intolerances or if they followed a vegan diet. Where appropriate, individuals were also excluded from participating if they self-reported symptoms of potential cognitive impairment via the ‘AD8’ dementia screening tool (Galvin et al., 2005). A stepwise approach to participant recruitment was adopted, whereby eligibility criteria were adjusted over time to target those aged ≥ 55 yrs, ≥ 40 yrs, ≥ 30 yrs, and ≥ 18 yrs. This meant that participant sign-ups were prioritised for different age groups throughout recruitment, but each group ultimately included participants of mixed ages. In line with previous recommendations, we over-recruited participants to include an average of five and no more than 10 individuals per group (Howitt, 2013).

2.3. Test food products

Samples of six test foods were presented to participants, including both savoury and sweet meal components (see Fig. 1). Test foods were selected to target multiple eating occasions and delivery methods (i.e., main meal dish, breakfast/beverage item, dessert food, snack food, supplementary garnish/seasoning), including different ingredients for fortification and functional properties that were suitable to each product. All test foods were developed and produced by local SMEs within [Blinded], with the exception of the seaweed seasoning that was purchased from an independent online UK retailer. All samples used in focus groups were stored and prepared in line with manufacturer instructions. Dumplings and potato wedges (to accompany the seaweed seasoning) were oven-baked shortly before each focus group session and served warm; all other samples were served chilled or at room temperature. Serving sizes were selected to provide an appropriate ‘tasting’ unit for each product (e.g., one whole dumpling, one single-serving tub of ice cream). See Table 1 for the nutritional composition of test foods.

2.4. Procedures

Prior to participating in focus groups, all participants who signed-up to the study were directed to complete an online screening questionnaire in ‘Qualtrics’ (Qualtrics, Provo, UT). Participants were provided with an information sheet and gave informed consent via an online tick-box form. Participants were instructed that the aim of the study was to explore “consumer beliefs about new recipes for food products”, and no mention was given about fortification of food products at this stage. Participants provided demographic information and completed a number of questionnaires (e.g., the ‘Simplified Nutritional Appetite



Fig. 1. Samples of test foods presented to participants. From left to right, top to bottom: dumpling, yoghurt drink, dried fruit & nut-based topping, chocolate ice cream, seaweed seasoning, chocolate cup.

Questionnaire' (SNAQ)) to indicate poor appetite and risk of significant weight loss (Wilson et al., 2005). Further detail on the screening questionnaire is provided in the supplementary materials.

All focus group sessions were scheduled during November 2022 to occur on weekdays between 13:30 and 15:00 p.m. Each discussion lasted approximately 60 min, with at least two researchers present to act as a group facilitator and note taker respectively, and to assist with food preparation. A semi-structured interview guide was used to divide each discussion into two phases (see Table 2).

During the first phase, participants remained blind to the study aim. They were asked to discuss their awareness of healthy eating, including their use of dietary guidelines and supplements. They were then presented with a tray of sample test foods (see Fig. 1) and were instructed to taste and discuss each item in turn, taking a sip of water between each food as a palate cleanser. Participants were asked about their initial beliefs relating to 1) sensory product appeal including the taste, texture, smell, and appearance of foods, and 2) expectations for product attributes including the healthiness, naturalness, sustainability, and

affordability of foods. Appetite ratings were not included, as we did not standardise food intake (participants were free to eat as much or as little of the food samples as they liked in order to engage in the focus group discussion).

During the second phase, participants were informed about the fortification of food products. They were asked to consider whether or not this changed their expectations for product attributes, and discuss their preferences for product labelling including potential health and nutritional claims for fortified foods (see supplementary materials). To close the discussion, participants were asked about their willingness to buy and pay for sample test foods.

Across both of these phases, the facilitator only interjected participant discussions to clarify questions, prompt further discussion, maintain relevance to the topic, or move the discussion forward where relevant. At the end of focus group sessions, each participant was presented with a debrief form and compensated with a £15 gift voucher as a thank you for their time.

2.5. Data analysis

For qualitative data, all focus group discussions were audio-recorded and initial transcripts were generated using the 'Transcribe' feature available in Microsoft 365 v2301. Reflexive thematic analysis was used to explore data and a primarily inductive approach to coding was adopted (Byrne, 2021), though we distinguished between focus group phases to recognise differences in context (i.e., when participants were 'blind' versus 'informed' about the fortification of test foods). This is a constructivist qualitative approach used to record and explore participant observations for the purpose of knowledge generation (Byrne, 2021).

Using the software 'Quirkos' (<https://www.quirkos.com/>), all transcripts were read multiple times and codes were generated prior to actively identifying themes. To aid in the development of a rich interpretation of data, three researchers independently coded data items and discussed progress at intervals before collaboratively merging and finalising common themes. As part of this process we acknowledge our contribution as researchers in identifying meanings, particularly as this relates to viewing data through the lens of our research objectives (Braun & Clarke, 2021). More broadly, this study was conducted as part of a project supporting 'healthy aging', with a key focus on improving the nutritional and sustainable qualities of food products available to consumers. As such, all authors involved in the study had an overarching interest in health and supporting successful product development within this field.

For quantitative data, descriptive statistics and frequencies were used to summarise demographic information and contextualise consumer segments within the sample, particularly as this related to age,

Table 1
Energy and macronutrient composition of test foods (per 100g) and source of fortification.

Food	Kcal	Fat (g)	Saturated fat (g)	Carbohydrate (g)	Sugar (g)	Protein (g)	Salt (g)	Sample serving size (g)	Source of fortification
Dumpling ^a	292	15.5	9.0	26.2	0.6	11.0	1.5	30	Made with added pea protein
Mango & passionfruit yoghurt drink	67	3.6	2.8	5.8	4.2	3.0	<0.1	30	Prebiotic drink (kefir-style)
Chocolate ice cream	172	5.2	2.6	21.0	20.1	10.4	0.1	102	Made with added pea protein and spirulina
Cashew butter, apricot & lemon dark chocolate cup	463	30.4	10.4	31.7	22.5	11.3	0.1	12	Made with added micronutrient powder (16 essential vitamins and minerals)
Almond, cranberry & flaxseed topping	428	32.8	4.4	11.2	6.0	17.2	0.0	10	Made with added micronutrient powder (16 essential vitamins and minerals)
Seaweed seasoning ^{b,c}	43	1.6	0.5	Tr	Tr	7.1	1.8	0.05	Made from Sugar Kelp (<i>Saccharina latissima</i>)

^a Also served with ≈50g of a meat-based sauce provided by the manufacturer (FG1) or store-bought tomato and basil pasta sauce (FG2 – FG5).

^b Sprinkled over a single oven-baked potato wedge.

^c Energy and macronutrient composition values based on proximate data for 'Seaweed, kombu, dried, raw' (Public Health England, 2021).

Table 2
Interview schedule for focus group discussions.

Research objective	Question
Consumer knowledge of dietary guidelines and use of available food sources to meet these needs	How would you interpret the term 'healthy eating'?
	Can you provide any examples of nutritional guidelines/recommendations that you are advised to follow?
	Have you made any adaptations to your diet for the purpose of increasing nutritional benefits/following these guidelines? <i>E.g., use of vitamin/mineral supplements, change in consumption of certain foods</i>
Consumer perception of fortified foods – Blind	How appetising do you think these foods are?//Why? <i>E.g., describe the taste, texture, appearance, smell</i>
	How healthy do you think these foods are?//Why?
	How natural do you think these foods are?//Why?
	How sustainable do you think these foods are?//Why?
	How affordable do you think these foods are?//Why?
	“ <i>These products have been fortified or enriched with ...</i> ” Are you aware of the use of <i>these ingredients/vitamins/minerals</i> to add to the nutritional content of foods? Have you consumed any other fortified/enriched products? Does this change your perception of these foods? <i>E.g., In terms of tastiness, healthiness, naturalness, sustainability, affordability</i>
Consumer beliefs about product design and marketing features for fortified foods	“ <i>Please take a moment to read the product descriptions in front of you ...</i> ” Do these descriptions change your perception of these foods? <i>E.g., In terms of tastiness, healthiness, naturalness, sustainability, affordability</i>
	What information do you think should be included on product packaging for fortified foods?
	Which product description do you prefer?//Why?
	Would you be willing to purchase these food products?//Why? <i>Are there any reasons why you might not want to consume/buy these foods/products?</i>
	How much would you be willing to pay for each of these products?//Why? Any other thoughts?
Consumer acceptance – Willingness to purchase and any potential barriers	

current health, and dietary intake status. To maintain anonymity for the duration of the study, participants were assigned a deidentified ID code to match quantitative and qualitative responses.

3. Results

3.1. Participant characteristics

Table 3 displays overall sample characteristics. Means and SDs for these measures were similar across age groups, and further information on frequency of consumption of test food types can be found in the supplementary materials.

3.2. Overview of key themes

We identified four main themes across focus groups; 1) taste & texture as drivers of product appeal, 2) healthy & sustainable foods as luxury products, 3) contextualising fortified foods to inform consumer

Table 3
Sample characteristics (N = 25).

Demographic	Frequency	Percentage
Age group (yrs)		
≥55	10	40.0
40–54	6	24.0
18–39	9	36.0
Gender		
Female	17	68.0
Male	7	28.0
Non-binary	1	4.0
Marital status		
Single, never married	15	60.0
Married	7	28.0
Divorced/separated	2	8.0
Widowed	1	4.0
Current residential household		
Single-person household	8	32.0
Multiple-person household	16	64.0
Prefer not to say	1	4.0
Annual household income (£)		
≤30,000	6	24.0
30,001–50,000	7	28.0
≥50,001	8	32.0
Don't know/Prefer not to say	4	16.0
Highest qualification completed		
No formal qualifications	2	8.0
High school level or equivalent	7	28.0
Undergraduate degree level or equivalent	7	28.0
Postgraduate degree or higher	9	36.0
Employment status		
In paid employment	13	52.0
Not in paid employment	2	8.0
Retired	5	20.0
Student	4	16.0
Prefer not to say	1	4.0
Dietary supplement user		
Yes	12	48.0
No	13	52.0
Trait	M	SD
Risk of frailty (FRAIL)	0.2	0.5
Risk of poor appetite (SNAQ)	15.9	1.8
Risk of inadequate protein intake (PRO 55+)	0.3	0.3
Dietary restraint (TFEQ-R18)	33.3	17.1
Self-reported BMI (Kg/m ²)	24.7	3.6

acceptance and 4) 'food' vs 'medicine' in nutrition, (see Fig. 2). Themes one, two and four predominantly relate to when participants were blinded to the study aim, whilst theme three relates to when participants were informed about the fortification of test foods. Some themes contain data from both phases, as knowledge of fortification appeared to add to prior beliefs about the taste, health, sustainability, and cost of products. These themes are discussed with reference to quotes from focus groups, and the participant ID number, age group, and gender are included in brackets. For brevity, only a summary narrative and quotes relating to the fourth theme are provided here, and additional discussion for this theme may be found in the supplementary materials (as this theme was more general in nature). For other themes, additional quotes are also provided in the supplementary materials.

3.2.1. Theme 1: taste & texture as drivers of product appeal

When asked to try sample foods (without knowledge of fortification), participants predominantly focussed on taste and texture and how this informed general liking (see Table 4). As would be expected, specific descriptors and their associated valence (positive/negative) differed between food products, and sometimes these beliefs were contradictory. For example, the consistency of the yoghurt drink was described as being both “thin” and “thick” across participants. The dumpling was mostly described as “bland”, “dense”, and “heavy”, but these characteristics were framed positively when paired with the accompanying sauce.

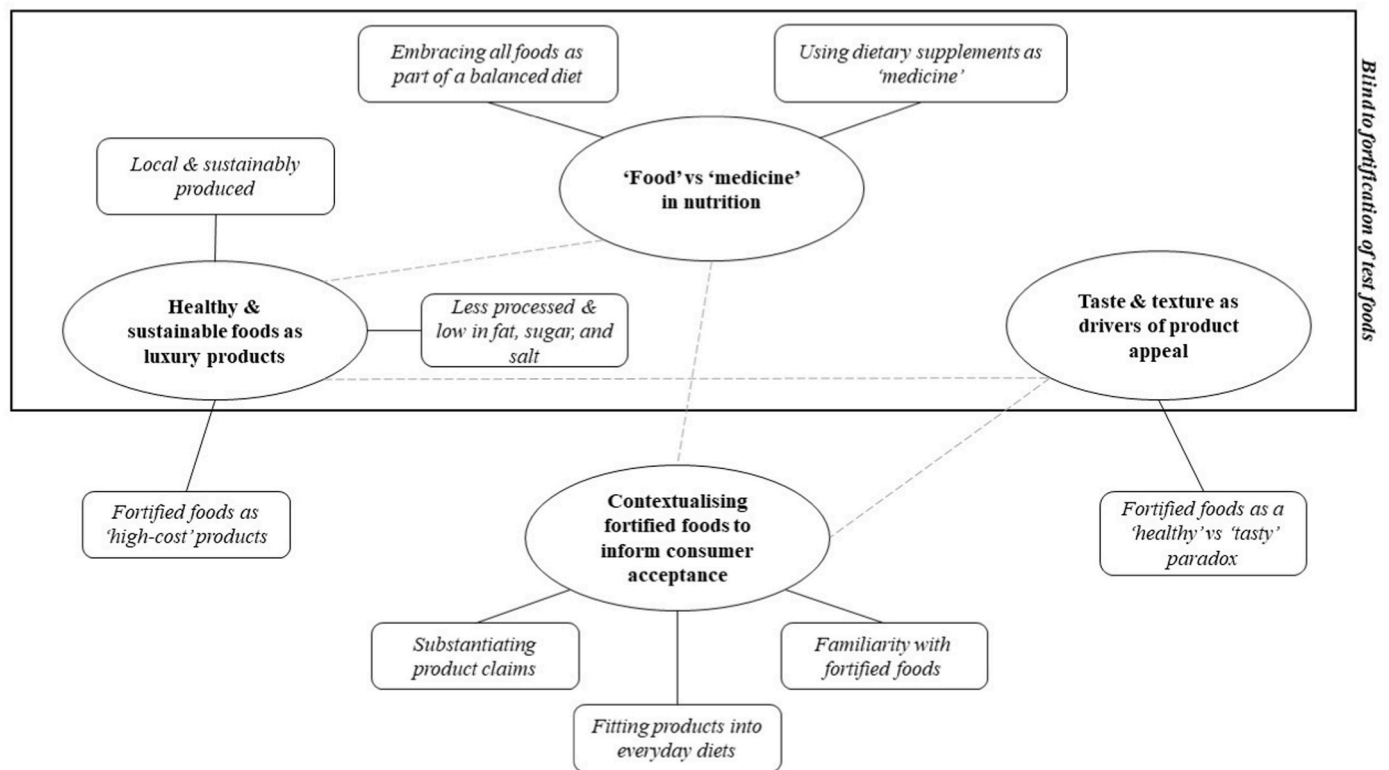


Fig. 2. Map of finalised themes (bold) and subthemes identified in focus group.

"But that's quite good 'cause the sauce has got quite a bit of flavour, so the dumpling is quite neutral, [and] it balances." (P934, ≥ 55 , f)

However, participants perceived an 'off-flavour' for some foods. The chocolate ice cream was generally well-liked (e.g., "It's nice you know, yeah I could eat more of it" P587, ≥ 55 , m), but participants referred to an artificial or concentrated flavour that they found difficult to describe:

"It does not taste like actual chocolate, it tastes [like] something different." (P717, 18–39, f)

The chocolate cup also elicited reports of an "odd" flavour, whilst some participants referred to a "strong" aftertaste for the dried fruit & nut-based topping:

"Oh no, some of it is actually not lovely. Oh no, there's a sort of ... taste of something like bicarbonate or something in it." (P010, ≥ 55 , f)

Beliefs about sensory characteristics were also sometimes influenced by the familiarity of foods, particularly as participants made comparisons to other products. For example, as the seaweed seasoning appeared to be more novel to participants, expectations about the taste and texture of the food influenced product appeal, particularly as the ability to mask the use of the seaweed seasoning within other foods was viewed as a potential advantage.

"I like the taste of seaweed ... I think some people might be put off by the... there is a slightly gelatinous feel to [the] consistency because you expect it to be like a herb, but it's got more body than a herb." (P010, ≥ 55 , f)

3.2.1.1. Subtheme: "I still don't like it": fortified foods as a 'healthy' vs 'tasty' paradox. Across participants, taste was often framed as a trade-off for additional health benefits. Participants inferred that their preference involved choosing between the 'less healthy, more tasty' or 'less tasty, more healthy' option. This was linked to participants' perception of

product attributes, whether or not these changed with information about fortification, and the individual's willingness to concede on individual 'taste' versus 'health' preferences.

On the one hand, where information about the fortification of test foods led to little change in the participants' perception of food products, health and nutritional claims had less influence on their acceptance of food products. For these participants, willingness to buy was predominantly driven by the palatability of foods and their initial liking of products during taste tests. Though the health connotations associated with fortification were generally positively perceived (see also Theme 3 below), participants remained mostly concerned with taste and how this compared to standard (unfortified) products in the wider market. For example, some participants described making the switch to other reformulated food products (e.g., low salt/sugar), but only when the same taste was guaranteed. Others referred to masking fortification ingredients as a way to benefit from nutritional attributes in a 'tasty' product, particularly for children.

"I would buy it to just see if it doesn't make any difference then I'll always go for the lower no added sugar or no added salt version, as long as it doesn't affect the taste too dramatically." (P108, 18–39, f)

On the other hand, where information about the fortification of test foods led to a greater change in the participants' perception of food products, participants appeared to be more health conscious. For the majority of these participants, fortification was associated with greater acceptance, as participants referred more positively to health claims. Participants were also motivated to buy these food products even if this required them to "keep persevering" in spite of taste and their initial liking.

"If it's going to give me all my omega and all the buzzwords – anti-inflammatory and my iron, double potassium – then, I'm happy." (P330, ≥ 55 , m)

However, for some of these participants, fortification was associated with lesser acceptance. One example of this related to beliefs about food

Table 4
Keywords used to describe the taste and texture of test foods during blind taste tests.

Test food	Taste	Texture	General liking
Dumpling	Bland/no taste	Dense Heavy Bread-like Doughy/ stodgy	"It's not unpleasant, I would happily eat it all." (P276, 40–54, f) "Not something I'd ever eat again ... Texture, taste, everything." (P907, ≥55, m)
Mango & passionfruit yoghurt drink	Fruity Sharp/tart Strong Sweet	Thin Thick	"It's nice, it's not unpleasant." (P686, 40–54, f) "It's not very creamy, it feels like a very you know, quite a thin yoghurt really, but the taste is good." (P010, ≥55, f)
Chocolate ice cream	Chocolate Rich Strong Bitter Powdery/artificial	Hard Solid Creamy Mousse-like Smooth	"It's quite sophisticated, it's quite nice." (P330, ≥55, m) "I don't like chocolate ice cream. I don't know why, I like chocolate, but I don't like chocolate ice cream personally, but it's a nice flavour." (P832, 40–54, f)
Cashew butter, apricot & lemon dark chocolate cup	Dark Bitter Raw (chocolate) Nutty Fruity Natural/healthy Bland/no taste Off-taste	Dry Dry Chewy Dense	"Pleasant enough." (P254) "It looked really nice and you think 'I know that looks really nice, I could use a box full of them' and then when you taste it, it's not." (P582, ≥55, f)
Almond, cranberry & flaxseed topping	Sweet Nutty Bland/no taste After-taste (strong)	Chewy Crunchy Dry	"It's really nice and lots of different colours, lots of different sizes of things." (P276, 40–54, f) "What I used to give my budgie" (P330, ≥55, m)
Seaweed seasoning	Weak Strong Salty/not salty	Dry Flaky	"Perfect, warm, good." (P280) "In my view, it's pointless. 'cause why would we have it on top of a perfectly lovely potato wedge with salt on?" (P744, 40–54, f)

processing. When blind to the fortification of test foods, almost all participants focussed on the natural quality of products and implied health benefits (e.g., "[they're] not full of other nasty ingredients"). In contrast, when they were made aware of the fortification of test foods, some participants associated products with higher levels of food processing that potentially conflicted with additional nutritional information and health claims:

"To add these extra things, that's a balance that is, 'cause I wouldn't necessarily buy them 'cause they've got a bit of vitamins in if it meant they were processed, I mean processed food should be kept for convenience and treats rather than ..." (P744, 40–54, f)

3.2.2. Theme 2: healthy & sustainable foods as luxury products

When blind to the fortification of test foods, participants generally identified all products as being targeted at 'luxury' consumers. This overlapped with perceived health and sustainability benefits, particularly for foods that were believed to be 'locally produced', 'more natural', 'less processed', and 'healthy' alternatives. Expected cost was often discussed as a barrier to consuming healthy and sustainable food products. These beliefs were unchanged when participants were made aware of the fortification of test foods.

3.2.2.1. Subtheme: "altogether it's quite balanced": less processed & low in fat, sugar, and salt. As mentioned in Themes 3 and 4, participants discussed the healthiness of food products in relation to levels of processing and nutritional information (i.e., calories, fat, sugar, and salt content). Without knowledge of fortification, participants described the test foods as "balanced", recognising the "good fats" included in nuts and seeds, the health value associated with dried fruits and vegetables (e.g., "natural sugars"), and the assumption that products were made with "minimal interference". Though participants found it difficult to put a price on products, these expected health qualities were often linked to lower

affordability. This included comparisons to the cost of other 'alternative' health foods, such as free-from products:

"There's a lot of free-from food. Whether it's sort of gluten free pasta or... they're always significantly more expensive." (P934, ≥55, f)

3.2.2.2. Subtheme: "It's made in [blinded]": local & sustainably produced. Prior to being given additional information, participants made some assumptions about the sustainability of products. This most often related to products being 'locally produced', as participants discussed the origin of ingredients and the potential for sustainable production in the UK. In turn, this led participants to question the sustainability of some test foods:

"We can't grow mangoes and passionfruit here though, can we?" (P276, 40–54, f)

Similar to the health qualities of products, participants appeared to value sustainability, but this conflicted with beliefs about the affordability of sustainable food products throughout focus groups. For example, though participants referred to "supporting local businesses", they also highlighted these products as being "more expensive than average". This meant that participants often backtracked on their own willingness to pay for sustainable food products:

"I wouldn't pay kind of anything more than what I already pay, so it's not particularly outstanding that I would pay a little bit extra, personally." (P052, 18–39, m)

3.2.2.3. Subtheme: "It's too fancy for me": fortified foods as a high-cost products. When presented with potential health and sustainability claims for test foods, participants categorised all products as high cost, "premium" and "luxury" items. In addition to being locally produced, fortification (with added ingredients) was believed to increase the cost

of production for manufacturers. This contributed to the idea that fortified foods are “aspirational” purchases that would be less accessible to the ‘everyday consumer’, particularly as some participants referred to a cost-of-living crisis in the UK:

“Nowadays with the problems with the cost of living and everything I think you’d struggle to get a target audience.” (P832, 40–54, f)

3.2.3. Theme 3: contextualising fortified foods to inform consumer acceptance

Theme 3 identifies a need to provide more information about fortified foods to consumers. Though participants were aware of and listed some examples of commonly fortified foods, they were less familiar with specific ingredients, and questioned the relevance of fortification to health. This meant that participants were sometimes uncertain about how they would use products as part of their everyday diet. In response to potential health and nutritional labels in particular, trust of product information was also a key concern, as participants wanted additional context or evidence to support these claims.

3.2.3.1. Subtheme: “are all of these very healthy foods?”: familiarity with fortified foods. When prompted to consider fortification, participants provided examples of products that related to three main categories: cereals and grains (e.g., “Breakfast cereal”, “flours”, “pasta”, “bread”, and “rice”), dairy products (e.g., “margarine”, “butter”, “yoghurt”, “yoghurt drinks”, “milk”), and plant-based alternatives to meat and dairy (e.g., “pea-protein burgers”, “mushrooms”). Some participants also expanded on the purpose of fortification, such as to increase “vitamin A”, “vitamin D”, and “vitamin B12”. However, participants appeared to be surprised by the use of fortification for some test foods, particularly where this related to potentially less familiar combinations of ingredients:

“I think the dumpling, because it was just yeah, it was the flavour, the look. You wouldn’t think it’s pea protein. You’d have thought it’s a normal ...” (P905, 40–54, f)

This led participants to question the purpose of fortification ingredients as well as the availability of fortified foods in supermarkets, particularly because consumers may not recognise a product as ‘fortified’. This potential for ‘nutrition in disguise’ was seen as a benefit for some consumers, predominantly for those with children.

“Are these added over and above what you would normally get... if you sort of went out and [bought] a bar of chocolate? That’s why I’m asking the question.” (P587, ≥55, m)

3.2.3.2. Subtheme: “I wouldn’t eat it every day”: fitting products into everyday diets. Participants considered how these food products would complement their existing diet, which was important to their potential willingness to buy. For some foods, participants appeared to be more confident when discussing recipe ideas compared to others. This included the dried fruit & nut-based topping, which was suggested as an addition to “yoghurt”, “oats”, or “in baking... might add to bread mix... or maybe add to flapjacks”. In contrast, other foods were viewed as being “not for everyday” consumption. For example, though participants also discussed the versatility of adding the seaweed seasoning to main meal dishes, this was a relatively less familiar option to participants:

“I think I wouldn’t buy the seaweed seasoning because as beneficial as seaweed is with iron and vitamins and things, I think I can still get those from other foods and other areas without having to think [about] how to use the seaweed seasoning.” (P686, 40–54, f)

This meant that participants considered the value of food products in terms of convenience, frequency of consumption, and the ability to prepare tasty meal combinations, in addition to perceived health

benefits. Labels that added context to these decisions (e.g., ‘Serve with...’) were viewed as a supportive strategy.

“I prefer the suggestions on like what to serve it with, things like garlic. ‘They’re delicious when served with...’, ‘cause I feel like that’s giving you things to put it with then.” (P852, 18–39, f)

3.2.3.3. Subtheme: “It’s just a new fad”: substantiating product claims.

Overall, consumer trust was identified as a potential barrier to acceptance of fortified foods, particularly as this relates to health and nutritional claims. Participants were initially positive about the use of labels as an informational resource, as they discussed being more aware of the nutritional content of foods and how to meet specific dietary needs (e.g., vegan diet).

“I might be influenced because as a vegetarian I’d be conscious... you just think a bit more about whether you’re missing out nutrients.” (P447, 18–39, m)

However, participants questioned the meaning behind most claims. They discussed wanting more evidence – particularly for those that were viewed as a marketing strategy – to justify potential health benefits and understand the difference between reformulated versions of food products. This was often linked to a need for regulated information, and a motivation to ‘do your own research’.

“So I would look at the percentages and want more information on the claim, ‘cause you know what... I wouldn’t necessarily know without having looked into it what a high amount of fibre is compared to a normal amount of fibre, like what’s the context?” (P108, 18–39, f)

3.2.4. Theme 4: ‘food’ vs ‘medicine’ in nutrition

This final theme described participants’ general beliefs about health and nutrition. ‘Healthy eating’ was interpreted as consuming a variety of foods in moderation, as participants considered different food groups, levels of food processing, and the nutritional content of foods. In contrast, participants were generally less focussed on diet and nutrition when discussing the use of supplements, as this appeared to be viewed as a separate strategy to improve health and fitness.

3.2.4.1. Subtheme: “you can eat anything you like, just don’t eat too much”: embracing all foods as part of a balanced diet. ‘Healthy eating’ was most often described (or inferred) to be about “balance”. Participants referred to eating ‘unhealthy’ foods in moderation (such as those that are highly processed and high in fat, sugar or salt), and also mentioned public health guidelines in the UK, such as the recommended daily intake of calories and food groups specified in the ‘Eatwell Guide’ (Public Health England, 2018), and ‘traffic light labelling’ included on food packaging (NHS, 2022).

3.2.4.2. Subtheme: “but that’s not nutritional supplements”: using dietary supplements as medicine. As displayed in Table 3, approximately half of participants self-reported being current users of dietary supplements, with participants most often mentioning “multivitamins” and “vitamin D”. Among those who further expanded on their use of supplements, younger participants tended to report using supplements to benefit sports recovery and performance, whilst most participants aged 55+ referred to treating a specific health problem in a ‘prescribed’ or ‘self-care’ capacity. Few comments referred to using supplements for a ‘dietary’ purpose.

“I took supplements purely because at one stage, they thought blood cancer but it was only iron [deficiency] problems.” (P330, ≥55, m)

“Yeah come to think of it I had to take some [calcium supplements] years ago ... It was obviously prescribed because the doctor said it was a problem with my bone structure.” (P907, ≥ 55 , m)

4. Discussion

For the first time, these results allow for direct comparisons across a range of locally-produced fortified foods. Previous research on acceptance of fortified foods has typically included specific nutritional targets within studies (such as ‘high protein’ or ‘high in vitamin D’) (Clark et al., 2019; Mills et al., 2018; Sossen et al., 2021), a small selection of fortification ingredients (such as milk/whey protein) (Norton et al., 2021), and/or a limited range of meals and snacks (such as soups, cakes and biscuits) (Mills et al., 2018; Sossen et al., 2021). In this study, we demonstrated the acceptance of fortification across both sweet and savoury meal options with a broader lens for applicability, though liking differed between individual products. This in part appeared to be due to the familiarity and effectiveness of delivery foods within each category, consistent with evidence of sensory masking as a well-established tool to increase acceptance for fortified foods (Civille & Oftedal, 2012).

More specifically, these results further highlight the potential challenges of introducing new fortified food products to consumers. Participants perceived some off-flavours, unpleasant after-tastes, dry and heavy textures for food products that may be directly linked to the source of fortification. Similar findings have been reported in previous studies where concentrated powders have been used as part of formulations, with minimal effects on sensory experience where fortification was limited to around 25% of daily intakes (Field et al., 2017; Norton et al., 2020; Tsikritzi et al., 2015). Though our study did not test changes in acceptance at different levels of fortification, it is notable that test foods were developed by manufacturers to meet regulated claims for nutritional labels. For example, this includes ‘high protein’, where protein contributes $\geq 20\%$ of the energy content of a food (EC no. 1924/2006), or the aim to fulfil whole recommended daily intakes for specific micronutrients (e.g., ≥ 10 mcg of Vitamin D (SACN, 2016)). As such, it may be difficult to achieve these levels within single components, and fortifying combinations of items (e.g., both the dumpling and accompanying sauce) may be considered as an alternative strategy within and across meals. This may be tested more directly in future work, where participants respond to both fortified and non-fortified formulations of test foods in an experimental setting to measure quantitative changes in consumer acceptance.

In addition to taste and texture, consumer acceptance for test foods was also influenced by perceived health benefits, sustainability, and affordability, particularly when participants were made aware of fortification. Though additional health and sustainability attributes were positively received by consumers, they also negatively contributed to the perceived affordability of products, and did not necessarily increase willingness to pay in response to real foods. Studies adopting hypothetical and shopping choice-based paradigms have also reported relatively conservative increases of 20% in response to eco labels in particular (such as “organic” and “local”) (Li & Kallas, 2021). This means that the additional costs associated with fortification ingredients may be more difficult for manufacturers (particularly SMEs) to offset as a USP, and marketing strategies may rely more heavily on upselling health and sustainability labelling to justify this price to consumers. Some of our results suggest that this may be difficult to achieve given that supplements and associated qualities may be viewed as a treatment to adhere to rather than a preferred food choice. Building consumer trust in these qualities of fortified foods, and strengthening the evidence base to support policy regulation for new claims and novel ingredients, will likely be important steps to provide this context to consumers.

In particular, food processing – as this relates to fortification – is a key concern for consumers, in line with a recent shift in consumer acceptance of processed foods more generally (Schirmacher et al.,

2023). Whilst the advantages and disadvantages of food processing in relation to health remain a contentious issue amongst experts, the importance of food processing to the longevity and sustainability of food systems is often still acknowledged (Drewnowski, Detzel, & Klassen-Wigger, 2022). Given that processed foods also tend to be highly palatable and widely consumed (Monteiro et al., 2019), fortification (as part of reformulation in this process) offers a relatively more feasible option to continue to improve the nutritional density of existing population diets (Drewnowski et al., 2022). However, there are other risks of fortification that were not discussed by participants, such as potential overconsumption above recommended levels (e.g., as previously discussed for protein (Smith et al., 2022)). Though this risk is likely to be minimal considering likely consumption and absorption levels.

There are also some general limitations to the methodology used in this study. Firstly, participants were predominantly female, highly-educated, and local to the South Wales region of the UK. We also did not observe any significant differences in acceptance between age groups. Though some heterogeneity across the sample can encourage a more diverse range of perspectives and highlight potential comparisons between different consumer segments, we note that this may limit some expressions within groups (for a discussion of this trade-off, see (Freeman, 2006). There remains a need to explore acceptance for fortified foods in healthcare settings specifically, particularly as older patient populations are likely to experience different mealtime contexts and have changing sensory needs (Edwards, Carrier, & Hopkinson, 2017). For example, people undergoing cancer treatment may experience a decline in subjective taste and smell perception (Postma, Kok, de Graaf, Kampman, & Boesveldt, 2020), which may further impact preferences for specific fortified foods. Secondly, it is important to acknowledge that consumer acceptance was measured in response to a taste test that tended to focus on the sensory properties of foods. Though this was useful to move beyond hypothetical expectations and acceptability in terms of liking, the relative importance of other product features (such as complete product packaging, retail price) may be better quantified using other methodologies, particularly where holistic concepts are considered in a competitive shopping environment with non-fortified standard foods.

This study provides additional knowledge about the consumer acceptance of fortification across a range of innovative food products. Findings suggest that in addition to improving taste and texture, there remains a need to build consumer trust in product brands for fortified foods, particularly as this relates to potential health and sustainability claims. Increasing familiarity of delivery foods, providing additional context for the nutritional density of fortified products, and liaising with manufacturers to support the feasibility of new product formulations, may be helpful to secure offerings that are healthy, affordable and acceptable to UK consumers.

CRediT authorship contribution statement

Conceptualization, RE, LW, LN, NR, AH, KS, CM, and AT; Methodology, RE and LW; Formal Analysis, RE, MD, and CM; Investigation, RE, MD and CM; Resources, LN, AT, NR, AH, and KS; Data Curation, RE; Writing – Original Draft, RE & LW; Writing – Review & Editing, RE and LW; Supervision, LW; Project Administration, RE and LW; Funding Acquisition, LN, LW, AT, RE, NR, AH, KS, and CM. All authors read and approved the final article for submission.

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Ethics

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by the School of Psychology Research Ethics Committee at Swansea University. Written informed consent was obtained from all participants.

Declaration of competing interest

This study was conducted as part of a multi-disciplinary project with BIC Innovation (LN, CM, NR, AH, KS) and involved collaborating with food manufacturers to test bespoke products at an early stage of development for each respective company. Within this capacity, BIC Innovation contributed to study conceptualization and assisted with study provisions including the sourcing of test foods, and minor adjustments to the study methodology were made to meet the needs of all food manufacturers and identified product attributes (including product labels and age range of participants). At the time of publication, CM was a postgraduate research student at Swansea University and was also employed by BIC Innovation as a research assistant to contribute to data collection and analyses as part of this project. BIC Innovation (as a collaborator) and the Welsh Government (as a funder) placed no restrictions on the design, methodology, and analysis of data, and had no influence on the interpretation or reporting of results. RE & LLW held primary responsibility for final study content.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.appet.2023.107139>.

References

- Bird, J. K., Barron, R., Pigat, S., & Bruins, M. J. (2022). Contribution of base diet, voluntary fortified foods and supplements to micronutrient intakes in the UK. *Journal of Nutritional Science*, 11, e51. <https://doi.org/10.1017/JNS.2022.47>
- Boukrid, F., Zannini, E., Carini, E., & Vittadini, E. (2019). Pulses for bread fortification: A necessity or a choice? *Trends in Food Science & Technology*, 88, 416–428. <https://doi.org/10.1016/j.tifs.2019.04.007>
- Braun, V., & Clarke, V. (2021). One size fits all? What counts as quality practice in (reflexive) thematic analysis? *Qualitative Research in Psychology*, 18(3), 328–352. <https://doi.org/10.1080/14780887.2020.1769238>
- British Dietetic Association (BDA). (2021). Food fortification policy statement. January 22 <https://www.bda.uk.com/resource/food-fortification.html>
- Byrne, D. (2021). A worked example of Braun and Clarke's approach to reflexive thematic analysis. Quality & Quantity. <https://doi.org/10.1007/s11135-021-01182-y>
- Cave, D. P., Abbey, K. L., & Capra, S. M. (2020). Can foodservices in aged care homes deliver sustainable food fortification strategies? A review. *International Journal of Food Sciences & Nutrition*, 71(3), 267–275. https://doi.org/10.1080/09637486.2019.1658722/SUPPL_FILE/IJFSA.1658722_SM6287.PDF
- Civille, G. V., & Oftedal, K. N. (2012). Sensory evaluation techniques — make “good for you” taste “good.”. *Physiology & Behavior*, 107(4), 598–605. <https://doi.org/10.1016/j.physbeh.2012.04.015>
- Clark, B., Hill, T., & Hubbard, C. (2019). Consumers' perception of vitamin D and fortified foods. *British Food Journal*, 121(9), 2205–2218. <https://doi.org/10.1108/BFJ-04-2018-0249/FULL/PDF>
- Clegg, M. E., Tarrado Ribes, A., Reynolds, R., Kliem, K., & Stergiadis, S. (2021). A comparative assessment of the nutritional composition of dairy and plant-based dairy alternatives available for sale in the UK and the implications for consumers' dietary intakes. *Food Research International*, 148, Article 110586. <https://doi.org/10.1016/j.foodres.2021.110586>
- Cofrades, S., Benedí, J., Garcimartín, A., Sánchez-Muniz, F. J., & Jimenez-Colmenero, F. (2017). A comprehensive approach to formulation of seaweed-enriched meat products: From technological development to assessment of healthy properties. *Food Research International*, 99, 1084–1094. <https://doi.org/10.1016/j.foodres.2016.06.029>
- Craig, W. J., & Brothers, C. J. (2021). Nutritional content and health profile of non-dairy plant-based yogurt alternatives. *Nutrients*, 13(11), 4069. <https://doi.org/10.3390/NU13114069/S1>
- Curtain, F., & Grafenauer, S. (2019). Plant-based meat substitutes in the flexitarian age: An audit of products on supermarket shelves. *Nutrients*, 11(11), 2603. <https://doi.org/10.3390/NU11112603>, 2019, Vol. 11, Page 2603.
- Drewnowski, A., Detzel, P., & Klassen-Wigger, P. (2022). Perspective: Achieving sustainable healthy diets through formulation and processing of foods. *Current Developments in Nutrition*, 6(6), Article nzac089. <https://doi.org/10.1093/cdn/nzac089>
- Edwards, D., Carrier, J., & Hopkinson, J. (2017). Assistance at mealtimes in hospital settings and rehabilitation units for patients (>65 years) from the perspective of patients, families and healthcare professionals: A mixed methods systematic review. *International Journal of Nursing Studies*, 69, 100–118. <https://doi.org/10.1016/j.ijnurstu.2017.01.013>
- Eichler, K., Hess, S., Twerenbold, C., Sabatier, M., Meier, F., & Wieser, S. (2019). Health effects of micronutrient fortified dairy products and cereal food for children and adolescents: A systematic review. *PLoS One*, 14(1), Article e0210899. <https://doi.org/10.1371/JOURNAL.PONE.0210899>
- Ferrari, J., Ferriday, D., Smit, H. J., McCaig, D. C., & Rogers, P. J. (2019). Identifying barriers to reducing portion size: A qualitative focus group study of British men and women. *Nutrients*, 11(5), 1054. <https://doi.org/10.3390/NU11051054>, 2019, Vol. 11, Page 1054.
- Field, K. M., Duncan, A. M., Keller, H. H., Stark, K. D., & Duizer, L. M. (2017). Effect of micronutrient powder addition on sensory properties of food for older adults. *Journal of Food Science*, 82(10), 2448–2455. <https://doi.org/10.1111/1750-3841.13849>
- Freeman, T. (2006). “Best practice” in focus group research: Making sense of different views. *Journal of Advanced Nursing*, 56(5), 491–497. <https://doi.org/10.1111/J.1365-2648.2006.04043.X>
- Galvin, J. E., Roe, C. M., Powlishta, K. K., Coats, M. A., Muich, S. J., Grant, E., et al. (2005). The AD8: A brief informant interview to detect dementia. *Neurology*, 65(4), 559–564. <https://doi.org/10.1212/01.wnl.0000172958.95282.2a>
- Haines, K. L., Gorenshstein, L., Lumpkin, S., Grisel, B., & Gallagher, S. (2023). Optimal nutrition in the older adult: Beneficial versus ineffective supplements. *Current Nutrition Reports*. <https://doi.org/10.1007/s13668-023-00459-y>
- Hennessy, A., Walton, J., & Flynn, A. (2013). The impact of voluntary food fortification on micronutrient intakes and status in European countries: A review. *Proceedings of the Nutrition Society*, 72(4), 433–440. <https://doi.org/10.1017/S002966511300339X>
- van den Heuvel, E., Newbury, A., & Appleton, K. M. (2019). The Psychology of nutrition with advancing age: Focus on food neophobia. *Nutrients*, 11(1), 151. <https://doi.org/10.3390/NU11010151>, 2019, Vol. 11, Page 151.
- Howitt, D. (2013). *Introduction to qualitative methods in psychology* (2nd ed.). Pearson Education Ltd, 2013.
- de Jong, M. H., Nawijn, E. L., & Verkaik-Kloosterman, J. (2022). Contribution of voluntary fortified foods to micronutrient intake in The Netherlands. *European Journal of Nutrition*, 61(3), 1649–1663. <https://doi.org/10.1007/S00394-021-02728-4/TABLES/4>
- Keller, H., Pereira De Paula, F. L., Wei, C., Duncan, A., & Duizer, L. (2019). Nutrition in disguise: Development, testing and cost-analysis of nutrient-enhanced food for residential care. *Journal of Clinical Nutrition and Food Science*, 2(2), 36–45.
- Li, S., & Kallas, Z. (2021). Meta-analysis of consumers' willingness to pay for sustainable food products. *Appetite*, 163, Article 105239. <https://doi.org/10.1016/j.appet.2021.105239>
- López-Nicolás, R., Frontela-Saseta, C., González-Abellán, R., Barado-Piqueras, A., Perez-Conesa, D., & Ros-Berruero, G. (2014). Folate fortification of white and whole-grain bread by adding Swiss chard and spinach. Acceptability by consumers. *LWT - Food Science and Technology*, 59(1), 263–269. <https://doi.org/10.1016/j.lwt.2014.05.007>
- Madruca, M., Steele, E. M., Reynolds, C., Levy, R. B., & Rauber, F. (2022). Trends in food consumption according to the degree of food processing among the UK population over 11 years. *British Journal of Nutrition*, 1–8. <https://doi.org/10.1017/S0007114522003361>
- Melville, H., Shahid, M., Gaines, A., McKenzie, B. L., Alessandrini, R., Trieu, K., et al. (2023). The nutritional profile of plant-based meat analogues available for sale in Australia. *Nutrition and Dietetics*, 80(2), 211–222. <https://doi.org/10.1111/1747-0080.12793>
- Mills, S. R., Wilcox, C. R., Ibrahim, K., & Roberts, H. C. (2018). Can fortified foods and snacks increase the energy and protein intake of hospitalised older patients? A systematic review. *Journal of Human Nutrition and Dietetics*, 31(3), 379–389. <https://doi.org/10.1111/JHN.12529>
- Monteiro, C. A., Cannon, G., Levy, R. B., Moubarac, J. C., Louzada, M. L. C., Rauber, F., et al. (2019). Ultra-processed foods: What they are and how to identify them. *Public Health Nutrition*, 22(5), 936–941. <https://doi.org/10.1017/S1368980018003762>
- NHS. (2022). *Food labels*. <https://www.nhs.uk/live-well/eat-well/food-guidelines-and-food-labels/how-to-read-food-labels/>
- Nicol, K., Thomas, E. L., Nugent, A. P., Woodside, J. V., Hart, K. H., & Bath, S. C. (2023). Iodine fortification of plant-based dairy and fish alternatives: The effect of substitution on iodine intake based on a market survey in the UK. *British Journal of Nutrition*, 129(5), 832–842. <https://doi.org/10.1017/S0007114522001052>
- Norton, V., Lignou, S., Bull, S. P., Gosney, M. A., & Methven, L. (2020). Consistent effects of whey protein fortification on consumer perception and liking of solid food

- matrices (cakes and biscuits) regardless of age and saliva flow. *Foods*, 9(9), 1328. <https://doi.org/10.3390/FOODS9091328>, 2020, Vol. 9, Page 1328.
- Norton, V., Lignou, S., & Methven, L. (2021). Influence of age and individual differences on mouthfeel perception of whey protein-fortified products: A review. *Foods*, 10(2), 433. <https://doi.org/10.3390/FOODS10020433>, 2021, Vol. 10, Page 433.
- Postma, E. M., Kok, D. E., de Graaf, C., Kampman, E., & Boesveldt, S. (2020). Chemosensory perception and food preferences in colorectal cancer patients undergoing adjuvant chemotherapy. *Clinical Nutrition ESPEN*, 40, 242–251. <https://doi.org/10.1016/j.clnesp.2020.09.012>
- Public Health England. (2018). The eatwell guide. <https://www.gov.uk/government/publications/the-eatwell-guide>.
- Public Health England. (2021). McCance and Widdowson's "The Composition of foods integrated dataset" (CoFID). <https://www.gov.uk/government/publications/composition-of-foods-integrated-dataset-cofid>.
- Ranawana, V., Campbell, F., Bestwick, C., Nicol, P., Milne, L., Duthie, G., et al. (2016). Breads fortified with freeze-dried vegetables: Quality and nutritional attributes. Part II: Breads not containing oil as an ingredient. *Foods*, 5(3), 62. <https://doi.org/10.3390/FOODS5030062>, 2016, Vol. 5, Page 62.
- (SACN), S. A. C. on N. (2016). SACN vitamin D and health. <https://www.gov.uk/government/publications/sacn-vitamin-d-and-health-report>.
- Saunders, J., & Smith, T. (2010). Malnutrition: Causes and consequences. *Clinical Medicine*, 10(6), 624. <https://doi.org/10.7861/CLINMEDICINE.10-6-624>
- Schirmacher, H., Elshiewy, O., & Boztug, Y. (2023). That's not natural! Consumer response to disconfirmed expectations about 'natural' food. *Appetite*, 180, Article 106270. <https://doi.org/10.1016/j.appet.2022.106270>
- Smith, R., Clegg, M., & Methven, L. (2022). Review of protein intake and suitability of foods for protein-fortification in older adults in the UK. <https://doi.org/10.1080/10408398.2022.2137777>
- Sossen, L., Bonham, M., & Porter, J. (2021). Can fortified, nutrient-dense and enriched foods and drink-based nutrition interventions increase energy and protein intake in residential aged care residents? A systematic review with meta-analyses. *International Journal of Nursing Studies*, 124, Article 104088. <https://doi.org/10.1016/j.ijnurstu.2021.104088>
- Tam, E., Keats, E. C., Rind, F., Das, J. K., & Bhutta, Z. A. (2020). Micronutrient supplementation and fortification interventions on health and development outcomes among children under-five in low- and middle-income countries: A systematic review and meta-analysis. *Nutrients*, 12(2), 289. <https://doi.org/10.3390/NU12020289>, 2020, Vol. 12, Page 289.
- The Spreadable Fats. (2008). (Marketing standards) and the milk and milk products (protection of Designations) (England) regulations 2008, pub. L. No. 1287. <https://www.legislation.gov.uk/uksi/2008/1287/made/data.pdf>.
- The bread and flour regulations 1998. (1998). *Pub. L. No. 141*. <https://www.legislation.gov.uk/uksi/1998/141/made/data.pdf>.
- Tsikritzi, R., Wang, J., Collins, V. J., Allen, V. J., Mavrommatis, Y., Moynihan, P. J., et al. (2015). The effect of nutrient fortification of sauces on product stability, sensory properties, and subsequent liking by older adults. *Journal of Food Science*, 80(5), S1100–S1110. <https://doi.org/10.1111/1750-3841.12850>
- Visser, M., Schaap, L. A., & Wijnhoven, H. A. H. (2020). Self-reported impact of the COVID-19 pandemic on nutrition and physical activity behaviour in Dutch older adults living independently. *Nutrients*, 12(12), 3708. <https://doi.org/10.3390/NU12123708>, 2020, Vol. 12, Page 3708.
- Wilson, M. M. G., Thomas, D. R., Rubenstein, L. Z., Chibnall, J. T., Anderson, S., Baxi, A., et al. (2005). Appetite assessment: Simple appetite questionnaire predicts weight loss in community-dwelling adults and nursing home residents. *The American Journal of Clinical Nutrition*, 82(5), 1074–1081. <https://doi.org/10.1093/AJCN/82.5.1074>