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Victoria Norton

"WAIT, do I need more fibre?" Exploring UK consumers' dietary fibre-related awareness and white bread as a viable solution to promote subsequent intake

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Abstract

Sufficient dietary fibre is associated with well-established health benefits, yet such intake is currently suboptimal globally. Thus, there is interest in developing strategies to improve dietary fibre intake. One such approach is to increase the dietary fibre content of staple foods; however, this needs relevant investigation. Forty-two UK-based consumers (18-76 years) were recruited to take part in seven focus group sessions investigating: (i) key factors in food choice; (ii) dietary fibre-related knowledge, awareness, consumption habits and engagement levels; (iii) willingness to consume dietary fibre-rich staple foods; and (iv) gain initial feedback on dietary fibre-rich breads. Overall, key dietary fibre themes emerged such as knowledge (benefits, foods, recommendations, labelling), consumption (not measuring intake), barriers (convenience, knowledge), resources (education, public appeal) and topics (food examples, cooking). Consumers were positive *per se* to the idea of dietary fibre-rich staple foods but with various caveats (no changes in appearance, taste and cost). White bread trends were centred around context (sandwich, toast), habit (comfort food), preferences (soft, fresh) and consumption is variable (daily to less often). In addition, consumers' preferred labelling strategy for dietary fibre-rich breads were predominately focused on transparency and visibility. Overall, the newly-developed breads were well received demonstrating the potential of our prototypes to fit into the white bread market; however, additional consumer insights are needed. Our findings recommend combining education with a personalised element of advice, coupled with a collective effort from the government and food industry, is essential to help encourage a step-change in dietary fibre consumption in the UK population.

Keywords: dietary fibre; focus groups, consumer-engagement; staple foods; white bread.

Introduction

Dietary fibre is an essential dietary component and is associated with well-proven health benefits such as reduced cardiovascular disease, coronary events, stroke, type 2 diabetes and cancer (colorectal) risk [1]. However, most of the UK population consume below the dietary fibre recommendation of 30g/d; hence, increasing such intake could have noteworthy public health benefits [2]. It is likely that a number of factors are driving the poor uptake such as perceived cost, inadequate cooking skills, limited sensory appeal, side effects, lack of knowledge and insufficient on-pack labelling [3-11]. More broadly, overriding food choice factors (such as societal, individual differences and food aspects) have a fundamental role in purchasing decisions; thus, clarifying such factors could help to support food system transformation [12]. Therefore, there is a collective effort within the food industry to help overcome the widespread dietary fibre-related deficit via feasible, cost effective and readily consumed solutions.

Staple foods provide an ideal basis to help increase dietary fibre intake and bread fits within this remit as well as being commonly consumed globally and considered affordable [13]. In addition, bread is typically consumed two to six times a week, often as a sandwich or toast by UK consumers [14]. More specifically, white bread (pre-packed) is the market leader in terms of bread sales in the UK; hence, an ideal and popular bread type that could be used to support higher dietary fibre consumption rates [14,15]. However, white flour (and bread) is produced by milling the grain to remove the bran and germ which leads to nutrient losses and subsequently negatively impacting disease risk; therefore, enhancing this staple food source quality could have noteworthy public health implications [16-19]. Hence, researchers have focused on developing novel wheat types (using conventional breeding strategies) with higher contents of the major dietary fibre component (arabinoxylan) in white flour [20]. Recently, such lines have been used to make white bread with relatively positive sensory and physical properties (e.g., smaller slice height, higher water activity/moisture content and darker in colour) [21]. However, additional research is needed to understand consumers' insights in relation to dietary fibre-rich white breads, so that such breads meet consumer expectations.

It is fundamental that appropriate methodologies are utilised to capture relevant consumer needs, attitudes and perceptions; accordingly, qualitative approaches such as using focus groups enable group interaction via an individual/shared perspective as well as gaining in-depth insight into

knowledge and experiences (including what, how and why) on a particular topic [22,23]. In addition, focus groups are useful at an early stage of research in order to explore the topic and understand key issues prior to future quantitative investigation [23]. It is evident that a range of focus groups in different countries (e.g., Australia, Iran, Singapore, USA, UK) have been successfully conducted predominately focused on promoting dietary fibre-rich foods (such as wholegrains) [9,24-30]. However, such an approach would also be appropriate for higher in dietary fibre white bread as this could be a potential viable route to support increased dietary fibre consumption [31]. Currently, this area has received less attention, most likely due to the need to fortify foods with exogenous fibre which can modulate cost and processing levels [31].

Accordingly, to address the associated research gaps, our study used focus groups as a medium to initiate conversation as well as to enable tastings of different white bread prototypes (varying in dietary fibre content) to understand initial consumer acceptability. This latter point is considered a limitation of previous dietary-fibre focus group-related studies and could help overcome any potential food neophobia concerns (e.g., reluctance/avoidance to eat novel foods) [9,25,26,30,32]. In addition, the overall emphasis was on providing the consumers with the relevant background (such as what is dietary fibre and why it is important) so that they understood the need for easy strategies to incorporate dietary fibre into everyday life and subsequently promote engagement. Accordingly, our study aimed to: (1) investigate consumers' key factors in food choice; (2) explore consumers' dietary fibre-related knowledge, awareness, consumption habits and engagement levels; (3) understand consumers' willingness to consume staple foods higher in dietary fibre; and (4) gain initial feedback on dietary fibre-rich white bread prototypes, in a UK context.

Methods

Study overview

Forty-two consumers (42.5 ± 17.7 years; range: 18-76 years; 31% male and 69% female) were recruited to take part in focus groups (between 75-and-90-min in length) in Reading either at the University or in community settings during September to November 2023. It was apparent that seven sessions (on average six consumers per focus group) would be sufficient to reach data saturation [33-35]. Healthy consumers (aged 18 years or above, willing to discuss/share ideas and with no allergies or intolerances) were recruited from the Reading area and/or attended the local community centre regularly. Consumers had the study fully explained, provided informed consent

and were notified that the data would be pseudo-anonymised as well as their right to withdraw at any time. The study received a favourable opinion for conduct by the University of Reading School of Chemistry, Food and Pharmacy Research Ethics Committee (study number: 38/2023) as well as complying with the Declaration of Helsinki.

Focus group design

The sessions were centred around five key areas (as summarised in Figure 1) where a semi-structured discussion guide was utilised for all sessions. Input from our previous work [11] was used to inform the discussion guide. All sessions were conducted by the same moderator to enable consistency and audio recorded via Microsoft Teams (Version 1.600.30658, Washington, USA) so that sessions could be subsequently transcribed verbatim.

<FIGURE ONE>

All focus groups started with an ice breaker task (e.g., what is your favourite hobby and food) to encourage conversation and participation. Consumers were informed how the session would work as well as having an emphasis on no right or wrong answers and contribution as they felt appropriate. In addition, consumers were asked about key factors in food choice to understand the main drivers as well as interest in their diet so as to capture initial engagement levels. The second section focused on understanding consumers' dietary fibre-related knowledge and they were asked to describe: (i) what do you know about dietary fibre (including benefits and food-based examples)?; (ii) what are the dietary fibre recommendations?; and (iii) do you check the dietary fibre content of foods? The third section explored consumers dietary fibre consumption habits and engagement levels where they discussed: (1) commonly consumed dietary fibre-rich foods; (2) barriers associated with dietary fibre; (3) current dietary fibre intake; and (4) potential dietary fibre resources and topics. The fourth section aimed to understand: (a) initial reactions for staple foods (e.g., rice, pasta, bread, etc.) higher in dietary fibre; (b) commonly consumed bread types; (c) views on white bread and consumption habits; and (d) expectations of dietary fibre-rich bread.

The final section focused on tasting three different white breads varying in dietary fibre content so as to gain qualitative feedback. The rationale for selecting the three breads (e.g., on-the-market control, Minax-100 and Minax-168) was based on sensory and physical properties results from our previous work [21]. In brief, the Minax lines (with a range of dietary fibre contents) were grown and milled as reported previously [20,21,36] whereas the on-the-market control utilised

commercial wheat lines [21]. The breads were baked in accordance with the commercial bakers' in-house procedures (800 g into a four-piece lidded loaf utilising a four-strap tin) using the Chorleywood breadmaking process and baked at 250°C for 24-min [21]. Consumers were presented (monadically in a balanced order across the seven sessions) with a slice of bread (40 g; Table 1) and asked to provide comments relating to the bread. In addition, they were asked to select their most preferred bread (post-initial evaluation) and purchase intentions as well as providing suggestions how to improve the breads. To finish, consumers were asked to express their views on labelling (e.g., health by stealth vs on-pack information), identify the bread they perceived to be higher in dietary fibre and whether now they would modulate their dietary fibre intake.

<TABLE ONE>

Data analysis

The transcribed data was coded in NVivo (release 14.23.0, Denver, USA) to identify, analyse and report emerging themes (e.g., thematic analysis) utilising an inductive data-driven approach [37,38]. In brief, the data was analysed in accordance with the Braun and Clarke step-by-step guide: (i) data familiarisation; (ii) initial codes generation; (iii) themes development; (iv) reviewing themes; (v) defining/naming themes; and (vi) reporting, as well as adhering to the good practice process checklist (such as transcription, coding, analysis, overall and report) for thematic analysis [38]. The codebook was subsequently cross-checked by a second author to ensure appropriate data representation as well as enabling a consensus on the coding and relevant themes (Figure S1).

Results

Food Choice

Five main themes emerged relating to key factors in food choice: (1) cost was dominating the conversation such as "*value for money comes first – I am looking for the most amount for the least amount of money*" and "*price is always part of it*"; (2) convenience was also considered fundamental especially in terms of accessibility "*large supermarkets can be far away and not all have free delivery*" and easy to cook "*pasta and sauce – easy – fills you up*"; (3) nutritional and health aspects namely ingredients "*I packet flip as I am vegan, so I don't get caught out*'' and

nutrients "*I like the traffic light system on the front-of-pack – green (healthy) vs red (unhealthy)"*; (4) sensory appeal covering appearance "*looks like"* and palatability *"taste, flavour*"; and (5) trust resulted in an emphasis on the essentials "*focus on the basics – same brands*" and trusted brands/individuals "*happy to try new things if people explain it to me*" (Figure 2 and Table 2).

<FIGURE TWO>

Dietary fibre knowledge and awareness

Overall, it was evident that dietary fibre is not at the forefront of consumers' minds; therefore, contributing to the widespread confusion and poor awareness such as *"it is not good for you or is it"* and "*fibre is brown*". More specifically, key themes relating to dietary fibre have been summarised in Figure 3 and Table 2. It was evident that there was a strong association between dietary fibre and digestive function "*guts happy, gut health, keep things moving*" as well as with satiety *"fuller for longer, weight management*". However, in most cases consumers were unaware that dietary fibre had additional health benefits such as reducing disease risk. Consumers cited "*cereals, wholegrains, vegetables, pulses/beans and fruits*" as key sources of dietary fibre as well as the role of marketing in increasing subsequent awareness "*cereals are the ones that comes to mind – mainly from the marketing/packaging*". There were also knowledge-related gaps "*what are good sources of fibre*" and "*what vegetables have fibre?*". Similarly, consumers' awareness relating to the 30 g/d dietary fibre recommendations for the majority resulted in notable confusion "*I did not know the number*" and "*5-a-day – is this the same*?". This lack of clarity trend continued into the labelling discussion. For example, key themes related to poor accessibility "*I need my reading glasses to check back-of-pack, so I often do this at home*", misleading on-pack information "*what is a portion size?*" and focus on fundamentals "*typically, not checking for fibre*".

<FIGURE THREE>

Dietary fibre consumption and engagement

Dominant consumption and engagement themes are outlined in Figure 3 and Table 2. It was evident that consumers focused on eating by feeling "*I focus on feeling and listening to my body*" and not measuring intake "*I feel I get enough but I do not measure it and not sure what is absorbed at the same time*" with typical dietary fibre consumption patterns centred on fundamental, safe and familiar foods (e.g., baked beans, cereals, fruits, vegetables, brown rice/pasta). In addition, there was an emphasis on lack of knowledge contributing to poor awareness "*it's not a topic widely*

discussed" and "*I don't know – I don't look for it*" as well as the need for more support and information "*sell the benefit – what changes will you notice and what will it fix*" and "*taste before you buy in supermarkets – might help me*". Consumers cited a number of noteworthy dietary fibre related barriers including: (i) insufficient knowledge (e.g., cooking skills, interpreting labelling, portion size and ingredients lists) "*lack of knowledge is a limiting factor, so my options in terms of fibre foods are limited*"; (ii) convenience (e.g., accessibility, time) "*I try and spend the least amount of time cooking, so I have more time for other things*"; (iii) preferences (e.g., childhood exposure, variety) "*family eating key role in learning what food combinations work*"; (iv) cost (e.g., expensive, no deals) "*cheapest meals may not have a huge amount of fibre*"; (v) culture (e.g., eating out, trust, cheap vs expensive) "*restaurants always give white rice*"; and (vi) side effects (e.g., heavy, stodgy, bloating) "*fibre is associated with being a heavy type of food*".

Two overriding themes emerged relating to dietary fibre-specific resources namely education to improve knowledge (e.g., healthy eating in schools, community focus, supermarket involvement, cooking classes) "*schools have a key role in promoting healthy eating*" and public appeal (e.g., trusted sources/information, similar messaging to 5-a-day, advertising, initiate conversation) "*consistency in information – changes over the years*" (Figure 3 and Table 2). Consumers were also keen to learn more relating to three key areas: (i) examples of dietary fibre-rich foods "*a long list of high fibre stuff*"; (ii) role of cooking "*more information on cooking and how this impacts fibre content – which method is better? (e.g., raw, boiling or steaming)*" and making meals "*ready steady cook style*"; and (iii) labelling "*hard to visualise the portion size without scales*" and "*user-friendly ingredient lists*" (Figure 3).

<TABLE TWO>

Staple foods and bread types

Overall, consumers were positive *per se* to the idea of dietary fibre-rich staple foods "*if more fibre in foods general probably will not be a bad thing*"; however, with various caveats "*keep same taste/look, nothing artificial and fibre without realising*" (Table 2). For example, the quality (e.g., shelf-life) taste and cost must be maintained "*if it tasted the same and no change in cost*" as well as suggestions of introduction of such foods at an early age "*if children grow up with high fibre foods they would get used to it*" and try before you buy "*in theory it would be great, but I would need to try it to see*". Consumers' expectations relating to dietary fibre-rich bread were

predominately sensory related: (i) appearance (e.g., brown colour) "*fibre is brown*"; (ii) taste "*like normal bread – exactly the same – otherwise no one will be eating it*"; and (iii) texture "*seeded*".

Consumers mainly consumed white, wholemeal/brown and seeded breads. In addition, other bread types (e.g., sourdough, granary bread, 50:50, baguette) were consumed but to a less frequent extent. Bread's functional role in the diet was also noted "*from a loaf of bread, I know how many sandwiches I can make*". More specifically, key trends relating to white bread were centred three areas: (1) context is driving consumption such as "*white bread toasts really well*" and "*I associate sandwiches with white bread*"; (2) habit from positive memories "*comforting – it is what you are used to*" and meal "*I have a meal if white bread is in the house*"; and (3) preferences "*white bread must be soft and fresh*" (Figure 4). In addition, white bread consumption was notably variable from daily to less often "*some weeks loads and other less*" (Figure 4 and Table 2). Consumers noted that their preferred labelling strategy for dietary fibre-rich white bread was predominately centred around transparency "*explain things to us*", awareness "*needs to be visible without looking back-of-pack with a magnific glass*" and health conditions "*its worrying if I have more fibre without being told it could upset my diet"*.

<FIGURE FOUR>

Bread tasting

Consumers provided a range of comments relating to the breads (Table 3). Overall, it was clear the control was considered like standard white bread, off-white, fresh, sweet/artificial and soft/sticky "*this is more like it – I knew it*" and "*standard white loaf*". The Minax breads were characterised as follows: (1) Minax-100 was considered the most different bread as it looked different/less attractive, colour/aroma differences, salty taste and textural changes (e.g., stodgy, heavier, chewy, body, bubbles) "*stodgy and more chewy*" and (2) Minax-168 was perceived to taste like bread, whiter in colour, sour aroma, salty/sour taste and springy "*very white like it's been bleached*". Forty-five percentage of consumers perceived Minax-168 as the most preferred bread closely followed by the control (36%) and the least preferred bread was Minax-100 (19%). There was a mixed consensus in terms of purchase intention for the breads such as positively "*if nutritious and high in fibre or in meal deal may consider it*" and "*if money was no object I would buy A* [Minax-168]" vs negatively "*lots of persuasion to switch*" and "*I won't buy C* [Minax-100] *as doesn't look right*". Consumers suggested changes for the breads where in most cases these were

predominately for Minax-100 and texture based (e.g., less chewy, dry, pasty/sticky) "*is dry, scaly and different*". In addition, comments related to modulating Minax-100 and 168 aroma "*smelt weird to me – not exactly what it was and different to normal*". Overall, it was apparent some consumers struggled to articulate how to improve the breads "*can't really say without butter*". Most consumers perceived Minax-100 as higher in dietary fibre due textural changes "*more body*" and colour differences "*we are all sitting here thinking fibre is brown*". Consumers were also asked if they will modulate their future dietary fibre intake and this resulted in two themes: (1) initiated conversation/educational such as saying the session was beneficial "*learning lots today*" and "*I will go home and look up what fibre does*" and (2) highlighted positive intentions yet challenging to implement "*maybe for a bit – unlikely to maintain*".

<TABLE THREE>

Discussion

Food choice

It is important to understand key factors in food choice in order to help ensure nutritious, healthy and sustainable foods are readily available for all. As expected in the current economic climate (e.g., cost-of-living crisis), cost was a driver for food-based decisions in most cases, coupled with convenience (accessibility, easy to cook, shelf-life), nutrition/health aspects, sensory appeal (appearance, taste, flavour) and trust (brands, packaging, family, friends). Such findings also reflect the key factors such as food (e.g., sensory, nutritional/health information, social/physical environmental), individual differences (e.g., biological, physiological, psychological) and societal (e.g., culture, economic, political) evident in the literature [12]. Practically, this can result in challenges in finding the balance in terms of cost vs healthy foods and access to nearby supermarkets as well as the role of food-related trust in food choice; similar findings were demonstrated from community-based interviews conducted in the North of England (Liverpool) [39]. In addition, a recent review highlighted that materials (e.g., local food environment, money, housing, transport), meanings (e.g., food for all, autonomy, independence, community, health, freshness) and competencies (e.g., poor mental and physical health, intake vs expenditure, learning) were dominating themes in disadvantaged communities from a qualitative food perspective [40]. More broadly, it is vital that any new product (e.g., white bread higher in dietary fibre) avoids such pitfalls. For example, it is apparent that a new white bread higher in dietary fibre

needs to deliver on being cost effective, accessible from main supermarkets, nutritious, clearly labelled (source of fibre or high in fibre) and tasty so as to ensure uptake and suitability for the target market.

Dietary fibre knowledge and awareness

Consumers need to have sufficient knowledge and awareness to make informed diet-related decisions. It was clear that dietary fibre was associated with confusion and poor awareness in most cases. Four key dietary fibre knowledge-related themes emerged: (1) lack of clarity relating to benefits (such as strong link with digestive function but unaware of disease risk aspects); (2) uncertainty of dietary fibre-rich sources and the role of marketing increasing awareness for certain foods (e.g., breakfast cereals); (3) misinterpretation of dietary recommendations (value related and confusion with 5-a-day); and (4) poor accessibility for dietary fibre labelling (e.g., back-of-pack and small font size). Interestingly, previous focus group-based studies have also highlighted the lack of knowledge relating to dietary fibre (e.g., benefits, recommendations and identification) as noteworthy challenges to consumption [9,25,30]. Such findings are likely to explain the low dietary fibre consumption evident in the UK and globally [2,41,42]. Overall, this suggests dietary fibre is not at the forefront of consumers' minds subsequently contributing to the low knowledge and awareness; accordingly, emphasis should be placed on consumer-centric approaches to promote uptake.

Dietary fibre consumption and engagement

Capturing consumers' current consumption and engagement habits can help in identifying any relevant areas for future focus. It was evident that consumers were not measuring their food intake and focused on eating by feeling via familiar dietary fibre-rich foods (e.g., baked beans, breakfast cereals, fruits, vegetables, brown rice/pasta) subsequently contributing to confusion in terms of meeting dietary fibre recommendations. More broadly, this suggests consumers have some awareness of the key dietary components (e.g., 49% of consumers eat healthily most of the time) yet measuring food intake from both a consumers' and researchers' perspective is not without substantive challenges [43,44]. Accordingly, developing a simple, quick and valid method to measure dietary fibre intake in different populations as well as provide personalised advice especially in a digital format is much needed.

Moreover, six dietary fibre-driven key barriers were identified (such as insufficient knowledge, convenience, individual preferences, cost, culture and side effects) are all likely to add to dietary fibre-consumption related challenges; accordingly, it is fundamental such barriers are overcome in order to increase dietary fibre intake. Similarly, lack of knowledge contributing to identification and meal incorporation issues as well as preferences over various sensory properties (e.g., taste, texture) have also been cited as key consumption barriers [9,25,30]. In addition, ensuring standardisation of labelling and definitions is fundamental to help guide consumers appropriately [9,30]. This is especially relevant for UK consumers as dietary fibre is usually reported on the back-of-pack (unless demonstrating a nutritional claim such as source of fibre or high fibre); therefore, it is reliant on consumers having sufficient awareness to find such information [3,4,10]. Consumers also cited cost implications of dietary fibre-rich foods and limited offers/deals; accordingly, it is likely that budget-related advice will resonate with consumers. Moreover, dietary fibre is associated with satiety effects; therefore, in the cost-of-living crisis this could be increasingly relevant to help manage hunger if budgets are limited [43,45]. In addition, it should be noted that Scarborough et al. modelled various scenarios utilising UK dietary recommendations and found adherence would not result in significant cost changes [46].

Positively, consumers would like education to enhance knowledge in different settings (such as schools, community, supermarkets) and public health campaigns (e.g., similar to 5-a-day as easy to remember) from trusted sources on key topics namely examples of dietary fibre-rich foods, role in cooking, on nutritional content/meal preparation and understanding food labelling. Previously, dietary fibre-specific educational materials were perceived as helpful and well received in terms of learning something new, changing future dietary fibre intake, format liking, engaging content and share with others in an ageing population [11]. Therefore, expanding this approach at a population level could be beneficial as well as a cost-effective solution to help overcome the associated dietary fibre knowledge gap. In addition, improving accessibility such as more dietary fibre-rich products across different categories that are easily identifiable without changes in sensory appeal and cost would help to increase consumer awareness and promote uptake. Overall, this suggests combining education with a personalised touch (e.g., catering for individual preferences and how to make a meal from affordable ingredients already in the household in a "ready steady cook" style) could help to make it easier for naive consumers to consume a dietary fibre-rich diet.

Staple foods and bread types

Staple foods (e.g., bread, pasta, rice) provide an ideal vehicle for fortification and are typically consumed daily to varying extents; therefore, enabling benefits at an individual and population level. Overall, consumers initial thoughts were positive related to dietary fibre-rich staple foods, but they also had a few concerns relating to cost, taste and quality. This suggests food neophobia could play a key role in perception of new foods [32]. Moreover, giving consumers the opportunity to 'try before you buy' (e.g., via tasting pods in supermarkets) could be a solution to encourage uptake, and address any potential food neophobia concerns, without consumers worrying about cost implications of buying a product. It was clear that consumers expectations towards dietary fibre-rich bread was sensory driven such as brown in colour and no distinct taste; interestingly, there was a strong association with dietary fibre being brown. This misconception may relate to the growing debate of white vs brown rice/pasta/bread as well as lack of awareness that dietary fibre is present in a wide range of food categories (such as fruits, vegetables, breakfast cereals, wholegrains, nuts, seeds, peas and beans) [10,47]. It was also important to check consumers' current consumption habits where their main bread types were white, wholemeal/brown and seeded breads. This aligns with current market research demonstrating that white and wholemeal/granary breads are most commonly consumed weekly in UK households [15]. More specifically, the consumers noted white bread was used for sandwiches (especially for children) and/or toast, considered a comfort food and needs to be soft/fresh with consumption very variable from daily to less often. In addition, consumers were asked about preferred labelling strategies for dietary fibre-rich white bread and transparency/visibility dominated the conversation. As alluded to earlier, this suggests that improved labelling by the government and/or food manufacturers such as adding dietary fibre to the traffic lights scheme on front-of-pack could help to bring dietary fibre to the forefront of consumers' minds. This insight is valuable as ensuring dietary fibre-rich white bread delivers on such components will encourage consumers to make the switch. There is widespread potential for this approach as white bread is the market leader in terms of bread sales in the UK [14,15].

Bread tasting

Finally, consumers tasted higher in dietary fibre white bread prototypes both to gain initial feedback as well as helping to overcome any potential concerns consumers might have relating to this concept. Positively, Minax-168 was consumers most preferred bread which demonstrates the

potential of our prototypes to fit into the white bread market. However, additional quantitative consumers insights (e.g., hedonic, acceptability and willingness to buy data, in-store supermarket trials, etc.) is warranted post further product development. More broadly, it was clear that consumers were able to notice the subtle differences between the three breads. For example, the dietary fibre-rich breads were characterised by visual, aroma and textural changes in most cases; accordingly, such breads will now be subject to various recipe improvements to address the cited issues. Overall, this supports the sensory profiling results to some extent which highlighted appearance modifications (e.g., colour differences) [21]. Going forwards, it is important that white bread is evaluated as it is commonly consumed (e.g., sandwich and toast forms) to ensure the prototypes match consumers' needs.

Importantly, the focus groups were conducted in two different locations in Reading including in an area of deprivation (Whitley) [48]. Therefore, future research should include focus groups in different parts of the UK to overcome any potential regional differences as well as including all stages of the lifecourse (e.g., from children to older adults). In addition, capturing socio-economic status information is also relevant to dietary fibre intake and white bread consumption; however, obtaining this data may result in some consumers not wishing to take part so a balance is needed to reach such communities.

Conclusion

This study conducted focus groups capturing initial background on dietary fibre to tasting white breads varying in dietary fibre content. Positively, this approach resonated with consumers subsequently enabling seven insightful sessions and the overall experience was considered educational in most cases. Overall, it was apparent that dietary fibre is not at the forefront of consumers' minds and dominant themes emerged in terms of knowledge (benefits, foods, recommendations, labelling), consumption (not measuring intake), barriers (convenience, knowledge), resources (education, public appeal) and topics (food examples, cooking). In addition, there was a positive reaction to staple foods being higher in dietary fibre; however, there was an expectation of no changes in terms of appearance, taste and cost. Consumers main bread types (e.g., white, wholemeal/brown and seeded breads) were as expected. More specifically, consumers noted that white bread is context driven (such as sandwich and toast), considered a comfort food, needs to be soft/fresh and consumption is fairly variable (daily to less often) as well as needing to

deliver on transparent/visible labelling for new dietary fibre-rich white breads. Overall, the newly-develop breads were well-received and Minax-168 was the most preferred by the consumers; thus, highlighting the potential of the initial prototypes. Moreover, a try before you buy scheme may help with enticing more sceptical consumers to make the switch as well as ensuring that the bread delivers on being cost effective, accessible from main supermarkets, nutritious and clearly labelled. Accordingly, this suggests there is a need to help consumers increase their dietary fibre-related knowledge via education (e.g., food-based examples, role of cooking and labelling) and a personalised element, which could lead to noteworthy public health implications. In addition, a collective effort from the government and food industry as well as the consumer is necessary to ensure a step-change in dietary fibre consumption at an individual and population level.

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Data availability

Data described in the manuscript and code book will be made available upon request.

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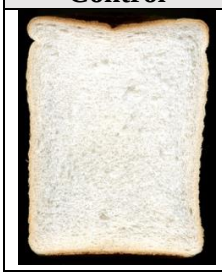
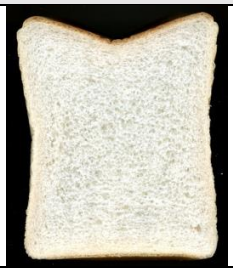
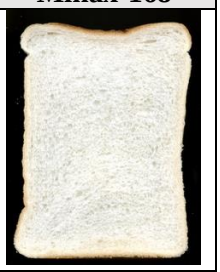
514 **Table 1.** Overview of scanned bread slices (scans reduced to 45%).

Control	Minax-100	Minax-168
		

515

516 **Table 2.** Summary of additional quotes within corresponding themes.

Theme	Quotes
Food choice	"*I try to balance everything the health, money, easy to cook & shelf-life*" F-23 "*towards the end of the month – you have £10 for three days – health may not come into it – it's just what can I eat for £10*" F-28
Dietary fibre knowledge and awareness	*"important for gut health but get a bit overwhelmed and confused with it all"* F-22 "*news to me that fibre did anything for your heart just purely digestive*" F-21 "*I am not sure I did realise there are dietary fibre recommendations in the UK*" M-70 "*if it is so good for you why is it not on the front?*" F-51
Dietary fibre consumption and engagement	"*I don't know what really contains fibre*" F-35 "*if you have kids running around and shopping you don't want to be there looking at the ingredients lists*" F-35 "*5-a-day is easy you can count on your fingers…bananas, peas, carrots, etc..*" M-59 "*information should be readily available not by accident*" F-40
Staple foods and bread types	"*if it's a price for everyone then that could work*" M-53 "*I would be wary as it's a change*" F-40 "*not dense - must keep softness!*" F-54 "*mine is white bread mainly as that was what I had growing up*" F-22 "*should I ignore the healthiness today and have white bread*" F-64 "*I would like it to be a natural process rather than it being injected*" M-30
Bread tasting	"*crust is tastier*" F-28 "*larger size – will it toast?"* F-70
Overall feedback	"*I didn't realise some of the foods had fibre*" M-70 "*I would consider trying or having more fibre*" F-22

517 **Table 3.** Summary of consumers key bread tasting comments and preference.

Themes	Control	Minax-100	Minax-168
Overall	STD white bread, nice, crust	Looks different/less attractive	Tastes like bread
Appearance	Off-white	Colour difference	Whiter
Aroma	Fresh	Smells different (sour)	Sour
Taste + flavour	Sweet, artificial	Salty, bland	Salty, sour, not sweet
Mouthfeel	Soft, sticky	Soft, stodgy/heavier, chewy, body, bubbles/scaly	Soft, springy
Preference*	15/42	8/42	19/42

518 *consumers (n = 42) were asked to select their most preferred bread.

519

520 **Figure 1**. Summary of the key areas covered during the focus group sessions.

521 **Figure 2.** Summary of consumers' key drivers in food choice.

522 **Figure 3.** Overview of consumers' key dietary fibre-related themes.

523 **Figure 4.** Overview of consumers' key white bread related trends.

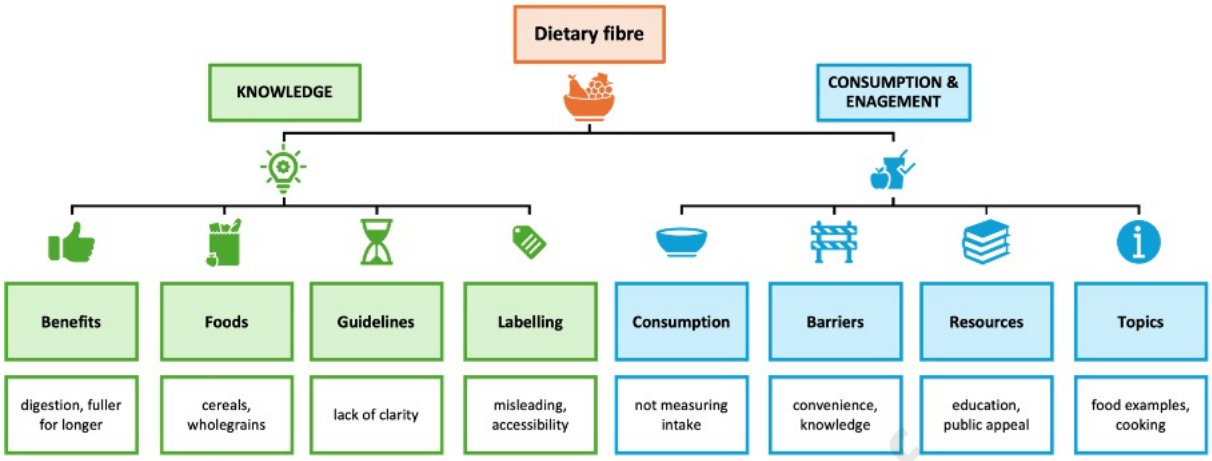
Cost
(price, value for money, discounts)

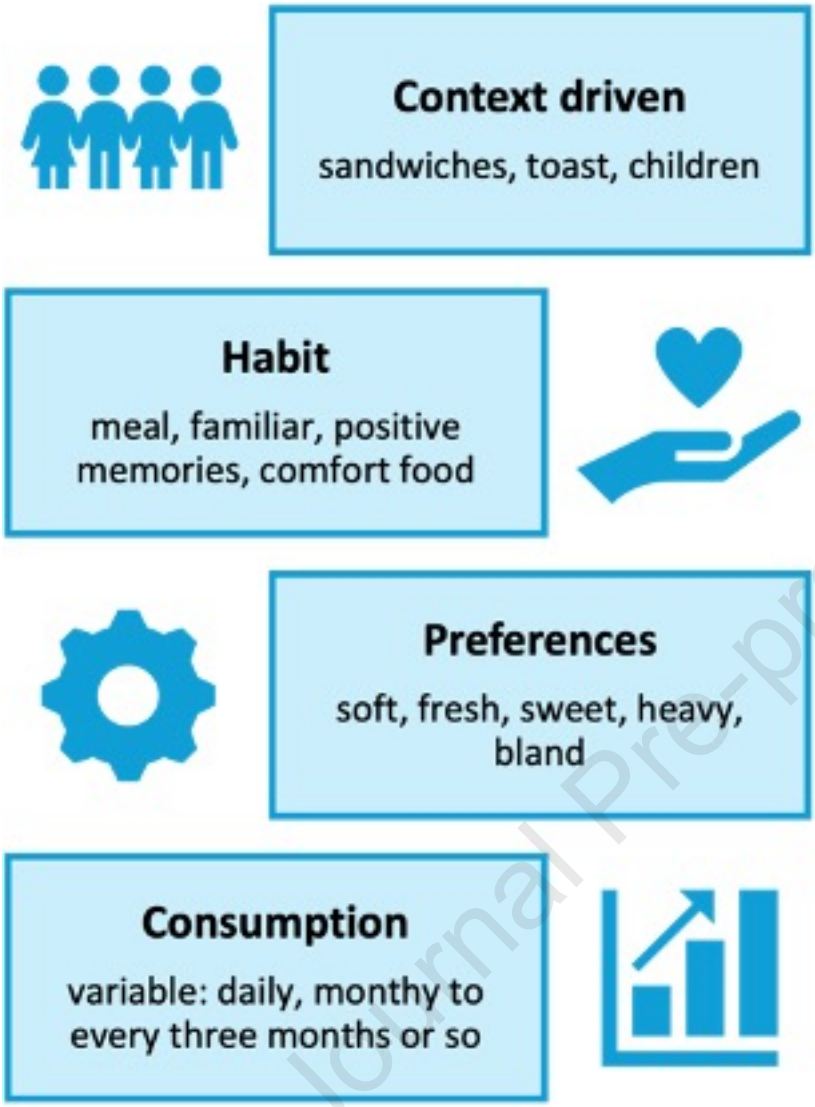
Convenience
(easy to cook, shelf-life, accessibility)

Nutrition + health
(ingredients, nutrients, processed)

Sensory
(appearance, taste, flavour)

Trust
(brands, family, friends, packaging)





bread as a viable solution to promote subsequent intake

Victoria Norton

FIGURES

Figure 1. Summary of the key areas covered during the focus group sessions.

Figure 2. Summary of consumers' key drivers in food choice.

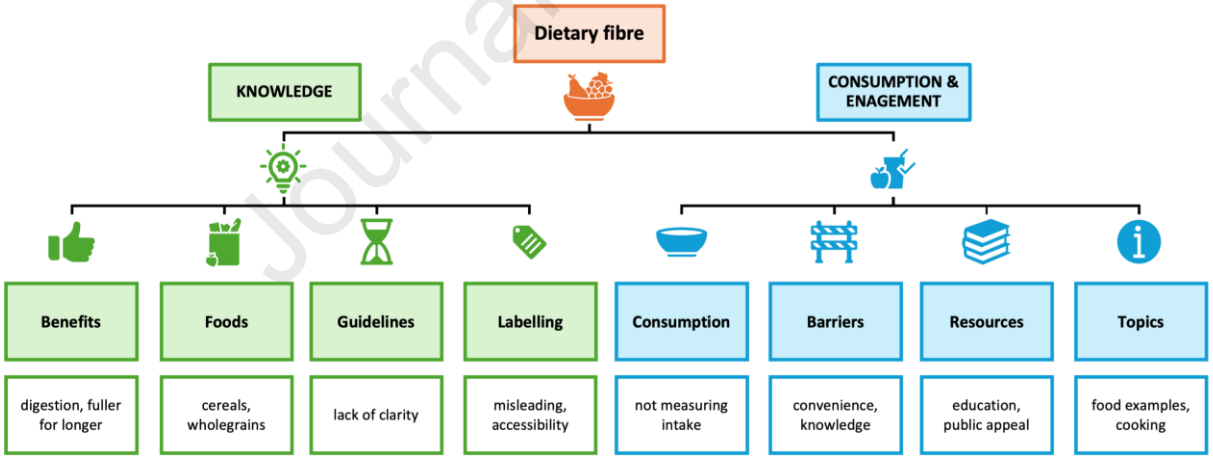


Figure 3. Overview of consumers' key dietary fibre-related themes.

bread as a viable solution to promote subsequent intake

Victoria Norton

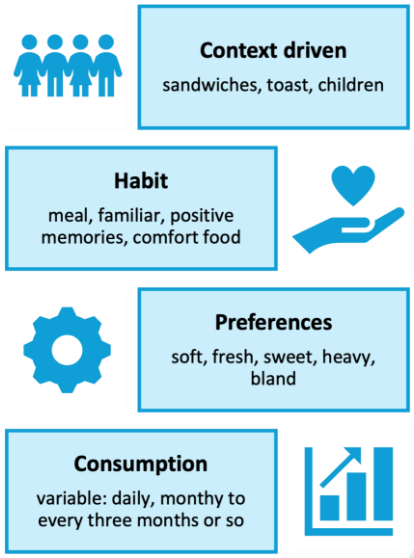


Figure 4. Overview of consumers' key white bread related trends.

bread as a viable solution to promote subsequent intake

Victoria Norton

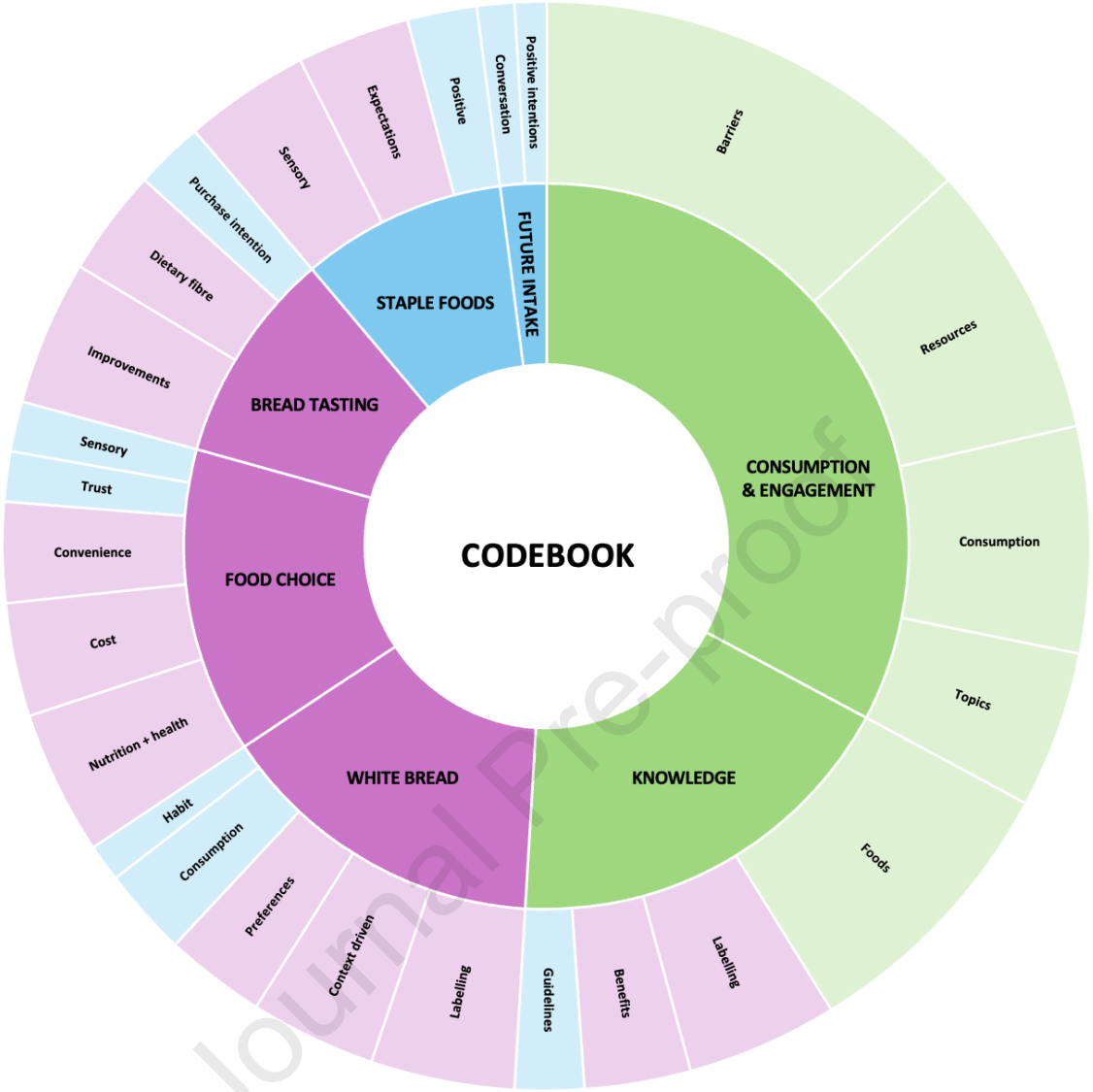


Figure S1. Codebook summary by overriding themes (high: more than 100 mentions (range: 120-188); medium: 50-99 mentions (range: 51-99); and low: less than 50 mentions (range: 11-43) and subsequent codes (high: more than 25 mentions (range: 25-71); medium: 15-25 mentions (range: 16-24); and low: less than 15 mentions (range: 5-14) by frequency (e.g., number of times mentioned by consumers).

Declaration of interests

☒ 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.

☐The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: